ENERGY SAVINGS IN 12 MULTIFAMILY BUILDINGS RETROFITTED UNDER A SHARED SAVINGS PROGRAM

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INTRODUCTION AND METHODOLOGY

Since 1983, the Energy Resource Center has invested over $450,000 in multifamily energy conservation retrofits through its Shared Savings Financing Program. The performance of 12 buildings (each having 5 to 33 units) retrofitted under this program was monitored over the 1985-86 heating season to determine the accuracy of audit predictions and to analyze the cost-effectiveness of energy efficiency retrofits in apartment buildings. Retrofit packages were chosen to produce energy savings sufficient to retire the debt incurred to make the improvements over six years. The retrofits for these buildings included both envelope measures and heating system improvements. Predicted energy savings were calculated using a computerized audit (CIRA 1.0) developed by LBL, along with estimates for heating system improvements provided by a local consulting engineer.

Data collected at the buildings included total building natural gas consumption on a bi-weekly basis, as well as submetered domestic hot water and space heat gas consumption at seven buildings. At three of the sites, individual heating system components were turned on and off every two weeks to provide data on the effectiveness of the individual components. Normalized annual energy consumption for each building was estimated using the Princeton Scorekeeping Model. Funding for the research project was provided by a grant from the Minnesota Department of Energy and Economic Development.

ANALYSIS AND RESULTS

Table 1 shows that significant energy savings were achieved at each of the 12 buildings. Measured energy savings ranged from a high of 56 percent at the Scudder and Laurel buildings to a low of eight (8) percent at Arundel, with an average measured reduction in total gas consumption of 31 percent. This compares to an average predicted savings of 28 percent for the buildings.

Figure 1 shows a good correlation between measured and predicted energy savings for the building set. These data suggest that energy savings for apartment buildings can be predicted with reasonable accuracy using readily available auditing techniques. While only three buildings performed better than predicted, these three buildings account for approximately 59 percent of the natural gas saved, thus producing the greater than average predicted savings.

An economic analysis of the energy improvement investments is shown in Figure 2 and indicates that all of the buildings except one saved energy at a cost per ccf saved that is less than the current cost of natural gas ($0.55/ccf). The average cost of conserved energy for the buildings is $0.32 per ccf, or approximately 40 percent lower than the market price of natural gas. The average simple payback for the 12 buildings equals 5.3 years and is based on an average energy savings of 0.33 ccf's per square foot and an improvement cost of $0.96 per square foot. Figure 2 also shows

that those investments which included a two-pipe steam to hot water conversion of the heating system appear to be very cost-effective despite the large initial investment cost.

In addition to maintaining strict quality control over the improvement installation process, the Shared Savings Program included on-going monitoring and tuning of building heating systems in order to ensure maximum energy savings. Because this monitoring can be considered an added retrofit cost, an additional $2,700 (estimated discounted monitoring cost over 15 years) was added to each building's cost of retrofit (shown by the dotted line in Figure 2). Figure 2 shows that this additional retrofit expense does not significantly reduce the cost-effectiveness of the energy investments. Our experience suggests that without on-site visits building energy performance can decrease significantly, indicating that on-going monitoring and tuning is an extremely important and cost-effective component of any multifamily retrofit program.

Analysis of the energy performance of two high efficiency front end modular boilers showed that the cost-effectiveness of the systems are dependent on their use for both space and domestic hot water heating. The simple payback for the two front end boiler retrofits are five (5) and six (6) years with measured annual energy savings of $1,133 and $863 respectively. Examination of the performance of an electric vent damper installed on a low-mass steam boiler showed annual energy savings of $563 and a simple payback of less than one year. An analysis of the performance of the domestic hot water heating systems in seven buildings is also included in the final research report (Evaluation of the Energy and Economic Performance of 12 Multifamily Buildings Retrofitted Under a Shared Savings Program).

