COMMERCIAL BUILDING ENERGY USE MONITORING FOR UTILITY LOAD RESEARCH

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Utilities are facing critical uncertainties regarding the future demands and sources for energy supplies as the costs of fuels escalate and conservation measures are implemented. A growing number of utilities are planning or undertaking demand-side load research programs involving the collection and analysis of field measurements to better understand the nature of energy end-use applications. The purpose of this presentation is to describe the protocols developed for one of the largest utility load research exercises in the hopes of achieving inter-comparability with related efforts by others.

In order to achieve an adequate understanding of the electrical requirements of buildings in the Pacific Northwest to reliably forecast the need for electrical supplies, the Bonneville Power Administration is sponsoring the End-Use Load and Conservation Assessment Program (ELCAP). This program includes the collection and analysis of hourly and sub-hourly time series measurements of electrical loads according to end-use (i.e., lighting, heating, etc.) and functional use zones (i.e., lobbies, offices, kitchens), as well as key climatic determinants such as inside temperature and solar flux.

A major challenge was the development of a taxonomy and classification scheme to unambiguously describe field observations from hundreds of sites. Given the unprecedented nature of this work it was important to develop a structured yet flexible and expandable scheme for the preparation of measurement plans and characteristics surveys in order to consistently classify observations without restricting enhancements as the experience base expands. Now that installation efforts have been completed for approximately 150 commercial sites, it is appropriate to share these procedures with the scientific community for critical review and possible adoption for related studies.

The presentation describes the overall structure of the commercial sector studies with respect to the sample design, units of analysis, and classification schemes in order to place the measurements in context. Then a site will be described in some detail to indicate both the process and substance of the measurement plans and characteristics surveys. Finally, preliminary results of measurements from a group of commercial buildings will be described to demonstrate the power and complexity of end-use measurements for commercial buildings.

This work is sponsored by the Bonneville Power Administration, Department of Conservation, through a related services agreement with the U.S. Department of Energy, Contract No. DE-AC06-76RLO 1830. Pacific Northwest Laboratory is operated for the U.S. Department of Energy by the Battelle Memorial Institute.

COMMERCIAL BUILDING CHARACTERIZATION

Most utilities define the commercial sector as the group of customers which is neither residential nor industrial. As such it may include loads such as billboards and street lights which will need to be disaggregated in order to understand the load associated with buildings. We have elected to split the commercial buildings into ten categories based upon primary use in order to draw a stratified sample. These primary use types are:

- office
- restaurant
- warehouse
- school
- health
- dry good retail
- grocery
- lodging
- university
- other

Within each of these we have defined three size types to distinguish small, large, and very large structures. The breakpoints are specific to each category. Sites are also classified as being pre or post 1980 construction for purposes of sampling.

Each commercial building is described with respect to its construction types, central systems, tenants, and functional use zones. An overall conductive UA is calculated, the central systems are classified and mapped to the functional use zones, and the tenants are surveyed to characterize how the building spaces are used.

For analytical purposes it is necessary to describe each of the tenants of a commercial structure, so as to understand the type and levels of activity. A standard industrial classification (SIC code) is assigned to each tenant, their square footage is noted, and information on the occupancy levels and schedule are assembled. Information regarding employment and sales levels are desireable as well.

It is useful to further subdivide tenants spaces into what are termed functional use zones owing to the diversity of building uses. For example a restaurant is typically comprised of lobby, office, kitchen, dining, bathroom, and common areas (hallways). A growing taxonomy of functional use types is maintained to assure consistency across building types such that an understanding of the commercial sector may be built up from either the primary building use or the functional use type. When developing a measurement plan these functional use zones are individually monitored if possible to permit detailed examination of the end-use loads associated with them.

ENERGY END-USE LOAD CLASSIFICATION

Energy use is separated insofar as possible into twenty distinct end-uses based upon the purposes for which energy is consumed. These end-uses are listed below:

- space heating
- space cooling
- ventilation
- hvac auxiliaries
- mixed hvac
- interior lighting
- exterior lighting
- refrigeration
- water heating
- receptacles
- vertical transport
- food preparation
- material handling
- data processing
- recreation
- sanitation
- laboratory equipment
- shop equipment
- specialty equipment
- mixed

The mixed HVAC and mixed categories are used when it is not practicable to individually meter loads sharing a common utility feed. Heat pumps for example typically fall into the mixed HVAC end use due to the difficulty of sensing heating, cooling, and ventilation loads individually for a packaged unit. However, if separate circuits are used to energize the electric resistance backup they are assigned to the space heating end-use. In any event these end-uses are considered to be mutually exclusive, such that the sum of all end-uses at a building should equal the total energy used.

EQUIPMENT CHARACTERIZATION

A taxonomy of equipment types is maintained to document which end-use category should be associated with a particular piece of equipment. This list is supplemented as necessary as the experience with end-use monitoring grows so as to assure consistent treatment of individual cases. The equipment list presently contains approximately 200 entries.

Specific information is acquired on each piece of equipment including equipment type and code, control code, capacity, location, and meter channel. This information is encoded into the project database for verification of the energy use measurements and characterization of the building loads.

SUMMARY

The presentation will describe the most current versions of the metering and characteristics data collection protocols in use for the ELCAP efforts. These will be demonstrated by way of example for several warehouses participating in the study. As the installation sequence for this project comes to a close, final versions of the Measurement Plan Handbook, and Building Characteristic Data Collection Handbook will be published to provide detailed guidance with respect to the collection of utility load research data.

Insofar as others planning related metering studies adopt the protocols established for ELCAP, the results of the efforts should be inter-comparable. This desire for compatibility extends to more detailed studies as well as those of more limited scope, as it is hoped that the structured approaches can be applied so other efforts can be placed in context and the results applied for mutual benefit.