FURTHER EXAMINATION OF PARTICIPATION IN ENERGY MANAGEMENT AND DSM PROGRAMS IN THE MANUFACTURING SECTOR

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INTRODUCTION

The Manufacturing Energy Consumption Survey (MECS) collected energy efficiency management activities data for the first time in the 1991 survey. The original motivation for the design of the collection reflected a desire to collect manufacturing utility-sponsored Demand Side Management (DSM) program information. Those programs were designed to lower or shift consumer electricity demand for the ultimate purpose of saving the cost of new power generation construction. While meeting that data requirement, the Energy Information Administration (EIA) staff wanted also to compare participation in those programs with participation in similar ones undertaken by the manufacturers without utility involvement. EIA believed that manufacturers routinely undertook energy efficiency measures without the influence of outside sponsors.

This paper examines the amount of participation in energy management activities by program type, categories of manufacturing establishment, and type of participation. Common explanations for participation are cited and MECS data are used to test two of them. Limitations of the MECS energy-management data are discussed in general and specifically for the purpose of program evaluation. Finally, there will be a discussion of the 1994 MECS energy management data collection and possibilities for future analysis.

HOW THE MECS COLLECTED ENERGY MANAGEMENT ACTIVITY DATA

The collection consisted of a list of programs and check-boxes indicating if and how the respondent participated. There were two ways a respondent could participate: (1) Through the sponsorship/involvement by their utility or supplier or (2) through their own or third-party sponsorship. Some manufacturers were involved with both modes of participation. If the utility or supplier was involved either exclusively or in combination with the manufacturer or third party, the program was counted as a DSM program.

The Program List

The list of programs can be divided into three subsets based on their general type. The first subset included many of the typical programs utilities offer to industry as part of DSM.[1] These were:

- Energy Audits — Any formal accounting of energy use in the plant, performed by utilities, third parties, or onsite energy management teams. The utilities have traditionally focused on building performance and some general industrial uses.
- Direct Load Control — Utilities will ask customers as part of a program to lower peak demand. Sometimes involves special equipment or targeting specific energy demands.
- Special Rate Schedule — Mostly time-of-use, or interruptible rate. Might also include an incentive rate for inducing a manufacturer to remain or relocate into an area.
- Standby Generation — During times of emergency, a utility would demand certain participants generate electricity to cover their own demand or demand of other utility customers. Often works in concert with special rate schedules.

The second subset of programs were those that involved equipment retrofit for energy conservation. Rather than turn to outside sources for this list, the MECS used its own terminology to link with a previous section of the questionnaire. That section was an inquiry in the form of a matrix that had respondents allocate their energy use for selected major energy sources to various end-uses. In developing the energy management/DSM inquiry, it was

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thought that there would be benefit in linking those end-uses to energy management programs. The programs contained in the second subset were:

- Steam Production (e.g., boilers, nozzles)
- Process Heating
- Process Cooling, Refrigeration
- Machine Drive (e.g., adjustable speed drives, motors, pumps)
- Facility heating, ventilation and air conditioning (HVAC)
- Facility Lighting

The third subset includes miscellaneous programs not previously discussed: Those programs were:

- Equipment retrofit for the *primary* purpose of switching fuels. This category is distinguished from normal fuel-switching activities in that it requires participation in a formal program. Utility electrification incentive programs would be counted here.

- Equipment rebates--Did a respondent receive a rebate from any source for equipment installations?

- Other programs--The participating respondent could enter the names of other formal programs that pertain to energy management.

How the MECS Can Show Participation

The MECS sample was selected on the basis of probability proportional to an energy measure of size. Therefore, establishment weights do not specifically represent numbers of establishments not selected into the sample. Consequently, the MECS does not reliably estimate population counts for the manufacturing sector. That means that participation rates in terms of numbers of establishments cannot be used for manufacturing.

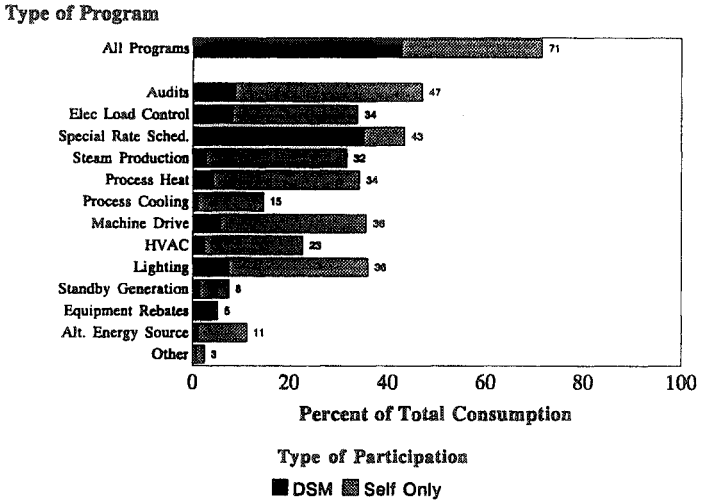
The weights *do* represent, however, a proportion of estimated energy consumption. Therefore, participation by MECS establishments is best expressed in terms of energy consumption. The measure chosen was total inputs for heat, power, and electricity generation (i.e., total fuel consumption) because it applies appropriately well to all the various types of manufacturing establishments.

