

4. Recommendations

Original Objectives

The original objectives of the 1989 Facility Survey were:

- to provide improved estimates of district heat consumption for sample buildings that lacked building-level metering.
- to provide a basis for estimating primary fuel consumption by central plants in noncommercial buildings located on commercial facilities.

In terms of its original objectives, the 1989 Facility Survey was largely unsuccessful due to widespread data quality problems (Appendix B) and high variances. However, the facility characteristics by themselves, especially facility activity and size, turned out to be useful in describing energy consumption in the commercial sector. While improvements to the characteristics questions are called for, this portion of the Facility Survey can be regarded as generally successful, and worth continuing in some form on future CBECS. For example, the 1992 CBECS Building Questionnaire collected the facility activity for all multibuilding facilities, whether or not they provided district heating and cooling. Other questions included on the 1992 Building Questionnaire asked whether the facility had a central plant, and what its outputs were.

Building-Level Estimates of Outputs from Central Plants

The original design of the Facility Survey anticipated that good input-output relationships for central plants would serve as a basis for improved building-level estimates of delivered steam, hot water, and chilled water. However, given the erratic data received for central plant inputs and outputs, basing building-level imputations on input-output relationships derived from the Facility Survey is unlikely to be a reliable alternative to the current method. Furthermore, the Facility Survey found that cases lacking building-level data tended also to lack facility-level output data (Appendix B, Table B9).

Nonetheless, improvements to the CBECS district heating and cooling estimates have resulted from the Facility Survey. Some improvements were the result of changes in the 1989 building-level District Heating and Cooling Form that were made in the course of developing the complementary Facility Form. In addition, attention to the Facility Form appeared to result in better understanding, by both respondents and survey staff, of the relationships among the data items being collected. Shortcomings of the Facility Survey also led to a 1992 CBECS District Heating and Cooling Survey question on meter location (either at central plant or at sampled building). This question was needed to account for energy transfer losses, an issue which arose in the analysis of the Facility Survey data.

Facility Inputs and Outputs

Although the 1989 Facility Survey provided some information on the types of energy used and produced in central plants, the central plant consumption (inputs) and production (outputs) data collected in the 1989 Facility Survey were much less satisfactory.

The most serious problem for inputs was that some Facility Survey respondents reported facility-wide consumption rather than central physical plant consumption. The most serious problem for outputs was that the data were unavailable (Appendix B, Table B4). Actually, the problem may have been that the facilities lacked information on *both* inputs and outputs; for inputs the facility managers reported the only data available, facility-wide

data. The CBECS Energy Suppliers Survey remains the best source for estimates of district heating and cooling supplied to commercial buildings.

The abundance of inconsistent, implausible, and missing responses indicated that many respondents misunderstood the type of information that was requested, or simply could not provide it. This was the main reason that a separate Facility Survey was not included with the 1992 CBECS. Unless changes can be made to the Facility Survey that will substantially improve the quality of the data on quantities of energy input and output, it is highly questionable whether this component of the Facility Survey should be repeated.

Data Collection at the Facility Level

Improving the Data Collection Form

If a version of the Facility Survey is repeated in future CBECS (1995 and beyond), several improvements should be made to the Facility Form. Most improvements are needed to clarify for the respondent what information is requested. An overriding problem with the Facility Form is the need for the respondent to adhere to several bounding rules. These include the definitions of a building, an in-scope (for CBECS) commercial building, a central physical plant, and the relationship between the Facility Form and the District Heating and Cooling Form. Even if the language of the form can make the survey definitions clear, it may be unrealistic to expect a respondent to read through all the material and interpret all the rules as intended. For the Building Questionnaire, the boundaries of a building and whether it is in scope are determined by listers and interviewers who have been trained in the definitions.

It would be very helpful to develop a general accounting scheme for interim or sequential outputs, including cogeneration, and transmission and generation losses. This could be exhibited as a simple schematic of an energy balance, accounting for all inputs and outputs. This would help to obtain more consistent reporting of cogenerated electricity, or steam or electricity used to generate chilled water. As indicated in Appendix B, the term "cogeneration" was not consistently interpreted by respondents. It would also help determine whether outputs were measured at the point of departure from the plant, at the point of delivery to buildings, or somewhere in between.

To develop a better Facility Form, it might be necessary to conduct a more in-depth pilot study of a smaller number of facilities. The 1989 Facility Survey was useful in determining the size and broad characteristics of the population; this pilot study would be used to develop a more effective and useful line of questioning for subsequent surveys.

