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COMMERCIAL HEATING AND COOLING LOADS COMPONENT ANALYSIS

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ABSTRACT

This study uses computer simulations of 120 commercial building prototypes to quantify the contributions of building components such as roofs, walls, windows, infiltration, outside air, lighting, equipment, and people to the aggregate heating and cooling loads in U.S. commercial buildings, and the efficiencies of typical commercial heating and cooling systems in meeting these loads. The prototypical buildings are based on previous LBNL work, and were refined following an extensive review of existing commercial building prototypes developed in 17 previous engineering studies. A novel procedure was developed to extract the component loads on a hourly basis from DOE-2 simulations. The results are presented as split pie charts, first at the national level, and then by building type, region, and vintage. The largest contributors to heating loads are found to be windows, walls, and infiltration, and the largest contributors to cooling loads to be lighting, solar gain, and equipment. "Free heating" from lights, equipment, occupants, and solar gain displace half of the heating load in commercial buildings, but "free cooling" from outside air and heat loss through the building shell has a much smaller effect.

The concept of System and Plant Factors is used to quantify the net efficiencies of air-handling systems in meeting building loads, and of central plants in providing the energy needed for heating and cooling. System Factors in heating can vary from 0.12 in hospitals with constant-volume systems and 100% outside air to slightly over 1.00 in small offices due to heat gain from fans. System Factors for cooling can vary from less than 0.50 in old large offices with reheat systems to over 1.00 for small buildings due to the free cooling of economizer cycles. Plant Factors are typically 0.60-0.70 for boilers, and 3.50-4.80 for chillers. When the parasitic energy use of fans and pumps, and a source-to-site multiplier of 3 for electricity are both taken into account, the Net Plant Factors drop to 0.29-0.57 for heating, and 0.56-0.89 for cooling. The overall source efficiency of the space conditioning system in commercial buildings taking into account both System and Plant Factors is 0.33 for heating and 0.57 for cooling.

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1. INTRODUCTION

According to the 1995 Commercial Building Energy Consumption Survey (CBECS), space conditioning in U.S. commercial buildings is responsible for 2 quadrillion Btus (Quads) per year of site energy use (EIA 1995). This study, summarized in the accompanying set of charts, quantifies the approximate contribution of the major building components - roofs, walls, foundations, windows, infiltration, equipment, lighting, people, etc. - to the heating and cooling loads of the U.S. commercial building stock. These building loads, when multiplied by factors expressing the net efficiencies of the space conditioning system and plant, give the estimated site energy consumed by commercial building for heating and cooling.

This study utilizes DOE-2 simulations of a modified set of building prototypes developed by Lawrence Berkeley National Laboratory (LBNL) in 1991-1994 covering 12 commercial building types and two vintages. In the course of selecting and refining the prototypes for this work, a lengthy review was undertaken of other prototypical building descriptions from 17 engineering studies dating as far back as 1983. The findings from that review are summarized in this report because of its general interest to other researchers. The LBNL prototypes were updated based on information from the review and other sources, resulting in a set of prototypical buildings developed with a consistent methodology and having a flexible data structure suitable for the parametric analysis needed for this study.

A novel method has been developed to extract from the DOE-2 simulations the contributions of different building components to a building's heating and cooling loads. The computed component loads for each prototypical building, normalized per ft^2 of conditioned floor area, are multiplied by the total floor area represented by that prototype to give the aggregated component loads for each sector of the commercial building stock. These building heating and cooling loads do not include the effects of the HVAC system and plant, which can often lead to a multi-fold increase in the actual amount of energy required to meet these loads. The magnitudes of these system and plant effects are quantified with further DOE-2 simulations assuming typical HVAC configurations by building type and vintage.

Two types of results are included. The component loads are presented in tabular form and as pie charts, first as "specific component loads" per $kBtu/ft^2$ of conditioned floor area by building type and vintage in three representative climates, and then aggregated to the national level for the 12 major building types. These tables and pie charts show the portion of commercial heating and cooling loads attributable to the major building components - roofs, walls, foundations, windows (conduction and solar gains), air infiltration, controlled outside as people, electric lights, and office equipment. This information is useful in clarifying the major contributors to space conditioning load, and the conservation potentials in building improvements within the commercial building sector.

The second set of results show the System and Plant Factors, and the actual amounts of fuel (gas or electricity) required by the prototypical buildings for space-conditioning and other end-uses. As with the component loads, this energy consumption is first normalized per ft^2 of floor area to produce End-Use Intensities (EUls), and then multiplied by the total floor area represented by each prototype, which are then summed to produce the aggregate site energy consumption at the national level. This information can be compared to the energy consumption totals estimated by other sources to assess the validity of the prototypical building descriptions and this "bottom-up" method to estimate total commercial building energy use. The data are also useful for determining the conservation potentials of system and plant improvements.