RESULTS

Manufacturers consumed approximately 15.0 quadrillion Btu of energy consumption for fuel purposes in 1991. Establishments representing 4.3 quadrillion Btu or 29 percent of the energy consumption did not participate in any of the programs listed. Of the remaining 10.7 quadrillion Btu, 6.4 quadrillion Btu (43 percent of the total) was consumed by establishments using utility involvement and 4.3 quadrillion Btu (29 percent) was consumed by establishments that participated in energy management activities through their own or third party sponsorship only.

The 6.4 quadrillion Btu of consumption from establishments participating with utility involvement indicates a fairly high rate of participation. Suppose, the

Figure 1: Manufacturing Energy Management Activity and DSM Participation by Type of Program and Type of Participation, U.S. Manufacturers, 1991



(Based on 15 quadrillion Btu of Manufacturing Consumption for Fuel)
Source: Energy Information Administration, 1991 Manufacturing Energy Consumption Survey

program, "special rate schedule" is excluded, which by its nature would necessitate utility involvement in the large majority of cases. The overall participation drops slightly from 71 percent to 68 percent. Yet, participation by establishments with utility sponsorship drops from the previous 43 percent to 24 percent of total consumption.

Participation rates vary greatly across programs (see Figure 1). "Audits" was the program most prevalent in terms of energy consumption. Establishments representing 47 percent of consumption (7.1 quadrillion Btu) had energy audits performed on site. Following closely was "special rate schedule" (43 percent of consumption). Programs that drew the least amount of participation were "other" (2 percent of consumption), "equipment rebates" (5 percent), and "standby generation" (8 percent). Of note in Figure 1 is the relatively higher participation in the category "All Programs" as opposed to each of the individual programs. This is especially striking for DSM. If an establishment participates in *any* program in conjunction with a utility, it would be counted as a DSM participant. Overall, however, the establishment might undertake energy management activities under its owns auspices in all but one program.

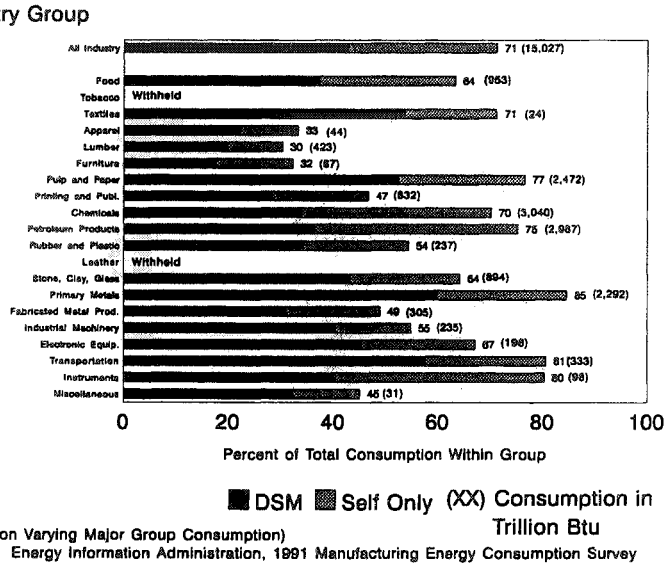
For most of the energy management programs, utility involvement is a small percentage of participating consumption. Other than for special rate schedule, consumption in establishments using utility involvement was not greater than 9 percent of total consumption for any program. Excluding equipment rebates and special rate schedule, which by their nature would necessarily include utility involvement for most cases, percentage of any participation with utility involvement was no greater than 28 percent of total participation. Equipment retrofit programs had especially low participation rates for utilities. This last result suggests two possible explanations:

(1) utilities are not making affective programs available for manufacturers in equipment retrofit, or
(2) manufacturers are especially reluctant to alter their plant processes unless by their own design.

