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Lawrence Berkeley Laboratory
UNIVERSITY OF CALIFORNIA

ENERGY & ENVIRONMENT DIVISION

Presented at the Second ACEEE Summer Study on Energy Efficient Buildings, Santa Cruz, CA, August 22-28, 1982

A SUMMARY REVIEW OF BUILDING ENERGY USE COMPILATION AND ANALYSIS (BECA) PART C: CONSERVATION PROGRESS IN RETROFITTED COMMERCIAL BUILDINGS

Leonard W. Wall and John Flaherty

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A SUMMARY REVIEW OF BUILDING ENERGY USE COMPILATION AND ANALYSIS (BECA) PART C: CONSERVATION PROGRESS IN RETROFITTED COMMERCIAL BUILDINGS*

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ABSTRACT

Data on actual energy use were compiled for 223 retrofitted commercial buildings and analyzed for energy performance and cost-effectiveness. 70% of the buildings were located in the northeastern region of the U.S. Dominant building types were schools and offices; over 75% of the buildings had floor areas larger than 50,000 ft^2. Nearly all (95%) of the buildings included operations and maintenance changes as part of the retrofit. The median value of source energy savings for the entire sample was 19% of the pre-retrofit consumption. Nine percent of the retrofits failed to save. The median value of retrofit cost was $0.56/$ft^2$ [N = 84]. Complete cost data were available for less than 30% of the sample; for them [N = 65] the median value of simple payback time was in the 1 to 2 year range and the median value of cost of conserved site energy was $3.30/MBtu (with first-costs amortized over 5 years at 10% real interest). Also included in this report are a study of the durability of retrofits and a comparison of predicted vs. actual savings.

1. INTRODUCTION

This study represents the first extensive data collection effort for commercial building retrofits based on actual metered energy usage. Rosenfeld et al. (1980) and Misuriello and Bily (1981) have previously made limited surveys of actual commercial building retrofit data. The bulk of the data in this report were collected in late 1980 and early 1981.

Energy consumption data for 223 retrofitted buildings are analyzed, along with economic calculations for about 30% of the buildings with complete cost data.

This compilation is a first step towards establishing a data base on "what works" for commercial building retrofits. These data and future additions will provide factual data needed for load forecasting, policy and program design, validation of computer models, and evaluation of conservation efforts in the existing commercial sector. The independent study by Ross and Whalen (1982) is now being used in an ongoing project at Lawrence Berkeley Laboratory that collects and critically reviews measured data on the energy performance and cost effectiveness of low-energy new homes (BECA-A), existing "retrofitted" homes (BECA-B), energy-efficient commercial buildings (BECA-C), appliances and equipment (BECA-D), and validation of computer programs (BECA-V).

2. INPUT DATA

The input data sought for each building included the following: building type, building location and floor area, year of retrofit installation, annual energy consumption by fuel type before and after retrofit, retrofit measures implemented, and retrofit cost.

First, the characteristics of the retrofitted buildings included in this compilation will be compared to the overall U.S. commercial stock. Then the types of retrofit actions will be examined.

2.1 Building Location

The input data indicate a heavy weighting towards retrofits located in the northeastern part of the country. The locations of the 223 commercial retrofits break down like this: Northeast 70.1%, North Central 8.5%, South 16.5%, West 2.2%, and Foreign (outside the U.S.) 2.7%. This differs drastically from the U.S. distribution of locations for commercial buildings

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This article is based on Building Energy Use Compilation and Analysis (BECA) Part C: Conservation Progress in Retrofitted Commercial Buildings, by Howard Ross and Sue Whalen [Buildings Division, U.S. Dept. of Energy, Washington, D.C.], LBL-14827, EEB-BED 82-09, August 1982.

Table I.				
Floor Area Categories	Distribution of BECA-C Buildings		Distribution of Overall U.S. Commercial Stock	
	By # of Bldgs.	By % of Total Area	By # of Bldgs.	By % of Total Area
> 100,000 ft^2	52.1%	94.70%	1.6%	33.2%
50 - 100,000	24.2	4.13	2.5	15.1
25 - 50,000	10.5	0.93	5.2	15.0
10 - 25,000	5.0	0.17	13.8	16.9
5 - 10,000	2.3	0.04	18.6	10.5
1 - 5,000	5.9	0.03	41.9	8.6
< 1,000	0	0	16.4	0.7

as reported by the Energy Information Administration (1981) in their "Nonresidential Buildings Energy Consumption Survey": Northeast 18%, North Central 31%, South 37%, and West 14%. A possible explanation for this East Coast regional emphasis is that Ross and Whalen, working out of Washington, D.C., had more information on the retrofit activities occurring in the East and were more successful in getting responses from nearby project leaders.

2.2 Floor Area

An examination of the sizes of the retrofitted buildings shows that this initial compilation consists mainly of those with large floor areas. The distribution according to floor area categories is listed above in Table I.

The U.S. profile [EIA, 1981] is listed alongside the BECA-C distribution and is seen to be quite different. However, the distribution in terms of numbers of buildings for each size category is not nearly as significant as the proportion of the overall square footage of commercial space that each category represents. An approximation from the EIA survey is that over 48% of the total U.S. commercial floor area is represented by buildings larger than 50,000 ft^2, even though these represent only about 4% of the total number of buildings. Less than 10% of the total commercial square footage is represented by the buildings smaller than 5,000 ft^2, even though these are about 58% of the total number of buildings. Since total energy usage in commercial buildings depends on the floor area, this over-representation of large buildings in the first edition of BECA-C is quite proper.

2.3 Use Category

The compilation includes mainly schools and office buildings. A breakdown according to use category is shown below in Table II.

Almost 60% of the number of recorded retrofits occurred at schools, a category that represents only 4% of the total number of commercial buildings. The ready availability of schools data can be explained by the "Saving Schoolhouse Energy" program by the American Association of Schools Administrators and the many state and utility audit/retrofit programs initiated through the federal Institutional Buildings Grants Program authorized by the 1978 National Energy Conservation Policy Act. Almost 18% of the number of retrofits were office buildings, which is similar to their proportion (15%) of the commercial stock. Although

Table II.				
Category	Distribution of BECA-C Buildings		Distribution of Overall U.S. Commercial Stock	
	By # of Bldgs.	By % of Total Floor Space	By # of Bldgs.	By % of Total Floor Space
Education	59.5%	40.7%	4.0%	12.3%
Office	17.6	22.7	15.0	17.2
Assembly	9.5	0.2	11.2	10.5
Health Care	6.8	25.0	1.1	3.5
Corrections	3.6	9.4	NA	NA
Lodging	1.8	1.7	2.5	4.2
Residential	0.5	0.1	8.7	6.5
Retail Services	0.9	0.3	17.9	16.0
Warehouse	0	0	10.8	12.7
Auto Sales and Service	0	0	10.0	3.8
Food Sales	0	0	9.2	3.9
Other and Vacant	0	0	9.6	9.2

Table III.		
Type of Measure	Frequency of Occurrence	Percent Occurrence
Operations and Maintenance (O & M)	211	95%
Lighting	58	26
HVAC	32	14
Windows	31	14
Insulation	31	14
Weatherstripping & Caulking	25	11
Energy Management System (EMS)	12	5
Doors	3	1

the "health care" category represents only about 7% of the number of retrofits in the BECA-C compilation, it includes a number of very large facilities and hence accounts for 25% of the total floor space. The last six categories in the preceding table represent over 50% of the commercial stock [both in terms of numbers of buildings and total floor space] but are barely covered, if at all, by this BECA-C study.

2.4 Types of Retrofits

Almost all of the buildings included operations and maintenance (O & M) as part of the retrofit. The distribution of types of measures [N = 223 buildings] is listed in Table III.

Not many of the buildings were retrofitted extensively. Only those measures with clearly established cost effectiveness were attempted. As indicated below, payback times were almost always less than three years (see Fig. 5).

3. RESULTS

From the previously discussed input data, the following outputs were calculated: site and source energy consumption before and after retrofit, magnitude and percent of energy savings, retrofit cost in 1980$/ft^2, cost of conserved energy in 1980$/MBtu, and simple payback period. Each one of these outputs is summarized below.

3.1 Energy Consumption Before and After Retrofit

Figure 1A, B shows a comparison of the energy intensity before and after retrofit. Both fossil fuel and electricity use per square foot are plotted. Both were reduced after retrofit but the reduction was more significant for fuel. As reference points, the estimated national average energy use for various building types are denoted, based on simulation runs using the Oak Ridge Commercial Model [Corum and Jackson, 1980]. The individually plotted data points show a lot of variation relative to the point representing the overall U.S. average for commercial buildings. The electrical energy use of schools in this compilation is noticeably less than the national average for schools as estimated by ORNL.

3.2 Energy Savings

Figure 2 shows the amount of source energy saved as a function of the pre-retrofit energy usage, both normalized to the building's floorspace. There is a general trend toward increased savings with increased energy use, but not a very close correlation. Reference lines of 5% through 40% savings are shown on the graph. Wide variations in percentage savings are quite evident.

The median value of source energy savings was 33.9 kBtu/ft^2-yr [N = 204], or 19% of the pre-retrofit consumption. Average/median savings (24%/21%) in fossil fuel exceeded the average/median savings (8%/7%) in electricity. This latter result is not surprising since the compilation includes a large number of schools with low pre-retrofit values of electricity usage [see Figure 1A] for which it would be relatively difficult to save large amounts of electrical energy.

Table IV displays the percent savings according to building types. There is not much variation between site savings and source savings. In addition, the average savings (ranging from 20 to 30 percent) were approximately the same for all building categories with reasonably large sample sizes.

3.3 Cost of Retrofit

Figure 3 displays the wide distribution in retrofit costs for the buildings in the compilation. The average costs were $0.62 ± $0.51/ft^2 [N = 79] excluding failed retrofits and $0.89 ± $1.30/ft^2 [N = 84] including the failures. The median value for retrofit cost was $0.56/ft^2 [N = 84]. The relatively low retrofit costs (equal to about one-half the median cost of energy for one year) are a clear indication of the dominance of O & M efforts in this compilation.

Table IV. Stratifying the Sample By Building Type--Savings in those building categories where significant sample sizes were obtained did not show much variation.

