END-USE LOAD AND CONSERVATION ASSESSMENT PROGRAM

CONSERVATION ASSESSMENT APPLICATIONS AGENDA

Version 1.0 - 12/85

Background and purpose

The End-use and Conservation Assessment Program (ELCAP) was originally
designed to serve a wide range of conservation assessment issues. The purpose
of this document is to briefly but clearly identify a series of specific
assessment-related applications designed to support these interests. The list
will provide a basis for the development of work plans and the initiation of
analyses supported under BPA's conservation assessment mission. It is
anticipated that this agenda will evolve over time as comments are received
and topics mature into work statements and actual applications. These
revisions and updates will be reflected in the Agenda Version number.
The applications are listed in general order of priority. Issues which are
designated as "critical" include those which are fundamental to further
analytical progress and/or which are expected to yield results in the short
term which are of vital importance to estimates of conservation potential in
the PNW region.

Issues designated as "high priority" generally pertain to relatively basic and critical assumptions underlying current assessment and planning methods. As a rule, they also require the collection of relatively large volumes of data over a considerable period of time before they can be addressed with an expectation of reasonable reliability.

Those applications designated as being of "moderate priority" involve issues of somewhat less immediate significance, require even more lengthy data collection periods, or involve the use of more complex and untested analytic techniques. As a result, the specification of these applications may be somewhat less clear and precise. Depending on the results of some of the early analytic efforts, however, the priorities of some of these issues may change rather rapidly.

Conservation Assessment

Conservation assessment involves the description of energy savings and costs associated with the implementation of conservation measures and practices. The savings may be described in terms of a matrix defined by the consumer sector, the end-use, and the motivation for adoption. Traditionally, consumers are divided into four major sectors: residential, commercial, industrial, and irrigated agriculture. Although the specific end-uses vary among the consumer sectors, the following general classification is proposed

as perhaps helpful: e.g., HVAC, water heat, refrigeration and freezing, cooking, and process-related equipment. The motives underlying adoption may be divided into three broad groups: price increases; program incentives; and changes in the techno-culture. "Costs" may be described in terms of a matrix defined by the end-use primarily affected, and the segment of the market which is to be addressed.

The data produced under the End-use Load and Conservation Assessment Program (ELCAP) will provide the most detailed portrait of building energy use patterns available to date. However, the samples of participating structures do not represent the population. As a result, the focus is on particular end-uses, the factors which affect the end-use load patterns, and, in particular, the impact of various conservation measures and practices on the load patterns.

I. METEOROLOGY

A. HIGH PRIORITY

1. Review and assessment of the performance of Pacific Northwest macroclimatology indicators in the analysis of energy usage patterns

Traditionally, energy analysts have relied on a relatively simple Heating Degree Day (HDD) measure to describe the climatology and weather associated with a particular PNW "zone." The purpose of this analysis is to identify and test a number of alternative approaches, including increased recording frequency, shorter integration periods, different mathematical procedures, as well as different parameters (i.e., wind, solar, humidity.)

B. MODERATE PRIORITY

1. Assessment of established PNW data collection networks with particular reference to the National Weather Service stations.

The ELCAP includes over 80 microclimatology data collection points distributed over the PNW at participating ELCAP sites. With this system as a baseline, it should be possible to assess the performance of other data collection networks relative to a number of analytic objectives. The analysis will result in the

identification of the appropriate sources of weather and climatology data for each participating ELCAP site. The analysis will also assess the relative efficiency of various networks in describing PNW macroclimatology.

2. The effects of relative exposure on microclimatology.

As a standard, the NWS collection points are located in thoroughly exposed sites; most PNW homes and related ELCAP climate sensors are not. This difference may have significant implications for the performance of NWS and ELCAP data (and other data sources) as a measure of weather and climate. To the extent that these impacts are systematic, relatively simple adjustments may be possible.

3. Assignment of appropriate meteorology data source

To adequately assess any space- or water-heating load and some equipment loads, it is necessary to take into account various meteorology parameters at each site. Since the sources may vary in terms of the parameters available and periodicity of reporting, the appropriate source may vary depending on the analysis plan. This application is intended to describe the available sources for each of the participating ELCAP sites. For certain sites, there may be no available source for certain parameters.

II. RESIDENTIAL SECTOR

A. CRITICAL

1. Basic end-use splits

Most of the forecasting and planning tools currently in use involve
assumptions concerning the basic end-use splits. Since the ELCAP data
represent the first opportunity to analyze end-use specific data, it is
logical to test these assumptions at the earliest possible date. In addition,
the analysis will attempt to characterize differences in end-use patterns over
varying time periods.

2. Fundamental demographic distributions

As a foundation for subsequent analyses and a basis for planning future
studies, it is critical to understand the distribution of the sample over a
number of demographic characteristics. It is also important to understand how
these distributions compare with the distributions of comparable
characteristics for the population. The characteristics include those
associated with the structure, the energy consuming equipment and appliances,
and the behavior and demographic characteristics of the occupants and
operators.

