Appendix A

The Economics of Energy-Saving Features in Home Construction

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This appendix provides an economic analysis of various energy-saving options for new residential construction in Florida. The analysis is presented for a 1500-square-foot frame home described more fully in footnote A on page A-16. Three economic tools are used for evaluating the various energy choices.

The first tool is the determination of net cash flow through a comparison of increased mortgage payment with fuel savings. In this approach, the increased cost of the energy-saving item (for example, insulation, high-efficiency appliance, etc.) is converted to an increased mortgage payment (for a 10%-interest, 30-year loan) less the tax savings for a person in the 15% tax bracket. For applications which have an expected life of less than 30 years, the energy savings in the first year are reduced by a pro-rated system replacement cost. This can be thought of as an annual payment into an escrow account for the purchase of a new unit at the end of its life. Thus, the selected energy-saving option pays for the cost to perpetuate itself over the full 30-year mortgage period. The energy savings are also reduced by maintenance costs for those items expected to need repairs.

The net cash flow is the dollar value of the first year energy savings less the net added annual mortgage payment. If the net cash flow is positive, it is definitely a good deal for the customer. Even if it is negative, the cash flow may become positive after a number of years because of escalating fuel prices. Also keep in mind that since the energy savings are tax-free income, net first year cash flow is, in effect, larger than shown.

A second economic tool presented here is the simple payback period. This is calculated by dividing the cost of the energy feature by the first year fuel savings (less extra maintenance and repair costs). For example, if a heat pump costs $300 more than an air conditioner and saves $100 per year in heating costs compared to electric resistance heating, then the simple payback is 3.0 years. For items with a life expectancy of 15 years or more, a simple payback of less than 10 years is a reasonable option, and less than 7 years is very good. For items which have shorter life expectancy, a shorter payback period is necessary for the option to be considered a good choice. A general rule of thumb is that a simple payback period of less than half the item's life expectancy is a good choice.

The third economic analysis tool is internal rate of return on investment (IRRI). This more accurately reflects an item's economic merit because it takes into account the estimated year-to-year escalation in energy costs. For this analysis we assume the nominal fuel inflation rate is 5% per year. The IRRI can be thought of as the interest rate which an energy investment yields over its life (years of analysis is listed in parentheses next to the IRRI value).

If there are added maintenance and repair costs associated with the energy option, then the fuel savings is reduced by that amount in the calculation of IRRI. Also, if the owner sells the house before the end of the option's expected life, the actual rate of return on investment will be smaller. However, it is likely that at the time of sale the energy option will have market value that increases the selling price of the property. In fact, options having a very long life expectancy may appreciate in value as much as the house itself.

The IRRI should be compared to the return expected from a savings account or other investment. An energy option that has a return on investment of 10% or greater should be a reasonable choice for most home buyers. The fact that the energy savings (though not the interest from reinvesting the energy savings) is tax-free income

makes the yield even more favorable than comparable taxable investments. Following this text are tables of these ecomomic performance indicators for a large number of energy-saving features. Caution is advised in using these tables.

First, it should be noted that cost data for the various energy features is subject to considerable variation. This is because product and material costs vary widely, as do labor and contractor costs. If your costs are very different from the values in the tables, you can make calculations to correct for these differences. The net added annual mortgage cost (NAAMC) can be adjusted by a straight proportion method. For example, if your cost for a 2.5-ton, 11.0 SEER air conditioner (compared to a SEER of 8.0) is $700 while the table uses $500, then the NAAMC will be $700/$500 x $45.18 = $63.25. The net first year cash flow (NFYCF) will be reduced by the amount $63.25 - 45.18 = $18.07. The NFYCF of installing an 11.0 SEER rather than an 8.0 SEER air conditioner in central Florida would be reduced by $18.07, from $75.34 to $57.27.

The simple payback (SPB) period would be calculated by dividing the new added system cost by the first year savings (less maintenance costs) found in footnote 82 on page A-22. The simple payback period would increase from 5.4 years to 7.6 years ($700/92.00 = 7.6 years). The rate of return on investment can be calculated for 15- and 30-year life items by means of the following formulas (note that ln is natural log):

$$IRRI = 97.72 - 72.57 * \ln(SPB) + 20.52 \times (\ln(SPB))^2 - 2.35 \times (\ln(SPB))^3 \quad \text{(15 years)}$$

$$IRRI = 91.82 - 63.41 * \ln(SPB) + 16.67 \times (\ln(SPB))^2 - 1.617 \times (\ln(SPB))^3 \quad \text{(30 years)}$$

For life expectancies other than 15 and 30 years we provide no easy means for calculating the IRRI.

A second caution is that in Florida's climate, home space conditioning energy use is strongly dependent upon occupant behavior. Especially important are variations in thermostat setpoints in the cooling and heating seasons, the fraction of the year the house is ventilated, and how much internal heat is generated from appliances and people.

If in the cooling season you raise your thermostat from 78° to 82°F, your cooling energy use will typically drop by about 37%. In the winter, if you lower your thermostat from 72°F to 68°F your heating energy use drops by about 55%. How much you ventilate your house during the summer greatly affects energy use. If you keep your house closed all year and do not ventilate, your cooling energy use in central Florida will be 16% higher than if you cool only May through October, and 49% higher than if you cool only June through September. The generation of heat inside your home affects your space conditioning energy use. In our analysis we have assumed 50,807 Btu/day of sensible internal heat generation. If electricity use within your home (for lights, cooking, television, refrigeration, freezer, dishwasher, heated waterbed, etc.) or the number of people generating heat within your home is greater than our assumption, then your cooling energy will be higher and your space heating requirements will be lower.

The importance of these occupant behavior effects upon space conditioning energy use depends on the extent to which you use your home differently than our stated simulation assumptions (footnote A). If you keep your thermostat at 82°F in the summer, the return on investment for high-efficiency cooling equipment will be lower. If you keep your house at 68°F in the winter in central Florida, then a heat pump may have an 8.1 year simple payback compared to 2.9 years at 72°F setpoint. Therefore, while a 4°F reduction in thermostat setpoint in heating-dominated climates like Minnesota may cause less than a 15% reduction in the heating utility bill, in Florida it can cause a 50% difference.

A third caution is that heating season energy savings are based here upon the use of heat pump. If you use electric resistance heating, those options which reduce heating load (insulation, double-pane windows, etc.) will actually save considerably more than what is shown.

Window shading options are presented on pages A-5 through A-10, for south, central, and north Florida. These options are applied to an unshaded window and to a partially shaded window. The unshaded window is assumed to have no window blinds or curtains and no shading by adjacent vegetation and buildings. Having only an exterior insect screen over half the window area reduces solar radiation striking the window by about 20%. Relatively

few windows have no external shading and no blinds or curtains in use. However, if you have such windows, you will find several options listed which yield good rates of return on investment.

When the same analysis is done for a more typical window which has 20% external shading from vegetation or structures, 20% shading from an outside insect screen, and about 30% shading from the blinds or curtains, the energy savings will be only about 60% as great for the given shading options. However, double-pane windows achieve much of their energy savings by stemming heat losses during the winter and therefore are not very greatly affected by partial shading.

Some caution should be observed in the use of shading options. Keep in mind that shading options may affect your view of the outdoors, the appearance of your house, and the amount of daylight coming into your home. These may be unwanted side-effects of your attempts to cut cooling costs. They may also cause you to use more electric lighting when daylight is not adequate, which can reduce or eliminate the savings achieved by the windows.

Note that sunlight enters your house in two forms: diffuse and beam solar radiation. Diffuse light enters the window all day long while beam sunlight enters usually for only a few hours. Even though the beam radiation is much more intense, over a whole day the diffuse solar is nearly two-thirds of the total for a west window during the cooling season. The diffuse light is generally considered desirable because it provides light throughout the house. The beam radiation is often undesirable because it creates glare, overheats the room, and heats anyone in its path. For example, the impact of the sun upon a dining area with a west exposure can produce considerable discomfort during the evening meal.

Therefore, obstruction of beam radiation is the most important window shading requirement. Fixed shading options such as window tinting, reflective coatings, awnings, shade screen, and Bahama shutters block heat gain from beam radiation and also diffuse radiation. Flexible shading options such as window blinds can be used to block the beam solar during a few hours of the day and yet provide unobstructed view and maximum daylight during other hours of the day. White vertical blinds can produce a shading coefficient as low as 0.25. (However, keep in mind that dark blinds have a shading coefficient of only 0.59.) Properly located vegetation also can be used to obstruct direct sunlight but still admit diffuse daylight throughout the day and provide a good view.

The tables that follow provide an assessment of the economic benefit of energy options in new construction that have identifiable added cost and energy savings. These are by no means the only energy-saving measures that can be employed. Excluded from this analysis are items that do not have added costs, such as white-colored exterior walls. Also excluded are options that do not have readily identifiable costs and/or energy savings, such as planting vegetation for shading or insuring that the air handler and duct system are tightly sealed.