Building Category	Site		Source	
	Ave % Savings	Sample Size	Ave % Savings	Sample Size
Elementary	24%	72	21%	72
Secondary	30%	38	28%	37
Large Office	23%	37	21%	24
Hospital	21%	13	17%	10
Community Center	56%	3	23%	18
Hotel	25%	4	24%	4
Corrections	7%	4	5%	4
Small Office	33%	1	30%	1
Shopping Center	11%	1	11%	1
Multi Family Apartment	44%	1	43%	1

Table V. Summary of Key Findings

	Excluding Failed Retrofits		Including Failed Retrofits		
	Average Values		Average Values	Median Values	
1. Cost of Retrofit (1980$/ft^2)	$0.62 ± 0.51	N = 79	$0.89 ± 1.30	$0.56	N = 84
2. Savings (Source)					
Total Electricity and Fuel	23.0% ± 15.3%	N = 184	19.9% ± 17.4%	19.0%	N = 204
Electricity	18.9% ± 17.3%	N = 127	8.3% ± 23.4%	7.0%	N = 177
Fossil Fuel	26.4% ± 17.6%	N = 156	23.7% ± 19.5%	21.1%	N = 169
3. Cost of Conserved Site Energy ($/MBtu)					
at CRR = 0.25	$3.97 ± 4.67	N = 56	$7.60 ± 13.85	$3.30	N = 65
CRR = 0.16	$2.54 ± 2.99	N = 56	$4.86 ± 8.87	$2.10	N = 65
CRR = 1.0	$15.89 ± 18.70	N = 56	$30.40 ± 55.41	$13.20	N = 65
4. Portion of Sample which had failed retrofits			9% (20 of 223)		
5. Portion of Sample with less than 3 year simple payback			89% (58 of 65)		
6. Median value of simple payback time in 1-2 year range [N = 65]					

3.4 Cost of Conserved Energy (CCE)

Figure 4A, B exhibits the distribution of the cost of conserved site energy with capital recovery rates (CRR) of 16%/yr (10% real interest, 10 year amortization) and 25%/yr (10% real interest, 5 year amortization). In both graphs, the CCE values compare favorably with 1981 prices for fuel and electricity. The second plot, using CRR = 0.25/yr, is probably the more applicable one since there are mainly short-term retrofits in this compilation. In this figure, 62% of the sample had a CCE below the mid-1981 average commercial sector gas price of $4/MBtu, 82% were below the oil price of $9.20/MBtu, and 89% were below the electricity price of $17.10/MBtu [site]. For CRR = 0.25/yr the median value for the cost of the conserved site energy was $3.30/MBtu [N = 65]. From Fig. 4 A, B one might conclude that the bulk of the retrofit projects in this compilation were cost-effective.

3.5 Simple Payback Period

Figure 5 shows the distribution of simple payback periods for a subset of the sample with complete cost data [excluding failed retrofits]. Almost 90% of the sample achieved payback periods of three years or less. The median value is in the 1 to 2 year range. From this distribution, one might conclude that many retrofits in this "generation" (late 1970's to early 1980's) still emphasized quick returns on investment, not extensive modifications with longer-term paybacks.

3.6 Failed Retrofits

Of the 223 buildings in which retrofits were installed, 20 (or 9%) failed to save energy, and in most of these instances consumption actually increased. The cause of the failures was traced generally to improper maintenance by on-site personnel.

3.7 Durability of Retrofits

The durability of retrofit measures is determined by comparing the energy consumption of the first post-retrofit year to the consumption several years later. This was done for 15 buildings, of which 9 saved even more in the following years whereas the other 6 increased consumption slightly. There were no large changes in retrofit performance over time for this small subset of the compilation (all except one building stayed within 15% of the energy use for the first post-retrofit year).

3.8 Predicted vs. Actual Savings

Figure 6 displays a plot of predicted vs. actual energy savings for a well-documented subset of 18 commercial buildings in the overall retrofit data base. There appears to be no significant correlation between estimated savings and measured results, as is true for the overall group of 60 buildings for which predictions were available. However, this sample is too limited to allow generalizations about the accuracy of energy audit procedures used to estimate savings.

3.9 Summary of Key Findings

The summary of key findings in this study is shown in Table V. Average and median values for retrofit cost, source energy savings, and cost of saved site energy are displayed along with information about failures and payback times. The inclusion of "failures" has a dramatic effect on the averages:

- increases the average cost/ft^2 by about 40%
- decreases the average source savings by approximately 13% (over 50% decrease for electricity savings)
- almost doubles the average CCE.

There is also an effect on the median values, but not nearly so pronounced.

4. CONCLUSIONS AND RECOMMENDATIONS

This initial compilation of a commercial buildings data base gives us a limited picture of this "first generation" of retrofit actions: mainly low-investment "proven" retrofits which cost less than $1/ft^2, save approximately 20% (source energy), and have relatively fast payback times (less than 3 years) and low costs of conserved energy (less than 1981 energy prices). There exists some likelihood of failure when retrofitting, about 9% for our (statistically non-significant) sample. No general conclusions can be drawn at this time from comparisons of predicted vs. actual energy savings nor from tracing the durability of retrofits, because of small sample sizes.

In this compilation the average savings of fossil fuel were found to be significantly larger than the average savings of electricity, contrary to the prediction by Rosenfeld, et al. [1980] that approximately equal percent savings should be attainable for both energy types. This result is understandable if one notices the small electricity usage and normal fossil fuel usage (compared to the national average values) in the pre-retrofit energy consumption for most buildings [especially the schools] shown in Fig. 1A. Hence it was easier to save fossil fuel than electricity for our sample of commercial buildings.

The data were not weather-normalized. It has long been thought by many analysts of building energy performance that the energy usage of large, internal-load-dominated

buildings is independent of climate. In this compilation the majority of the retrofitted buildings fit in the "large" category (over 50,000 ft^2). However, this study contains a large number of schools that, despite their large total floor areas, might have a significant amount of heat loss or gain through the building shell--especially if some of the school "buildings" in our sample actually consist of numerous individual low-rise structures that are relatively narrow in order to maximize daylighting (as is suggested by their low electricity usage). Thus, in future reports we will examine more closely the need to make weather corrections to at least some of the retrofit data. A recent study by Carroll, et al. [1982] demonstrates the climate sensitivity of computer-simulated energy usage in both one-story and 10-story buildings. In that report there was a factor of 2 difference in the estimated total energy usage for an identical 100,000 ft^2 office building when located in a Minneapolis climate versus a Los Angeles one. Therefore the applicability and the methodology of weather corrections for commercial buildings must be pursued further by building energy scientists.

Finally, we offer some recommendations for future editions of this data compilation. The data base needs to be broadened in the following ways so that it will be more representative of the present existing commercial stock: better geographical coverage of other regions besides the Northeast, more emphasis on building use categories other than schools and office buildings, and more concentration on small commercial buildings [for which weather adjustments clearly must be made]. We need to seek out more of the extensive retrofits as opposed to the short-payback (mainly O & M) efforts. The study should continue to track predicted savings vs. actual savings, the durability of retrofits (based on additional multi-year savings data), and the factors related to notable successes and failures. Peak power savings must be taken into account and efforts made to separate out the effects of individual retrofit measures [component savings]. More accurate cost data and better estimates of the lifetimes of the retrofit measures would improve the economic analysis.

For the next edition of this data compilation we solicit your data, your references to other possible data sources, and your suggestions so that we can greatly increase the scope and accuracy of this compilation.

5. ACKNOWLEDGEMENTS

Special thanks go to the many people and organizations that collected the primary data found in this report [they are acknowledged individually in the full BECA-C report by Ross & Whalen, LBL-14827, August 1982]. We also thank Jeffrey Harris, who guided us with many helpful suggestions and critical comments.

The work described in this report was supported by the Assistant Secretary for Conservation and Renewable Energy, Office of Building Energy Research and Development, Buildings Systems Division of the U.S. Department of Energy directly and under Contract No. DE-AC03-76SF00098.

6. REFERENCES

Carroll, W., Webster, T., Mertol, A., Andersson, B., Kammerud, R., Place, W., Martin, M., Peterson, J., Mangeng, C., Roach, F., Whiddon, W., Hart, G. June 1982. Passive cooling technology assessment: synthesis report. Berkeley, CA: Lawrence Berkeley Laboratory LBL-14558.

Corum, K. and Jackson, J. March 1980. ORNL commercial building energy simulation, 1970-2000. Oak Ridge, TN: Oak Ridge National Laboratory.

Energy Information Administration (EIA). March 1981. Nonresidential buildings energy consumption survey: building characteristics. DOE/EIA-0246.

Misuriello, H. and Bily, R. April 1981. A study of actual metered energy savings for energy conservation retrofit measures reported for commercial buildings. Proceedings of the First International Energy Agency Conference on Advanced Energy Conservation. Technology and Their Commercialization.

Rosenfeld, A., Goldstein, D., Gawell, K., and Claridge, D. August 1980. Solar/Conservation study, part 1--buildings. Berkeley, CA: Lawrence Berkeley Laboratory Report-11300.

Ross, H. and Whalen, S. August 1982. Building energy use compilation and analysis (BECA) part C: conservation progress in retrofitted commercial buildings. Berkeley, CA: Lawrence Berkeley Laboratory LBL-14827. (The preceding reference contains a complete listing of all the sources used in assembling the retrofit data base discussed in this article.)

