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DEVELOPMENT OF PRELIMINARY REGIONAL END-USE LOADS ESTIMATES

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Prepared by

BAKER, REITER & ASSOCIATES
2323 Eastlake Ave. East
Seattle, WA 98102
(206)328-0100

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Pacific Northwest Laboratories

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TABLE OF CONTENTS

1

Introduction

Commercial buildings account for a significant portion of the electricity consumption in the region. Recognizing this, regional planners have been interested in analyzing consumption in the commercial sector in order to better understand how and when energy is used. Reliable estimates of regional hourly consumption by end use are a valuable analysis tool for answering questions about the nature of consumption in commercial buildings. For example, hourly end-use data can be used to evaluate the impact on regional consumption of changes in commercial buildings (e.g. adoption of new HVAC systems), or utility policy (e.g. promotion of efficient lighting systems). In addition, regional forecasting models require estimates of consumption at an hourly or end-use level.

Until this time, reliable hourly estimates of commercial building electricity consumption by end use have been unavailable. Making such estimates is now possible because hourly end-use data has become available from BPA's End-use Load and Conservation Assessment Program (ELCAP). In addition, other recent commercial studies provide useful data on hourly total commercial consumption and regional commercial building characteristics. These studies include:

- SCLCDB (Seattle City Light Commercial Database)
- PNNonRES (Pacific Northwest Non-Residential Energy Survey)

While each of the three studies has produced interesting data in its own right, the studies are most effective when jointly applied to the analysis of regional commercial building consumption. No single study provides the whole picture, but each contributes a piece. Together they can provide valuable insight into the region's commercial sector.

The purpose of this project is to combine the data from these studies in order to develop preliminary estimates of regionally representative end-use electricity loads for Office and Dry Good Retail (DGR) buildings in the Pacific Northwest. These estimates encompass the following components:

- consideration of four building types: Large Office, Small Office, Large DGR, Small DGR
- hourly profiles for both total load and end-use loads
- class-level estimates for Seattle City Light's service territory and for the Pacific Northwest region.

It is important to note that the work completed under this project is exploratory. In particular, the estimates are based on a small amount of hourly end-use data, since that is all that was available at the start of this project in June of 1987. The end-use estimates will become more reliable when an additional year of ELCAP data can be incorporated into the analysis. In addition, the extension of the results to the region will be more thorough once the data from the second stage of the Pacific Northwest Non-Residential Energy Survey (PNNonRES) are available to provide regionally representative estimates of HVAC system type and fuel type saturations. A second reason that the work is exploratory is that the estimation methods used in this project are exploratory. Simple approaches, primarily ratio based estimation, were applied in this effort. While these approaches provide a useful preliminary set of estimates, we expect that ultimately it will be necessary to develop a model-based approach to estimation. Such a model could exploit the wealth of physical characteristics data that will come from PNNonRES, potentially allow for the decomposition of large building PURPA loads into end-use components, and provide a basis for weather normalization of HVAC loads in order to correctly extend the ELCAP sample results to buildings located in regions with different climatic conditions than those experienced in the Seattle area.

As part of the study, we have evaluated different methods for improving the estimates that were developed. The concluding sections of Chapters Two and Three contain recommendations on what we believe are the most cost-effective methods for improving the estimates derived from this preliminary analysis.

1.1. REPORT ORGANIZATION

This report consists of four chapters. The balance of this chapter describes the data currently available to support preliminary regional end-use estimates. Chapter Two provides a detailed description of the procedures used to derive end-use estimates for the SCL service territory, and presents the results of this effort. Chapter Three describes the procedures used to extend the SCL estimates to the region. Chapter Four contains a description of the data products which resulted from this work.

1.2 AVAILABLE DATA SOURCES

The estimation of regional end-use loads is a complicated process because it has not been possible for BPA to conduct end-use load measurements for a regionally representative sample of commercial buildings. Given the diversity of the region's commercial building stock (including wide variations in building size and composition of use across business types), a large sample would be required to directly estimate regional parameters (for example, the second stage of PNNonRES, which will gather regionally representative building characteristics data, entails a sample size of 700 buildings). An end-use study of this magnitude is prohibitively expensive. As a result, alternative methods for developing regionally representative end-use estimates must be explored.

The method used in this project consists of combining data from a variety of regional sources in order to develop consumer class level estimates first for the Seattle City Light service territory and then for the Pacific Northwest region. A combination of four separate data sources provides the necessary data. Two of these data sources provide hourly consumption data for specific commercial buildings. Battelle's End-use Load and Conservation Assessment Project (ELCAP) entails the hourly monitoring of end-use loads in roughly 100 commercial buildings, most of which are located in the Seattle City Light (SCL) service territory. A second study, Seattle City Light's Commercial Database (SCLCDB) provides data on total hourly loads for a larger sample of buildings (approximately 500) in the SCL service territory.

The remaining two data sources provide population estimates, and are used as "anchors" in this project. These population estimates provide the basis for extending detailed building-specific data from the end-use samples to the SCL service territory and subsequently to the region. The population estimates available for the Seattle City Light (SCL) service territory are derived from SCL's database of billing histories for commercial meters. Commercial consumption estimates for the year 1986 were derived from this database by aggregating individual meters in the population by building type and consumption strata. These aggregations represent commercial population consumption for the SCL service territory.

The second "anchor" is the Pacific Northwest Non-Residential Energy Survey (PNNonRES). It provides the best available source of regional commercial building floor area characteristics. Presently, only the first stage has been completed, providing us with regional floor space estimates by building type, utility type and vintage. The second stage of PNNonRES will become available next year, providing data on building characteristics and monthly total consumption for a much larger sample of buildings, selected to be statistically representative of the region.

Each of the four data sources mentioned above are described in more detail below.

ELCAP

The End-use Load Conservation Assessment Project (ELCAP) involves the hourly monitoring of end-use loads in 115 commercial sites. The majority (85) of these sites are located in the Seattle City Light service territory. Each of these sites was also thoroughly audited. As a result, the ELCAP study provides us with the most detailed combination of end-use loads and characteristics data available in the region.

Building Selection

The majority of the ELCAP sites were selected in a two stage stratified random sample of the commercial tax parcels in the SCL service territory. In the first stage, the population was stratified by building type, according to SIC code classifications, and a sample of about 10% was drawn. Data on building size and age were then collected for the buildings in this sample. In the second stage, the buildings selected in the first stage were stratified by size (small, large, very large), and a stratified random sample was drawn.

One characteristic of the sample was a scarcity of recently constructed buildings. Since significantly more stringent energy codes were introduced in 1980-81, the ELCAP sample was supplemented with some additional buildings that had been constructed since 1980. These buildings were chosen randomly from the population of post-80 buildings, stratified by building type.

The final group of 85 buildings, called the ELCAP Commercial Building Base Study, was supplemented with 30 BPA Commercial Audit Program (CAP) buildings located in six cities throughout the region. Data have therefore been collected for 115 commercial buildings, most of which are located in the SCL service territory.

Consumption Data

For each building, hourly data are being collected for approximately 20 end uses, including heating, cooling, ventilation, auxiliary HVAC, mixed HVAC, interior lighting, exterior lighting, service hot water, refrigeration, and a variety of other specialized end uses. These end uses are typically aggregated into 10-12 broader categories by combining various non-HVAC end uses. Data collection began in 1985 for some buildings; the remaining buildings were brought on line in ensuing months. Presently, a full year of data is available for most of the ELCAP sites.

Fifty-six of the 115 ELCAP Commercial Base Study and CAP buildings are Office and Dry Good Retail buildings. For this project, end-use data for these buildings were obtained for the year spanning July 1986 to June 1987.

Characteristics Data

Characteristics data were collected for each building during a thorough audit of the site. Data were collected at three levels:

- building -- data about the building as a whole, including total floor area, number of stories, number of tenants, type of construction, heat loss information, and age
- tenant -- data about each tenant in the building, including SIC code, floor area, and occupancy schedules
- zone -- data about each separate functional use zone within a given tenant area (e.g. food prep versus dining area for a restaurant), including HVAC system serving the zone, all connected loads located in the zone, floor area, and type of functional use.

For this project, data for the Office and Dry Good Retail sites were obtained and aggregated to the building level. Summary variables that were derived included primary HVAC type, primary space heat fuel, total HVAC capacity, total interior lighting capacity, total exterior lighting capacity, and total capacity of all other equipment.

Seattle City Light Commercial Database (SCLCDB)

Seattle City Light maintains ongoing monitoring of a sample of its commercial customers. Presently, the hourly total load is being monitored at about 500 sites in the SCL service territory. This sample is useful because it is a larger sample than ELCAP, but was selected from the same population as ELCAP. The consumption data from the SCLCDB provides an opportunity for comparison and validation of the more detailed ELCAP data. A detailed discussion of the origin and contents of the SCLCDB can be found in *Estimation of Hourly Commercial Class Load Using the Seattle City Light PURPA Sample (Baker, Reiter and Associates, June, 1987).*

Sample Selection

The meters in the SCLCDB were monitored for one of three reasons. Most of the meters were selected in 1983 from the SCL population of meters in a Probability Proportional to Size (PPS) sample, stratified by building type. This sample was selected in order to fulfill PURPA reporting requirements (the entire database is often referred to as the PURPA database, but this is a misnomer since the database includes meters not selected in the PURPA sample).

The PURPA sample was supplemented with two other groups of meters. First, the largest of SCL's commercial customers have hourly meters for billing purposes. All of these sites were added to the PURPA sample. Second, since the original sample underrepresents small and medium consumption meters, a supplemental random sample of these meters was included in Fall of 1985. This addition was necessitated by a change in SCL's customer classifications, which required a cost-of-service study for small general service customers.

Consumption Data

Each SCLCDB site has at least one hourly (PURPA) meter. In addition, there may be conventional meters at the site, for which monthly or bimonthly data is available. In order to obtain an hourly profile that represented the entire site, we incorporated data from the conventional meters into the hourly data measured on the PURPA meter. This was accomplished by calculating the ratio of total annual consumption at the site (the sum of the PURPA meter plus all conventional meters) to total annual PURPA consumption. Each hourly value was then multiplied by this ratio in order to obtain an hourly profile that maintained the original hourly data's shape, but with increased consumption at each hour in order to represent all consumption at the site. Thus, the consumption data for each SCLCDB site includes all meters at the site.

Hourly data was collected for the years 1984-1986. For this project, we used data from mid 1985 to mid-1986.

Characteristics Data

Characteristics data was collected for a sample of the SCLCDB sites in the 1984 Seattle Commercial Building Survey (SCBS). This survey provided data at the site, building and tenant level, including such characteristics as floor area, predominant fuel type, type of primary electric HVAC system, tenant land use codes, and breakdowns of conditioned vs. unconditioned areas. The SCBS data was supplemented with a walk-by survey of each SCLCDB site in 1986. The walk-by survey included sites that had been added to the SCLCDB after the original characteristics survey had been completed. As a result, more sites were examined during the walk-by survey than during the 1984 SCBS. The walk-by survey provided estimates of floor area, number of stories and number of tenants. In addition, each site was classified by business type according to the BPA definitions developed for PNNonRES.

Pacific Northwest Non-Residential Energy Survey (PNNONRES)

The Pacific Northwest Non-Residential Energy Survey is a two-stage survey undertaken by BPA to provide a statistically robust assessment of commercial building characteristics in the Northwest. It provides a means for extending data from a limited area (e.g. the SCL service territory) to the region as a whole.

First Stage

The first stage of the survey entailed the PPS sampling of 73 ZIP areas in the region. Each non-residential building in a sampled ZIP area was surveyed in a walk-by audit. This sample was supplemented with mail survey data for a sample of the region's hospitals and post-secondary education institutions. Data were collected for a total of 13,600 commercial buildings in the region. The sampling weight associated with each building can be used to generate regional results from the sample. The primary information gathered in the first stage included floor area, primary business type, number of tenants, and number of stories. The first stage results are documented in *Pacific Northwest Non-Residential Building Characteristics Survey: First Stage Results (Baker, Reiter and Associates, August 1987).*

Second Stage

The second stage of PNNonRES will entail detailed audits of approximately 700 buildings selected from the first stage sample of buildings. Second stage results will provide data on monthly energy consumption (from billing data), HVAC system type and capacity, fuels used by end use, lighting capacities, and functional use areas within the building. Again, sampling weights will be developed for each of the buildings to enable results from the sample to be extended to the region. Results from the second stage will include regional HVAC equipment, fuel and end-use saturations. These results will be available later this year.

Seattle City Light Commercial Sector Sales

Seattle City Light maintains a billing records database for its commercial customers. This database includes monthly or bi-monthly consumption and an SIC code for each commercial meter. Total SCL sales to the Office and Dry Good Retail building types was derived from this file for the year of 1986. All meters with SIC codes corresponding to Office or Dry Good Retail were extracted from the database. These meters were then aggregated by building type (Office and Dry Good Retail) and by annual consumption strata (using the eight strata originally used in selecting the PURPA sample). Thus total SCL population consumption was obtained for each building type and consumption strata for the year 1986.