Participation by Industry. Overall participation is not uniform across industries. Figure 2 shows participation by major industrial group.[2] "Primary Metals Industries" consumes the highest percentage of energy in establishments that participate in some way in energy management activities (85 percent). The major industrial groups, "Transportation Equipment" and "Instruments and Related Products" also have high overall participation (approximately 80 percent for each). On the lower end, "Lumber and Wood Products" has the least amount of overall participation (31 percent of energy consumption). Also markedly less in participation are establishments in "Furniture and Fixtures," (33 percent) and "Apparel and Other Products" (36 percent).

Utility involvement also varies according to industrial group. For example, Figure 2 shows that "Transportation Equipment" and "Instruments and Related Products" each had approximately 80 percent of their consumption in establishments that participated in energy management activities. However, in "Transportation Equipment" 71 percent of that participating consumption was with utility involvement, while in "Instruments" only 51 percent was with utility involvement.

Figure 2: Energy Management Participation by Industry and Type of Participation, U.S. Manufacturers, 1991



(Based on Varying Major Group Consumption)
Source: Energy Information Administration, 1991 Manufacturing Energy Consumption Survey

Specific program participation also varies across industries. This is especially true for the programs concerning equipment retrofit. Consider, for example, HVAC retrofit in two of the major industry group showing the highest percentage of participation. In the primary metals industries, facility HVAC retrofit is not a program that is particularly emphasized. Only 34 percent of consumption was in establishments participating in this program. Yet, in the "Instruments and Related Products" major industry group, 63 percent of consumption is in establishments performing this type of retrofit. The difference might be due to the percentage of consumption attributable to HVAC. From 1991 MECS end-use estimates, 26 percent of electricity consumption in "Instruments" is due to HVAC compared with 3 percent for "primary metal industries."[3] Another reason for the relative emphasis in "Instruments" might be the importance to the product of a controlled internal environment.[4]

Other Characteristics of Manufacturing

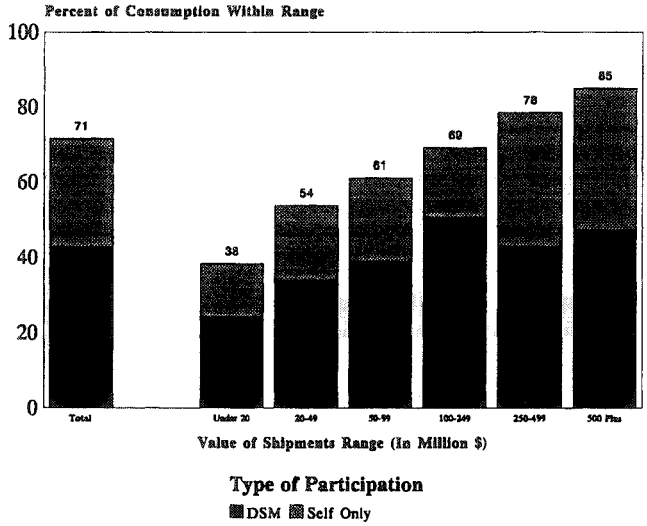
Manufacturing as an economic sector is quite diverse and much of that diversity can be explained by industry type. Therefore, it is not surprising that the type of program participation is dependent on SIC. Interesting questions arise when examining manufacturing disregarding SIC.

In trying to understand the manufacturing market for energy management activities including DSM, the MECS certain barriers to participation have been proposed. These include:[5]

- Lack of information about alternative technologies,
- Inadequate staff and time for testing and installation, and
- Lack of willingness in higher management to devote scarce capital to energy-saving projects.

Energy projects must compete with other investments that are viewed as more strategic. Often the payback periods, the estimated time necessary to fully recoup the cost of investment, are too long for manufacturers to accept. All of those obstacles would prevent investment in energy conservation. However, they would probably impede larger establishments less critically than smaller ones. Larger manufacturing concerns with more discretionary resources are more likely to invest, especially with favorable economic conditions. That premise is examined in the following analysis.

Figure 3: Energy Management Participation by Value of Shipments and Type of Participation, U.S. Manufacturers, 1991