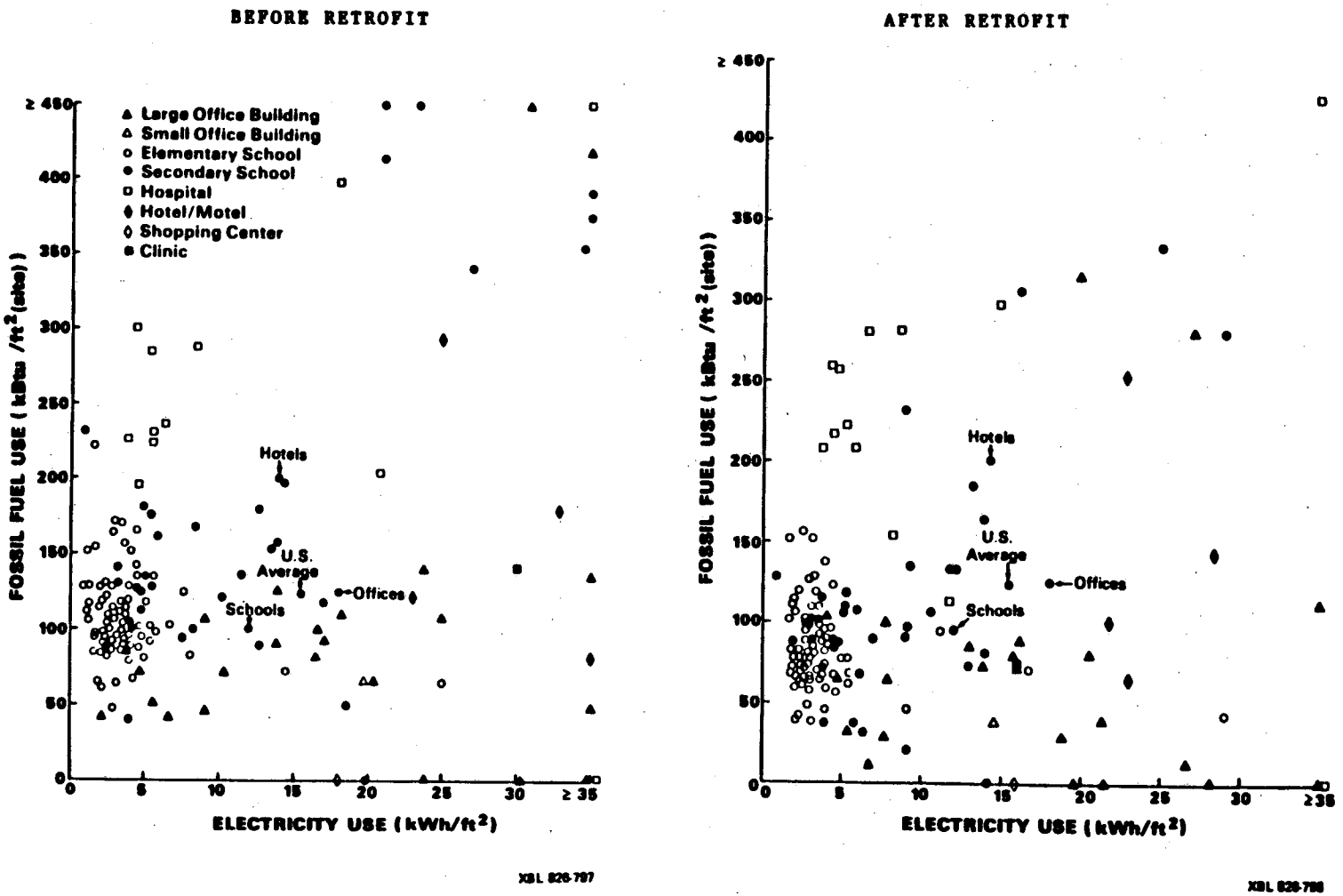


Figure 1A, B. Energy Use Before and After Retrofit--Note that the largest energy users (located in the upper right of each figure) tend to have the greatest reduction in energy use. Also, the figures show the national average energy use for various building types (denoted as ⊗). Our sample shows that electrical energy use of schools is much below the published school national average (Corum and Jackson, 1980); the overall source energy difference is about 50%.

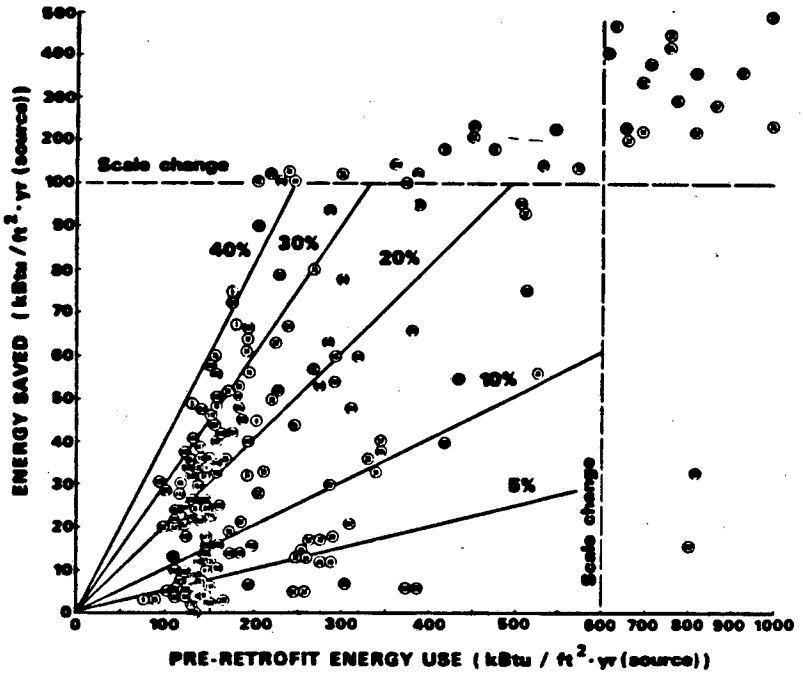


Figure 2. Energy Savings Versus Energy Use--Beware the scale change on the figure. While there exists a general trend toward increased savings as pre-retrofit energy use increases, simple correlations do not exist; however, to guide the eye, we have plotted lines corresponding to 5% through 40% savings.

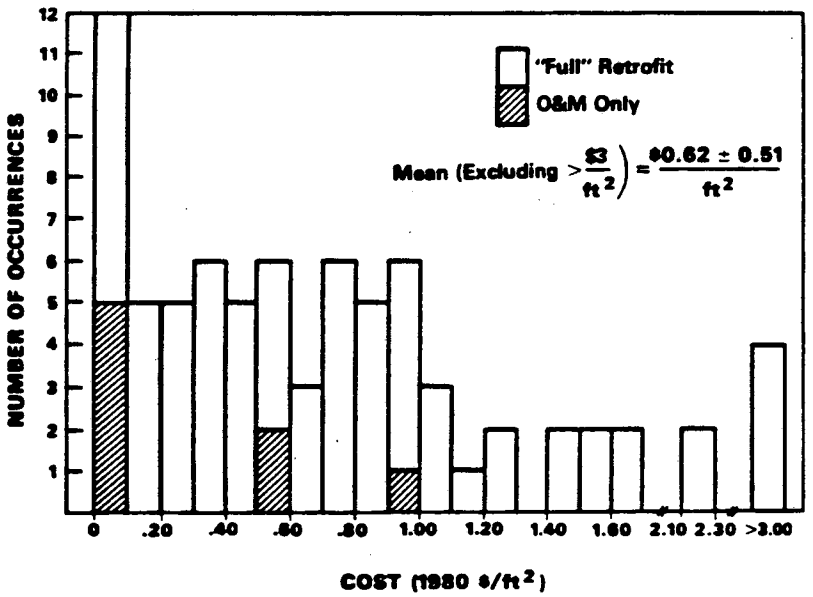
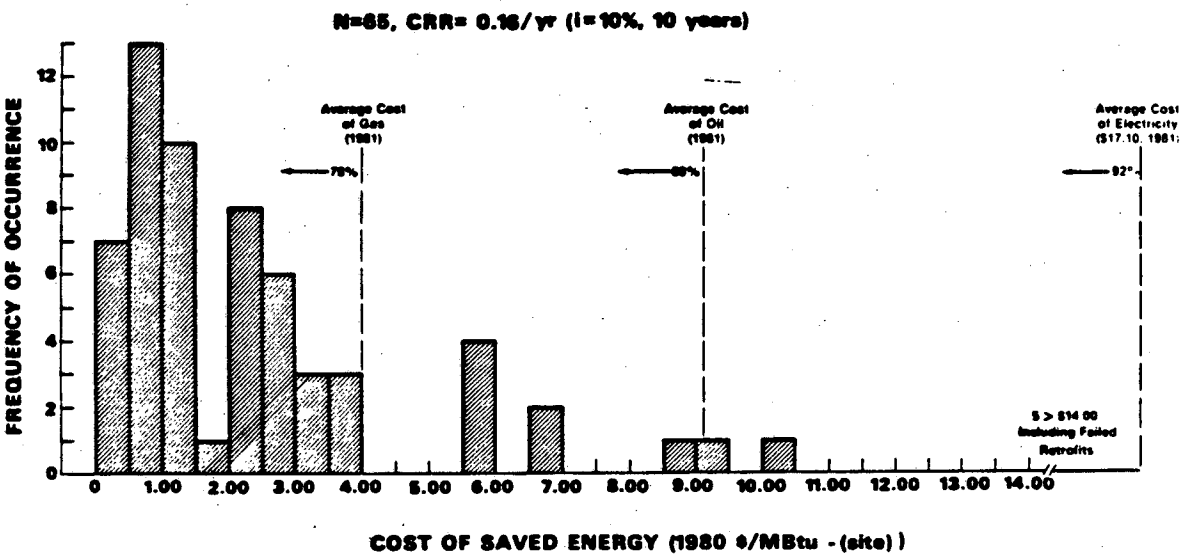


Figure 3. Retrofit Cost--Those buildings over $3/sq. ft. are European.



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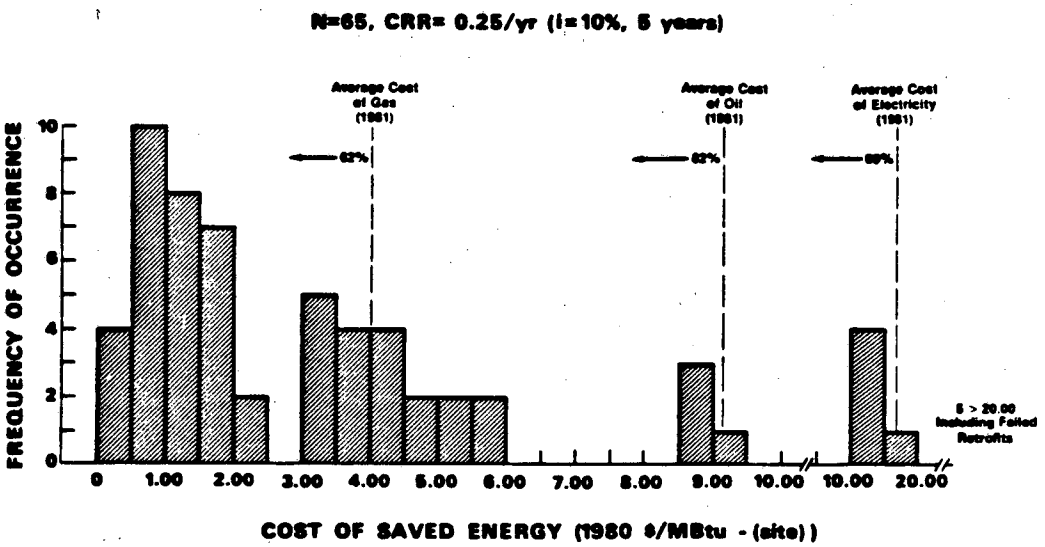

Figure 4A, B. Cost of Saved Energy--While the cost of saved energy shows a wide distribution, it is usually less than the cost of supplying an equivalent amount of energy. At a CRR = 0.25/yr, 89% of the sample saved energy at a cost less than the mid-1981 commercial building electricity cost as estimated by the U.S. Energy Information Administration.

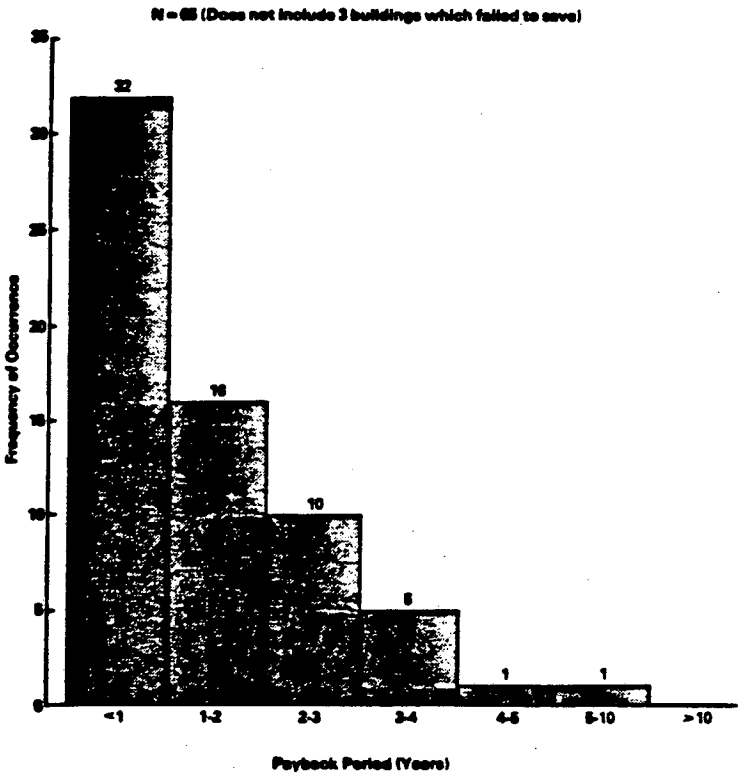

Figure 5. Simple Payback Period--Note that 89% of the sample achieved a payback within three years. Payback was calculated based on local utility costs or reported "cost avoidance."