2

Development of SCL Population Estimates

The ELCAP buildings provide the most detailed load data available in the Northwest. However, these buildings represent only a small fraction of the region's buildings, and virtually all are located in the Seattle City Light service area. The logical first step in drawing generalizations from the ELCAP buildings is to use them to develop energy use estimates that are representative of the Seattle City Light service territory. However, because the ELCAP sample is small, we cannot assume, without comparison to other load shape estimates, that class load shapes derived from ELCAP provide a reliable representation of the SCL population load shapes.

The SCLCDB buildings provide a good standard for comparison. The SCLCDB sample is large and provides statistically reliable estimates of SCL population class load shapes. The class load shapes derived from ELCAP can be compared with those derived from SCLCDB to determine whether ELCAP provides a good representation of the SCL population.

The weighting method used to develop SCL population estimates from the individual buildings in SCLCDB and ELCAP is based on annual consumption. This approach was used because the best available representation of SCL commercial building consumption is the billing database maintained by Seattle City Light for all of its commercial meters. This database provides estimates of total SCL consumption by building type and consumption strata. Use of this database enabled us to develop class load estimates for Office and Dry Good Retail. However, since the billing database does not include data on SCL floor area, it was not possible to subdivide the building types into the Small and Large categories used by BPA.

This chapter discusses the methodology used to derive the SCL population level class load shapes from ELCAP and SCLCDB building data. Four steps were involved:

1. *Prepare site level data from ELCAP and SCLCDB*
   Building level characteristics and load data were extracted, processed and cleaned. Buildings with particularly problematic or anomalous data were dropped from the analysis.

2. *Calculate SCL population weights (i.e. weights used to develop SCL population estimates from the individual sites)*
   Treating ELCAP and SCLCDB separately, consumption-based weights were developed to generalize from individual sites to the SCL population. Weights were developed for each combination of building type and consumption strata. Each building in a stratum received the same weight.

3. *Develop SCL class total load shapes*
   Using the weights developed in Step 2, the hourly profiles from the individual buildings were aggregated to form SCL class load shapes. Four class load shapes were produced: Office and Dry Good Retail based on SCLCDB, and Office and Dry Good Retail based on ELCAP.

4. *Compare SCLCDB and ELCAP based class load shapes*
   Visual examination of profiles was used to identify similarities and differences in the ELCAP and SCLCDB based class load shapes, and to ascertain whether we could safely assume that ELCAP was representative of the SCL population (as represented by SCLCDB).

Each of these steps are discussed below.

The results of this process were two separate sets of total load profiles for the SCL service territory. One set is based on ELCAP, and one set is based on SCLCDB. Each set includes total load profiles for Office and Dry Good Retail (DGR) for January and July, and for weekdays and weekends. These profiles are presented and discussed at the end of this chapter.

2.1 PREPARE SITE LEVEL DATA

In this step, ELCAP and SCLCDB load and characteristics data for Office and DGR sites were extracted and processed to develop hourly consumption data for each building. Sites were then screened to remove those that were unsuitable for analysis.

ELCAP Data

Extract ELCAP Load Data

Using EASE, the ELCAP Access System, hourly load data for all Office and DGR sites were extracted and written to tape. The aim was to assemble a collection of sites each of which had one year of data recorded starting July, 1986. This constituted a total of 56 sites, including both base study and metered CAP sites.

The SAS programs designed to copy the data files from tape performed some preliminary processing, that is, the construction of "meta-end uses". These were equal to ELCAP end uses where possible, and were sums of ELCAP end uses in other cases. The meta-end uses so constructed were:

Heating	Food Preparation
Cooling	Receptacles
Ventilation	Elevator
Auxiliary	Data Processing
Mixed HVAC	Hot Water/Sanitation
Interior Lights	Specialty
Outside Lights	Other
Refrigeration	Total

Fill ELCAP Missing Values

Missing values were estimated for the data by assembling, for each site, a matrix of average hourly values by end use for each daytype for each month. The daytype categorization used was weekday/weekend for both building types, based on the results of previous cluster analyses conducted as part of the BPA Commercial Building Prototype Review and Revision project (see Johnston, *Day Type in PURPA, CHEUS, and ELCAP Dry Goods Retail Stores* and *Day Type in PURPA, CHEUS, and ELCAP Offices, Baker, Reiter and Associates, 1987*).

If all cells -- or combinations of month, daytype, and hour -- had at least one occurrence, then the "missing value matrix" was complete, and the matrix was merged with the hourly file, filling all missing values in the data with the appropriate mean value from the matrix file.

If any cells of the matrix file were missing from the first aggregation, then the month variable was recoded into a trichotomous season variable (November through February, June through August, and all other months), and the data were again aggregated -- that is, hourly means were taken for each combination of season, daytype and month.

If the recoding of months to seasons did not yield a complete matrix of hourly means, then the month variable was dropped from the aggregation altogether and the mean hourly values were taken for each combination of daytype and hour. If this failed to fill all the cells of the matrix file, then daytype was dropped and average hourly values were used (it is worthwhile pointing out that this last situation never occurred, since the sites with many missing values had already been eliminated from the sample).

In all cases, after the matrix was filled, the file was merged with the hourly data file, and missing values in the hourly file were filled from the matrix. A new hourly level variable was created in the missing value filling exercise -- this was a flag indicating the aggregation level of the matrix used to fill each record.

The result, in all cases for which there was an acceptable amount of data, was a filled file containing 8760 values for each site for each of the meta-end uses.

Develop ELCAP Summary Files

A number of summary data files were created for subsequent analysis. Total annual building loads were computed for use in developing weights. A single file containing all monthly end-use totals for each site in the sample was created, and, finally, for each site, a file consisting of one record for each month-daytype-hour combination was created, and these files, which are about 10% the size of the "8760-files" from which they are derived, became the basis for all subsequent analysis.

Extract and Process ELCAP Characteristics Data

A variety of building level ELCAP characteristics data were needed to support the analysis of the Office/DGR ELCAP buildings. Each table in the ELCAP commercial database (CDB) was converted into an ASCII file, and read into SAS. The data was then processed in SAS.

Some of the required variables, such as building floor area, age, and number of tenants, could be extracted directly from the building level file. The remaining characteristics were calculated from zone level data. These characteristics included primary HVAC system type (the system type which serves the largest fraction of the building's floor area), primary space heat fuel (the fuel associated with the primary system), interior and exterior lighting capacities, HVAC equipment capacity, and other equipment capacity.

For validation purposes, the derived summary characteristics from the CDB were checked against comparable summaries from a review of paper copies of the actual audits. In one third of the buildings, the database contained incorrect or insufficient information to correctly identify the primary HVAC system type. The building level HVAC system type values from the database were therefore supplemented and corrected with the "hard copy" of the audit data. Given the high occurrence of error in the HVAC characteristics data currently resident in the ELCAP CDB, we would not recommend relying solely on the characteristics database for HVAC system type data until validation is complete.

Screen ELCAP Data

In order to use the ELCAP data to develop class load shapes, it was necessary to identify and remove data with questionable values. Initially, there were 56

Office and Dry Good Retail sites in the ELCAP data base. In the first pass through the data, 23 of these sites were excluded from further analysis. Sites were removed for the following reasons:

- Missing all characteristics data (5 sites)
- Missing all load data (2 sites)
- Missing load data for over 50% of the hours in the year (7 sites)
- Commercial ELCAP sites located east of the Cascades (5 sites):
  In order to retain maximum comparability between the ELCAP base study sites from the Seattle area and end-use metered CAP sites from six cities throughout the region, only those end-use metered CAP sites located West of the Cascades were retained for analysis.
- Mixed use, multiple site ELCAP buildings (4 sites):
  Some ELCAP buildings included more than one monitored site. In these cases it was difficult to readily determine the Office or DGR component of the load and characteristics data. To avoid confusion, these sites were removed from analysis.

The remaining 33 sites were then examined to determine if extreme or "atypical" values could be found within any of the important variables related to consumption and characteristics data. Sites which contained anomalous data related to the key analytic variables (e.g., square footage, light and HVAC consumption, etc.) that could neither be explained nor reconciled were eliminated. Three additional sites were removed in the course of this evaluation, leaving a total of 30 sites for use in the analysis.

SCLCDB Data

In analyzing the SCLCDB data, we chose to use sites rather than individual buildings as our units of analysis. This decision was based primarily on the fact that electricity meters often serve more than one building, so while it is possible to collect building level characteristics, it is not always possible to collect building level consumption data. An SCLCDB site was identified as all buildings served by a PURPA (hourly) meter, and all other conventional meters also serving those buildings. Thus an SCLCDB site may consist of one or more buildings, and may include several conventional meters in addition to the hourly meter that defines the site.

Develop Site-Representative Hourly Load Files

Each SCLCDB site has at least one hourly (PURPA) meter. In addition, there may be conventional meters at the site, for which monthly or bimonthly data are available. In order to obtain an hourly profile that represented the entire site, we incorporated data from the conventional meters into the hourly data measured on the PURPA meter. This was accomplished by calculating the ratio of total annual consumption at the site (the sum of the PURPA meter plus all conventional meters) to total annual PURPA consumption. Each hourly value was then multiplied by this ratio in order to obtain an hourly profile that maintained the original hourly data's shape, but with increased consumption at each hour in order to represent all consumption at the site. In this way, an 8760 file (hourly observations) that included all the consumption at a site was created for each site.

For most SCLCDB sites, hourly data were available from 1984 through mid-86. For this project, we chose to use the most recent data available in order to be consistent with ELCAP. In addition, we chose to use only one year of data in order to reduce complications associated with weighting. The data period used for this project covered mid-1985 to mid-1986. The small buildings added to the sample in late 1985 are missing hourly data until the beginning of 1986.

Develop SCLCDB Summary Files

Several summary data files were created for subsequent analysis. Total annual building loads were computed for each building site for later use in calculating weights. These files consisted of the sum of annual consumption for each meter at the site, including the hourly meter. In addition, for each site a file consisting of one record for each month-daytype-hour combination was created, and these files, which are about 10% the size of the "8760-files" from which they are derived, became the basis for all subsequent analysis of hourly profiles.

Process SCLCDB Characteristics Data

The characteristics data available for the SCLCDB sites came from two separate sources. Characteristics data were collected for a sample of the SCLCDB sites in the 1984 Seattle Commercial Building Survey (SCBS). This survey provided data at the site, building and tenant level, including such characteristics as floor area, predominant fuel type, type of primary electric HVAC system, tenant land use codes, and breakdowns of conditioned versus unconditioned areas. The SCBS data were supplemented with a walk-by survey of each SCLCDB site in 1986. The walk-by survey included sites which had been added to the SCLCDB after the original characteristics survey had been completed. As a result, more sites were examined during the walk-by survey than during the 1984 SCBS. The walk-by survey provided estimates at the building level of floor area, number of stories and number of tenants. In addition, each building was classified by business type according to the BPA definitions developed for PNNonRES.

The primary source of characteristics data used for this project was the walk-by survey, since it included more sites and because we felt its data were more reliable. In order to use the walk-by data it was necessary to aggregate characteristics from the building level up to the site level. Site level floor area was obtained by summing the floor area of all buildings in the site. Site level business type and vintage were obtained by choosing the business type/vintage which represented the greatest amount of floor area at the site.

Information on fuel type was obtained from the 1984 SCBS data. Since this survey did not cover all SCLCDB sites, no fuel type data were available for some sites. The fuel type data were merged with the other site level characteristics data.

Screen SCLCDB Data

In order to use the SCLCDB data to develop class load shapes, it was necessary to identify and remove data with questionable values. Originally, the SCL database contained 156 sites which had been identified as Office or DGR sites during the walk-by survey. However, characteristics data necessary to conduct the analysis were only available for 78% of these sites. Given the importance of these characteristics, we chose to eliminate all sites missing these characteristics. This left a total of 123 Office and Dry Goods Retail sites.

In addition, we did not want to complicate the analytic process by utilizing sites whose building type was questionable. We wanted to insure that only Office and Dry Good Retail sites were used from this database. The method used to demonstrate membership in either the Office or Dry Good Retail building type was to require the site to match on both the walk-by based building classification and the SIC classification assigned by the utility to the consumption meter(s) for the site. This process resulted in the elimination of another 37 sites.

The remaining 86 sites were then examined to determine if extreme or "atypical" values could be found within any of the consumption or floor area variables. Sites containing anomalous floor area or consumption data were identified from plots of consumption versus floor area and total annual Energy Use Intensity (EUI) versus floor area. If the anomalous data could not be satisfactorily explained, then the site was removed from the analysis. Nine additional sites were removed in the course of this evaluation.

The final screen removed sites with problems in the hourly load data. A total of 19 sites were removed during this screen:

- 5 sites with less than 50% of total site consumption recorded on the hourly PURPA meter. In these cases, we could not assume that the hourly profile recorded on the PURPA meter would be representative of the site.

- 1 site where the hourly meter possessed a different SIC code than the remainder of the site. Again, this indicated that the hourly load profile was potentially misrepresentative of the site as a whole.

- o 5 sites with no hourly data for 1985.
- o 8 sites with no hourly load data.

After all screening and cleaning, a total of 58 Office and Dry Good Retail sites remained for analysis. Clearly, this process removed a large fraction of the possible Office and DGR sites from the analysis. Given greater resources, we believe that a large number of these sites could be utilized, although additional primary data collection at individual sites would be required. This is probably the single most cost-effective way to substantially improve the estimates of regional end-use loads presented in this report.

