Prescriptive Path Strategy Sets for the Small Commercial Construction Market

Richard O. Weijo, Portland General Electric
Jeffrey B. Ponsness, Criterion, Inc.
Kenneth J. Anderson, Pacific Power

Prescriptive path design assistance with fixed format strategy sets were developed and tested on 21 small commercial buildings. Two primary goals of the field test were to keep utility program costs (excluding rebates) at less than 20% of the total resource cost, and to deliver recommendations to builder/developers in ten days or less.

The following findings were derived from the field test. First, use of prescriptive packages of EEM's reduced utility program costs as compared to full design assistance. On average, program costs were 22% of the resource cost, slightly above the desired goal. Second, delivery times were reduced as compared to full design assistance. On average, delivery times ranged from 12 to 15 days, depending upon the need for trade-off calculations.

Based upon the experience gained during the field test, a more flexible menu format is recommended rather than using fixed format strategy set packages. This will eliminate the time consuming task of doing trade-off analysis calculations.

Introduction

Utility-sponsored new commercial construction programs strive to provide cost-effective energy efficiency recommendations for all commercial buildings. Detailed engineering studies for larger buildings have generally been cost effective. However, for small buildings, engineering studies become prohibitively expensive for the energy savings achieved. This study explores the cost and time constraints of engineering studies, describes Prescriptive Path design assistance, and reviews the findings for the first 21 participants in a new program for small commercial buildings.

Program Delivery Costs

A simple rule of thumb often used by utilities is to manage utility program costs -- excluding customer incentives -- to be less than 20% of the total resource cost of energy efficiency measures (EEMs). This goal is easily achieved for large commercial construction programs, but is a challenging target for small commercial buildings.

Figure 1 depicts typical utility costs for a new commercial construction program offering detailed engineering studies for three different sized facilities: 6,500 square feet; 25,000 square feet; and 100,000 square feet. For the 6,500 square foot facility, utility program costs are about 28 percent of total resource costs. This contrasts to a utility program cost of 14% for 25,000 square foot facility and only 7% for the 100,000 square foot facility.

This high utility program cost for small buildings is important because of the size of the small commercial construction market. Buildings smaller than 50,000 square feet comprise 95% of the number of commercial buildings but only 55% of total commercial square footage (Hirst, Geller, Clinton and Kroner 1986). These smaller facilities have a median size of between 5,000 and 6,000 square feet. Thus, most new commercial buildings in a utility's service territory are not effectively reached through energy efficiency programs offering detailed engineering studies.

Timeliness of Design Recommendations

Providing timely recommendations to owners/developers is another important consideration in new commercial construction programs. The time available to influence EEMs in commercial buildings varies with the building size. Planning for large commercial buildings occurs over a period of months (or years). Utility staff are usually aware of these larger projects early in the design process.