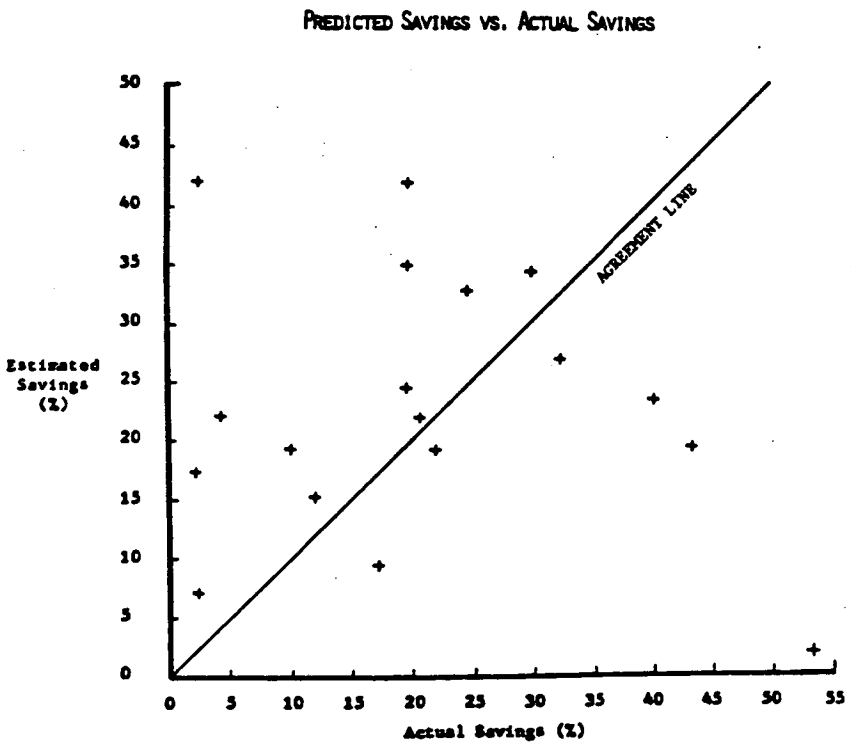

Figure 6. Predicted vs. Actual Energy Savings (percent) for 18 well-documented commercial building retrofit projects, showing no significant correlation between predictions and measured results.

APPENDIX A: DATA TABLES

A	B		C	D	D1	E	E1	E2	E(F)	E(T)	F	F1	F2	F(F)	F(T)
						<-- ANNUAL ENERGY USE PER SQ. FT. -->									
						<------ BEFORE ------>					<------ AFTER ------>				
						<--ELECTRICITY-->			FUEL	TOTAL	<--ELECTRICITY-->			FUEL	TOTAL
BLDG NO	LOCATION		AREA (KSQFT)	USE CAT.	RETROFIT MEASURE	(KWH)	(KBTU) SITE	(KBTU) SOURC	(KBTU) SOURC	(KBTU) SOURC	(KWH)	(KBTU) SITE	(KBTU) SOURC	(KBTU) SOURC	(KBTU) SOURC
1	AUBURN	ME	33.6	ELEM	W				112	112.0				74	74.0
2	AUBURN	ME	55.6	ELEM	W I				88	88.0				45	45.0
3	AUBURN	ME	133.5	SEC	O C				115	115.0				84	84.0
4	BREWER	ME	111.7	SEC	OLWC	4.33	14.8	44.4	100	144.4	3.85	13.1	39.4	72	111.4
5	BREWER	ME	16.7	ELEM	O WC	2.14	7.3	21.9	152	173.9	2.04	7.0	20.9	78	98.9
6	BREWER	ME	10.4	ELEM	O WC	2.46	8.4	25.2	106	131.2	2.46	8.4	25.2	61	86.2
7	BREWER	ME	15.6	ELEM	OLWC	4.51	15.4	46.2	134	180.2	3.05	10.4	31.2	82	113.2
8	CHINA	ME	28.8	ELEM	O I	3.54	12.1	36.3	170	206.3	3.32	11.3	34.0	127	161.0
9	LIMESTONE	ME	147.6	SEC	O	4.03	13.8	41.3	39	80.3	3.87	13.2	39.6	37	76.6
10	LITCHFIELD	ME	26.0	ELEM	O WC	2.30	7.9	23.6	133	156.6	2.40	8.2	24.6	83	107.6
11	MILLINOCKET	ME	17.6	ELEM	WCI				123	123.0				71	71.0
12	PORTLAND	ME	55.6	ELEM	O CI	5.70	19.5	58.4	135	193.4	5.00	17.1	51.2	78	129.2
13	PORTLAND	ME	21.5	ELEM	O CI A	4.50	15.4	46.1	165	211.1	3.90	13.3	40.0	138	178.0
14	PORTLAND	ME	99.0	ELEM	O CI	4.10	14.0	42.0	152	194.0	3.60	12.3	36.9	99	135.9
15	PORTLAND	ME	153.7	EL+SEC	O CI	3.60	12.3	36.9	112	148.9	3.30	11.3	33.8	78	111.8
16	DEXTER	ME	8.8	ELEM	O W H	2.40	8.2	24.6	130	154.6	3.00	10.2	30.7	64	94.7
17	DEXTER	ME	54.8	ELEM	O W I	3.40	11.6	34.8	156	190.8	4.10	14.0	42.0	90	132.0
18	DEXTER	ME	66.5	SEC	O C	5.00	17.1	51.2	171	222.2	4.50	15.4	46.1	124	170.1
19	DEXTER	ME	5.8	ELEM	O W H	3.00	10.2	30.7	173	203.7	2.90	9.9	29.7	73	102.7
20	ELLSWORTH	ME	90.5	SEC	O W I A				146	146.0				72	72.0
21	LAMOINE	ME	14.4	ELEM	O W I A				96	96.0				48	48.0
22	PHILADELPHIA	PA	496.0	LO	OL										
23	PHILADELPHIA	PA	207.8	LO	OL										
24	PHILADELPHIA	PA	435.0	LO	OL										
25	PHILADELPHIA	PA	385.0	LO	OL										
26	PHILADELPHIA	PA	255.2	LO	OL										
27	PHILADELPHIA	PA	149.4	LO	OL										
28	PHILADELPHIA	PA	422.3	LO	OL										
29	PHILADELPHIA	PA	113.8	LO	OL										
30	PHILADELPHIA	PA	218.1	LO	OL										
31	PHILADELPHIA	PA	245.9	LO	O										
32	PHILADELPHIA	PA	234.8	LO	O										
33	PHILADELPHIA	PA	545.1	LO	OL										
34	HOUSTON	TX	486.9	SEC	OL	11.50	39.3	117.8	137	254.8	11.90	40.6	121.9	128	249.9
35	ST PAUL	MN	840.0	LO	OL	18.30	62.5	187.5	110	297.5	11.50	39.3	117.8	55	172.8
36	ATLANTA	GA	320.0	LO	OL	40.50	138.3	414.9	57	472.1	26.60	90.8	272.5	15	287.5
37	HOUSTON	TX	578.2	LO	OL	65.20	222.7	668.0		668.0	45.30	154.7	464.1		464.1
38	ATLANTA	GA	566.8	HOTEL	E	23.10	78.9	236.7	123	359.7	21.80	74.4	223.3	100	323.3
39	ATLANTA	GA	197.0	HOTEL	H	66.00	225.4	676.2	81	757.2	23.00	78.5	235.6	65	300.6
40	CHICAGO	IL	331.5	HOTEL	O H	32.30	110.3	330.9	179	509.9	28.40	97.0	291.0	144	435.0
41	PHILADELPHIA	PA	430.5	HOTEL	H	25.00	85.4	256.1	294	550.1	22.80	77.9	233.6	254	487.6
42	CLEVELAND	OH		HOS	O										
43	LONG BEACH	CA		HOS	L E										
44	NEW BRUNSWICK	NJ		HOS	OL										
45	NEWARK	NJ	938.8	DC1	O	5.50	18.8	56.3	223	279.3	5.70	19.5	58.4	209	267.4
46	BINGHAMTON	NY	3308.5	SEC	O	13.40	45.8	137.3	154	291.3	9.30	31.8	95.3	135	230.3
47	SYRACUSE	NY	1322.2	PC	O	4.60	15.7	47.1	196	243.1	4.50	15.4	46.1	218	264.1
48	ROME	NY	1385.0	PC	O	5.50	18.8	56.3	230	286.3	5.20	17.8	53.3	221	274.3
49	MORRISTOWN	NY	1124.5	SEC	O	8.30	28.3	85.0	168	253.0	8.20	28.0	84.0	154	238.0
50	ALBANY	NY	553.3	CORR	O				289	289.0				302	302.0
51	STATEN ISLAND	NY	2639.2	DC	O	5.30	18.1	54.3	285	339.3	4.70	16.1	48.2	258	306.2
52	ISLIP	NY	2681.8	PC	O	4.40	15.0	45.1	300	345.1	4.40	15.0	45.1	260	305.1
53	LONG ISLAND	NY	4361.4	PC	O	3.80	13.0	38.9	226	264.9	3.80	13.0	38.9	209	247.9
54	NAPPONOCK	NY	755.0	CORR	O	5.60	19.1	57.4	193	250.4	6.20	21.2	63.5	182	245.5
55	ROCHESTER	NY	1201.3	CORR	O	5.10	17.4	52.2	205	257.2	5.40	18.4	55.3	189	244.3
56	CLINTON	NY	1317.4	CORR	O	9.20	31.4	94.3	382	476.3	10.30	35.2	105.5	392	497.5
57	AUBURN	NY	1074.0	CORR	O				192	192.0				189	189.0
58	ELMIRA	NY	1315.5	CORR	O	3.60	12.3	36.9	180	216.9	3.80	13.0	38.9	187	225.9
59	ALBANY	NY	553.0	CORR	O	3.20	10.9	32.8	140	172.8	3.50	12.0	35.9	118	153.9
60	NEW YORK	NY	2018.6	PS	O	6.30	21.5	64.5	236	300.5	6.60	22.5	67.6	281	348.6
61	PARIS	FR	988.2	LO	O	9.10	31.1	93.2	46	139.2	7.60	26.0	77.9	29	106.9
62	ROCHEFORT	FR	6.4		O H										
63	STOCKHOLM	SW	96.9	LO	O W I	2.10	7.2	21.5	43	64.5					
64	STOCKHOLM	SW	452.1	LO	O W E	5.60	19.1	57.4	50	107.4	5.40	18.4	55.3	32	87.3
65	STOCKHOLM	SW	183.0	LO	O W	6.60	22.5	67.6	41	108.6	6.60	22.5	67.6	11	78.6