2.2 CALCULATE SCL POPULATION WEIGHTS

In this step, the weights necessary to extend ELCAP and SCLCDB data to the SCL population were developed, using the consumption data from SCL's commercial meters.

Separate sets of weights were developed for ELCAP and for SCLCDB. However, the methodology used is identical for both cases, so they are discussed here together. The following steps were used for both datasets:

1. *Classify sites by building type*

   Sites in each dataset were separated according to the building type (Office or Dry Good Retail) associated with the site. Building type was the first dimension used to classify the sites in each data set.

2. *Classify the sites in each building type by consumption*

   The second dimension used to classify sites in each dataset was consumption. This dimension was included in order to be able to develop different weights for small and large buildings within a building type. Consumption was used as a measure of size because the available SCL population data consists of annual consumption.

   Total annual consumption had been calculated for each site in the ELCAP and SCLCDB datasets. For ELCAP sites, total consumption covered the period of mid-86 to mid-87, the only period for which data were available. For SCLCDB, total consumption represented the period mid-85 to mid-86, the latest period for which consumption was available.

   Using the total annual consumption, each site was allocated to one of the eight consumption strata used by SCL to classify commercial meters (a consumption strata is simply a range of consumption levels, e.g. 75 MWh to 155 MWh). The small sample size in the ELCAP and SCLCDB datasets caused poor or no representation in some datasets. To remedy this problem, the eight SCL strata were collapsed into three strata for this analysis. The exact consumption ranges covered by each stratum varied for

ELCAP and SCLCDB, and for building types within ELCAP. The goal in setting the strata ranges was to have good representation in each stratum, and to have no empty strata.

Table 2.1 shows the allocation of the SCLCDB and ELCAP buildings into consumption strata.

Table 2.1

Assignment of ELCAP/SCLCDB Buildings to Consumption Strata

ELCAP			
DRY GOOD RETAIL		OFFICE	
STRATA	N	STRATA	N
Small <= 75 Mwh	4	Small <= 155 Mwh	10
Medium 76 to 304 Mwh	4	Medium 156 to 600 Mwh	5
Large >= 305 Mwh	4	Large > 600 Mwh	3
SCLCDB			
DRY GOOD RETAIL		OFFICE	
STRATA	N	STRATA	N
Small < 305 Mwh	3	Small < 305 Mwh	7
Large 305 to 3000 Mwh	4	Large 305 to 3000 Mwh	11
Very Large > 3000 Mwh	7	Very Large > 3000 Mwh	26

It is important to note that the ELCAP buildings tend to have lower consumption than the SCLCDB buildings. This is because in general, the ELCAP buildings are smaller in size than the SCLCDB buildings. This is discussed in more detail later.

3. *Group the commercial meters in the SCL population into identical consumption strata*

Our measure of the SCL population was the SCL database of all commercial meters in the SCL service territory. These meters were classified by building type (Office or Dry Good Retail) and by consumption strata. The consumption classification was based on total metered consumption for mid-85 to mid-86.

The population data for each building type were divided into consumption strata that exactly corresponded to those used to classify the ELCAP and SCLCDB buildings. This process was completed separately for the two datasets, since the strata ranges differ for each dataset (see Table 2.1).

All DGR meters in the SCL population were grouped into three strata to correspond to ELCAP. For example, meters with less than 75 MWh of annual consumption were classified as small, and meters with 76 to 304 MWh of annual consumption were classified as medium. For use with the SCLCDB sites, the SCL DGR meters were grouped into strata with different ranges. For example, meters with less than 305 MWh of annual consumption were classified as small, and meters with 305 to 3000 MWh of annual consumption were classified as large.

4. *Calculate total consumption for each building type and consumption strata*

Once ELCAP and SCLCDB buildings were allocated to building type and consumption strata, the total consumption was calculated for each stratum. This was done by summing the annual consumption for all the buildings in a stratum. For example, total consumption for all ELCAP DGR buildings with less than 75 MWh of annual consumption (Figure 2.1 shows four buildings in this stratum) is 171 MWh. In this way, total consumption was calculated for each of the strata shown in Figure 2.1.

Similarly, total consumption was calculated for each stratum in the SCL population of commercial meters. For example, the total SCL population for all DGR meters with annual consumption less than 75 MWh (the small cell corresponding to ELCAP) is 74,919 MWh.

5. *Calculate sample-to-SCL population weights for each strata*

Sample-to-SCL population weights were calculated separately for each building type and stratum within each dataset. For each strata, the sample-to-SCL population weight is calculated as:

wt = (total SCL pop. cons. in strata)/(total sample cons. in strata)

For example, for our ELCAP DGR buildings in the "small" (less than 75 MWh annual consumption) strata:

wt = 74,919/171 = 438.12

All SCLCDB or ELCAP buildings in a strata received the weight calculated for that strata. Table 2.2 shows the sample-to-SCL population weights calculated for each strata.

Table 2.2

Sample-to SCL Population Weights for Each Strata

ELCAP			
DRY GOOD RETAIL		OFFICE	
STRATA	WEIGHT	STRATA	WEIGHT
Small <= 75 Mwh	438.12	Small <= 155 Mwh	206.40
Medium 76 to 304 Mwh	118.70	Medium 156 to 600 Mwh	92.70
Large >= 305 Mwh	74.65	Large > 600 Mwh	133.50
SCLCDB			
DRY GOOD RETAIL		OFFICE	
STRATA	WEIGHT	STRATA	WEIGHT
Small < 305 Mwh	455.16	Small < 305 Mwh	391.97
Large 305 to 3000 Mwh	19.36	Large 305 to 3000 Mwh	18.28
Very Large > 3000 Mwh	1.70	Very Large > 3000 Mwh	2.61

In general, smaller buildings (in terms of consumption) tend to have higher weights, while larger buildings tend to have lower weights. This is because the larger buildings include a larger fraction of the total population consumption for that strata -- in the case of the SCLCDB virtually all of the largest buildings in the population are included in the sample.

2.3 DEVELOP SCL CLASS TOTAL LOAD SHAPES

Once weights were calculated, they were used to develop class level load shapes from the individual building data. Separate load shapes were developed from each set of building data (one set from ELCAP, one set from SCLCDB). Each set of building data was used to develop an Office and a DGR class load shape.

The class load shapes were developed by applying each building's weight to its hourly load profile to obtain building level load profiles weighted to the SCL population, and then summing these weighted load shapes for all the buildings in a given building type. This process aggregates buildings across consumption strata to generate class load shapes by building type from each dataset.

The use of weights that are related to consumption strata ensures that the large consumption buildings do not obscure the small consumption buildings. Small buildings have higher weights than larger buildings, which helps to balance out the differences in consumption. The resultant aggregate load shape provides a representative picture of large and small consumers combined.

2.4 COMPARE SCLCDB AND ELCAP BASED CLASS LOAD SHAPES

As we have seen, ELCAP is the only available source of hourly end-use load data. However, the ELCAP sites represent a small sample that was selected randomly without regard to annual electricity consumption. Because of this, they provide an inherently less reliable representation of the SCL population than the SCLCDB sites, which were sampled using PPS techniques. We therefore need to determine if the ELCAP sites *are* representative of the SCL population.

We would like to be able to assume that ELCAP is representative of the SCL population so that we can use ELCAP to obtain end-use breakdowns of the SCLCDB total load data. We therefore must compare the SCL population load shapes derived from ELCAP to those derived from SCLCDB to see if ELCAP provides an acceptable representation of the SCL population.

Comparison of the Samples

In order to be able to conduct an insightful comparison of class load shapes based on two different datasets, it is important to understand the differences and similarities in the underlying datasets. In the case of the ELCAP and SCLCDB datasets used in this project, four important differences arise:

- o sample size
- o distribution of electric versus non-electric space heat buildings
- o distribution of floor area within each building type
- o weather

Table 2.3 shows the sample size for each dataset, broken down by BPA building type and by space heat type. The BPA building type categories include a size categorization based on floor area. Thus Office is broken into Large Office and Small Office, and DGR is broken into Large DGR and Small DGR. These building type categories *were not* used in representing the SCL population because we had no way of breaking the SCL population into size categories based on floor area. However, they are included here because they help to demonstrate the size differences between the ELCAP and SCLCDB buildings.

As Table 2.3 shows, there are significant differences between the two datasets in terms of the distribution of buildings across floor area categories and heat types. In general, the SCLCDB sample represents large buildings well and small buildings poorly. The ELCAP sample shows exactly the reverse pattern. It includes a large number of small buildings, and few large buildings. As a result, SCLCDB is better able to provide a robust estimate of consumption patterns in larger buildings, while ELCAP is better able to provide a robust estimate of consumption patterns in smaller buildings. Also, since ELCAP has poor representation for larger buildings, the end-use splits for larger buildings will be less robust than those for smaller buildings.

Table 2.3

Characteristics of the ELCAP and SCLCDB Samples

ELCAP			
BPA BUILDING TYPE	SPACE HEAT TYPE Elec	Non-Elec	TOTAL
Large DGR > 20,000 sqft	0	3	3
Small DGR < 20,000 sqft	4	5	9
Large Office > 30,000 sqft	4	0	4
Small Office < 30,000 sqft	11	3	14
SCLCDB			
BPA BUILDING TYPE	SPACE HEAT TYPE Elec	Non-Elec	TOTAL
Large DGR > 20,000 sqft	3	9	12
Small DGR < 20,000 sqft	2	1	3
Large Office > 30,000 sqft	24	12	36
Small Office > 30,000 sqft	3	4	7

In addition, the distribution of space heat types varies between the two datasets. In particular, all Large DGR buildings in the ELCAP sample have non-electric space heat, while all Large Office buildings have electric space heat. Since ELCAP is our only source of end-use data, these sample limitations affect the development of class load shapes by end use.

Another difference in the two datasets is that the Large buildings in the SCLCDB dataset tend to be bigger than those in ELCAP. This is shown in Table 2.4. Not only does SCLCDB have many more Large buildings than ELCAP, but those buildings are larger in floor area than the Large buildings in ELCAP.

As Table 2.4 shows, the mean building size for Large SCLCDB buildings is roughly three times the size of ELCAP sites of the same type. Again we see evidence that ELCAP cannot provide robust end-use breakdowns for very large buildings.

Table 2.4

Distribution of Building Floor Area in the ELCAP and SCLCDB Samples

ELCAP			
BPA BUILDING TYPE	FLOOR AREA (SQFT) Min	Max	Mean
Large DGR > 20,000 sqft	20,819	99,616	56,851
Small DGR < 20,000 sqft	2,045	19,026	8,717
Large Office > 30,000 sqft	31,691	127,590	63,562
Small Office < 30,000 sqft	2,508	28,649	9,697
SCLCDB			
BPA BUILDING TYPE	FLOOR AREA (SQFT) Min	Max	Mean
Large DGR > 20,000 sqft	20,231	648,641	146,503
Small DGR < 20,000 sqft	4,165	17,861	12,423
Large Office > 30,000 sqft	37,434	1,232,526	239,152
Small Office > 30,000 sqft	1,153	22,005	7,015

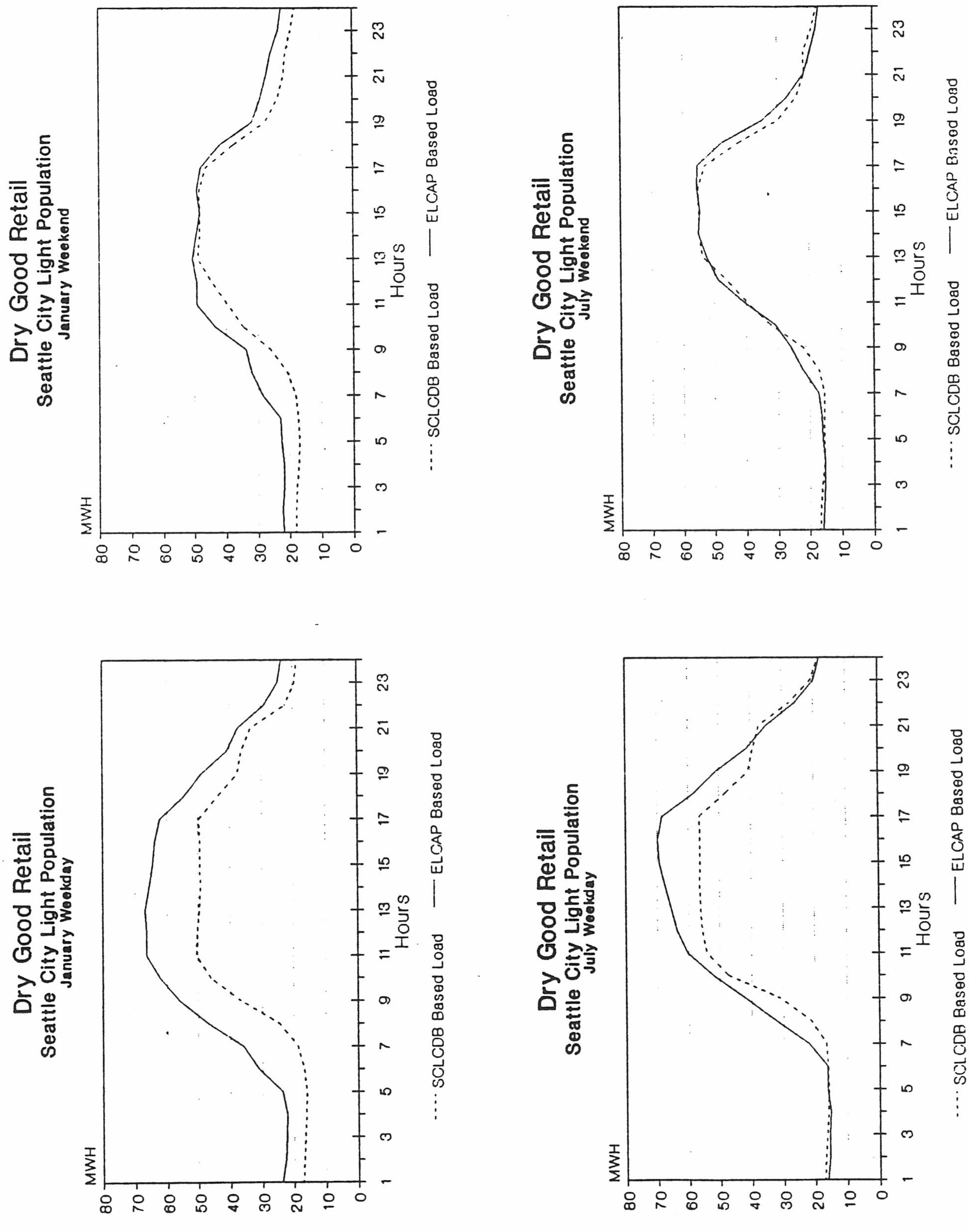
The final notable difference between the two datasets is the potential influence of weather. The SCLCDB data cover the period of September 1985 to August 1986. The ELCAP data cover the period of July 1986 to June 1987. Therefore the datasets overlap only for July and August of 1986. In general, the ELCAP year (86-87) was colder than the SCLCDB year (85-86). However, November and December of 1985 (SCLCDB) were extremely cold.

