Equipment Submetering to Verify Demand Reduction Claims of Selected Measures of a Commercial Rebate Program: Four Case Studies

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INTRODUCTION

This paper describes a project undertaken by a major Midwestern utility to verify the kilowatt demand reduction of conservation measures supported by their commercial, industrial and farm rebate program. The purpose of the submetering project is to determine if the demand reduction calculated by the Field Engineer before installation approximates the reduction after installation. Verification of demand reduction was accomplished through submetering selected measures with power analyzing equipment before and after the conservation measures were installed.

REBATE PROGRAM

The purpose of a rebate program is to provide customers with financial incentives to install energy efficient equipment. The desired end result of such a program is a reduction in peak demand on the utility grid. This major utility implemented an extensive rebate program in response to a public service commission mandate. The rebates are divided into eight categories: Lighting; HVAC; Water Heating; Controls; Refrigeration; Process Improvements; Farm; and Load Management. Each category is subdivided into specific measures where guidelines for project eligibility and rebate levels are defined.

MEASUREMENT APPROACH

Numerous projects were randomly chosen from a data base to obtain a sampling of projects in the program. The projects chosen are representative of those where calculating a KW demand reduction is difficult, such as with variable speed drives, compressor replacement, refrigeration compressor controls and heat recovery.

Commercially available power analyzers which monitor KW, volts, amps, PF, KVA & KVAR were utilized. These meters can store the data in memory and transfer it to a personal computer for analysis. The measurement accuracy reported by the manufacturer is ± .8% of the reading.

Variables which may affect the component's demand and energy use, such as, production rate, schedule of operation and frequency of use, were minimized during testing to maintain consistency in the data obtained. Each site was submetered as close to the retrofit date as possible so that other variables such as weather would not influence the results.

DATA ANALYSIS

Data collected at each site was downloaded from the power analyzer to a personal computer where the results were analyzed to determine actual KW savings. Raw data was transferred to a spreadsheet where calculations were performed and graphs generated to show the KW demand of the equipment before and after the retrofit. In most cases the KW demand reduction is evident in the 24 hour load profiles. Additional analysis determined the average KW reduction during the 12-4 p.m. peak period.

CASE STUDIES

Four case studies which represent a wide spectrum of applicable projects are presented to illustrate results obtained in the submetering project. They are:

1. A DC-driven dispatch conveyor system converted to variable speed drive (VSD) with high efficiency AC motors.
2. A grocery refrigeration system with solid state control.
3. A dairy domestic hot water heat recovery system.
4. Replacement of two reciprocating with one screw compressor.

Table I summarizes the KW reduction calculated versus actual measured values, for each case study. Figure 1 illustrates the variance in demand profiles of a composite day on the same graph before and after retrofit. A composite day is a twenty-four hour characteristic demand profile consisting of mean interval demands determined by averaging the demand for each interval over the total submetering period. The submetering periods were between 3 and 8 days before and after retrofit.

Table I. Comparison of Calculated and Measured KW of Each Case Study.

Case	Calculated		Measured		Calculated		Measured	
Study	KW Before	KW After	KW Before	KW After	ΔKW	%	ΔKW	%
1	8.09	5.83	8.00	5.20	2.26	27.9	2.80	35.00
2	25.00	21.25	25.21	18.77	3.75	15.0	6.44	25.50
3	5.00	0.00	2.13	0.12	5.00	100.0	2.01	94.40
4	129.00	111.00	87.23	93.55	18.00	14.0	-6.32	-7.25

Project 1

The scope of this project included replacing four (4) VSD DC motors with four (4) VSD high efficiency AC motors. The motors drive conveyors which move paper bundles from the production area. A total reduction of 0.66 KW was calcuated due to the change in motor efficiency. The effect of replacing a DC VSD with an AC VSD (with an average-to-full-load RPM ratio of .833) was calculated to be a 1.60 KW reduction. The total reduction calculated by the Field Engineer was 2.26 KW. An average reduction of 2.80 KW was recorded during the peak period between 12 p.m. and 4 p.m. of a composite day for all motors combined.

Project 2

In this project an "intelligent" solid state suction pressure control system was installed on an existing super market low temperature refrigeration rack. It operates only those compressors which will satisfy the load. A fifteen percent savings from the base KW was assumed for the rebate calculation. This proved to be a conservative estimate for the project. Savings were much greater than expected; 6.44 KW (25.8%) rather than 3.75 KW (15%).

Project 3

The scope of this project was to retrofit a domestic hot water heater with refrigeration waste heat recovery. The reduction in KW calculated by the Field Engineer was 5.0 KW. Essentially the project is intended to eliminate the hot water coil. The composite day illustrates that the heat recovery effectively eliminates electric heating except when tank recovery capacity is not sufficient. The on-peak demand decreased 2.01 KW. The greatest demand reduction (>4.0 KW) occurs during non-critical periods of the 12 hour demand period.