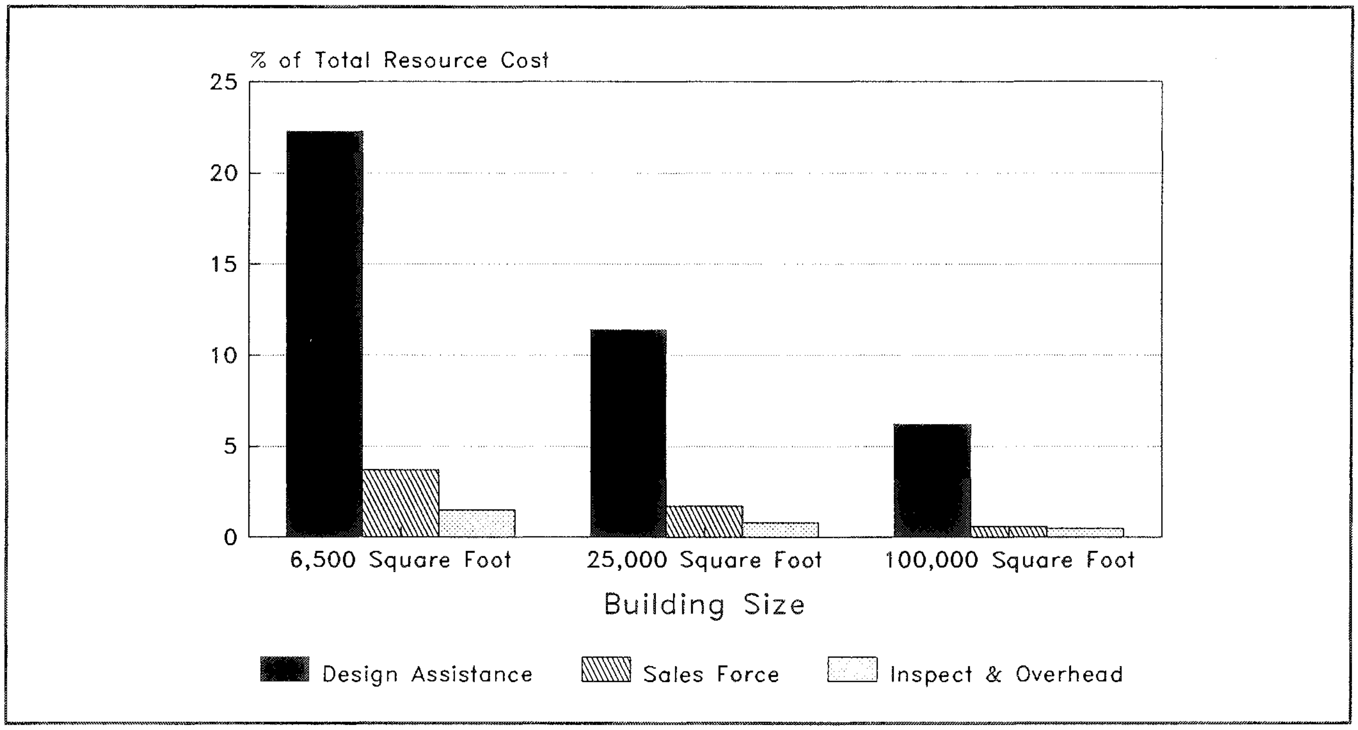

Figure 1. Typical Project Costs for Customized Design Assistance

The time period required to complete detailed engineering studies generally does not delay construction.

For small commercial construction, however, quick delivery time is a very important consideration for owner/developers. Typically, utility staff are not aware of small construction projects until just before ground breaking. The window of opportunity to influence design decisions and product choice for small commercial buildings can be as short as a few weeks. The time required to complete detailed engineering studies causes unacceptable project delays that lead to non-participation in the utility program.

For small commercial construction, a timely and cost-effective approach for offering design assistance is needed. In an effort to respond to these needs, Prescriptive Path strategy sets were developed by Bonneville Power Administration (BPA 1990). This approach was intended to be a quicker and cheaper alternative for providing design assistance.

Prescriptive Solutions for Small Commercial Construction

Bonneville Power Administration developed Prescriptive Path strategy sets to overcome cost and time barriers for the small commercial construction market. Each strategy set recommends specific EEMs by building type to achieve electric energy savings totalling at least 10% beyond regional energy code. To allow customer choice, several different strategy sets were developed for each prototype building. Bonneville created prescriptive path strategy sets based on detailed engineering studies of several prototype buildings in four states. The energy savings results presented in this paper are limited to small commercial buildings located in Western Oregon.

The DOE 2.1D computer simulation model was used to construct prescriptive strategy sets for the following small commercial facilities:

(1) Office Buildings
(2) Retail
(3) Restaurants - Fast Food
(4) Restaurants - Full Service
(5) Shops & Warehouses
(6) Churches
(7) Theaters
(8) Motels

Prescriptive Path strategy sets are designed for use with most commercial construction under 12,000 square feet. Buildings over 12,000 square feet may participate in the program on a case-by-case basis. Incremental construction costs and energy savings for each strategy set are calculated per square foot. These unit savings and costs are then used to estimate the total costs and energy savings for various-sized small commercial buildings.

Prescriptive Paths also apply to building designs that comprise a combination of building types. For example, if a building contained both office and warehouse spaces, the office strategy sets would be applied to that portion of the building that contained office space. The warehouse strategy sets would be used for the warehouse space.

A building cannot use the Prescriptive Path approach if more than one "special feature" is included in the facility. Special features include interior thermal mass, daylighting, water loop heat pumps, and active thermal storage systems. If the building does not meet the prescriptive path criteria, it is referred to BPA's Energy Smart Design program where a bin model or an hourly simulation method is recommended, depending on the "special features" present in that facility.