The class load profiles shown below depict only January and July. Of these months, January of the ELCAP year (87) was considerably colder than January of the SCLCDB year (86). July (86) is used in both datasets.

Class Load Profile Results and Comparisons

Figure 2.1 shows the class load profiles for Dry Good Retail for the Seattle City Light population. Four plots are shown: January weekdays and weekends, and July weekdays and weekends. Each plot contains two load shapes. One is the population total load based on ELCAP, and the other is the population total load based on SCLCDB.

FIGURE 2.1


Dry Good Retail
Seattle City Light Population
January Weekday
Dry Good Retail
Seattle City Light Population
January Weekend
Dry Good Retail
Seattle City Light Population
July Weekday
Dry Good Retail
Seattle City Light Population
July Weekend
MWH
80
70
60
50
40
30
20
10
0
1
3
5
7
9
11
13
15
17
19
21
23
Hours
---- SCLCDB Based Load
—— ELCAP Based Load

The January weekday plot shows the two profiles to have similar shapes but different magnitudes. Part of the higher consumption seen in ELCAP is probably due to the fact that the ELCAP data was collected during a colder January than the SCLCDB data. Since the majority of the ELCAP DGR buildings are small and therefore more likely to be impacted by the effects of weather, we would expect the ELCAP values to be somewhat higher. The two profiles show similar shapes: some level of base consumption during night hours, then a large jump in consumption during business hours. A slight morning peak indicates the presence of morning warm-up heating (less heat is required in the afternoon because of the internal gains provided by the lighting). The transition between business and non-business hours is somewhat smoothed by the presence of many buildings with different business hours. The winter weekday peak is 50 MW for the SCLCDB-based load profile, and approximately 67 for the ELCAP-based load profile.

The January weekend plot shows a similar shape to the weekday plot. This occurs because stores are open on weekends as well as weekdays. The gradual increase in consumption in the AM is a result of stores opening at different times. In contrast, consumption drops sharply as stores close between 5 and 7 PM. The ELCAP-based and SCLCDB-based profiles show very similar shapes. The peak for both profiles is about 50 MW, and the peak lasts throughout the day (during business hours).

The profiles shown on the July plots are directly comparable, since they represent consumption measured during the same year. The weekday profiles again show a similar shape, with ELCAP showing a higher peak (approximately 70 MW). Note that the summer peak occurs in the afternoon, when cooling loads are highest.

The profiles for July weekends are virtually identical. Both profiles show a classic DGR shape: large increase in consumption during business hours due to lighting needs, relatively constant consumption throughout the day, and an afternoon peak due to cooling requirements. The peak for July is 55 MW. Note that the summer peaks are slightly higher than the winter peaks, but in general are very close. Note too, that base consumption (consumption during non-business hours) hovers around 20 MW in the winter, and slightly less than that in the summer.

In general, the ELCAP-based and SCLCDB-based profiles for DGR seem quite similar. On weekends they are very close; on weekdays the ELCAP profile shows a constantly higher level of consumption. This may be due to the presence of one or more ELCAP buildings that are high consumers and are open only during the week.

In order to illustrate the range in typical profiles underlying the aggregate profile, we calculated the standard deviation for each hour in the load profile for each dataset. The standard deviation is a measure of variation in the weighted building-level values used to develop the single aggregate profile. In a normal distribution, 68 percent of the observations fall within plus or minus one standard deviation from the mean. We calculated the profiles corresponding to the aggregate plus one standard deviation and the aggregate minus one standard deviation. Together, these profiles depict a range of typical consumption for each hour. Figure 2.2 shows the ranges for ELCAP and SCLCDB based profiles for a January weekday.

As the plot shows, deviation for both ELCAP and SCLCDB is larger during business hours than during non-business hours. In addition, the variation is much larger for ELCAP than for SCLCDB. The ELCAP sites apparently tend to begin business earlier in the day -- only between 5 and 9 AM is there any significant lack of overlap between the two ranges. For both datasets, the lower boundary probably represents buildings with lower lighting levels and some with non-electric space heat. The upper boundary probably represents buildings with extremely high lighting loads or high HVAC requirements.

However, the SCLCDB range falls almost entirely within the ELCAP range. Therefore, we can safely assume that both datasets are representative of DGR buildings in the SCL population.

FIGURE 2.2

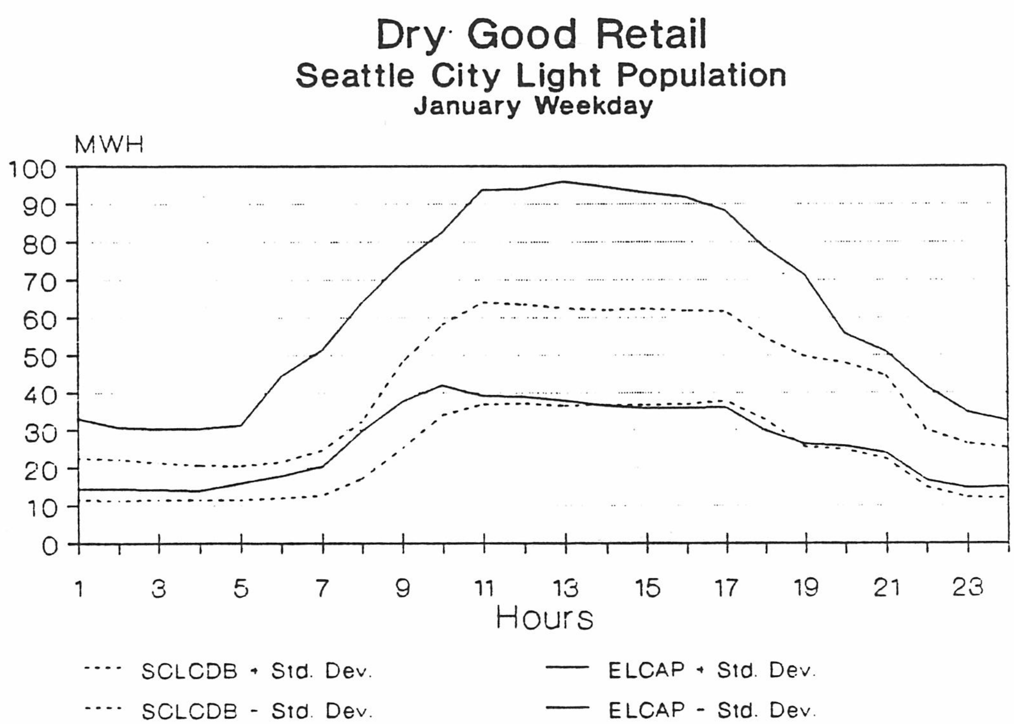


FIGURE 2.3

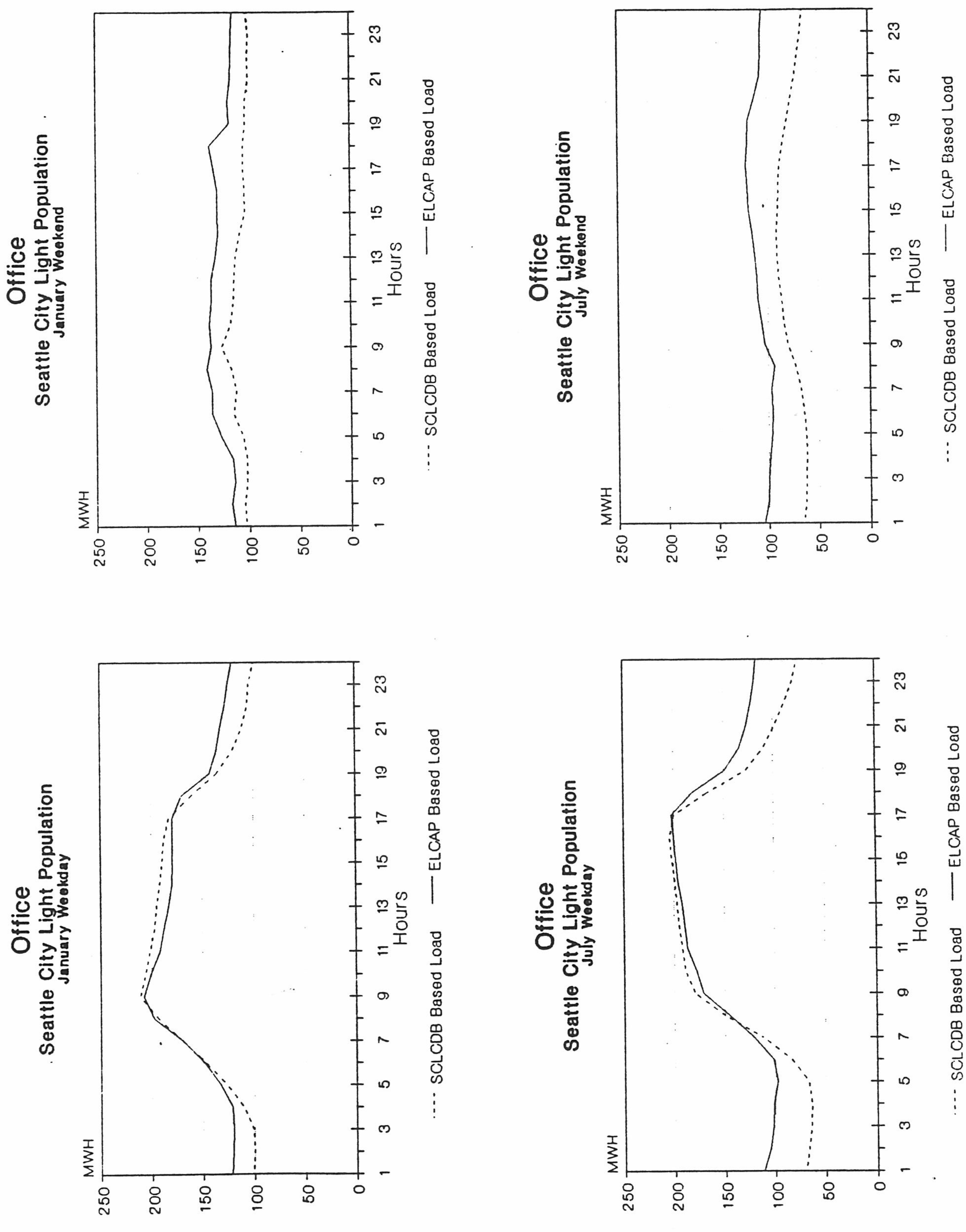
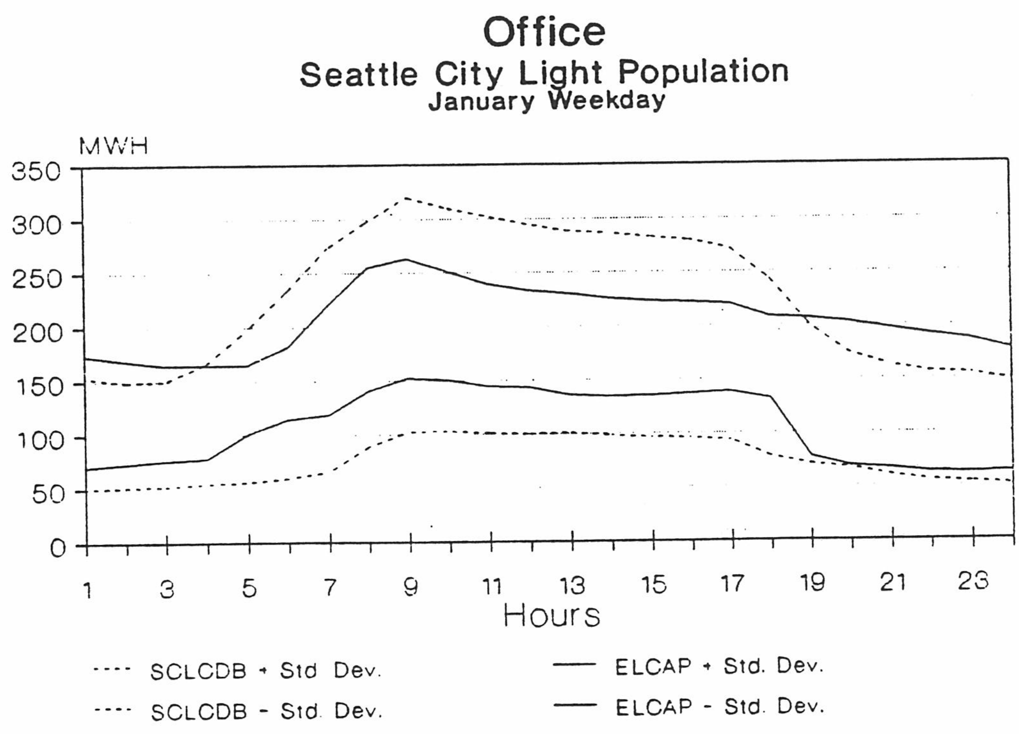