3. Space heating loads and the thermal properties of residential structures

The use of energy for purposes of space heating accounts for the largest portion of residential consumption. As a result, it has been the object of the most ambitious conservation efforts directed at improving the thermal properties of residences. This analysis will seek to identify and assess alternative approaches to analyzing thermal performance, especially with reference to measures of weather characteristics of the building shell and equipment.

The work envisioned here is closely related to work which will be proceeding simultaneously on other applications. In particular, the meteorology applications will assist in the identification of the appropriate weather-related data. As a result, the work will likely iterate, with the initial phase concentrating on first describing the load shape distributions and then attempting to explain variations in the distributions.

B. HIGH PRIORITY

1. Disaggregation of mix-use channels

In some cases, a "major appliance" may be served through a circuit which also serves one or more other pieces of equipment. Perhaps the most obvious

example is the refrigerator. Due to vintage-related and other problems, there may be systematic bias -- if these structures are excluded from analysis due to this problem of channel mixture. The purpose of this application is to systematically disaggregate mixed-use channels, especially those which include "major end-uses", and to develop more generalized and routine protocols for the disaggregation of mixed-use channels.

2. The water heat load: the impacts of location and wrapping strategies

Following space heating requirements, water heating represents the next most significant use of energy in residential structures. This application is designed to address two interrelated issues of considerable interest and debate among analysts: the location of the heater in heated or unheated space; and the appropriate wrapping strategy. Clearly, the appropriate wrapping strategy may vary depending on the location of existing water heaters.

3. Patterns of usage and interaction between wood and electricity for purposes of space heating

A significant portion of PNW residences have installed capacity for both wood and electric space heating. Analyses suggest that both are employed under varying conditions. Understanding these patterns will contribute to our

understanding of the impacts of weatherization programs and, as a result, our expectations concerning potential savings.

4. Differences between electric heating system types

Previous studies suggest that there are important differences in load shape and consumption patterns between the three major types of electric heating systems: baseboard, forced air, and heat pump. A better understanding of these differences is important for forecasting, assessment, and program planning purposes.

5. Appliance and equipment interactions with the space heating requirements

A thorough understanding of the residential space heat load and the impacts of conservation measures requires an understanding of the basic relationships between appliance and equipment contributions to the space heating requirements of residences.

6. Methods for estimating PNW population parameters using ELCAP data

The procedures used in the selection of the ELCAP/Residential Base Study sample were not designed to support simple statistically based estimates of relevant population parameters. The relatively low response rate further

limits the propriety of using these techniques. Nevertheless, it is necessary to arrive at such estimates to support BPA forecasting, assessment, and program planning applications. A thorough assessment of various techniques at an early date is, therefore, appropriate.

7. Peak characteristics and equipment duty cycles

The evidence to date suggests that residential loads tend toward a "bimodal" distribution over each 24 hour period. The total load for most residential structures tends to be at its lowest in the early morning, rising steeply through the mid-morning. The load then tends to diminish until late afternoon-early evening when it again rises. After about 9:00 pm, the loads diminish once again. This application is designed to compare and contrast these two "peaks" in terms of the contributing loads and associated occupant behavior patterns. Included in the characterization of the loads will be an investigation of the role of appliance and equipment duty cycles in explaining peak magnitudes and variations and an investigation of the geographic and temporal response to changes in weather conditions, especially during peak and near-peak periods. These investigations may require alteration of the integration and polling periods for the network for well-defined window of time.

C. MODERATE PRIORITY

1. "Functional" and "Activity" based clusters of end-use loads

Traditional end-use definitions have relied on simple "functional" distinctions. The ELCAP data permit an empirical examination of the utility of these distinctions and of alternative definitions of "end-use clusters." Since this work involves the application of tools developed to serve other purposes, this work must proceed cautiously.

2. Food storage and preparation

The cold storage and cooking of food represent two important energy use "activities." Since they involve opposite energy requirements (cooling vs. heating), but are frequently in close geographic proximity for convenience, the observed loads are likely to interact. Major steps in this analysis require rather intensive data collections which will not be completed and the results available for several months.

3. Application of channel disaggregation technology to total load data

A number of utilities have access to relatively high quality total load data for substantial numbers of residential customers. This application will

attempt to apply the techniques developed for disaggregating mixed-use channels and to account for variations in the distribution of load shares to the disaggregation of these total load data. To the extent that this effort succeeds, it will be possible to significantly improve the reliability of assessments of conservation potential.

4. Comparison of ELCAP and utility billing data

This application is designed to serve at least two purposes. First, every electric utility has access to regular periodic billing records, based on standard electric utility meter readings. Comparing these data for the ELCAP sites will contribute to our understanding of the limits and strengths of using billing records data. At the same time, the utility data will provide a "standard" against which the ELCAP data can be compared.