Project 4

The project involved replacing two aging 75 HP reciprocating air compressors with one 150 HP screw compressor in a cheese processing plant. The air requirement of the processes was similar with both systems. The rebate level was calculated using figures for savings supplied by the manufacturer. The vendor calculated an 18 KW reduction with the new system. The results of the test illustrated that the new compressor actually used 6.3 KW more than the old system. This occurred because screw compressors are less efficient than reciprocating compressors.

CONCLUSION

Calculating an accurate KW reduction for a rebate application can be difficult since many factors that influence savings cannot be determined except through submetering. Submetering has shown that the accuracy of an engineer's estimate can vary greatly. A substantially high percentage of utility rebates occur in the lighting category. The accuracy of predicting KW reductions is well documented in lighting applications. Three recommendations are suggested for planning and implementing rebate programs:

1) Field Engineers should not rely wholly on calculations provided by vendors as a basis for calculating demand reductions.
2) Submetering a multiple number of actual retrofit measures should be a foundation for setting or adjusting rebate levels.
3) Submetering should be considered when determining rebate amounts for certain applications where load and capacity factors are difficult to determine and when the expected rebates exceed a predetermined ceiling, perhaps $20,000. The additional cost of submetering will be recouped if an accurate rebate can be determined. It is estimated that submetering before and after will require approximately 8 to 10 hours of engineering time (approximately $500) per project.

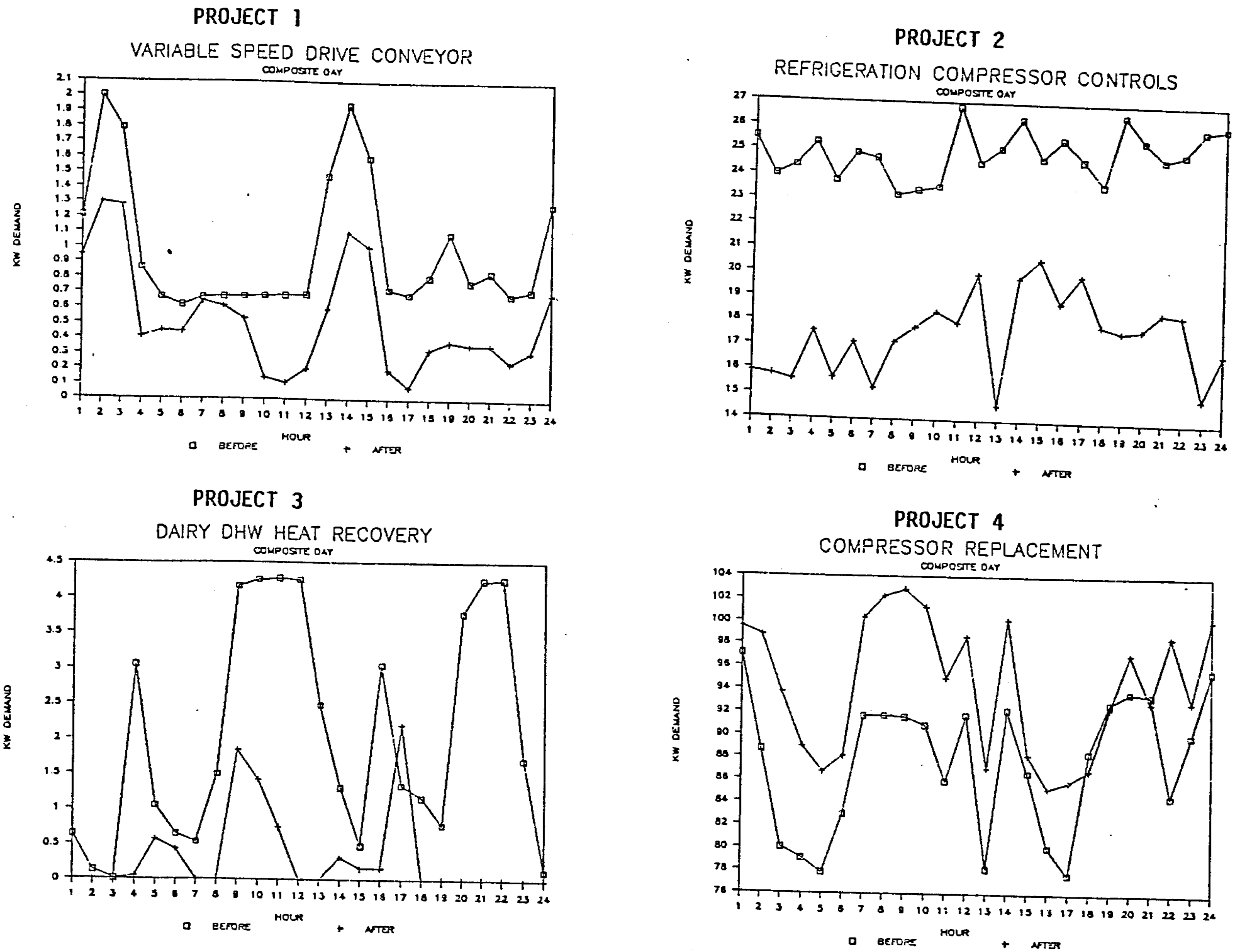

FIGURE 1. Composite day comparisons for Projects 1-4.