A	C1	C2	H1	H2	K	J	L1	L2	L3	L4	M	N	
	<—— S A V E D ——>					COST OF RETRO-FIT	COST PER ANNUAL SAVINGS		COST OF CONSEVED SITE ENERGY				
BLDG NO	(KBTU/SQFT) SITE	SOURC	(PERCENT) SITE	SOURC	SIMP PAYB YRS	(1980$ /SQFT)	(1980 $/ MBTU/YR) SITE	SOURC	($/MBTU) CRR= .16	CRR= .25	COOLG DECR DAYS	HEATG DECR DAYS	COMMENTS
1	38.0	38.0	34	34	3-4	.89	23.4	23.4	3.7	5.9	1890	6035	
2	43.0	43.0	49	49	2-3	.19	4.4	4.4	.7	1.1	1890	6035	
3	31.0	31.0	27	27	<1	.01	.3	.3	.1	.1	1890	6035	
4	29.6	32.9	26	23	1-2	.41	13.8	12.5	2.2	3.5	1896	6496	
5	74.3	75.0	47	43	1-2	1.05	14.1	14.0	2.3	3.5	1896	6496	
6	45.0	45.0	39	34	1-2	.42	9.3	9.3	1.5	2.3	1896	6496	
7	57.0	67.0	38	37	1-2	.96	16.8	14.3	2.7	4.2	1896	6496	
8	43.8	45.3	24	22	<1	.26	5.9	5.7	1.0	1.5	1896	6496	
9	2.5	3.6	5	5	3-4	.05	19.6	13.7	3.1	4.9	128	9632	
10	49.7	49.0	35	31	<1	.34	6.8	6.9	1.1	1.7	1890	6035	
11	52.0	52.0	42	42	3-4	2.30	44.2	44.2	7.1	11.1	1379	8044	
12	59.4	64.2	38	33	<1	.42	7.1	6.5	1.1	1.8	1890	6035	
13	29.0	33.1	16	16	2-3	.60	20.7	18.1	3.3	5.2	1890	6035	
14	54.7	58.1	33	30	<1	.36	6.6	6.2	1.1	1.6	1890	6035	
15	35.0	37.1	28	25	<1	.22	6.3	5.9	1.0	1.6	1890	6035	
16	64.0	59.9	46	39	1-2	1.00	15.6	16.7	2.5	3.9	1896	6496	
17	63.6	58.8	38	31	2-3	1.42	22.3	24.1	3.6	5.6	1896	6496	
18	48.7	52.1	26	23	<1	.18	3.7	3.5	.6	.9	1896	6496	
19	100.3	101.0	55	50	2-3	1.60	15.9	15.8	2.6	4.0	1896	6496	
20	74.0	74.0	51	51							1896	6496	
21	48.0	48.0	50	50							1896	6496	
22	17.0		15								3679	3753	
23	17.0		18								3679	3753	
24	43.0		36								3679	3753	
25	60.0		27								3679	3753	
26	53.0		4								3679	3753	
27	43.0		36								3679	3753	
28	9.0		8								3679	3753	
29	9.0		8								3679	3753	
30	2.0		2								3679	3753	
31	-32.0		-23								3679	3753	
32	50.0		27								3679	3753	
33	39.0		20								3679	3753	
34	7.6	4.9	4	2							7150	864	
35	78.2	124.7	45	42							2575	6842	
36	89.7	184.6	46	39							4880	2189	STEAM FED, FUEL INCREASED 20 PERCENT
37	68.0	203.9	31	31							7150	684	
38	27.4	36.3	14	10							4880	2189	
39	162.8	456.5	53	60							4880	2189	
40	48.3	75.0	17	15							3372	4952	
41	47.5	62.5	13	11							3679	3753	
42	61.0		18								2807	4901	
43	174.0		62								4928	772	
44	53.0		12								3482	3818	
45	13.3	12.0	6	4							3533	3911	
46	33.0	61.0	17	21							2231	5908	
47	-21.7	-21.0	-9	-8							2621	5379	
48	10.0	12.1	4	4							2621	5379	
49	14.3	15.0	7	6							2621	5379	
50	-13.0	-13.0	-3	-3							2619	5596	
51	29.0	33.1	10	10							3533	3911	
52	40.0	40.0	13	12							3278	4023	
53	17.0	17.0	7	6							3278	4023	
54	9.0	4.9	4	2							2619	5596	
55	15.0	12.9	7	5							2580	5417	
56	-13.8	-21.3	-2	-3							2180	6488	
57	3.0	3.0	2	2							2621	5779	
58	-7.7	-9.0	-3	-3							2231	5908	
59	21.0	18.9	14	11							5596	2619	
60	-46.0	-48.1	-17	-15							3653	3739	
61	22.1	32.4	29	23							193	4986	
62	242.0		61		3-4	8.80	36.4		5.8	9.1			
63	22.0		43			3.08	140.0		22.4	35.0	159	7832	
64	18.7	20.0	27	19		.75	40.1	37.4	6.4	10.0	159	7832	
65	30.0	30.0	47	28		1.02	34.0	34.0	5.4	8.5	159	7832	

APPENDIX A (cont'd)

A	B		C	D	D1		E	E1	E2	E(F)	E(T)	F	F1	F2	F(F)	F(T)
							<-- A N N U A L E N E R G Y U S E P E R S Q. F T. -->									
							<------- B E F O R E ------->					<------- A F T E R ------->				
							<--ELECTRICITY-->			FUEL	TOTAL	<--ELECTRICITY-->			FUEL	TOTAL
BLDG NO	LOCATION		AREA (KSQFT)	USE CAT.	RETROFIT MEASURE		(KWH)	(KBTU) SITE	(KBTU) SOURC	(KBTU) SOURC	(KBTU) SOURC	(KWH)	(KBTU) SITE	(KBTU) SOURC	(KBTU) SOURC	(KBTU) SOURC
66																
67	CAMBRIDGE	UK	133.5	SEC	O	H E										
68	NEW YORK	NY	1500.0	LO	O		16.60	56.7	170.1	120	290.1	16.10	55.0	164.9	107	271.9
69	NEW YORK	NY	589.0	LO	O		17.10	58.4	175.2	112	287.2	15.80	54.0	161.9	95	256.9
70	NEW YORK	NY	449.0	LO	O		16.50	56.3	169.0	98	267.0	16.00	54.6	163.9	86	249.9
71	NEW YORK	NY	448.0	LO	O	H	10.40	35.5	106.5	85	191.5	7.90	27.0	80.9	78	158.9
72	NEW YORK	NY	412.0	LO	O	H	13.90	47.5	142.4	108	250.4	13.80	47.1	141.4	86	227.4
73	HARTSDALE	NY	48.0	SO	O		19.70	67.3	201.8	66	267.8	14.60	49.9	149.6	39	188.6
74	NEW YORK	NY	141.0	LO	O	H	51.50	175.9	527.6	162	689.6	49.10	167.7	503.0	134	637.0
75	MACON	GA	600.0	HOSP	O W	H	20.70	70.7	212.1	203	415.1	11.80	40.3	120.9	113	233.9
76	LOS ANGELES	CA	208.0	HOSP	O	H	45.70	156.1	468.2	563	1031.2	35.40	120.9	362.7	428	790.7
77																
78	NEW YORK	NY	1507.0	HOSP	OL CIH	E	16.90	57.7	173.1	396	569.1	14.60	49.9	149.6	299	448.6
79	ENGLEWOOD	CA	148.0	HOSP	OL H		126.00	430.3	1290.9		1290.9	70.00	239.1	717.2		717.2
80	MADISON	NJ	354.0	SEC	OL CIH		5.50	18.8	56.3	128	184.3	4.60	15.7	47.1	84	131.1
81	LOS ANGELES	CA	124.0	SEC	OLW H	E	18.50	63.2	189.5	50	239.5	9.20	31.4	94.3	20	114.3
82	MADISON	NJ	686.0	SEC	OLW IH		10.20	34.8	104.5	121	225.5	7.00	23.9	71.7	90	161.7
83	NEW YORK	NY	1482.0	LO	OLW IH		13.90	47.5	142.4	125	267.4	13.00	44.4	133.2	85	218.2
84	NEW YORK	NY	76.0	MF	WCIH		.90	3.1	9.2	233	242.2	.90	3.1	9.2	129	138.2
84A	POTOMAC	MD	158.5	MALL		E	18.00	61.5	184.4		184.4	15.90	54.3	162.9		162.9
85	ROCK SPRINGS	MD	136.0	LO		E	23.90	81.6	244.9		244.9	19.60	66.9	200.8		200.8
85A	TUCKER	GA	251.3	LO	OLW H		35.10	119.9	359.6		359.6	21.50	73.4	220.3		220.3
86	WORTHINGTON	OH	62.1	SEC	OL		7.50	25.6	76.8	90	167.2	6.30	21.5	64.5	66	131.0
87	TAMPA	FL	216.0	SEC		E	19.90	68.0	203.9		203.9	14.30	48.8	146.5		146.5
88	COLUMBUS	OH	221.8	LO	OL H		49.00	167.3	502.0	418	920.0	27.00	92.2	276.6	280	556.6
89	COLUMBUS	OH	114.9	SEC	OL H		43.00	146.8	440.5	375	815.5	25.00	85.4	256.1	334	590.1
90	COLUMBUS	OH	66.3	SEC	OL H		21.00	71.7	215.1	491	706.1	9.00	30.7	92.2	232	324.2
91	COLUMBUS	OH	79.5	SEC	OL H		21.00	71.7	215.1	414	629.1	9.00	30.7	92.2	91	183.2
92	COLUMBUS	OH	102.7	SEC	OL H		27.00	92.2	276.6	340	616.6	13.00	44.4	133.2	73	206.2
93	COLUMBUS	OH	108.9	CLINIC	OL H		30.00	102.5	307.4	142	449.4	16.00	54.6	163.9	75	238.9
94	COLUMBUS	OH	94.5	CONICE	OL H		26.00	88.8	266.4	431	697.4	17.00	58.1	174.2	181	355.2
95	COLUMBUS	OH	84.0	SEC	OL H		35.70	121.9	365.7	392	757.7	13.20	45.1	135.2	185	320.2
96	COLUMBUS	OH	104.7	SEC	OL H		23.40	79.9	239.7	530	769.7	16.20	55.3	166.0	306	472.0
97	COLUMBUS	OH	181.6	SEC	OL		34.60	118.2	354.5	510	864.5	28.90	98.7	296.1	280	576.1
98	LUBBOCK	TX	36.8	ELEM	O		2.10	7.2	21.5	62	83.5	2.10	7.2	21.5	60	81.5
99	LANCHORNE	PA	49.3	ELEM	O		3.20	10.9	32.8	64	96.8	4.70	16.1	48.2	57	105.2
100	GLENROCK	NJ	45.4	ELEM	O	I	3.40	11.6	34.8	86	120.8	4.40	15.0	45.1	68	113.1
101	WARWICK	RI	27.6	ELEM	O	I	4.00	13.7	41.0	70	111.0	4.00	13.7	41.0	45	86.0
102	SIOUX FALLS	SD	33.7	ELEM	O		25.00	85.4	256.1	65	321.1	29.00	99.0	297.1	44	341.1
103	COLUMBUS	OH	43.8	ELEM	O		3.70	12.6	37.9	120	157.9	4.40	15.0	45.1	96	141.1
104	KENNIWICK	WA	40.1	ELEM	OL	I	5.00	17.1	51.2	81	132.2	3.50	12.0	35.9	70	105.9
105	STEVENS PT	WI	44.0	ELEM	OL		8.20	28.0	84.0	51	135.0	9.20	31.4	94.3	46	140.3
106	LINCOLN	NB	32.0	ELEM	OL		2.90	9.9	29.7	48	77.7	2.90	9.9	29.7	48	77.7
107	NEWARK	NJ	1527.0	LO	O		23.70	80.9	242.8	140	382.8	20.30	69.3	208.0	80	288.0
108	NEWARK	NJ	2077.0	LO	O		4.70	16.1	48.2	71	119.2	4.80	16.4	49.2	65	114.2
109	NEWARK	NJ	650.0	LO	O		3.80	13.0	38.9	110	148.9	4.10	14.0	42.0	105	147.0
110	NEWARK	NJ	1268.0	LO	O		9.10	31.1	93.2	107	200.2	8.30	28.3	85.0	100	185.0
111	NEWARK	NJ	9485.0		O		8.50	29.0	87.1	287	374.1	8.60	29.4	88.1	281	369.1
112	NEWARK	NJ	1624.0	CORR	O		18.80	64.2	192.6	607	799.6	18.60	63.5	190.6	594	784.6
113	NEWARK	NJ	837.0	SEC	O		13.80	47.1	141.4	159	300.4	11.10	37.9	113.7	108	221.7
114	NEWARK	NJ	10311.0	SEC	O		12.60	43.0	129.1	180	309.1	12.10	41.3	124.0	137	261.0
115	NEWARK	NJ	7592.0	SEC	O		14.40	49.2	147.5	197	344.5	13.90	47.5	142.4	164	306.4
116	NEWARK	NJ	400.0	LO	O											
117	CHARLESTON	WV	226.8	LO	OL		30.20	103.1	309.4		309.4	28.10	96.0	287.9		287.9
118	CHARLESTON	WV	88.3	LO	OL		20.30	69.3	208.0	66	274.0	18.80	64.2	192.6	29	221.6
119	CHARLESTON	WV	1079.2	LO	OLW	E	25.00	85.4	256.1	117	373.1	22.60	77.2	231.5	39	270.5
120	BUFFULO	NY	64.0	ELEM	O		2.20	7.5	22.5	105	127.5	3.00	10.2	30.7	88	118.7
121	BUFFALO	NY	87.0	ELEM	O		3.10	10.6	31.8	95	126.8	3.10	10.6	31.8	110	141.8
122	BUFFALO	NY	139.0	ELEM	O		1.80	6.1	18.4	98	116.4	2.70	9.2	27.7	95	122.7
123	BUFFALO	NY	109.0	ELEM	O		2.90	9.9	29.7	70	99.7	2.00	6.8	20.5	51	71.5
124	BUFFALO	NY	81.8	ELEM	O		2.10	7.2	21.5	113	134.5	2.40	8.2	24.6	120	144.6
125	BUFFALO	NY	67.8	ELEM	OL		2.00	6.8	20.5	85	105.5	1.80	6.1	18.4	82	100.4