Table I. Simple payback and cost of conserved energy based on a constant energy cost of $0.55 per ccf and a present value factor of 9.11 (15 year investment lifetime and 7 percent real discount rate).

BUILDING LABEL	PRE NAC (CCF/YR)	POST NAC (CCF/YR)	ENERGY SAVED (CCF/YR)	ENERGY SAVED (PERCENT)	PREDICTED SAVINGS (PERCENT)	COST TO RETROFIT		SIMPLE PAYBACK (YEARS)	COST OF CONSERVED ENERGY ($/CCF)
						TOTAL ($)	PER SQFT ($/SQFT)		
MONTROSE	7857	4366	3491	44	51	10659	1.35	6	0.34
ST. CLAIR	31776	22583	9193	29	19	22348	0.69	4	0.27
SUMMIT	13414	9869	3545	26	31	11287	0.88	6	0.35
LINWOOD	9862	7458	2404	24	31	5477	0.44	4	0.25
GRAND	39451	31008	8443	21	22	36777	0.96	8	0.48
MARSHALL	9771	7758	2013	21	24	6117	0.94	6	0.33
LAUREL	10355	4532	5823	56	58	16678	1.47	5	0.31
ARUNDEL	12014	11077	937	8	16	6516	0.34	13	0.76
HOLLY	22051	12688	9363	42	51	35529	2.12	7	0.42
VIRGINIA	12418	7954	4464	36	48	14076	1.60	6	0.35
BIRMINGHAM	136313	91499	44814	33	24	105660	0.86	4	0.26
SCUDDER	6194	2720	3474	56	39	10825	2.37	6	0.34