Table 1 depicts the cost advantages of using Prescriptive Path strategy sets for the small commercial construction market. This table contrasts the costs for providing design assistance for a 6,500 square foot commercial office building. These costs are representative of the results found in a sponsoring utility's new commercial construction program. Notice that Prescriptive Path strategy sets still have some cost for design assistance. This budget is used to evaluate construction plans and to recommend a specific strategy set for a small commercial building. No computer simulations are required for this approach.

Utility program costs are approximately 28% of installed EEM costs for the customized design assistance study. Recommendations based on Prescriptive Path strategy sets are expected to cost only 11% of installed equipment costs. Thus, Prescriptive Path strategy sets are a much more cost effective solution for estimating savings in small commercial construction.

Two Oregon utilities sponsored a study to revise BPA's Prescriptive Path strategy sets. This was done for the following reasons:

(1) to modify the strategy sets developed by Bonneville Power Administration to recognize the real interest rates and avoided costs of the investor-owned utilities.[1]

(2) to add strategy sets for different heating systems and fuel types. Electric heat pumps, electric resistance, and natural gas systems were evaluated.

(3) to adjust equipment costs and climate data assumptions for the Western Region of Oregon, territory where both utilities are located.

(4) to create additional technical information to be used with a shared savings approach to fund equipment investments in energy efficiency.

(5) to adjust strategy set recommendations to comply with the requirements needed for Oregon's Business Energy Tax Credit (BETC) Program.

Table 1. Comparison of Customized and Prescriptive Design Assistance Costs for a 6,500 ft² Building

	Customized	Prescriptive
Installed Equipment Cost	$9,750	$9,750
Utility Program Costs:		
Sales Force	$ 500	$ 500
Design Assistance	3,500	500
Inspection	100	100
Program Overhead	100	100
	$3,700	$1,200
Total Resource Cost	$13,450	$10,950
Utility Program Costs as % of Total Resource Cost	28%	11%

Example Prescriptive Path Strategy Set - Small Office

Table 2 presents a representative strategy set developed for a 6,500 square foot prototype office building with electric heat pumps. Two different types of strategy sets were developed. The Energy Smart strategy sets provide total building energy savings of approximately 10% beyond code. The Energy Edge strategy sets offer savings of 20% or more.

The Energy Smart strategy sets identify between 1.6 and 2.1 kWh/square foot of electric energy savings at an estimated cost of $.48 to $.77 per square foot, respectively. The Energy Edge strategy sets offer between 3.1 and 4.7 kWh/square foot of electric savings at a cost of $.96 to $1.47 per square foot, respectively.

Strategy sets were also developed for buildings with natural gas and with electric resistance heat. The natural gas strategy sets required more energy efficient lighting systems to satisfy Oregon's Business Energy Tax Credit (BETC) program requirements. Under the BETC program, overall building energy savings for all fuels must be 10% above code. Reduced internal gains from lighting EEMs caused an increase in natural gas use that was compensated for by more aggressive lighting EEMs. Based on cost-effectiveness, a decision was made against increasing insulation levels to achieve a similar compensating effect. Strategy sets for natural gas identified between 3.2 and 4.3 kWh/square foot of electric energy savings at an estimated cost of $.62 to $1.14 per square foot, respectively.

Strategy sets developed for electric resistance heating identified between 2.0 and 6.4 kWh/square foot of electric energy savings at an estimated cost of $.59 to $2.50 per square foot, respectively.

Pilot Program Findings

A pilot program evaluated customer response to the Prescriptive Path strategy sets. Results are preliminary findings from Portland General Electric's Small Commercial Construction Program. Findings from the first 21 buildings participating in this program are summarized in Table 3.

The average small building participating in this program is approximately 6,600 square feet. The size range of buildings included in this test was 2,000 square feet to 14,062 square feet. Approximately three-fourths of the buildings are heated by natural gas, most of the remaining facilities use heat pumps. The average building saved over 18,500 kWh or 2.8 kWh per square foot.

The most prevalent type of building included in the pilot program was offices. Eighty-six percent of facilities had at least a portion of the facility that contained offices. Surprisingly, forty-three percent were combination use building types. The most typical combination was office space with a shop.