A	G1	G2	H1	H2	K	J	L1	L2	L3	L4	M	N	
	<—— S A V E D ——>												
BLDG NO	(KBTU/SQFT) SITE	SOURC	(PERCENT) SITE	SOURC	SIMP PAYB YRS ****	COST OF RETRO-FIT (1980$ /SQFT) ******	COST PER ANNUAL SAVINGS (1980 $/ MBTU/YR) SITE	SOURC	COST OF CONSERVED SITE ENERGY ($/MBTU) CRR= .16	CRR= .25	COOLG DEGR DAYS *****	HEATG DEGR DAYS *****	COMMENTS
66													
67	47.0		44		1-2	.62	13.2		2.1	3.3			
68	14.7	18.1	8	6	<1	.02	1.3	1.0	.2	.3	3653	3739	STEAM FED, FUEL INCREASED 20 PERCENT
69	21.4	30.3	13	11	<1	.06	2.6	1.8	.4	.6	3653	3739	STEAM FED, FUEL INCREASED 20 PERCENT
70	13.7	17.1	9	6	<1	.05	3.9	3.2	.6	1.0	3653	3739	STEAM FED, FUEL INCREASED 20 PERCENT
71	15.5	32.6	13	17	<1	.06	4.1	2.0	.7	1.0	3653	3739	STEAM FED, FUEL INCREASED 20 PERCENT
72	22.3	23.0	14	9	<1	.06	2.9	2.8	.5	.7	3653	3739	STEAM FED, FUEL INCREASED 20 PERCENT
73	44.4	79.2	33	30	<1	.56	12.6	7.1	2.0	3.2	3653	3739	
74	36.2	52.6	11	8	<1	.60	16.7	11.5	2.7	4.2	3653	3739	STEAM FED, FUEL INCREASED 20 PERCENT
75	120.4	181.2	44	44	2-3	1.68	14.0	9.3	2.2	3.5	6068	1492	
76	170.2	240.5	24	23	1-2	1.30	7.6	5.4	1.2	1.9	5442	522	
77													
78	104.9	120.6	23	21	1-2	.80	7.6	6.6	1.2	1.9	3653	3739	
79	191.2	573.7	44	44	5-10	3.06	16.0	5.3	2.6	4.0	1414	2925	
80	47.1	53.2	32	29	4-5	.85	18.1	16.0	2.9	4.5	3533	3911	
81	61.8	125.3	55	52	3-4	2.16	35.0	17.2	5.6	8.7	5442	522	
82	41.9	63.8	27	28	2-3	.63	15.0	9.9	2.4	3.8	3533	3911	
83	43.1	49.2	25	18	1-2	.56	13.0	11.4	2.1	3.3	3653	3739	
84	104.0	104.0	44	43	2-3	.90	8.7	8.7	1.4	2.2	3653	3739	
84A	7.2	21.5	12	12	2-3	.39	54.4	18.1	8.7	13.6	4237	3182	
85	14.7	44.1	18	18	1-2	.38	25.9	8.6	4.1	6.5	4237	3182	ALL ELECTRIC
85A	46.4	139.3	39	39							4880	2189	
86	28.0	36.2	24	22	<1	.19	6.8	5.2	1.1	1.7	3183	4513	
87	19.1	57.4	28	28	<1	.11	5.8	1.9	.9	1.4	8172	364	ALL ELECTRIC
88	213.1	363.4	36	39	<1	.79	3.7	2.2	.6	.9	3183	4513	
89	102.5	225.4	20	28	<1	.49	4.8	2.2	.8	1.2	3183	4513	
90	300.0	381.9	53	54	1-2	.97	3.2	2.5	.5	.8	3183	4513	
91	364.0	445.9	75	71	<1	.86	2.4	1.9	.4	.6	3183	4513	
92	314.8	410.4	73	67	<1	.83	2.6	2.0	.4	.7	3183	4513	
93	114.8	210.4	47	47	2-3	1.42	12.4	6.7	2.0	3.1	3183	4513	
94	280.7	342.2	54	49	1-2	1.68	6.0	4.9	1.0	1.5	3183	4513	
95	283.8	437.5	55	58	<1	.67	2.4	1.5	.4	.6	3183	4513	
96	248.6	297.8	41	39	<1	.37	1.5	1.2	.2	.4	3183	4513	
97	249.5	288.4	40	33	<1	.29	1.2	1.0	.2	.3	3183	4513	
98	2.0	2.0	3	2		.17	85.0	85.0	13.6	21.3	4745	2603	
99	1.9	-8.4	3	-8		.51	271.6	-61.0	43.5	67.9	3482	3818	
100	14.6	7.8	15	6		1.53	104.9	197.3	16.8	26.2	3533	3911	
101	25.0	25.0	30	23		1.12	44.8	44.8	7.2	11.2	2625	4682	
102	7.3	-20.0	5	-5		.94	128.1	-47.0	20.5	32.0	2746	6543	
103	21.6	16.8	16	11		.96	44.4	57.0	7.1	11.1	3183	4513	
104	16.1	26.4	16	20		5.12	317.6	194.2	50.8	79.4	3260	3616	
105	1.6	-5.2	2	-3		.13	82.0	-24.8	13.1	20.5	2331	7033	
106	0.	0.	0	0		.40					3634	4875	
107	71.6	94.8	32	25							3533	3911	
108	5.7	5.0	7	4							3533	3911	
109	4.0	1.9	3	1							3533	3911	
110	9.7	15.2	7	8							3533	3911	
111	5.7	5.0	2	1							3533	3911	
112	13.7	15.0	2	2							3533	3911	
113	60.2	78.7	29	26							3533	3911	
114	44.7	48.1	20	16							3533	3911	
115	34.7	38.1	14	11							3533	3911	
116	23.0		43								3533	3911	DATA NORMALIZED TO 5000 HDD AT 65 DEG.
117	7.2	21.5	7	7							3750	3500	
118	42.1	52.4	31	19							3750	3500	
119	86.2	102.6	43	27							3750	3500	
120	14.3	8.8	13	7							2388	5591	
121	-15.0	-15.0	-13	-11							2388	5591	
122	-.1	-6.2	0	-4							2388	5591	
123	22.1	28.2	28	28							2388	5591	
124	-8.0	-10.1	-6	-6							2388	5591	
125	3.7	5.0	4	5							2388	5591	

APPENDIX A (cont'd)