These tables are not designed for assessing energy changes to existing homes. The energy savings associated with retrofit options will be the same, but the costs of installing the options will generally be greater. In some cases the energy choice may be all but impossible in an existing home.

	Added Costs [B]	Net First Year Savings [C]	Net Added Annual Mortgage Cost [D]	Net First Year Cash Flow [E]	Simple Payback Period Years [F]	Rate of Return on Investment Percent [G] (System Life)
BUILDING ENVELOPE [A]						
Attic insulation & radiant barriers [H] **SOUTH FLORIDA**						
R-19 (fiberglass batts) -> R-30 (fiberglass batts)	$ 324 [I]	$ 24.64	$ 29.27	$ -4.63	13.2	11.7 (30)
R-19 (blown fiberglass) -> R-30 (blown fiberglass)	180 [J]	24.64	16.27	8.37	7.3	19.0 (30)
R-19 (batts) -> R-30 (blown fiberglass)	- 36	24.64	-3.41	28.05	<0	100+ (30)
R-19 (batts) -> R-30 (blown cellulose)	- 54 [K]	24.64	-4.88	29.52	<0	100+ (30)
R-19 -> R-19 + radiant barrier	325 [L]	46.88	29.36	17.52	6.9	19.9 (30)
R-30 -> R-30 + radiant barrier	325	30.83	29.36	1.47	10.5	14.2 (30)
Wall insulation (block construction)						
R-3 (fiberglass batt) -> R-8 (foil-faced foam board)	$ 277 [M]	$ 15.71	$ 25.03	$ -9.32	17.6	9.0 (30)
Wall insulation (frame construction)						
R-11 -> R-19 (foil-faced foam board exterior)	$ 324 [N]	$ 9.74	$ 29.27	$-19.53	33.3	4.3 (30)
Ceiling fans (6 fans)	$ 600	$137.62 [1]	$ 54.22	$ 73.40	4.4	29.0 (30)
(savings from setting thermostat from 78 to 82° during cooling season)						
Attic insulation & radiant barriers [H] **CENTRAL FLORIDA**						
R-19 (fiberglass batts) -> R-30 (fiberglass batts)	$ 324 [I]	$ 27.06	$ 29.27	$ -2.21	12.0	12.7 (30)
R-19 (blown fiberglass) -> R-30 (blown fiberglass)	180 [J]	27.06	16.27	10.79	6.7	20.5 (30)
R-19 (batts) -> R-30 (blown fiberglass)	- 36	27.06	-3.41	30.47	<0	100+ (30)
R-19 (batts) -> R-30 (blown cellulose)	- 54 [K]	27.06	-4.88	31.94	<0	100+ (30)
R-19 -> R-19 + radiant barrier	325 [L]	49.28	29.36	19.92	6.6	20.7 (30)
R-30 -> R-30 + radiant barrier	325	31.34	29.36	1.98	10.4	14.3 (30)
Wall insulation (block construction)						
R-3 (fiberglass batt) -> R-8 (foil-faced foam board)	$ 277 [M]	$ 22.26	$ 25.03	$ -2.77	12.4	12.3 (30)
Wall insulation (frame construction)						
R-11 -> R-19 (foil-faced foam board exterior)	$ 324 [N]	$ 13.95	$ 29.27	$-15.32	23.2	6.8 (30)
Ceiling fans (6 fans)	$ 600	$ 95.90 [2]	$ 54.22	$ 31.68	6.3	21.6 (30)
(savings from setting thermostat from 78 to 82° during cooling season)						
Attic insulation & radiant barriers [H] **NORTH FLORIDA**						
R-19 (fiberglass batts) -> R-30 (fiberglass batts)	$ 324 [I]	$ 27.57	$ 29.27	$ -1.70	11.8	12.9 (30)
R-19 (blown fiberglass) -> R-30 (blown fiberglass)	180 [J]	27.57	16.27	11.30	6.5	20.9 (30)
R-19 (batts) -> R-30 (blown fiberglass)	- 36	27.57	-3.41	30.98	<0	100+ (30)
R-19 (batts) -> R-30 (blown cellulose)	- 54 [K]	27.57	-4.88	32.45	<0	100+ (30)
R-19 -> R-19 + radiant barrier	325 [L]	48.00	29.36	18.64	6.8	20.2 (30)
R-30 -> R-30 + radiant barrier	325	30.61	29.36	1.25	10.6	14.2 (30)
Wall insulation (block construction)						
R-3 (fiberglass batt) -> R-8 (foil-faced foam board)	$ 277 [M]	$ 29.08	$ 29.08	$ 4.05	9.5	15.4 (30)
Wall insulation (frame construction)						
R-11 -> R-19 (foil-faced foam board exterior)	$ 324 [N]	$ 16.46	$ 29.27	$-12.81	19.7	8.1 (30)
Ceiling fans (6 fans)	$ 600	$ 85.86 [3]	$ 54.22	$ 21.64	7.0	19.7 (30)
(savings from setting thermostat from 78 to 82° during cooling season)						

	Added Costs [B]	Net First Year Savings [C]	Net Added Annual Mortgage Cost [D]	Net First Year Cash Flow [E]	Simple Payback Period Years [F]	Rate of Return on Investment Percent [G] (System Life)
WINDOW OPTIONS (savings compared to unshaded clear windows with with insect screen on 50% of window, SC=0.80, 100 ft^2 area) [O,P]						
South Florida						
Tinted glass (SC = .85)	$ 190					
South		$ 9.92	$ 17.17	$ -7.25	19.2	8.3 (30)
North		8.16	17.17	-9.01	23.3	6.4 (30)
East/West		11.28	17.17	-5.89	16.8	9.2 (30)
Reflective glass (SC = .51)	$ 190					
South		$ 32.16	$ 17.17	$ 14.99	5.9	22.5 (30)
North		26.64	17.17	9.47	7.1	19.5 (30)
East/West		36.56	17.17	19.39	5.2	24.9 (30)
Double pane (clear) (SC = .91)	$ 250					
South		$ 4.88	$ 22.59	$ -17.71	51.2	1.6 (30)
North		3.92	22.59	-18.67	63.8	0.7 (30)
East/West		5.68	22.59	-16.91	44.0	2.4 (30)
Double pane (tinted) (SC = .71)	$ 375					
South		$ 18.08	$ 33.88	$ -15.80	20.7	7.3 (30)
North		14.80	33.88	-19.08	25.3	5.7 (30)
East/West		20.64	33.88	-13.24	18.2	8.5 (30)
Double pane (reflective)(SC = .42)	$ 500					
South		$ 37.04	$ 45.18	$ -8.14	13.5	11.5 (30)
North		30.48	45.18	-14 70	16.4	9.5 (30)
East/West		42.24	45.18	-2.94	11.8	12.9 (30)
Solar screen (SC = .36) [I]	$ 300					
South		$ 31.24 [4]	$ 27.11	$ 4.13	8.3	16.0 (20)
North		25.00 [5]	27.11	-2.11	10.0	13.1 (20)
East/West		36.20 [6]	27.11	9.09	7.3	18.0 (20)
Bahama shutters (SC = .42)	$ 600					
South		$ 27.92 [7]	$ 54.22	$ -26.30	21.5	7.4 (30)
North		21.44 [8]	54.22	-32.78	28.0	5.5 (30)
East/West		33.12 [9]	54.22	-21.10	18.1	8.8 (30)
Metal awnings (SC = .31)	$ 750					
South		$ 45.36 [10]	$ 67.77	$-22.41	16.5	9.6 (30)
North		37.52 [11]	67.77	-30.25	20.0	8.0 (30)
East/West		51.52 [12]	67.77	-16.25	14.6	10.8 (30)
Fabric awnings (SC = .35)	$ 900					
South		$-20.12 [13]	$ 81.32	$-101.44	32.3	<0 (12)
North		-27.48 [14]	81.32	-108.80	43.9	<0 (12)
East/West		-14.28 [15]	81.32	-95.60	26.7	<0 (12)