On average, electric energy savings of twenty-one percent were identified in the buildings. The largest portion of the savings, about fifteen percent, was from lighting improvements. Approximately five percent of savings were achieved from HVAC-related improvements, such as economizers and HVAC controls. Only about 1% of electric energy savings were achieved from envelope improvements. This is attributed to the large number of buildings heated with natural gas. In gas-heated facilities, about a 12% reduction in total BTU's was achieved from both electricity and gas.

EEM Trade-Off Procedures

This pilot program identified early a need for **trade-off procedures** to provide owner/developers more flexibility in the selection of EEMs. A trade-off involves the exchange of one EEM included in a strategy set with another EEM with equivalent energy savings. Eighty-six percent of all buildings participating in this utility program required some form of trade-off analysis. Over one-half of the trade-offs involved lighting systems. Most of the remaining trade-offs involved the building envelope.

A variety of trade-off analyses were conducted for these buildings using either hand calculations or simple spreadsheet models. These include trade-offs between building envelope components, between interior and exterior lighting, and between HVAC energy efficiency measures. For example, a common lighting trade-off was a lower lighting power density in place of occupancy sensors as listed in the strategy set. A frequent envelope trade-off required higher R-value wall or ceiling insulation to compensate for a large window/door area.

The goal of this pilot program was to keep administrative costs under twenty percent of total resource costs. Trade-off analysis significantly increased utility program costs. On average, program costs were about 22%, above the desired goal.

Table 2. Prescriptive Strategy Sets Based on 6,500-sq.ft. Office Building Using Heat Pumps

Set No.	Description	Life	Cost	Annual Electric Savings (kWh)	Annual Electric Savings (%)
	Energy Smart Strategy Sets (Individual and Combined ECM's)				
Energy Smart Set 1	Roof Insul, R-19	30	1,365	2,044	2%
	Ins Window, U=0.49	20	826	1,686	2%
	HVAC Controls	10	1,129	3,592	3%
	Eff Int Light, 1.2	15	1,658	6,200	6%
	Interactive	17	4,978	13,565	13%
Energy Smart Set 2	Economizer Cooling	15	1,444	5,182	5%
	Eff Int Light, 1.2	15	1,658	6,200	6%
	Interactive	15	3,102	10,517	10%
Energy Smart Set 3	Roof Insul, R-19	30	1,365	2,044	2%
	Ins Window, U=0.49	20	826	1,686	2%
	HVAC Controls	10	1,129	3,592	3%
	Economizer Cooling	15	1,444	5,182	5%
	Interactive	17	4,764	12,781	12%
Energy Smart Set 4	Roof Insul, R-19	30	1,365	2,044	2%
	Economizer Cooling	15	1,444	5,182	5%
	Occupancy Sensors	10	1,691	7,346	7%
	Interactive	14.6	4,500	13,952	13%
	Energy Edge Strategy Sets				
Energy Edge Set 5	Roof Insul, R-19	30	1,365	2,044	2%
	Ins Window, U=0.49	20	826	1,686	2%
	Economizer	15	1,444	5,182	5%
	Occupancy Sensors	15	1,691	7,346	7%
	Eff. Ext Lights	15	(780)	4,700	4%
	HVAC Controls	10	1,129	3,592	3%
	Eff Int Light, 1.0	15	3,915	10,203	9%
	Interactive	15.6	9,590	30,794	29%
Energy Edge Set 6	Economizer Cooling	15	1,444	5,182	5%
	Roof Insul, R-19	30	1,365	2,044	2%
	Ins Window, U=0.49	20	826	1,686	2%
	Eff Ext Lights	15	(780)	4,700	4%
	Eff Int Light, 1.0	15	3,915	10,203	9%
	Interactive	15,6	6,770	23,232	22%
Energy Edge Set 7	Roof Insul, R-19	30	1,365	2,044	2%
	Ins Window, U=0.49	20	826	1,686	2%
	Economizer Cooling	15	1,444	5,182	5%
	Occupancy Sensors	15	1,691	7,346	7%
	Eff Int Light, 1.2	15	1,658	6,200	6%
	Interactive	16.7	6,984	20,193	19%
Energy Edge Set 8	Economizer Cooling	15	1,444	5,182	5%
	Occupancy Sensors	15	1,691	7,346	7%
	Eff Ext Lights	15	(780)	4,700	4%
	Eff Int Light, 1.0	15	3,915	10,203	9%
	Interactive	15.0	6,270	22,906	21%