Office
Seattle City Light Population
January Weekday
Office
Seattle City Light Population
January Weekend
Office
Seattle City Light Population
July Weekday
Office
Seattle City Light Population
July Weekend
MWH
250
200
150
100
50
0
1 3 5 7 9 11 13 15 17 19 21 23
Hours
SCLCDB Based Load
ELCAP Based Load

Figure 2.3 shows the class load profiles for Office buildings in the Seattle City Light population. Four plots are shown: January weekdays and weekends, and July weekdays and weekends. Each plot contains two load shapes. One is the population total load based on ELCAP, and the other is the population total load based on SCLCDB.

In contrast to DGR, the Office profiles show a marked difference between weekdays and weekends. We can clearly see that weekend consumption remains close to the base level seen during the non-business hours on weekdays. In January, this base level is slightly higher for ELCAP than for SCLCDB (120 versus 100 MWh per hour), which may reflect the difference in weather for that month. During July, base consumption is again constant during weekday non-business hours and weekend hours. Interestingly, the ELCAP base consumption remains constant from January to July, while the SCLCDB base drops from 100 in January to 70 in July.

FIGURE 2.4



In all cases, the two datasets show very similar shapes, and the magnitude of the weekday peaks is virtually identical. In winter, both weekday profiles show a large increase in consumption during business hours, with a morning peak of 210 MWH corresponding to early AM warm-up. In summer, the peak of 200 MWH occurs in late afternoon and is due to cooling requirements. Note that the magnitude of the summer and winter peaks is nearly identical, though Seattle is generally a winter peak city. The magnitude of the winter class load peak is tempered somewhat by the presence of buildings with non-electric heat.

Figure 2.4 shows the typical ranges for January weekdays. The ELCAP range is virtually entirely subsumed in the SCLCDB range, and ELCAP shows much less variation. This may be due to the fact that SCLCDB truly covers a wide range of building sizes, while ELCAP includes no buildings larger than 120,000 sq ft (small for a large office building). Note that the lower boundary profiles do not show an AM peak; these profiles probably represent buildings with non-electric space heat. Given the overlap in the ranges, we can safely assume that ELCAP provides a reasonable representation of the SCL population of Offices.

2.5 CONCLUSIONS

Although the ELCAP and SCLCDB samples are significantly different in some respects, both can be used to provide good representations of the SCL population. For the most part, class load shapes derived from the two datasets are quite similar. The deviations we see are well within the range of typical values for these class load profiles.

Since ELCAP and SCLCDB are comparable at the SCL population level, they can be used to supplement each other. SCLCDB can be used to provide total load profiles, and ELCAP can then be used to provide end-use breakdowns. While not undertaken at the SCL level, this approach was used in the development of regional load profiles, discussed in the next chapter.

While the results presented here provide useful preliminary estimates, there are a number of ways in which they could be substantially improved. Several potential approaches for improving the estimates are listed below, ranked in order of probable cost-effectiveness:

- Recover the SCLCDB sites that were dropped from analysis due to conflicting information on building type. The SCLCDB is a large sample, but we were not able to utilize it fully because one half of the sites showed differences between the SIC code assigned by the utility to the site and the building type assigned during the walk-by survey. A re-evaluation of each of the "confused" sites could resolve this problem for most sites, enabling them to be included in the analysis. Full use of the SCLCDB sample would improve the reliability of the estimates considerably.

- Once sufficient additional hourly end-use data are available (mid-1988 at the earliest), incorporate multiple-year end-use data into the analysis. Again, the presence of more data would improve the reliability of the end-use estimates.

- o Conduct a case level examination and analysis of the ELCAP sites. The ELCAP sample is small, and is the only available source of hourly end-use data. Consequently, it is important to examine the data for each individual site. The most prudent approach would be to first examine sites that have been flagged as anomalous. If certain sites are in fact outliers, they can can be eliminated from the estimation process. If there are data problems, they can be corrected.

- o Develop a model that can be used to estimate end use shares given data on total hourly load, characteristics and weather. A model of this type could be used to estimate end use shares for each of the SCLCDB sites. This would provide a substantially more reliable method than the direct imposition of the ELCAP shares on the SCLCBD aggregate building type profile. In order to develop such a model, a thorough analysis of the relationships between weather, total and end use consumption, and characteristics would be necessary. This analysis would provide the basis for the model.

- o Examine other building types. Using the methods discussed in this report (or the model mentioned above), develop estimates of SCL load shapes for other building types.

3

Development of Preliminary Regional Estimates

After the SCL population values had been developed, they were used to make estimates for the region. Ideally, we do this by identifying characteristics that systematically affect consumption, then noting whether the distribution for each of these characteristics is different for the region as a whole than for the SCL service territory. This step requires the availability of regionally representative characteristics data. Data from the second stage of PNNonRES will provide the detailed characteristics data necessary to do a thorough analysis; data from the first stage of PNNonRES enables us to make necessary adjustments based on distribution of building floor area. Since only first stage PNNonRES data are currently available, this analysis uses only differences in the distribution of floor area to generalize from the SCL population to the region. The results of this analysis should be considered to be preliminary, since a much more thorough regionalization process can be used once the second stage PNNonRES results are available.

In this phase of the project we used floor-area based weights to extend data from the SCL population to the region. Both SCLCDB and ELCAP data were extended to the region using weights derived from the first stage of PNNonRES. Since PNNonRES enables us to distinguish between Large and Small buildings within each building type (based on BPA's definition, Large DGR includes all buildings over 20,000 sqft, and Large Office includes all buildings over 30,000 sqft), we have developed regional load shapes using this distinction. Regional class load shapes were developed from the SCLCDB data for Large and Small Office, and for Large and Small DGR. End-use shares were calculated from the

ELCAP data for each of these four BPA building types, and these shares were applied to the SCLCDB based load shapes to obtain end-use class load shapes.

This chapter discusses the methodology used to derive the regional class load shapes from the SCLCDB and ELCAP data, and presents the results of the process. Three steps are involved:

1. *Develop SCL to region weights*
   Treating ELCAP and SCLCDB separately, weights were developed to generalize from the SCL population to the Pacific Northwest region. Buildings were assigned to cells based on building type and floor area; then weights were calculated for each cell using the PNNonRES estimates of regional floor area.

2. *Develop regional class total load shapes*
   Combining the weights developed in Chapter 2 with those developed in Step One above, the hourly load profiles for the individual buildings were aggregated to form regional class load shapes. These class load shapes are based on SCLCDB, and include profiles for: Large Office (greater than 30,000 sq ft.), Small Office (less than 30,0000 sq ft), Large Dry Good Retail (greater than 20,000 sq ft), and Small Dry Good Retail (less than 20,000 sq ft).

3. *Develop regional class load shapes by end use*
   Regionally weighted ELCAP data were used to calculate end-use shares as a percentage of total consumption. These shares were then applied to the regional load shapes to develop regional end-use load shapes.

Each of these steps is discussed below.

3.1 CALCULATE REGIONAL WEIGHTS

Ideally, in generalizing results from one population to a larger population, we would like to be able to consider a variety of factors that affect consumption and that may be distributed differently in the two populations. However, in this case our only source of regional characteristics data is the first stage of PNNonRES, which only contains data on floor area by building type. Therefore at this time the only adjustment that can be made to reflect differences between SCL and the region is to adjust for differences in the distribution of floor area. All other factors, such as fuel saturations, hours of operation, lighting capacity and HVAC system type, will have to be held constant until data from the second stage of PNNonRES are available.

In this step, the weights necessary to extend ELCAP and SCLCDB data from the SCL population to the region were developed. These weights are based on estimates of regional floor area by building type obtained from the first stage of PNNonRES.

Separate sets of weights were developed for ELCAP and for SCLCDB. However, since the methodology used is identical for both cases, they are discussed here together. The process included the following steps:

1. *Classify sites by BPA building type*

   Because the weighting system used to develop regional estimates is based on floor area, it was possible to consider each of the four BPA building types (Small Office, Large Office, Small DGR, Large DGR) rather than the more general Office and DGR categories. Therefore, sites in each dataset were classified according to the building type (Office or Dry Good Retail) and floor area associated with the site. Office buildings with more than 30,000 sqft were classified as Large Office (LGDGR), Offices with less than 30,000 sqft were classified as Small Office (SMDGR), DGR buildings with more than 20,000 sqft were classified as Large DGR (LGDGR), and DGR buildings with less than 20,000 sqft were classified as Small DGR (SMDGR). BPA building type was the first dimension used to classify the sites in each data set.

2. *Classify the sites in each BPA building type by floor area size strata*

   The second dimension used to classify sites in each dataset was floor area. This dimension was included in order to be able to develop different weights for small and large buildings within a building type. Floor area was used as a measure of size because the available regional data consists of floor area estimates.

   Using the total floor area, each site was allocated to a floor area size stratum. The exact floor area ranges covered by each size stratum varied for ELCAP and SCLCDB, and for each BPA building type. The goal in setting the size strata ranges was to have good representation in each stratum, and to have no empty size strata.

   Table 3.1 shows the allocation of the ELCAP and SCLCDB buildings into floor area size strata. It is important to note that the ELCAP buildings tend to concentrate at the lower end of the floor area spectrum. In particular, there are fewer LGOFF and LGDGR buildings in ELCAP than in SCLCDB, and the ELCAP LGOFF and LGDGR buildings tend to be smaller than those in SCLCDB. This means that end-use splits for LGDGR and LGOFF buildings will be less robust, and based on relatively small buildings.

Table 3.1

Assignment of ELCAP/SCLCDB Buildings to Floor Area Size Strata

ELCAP			
LARGE DRY GOOD RETAIL		LARGE OFFICE	
STRATA	N	STRATA	N
1 >= 20k sqft	3	1 >= 30k sqft	4
SMALL DRY GOOD RETAIL		SMALL OFFICE	
STRATA	N	STRATA	N
1 <= 10k sqft	5	1 < 6k sqft	5
2 10k to 20k sqft	4	2 6k to 12k sqft	5
		3 12k to 30k sqft	4
SCLCDB			
LARGE DRY GOOD RETAIL		LARGE OFFICE	
STRATA	N	STRATA	N
1 20k to 100k sqft	4	1 30k to 130k sqft	13
2 100k to 200k sqft	5	2 130k to 300k sqft	14
3 >= 200k sqft	2	3 >= 300k sqft	10
SMALL DRY GOOD RETAIL		SMALL OFFICE	
STRATA	N	STRATA	N
1 < 20k sqft	3	1 < 6k sqft	4
		2 6k to 30k sqft	3

3. *Group the PNNonRES regional floor area data into the floor area strata developed in step 2*

Our measures of the regional population were the regional floor area estimates provided by the first stage of PNNonRES. In PNNonRES, approximately 14 thousand commercial buildings were surveyed, and then weights were developed to extend data from these buildings to the region. Information collected for each building included building type and floor area. For this project, we selected all PNNonRES Office and DGR buildings, divided them into Large and Small groupings based on their floor area, and then assigned them to the floor area size strata used for ELCAP and SCLCDB.

4. *Calculate total floor area for each BPA building type/size strata*

Once ELCAP and SCLCDB buildings were classified by BPA building type and floor area size strata, the total floor area, *weighted to the SCL population*, was calculated for each stratum. The sample-to-SCL population weights described in Chapter Two were applied to each building, and the weighted floor area for each building in a stratum was summed to provide an estimate of the total SCL floor area in each stratum. For example, total SCL floor area for all ELCAP SMDGR buildings with less than 10,000 sq ft of floor area (Figure 3.1 shows five buildings in this stratum) is 6.1 million sqft. In this way, total SCL floor area was calculated for each of the strata shown in Figure 3.1.

Similarly, total floor area was calculated for each stratum in the PNNonRES dataset. Again, the PNNonRES sample to region weights were applied to each building, and the weighted floor area was summed for all buildings in a stratum. For example, the total regional floor area for all SMDGR buildings with less than 10,000 sqft is 115.7 million sqft.