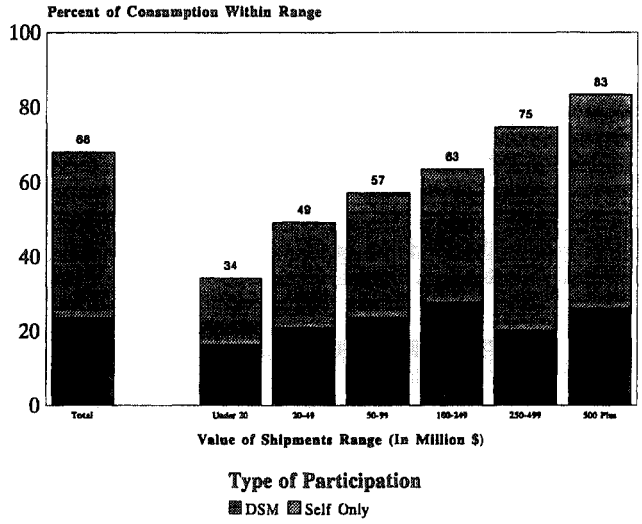
Source: Energy Information Administration, 1991 Manufacturing Energy Consumption Survey

Establishment Size

Establishment size was found to be highly related to participation in energy management activities. Figure 3 shows percentage of participation related to establishment value of shipment category. In a rather convincing trend, participation as a percentage of consumption within size group varies from 38 percent in the smallest category (less than 20 million dollars) to 85 percent in the largest size category (500 million dollars and over). The same trend can be found when looking at employment size categories. Although establishment size is related to the type of industry, nevertheless this trend lends credence to the idea that investment in energy conservation in manufacturing is a luxury that the larger establishments can better afford, especially when energy costs in general represent a relatively small percent of cost of materials.

Size category was a critical component in determining overall participation but less so when examining utility involvement. Figure 3 shows that utility involvement was approximately 64 percent of the total participating consumption for the smaller size categories. The remaining categories showed slight variations from the manufacturing-wide proportion but nothing too notable. When special rate schedule is excluded (Figure 4), the lower four categories show a rather constant relationship of 41-48 percent of the participating consumption. However, utility involvement in the upper two categories varies from 27 to 31 percent of the participating consumption.

Figure 4: Energy Management Participation by Value of Shipments and Type of Participation (Excluding "Special Rate Schedule), U.S. Manufacturers, 1991



Source: Energy Information Administration, 1991 Manufacturing Energy Consumption Survey

Larger establishments often have energy managers and energy management teams onsite. The presence of these teams would allow the establishment to participate in energy management activities to a greater extent than establishments without such teams. It is reasonable also that utility involvement is not as necessary to the larger establishments because of their onsite expertise and greater resources.

Does Energy Cost Matter?

MECS data can be used to test another often-cited barrier to participation. Energy costs are typically a small percentage of the actual cost of production. Although it can vary greatly according to industry type and individual establishments, 3 to 5 is a range often cited.[6] Because of that small percentage, investment in energy efficiency programs might substantially reduce energy costs but minutely affect overall production costs.

If the ratio of energy costs to production costs is a factor in participation, the MECS data should show such a relationship. Figure 5 shows electricity costs as a percentage of total costs broken out by value of shipment category and overall participation in energy management activities. Electricity cost was chosen, rather than total energy cost, because of its direct applicability to possible utility involvement. Overall, establishments participating in energy management activities have a slightly higher average electricity (2.3 percent) to total cost ratio than establishments that do not (2.1 percent).[7] However, within value of shipment size category, differences are more striking. In all size categories, participants have a larger energy to total cost ratio than nonparticipants. However, in the smallest size category the difference is larger than any of the others. In the largest size category, the difference is smaller than any of the others.

This suggests that higher electricity costs as a percentage of total costs is more of a determinant of energy management participation in smaller establishments than larger establishments. As already noted, larger establishments have higher rates of participation, even in the face of lower relative electricity costs. The smaller differences in relative electricity costs between participants and nonparticipants suggests that other barriers are more relevant to participation in larger establishments.

The situation is less clear when dividing overall participation into utility and nonutility. Differences in cost ratio is small between utility-sponsored and self-only participants in general. However, for the smallest category, utility

involvement establishments have a higher cost ratio than self-only. The trend reverses itself in the two largest value of shipment categories. Reasons for this reversal are unclear.

WHAT IS NOT KNOWN

What has been presented up to this point in terms of energy consumptions is:

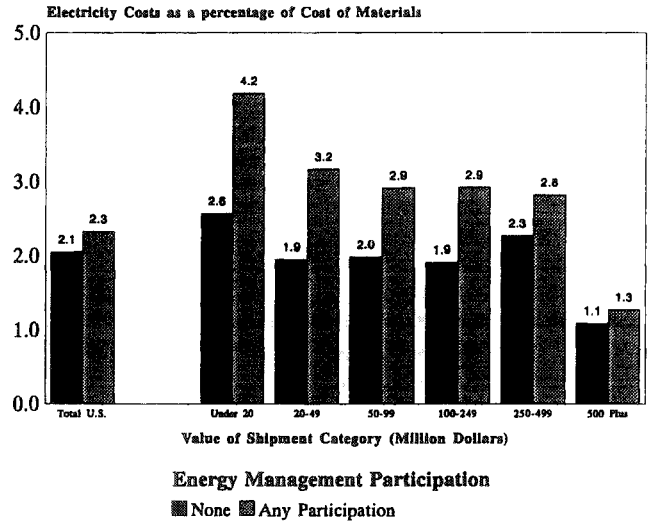
(1) How much participation was there,

(2) What type of participation it was,

(3) What were some of the characteristics of those participants, and

(4) What were some of the barriers to participation.