Table 3. Prescriptive Path Program Preliminary Findings

Bldg Type(s)	Bldg (sq ft)	Heating System	Electric Savings (kWhs)	Electric Savings (%)	Light Savings (%)	Env. Savings (%)	HVAC Savings (%)	Trade-Off (Y/N)	Type of Tradeoff	Agree to Participate? (Y/N)	Est. Installation Costs ($)	Utility Sales and Analysis Cost ($)	Utility Sales and Analysis Cost % of Total Resource Costs	Working Days to Complete Analysis
Office	8,157	Heat Pump	16,314	13	6	4	3	Y	Envelope	Y	6,362	2,700	30	7
Office	10,462	Gas	36,617	26	21	0	5	Y	Lighting	Y	6,486	3,759	37	38
Office	5,103	Heat Pump	10,206	13	6	2	5	N	--	Y	3,623	1,549	30	10
Office	2,135	Heat Pump	4,270	13	6	4	3	Y	Envelope	N	1,665	1,265	43	16
Office	3,920	Gas	13,720	26	21	0	5	Y	Lighting	N	2,430	890	27	16
Office	2,047	Heat Pump	4,094	13	6	2	5	Y	Envelope/ Lighting	N	1,453	700	33	4
Office/Shop Retail	6,499	Gas	10,209	17	15	0	2	Y	Envelope	Y	1,165	825	41	5
Office/ Church	13,056	Gas	36,658	25	20	0	5	Y	Envelope	N	5,940	625	10	6
Office	5,068	Gas	17,738	26	21	0	5	Y	Lighting	N	3,140	425	12	6
Office/Shop	14,062	Gas	46,054	26	21	0	5	Y	Lighting	Y	8,125	1,225	13	24
Office/Shop	9,048	Gas	21,026	23	19	0	4	Y	Envelope	Y	3,614	1,175	25	15
Office/Shop	9,932	Heat Pump/ Gas	12,527	13	11	0	2	Y	Envelope	N	2,649	800	23	18
Office	4,975	Gas	17,413	26	21	0	5	Y	Lighting	N	3,084	900	23	17
Office/Shop	6,560	Electric/ Gas	8,316	13	11	1	1	Y	Envelope	Y	1,645	900	35	20
Office	3,750	Gas	13,125	26	21	0	5	Y	Lighting	Y	2,325	538	19	18
Retail/ Office	11,92-	Gas	50,064	24	19	0	5	Y	Lighting	Y	11,563	825	7	12
Office/Shop	6,600	Electric/ Gas	8.127	13	11	1	1	N	--	Y	1,539	475	24	10
Shop	2,000	Heat Pump	8,400	37	6	2	29	Y	HVAC	Y	3,580	425	11	17
Fast Food	2,912	Gas	18,637	31	15	0	16	N	--	N	1,289	1,050	45	17
Retail/ Office	5,441	Gas	19,043	21	15	0	6	Y	Lighting	N	3,007	1,300	30	15
Retail	5,040	Gas	17.640	19	19	0	0	Y	Lighting	Y	4,738	425	8	13
Average	6,604		18,581	21%	15%	1%	5%	86% (Yes)		57% (Yes)	$3,782	$1,085	22%	14.5

Another undesirable side effect of the trade-off calculations is the time required to provide prescriptive recommendations to customers. Though data is limited, it appears that projects that did not require trade-off analysis required about 12.3 days to provide design recommendations to customers. Those projects that did require trade-off analysis required about 14.5 days, or about 2.2 days longer. In general, a goal of 10 days (or less) is advocated.

Fifty-seven percent of the first 21 buildings participating in the pilot agreed to install the recommended measures. An estimated 246,098 kWh annually was saved in these buildings. In 1991, including all program management and overhead expenses, the total resource cost and the utility program cost -- with rebates -- for this pilot were approximately 47 and 31 mills/kWh, respectively. This includes the costs for buildings not agreeing to participate in the program. The utility program cost was significantly higher than the 15 mills/kWh budgeted.

Conclusions

Compared to customized design assistance, prescriptive packages of EEMs reduced utility program costs from an estimated 28% to 22% of total resource cost. The delivery time was also significantly reduced, from 30-45 days to 14.5 days on average. However, the goals of a utility program cost (excluding incentives) of less than 20% of total resource costs and a 10 day delivery time have not been achieved in the first 21 buildings in the pilot. Further, the required trade-off analysis proved burdensome.