5. *Calculate SCL-to-region weights for each stratum*

SCL-to-region weights were calculated separately for each BPA building type/floor area stratum within each dataset. For each strata, the SCL-to-region weight is calculated as:

wt = (total region floor area in stratum)/(total SCL floor area in stratum)

For example, for our ELCAP SMDGR buildings with less than 10,000 sqft (stratum 1 for ELCAP SMDGR in Table 3.1):

wt = 115.7/6.1 = 18.97

All SCLCDB or ELCAP buildings in a stratum received the weight calculated for that strata. Table 3.2 shows the SCL-to-region weights calculated for each stratum.

6. *Calculate combined weights (sample-to-region) for each building*

In order to aggregate building level hourly data up to the region, it is necessary to use a sample-to-region weight. This step is necessary because we are developing different class load shapes for the region than we did for the SCL population. For the population, we looked simply at Office and DGR; for the region we are refining these categories to include Small and Large designations. We must therefore go back to the building level data to derive the regional class load shapes.

Table 3.2

SCL-to-Region Weights for Each Stratum

ELCAP			
LARGE DRY GOOD RETAIL		LARGE OFFICE	
STRATA	WEIGHT	STRATA	WEIGHT
1 >= 20k sqft	8.60	1 >= 30k sqft	5.80
SMALL DRY GOOD RETAIL		SMALL OFFICE	
STRATA	WEIGHT	STRATA	WEIGHT
1 <= 10k sqft	18.94	1 < 6k sqft	12.70
2 10k to 20k sqft	5.30	2 6k to 12k sqft	4.19
		3 12k to 30k sqft	8.02

SCLCDB			
LARGE DRY GOOD RETAIL		LARGE OFFICE	
STRATA	WEIGHT	STRATA	WEIGHT
1 20k to 100k sqft	28.40	1 30k to 130k sqft	5.38
2 100k to 200k sqft	16.74	2 130k to 300k sqft	5.80
3 >= 200k sqft	8.05	3 >= 300k sqft	4.91
SMALL DRY GOOD RETAIL		SMALL OFFICE	
STRATA	WEIGHT	STRATA	WEIGHT
1 < 20k sqft	9.44	1 < 6k sqft	12.98
		2 6k to 30k sqft	5.90

The sample-to-region weight (called the combined weight) is calculated for each building simply by multiplying its sample-to-SCL weight and its SCL-to-region weight:

combined wt = sample-to-SCL wt * SCL-to-region wt

For example for an ELCAP SMDGR building with less than 75 MWH of annual consumption and less than 10,000 sqft:

combined wt = 438.12 * 18.94 = 8298

3.2 DEVELOP REGIONAL CLASS TOTAL LOAD SHAPES

Estimates of regional total hourly loads were derived by applying the combined weight figures to the SCLCDB hourly data. The SCLCDB data was chosen for this purpose because its SCL population estimates are thought to be more reliable than those derived from ELCAP. Class level load shapes were developed for Large and Small Office and for Large and Small Dry Good Retail.

The regional class load shapes were developed by applying each SCLCDB building's combined weight to its hourly load profile to obtain building level load profiles weighted to the region, and then summing these weighted load shapes for all the buildings in a given BPA building type. This process aggregates buildings across consumption strata and floor area strata to generate regional class load shapes by BPA building type.

3.3 DEVELOP REGIONAL END-USE SHARES FROM ELCAP

Since ELCAP is the only available source of hourly end-use data, it was used to develop end-use shares which could then be applied to the regional total load shapes generated in the last step.

Estimates of regional end-use hourly loads were derived by applying the combined weight to the ELCAP hourly data. Regional load shapes were produced by end use for each of the four BPA building types. These regional end-use loads were then recalculated as a percentage of total load by dividing each end-use observation by the corresponding total load for that hour.

The percentage end-use shares were then applied to the total load shapes derived from the SCLCDB to obtain end-use profiles for each building type.

For reporting purposes, end uses were collapsed into three categories:

- HVAC -- includes heating, cooling, ventilation, and auxiliary
- Lighting -- includes interior lighting only
- Other -- includes all other end uses

These categories were chosen for several reasons. First, while it would be nice to be able to treat heating and cooling separately, this is impossible for many of the ELCAP buildings. In many buildings, the primary HVAC system type was an air-to-air heat pump or all-electric package unit. For these buildings, it was impossible to separate the heating and cooling components of the HVAC consumption. HVAC load data for these buildings were collected as "Mixed HVAC". In order to develop a consistent approach in this analysis, a combined HVAC category was used for all buildings. In addition, Lighting and HVAC are by far the two most significant end use categories in the building types being examined in this project. We therefore lose little information by aggregating all other end uses into an "Other" category.

3.4 RESULTS

Results are presented and discussed here for each of the four BPA building types. In order to demonstrate typical winter and summer load shapes, we are presenting results for January and July, as was done in Chapter Two.

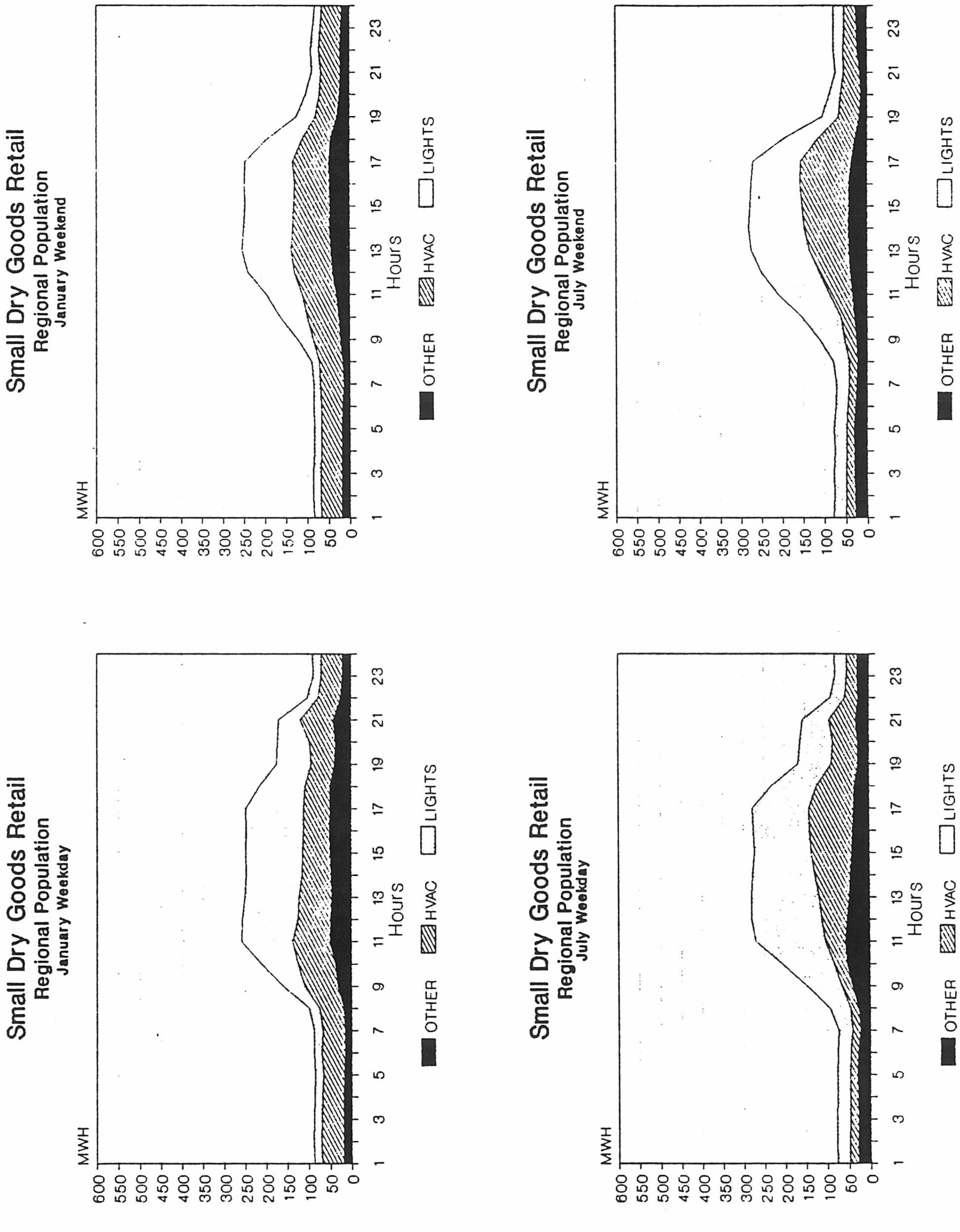
When examining these results, it is important to keep several points in mind. First, the sample sizes used to develop these profiles are small. The SCLCDB sample, from which the total load profile was developed is particularly small for Small Office and Small DGR. The ELCAP sample, from which the end-use splits were developed, is particularly weak in Large Office and Large Dry Good Retail. Second, these results are preliminary. They are based on one year of ELCAP data (all that was available when we began this analysis), and the extrapolations to the region are based strictly on floor area (no other regional characteristics are currently available). Since all of the buildings used in this analysis are located in the Seattle area, these results are based on Seattle weather. Repeating this analysis with additional ELCAP load data and more extensive regional characteristics data would aid in the development of more robust results. Finally, given the small sample size and absence of regional data on fuel saturations and other characteristics, we have chosen not to disaggregate the results by space heat fuel type.

Small Dry Good Retail

Figure 3.1 shows regional end-use profiles for Small Dry Good Retail (less than 20,000 square feet). All profiles clearly show the boxy shape characteristic of Dry Good Retail buildings. This shape corresponds to the typical business hours in these buildings -- consumption is low during non-business hours (9 PM to 9 AM) and high during business hours (9 AM to 9 PM). In general, the total load shape is remarkably consistent between summer and winter. Consumption during non-business hours is 90 MWh per hour; consumption throughout business hours remains steady at just over 250 MWh per hour for both weekdays and weekends. The weekend profiles show clearly that stores are open for business during the weekend. However, the transitions from base to peak consumption are more gradual on weekends, reflecting the larger variation in business hours on those days.

Lighting is the largest single cause of the increase in consumption during business hours. During business hours, lighting accounts for 150 MWh per hour, while it accounts for only 25 MWh per hour during non-business hours. The sudden switching on and off of the lighting causes most of the overall boxlike shape seen in the total load.

FIGURE 3.1



Small Dry Goods Retail
Regional Population
January Weekday
Small Dry Goods Retail
Regional Population
January Weekend
Small Dry Goods Retail
Regional Population
July Weekday
Small Dry Goods Retail
Regional Population
July Weekend
MWH
600 550 500 450 400 350 300 250 200 150 100 50 0
1 3 5 7 9 11 13 15 17 19 21 23
Hours
OTHER
HVAC
LIGHTS

The HVAC loads also show a pattern corresponding to business hours. In winter, HVAC uses about 50 MWh per hour during non-business hours, and about 100 MWh per hour during business hours. January weekdays show pronounced HVAC spikes at both 9 AM and 9 PM. The morning spike reflects the morning warm-up common in commercial buildings during the heating season. However, while it is possible that some cooling is required in the afternoon to offset internal gains from lighting, the evening HVAC spike is probably spurious. Most likely, the shoulder seen in the total load profile from 7 to 9 PM is due to an anomaly in one of the SCLCDB buildings used to generate the total load profile. Given the small SCLCDB sample size for this building type (3 buildings), spurious data in one building can significantly affect the aggregate result. The HVAC spike seen at 9 PM is probably a result of applying valid end-use breakdowns to this spurious total loads data.

In summer, HVAC loads increase noticeably throughout the day, peaking in the late afternoon when cooling loads are highest. There is no morning warm-up (heating) spike at all. During non-business hours in the summer, HVAC consumes about 25 MWh per hour; during business hours HVAC loads increase to almost 125 MWh per hour.