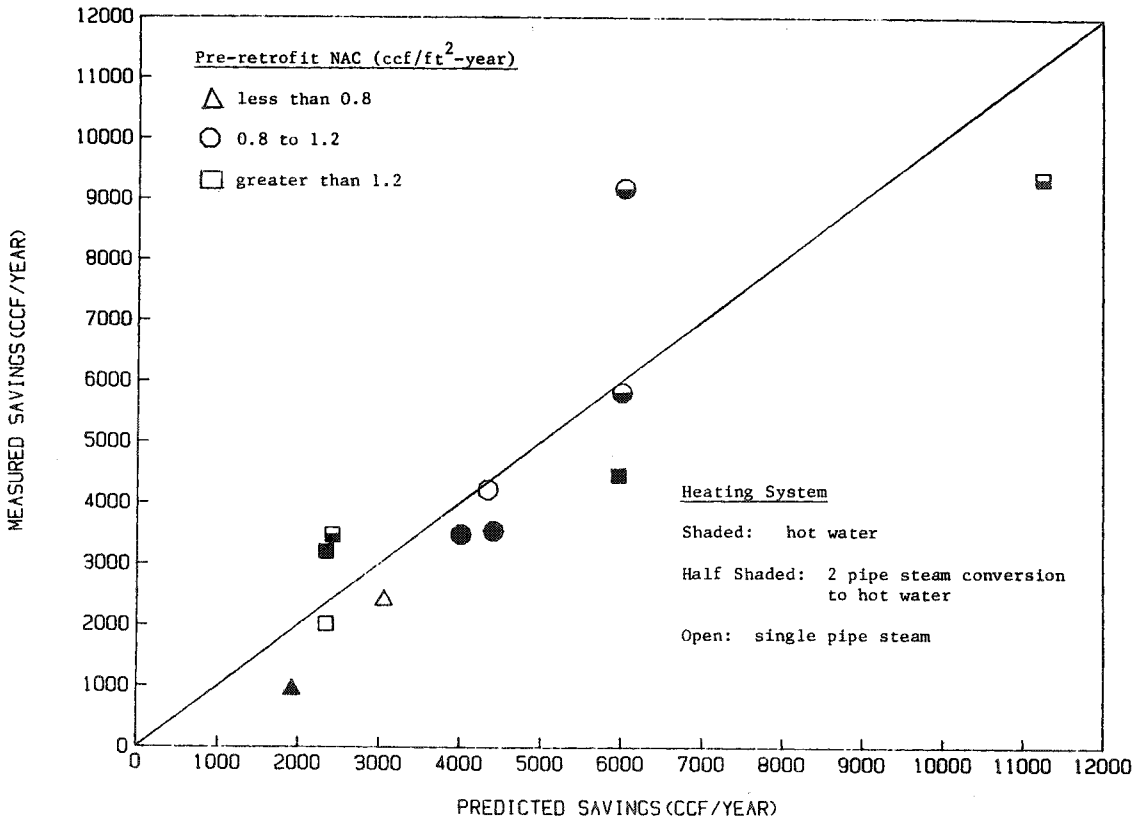

Figure 1. Comparison of measured and predicted energy savings.

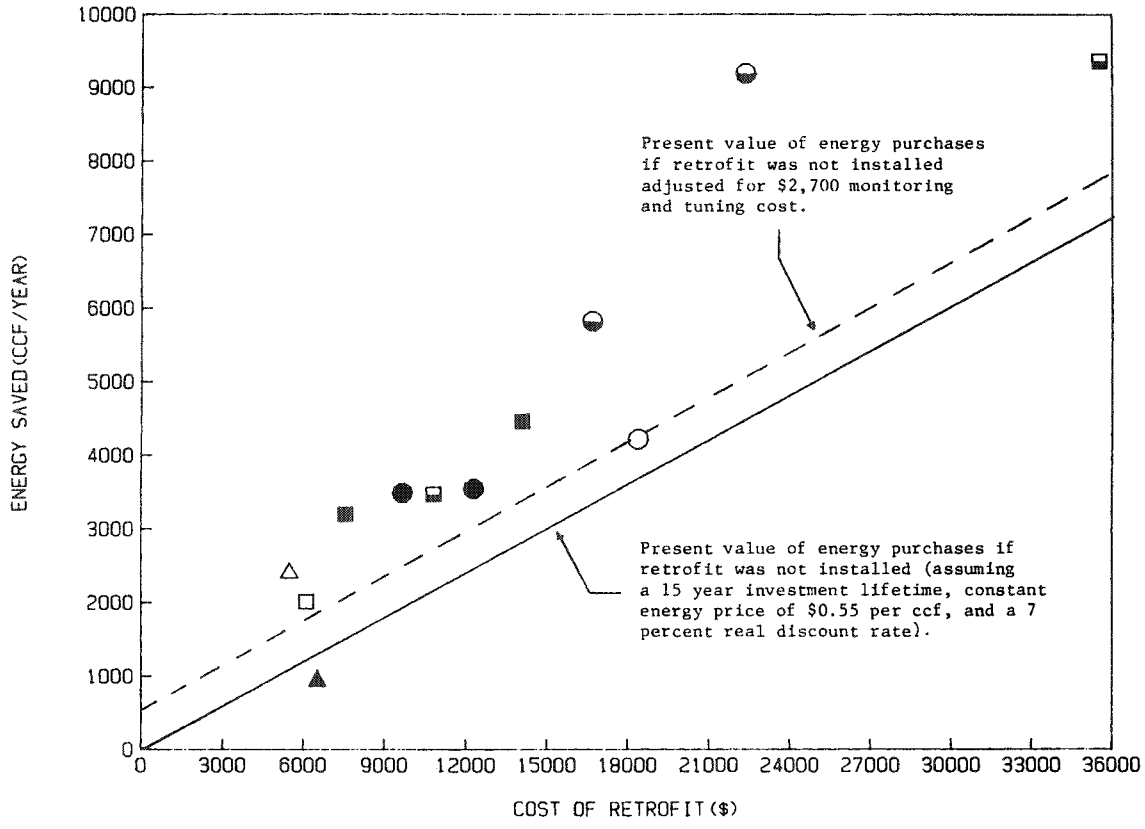

Figure 2. Annual energy savings compared to total cost of retrofit.