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ENERGY SAVINGS ATTRIBUTABLE TO SWITCHING FROM MASTER
METERING TO INDIVIDUAL METERING OF ELECTRICITY

by

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January 1981

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INTRODUCTION

Master metering, or the use of one meter to measure the electricity consumption in more than one unit in a multiunit building, is widespread in the United States. In a master-metered building, tenants pay for their electricity in their rents, unless the landlord submeters, so there is little incentive for tenants to conserve electric power. However, in a building with individual meters, electric bills go directly to each tenant, so there is an incentive to conserve electricity.

This technical memo reviews and analyzes the published literature on electricity consumption by tenants in buildings with individual meters, compared with electricity consumption in buildings with master meters. An important finding is that energy savings of individual over master metering are strongly correlated with the price of electricity.

DATA SOURCES

The reports reviewed here compare individual metering with master metering in residential buildings.¹⁻⁴ The studies in the reports fall into two categories: (1) comparisons of electric power consumption in buildings converted to individual metering from master metering and (2) comparisons of matched buildings with individual and master metering. Some of the studies were considered inadequate, such as one in which the comparison of energy consumption was limited to just two months. These were not included in Table 1, which lists the validated studies.

All the studies reviewed reported savings from the use of individual meters, compared to use of master meters, but the percentage savings varied widely. There are a number of reasons for these variations. Some are reflections of differences in study methodology. Other variations result from factors that a priori may be expected to affect savings, such as differences in the price of electricity, tenant income, proportion of tenant income spent on electricity, the way electricity is used, and geographic location. Also, the studies in Table 1 were made from 1969 to 1977, a period when major changes occurred in electricity price and in the public perception of future energy prices and availability. Those studies that overlapped in time the 1974 oil embargo may have been especially affected.

There also may be potential data biases in the studies listed in Table 1. This is especially true of data in matched building studies, for no two buildings are completely identical. In addition, it is possible that multiunit residential buildings with master meters attract high energy users. Consequently, a difference in electricity use in a building converted from a master meter to individual meters may result from lower energy use by the tenants that remain in the building as well as from the replacement of high energy users with low energy users. Because of these biases, the question, "What energy savings would result from elimination of master metering?" may best be answered by before-and-after studies of one market area in which all the rental buildings in the study are converted simultaneously.

Table 1 Differences in Electric Energy Consumption for Master Metering and Individual Metering of Tenants in Multi-unit Residential Buildings

Location	Reported Savings (%)	Energy Use	Study Period (years)		Consumption, Master metering (kWh/yr/unit)
			Master	Individual	
<u>Conversion Studies</u>					
Los Angeles	7	Lights ^a	1972	1974	2,868
San Francisco	25	Lights	1970	1973	3,105
San Francisco	25	Lights	1976	1977	6,736
Los Angeles	50	Lights	1972	1974	1,968
Los Angeles	63	Lights	1973	1974	3,456
Rochester, N.Y.	4 ^b	Cooling ^c	1975	1976	9,540
Rochester, N.Y.	8 ^b	Cooling	1975	1976	8,176
Houston	15 ^b	Cooling	1975	1974	18,895
Washington, D.C.	26 ^b	Cooling	1976	1978	4,968
Baltimore, Md.	32	Cooling	1974	1975	8,413
Pittsburgh	38 ^b	Cooling	1972-73	1973-74	4,446
Pittsburgh	40	Cooling	1971	1973-74	4,436
Pennsylvania	12	Heating ^d	1974	1975	11,406
Arkansas	13 ^b	Total ^e	1974	1975	13,908
Los Angeles	18	Total	1974-75	1975-76	6,404
Washington, D.C.	34	Total	1973	1974	4,176
Atlantic City, N.J.	35 ^b	Total	1972-73	1974	18,586
Houston	8 ^b	Total	1969	1974	10,956
<u>Matching Studies</u>					
Detroit	40	Lights	1974	1974	2,904
Washington, D.C.	22	Cooling	1974	1974	3,684
Detroit	35	Cooling	1974	1974	9,745
Kansas City, Mo.	47	Cooling	1974	1974	10,168
Houston	9	Total	1972	1972	15,000
Houston	12	Total	1972	1972	14,124
Boston	14	Total	1972	1972	13,032
Pennsylvania	14	Total	1972	1972	16,788
Pennsylvania	23	Total	1972	1972	17,316
Philadelphia	38	Total	1974-75	1974-75	9,696

^aLights includes appliances.