	Added Costs [B]	Net First Year Savings [C]	Net Added Annual Mortgage Cost [D]	Net First Year Cash Flow [E]	Simple Payback Period Years [F]	Rate of Return on Investment Percent [G] (System Life)
WINDOW OPTIONS (savings compared to unshaded clear windows with insect screen on 50% of window, SC=0.80, 100 ft^2 area) [O,P]						
Central Florida						
Tinted glass (SC = .85)	$ 190					
South		$ 6.08	$ 17.17	$ -11.09	31.3	4.3 (30)
North		6.16	17.17	-11.01	30.8	4.4 (30)
East/West		8.00	17.17	-9.17	23.8	6.2 (30)
Reflective glass (SC = .51)	$ 190					
South		$ 19.76	$ 17.17	$ 2.59	9.6	15.4 (30)
North		20.00	17.17	2.83	9.5	15.6 (30)
East/West		26.08	17.17	8.91	7.3	19.2 (30)
Double pane (clear) (SC = .91)	$ 250					
South		$ 18.72	$ 22.59	$ -3.87	13.4	11.6 (30)
North		18.80	22.59	-3.79	13.3	11.6 (30)
East/West		19.92	22.59	-2.67	12.6	12.3 (30)
Double pane (tinted) (SC = .71)	$ 375					
South		$ 26.88	$ 33.88	$ -7.00	14.0	11.2 (30)
North		27.04	33.88	-6.84	13.9	11.2 (30)
East/West		30.56	33.88	-3.32	12.3	12.5 (30)
Double pane (reflective) (SC = .42)	$ 500					
South		$ 38.48	$ 45.18	$ -6.70	13.0	11.9 (30)
North		38.80	45.18	-6 38	12.9	11.9 (30)
East/West		46.00	45.18	.82	10.9	13.9 (30)
Solar screen (SC = .36) [I]	$ 300					
South		$ 17.24 [16]	$ 27.11	$ -9.87	13.5	9.3 (20)
North		17.56 [17]	27.11	-9.55	13.3	9.5 (20)
East/West		24.44 [18]	27.11	-2.67	10.2	12.9 (20)
Bahama shutters (SC = .42)	$ 600					
South		$ 13.28 [19]	$ 54.22	$ -40.94	45.2	2.4 (30)
North		13.60 [20]	54.22	-40.62	44.1	2.6 (30)
East/West		20.72 [21]	54.22	-33.50	29.0	5.2 (30)
Metal awnings (SC = .31)	$ 750					
South		$ 27.84 [22]	$ 67.77	$-39.93	26.9	5.7 (30)
North		28.24 [23]	67.77	-39.53	26.6	5.8 (30)
East/West		36.80 [24]	67.77	-30.97	20.4	7.8 (30)
Fabric awnings (SC = .35)	$ 900					
South		$-36.68 [25]	$ 81.32	$-118.00	79.5	<0 (12)
North		-36.28 [26]	81.32	-117.60	76.8	<0 (12)
East/West		-28.20 [27]	81.32	-109.52	45.5	<0 (12)

	Added Costs [B]	Net First Year Savings [C]	Net Added Annual Mortgage Cost [D]	Net First Year Cash Flow [E]	Simple Payback Period Years [F]	Rate of Return on Investment Percent [G] (System Life)
WINDOW OPTIONS (savings compared to unshaded clear windows with insect screen on 50% of window, SC=0.80, 100 ft^2 area) [O,P]						
North Florida						
Tinted glass (SC = .85)	$ 190					
South		$ 3.84	$ 17.17	$ -13.33	49.5	1.8 (30)
North		4.64	17.17	-12.53	40.9	2.7 (30)
East/West		5.68	17.17	-11.49	33.5	3.9 (30)
Reflective glass (SC = .51)	$ 190					
South		$ 12.40	$ 17.17	$ -4.77	15.3	10.1 (30)
North		15.20	17.17	-1.97	12.5	12.3 (30)
East/West		18.48	17.17	1.31	10.3	14.6 (30)
Double pane (clear) (SC = .91)	$ 250					
South		$ 29.52	$ 22.59	$ 6.93	8.5	17.1 (30)
North		31.68	22.59	9.09	7.9	18.1 (30)
East/West		30.96	22.59	8.37	8.1	17.7 (30)
Double pane (tinted) (SC = .71)	$ 375					
South		$ 33.92	$ 33.88	$ .04	11.1	13.7 (30)
North		37.92	33.88	4.04	9.9	15.1 (30)
East/West		38.48	33.88	4.60	9.7	15.3 (30)
Double pane (reflective) (SC = .42)	$ 500					
South		$ 40.16	$ 45.18	$ -5.02	12.5	12.3 (30)
North		46.88	45.18	1 70	10.7	14.2 (30)
East/West		49.44	45.18	4.26	10.1	14.8 (30)
Solar screen (SC = .36) [I]	$ 300					
South		$ 9.00 [28]	$ 27.11	$ -18.11	21.4	4.3 (20)
North		12.04 [29]	27.11	-15.07	17.6	6.3 (20)
East/West		15.96 [30]	27.11	-11.15	14.3	8.6 (20)
Bahama shutters (SC = .42)	$ 600					
South		$ 4.64 [31]	$ 54.22	$ -49.58	100+	<0 (30)
North		7.84 [32]	54.22	-46.38	76.5	<0 (30)
East/West		11.92 [33]	54.22	-42.30	50.3	1.8 (30)
Metal awnings (SC = .31)	$ 750					
South		$ 17.44 [34]	$ 67.77	$-50.33	43.0	2.7 (30)
North		21.44 [35]	67.77	-46.33	35.0	4.0 (30)
East/West		26.08 [36]	67.77	-41.69	28.8	5.3 (30)
Fabric awnings (SC = .35)	$ 900					
South		$-46.44 [37]	$ 81.32	$-127.76	100+	<0 (12)
North		-42.76 [38]	81.32	-124.08	100+	<0 (12)
East/West		-38.44 [39]	81.32	-119.76	94.1	<0 (12)

	Added Costs [B]	Net First Year Savings [C]	Net Added Annual Mortgage Cost [D]	Net First Year Cash Flow [E]	Simple Payback Period Years [F]	Rate of Return on Investment Percent [G] (System Life)
WINDOW OPTIONS (savings compared to clear windows with screen which has 20% exterior shading and some use of blinds or curtains; SC=0.50, 100 ft^2 area) [O,Q]						
South Florida						
Tinted glass (SC = .85)	$ 190					
South		$ 5.76	$ 17.17	$ -11.41	33.0	3.9 (30)
North		4.80	17.17	-12.37	39.6	2.9 (30)
East/West		6.56	17.17	-10.61	29.0	4.8 (30)
Reflective glass (SC = .51)	$ 190					
South		$ 18.96	$ 17.17	$ 1.79	10.0	14.9 (30)
North		15.68	17.17	-1.49	12.1	12.7 (30)
East/West		21.52	17.17	4.35	8.8	16.5 (30)
Double pane (clear) (SC = .91)	$ 250					
South		$ 1.60	$ 22.59	$ -20.99	156.3	<0 (30)
North		1.12	22.59	-21.47	223.2	<0 (30)
East/West		1.92	22.59	-20.67	130.2	<0 (30)
Double pane (tinted) (SC = .71)	$ 375					
South		$ 9.04	$ 33.88	$ -24.84	41.5	2.6 (30)
North		7.36	33.88	-26.52	51.0	1.5 (30)
East/West		10.40	33.88	-23.48	36.1	3.5 (30)
Double pane (reflective) (SC = .42)	$ 500					
South		$ 23.84	$ 45.18	$ -21.34	21.0	7.3 (30)
North		16.88	45.18	-28 30	29.6	4.7 (30)
East/West		27.20	45.18	-17.98	18.4	8.4 (30)
Solar screen (SC = .36) [I]	$ 300					
South		$ 18.04 [40]	$ 27.11	$ -9.07	13.0	9.7 (20)
North		14.12 [41]	27.11	-12.99	15.7	7.6 (20)
East/West		21.24 [42]	27.11	-5.87	11.4	11.3 (20)
Bahama shutters (SC = .42)	$ 600					
South		$ 14.72 [43]	$ 54.22	$ -39.50	40.8	3.0 (30)
North		10.48 [44]	54.22	-43.74	57.3	1.1 (30)
East/West		18.08 [45]	54.22	-36.14	33.2	4.3 (30)
Metal awnings (SC = .31)	$ 750					
South		$ 28.88 [46]	$ 67.77	$-38.89	26.0	6.0 (30)
North		23.92 [47]	67.77	-43.85	31.4	4.7 (30)
East/West		32.90 [48]	67.77	-34.87	22.9	6.9 (30)
Fabric awnings (SC = .35)	$ 900					
South		$-35.80 [49]	$ 81.32	$-117.12	73.8	<0 (12)
North		-40.44 [50]	81.32	-121.76	100+	<0 (12)
East/West		-32.04 [51]	81.32	-113.36	56.4	1.1 (12)