A	B	C	D	D1	E	E1	E2	E(F)	E(T)	F	F1	F2	F(F)	F(T)
					<-- ANNUAL ENERGY USE PER SQ. FT. -->									
					<------ BEFORE ------>					<------ AFTER ------>				
					<--ELECTRICITY-->			FUEL	TOTAL	<--ELECTRICITY-->			FUEL	TOTAL
BLDG NO	LOCATION		AREA (KSQFT)	USE CAT.	RETROFIT MEASURE	(KWH)	(KBTU) SITE	(KBTU) SOURC	(KBTU) SOURC	(KBTU) SOURC	(KWH)	(KBTU) SITE	(KBTU) SOURC	(KBTU) SOURC	(KBTU) SOURC
126	BUFFALO	NY	41.9	ELEM	O	3.90	13.3	40.0	86	126.0	3.00	10.2	30.7	58	88.7
127	BUFFALO	NY	78.8	ELEM	O	3.40	11.6	34.8	110	144.8	3.80	13.0	38.9	89	127.9
128	BUFFALO	NY	83.1	ELEM	OL	2.30	7.9	23.6	128	151.6	2.00	6.8	20.5	76	96.5
129	BUFFALO	NY	51.3	ELEM	O	3.10	10.6	31.8	95	126.8	3.90	13.3	40.0	83	123.0
130	BUFFALO	NY	36.7	ELEM	O	3.60	12.3	36.9	105	141.9	2.20	7.5	22.5	107	129.5
131	BUFFALO	NY	69.8	ELEM	OL	1.90	6.5	19.5	129	148.5	2.00	6.8	20.5	111	131.5
132	BUFFALO	NY	46.0	ELEM	O	5.50	18.8	56.3	102	158.3	5.50	18.8	56.3	62	118.3
133	BUFFALO	NY	58.5	ELEM	O	3.70	12.6	37.9	83	120.9	4.70	16.1	48.2	67	115.2
134	BUFFALO	NY	74.0	ELEM	O	2.30	7.9	23.6	119	142.6	2.10	7.2	21.5	114	135.5
135	BUFFALO	NY	73.7	ELEM	O	2.90	9.9	29.7	114	143.7	3.40	11.6	34.8	120	154.8
136	BUFFALO	NY	120.0	ELEM	O	2.60	8.9	26.6	100	126.6	2.40	8.2	24.6	68	92.6
137	BUFFALO	NY	62.3	ELEM	O	2.60	8.9	26.6	111	137.6	1.90	6.5	19.5	71	90.5
138	BUFFALO	NY	41.9	ELEM	O	3.90	13.3	40.0	96	136.0	4.20	14.3	43.0	59	102.0
139	BUFFALO	NY	128.6	ELEM	O	3.80	13.0	38.9	91	129.9	2.40	8.2	24.6	73	97.6
140	BUFFALO	NY	83.7	ELEM	O	4.20	14.3	43.0	100	143.0	3.60	12.3	36.9	92	128.9
141	BUFFALO	NY	125.3	ELEM	O	2.80	9.6	28.7	63	91.7	2.20	7.5	22.5	39	61.5
142	BUFFALO	NY	107.5	ELEM	O	3.10	10.6	31.8	96	127.8	2.20	7.5	22.5	66	88.5
143	BUFFALO	NY	61.2	ELEM	O	4.70	16.1	48.2	101	149.2	4.70	16.1	48.2	38	86.2
144	BUFFALO	NY	110.0	ELEM	O	2.20	7.5	22.5	90	112.5	2.70	9.2	27.7	89	116.7
145	BUFFALO	NY	101.1	ELEM	O	2.30	7.9	23.6	94	117.6	3.00	10.2	30.7	64	94.7
146	BUFFALO	NY	120.0	ELEM	O W	3.60	12.3	36.9	120	156.9	2.80	9.6	28.7	88	116.7
147	BUFFALO	NY	140.0	ELEM	O	3.90	13.3	40.0	87	127.0	3.60	12.3	36.9	65	101.9
148	BUFFALO	NY	65.0	ELEM	O	2.80	9.6	28.7	128	156.7	1.70	5.8	17.4	102	119.4
149	BUFFALO	NY	14.9	ELEM	O	2.50	8.5	25.6	103	128.6	2.50	8.5	25.6	80	105.6
150	BUFFALO	NY	73.5	ELEM	OL	2.30	7.9	23.6	86	109.6	2.80	9.6	28.7	72	100.7
151	BUFFALO	NY	99.0	ELEM	O	1.70	5.8	17.4	155	172.4	2.60	8.9	26.6	157	183.6
152	BUFFALO	NY	107.5	ELEM	O	4.20	14.3	43.0	67	110.0	5.50	18.8	56.3	68	124.3
153	BUFFALO	NY	65.2	ELEM	O	2.30	7.9	23.6	60	83.6	2.20	7.5	22.5	41	63.5
154	BUFFALO	NY	52.8	ELEM	O W	2.30	7.9	23.6	89	112.6	2.60	8.9	26.6	80	106.6
155	BUFFALO	NY	42.9	ELEM	O W	3.80	13.0	38.9	128	166.9	3.40	11.6	34.8	80	114.8
156	BUFFALO	NY	96.0	ELEM	O	2.40	8.2	24.6	99	123.6	2.50	8.5	25.6	94	119.6
157	BUFFALO	NY	68.5	ELEM	O W	3.30	11.3	33.8	95	128.8	2.80	9.6	28.7	129	157.7
158	BUFFALO	NY	82.0	ELEM	O	2.60	8.9	26.6	109	135.6	2.70	9.2	27.7	86	113.7
159	BUFFALO	NY	62.7	ELEM	O	2.90	9.9	29.7	123	152.7	2.80	9.6	28.7	113	141.7
160	BUFFALO	NY	60.2	ELEM	O	1.90	6.5	19.5	64	83.5	2.20	7.5	22.5	60	82.5
161	BUFFALO	NY	59.1	ELEM	O	1.50	5.1	15.4	223	238.4	1.80	6.1	18.4	153	171.4
162	BUFFALO	NY	73.8	ELEM	O	3.10	10.6	31.8	89	120.8	2.60	8.9	26.6	73	99.6
163	BUFFALO	NY	79.7	ELEM	OL	2.50	8.5	25.6	108	133.6	2.00	6.8	20.5	80	100.5
164	BUFFALO	NY	74.0	ELEM	O	4.60	15.7	47.1	87	134.1	3.60	12.3	36.9	67	103.9
165	BUFFALO	NY	72.2	ELEM	O	3.00	10.2	30.7	106	136.7	2.80	9.6	28.7	100	128.7
166	BUFFALO	NY	45.6	ELEM	O	2.90	9.9	29.7	163	192.7	3.20	10.9	32.8	153	185.8
167	BUFFALO	NY	70.2	ELEM	O	3.00	10.2	30.7	101	131.7	3.80	13.0	38.9	58	96.9
168															
169	BUFFALO	NY	73.7	ELEM	O	3.60	12.3	36.9	98	134.9	3.00	10.2	30.7	79	109.7
170	BUFFALO	NY	69.0	ELEM	O	2.80	9.6	28.7	93	121.7	2.50	8.5	25.6	78	103.6
171	BUFFALO	NY	80.6	ELEM	O	2.10	7.2	21.5	128	149.5	2.70	9.2	27.7	76	103.7
172	BUFFALO	NY	78.0	ELEM	O	4.50	15.4	46.1	141	187.1	3.60	12.3	36.9	110	146.9
173	BUFFALO	NY	78.5	ELEM	OL	1.60	5.5	16.4	97	113.4	1.70	5.8	17.4	68	85.4
174	BUFFALO	NY	79.5	ELEM	OL	2.30	7.9	23.6	109	132.6	1.90	6.5	19.5	74	93.5
175	BUFFALO	NY	80.2	ELEM	OL	2.40	8.2	24.6	122	146.6	3.30	11.3	33.8	90	123.8
176	BUFFALO	NY	83.6	ELEM	O	2.10	7.2	21.5	115	136.5	2.00	6.8	20.5	81	101.5
177	BUFFALO	NY	34.3	ELEM	O	4.80	16.4	49.2	95	144.2	3.80	13.0	38.9	95	133.9
178	BUFFALO	NY	13.0	ELEM	O	3.10	10.6	31.8	103	134.8	4.20	14.3	43.0	88	131.0
179															
180	BUFFALO	NY	54.8	ELEM	O	2.50	8.5	25.6	81	106.6	2.40	8.2	24.6	69	93.6
181	BUFFALO	NY	191.0	ELEM	O	14.50	49.5	148.6	72	220.6	16.60	56.7	170.1	72	242.1
182	BUFFALO	NY	280.0	ELEM	O H	3.50	12.0	35.9	118	153.9	2.70	9.2	27.7	82	109.7
183	BUFFALO	NY	104.5	ELEM	O	6.70	22.9	68.6	103	171.6	4.70	16.1	48.2	56	104.2
184	BUFFALO	NY	112.4	ELEM	O	7.60	26.0	77.9	125	202.9	4.00	13.7	41.0	72	113.0
185	BUFFALO	NY	201.5	ELEM	O H	5.40	18.4	55.3	91	146.3	5.20	17.8	53.3	78	131.3

A	G1	G2	H1	H2	K	J	L1	L2	L3	L4	M	N	
	<---- S A V E D			---->		COST OF RETRO-	COST PER ANNUAL SAVINGS		COST OF CONSEVED SITE ENERGY				
BLDG NO	(KBTU/SQFT) SITE	SOURC	(PERCENT) SITE	SOURC	SIMP PAYB YRS ****	FIT (1980$ /SQFT) ******	(1980 $/ MBTU/YR) SITE	SOURC	($/MBTU) CRR= .16	CRR= .25	COOLG DECR DAYS *****	HEATG DECR DAYS *****	COMMENTS
126	31.1	37.2	31	30							2388	5591	
127	19.6	16.9	16	12							2388	5591	
128	53.0	55.1	39	36							2388	5591	
129	9.3	3.8	9	3							2388	5591	
130	2.8	12.3	2	9							2388	5591	
131	17.7	17.0	13	11							2388	5591	
132	40.0	40.0	33	25							2388	5591	
133	12.6	5.8	13	5							2388	5591	
134	5.7	7.0	4	5							2388	5591	
135	-7.7	-11.1	-5	-7							2388	5591	
136	32.7	34.0	30	27							2388	5591	
137	42.4	47.2	35	34							2388	5591	
138	36.0	33.9	33	25							2388	5591	
139	22.8	32.3	22	25							2388	5591	
140	10.0	14.1	9	10							2388	5591	
141	26.0	30.1	36	33							2388	5591	
142	33.1	39.2	31	31							2388	5591	
143	63.0	63.0	54	42							2388	5591	
144	-.7	-4.1	-0	-3							2388	5591	
145	27.6	22.8	27	19							2388	5591	
146	34.7	40.2	26	26							2388	5591	
147	23.0	25.1	23	20							2388	5591	
148	29.8	37.3	22	24							2388	5591	
149	23.0	23.0	21	18							2388	5591	
150	12.3	8.9	13	8							2388	5591	
151	-5.1	-11.2	-2	-6							2388	5591	
152	-5.4	-14.3	-6	-12							2388	5591	
153	19.3	20.0	29	24							2388	5591	
154	8.0	5.9	8	5							2388	5591	
155	49.4	52.1	35	31							2388	5591	
156	4.7	4.0	4	3							2388	5591	
157	-32.3	-28.9	-29	-21							2388	5591	
158	22.7	22.0	19	16							2388	5591	
159	10.3	11.0	8	7							2388	5591	
160	3.0	.9	4	1							2388	5591	
161	69.0	66.9	30	28							2388	5591	
162	17.7	21.1	18	17							2388	5591	
163	29.7	33.1	25	25							2388	5591	
164	23.4	30.2	23	23							2388	5591	
165	6.7	8.0	6	6							2388	5591	
166	9.0	6.9	5	4							2388	5591	
167	40.3	34.8	36	26							2388	5591	
168													
169	21.0	25.1	19	19							2388	5591	
170	16.0	18.1	16	15							2388	5591	
171	50.0	45.9	37	31							2388	5591	
172	34.1	40.2	22	21							2388	5591	
173	28.7	28.0	28	25							2388	5591	
174	36.4	39.1	31	29							2388	5591	
175	28.9	22.8	22	16							2388	5591	
176	34.3	35.0	28	26							2388	5591	
177	3.4	10.2	3	7							2388	5591	
178	11.2	3.7	10	3							2388	5591	
179													
180	12.3	13.0	14	12							2388	5591	
181	-7.2	-21.5	-5	-9							2388	5591	
182	38.7	44.2	30	29							2388	5591	
183	53.8	67.5	43	39							2388	5591	
184	65.3	89.9	43	44							2388	5591	
185	13.7	15.0	13	10							2388	5591	