^bAdjusted for year to year differences in weather.

^cCooling includes lights.

^dHeating includes lights.

^eTotal includes heating and cooling.

EFFECT OF ELECTRICITY USE ON REPORTED SAVINGS

The data in Table 1 indicate there are significant differences in electricity savings and suggest that these result from the way electricity is used. Table 2, based on a format from an earlier literature review,³ shows that savings are smaller when electricity is also used for heating than when it is used only for lights and appliances or only for lights, appliances, and cooling. Based on the average of these best guesses, the average electricity savings are about 20%. However, as discussed below, a significant portion of the differences in savings is due to differences in electricity price.

EFFECT OF ELECTRICITY PRICE ON SAVINGS

When a tenant pays his electric bill out of his own pocket, the cost of electricity is an important factor in the amount used. An unpublished Argonne study indicates that electricity price is the primary reason for differences in consumption between individual and master metering.

To analyze the effect of electricity price on savings, marginal electricity prices were estimated on the basis of the average building unit consumption and the applicable utility rate structure for July 1, 1974. For more than 80% of the studies in Table 1, the rate structure included declining block rates. Table 3 shows a typical declining block rate schedule. Under such a schedule, a tenant using 158 kWh/mo would face a marginal electricity price of 3.5¢/kWh, while one using 580 kWh/mo would face a marginal electricity price of 2.1¢/kWh. A fuel adjustment, if any, would be added to all rate blocks uniformly.

Table 2 Expected Energy Savings from Use of Individual Meters Instead of Master Meters

Energy Use	Best Guess ^a (%)	Expected Minimum ^b (%)	Expected Maximum ^b (%)
Lights and appliances	21	16	35
Cooling, lights, and appliances	23	8	35
Total electric	14	12	28

^aBest guess is the mean of the results reported in Table 1.

^bExpected minima and maxima are approximately the 20th and 80th percentile savings values, respectively, from Table 1.

Figure 1 plots electricity savings versus the July 1, 1974, marginal electric price without fuel adjustment. Addition of fuel adjustments does not materially affect this relationship. The line drawn in Fig. 1 is defined by the following equation:

$$S = -16.5 + 19.5PE$$

where S = percent savings and PE = price of electricity in cents per kWh. The R^2 value, a measure of the goodness of fit, is 0.58, while the f statistic is 36.6. The R^2 value means that 58% of the variation in the savings can be accounted for by price. The f statistic indicates the relationship is statistically significant at the 99% level. When fuel adjustments

Table 3 Typical Declining Block Electric Rate Schedule

Consumption per Month (kWh)	Cost (¢/kWh)
0-100	3.5
101-300	3.0
301-500	2.5
>500	2.1

Fig. 1 Percent Electric Savings Versus Marginal Electricity Price

are included, the goodness of fit is reduced to 0.53 and the f statistic to 28.9; this is still statistically significant at the 99% level.

Thus the evidence supports the conclusion that electricity price is the key factor in variations in electricity savings in the studies of individual versus master metering. There is insufficient information in the studies reviewed to determine the effects of other uncontrolled factors on variations in electricity savings.

CONCLUSIONS

Two conclusions may be drawn from this review and analysis of current published literature on consumption of electricity by tenants with master metering, compared to those with individual metering:

1. The price of electric power is an important factor in accounting for variations in the amount of electricity saved with individual metering.
2. The average savings reported in the studies reviewed here, when use is considered, is about 20%.

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