	Added Costs [B]	Net First Year Savings [C]	Net Added Annual Mortgage Cost [D]	Net First Year Cash Flow [E]	Simple Payback Period Years [F]	Rate of Return on Investment Percent [G] (System Life)
WINDOW OPTIONS (savings compared to clear windows with screen which has 20% exterior shading and some use of blinds or curtains; SC=0.50, 100 ft^2 area) [O,Q]						
Central Florida						
Tinted glass (SC = .85)	$ 190					
South		$ 3.52	$ 17.17	$ -13.65	54.0	1.4 (30)
North		3.60	17.17	-13.57	52.8	1.5 (30)
East/West		4.72	17.17	-12.45	40.3	2.8 (30)
Reflective glass (SC = .51)	$ 190					
South		$ 11.68	$ 17.17	$ -5.49	16.3	9.6 (30)
North		11.84	17.17	-5.33	16.0	9.7 (30)
East/West		15.36	17.17	-1.81	12.4	12.4 (30)
Double pane (clear) (SC = .91)	$ 250					
South		$ 16.72	$ 22.59	$ -5.87	15.0	10.4 (30)
North		16.72	22.59	-5.87	15.0	10.4 (30)
East/West		17.20	22.59	-5.39	14.5	10.7 (30)
Double pane (tinted) (SC = .71)	$ 375					
South		$ 21.28	$ 33.88	$ -12.60	17.6	8.8 (30)
North		21.36	33.88	-12.52	17.6	8.8 (30)
East/West		23.20	33.88	-10.68	16.2	9.6 (30)
Double pane (reflective) (SC = .42)	$ 500					
South		$ 31.92	$ 45.18	$ -13.26	15.7	9.9 (30)
North		28.56	45.18	-16 62	17.5	8.8 (30)
East/West		32.56	45.18	-12.62	15.4	10.1 (30)
Solar screen (SC = .36) [I]	$ 300					
South		$ 9.16 [52]	$ 27.11	$ -17.95	21.2	4.4 (20)
North		9.40 [53]	27.11	-17.71	20.8	4.6 (20)
East/West		13.72 [54]	27.11	-13.39	16.0	7.3 (20)
Bahama shutters (SC = .42)	$ 600					
South		$ 5.20 [55]	$ 54.22	$ -49.02	39.5	3.2 (30)
North		5.44 [56]	54.22	-48.78	38.9	3.3 (30)
East/West		10.08 [57]	54.22	-44.14	29.9	5.0 (30)
Metal awnings (SC = .31)	$ 750					
South		$ 17.76 [58]	$ 67.77	$-50.01	42.2	2.8 (30)
North		18.00 [59]	67.77	-49.77	41.7	2.9 (30)
East/West		23.44 [60]	67.77	-44.33	32.0	4.6 (30)
Fabric awnings (SC = .35)	$ 900					
South		$-46.28 [61]	$ 81.32	$-127.60	100+	<0 (12)
North		-46.04 [62]	81.32	-127.36	100+	<0 (12)
East/West		-40.92 [63]	81.32	-122.24	100+	<0 (12)

	Added Costs [B]	Net First Year Savings [C]	Net Added Annual Mortgage Cost [D]	Net First Year Cash Flow [E]	Simple Payback Period Years [F]	Rate of Return on Investment Percent [G] (System Life)
WINDOW OPTIONS (savings compared to clear windows with screen which has 20% exterior shading and some use of blinds or curtains; SC=0.50, 100 ft^2 area) [O,Q]						
North Florida						
Tinted glass (SC = .85)	$ 190					
South		$ 2.24	$ 17.17	$ -14.93	84.8	<0 (30)
North		2.64	17.17	-14.53	72.0	0.4 (30)
East/West		3.20	17.17	-13.97	59.4	1.1 (30)
Reflective glass (SC = .51)	$ 190					
South		$ 7.36	$ 17.17	$ -9.81	25.8	5.6 (30)
North		8.96	17.17	-8.21	21.2	7.3 (30)
East/West		10.88	17.17	-6.29	17.5	8.9 (30)
Double pane (clear) (SC = .91)	$ 250					
South		$ 24.80	$ 22.59	$ 5.81	8.8	16.6 (30)
North		30.16	22.59	7.57	8.3	17.4 (30)
East/West		29.04	22.59	6.45	8.6	16.9 (30)
Double pane (tinted) (SC = .71)	$ 375					
South		$ 30.88	$ 33.88	$ -3.00	12.1	12.6 (30)
North		33.60	33.88	-.28	11.2	13.6 (30)
East/West		33.28	33.88	-.60	11.3	13.5 (30)
Double pane (reflective) (SC = .42)	$ 500					
South		$ 34.72	$ 45.18	$ -10.46	14.4	10.8 (30)
North		39.12	45.18	-6.06	12.8	12.1 (30)
East/West		39.92	45.18	-5.26	12.5	12.3 (30)
Solar screen (SC = .36) [I]	$ 300					
South		$ 3.96 [64]	$ 27.11	$ -23.15	33.5	0.3 (20)
North		5.96 [65]	27.11	-21.15	27.4	2.0 (20)
East/West		8.36 [66]	27.11	-18.75	22.5	3.9 (20)
Bahama shutters (SC = .42)	$ 600					
South		$ -.40 [67]	$ 54.22	$ -54.62	100+	<0 (30)
North		1.76 [68]	54.22	-52.46	100+	<0 (30)
East/West		4.32 [69]	54.22	-49.90	100+	<0 (30)
Metal awnings (SC = .31)	$ 750					
South		$ 11.20 [70]	$ 67.77	$ -56.57	67.0	0.2 (30)
North		13.60 [71]	67.77	-54.17	55.2	1.3 (30)
East/West		16.56 [72]	67.77	-51.21	45.3	2.4 (30)
Fabric awnings (SC = .35)	$ 900					
South		$-52.44 [73]	$ 81.32	$ -133.76	100+	<0 (12)
North		-50.20 [74]	81.32	-131.52	100+	<0 (12)
East/West		-47.40 [75]	81.32	-128.72	100+	<0 (12)

	Added Costs [B]	Net First Year Savings [C]	Net Added Annual Mortgage Cost [D]	Net First Year Cash Flow [E]	Simple Payback Period Years [F]	Rate of Return on Investment Percent [G] (System Life)
SPACE CONDITIONING EQUIPMENT [R]						
Air conditioner (South Florida)						
SEER						
8.0 -> 9.0	$ 175	$ 45.17 [76]	$ 15.81	$ 29.36	3.4	35.0 (15)
8.0 -> 10.0	350	80.34 [77]	31.63	48.71	3.8	31.8 (15)
8.0 -> 11.0	500	109.34 [78]	45.18	64.16	4.0	30.3 (15)
8.0 -> 12.0	600	134.00 [79]	54.22	79.78	3.9	31.1 (15)
Air conditioner (Central Florida)						
SEER						
8.0 -> 9.0	$ 175	$ 31.17 [80]	$ 15.81	$ 15.36	4.7	25.6 (15)
8.0 -> 10.0	350	55.34 [81]	31.63	23.71	5.2	23.4 (15)
8.0 -> 11.0	500	75.39 [82]	45.18	30.15	5.4	22.5 (15)
8.0 -> 12.0	600	92.00 [83]	54.22	37.78	5.4	22.6 (15)
Air conditioner (North Florida)						
SEER						
8.0 -> 9.0	$ 175	$ 27.17 [84]	$ 15.81	$ 11.36	5.3	22.9 (15)
8.0 -> 10.0	350	47.34 [85]	31.63	15.71	5.9	20.5 (15)
8.0 -> 11.0	500	63.33 [86]	45.18	18.18	6.3	19.2 (15)
8.0 -> 12.0	600	78.00 [87]	54.22	23.78	6.1	19.6 (15)
Incremental Comparisons						
Air conditioner (South Florida)						
SEER						
8.0 -> 9.0	$ 175	$ 45.17 [88]	$ 15.81	$ 29.36	3.4	35.0 (15)
9.0 -> 10.0	175	35.17 [89]	15.81	19.36	4.3	28.4 (15)
10.0 -> 11.0	150	29.00 [90]	13.56	15.44	4.4	27.5 (15)
11.0 -> 12.0	100	24.67 [91]	9.03	15.64	3.6	33.8 (15)
Air conditioner (Central Florida)						
SEER						
8.0 -> 9.0	$ 175	$ 31.17 [92]	$ 15.81	$ 15.36	4.7	25.6 (15)
9.0 -> 10.0	175	24.16 [93]	15.81	8.35	5.8	20.6 (15)
10.0 -> 11.0	150	20.00 [94]	13.56	6.44	6.0	20.1 (15)
11.0 -> 12.0	100	16.67 [95]	9.03	7.64	5.0	24.3 (15)
Air conditioner (North Florida)						
SEER						
8.0 -> 9.0	$ 175	$ 27.16 [96]	$ 15.81	$ 11.35	5.3	22.9 (15)
9.0 -> 10.0	175	20.16 [97]	15.81	4.35	6.7	17.7 (15)
10.0 -> 11.0	150	16.00 [98]	13.56	2.44	7.1	16.5 (15)
11.0 -> 12.0	100	14.67 [99]	9.03	5.64	5.6	21.8 (15)