The pilot program found it difficult to utilize prepackaged strategy sets that require specific EEMs to be present in each building's energy system (e.g., lighting, HVAC, and envelope). Ultimately, every facility and decision maker is unique and different. Many decision makers will refuse to consider certain technologies for their facility. When this occurs, the building can not meet the package guidelines, resulting in non-participation. Similar difficulties have been reported with the fixed strategy set approach now being offered by Bonneville Power Administration.

Building owners and developers must be offered flexibility of choice. A prescriptive program using the "menu format" responds to this need. Table 4 depicts an example menu format. The menu allows a variety of EEM "packages" to be assembled by the owner and the design team. The menu format summarizes energy savings in kWh/square foot and percent. Any interactive savings are factored into the numbers. This approach is simple in format and provides owners/developers with a choice. The owner/developer simply checks off the set of EEMs they want to install in their facilities. The menu format is designed to allow easy calculation of total energy saving, total additional costs, and total percent energy savings. A summary form is used to calculate any utility rebates being provided to the customer.

While this menu format has not been field tested by the sponsoring utilities, it may reduce the accuracy of energy savings and cost estimates. However, it is anticipated to increase customer choice and participation rates while reducing program delivery costs.

The need for flexibility has been reflected in other prescriptive programs - Design 2000 (New England Power Service Company); Title 24 Plus (San Diego Gas and Electric Company); and Design Awards Point System (Northern States Power Company - Wisconsin). Each one of these programs offers a product or performance based incentive payment in the form of a rebate.

Endnote

1. The real interest rate used in this study was 5.22%. The avoided cost includes deferred generation, transmission, and distribution costs. Real levelized avoided costs of $.047, $.050, $.051 and $.054/kWh were used for equipment measure lives of 10, 15, 20 and 30 years, respectively.

References

Bonneville Power Administration. 1990. *Summary Report for the Prescriptive Path Manual Project.* Brown and Caldwell Consultants. Bonneville Power Administration, Portland, OR.

Hirst, Eric, Jeanne Clinton, Howard Geller, and Walter Kroner. 1986. *Energy Efficiency in Buildings: Progress & Promise.* F.M. O'Hara, Jr., Editor. American Council for an Energy-Efficiency Economy: Washington, D.C.

McAteer, Michael L. 1992. "Design 2000: New Construction and Equipment Replacement Program." *1992 Proceedings of the New Construction Programs for Demand-Side Management Conference.* ADM Associates, Inc., Sacramento, CA.

Stern, Frank and Marshall Keneipp. 1992. "An Awards Program for Energy-Efficient Commercial Building Design." *1992 Proceedings of the New Construction Programs for Demand-Side Management Conference.* ADM Associates, Inc., Sacramento, CA.

Urtasun, Frank J. 1992. "Attributes and Drawbacks to a Performance-Based Title 24 Program." *1992 Proceedings of the New Construction Programs for Demand-Side Management Conference.* ADM Associates, Inc., Sacramento, CA.

Table 4. Small Office Building Menu Format -- Electric Heat Pump

Saving Measure	Y/N	Savings kWhr/sq.ft.	Added Cost/sq.ft.	Savings Above Code
Ceiling Insulation				
R19		0.35	$0.15	2.00%
R30		0.40	$0.40	3.00%
R38		0.45	$0.45	3.25%
Windows				
U = .52 maximum		0.30	$0.50	2.00%
U = .42 maximum		0.50	$0.90	3.00%
Walls				
R15 (high density)		0.10	$0.10	0.50%
R19		0.15	$0.15	0.75%
HVAC System				
High efficiency unit		0.90	$0.30	5.00%
Economizers		0.85	$0.25	4.75%
Interior Lighting				
1.4 WPF maximum		0.35	$0.10	2.00%
1.3 WPF maximum		0.65	$0.15	4.00%
1.2 WPF maximum		1.05	$0.30	6.00%
1.1 WPF maximum		1.25	$0.40	8.00%
Exterior Lighting				
5.0 WPLF		0.50	$0.05	3.00%
3.5 WPLF		0.70	$0.07	4.00%
Selected Savings Measures				
Total				

Recommended Measures		
Building floor area (sq.ft.)		
Savings (kWhr/yr)		
Added construction cost ($)		
Savings above code (%)		