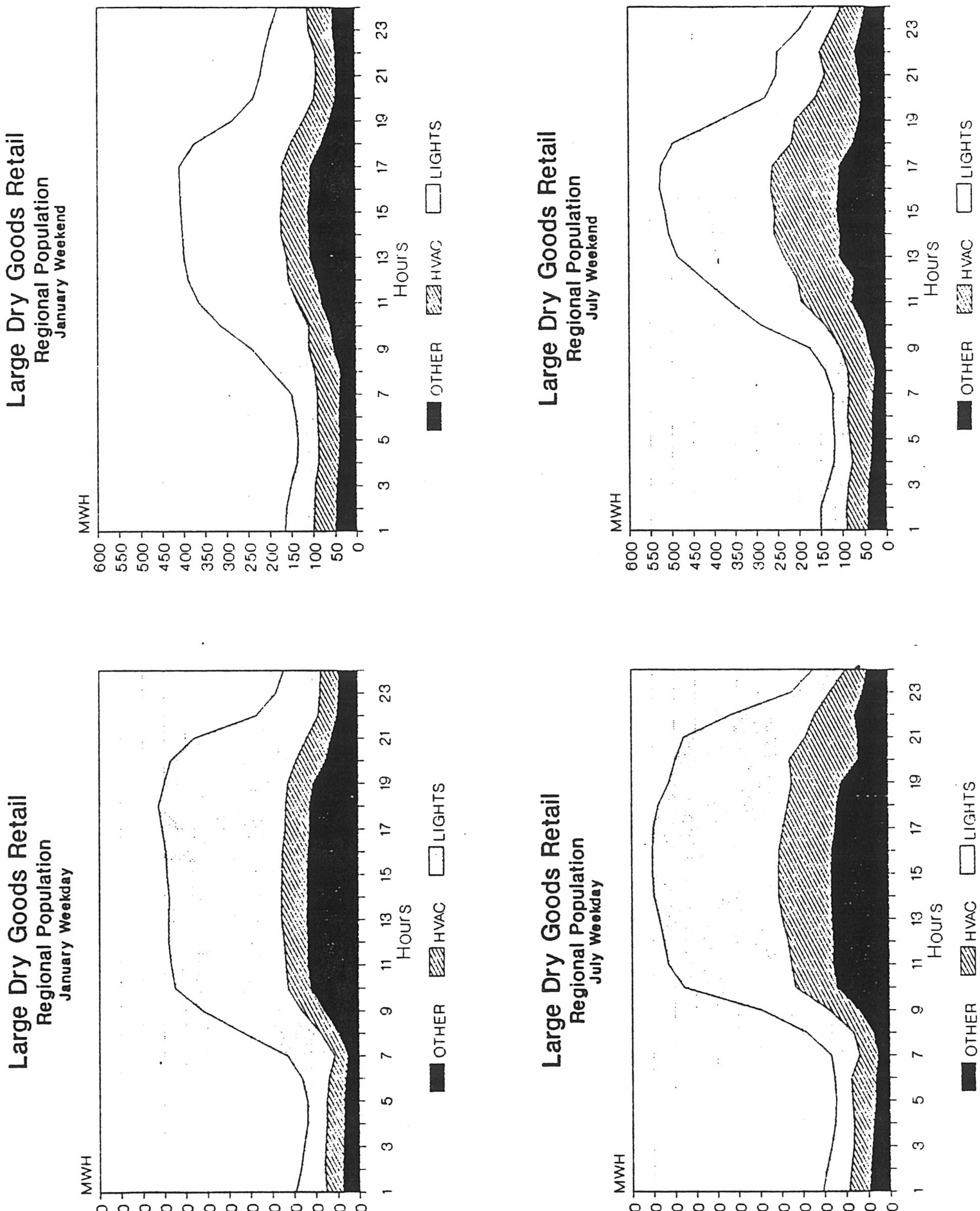
The Other load end-use category is relatively small, ranging from 25 MWh per hour during non-business hours to 50 MWh per hour during business hours.

Large Dry Good Retail

Figure 3.2 shows regional end-use profiles for Large Dry Good Retail (greater than 20,000 sq ft). It is important to note that these profiles are more representative of buildings with non-electric heat than buildings with electric heat, although we may find from PNNonRES that Large DGR buildings tend to have non-electric heat systems everywhere in the region. The total load profiles are based on 12 SCLCDB buildings, 9 of which have non-electric heat. The end-use splits are based on 4 ELCAP buildings, *all* of which have non-electric heat.

In general, the Large DGR profiles show higher consumption levels than the Small DGR profiles for both business and non-business hours. The Large DGR profiles show a base consumption of 125-150 MWh per hour, and a peak consumption of 400-550 MWh per hour. Most of the difference is due to significantly larger lighting loads in the Large DGR buildings. In the January profiles, much of the difference in HVAC consumption between Small and Large DGR is simply due to the fact that the Small DGR HVAC profiles reflect a mixture of electric and non-electric heat, while the Large DGR HVAC profiles reflect only non-electric heat buildings.

FIGURE 3.2



Large Dry Goods Retail
Regional Population
January Weekday
Large Dry Goods Retail
Regional Population
January Weekend
Large Dry Goods Retail
Regional Population
July Weekday
Large Dry Goods Retail
Regional Population
July Weekend
MWH
600
550
500
450
400
350
300
250
200
150
100
50
0
1
3
5
7
9
11
13
15
17
19
21
23
Hours
OTHER
HVAC
LIGHTS

Like Small DGR, the Large DGR profiles (Figure 3.2) show a large increase in consumption during business hours on both weekdays and weekends. The total load shapes are more boxy than those estimated for Small DGR (Figure 3.1), due mainly to the tremendous impact of lighting during business hours. The end-use loads show some bumps and dips that are probably due to the fact that they are based on only three ELCAP buildings. However, the general patterns in end-use consumption are probably reliable.

The Large DGR HVAC loads in January are low (50 MWh per hour) and constant throughout the day, regardless of store business hours. Since the HVAC end-use was based on buildings with non-electric space heat, this pattern is not surprising. The constant level of consumption is probably due to the operation of ventilation fans or hydronic system pumps.

During July, we see some increase in Large DGR HVAC consumption during business hours (50 MWh per hour versus 100 MWh per hour), HVAC generally remains steady throughout the day; there is little evidence of an afternoon cooling hump. The difference in summer HVAC load shapes between Small DGR and Large DGR is probably due to the fact that larger buildings are less temperature sensitive than smaller buildings. HVAC consumption in large buildings tends to be less sensitive to weather than HVAC consumption in small buildings, because the ratio of exposed building envelope to conditioned floor area is lower. Very small commercial buildings tend to have "spiky" HVAC profiles, similar to those seen in residences. As the buildings become larger, they become more dominated by internal gains (which are scheduled and tend to remain constant throughout the day), and less dominated by the outside temperature. Hence HVAC profiles in larger buildings tend to be smoother and less "spiky".

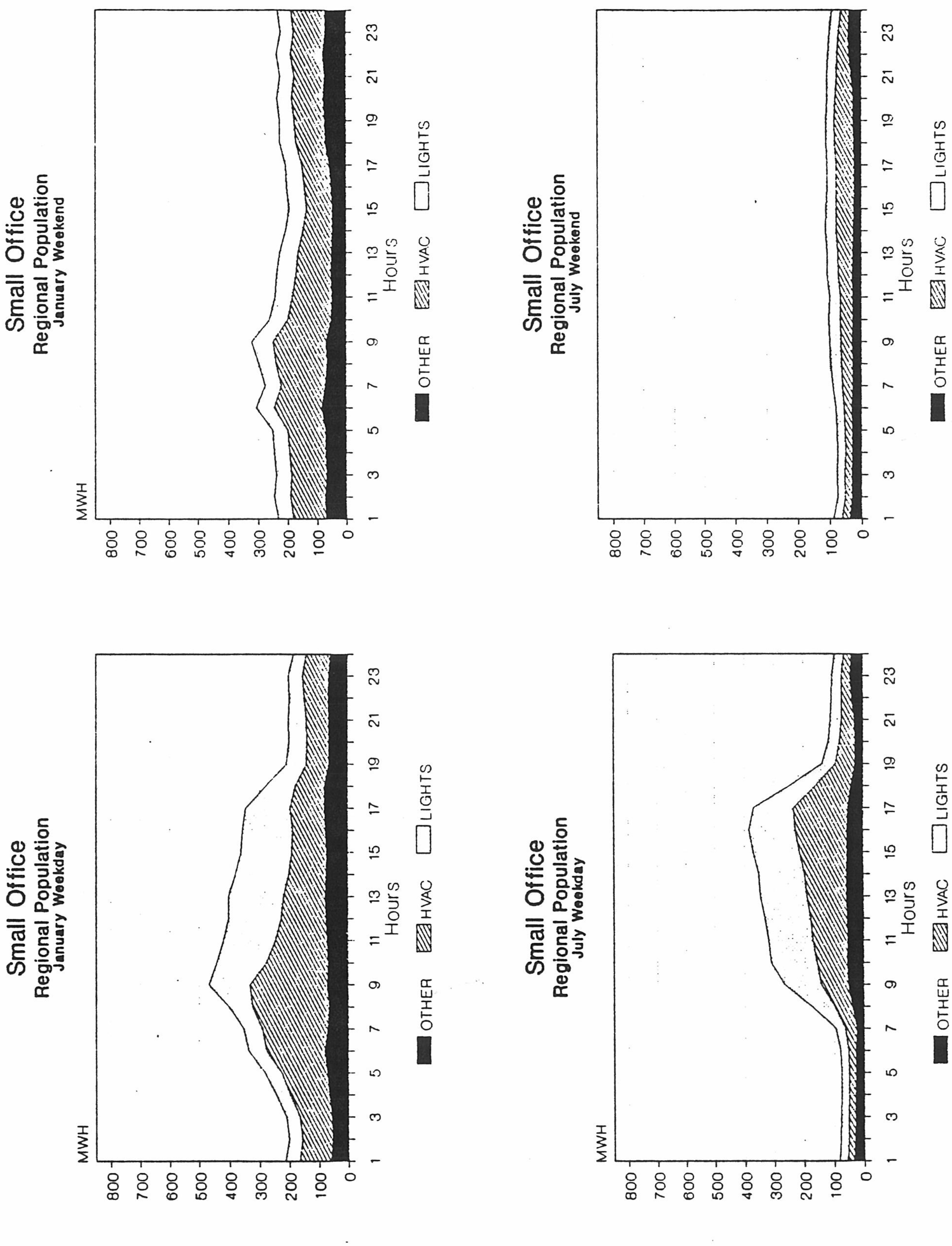
Lighting increases significantly during business hours for all Large DGR profiles. Generally, lighting consumption ranges from 50 MWh per hour during non-business hours to 300 MWh per hour during business hours. Lighting consumption gradually increases on weekend mornings and gradually decreases during all evenings, reflecting variation in store opening and closing times.

As was the case for Small DGR, the Other load category accounts for a relatively small amount of total consumption, and varies from 50 MWh per hour during the night to 100 MWh per hour during the day.

Small Office

Figure 3.3 shows regional end-use profiles for Small Office (less than 30,000 square feet). In general, consumption is much higher during weekdays than during weekends, indicating that most office buildings are not in operation on the weekend. In addition, the timing of the total load peaks are strongly affected by the HVAC consumption profile. In the winter, a clear morning peak is present, reflecting high heating consumption during the morning warm-up. In the summer, the total load peak is in the late afternoon, when cooling requirements are largest.

FIGURE 3.3


Small Office
Regional Population
January Weekday
Small Office
Regional Population
January Weekend
Small Office
Regional Population
July Weekday
Small Office
Regional Population
July Weekend
MWH
0
100
200
300
400
500
600
700
800
1
3
5
7
9
11
13
15
17
19
21
23
Hours
OTHER
HVAC
LIGHTS

On January weekdays, total consumption peaks at 9 AM at 480 MWh per hour. This peak is entirely due to large HVAC consumption for the morning warm-up of the building. HVAC consumption then falls off through the day as lights and other internal gains reduce the heating load. HVAC consumption during the night remains at almost 100 MWh per hour; during the morning it increases to over 250 MWh per hour. Note that the base level of HVAC consumption is significantly higher than that seen in July. This seems to indicate that heating is being used throughout all 24 hours. Lighting consumption shows the sudden on/sudden off pattern we saw in the Small Dry Good Retail profiles. During non-business hours, lighting remains constant at 50 MWh per hour. It climbs to 150 MWh per hour at about 9AM, and remains consistently at that level until 5 PM, when it begins dropping again. The Other load remains constant at about 50 MWh per hour throughout the 24 hour profile.

The January weekend profiles show much lower consumption levels -- they are similar to weekday consumption levels during non-business hours. Lighting remains constant at 50 MWh per hour for all hours. The Other load also remains constant at 50 MWh per hour. HVAC remains relatively constant at about 100 MWh per hour. There is some indication of a morning warm-up spike The bimodal appearance of the spike is probably due to the small sample size in the SCLCDB data, or it may be due to HVAC systems operating regardless of occupancy.