	Added Costs [B]	Net First Year Savings [C]	Net Added Annual Mortgage Cost [D]	Net First Year Cash Flow [E]	Simple Payback Period Years [F]	Rate of Return on Investment Percent [G] (System Life)
Heat pump (South Florida)						
SEER/COP						
8.0/2.7 -> 9.0/2.9	$ 175	$ 46.17 [100]	$ 15.81	$ 30.36	3.4	35.8 (15)
8/0/2.7 -> 10.0/3.0	400	79.66 [101]	36.14	43.52	4.3	28.3 (15)
8.0/2.7 -> 11.0.3.2	600	108.00 [102]	54.22	53.78	4.7	26.0 (15)
8.0/2.7 -> 12.0/3.3	750	131.00 [103]	67.76	63.24	4.8	25.3 (15)
Heat pump (Central Florida)						
SEER/COP						
8.0/2.7 -> 9.0/2.9	$ 175	$ 35.16 [104]	$ 15.81	$ 19.35	4.3	28.3 (15)
8/0/2.7 -> 10.0/3.0	400	59.33 [105]	36.14	23.19	5.5	22.0 (15)
8.0/2.7 -> 11.0.3.2	600	81.00 [106]	54.22	26.78	5.9	20.5 (15)
8.0/2.7 -> 12.0/3.3	750	98.00 [107]	67.76	30.24	6.1	19.7 (15)
Heat pump (North Florida)						
SEER/COP						
8.0/2.7 -> 9.0/2.9	$ 175	$ 34.16 [108]	$ 15.81	$ 18.35	4.4	27.6 (15)
8/0/2.7 -> 10.0/3.0	400	55.66 [109]	36.14	19.52	5.8	20.8 (15)
8.0/2.7 -> 11.0.3.2	600	75.00 [110]	54.22	20.78	6.3	19.1 (15)
8.0/2.7 -> 12.0/3.3	750	91.00 [111]	67.76	23.24	6.5	18.4 (15)
Incremental Comparisons						
Heat pump (South Florida)						
SEER/COP						
8.0/2.7 -> 9.0/2.9	$ 175	$ 46.17 [112]	$ 15.81	$ 30.36	3.4	35.4 (15)
9.0/2.9 -> 10.0/3.0	225	33.50 [113]	20.33	13.17	5.5	22.0 (15)
10.0/3.0 -> 11.0.3.2	200	28.33 [114]	18.07	10.26	5.7	21.2 (15)
11.0/3.2 -> 12.0/3.3	150	23.00 [115]	13.56	9.44	5.4	22.5 (15)
Heat pump (Central Florida)						
SEER/COP						
8.0/2.7 -> 9.0/2.9	$ 175	$ 35.16 [116]	$ 15.81	$ 19.35	4.3	28.3 (15)
9/0/2.9 -> 10.0/3.0	225	24.50 [117]	20.33	4.17	7.0	16.9 (15)
10.0/3.0 -> 11.0.3.2	200	21.33 [118]	18.07	3.26	7.1	16.7 (15)
11.0/3.2 -> 12.0/3.3	150	17.00 [119]	13.56	3.44	6.8	17.5 (15)
Heat pump (North Florida)						
SEER/COP						
8.0/2.7 -> 9.0/2.9	$ 175	$ 34.16 [120]	$ 15.81	$ 18.35	4.4	27.6 (15)
9/0/2.9 -> 10.0/3.0	225	21.50 [121]	20.33	1.17	7.8	14.9 (15)
10.0/3.0 -> 11.0.3.2	200	19.33 [122]	18.07	1.26	7.7	15.1 (15)
11.0/3.2 -> 12.0/3.3	150	16.00 [123]	13.56	2.44	7.1	16.7 (15)

	Added Costs [B]	Net First Year Savings [C]	Net Added Annual Mortgage Cost [D]	Net First Year Cash Flow [E]	Simple Payback Period Years [F]	Rate of Return on Investment Percent [G] (System Life)
Heat pump vs. AC with elec. resis. heat (South Florida)						
AC SEER ---> HP SEER/COP						
8.0 ---> 8.0/2.7	$ 300	$ 11.00 [124]	$ 27.10	$-16.10	14.3	5.7 (15)
8.0 ---> 9.0/2.9	525	55.50 [125]	47.44	8.06	7.2	16.4 (15)
8.0 ---> 10.0/3.0	750	89.00 [126]	67.76	21.24	6.6	18.1 (15)
8.0 ---> 11.0/3.2	1000	115.67 [127]	90.36	25.31	6.7	17.8 (15)
8.0 ---> 12.0/3.3	1200	137.00 [128]	108.43	28.57	6.8	17.5 (15)
Heat pump vs. AC with elec. resis. heat (Central Florida)						
AC SEER ---> HP SEER/COP						
8.0 ---> 8.0/2.7	$ 300	$ 94.00 [129]	$ 27.10	$ 66.90	2.9	40.9 (15)
8.0 ---> 9.0/2.9	525	127.50 [130]	47.44	80.06	3.6	33.5 (15)
8.0 ---> 10.0/3.0	750	152.00 [131]	67.76	84.24	4.2	28.9 (15)
8.0 ---> 11.0/3.2	1000	171.67 [132]	90.36	81.31	4.9	24.8 (15)
8.0 ---> 12.0/3.3	1200	187.00 [133]	108.43	78.57	5.3	22.9 (15)
Heat pump vs. AC with elec. resis. heat (North Florida)						
AC SEER ---> HP SEER/COP						
8.0 ---> 8.0/2.7	$ 300	$163.00 [134]	$ 27.10	$135.90	1.7	65.6 (15)
8.0 ---> 9.0/2.9	525	195.50 [135]	47.44	148.06	2.5	47.2 (15)
8.0 ---> 10.0/3.0	750	217.00 [136]	67.76	149.24	3.1	38.5 (15)
8.0 ---> 11.0/3.2	1000	234.67 [137]	90.36	144.31	3.7	32.7 (15)
8.0 ---> 12.0/3.3	1200	249.00 [138]	108.43	140.57	4.2	28.9 (15)
Incremental Comparisons						
Heat pump vs. AC with elec. resis. heat (South Florida)						
AC SEER ---> HP SEER/COP						
8.0 ---> 8.0/2.7	$ 300	$ 11.00 [139]	$ 27.10	$-16.10	14.3	5.7 (15)
9.0 ---> 9.0/2.9	350	10.33 [140]	31.63	-21.30	15.9	4.3 (15)
10.0 ---> 10.0/3.0	400	8.67 [141]	36.14	-27.47	18.2	2.6 (15)
11.0 ---> 11.0/3.2	500	6.33 [142]	45.18	-38.85	21.7	0.4 (15)
12.0 ---> 12.0/3.3	600	3.00 [143]	54.22	-51.22	26.1	< 0 (15)
Heat pump vs. AC with elec. resis. heat (Central Florida)						
AC SEER ---> HP SEER/COP						
8.0 ---> 8.0/2.7	$ 300	$ 94.00 [144]	$ 27.10	$ 66.90	2.9	40.9 (15)
9.0 ---> 9.0/2.9	350	96.33 [145]	31.63	64.70	3.2	37.4 (15)
10.0 ---> 10.0/3.0	400	96.67 [146]	36.14	60.53	3.6	33.5 (15)
11.0 ---> 11.0/3.2	500	96.33 [147]	45.18	51.15	4.4	27.6 (15)
12.0 ---> 12.0/3.3	600	95.00 [148]	54.22	40.78	5.2	23.4 (15)
Heat pump vs. AC with elec. resis. heat (North Florida)						
AC SEER ---> HP SEER/COP						
8.0 ---> 8.0/2.7	$ 300	$163.00 [149]	$ 27.10	$135.90	1.7	65.6 (15)
9.0 ---> 9.0/2.9	350	168.33 [150]	31.63	136.70	1.9	59.0 (15)
10.0 ---> 10.0/3.0	400	169.67 [151]	36.14	133.53	2.2	52.1 (15)
11.0 ---> 11.0/3.2	500	171.33 [152]	45.18	126.15	2.7	43.6 (15)
12.0 ---> 12.0/3.3	600	171.00 [153]	54.22	116.78	3.1	38.5 (15)
Gas heat vs. elec. resis. heat [J,K,L]						
South Florida	$ 300	$ 16.00 [154]	$ 27.10	$-11.10	14.3	8.6 (20)
Central Florida	300	100.00 [155]	27.10	72.90	2.9	41.7 (20)
North Florida	300	169.00 [156]	27.10	141.90	1.7	65.9 (20)