Any redesigned Facility Survey would have to address the fundamental fact that many central plants currently do not maintain records of inputs and outputs required. In response to this fact, the Facility Survey could collect more detailed information on plant characteristics, which could then be used in conjunction with engineering estimates to impute for missing inputs and outputs.

Alternate Design Approaches

An alternative to revising the 1989 adjunct Facility Survey would be to move toward a more facility-oriented data collection in CBECS. Such a change was not made for the 1992 CBECS (which did not have a facility component), but might be for a later CBECS, as part of a general survey redesign. A facility-based approach would target facilities, and try to collect facility-level consumption, as well as other energy-related data. Considerable work would be required to develop such an approach, which could constitute a major departure from the existing CBECS design. That approach would therefore need to be considered in the context of the broad goals of EIA's end-use data collection activities.

There are benefits in using facilities as a unit of data collection. To the extent that the facility, rather than the individual building, coincides with the economic decision-making unit, facilities represent a fruitful area for future work on conservation and energy management. Facilities are often natural economic units, unlike buildings, and buildings on facilities account for a large fraction of total commercial energy consumption. In terms of adoption of conservation features or participation in demand-side management (DSM) programs, the decision makers operate at the facility level. Also, buildings could be subselected from facilities to get characteristics data and building-specific energy use data for the traditional consumption benchmarking and analysis purposes.

The quality of the facility-based estimates could be improved by collecting data from a larger number of facilities, since a major data quality problem was the high variance of the estimates. Facilities are larger and more heterogeneous than commercial buildings. The sample of 393 facilities, yielding 237 respondents, was sufficient to support gross estimates for a pilot study, but not for a detailed substantive analysis within population subgroups. However, it is not altogether clear how to get a larger facility sample. Currently, the facility sample is derived from the building sample. One strategy might be to shift the building sample design to favor buildings on multibuilding facilities, such that a larger number of distinct facilities would be included.

Another possibility might be to target facilities directly at the sampling stage. The CBECS sample already has a list component, presently used solely to generate lists of large buildings. However, many of the elements on the multiple lists used in sampling are facilities: colleges, hospitals, and federal installations. If these elements were sampled as facilities specifically for a Facility Survey, the resulting sample would probably yield better results than the network estimator (Appendix C) used in the 1989 Facility Survey to translate the building-based CBECS sample to provide facility-level estimates. The special facility list would supplement the facilities drawn into the facility sample via the CBECS Building Characteristics Survey (as done in 1989).

Two additional advantages of a special facilities sample are:

- Measures of size are available on the special lists, so that eligibility cutoffs could be set. The CBECS has a minimum size of 1,001 square feet for the building survey, but had no minimum facility size for the 1989 Facility Survey. A minimum size would allow concentration of resources on the larger facilities.
- Sampling facilities might provide a method of measuring the overlap between the building-based CBECS and the facility-based Manufacturing Energy Consumption Survey (MECS). If facilities sampled for CBECS could be identified as existing on the frame for the MECS, or perhaps, even more simply, as being in-scope for the MECS, then their weighted contribution would overlap the MECS. This process might also allow coordination with other EIA surveys of nonutility generators. Such coordination will be more difficult if CBECS continues to sample only buildings.

The facilities sample would not replace the CBECS area sample (required for coverage of small-to-medium sized buildings) or list sample (required for coverage of large buildings not contained in multibuilding facilities). Rather, the facilities sample would supplement the area and list samples, just as the CBECS list sample does.

Mode of Data Collection

Despite the fact that CBECS had interviewers on site at each of the facilities in the 1989 Facility Survey to collect information on the CBECS sampled building(s), the facility data collection was completed by mail. The Facility Survey data might have been of much higher quality if trained interviewers had administered at least part of the Facility Form while at the site. In particular, the interviewer could have assisted in some of the bounding questions, such as defining buildings, defining what constitutes a commercial building, and determining the energy sources delivered to the central plant versus delivered to other buildings on the facility. The interviewer could also have identified, for later (mail) follow-up, the appropriate respondents for other parts of the Facility Survey, such as questions dealing with PURPA, DSM participation, or purchasing arrangements for natural gas.

The development of the Facility Survey and analysis of the data from the 1989 survey have already reshaped EIA's approach to collecting data for district heating and cooling, and have raised awareness of multibuilding facilities in general. Whether or not a Facility Survey is continued, the insights from the 1989 Facility Survey will help guide the future CBECS survey efforts.