APPENDIX A (cont'd)

A	B		C	D	D1		E	E1	E2	E(F)	E(T)	F	F1	F2	F(F)	F(T)
							<-- ANNUAL ENERGY USE PER SQ. FT. -->									
							<------ BEFORE ------>					<------ AFTER ------>				
							<--ELECTRICITY-->			FUEL	TOTAL	<--ELECTRICITY-->			FUEL	TOTAL
BLDG NO	LOCATION		AREA (KSQFT) *******	USE CAT.	RETROFIT MEASURE		(KWH) *****	(KBTU) SITE	(KBTU) SOURC	(KBTU) SOURC *****	(KBTU) SOURC	(KWH) *****	(KBTU) SITE	(KBTU) SOURC	(KBTU) SOURC *****	(KBTU) SOURC
186	BUFFALO	NY	191.6	ELEM	O		5.70	19.5	58.4	99	157.4	4.30	14.7	44.1	80	124.1
187	BUFFALO	NY	180.0	ELEM	O		5.20	17.8	53.3	119	172.3	4.60	15.7	47.1	83	130.1
188	BUFFALO	NY	236.0	SEC	O		4.50	15.4	46.1	127	173.1	5.20	17.8	53.3	106	159.3
189	BUFFALO	NY	42.0	SEC	O		4.70	16.1	48.2	112	160.2	3.30	11.3	33.8	101	134.8
190	BUFFALO	NY	185.2	SEC	O		4.80	16.4	49.2	125	174.2	3.30	11.3	33.8	89	122.8
191	BUFFALO	NY	175.0	SEC	O		5.50	18.8	56.3	177	233.3	3.80	13.0	38.9	115	153.9
192	BUFFALO	NY	155.0	SEC	O		5.90	20.1	60.4	161	221.4	5.30	18.1	54.3	117	171.3
193	BUFFALO	NY	168.4	SEC	O		2.40	8.2	24.6	88	112.6	2.00	6.8	20.5	89	109.5
194	BUFFALO	NY		SEC	O		3.70	12.6	37.9	101	138.9	3.60	12.3	36.9	103	139.9
195	BUFFALO	NY	197.0	SEC	O		3.30	11.3	33.8	142	175.8	3.00	10.2	30.7	97	127.7
196	BUFFALO	NY	185.0	SEC	O		5.10	17.4	52.2	134	186.2	4.50	15.4	46.1	89	135.1
197	BUFFALO	NY	160.0	SEC	O		3.80	13.0	38.9	102	140.9	4.80	16.4	49.2	88	137.2
198	BUFFALO	NY	255.0	SEC	O		8.20	28.0	84.0	100	184.0	9.20	31.4	94.3	98	192.3
199	BUFFALO	NY	175.0	SEC	O		5.50	18.8	56.3	127	183.3	6.00	20.5	61.5	108	169.5
200	BUFFALO	NY	167.0	SEC	O		4.00	13.7	41.0	96	137.0	3.80	13.0	38.9	72	110.9
201	BUFFALO	NY	211.0	SEC	O		3.40	11.6	34.8	130	164.8	5.10	17.4	52.2	110	162.2
202	ROCKVILLE	MD	195.2	SEC		E	12.60	43.0	129.1	89	218.1	6.40	21.9	65.6	32	97.6
203	ROCKVILLE	MD	218.5	SEC		E	10.50	35.9	107.6	119	226.6	5.80	19.8	59.4	47	106.4
204	CLAYTON	OH	287.2	SEC	O C	E	17.00	58.1	174.2	117	291.2	14.00	47.8	143.4	83	226.4
205	CROTON-ON-HUDSON	NJ	7.7	COMCEN	OLW											
206	AUSTIN	TX	219.0	LO	OL H		30.70	104.8	314.5	500	814.5	19.90	68.0	203.9	247	450.9
207	COLUMBIA	MD	31.9	COMCEN	O I											
208	COLUMBIA	MD	14.4	COMCEN	O C											
209	COLUMBIA	MD	3.2	COMCEN	O CI											
210	COLUMBIA	MD	2.4	COMCEN	O C											
211	COLUMBIA	MD	28.9	COMCEN	OL											
212	COLUMBIA	MD	4.1	COMCEN	OLWCI											
213	COLUMBIA	MD	2.7	COMCEN	OLWCI											
214	COLUMBIA	MD	2.7	COMCEN	O W I											
215	COLUMBIA	MD	1.3	COMCEN	O WC											
216	COLUMBIA	MD	1.5	COMCEN	O CI											
217	COLUMBIA	MD	1.5	COMCEN	O CI											
218	COLUMBIA	MD	2.1	COMCEN	O											
219	COLUMBIA	MD	2.3	COMCEN	O C											
220	COLUMBIA	MD	1.6	COMCEN	O CI											
221	COLUMBIA	MD	1.8	COMCEN	O CI											
222	COLUMBIA	MD	1.3	COMCEN	OLWCI											
223	COLUMBIA	MD	6.4	COMCEN	OL C											
224	COLUMBIA	MD		COMCEN												
225	COLUMBIA	MD		COMCEN												
226	COLUMBIA	MD	12.6	COMCEN	OL											
227	COLUMBIA	MD		COMCEN												
228	COLUMBIA	MD		COMCEN												
229	COLUMBIA	MD		COMCEN												
230	COLUMBIA	MD	11.8	COMCEN	O											
231	COLUMBIA	MD		COMCEN												
232	COLUMBIA	MD		COMCEN												
233	COLUMBIA	MD		COMCEN												
234	COLUMBIA	MD		COMCEN												
235	COLUMBIA	MD		COMCEN												

A	G1	G2	H1	H2	K	J	L1	L2	L3	L4	M	N	
	<—— S A V E D			——>		COST OF RETRO-	COST PER ANNUAL SAVINGS		COST OF CONSEVED SITE ENERGY				
BLDG NO	(KBTU/SQFT) SITE	SOURC	(PERCENT) SITE	SOURC	SIMP PAYB YRS	FIT (1980$ /SQFT)	(1980 $/ MBTU/YR) SITE	SOURC	($/MBTU) CRR= .16	CRR= .25	COOLG DEGR DAYS	HEATG DEGR DAYS	COMMENTS
186	23.8	33.3	20	21							2388	5591	
187	38.0	42.1	28	24							2388	5591	
188	18.6	13.8	13	8							2388	5591	
189	15.8	25.3	12	16							2388	5591	
190	41.1	51.4	29	29							2388	5591	
191	67.8	79.4	35	34							2388	5591	
192	46.0	50.1	25	23							2388	5591	
193	.4	3.1	0	3							2388	5591	
194	-1.7	-1.0	-0	-0							2388	5591	
195	46.0	48.1	30	27							2388	5591	
196	47.0	51.1	31	27							2388	5591	
197	10.6	3.8	9	3							2388	5591	
198	-1.4	-8.2	-0	-3							2388	5591	
199	17.3	13.9	12	8							2388	5591	
200	24.7	26.0	23	19							2388	5591	
201	14.2	2.6	10	2							2388	5591	
202	78.2	120.5	59	55							4237	3182	
203	88.1	120.2	57	53							4237	3182	
204	44.2	64.7	25	22		.08	1.8	1.2	.3	.5		5622	
205	100.0		52			5.83	58.3		9.3	14.6		3739	
206	289.9	363.6	48	45		1.28	4.4	3.5	.7	1.1		1737	
207		236.0		53	<1	.02		.1			4237	3182	ONLY HAVE SOURCE TOTALS
208		-8.0		-1		.02		-1.9			4237	3182	ONLY HAVE SOURCE TOTALS
209		33.0		4	1-2	.94		28.5			4237	3182	ONLY HAVE SOURCE TOTALS
210		6.0		2	<1	.17		28.3			4237	3182	ONLY HAVE SOURCE TOTALS
211		148.0		28		.05		.3			4237	3182	DROPPED FROM STUDY
212		7.0		2		.56		80.0			4237	3182	ONLY HAVE SOURCE TOTALS
213		117.0		30	<1	.45		3.8			4237	3182	ONLY HAVE SOURCE TOTALS
214		54.0		19	1-2	.73		13.5			4237	3182	ONLY HAVE SOURCE TOTALS
215		-176.0		-31		.78		-4.4			4237	3182	ONLY HAVE SOURCE TOTALS
216		95.0		19	2-3	1.09		11.5			4237	3182	ONLY HAVE SOURCE TOTALS
217		66.0		17							4237	3182	ONLY HAVE SOURCE TOTALS
218		60.0		19	1-2	.27		4.5			4237	3182	ONLY HAVE SOURCE TOTALS
219		55.0		12	<1	.21		3.8			4237	3182	ONLY HAVE SOURCE TOTALS
220		233.0		43	<1	.41		1.8			4237	3182	ONLY HAVE SOURCE TOTALS
221		94.0		19	<1	.36		3.8			4237	3182	ONLY HAVE SOURCE TOTALS
222		39.0		9	1-2	.47		12.1			4237	3182	ONLY HAVE SOURCE TOTALS
223		69.0		24	<1	.17		2.5			4237	3182	ONLY HAVE SOURCE TOTALS
224		94.0		33							4237	3182	
225											4237	3182	
226		230.0		40	<1	0.					4237	3182	ONLY HAVE SOURCE TOTALS
227											4237	3182	
228											4237	3182	
229											4237	3182	
230		63.0		22	<1	.06		1.0			4237	3182	ONLY HAVE SOURCE TOTALS
231											4237	3182	
232											4237	3182	
233											4237	3182	
234											4237	3182	
235											4237	3182	WINDOW DID NOT WORK BECAUSE OF CLUE

This report was done with support from the Department of Energy. Any conclusions or opinions expressed in this report represent solely those of the author(s) and not necessarily those of The Regents of the University of California, the Lawrence Berkeley Laboratory or the Department of Energy.

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