Figure 5: Cost of Electricity as a Percentage of Cost of Materials by Value of Shipments and Participation in Energy Management Activities, U.S. Manufacturers, 1991



Source: Energy Information Administration, 1991 Manufacturing Energy Consumption Survey

However, the MECS data cannot adequately address the question "If an establishment participated in an energy management activity, how much energy was saved by the establishment as a result of the participation?" The current method of data collection does not allow for such evaluation for a number of reasons:

- It is not known when the establishment started and completed the energy management activity. It is known only that it occurred during the period between the 1988 and 1991 surveys.

- It is not known if the establishment was participating prior to the time being considered.

- Most importantly, we do not know how much of an impact employing an energy-management activity had.

The last reason is caused by the limitation of having an inquiry using check-off boxes. Participation in general is not enough to determine whether the program has lowered energy consumption significantly. What would be needed is an indication of how much of the end-use or process was covered by the original equipment and then by the energy-efficient replacement. For lighting retrofit, an analyst would need data on the number and type of lights that were originally in place, and the number and type that replaced them. The same could be said for electric motors. As can be understood, the data required to use MECS as an energy-savings evaluation tool could quickly grow unreasonably. Both respondent burden and data reliability could be adversely affected.

WHAT DOES THE FUTURE HOLD?

The MECS went through a user needs assessment program to try to incorporate manufacturing energy data needs into the survey. As part of that effort, the MECS staff will examined what could reasonably be added to the survey to enhance the energy management portion of the survey. The enhancements that were accomplished were: adding to the list of programs, splitting out natural gas oriented programs from electricity, and having a column to indicate whether federal or local government was involved.

The sample size also increased. This should allow for finer geographic breakdowns than was previously possible. More importantly, through the addition of an alternative set of sample weights, the MECS will be able to produce

population counts for the first time. This will mean that percentages of participating establishments will be publishable as well as the percentages in terms of energy consumption.

By the very nature of manufacturing and the MECS sample, many establishments re-appear in the sample from cycle to cycle. This would be especially true for larger establishments. By examining that longitudinal panel of establishments, analysts could see if participation was having an effect on energy intensity, especially for certain end-uses. The energy intensity *change* could be contrasted between the participants and nonparticipants. By virtue of the link between the end-use estimates and the corresponding set of energy management activities, intensity changes could be examined for certain end-uses as well. Of course, not having the extent of participation within the establishment as discussed previously would still be a major drawback.

REFERENCES AND NOTES

1. Electric Power Research Institute, *1990 Survey of Industrial-Sector Demand-Side Management Programs*, EPRI CU-7089 (Palo Alto, CA, 1991).

2. Office of Management and Budget, *Standard Industrial Classification Manual, 1987*, (Washington, DC, 1987). "Major industrial group" refers to the Standard Industrial Classification (SIC) 2-Digit industries included in SIC 20-39.

3. Energy Information Administration, *Manufacturing Consumption of Energy, 1991*, DOE/EIA-0512(91), (Washington, DC, 1994), Table A37. Electricity consumption was used instead of total Btu because consumption by end-use is not available for steam and other nonpurchased fuels.

4. *Manufacturing Energy Consumption Survey, 1991*, op. cit., p 20.

5. Jordan, J. and Nadel, S. *Industrial Demand-Side Management Programs: What's Happened, What Works, What's Needed*, US Department of Energy, DOE/EE/01830-H1, 1993. See especially pages 7-11.

6. Jordan and Nadel, op. cit. Also, the U.S. Bureau of the Census, *1991 Annual Survey of Manufactures, Statistics for Industry Groups and Industries*, M91(AS)-1, (Washington, DC, 1992) presents data that would show a ratio of cost of fuels and electricity to cost of materials of approximately 4 percent.

7. Differences are significant according to Analysis of Variance (Value of Shipment Category/Participation, $F=5.45$, $p<.0001$; Participation, $F=96.99$, $p<.0001$; Value of Shipment Category, $F=45.71$, $p<.0001$)