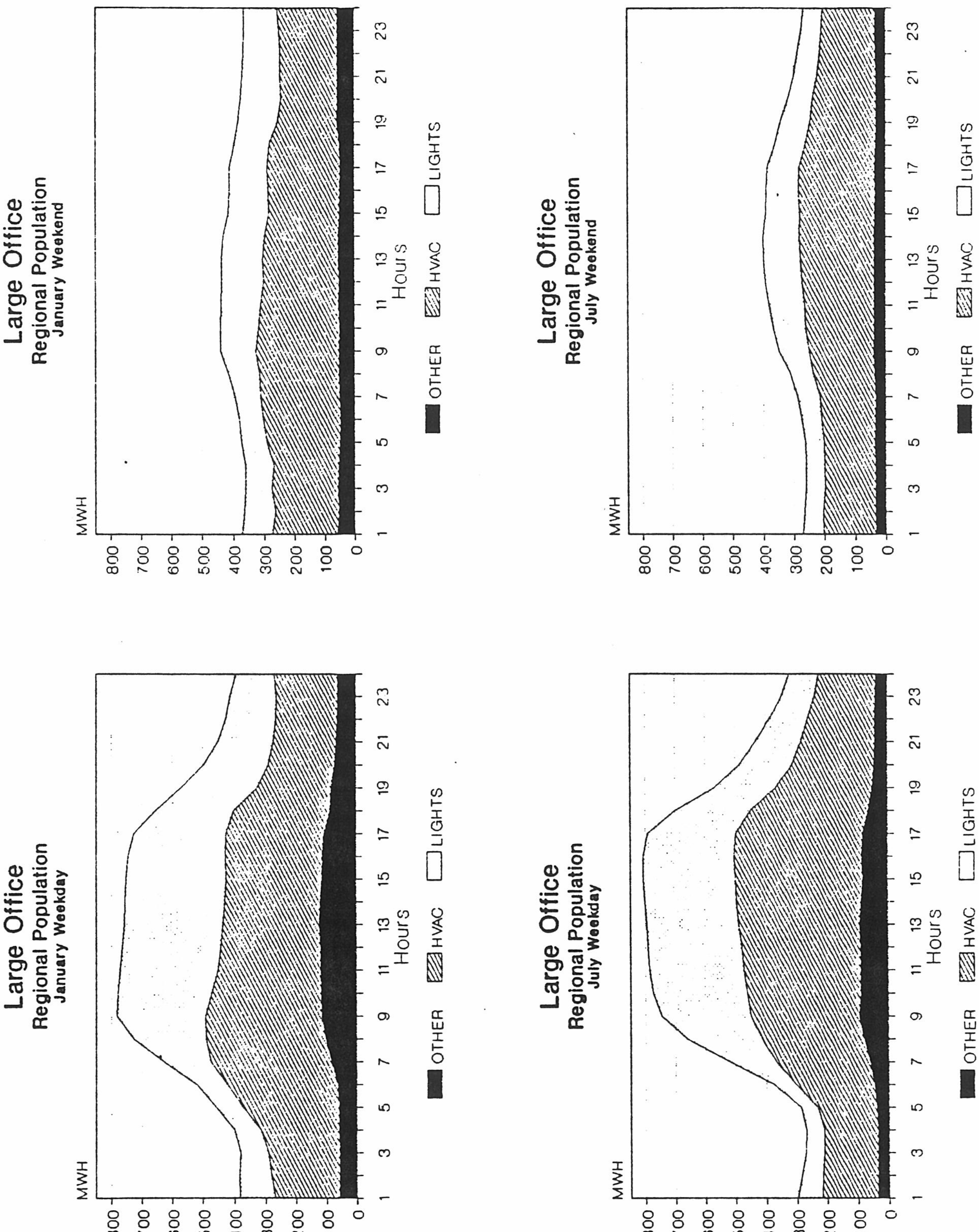
The July weekday total load profile shows a clear peak of almost 400 MWh occurring at 4 PM. This peak is entirely driven by the late afternoon HVAC consumption needed to meet the cooling load. During non-business hours HVAC consumes 25 MWh per hour (half the level of January base consumption). HVAC consumption gradually increases throughout the day, peaking at 175 MWh per hour at 4 PM. The summer HVAC peak is significantly lower than the winter HVAC peak. As was the case in the January weekday profile, lighting remains at a constant 30 MWh per hour during the night and a constant 150 MWh per hour during business hours. The Other load shows some variation throughout the day, but basically is the same as the Other load in January, at 25 - 50 MWh per hour.

The July weekend profile shows very low consumption levels for all end uses throughout the day. A slight afternoon peak due to cooling can be identified. As was the case for January, the weekend consumption levels are similar to those seen in non-business hours during the week.

Large Office

Figure 3.4 shows regional end-use profiles for Large Office (larger than 30,000 square feet). Large Offices are by far the largest consumers of any of the building types we have analyzed so far. Both summer and winter peak consumption falls around 800 MWh per hour. As was the case for small office, the timing and magnitude of the total load peak is driven by the HVAC load profile. The winter total load peak, caused by morning warm-up, occurs at 9 AM. The summer total load peak, caused by cooling requirements, occurs at 4 PM.

FIGURE 3.4


Large Office
Regional Population
January Weekday
Large Office
Regional Population
January Weekend
Large Office
Regional Population
July Weekday
Large Office
Regional Population
July Weekend
MWH
800
700
600
500
400
300
200
100
0
1 3 5 7 9 11 13 15 17 19 21 23
Hours
OTHER
HVAC
LIGHTS

In examining these plots, it is important to remember that all 4 ELCAP buildings used to develop the end-use breakdowns have electric heat. Thus it is likely that the contribution of HVAC to the January total load is somewhat over estimated, since it is not tempered by the presence of any non-electric buildings.

The January weekday profile shows a high level of HVAC consumption throughout all 24 hours. As mentioned above, this level of consumption may be slightly overestimated due to the exclusive use of buildings with electric heat to develop the end-use breakdowns for Large Offices. The HVAC profile shows a morning peak due to warm-up, and then remains relatively constant rather than tailing off through the day as we saw in Small Office. It is possible that the internal gains in these large buildings create a cooling load in the afternoon. Total HVAC load (heating and cooling combined) therefore remains constant after the morning spike. During non-business hours, HVAC uses 200 MWh per hour; the morning peak requires 350 MWh per hour, and consumption for the rest of the business day is steady at 300 MWh per hour. As is typical for commercial buildings, lighting remains a constant 100 MWh per hour during the night and a constant 300 MWh per hour during business hours. The Other load varies from 50 MWh per hour at night to 100 MWh per hour during the day.

As was the case with Small Offices, January weekends show consumption levels similar to those found in non-business hours during the week. These is little fluctuation in total load throughout the day, though a slight morning peak due to HVAC is apparent.

July weekdays show a profile that is similar in magnitude but different in timing compared to that seen for January weekdays. In July, the peak occurs at 4 PM, driven by the HVAC cooling requirements. The HVAC load is very similar in magnitude to that seen in January, except that consumption during non-business hours is slightly lower. The HVAC peaks for the two months are also similar in magnitude but different in timing. The profiles for other and lighting are very similar to those seen in January. Basically the only differences between the January and July weekday profiles are that base consumption is 25% lower in the summer, and the peak occurs at different times of the day.

Again, the July weekend profile mostly reflects the consumption during non-business hours already seen for July weekdays. There is however, a noticeable afternoon increase in HVAC consumption, probably to counteract the internal gains provided by the lights that are on.

3.5 CONCLUSIONS

Combining currently available hourly end-use data with regional characteristics data enables us to develop a regional view of how commercial buildings use electricity. While these results are only preliminary, they do indicate that the data sources can be effectively combined to produce useful data for planners and forecasters.

The existing datasets (and those that are currently being assembled) can be used in a variety of ways to substantially improve the preliminary regional results presented in this report. If these preliminary results are valuable to planners at BPA, then it will be useful to consider potential approaches for improving them. However, the data are complex, and care must be exercised to pursue only cost-effective improvements. Several potential approaches for improving the estimates are listed below, ranked in order of probable cost-effectiveness:

Approaches to improve the underlying data:

- o Recover the SCLCDB sites that were dropped from analysis due to conflicting information on building type. The SCLCDB is a large sample, but we were not able to utilize it fully because one half of the sites showed differences between the SIC code assigned by the utility to the site and the building type assigned during the walk-by survey. A re-evaluation of each of the "confused" sites could resolve this problem for most sites, enabling them to be included in the analysis. Full use of the SCLCDB sample would improve the reliability of the estimates considerably.

- o Once sufficient additional hourly end-use data are available (mid-1988 at the earliest), incorporate multiple-year end-use data into the analysis. Again, the presence of more data would improve the reliability of the end-use estimates.

- o Conduct a case level examination and analysis of the ELCAP sites. The ELCAP sample is small, yet it is the only available source of hourly end-use data. It is therefore important to examine the data for each individual site. The most prudent approach would be to focus efforts on sites that have been flagged as anomalous. If certain sites are in fact outliers, they can be eliminated from the estimation process. If there are data problems, they can be corrected.

Approaches to improve the method of obtaining regional end use estimates:

- o Develop a model that can be used to estimate annual end use shares given data on total annual load, characteristics and weather. A model of this type could be used to estimate end use shares for each of the sites surveyed in the second stage of PNNonRES. Such a model could also be applied to total hourly load data for the PURPA studies conducted by other northwest utilities. This model would provide the best means for extending ELCAP results to the region in a thorough and reliable manner. It would provide substantially more reliable regional estimates than those obtained by directly imposing the ELCAP shares on the SCLCDB aggregate building profile.

- o Reconcile regional results with regional total sales. This approach would serve as a "reality check" on the regional estimates, enabling them to be calibrated to actual regional consumption.

Approaches to supplement the existing estimates:

- o Examine other building types. Using the methods discussed in this report (or the model mentioned above) develop estimates of regional load shapes for other building types.

4

Data Product

In the process of conducting this preliminary analysis of regional end-use loads, we have prepared a data product that may be of interest to others in the region. However, it is important to emphasize the preliminary nature of this product. Those who choose to use it should become familiar with the methods used to derive the values contained in the file. Furthermore, improved versions of these estimates may become available at any time, and, consequently, users of the data should make sure that they stay informed of such revisions so that they do not propagate "outdated" estimates.

This chapter provides documentation for the data file. It includes a brief discussion of the datasets used in its creation (for a more detailed discussion, see Chapters 1 and 2) and a data dictionary describing the variables in the file.

4.1 DATASETS USED TO CREATE THE REGIONAL LOAD DATA

The regional hourly load estimates were created from four basic data sources: (1) the End-use Load and Conservation Assessment Project (ELCAP) Commercial Base and CAP studies; (2) the Seattle City Light Commercial Database (SCLCDB, also known as the SCL PURPA dataset); (3) the Pacific Northwest Non-Residential Energy Survey (PNNonRES) first stage dataset; and (4) a dataset provided by Seattle City Light that contains the total consumption of all Office and Dry Good Retail meters for the Seattle City Light commercial customer population.

ELCAP

A primary data file was obtained from the ELCAP Commercial Studies database for 56 commercial building sites. The period of measurement included in this file was from July 1986 through June 1987. Sites were dropped from the primary data file if they had severe consumption or characteristics data problems, were located east of the Cascades, or were located in multiple ELCAP-site buildings. In addition, missing hourly loads were filled with estimated values. An initial analytic form of this data was prepared that contained hourly end-use (17 end-use categories) load data for 30 Office and Dry Good Retail sites. This file was then aggregated to a form that contained average hourly end use loads (HVAC, Lights, Other) for each month, by weekday and weekend, for each site. In addition, characteristics data were assembled for each of these sites.

SCLCBD

The SCLCBD dataset contained total metered hourly load shapes for a stratified sample of SCL commercial meters. A "clean" Office and Dry Good Retail subset was used in this study. The original dataset was for the period of September 1985 through August 1986. Like the ELCAP dataset, the SCLCBD data were aggregated to hourly loads, by month, for each week-day and week-end, for each site. Sites were dropped from the original dataset if: the meter associated with the hourly recorder accounted for less than 50 percent of the site's billed consumption, the SCL assignment of SIC code did not match an independent measurment of the site's primary building type (for example an hourly load data meter on a small dry good retail store in a larger office building), or a large fraction of the hourly load values were missing. Building characterisitcs for these sites where assembled from a 1984 on-site audit administered by SCL and a walk-by survey administered for this project.

PNNonRES

Regional floor area data were obtained from the results of the first stage of PNNonRES. A data file was used that provided building type and floor area measures for approximately 14,000 buildings surveyed by BPA. Separate estimates of regional floor area were derived for each of the four BPA building types (Large Office, Small Office, Large Dry Good Retail, Small Dry Good Retail).

4.2 DATA PRODUCT SPECIFICATION

The record structure and variable definitions of the data product are shown below. The file contains a record for each combination of BLDGTYPE, MONTH, DAYTYPE and HOUR for a one year period September, 1986 through August, 1987. There are 2,304 records in the file (4 BLDGTYPE * 12 MONTH * 2 DAYTYPE * 24 HOUR). This data product can be made available either as a SAS dataset or a flat file. A floppy diskette containing the data in an ASCII file called REGPROD.DAT as well as an electronic copy of this chapter (CHAP4.DOC) is provided with the initial copy of this report.

Record Layout

Variable Name	Column Location	Format
BT1 Primary business type	2 - 4	A3
BLDGTYPE BPA building type by size	8 - 12	A5
MONTH Month of Year	19 - 20	I2
DAYTYPE Week-day or week-end day type	24 - 24	I1
HOUR Hour of Day	28 - 29	I2
REGLOAD Regional Estimated Load	30 - 38	F9.2
FHVAC HVAC End-Use Fraction	39 - 46	F8.4
FLIGHTS Lighting End-Use Fraction	47 - 54	F8.4
FOTHER All Other End-Use Fraction	55 - 62	F8.4

Data Dictionary

Variables	Variable and Value Labels
BT1	Primary business type in building OFF = Office Building Type DGR = Dry Good Retail Building Type
BLDGTYPE	BPA building type by size classification LGDGR = Large Dry Good Retail (> 20,000 Sq. Ft.) SMDGR = Small Gry Good Retail (<= 20,000 Sq. Ft.) LGOFF = Large Office (> 30,000 Sq. Ft.) SMOFF = Small Office (<= 30,000 Sq. Ft.)
MONTH	Month of year
DAYTYPE	Day type 0 = Week-end 1 = Week-day
Hour	Hour of day
REGLOAD	Regional estimate of total hourly load for the BLDGTYPE (Baised on the weighted SCLCBD/PURPA data.)
FHVAC	Fraction of total hourly load used by total HVAC system.
FLIGHTS	Fraction of total hourly load used by all interior lights.
FOTHER	Fraction of total hourly load that is not HVAC or interior lights.