		Added Costs [B]	Net First Year Savings [C]	Net Added Annual Mortgage Cost [D]	Net First Year Cash Flow [E]	Simple Payback Period Years [F]	Rate of Return on Investment Percent [G] (System Life)
HOT WATER HEATING [S,T,U]							
(added cost & savings vs. standard elec. water heat)							
Superinsulated tanks (40 gal)		$ 70	$ 17.94 [157]	$ 6.32	$ 11.62	3.3	36.0 (12)
	Gal/day						
AC waste heat recovery	40	$ 450	$ 13.93 [158]	$ 40.66	$-26.73	14.3	2.2 (12)
	55		31.45 [159]	40.66	-9.21	9.2	9.6 (12)
	70		48.68 [160]	40.66	8.02	6.8	15.5 (12)
Heat pump water heater	40	$ 800	$ -3.24 [161]	$ 72.28	$-75.52	100+	<0 (12)
	55		27.42 [162]	72.28	-44.86	12.8	4.0 (12)
	70		57.79 [163]	72.28	-14.49	8.6	10.7 (12)
Heat pump water heater	40	$1100	$ 32.76 [164]	$ 99.39	$-66.63	16.2	0.4 (12)
(cool exhaust from unit ducted	55		77.42 [165]	99.39	-21.97	9.8	8.5 (12)
to house during cooling season)	70		121.79 [166]	99.39	22.40	7.0	14.9 (12)
Natural gas	40	$ 200	$ 70.50 [167]	$ 18.07	$ 52.43	2.2	52.0 (12)
	55		108.92 [168]	18.07	90.85	1.6	69.9 (12)
	70		142.34 [169]	18.07	124.27	1.3	87.5 (12)
Solar water heating		$2000					
pumped system (40 ft^2, 80 gal)	40		$ 53.67 [170]	$180.69	$-127.02	23.0	3.6 (20)
	55		80.67 [171]	180.69	-100.02	17.5	6.4 (20)
	70		99.67 [172]	180.69	-81.02	15.0	8.0 (20)
batch type (32 ft^2)	55	$1800	$120.00 [173]	162.62	-42.62	15.0	10.5 (30)
Insulate 70' of hot water pipes in slab and walls		$ 70	$ 27.00	$ 6.32	$ 20.68	2.6	45.5 (30)
Reduce hot water runs from 30' to 10' by adding second water heater and insulating pipes		$ 200	$ 26.00 [174]	$ 18.07	$ 7.93	5.6	20.1 (12)
APPLIANCES							
High-efficiency refrigerators [V]							
size range: 16.5 - 18.4 ft^3		$ 50	$ 17.50 [175]	$ 4.52	$ 12.98	2.5	46.2 (12)
18.5 - 20.4 ft^3		60	17.00 [176]	5.42	11.58	3.0	38.7 (12)
20.5 - 24.0 ft^3		70	21.50 [177]	6.32	15.18	2.8	41.4 (12)
High-efficiency freezer (18 ft^3)		$ 50	$ 17.50 [178]	$ 4.52	$ 12.98	2.5	46.2 (12)
Microwave oven (savings from doing 50% of cooking in microwave)		$ 250	$ 12.50 [179]	$ 22.59	$-10.09	10.0	8.1 (12)

	Added Costs [B]	Net First Year Savings [C]	Net Added Annual Mortgage Cost [D]	Net First Year Cash Flow [E]	Simple Payback Period Years [F]	Rate of Return on Investment Percent [G] (System Life)
High efficiency indoor lighting (savings from converting 33% of lighting to fluorescent or other high efficiency lights)	$ 100	$ 20.00 [180]	$ 9.03	$ 10.97	5.0	25.9 (30)
High efficiency outdoor lighting (150 W lighting, 12 hrs/day)						
- use mercury vapor lighting	$ 30	$ 29.00 [181]	$ 2.71	$ 26.29	1.0	113.4 (10)
- use high pressure sodium	30	40.00 [182]	2.71	37.29	0.7	152.0 (10)
Low-flow shower heads (2 units) Reduce 3.0 gpm to 1.5 gpm flow	$ 30	$ 42.00 [183]	$ 2.71	$ 39.29	0.6	169.4 (5)
Low-water use toilets 2 toilets, save 2 gal/flush (12 flushes/day)	$ 200	$ 25.00 [184]	$ 18.07	$ 6.93	8.0	17.7 (30)
Gas range/oven	$ 200	$ 36.67 [185]	$ 18.07	$ 18.60	5.0	24.4 (15)
Gas dryer	$ 100	$ 59.00 [186]	$ 9.03	$ 49.97	1.6	66.0 (15)

Footnotes

[A] Description of house used for energy analysis

1. 1-story slab-on-grade construction
2. 1500 ft^2 floor area - 50′ east/west axis, 30′ north/south axis
3. 214 ft^2 window area — SC (shading coefficient)
   - south - 70 ft^2 — .60
   - north - 60 ft^2 — .42
   - east - 42 ft^2 — .42
   - west - 42 ft^2 — .42

   single-pane windows
4. roof overhangs - 2′ (all sides)
5. roof slope 5/12
6. roof absorptivity a=0.80
7. walls R11, frame construction, absorptivity a=0.50
8. attic insulation =R19
9. air infiltration =0.43 air changes per hour (annual average)
10. internal load 50,807 Btu/day (sensible)
11. computer simulations done by TARP (Thermal Analysis Research Program)
12. the three Florida climate zones are represented by:
    - South - Miami
    - Central - Orlando
    - North - Jacksonville

Additional assumptions

1. electricity cost is $0.08/kWh
2. cooling SEER is 8.0
3. heating is done by heat pump, COP=2.7, which operates at COP = 2.43 as a result of duct conduction and infiltration losses.
4. summer thermostat setpoint is 78°F - assumed for all day
5. winter thermostat setpoint is 72°F - assumed for all day
6. annual cooling costs: south - $462; central - 337; north - 295
7. annual heating costs:

	elec. resistance	heat pump
south	$ 33	$ 12
central	165	61
north	274	101

[B] This is the estimated added cost the home buyer will pay. Cost information for energy-saving options were obtained from surveys of contractors and product supply companies. Effort was made to determine costs that are representative of the actual prices builders would charge their customers. Because of variability in material and labor costs from one contractor to another, and from one portion of the state to another, the amount the home buyer will actually pay may be diferent from this.

[C] For most energy saving options being evaluated, the annual energy savings are reduced by system replacement costs. These are the funds necessary to perpetuate the equipment through the end of the 30-year mortgage period. With the exception of very long-lasting items (e.g. insulation, windows, etc.), all options are so adjusted. For example, if a heat pump costs $500 more than an air conditioner and has a 15-year life expectancy, then the unit will have to be replaced once in 30 years and the annual fuel savings would have to be reduced by $500/30. The assumption is being made that interest accumulation of the replacement funds approximately equals the inflation in cost of the energy option.

[D] This is the annual mortgage payment (sum of 12 monthly payments) for a 30-year mortgage with an interest rate of 10% less the tax savings from deducting mortgage interest payments from income (assuming 15% tax bracket).

[E] Net cash flow is the net first year savings less the after-tax added mortgage payment. If the net cash flow is positive, the energy option is more than paying for the added cost of the option in the first year. Actual cash flow in the second and subsequent years will be greater if fuel prices escalate. Net cash flow does not give credit for the fact that energy savings are tax-free. Real net cash flow will in effect be greater than is shown.

[F] The simple payback period is the number of years required for the accumulated energy savings (less maintenance and repair costs) to equal the initial cost of the option.

[G] Internal Rate of Return on Investment. This is (in effect) the interest rate yield the consumer receives in energy savings (less maintenance and repair costs) from the initial principal invested. This analysis assumes a nominal 5% annual fuel price escalation. In parentheses are the number of years used for IRRI analysis, which is generally the system life expectancy. This analysis provides a more favorable economic assessment than net cash flow because it takes into account escalating fuel costs. A shortcoming of any IRRI analysis is that extremely high rates of return are not the true investment return, since it assumes savings can be reinvested at the same rate of return. An IRRI greater than 10.0% can generally be considered a good option and an IRRI greater than 15% is an excellent investment. This IRRI yield is actually superior to taxable investment options of comparable risk because the energy savings are a tax-free return on investment. The interest earnings on the energy savings, however, is taxable income.

[H] Energy savings for radiant barriers and attic and wall insulation assume a heat pump for space heating. If electric resistance heat is used, savings will be significantly higher for central and north Florida.

[I] R19 batt is $\$.36/ft^2$ to homeowner in this calculation.
R30 batt is $\$.58/ft^2$ to homeowner in this calculation.

[J] R19 blown fiberglass is $\$0.22/ft^2$ to homeowner.
R30 blown fiberglass is $\$0.34/ft^2$ to homeowner.

[K] R30 cellulose fiberglass is $\$0.33/ft^2$ to homeowner.