5. Performance of audits and computerized models

Experience suggests that there is considerable variance in the accuracy of various audit methodologies and computerized models of residential energy use. Furthermore, the performance of even the best models is frequently less than desirable. Assessing the performance of these technologies depends heavily on the completion of at least significant portions of several of the applications listed previously.

6. End-use load shapes: Wave form distributions and the contributions of schedules

The results of early analyses suggest that there are distinctive wave form patterns associated with different end-uses. In some cases, these patterns appear to have distinctive time periodicities. The implications for forecasting, assessment, and load management are far-reaching. The techniques involved are innovative and caution is required as the application proceeds.

7. Effects of information feedback on load shapes and consumption

The ELCAP residents are likely to become more distinctive as time passes; especially as regards their awareness of energy-related issues and their access to information. Exposure to ELCAP results will be monitored on an on-going basis, and the information provided will be carefully selected. Since electricity usage is monitored, changes will be apparent. Occupant reports of actions taken will be requested on a regular basis.

III. COMMERCIAL SECTOR

A. CRITICAL

1. End-use splits for traditional building types

As in the residential sector, many of the forecasting and modeling tools currently in use involve assumptions concerning the end-use shares for different types of buildings. This application seeks to test those assumptions and to initiate the development of an empirical foundation for end-use estimates. Thus, for each of the traditional building activity types, the distribution of energy use over the major end-uses will be described, both in terms of mean values and measures of dispersion. The distributions for various periods of integration, various times of the year, and various types and times of day. The end-use splits may then be compared across the traditional building types and may enable an empirically-based grouping of buildings into a smaller number of different categories.

2. Support for the design of the PNNonRES

A survey of nonresidential structures has been initiated under BPA sponsorship. The fieldwork for the first phase of data collection is scheduled to begin in the Spring 1986. A second phase is scheduled for the

Fall 1986. The first phase involves the recording of a limited number of observations by trained surveyors from the exterior of the building. The surveyors will not enter the building until the second phase, at which time approximately 1,200 buildings will be subjected to moderately detailed inspection. It is important that the observations are recorded in a format which is compatible with the ELCAP. In addition, it is likely that the results of early ELCAP analytic work will contribute to the selection of items to be observed and the information to be captured. This application is designed to provide explicit support for the identification of the relevant and appropriate data elements.

B. <u>HIGH PRIORITY</u>

1. <u>Scheduling effects on commercial building loads</u>

Since many commercial buildings are operated on relatively routine schedules, it is not surprising to find confirmation of the long-held assumption that schedules explain a significant portion of building loads. As a basis for a range of subsequent applications, further investigation of the load shape impacts of load scheduling is clearly warranted.

2. The lighting load in commercial buildings

Lighting accounts for a significant portion of the load in commercial buildings. As a result, significant savings may be available through the use of alternative lighting technologies. Lighting also follows relatively routine schedules, so that there is a clear and strong relationship between this and the previous analysis.

3. Thermal performance of commercial buildings

Commercial buildings frequently involve both heating and cooling requirements in addition to basic ventilation. This application is designed to provide basic descriptions of the heating and cooling loads and the factors which impact the shape and size of these loads by building type.

4. Performance of audits and computerized models

As in the residential sector, experience suggests that current auditing techniques and computerized simulation models are weakly grounded, at best, and of questionable accuracy. The ELCAP data provide an unprecedented opportunity to test these technologies and to initiate the development of a sound empirical base.

5. Development of a minimum metering audit technique

One of the known weaknesses of audit methodologies is the lack of benchmark data against which limited observations and interview data can be compared. This weakness can be overcome with even limited meter-based data. The purpose of this application is to identify the critical contributions of detailed metering data to the understanding of the building behavior and occupant operations, and to design hardware and software intended to provide measures of reasonable quality for these critical parameters.

C. MODERATE PRIORITY

1. Unit, sector and system peak and contributing end-uses

Long-term distribution system management strategies require an understanding of the factors contributing to the system peak. This application is designed to characterize commercial building peak loads on an individual building basis, as well as by building type and for the sector as a whole. Although early estimates may be derived, reliable analyses will likely require significant amounts of data.

2. Energy use and space allocation in PNW warehouses

Current estimates of energy use in warehouses differ greatly. Clearly, whether the warehouse is cooled is of significance. For unconditioned warehouses, however, indicated usage may be attributed to associated office space. The disaggregation involved in the ELCAP sites offers an unprecedented opportunity to address this issue.

3. Alternative criteria for classifying commercial buildings

Many of the forecasting and modeling tools currently in use divide the commercial sector into some discrete but not well-defined set of categories. This application will investigate a series of alternative criteria based on the distribution of end-use loads.

4. Building owner and occupant response to information feedback

In order to help guide the design and planning of conservation programs, this application will guide and monitor the transfer of information back to the participants, and will seek to measure participant response and the impacts on energy use.

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