[L] Radiant barrier cost is $\$.20/ft^2$ (roof area) to customer. As with all costs, they will vary from one contractor to another, and from one portion of the state to another. However, because of the relatively new status of radiant barriers, more variation can be anticipated than with more established technologies. In addition, there appears to be considerable opportunity for price reductions to occur as volume increases and the most cost-effective means for installation are discovered.

[M] 3/4" polyisocyanurate or closed-cell phenolic foam (foil faced) board against block with firring strips securing to the wall. $\$9/32$ ft^2 sheet.

[N] 3/4" polyiso board or closed-cell phenolic foam as exterior sheathing. Added cost includes material cost difference between board insulation and 1/8" sheathing board plus the added cost ($100) for corner let-in bracing. This option may significantly reduce infiltration, and by taping the seams with acrylic adhesive tape it can serve in lieu of a vapor barrier. The energy savings do not reflect the reduced infiltration.

[O] Window shading savings were done using the TARP simulation program. The savings assume a heat pump for space heating. If electric resistance heating is used, the savings for the shading options will be reduced in central and north Florida, and the savings from double-pane windows will be much higher.

[P] Shading coefficient (SC) of 0.80 represents totally unshaded windows which have an external insect screen over 50% of the window area. The savings associated with each shading option are compared against these SC=0.80 windows. A 2-foot overhang provides shade on all sides of the house.

[Q] Shading coefficient (SC) of 0.50 represents windows which have an external insect screen over 50% of the window, 20% shading of the window by vegetation or nearby structures, and some use of internal shading (blinds, curtains, etc.). Curtain impact upon and interaction with the shading options is assessed by use of Table 39 in Chapter 27 of the 1985 ASHRAE Fundamentals. The savings associated with each shading option are compared against the base case SC=0.50 windows. A 2-foot overhang provides shade on all sides of the house.

[R] Total cooling and heating energy use was determined from TARP and Typical Meterological Year Solmet data developed by Trinity University. Cost data is for 2.5 ton cooling equipment. The COP of electric resistance heating using a forced-air system is assumed to be 0.90. The heat pump COP is rated at 2.7, but we actually use a 2.23 COP. Savings in cooling and heating energy are determined by proportion to the base case energy efficiency rating. For example, if an 8.0 SEER air conditioner uses $337/year for cooling, a 10.0 SEER unit will use 8.0/10.0 x $337=$269.60/year.

[S] Following are annual maintenance costs for some hot water heating options, as assumed for the rate of return on investment analysis only.

AC waste heat recovery	$15
Heat pump water heater	$50
Gas water heater	$10
Active solar system	$50
Batch solar system	$10

[T] Water heating energy use is based on 75°F cold water coming into the water heater and 122°F tank setpoint. Standard electric water heater is assumed to have an EF (energy factor) of .88. Gas water heater has an EF of .55 and RE (recovery efficiency) of .77. Values for EF and RE can be obtained from the GAMA (Gas Appliance Manufacturer's Association) "Consumer's Directory of Certified Water Heater Efficiency Ratings."

Calculation of annual energy cost (AEC) can be made using the following formulas.

Gas units:

$$\text{AEC \$} = \left[\frac{\text{Temp rise } (^{o}\text{F}) \times \frac{\text{Gal}}{\text{day}} \times 8.3 \frac{\text{Btu}}{\text{gal } ^{o}\text{F}}}{\text{RE}} + \left[\frac{1.0}{\text{EF}} - \frac{1.0}{\text{RE}}\right] \times 47{,}743 \right]$$

$$\times \left[\frac{365 \text{ days} \times \frac{\$}{\text{therm}}}{100{,}000 \frac{\text{Btu}}{\text{therm}}} \right]$$

Electric units:

$$\text{AEC \$} = \left[\text{Temp rise } (^{o}\text{F}) \times \frac{\text{Gal}}{\text{day}} \times 8.3 \frac{\text{Btu}}{\text{gal } ^{o}\text{F}} + \left[\frac{1.0}{\text{EF}} - 1.0 \right] \times 47{,}743 \right]$$

$$\times \left[\frac{365 \text{ days} \times \frac{\$}{\text{kWh}}}{3413 \frac{\text{Btu}}{\text{kWh}}} \right]$$

[U] Energy savings for AC waste heat recovery, heat pump water heater, gas water heating, and solar water heating are based on field data from Tim Merrigan, "Residential Conservation Demonstration - Domestic Hot Water," FSEC-CR-90-83, Florida Solar Energy Center, September 1983.

[V] The refrigerator energy savings are for the most efficient units compared to typical units.

	Net 1st year savings		1st year savings		30-year replacement cost		maintenance costs	
[1]	$137.62	=	$143.62*	-	$ 180/30			(replace 3 fans)
[2]	95.90	=	101.90*	-	180/30			
[3]	85.86	=	91.86*	-	180/30			

* This first year savings takes into account fan electricity use and increased air-conditioning costs.

Window shading options (base SC=0.80)

South Florida

[4]	$ 31.24	=	$ 36.24	-	$ 150/30			(replace 0.5 times)
[5]	25.00	=	30.00	-	150/30			(replace 0.5 times)
[6]	36.20	=	41.20	-	150/30			(replace 0.5 times)
[7]	27.92	=	37.92	-	0	-	300/30	(repaint once)
[8]	21.44	=	31.44	-	0	-	300/30	(repaint once)
[9]	33.12	=	43.12	-	0	-	300/30	(repaint once)

	Net 1st year savings		1st year savings		30-year replacement cost		maintenance costs	
[10]	45.36	=	45.36	-	0			
[11]	37.52	=	37.52	-	0			
[12]	51.52	=	51.52	-	0			
[13]	-20.12	=	42.88	-	1350/30	-	540/30	(replace 1.5 times
[14]	-27.48	=	35.52	-	1350/30	-	540/30	resew three times)
[15]	-14.28	=	48.72	-	1350/30	-	540/30	
Central Florida								
[16]	$ 17.24	=	$ 22.24	-	$ 150/30			(replace 0.5 times)
[17]	17.56	=	22.56	-	150/30			(replace 0.5 times)
[18]	24.44	=	29.44	-	150/30			(replace 0.5 times)
[19]	13.28	=	23.28	-	0	-	300/30	(repaint once)
[20]	13.60	=	23.60	-	0	-	300/30	(repaint once)
[21]	20.72	=	30.72	-	0	-	300/30	(repaint once)
[22]	27.84	=	27.84	-	0			
[23]	28.24	=	28.24	-	0			
[24]	36.80	=	36.80	-	0			
[25]	-36.68	=	26.32	-	1350/30	-	540/30	(replace 1.5 times,
[26]	-36.28	=	26.72	-	1350/30	-	540/30	resew three times)
[27]	-28.20	=	34.80	-	1350/30	-	540/30	
North Florida								
[28]	$ 9.00	=	$ 14.00	-	$ 150/30			(replace 0.5 times)
[29]	12.04	=	17.04	-	150/30			(replace 0.5 times)
[30]	15.96	=	20.96	-	150/30			(replace 0.5 times)
[31]	4.64	=	14.64	-	0	-	300/30	(repaint once)
[32]	7.84	=	17.84	-	0	-	300/30	(repaint once)
[33]	11.92	=	21.92	-	0	-	300/30	(repaint once)
[34]	17.44	=	17.44	-	0			
[35]	21.44	=	21.44	-	0			
[36]	26.08	=	26.08	-	0			
[37]	-46.44	=	16.56	-	1350/30	-	540/30	(replace 1.5 times,
[38]	-42.76	=	20.24	-	1350/30	-	540/30	resew three times)
[39]	-38.44	=	24.56	-	1350/30	-	540/30	

	Net 1st year savings		1st year savings		30-year replacement cost		maintenance costs	
			Window shading options		(base SC=0.50)			
South Florida								
[40]	$ 18.04	=	$ 23.04	-	$ 150/30			(replace 0.5 times)
[41]	14.12	=	19.12	-	150/30			(replace 0.5 times)
[42]	21.24	=	26.24	-	150/30			(replace 0.5 times)
[43]	14.72	=	24.72	-	0	-	300/30	(repaint once)
[44]	10.48	=	20.48	-	0	-	300/30	(repaint once)
[45]	18.08	=	28.08	-	0	-	300/30	(repaint once)
[46]	28.88	=	28.88	-	0			
[47]	23.92	=	23.92	-	0			
[48]	32.90	=	32.80	-	0			
[49]	-35.80	=	27.20	-	1350/30	-	540/30	(replace 1.5 times,
[50]	-40.44	=	22.56	-	1350/30	-	540/30	resew three times)
[51]	-32.04	=	30.96	-	1350/30	-	540/30	
Central Florida								
[52]	$ 9.16	=	$ 14.16	-	$ 150/30			(replace 0.5 times)
[53]	9.40	=	14.40	-	150/30			(replace 0.5 times)
[54]	13.72	=	18.72	-	150/30			(replace 0.5 times)
[55]	5.20	=	15.20	-	0	-	300/30	(repaint once)
[56]	5.44	=	15.44	-	0	-	300/30	(repaint once)
[57]	10.08	=	20.08	-	0	-	300/30	(repaint once)
[58]	17.76	=	17.76	-	0			
[59]	18.00	=	18.00	-	0			
[60]	23.44	=	23.44	-	0			
[61]	-46.24	=	16.72	-	1350/30	-	540/30	(replace 1.5 times,
[62]	-46.04	=	16.96	-	1350/30	-	540/30	resew three times)
[63]	-40.92	=	22.08	-	1350/30	-	540/30	
North Florida								
[64]	$ 3.96	=	$ 8.96	-	$ 150/30			(replace 0.5 times)
[65]	5.96	=	10.96	-	150/30			(replace 0.5 times)
[66]	8.36	=	13.36	-	150/30			(replace 0.5 times)
[67]	-.40	=	9.60	-	0	-	300/30	(repaint once)
[68]	1.76	=	11.76	-	0	-	300/30	(repaint once)
[69]	4.32	=	14.32	-	0	-	300/30	(repaint once)
[70]	11.20	=	11.20	-	0			
[71]	13.60	=	13.60	-	0			
[72]	16.56	=	16.56	-	0			

	Net 1st year savings		1st year savings		30-year replacement cost		maintenance costs	
[73]	-52.44	=	10.56	-	1350/30	-	540/30	(replace 1.5 times,
[74]	-50.20	=	12.80	-	1350/30	-	540/30	resew three times)
[75]	-47.40	=	15.60	-	1350/30	-	540/30	

Air conditioners

South Florida

[76]	$ 45.17	$ 51.00	$ 175/30
[77]	80.34	92.00	350/30
[78]	109.34	126.00	500/30
[79]	134.00	154.00	600/30

Central Florida

[80]	31.17	37.00	175/30
[81]	55.34	67.00	350/30
[82]	75.33	92.00	500/30
[83]	92.00	112.00	600/30

North Florida

[84]	27.17	33.00	175/30
[85]	47.34	59.00	350/30
[86]	63.33	80.00	500/30
[87]	78.00	98.00	600/30

South Florida

[88]	$ 45.17	$ 51.00	$ 175/30
[89]	35.17	41.00	175/30
[90]	29.00	34.00	150/30
[91]	24.67	28.00	100/30

Central Florida

[92]	31.17	37.00	175/30
[93]	24.16	30.00	175/30
[94]	20.00	25.00	150/30
[95]	16.67	20.00	100/30

North Florida

[96]	27.16	33.00	175/30
[97]	20.16	26.00	175/30
[98]	16.00	21.00	150/30
[99]	14.67	18.00	100/30

	Net 1st year savings		1st year savings		30-year replacement cost	maintenance costs
			Heat pumps			
South Florida						
[100]	$ 46.17	=	$ 52.00	-	$ 175/30	
[101]	79.66	=	93.00	-	400/30	
[102]	108.00	=	128.00	-	600/30	
[103]	131.00	=	156.00	-	750/30	
Central Florida						
[104]	35.16	=	41.00	-	175/30	
[105]	59.33	=	73.00	-	400/30	
[106]	81.00	=	101.00	-	600/30	
[107]	98.00	=	123.00	-	750/30	
North Florida						
[108]	34.16	=	40.00	-	175/30	
[109]	55.66	=	69.00	-	400/30	
[110]	75.00	=	95.00	-	600/30	
[111]	91.00	=	116.00	-	750/30	
South Florida						
[112]	$ 46.17	=	$ 52.00	-	$ 175/30	
[113]	33.50	=	41.00	-	225/30	
[114]	28.33	=	35.00	-	200/30	
[115]	23.00	=	28.00	-	150/30	
Central Florida						
[116]	35.16	=	41.00	-	175/30	
[117]	24.50	=	32.00	-	225/30	
[118]	21.33	=	28.00	-	200/30	
[119]	17.00	=	22.00	-	150/30	
North Florida						
[120]	34.16	=	40.00	-	175/30	
[121]	21.50	=	29.00	-	225/30	
[122]	19.33	=	26.00	-	200/30	
[123]	16.00	=	21.00	-	150/30	

	Net 1st year savings		1st year savings		30-year replacement cost	maintenance costs
			HP vs. AC with electric resistance heat			
South Florida						
[124]	$ 11.00	=	$ 21.00	-	$ 300/30	
[125]	55.50	=	73.00	-	525/30	
[126]	89.00	=	114.00	-	750/30	
[127]	115.67	=	149.00	-	1000/30	
[128]	137.00	=	177.00	-	1200/30	
Central Florida						
[129]	94.00	=	104.00	-	300/30	
[130]	127.50	=	145.00	-	525/30	
[131]	152.00	=	177.00	-	750/30	
[132]	171.67	=	205.00	-	1000/30	
[133]	187.00	=	227.00	-	1200/30	
North Florida						
[134]	163.00	=	173.00	-	300/30	
[135]	195.50	=	213.00	-	525/30	
[136]	217.00	=	242.00	-	750/30	
[137]	234.67	=	268.00	-	1000/30	
[138]	249.00	=	289.00	-	1200/30	
South Florida						
[139]	$ 11.00	=	$ 21.00	-	$ 300/30	
[140]	10.33	=	22.00	-	350/30	
[141]	8.67	=	22.00	-	400/30	
[142]	6.33	=	23.00	-	500/30	
[143]	3.00	=	23.00	-	600/30	
Central Florida						
[144]	94.00	=	104.00	-	300/30	
[145]	96.33	=	108.00	-	350/30	
[146]	96.67	=	110.00	-	400/30	
[147]	96.33	=	113.00	-	500/30	
[148]	95.00	=	115.00	-	600/30	

	Net 1st year savings		1st year savings		30-year replacement cost	maintenance costs	
North Florida							
[149]	163.00	=	173.00	-	300/30		
[150]	168.33	=	180.00	-	350/30		
[151]	169.67	=	183.00	-	400/30		
[152]	171.33	=	188.00	-	500/30		
[153]	171.00	=	191.00	-	600/30		
			Gas heating				
[154]	$ 16.00	=	$ 21.00	-	$ 150/30		(replace 0.5 times)
[155]	100.00	=	105.00	-	150/30		
[156]	169.00	=	174.00	-	150/30		
			Water heating				
[157]	$ 17.94	=	$ 21.44	-	$ 105/30		(replace 1.5 times)
[158]	13.93	=	46.43	-	525/30	15	(replace 1.5 times)
[159]	31.45	=	63.95	-	525/30	15	(replace 1.5 times)
[160]	48.68	=	81.18	-	525/30	15	(replace 1.5 times)
[161]	-3.24	=	81.76	-	1050/30	50	(replace 1.5 times)
[162]	27.42	=	112.42	-	1050/30	50	(replace 1.5 times)
[163]	57.79	=	142.79	-	1050/30	50	(replace 1.5 times)
[164]	32.76	=	117.76	-	1050/30	50	(replace 1.5 times)
[165]	77.42	=	162.42	-	1050/30	50	(replace 1.5 times)
[166]	121.79	=	206.79	-	1050/30	50	(replace 1.5 times)
[167]	70.50	=	90.50	-	150/30	10	(replace 1.5 times)
[168]	108.92	=	123.92	-	150/30	10	(replace 1.5 times)
[169]	142.34	=	157.34	-	150/30	10	(replace 1.5 times)
[170]	53.67	=	137.00	-	1000/30	50	(replace 0.5 times)
[171]	80.67	=	164.00	-	1000/30	50	(replace 0.5 times)
[172]	99.67	=	183.00	-	1000/30	50	(replace 0.5 times)
[173]	120.00	=	130.00	-	0	10	
[174]	26.00	=	71.00	-	300/30	35	(second tank heat loss and added AC load)
			Appliances				
[175]	$ 17.50	=	$ 20	-	$ 75/30		(replace 1.5 times)
[176]	17.00	=	20	-	90/30		(replace 1.5 times)
[177]	21.50	=	25	-	105/30		(replace 1.5 times)
[178]	17.50	=	20	-	75/30		(replace 1.5 times)
[179]	12.50	=	25	-	375/30		(replace 1.5 times)
[180]	20.00	=	20	-	0		
[181]	29.00	=	31	-	60/30		(replace 2 times)
[182]	40.00	=	42	-	60/30		(replace 2 times)
[183]	42.00	=	47	-	150/30		(replace 5 times)
[184]	25.00	=	25	-	0		
[185]	36.67	=	40	-	100/30		(replace 1 times)
[186]	59.00	=	61	-	60/30		(replace 1 times)