2. METHODOLOGY

Estimates of the commercial building population by building type, region, and vintage are derived from the 1992 Commercial Building Energy Consumption Survey (CBECS) database (EIA 1995). The estimation of component loads is done using DOE-2 simulations of a set of 36 prototypical commercial buildings developed by LBNL through several previous research efforts, the most critical of which was a project supported by the Gas Research Institute (GRI), hereafter referred to as the LBNL/GRI project (Huang et al. 1991). The outcome of the LBNL/GRI project is a collection of 481 prototypical commercial buildings for 13 building types in 13 major U.S. cities. These prototypes were refined and upgraded to DOE-2.1E through a follow-on GRI project (Tuluca and Huang 1995) and then further modified to two broad U.S. regions (North and South) based on 1989 CBECS data through work sponsored by DOE's Office of Policy, Planning and Analysis (Sezgen et al. 1995). In addition, new building prototypes are developed for three smaller building types not covered in the original LBNL/GRI work - small office, small retail, and warehouse. These modeling efforts are continued in this project, resulting in a consistent set of 36 prototypical buildings covering 12 commercial building types. For the most numerous building sectors such as offices and retail stores, there are two variations of the building prototypes by geographical region, two by vintage, and two by building size, or eight building prototypes in all. For the other less numerous building types, only variations in vintage and/or geographical region have been defined. The total number of simulations done for this project is 120, since each prototypical building has been simulated in at least two representative climates.

The heating and cooling loads of these prototypical buildings are simulated using the DOE-2.1E program (Winkelmann et al. 1993). These loads are then disaggregated into component loads showing the net contribution of building components such as the walls, roof, windows, or internal gains. In a precursor to this project, one of the authors estimated component loads for residential buildings through regression analysis of the differences in total energy use from parametric simulations (Hanford and Huang 1993). Such a procedure was found to be unreliable for commercial buildings due to their intermittent hours of operation, large internal gains, and high thermal mass. Consequently, a new procedure has been devised that records the hour-by-hour component loads calculated at a fixed temperature in DOE-2's *Loads* subprogram, modifies these loads for the actual zone temperatures calculated by DOE-2's *System* subprogram, and then sums the loads as either heating or cooling depending on the HVAC mode that hour. Although this is a more rigorous method that duplicates to a great extent how DOE-2 calculates the true system loads, it still ignores certain transient thermal effects when zone temperatures change from hour to hour. Some ambiguity is unavoidable in attempting to attribute transient pick-up loads when the thermostat setting changes to specific building components. Overall, the sum of the component loads calculated by this procedure match the heating and cooling loads from the DOE-2 program to within 2% when the loads are significant, such as for heating in Chicago, or cooling in Houston, and to within 10% when the loads are from small to moderate, as in Los Angeles.

Component loads are calculated using the above procedure for different building types, vintages, and regional variations in five typical U.S. climates, requiring a total of 120 DOE-2 simulations. The aggregation of the component loads to the national level is done in a straightforward manner where the "specific component loads" per ft^2 of floor area of each prototypical building are multiplied by the floor area of the building sector represented by the prototype as determined from the 1992 CBECS survey. The space conditioning loads for the entire commercial building stock are derived by summing the loads in each of the 120 building subsectors.[1]

3. REVIEW OF EXISTING COMMERCIAL BUILDING PROTOTYPES

As a preliminary step to selecting the prototypical buildings used in this study, a lengthy review was undertaken of existing prototypes from 17 engineering studies dating back to 1983 to assess their suitability for this study as well as to gain insight into typical commercial building characteristics. The intent of this review was not to critique the validity of the prototypes, but to document the basis for their building descriptions, their level of modeling detail, and the limitations in their use for evaluating energy conservation potentials.

The engineering studies reviewed are listed in Table 1 and briefly described in Appendix A. The major characteristics of the prototypes developed for each building type are summarized in Tables 2 through 9.

3.1 General Observations on Building Prototypes

The prototypes developed in all but one of the studies are synthetic buildings compiled from statistical data from building surveys or conclusions from previous such studies. In other words, these prototypes are not real buildings, but hypothetical constructs with size, shell construction, window area, HVAC system type, operating schedules, etc., based on the mean or prevailing condition among statistical samples. Since the amount of information that can be gleaned from the statistical data is insufficient to create even the simplest building description adequate for detailed computer simulations, a great deal of engineering judgment is used to complete the modeling of the prototypical buildings. This does not imply that hypothetical prototypes are not valid analysis tools, but only that they can be expected to vary greatly depending on the experience and intent of their authors.

In the single exception, the ASHRAE Special Project 41 (SP-41) project in support of commercial building energy standards (PNL 1983), the prototypes are taken from actual buildings selected by a committee of architects and engineers as typical for that building use type. Although the existence of actual building plans resolved the modeling of the physical building, engineering judgment or typical design values are still needed in modeling the internal loads and operating conditions of these buildings.

The description of a prototypical building can be separated into three major issues - (a) the physical building characteristics (size, number of floors, shell characteristics, window areas,

[1] The 12 building types in this study cover 74% of the total floor area and 79% of the total energy use in commercial buildings, based on the 1992 CBECS database. Not included are assembly buildings, parking garages, public order, and "miscellaneous others". In addition, 20% of the health and 17% of the lodging floor areas are also not included (see Table 38).

etc.), (b) the HVAC system characteristics (type, configuration, efficiency, etc.) and (c) the building's internal conditions and operational patterns (zoning, internal loads, hours of operation, thermostat settings, etc.).

In addition to the engineering approach of evaluating the building descriptions, the building prototypes can also be evaluated functionally comparing their calculated energy intensities and load shapes to those of the building population the prototypes are supposed to represent. This calibration is especially important since, as mentioned, a great deal of guesswork goes into the modeling of any building. Having the engineering inputs correct helps, but does not guarantee that the calculated energy usage is also correct. Since prototypical buildings are often used for evaluating energy conservation potentials, it may be actually more important to get the latter correct, rather than the former. Unfortunately, calibrating the simulated energy usage of a prototypical building to measured data is difficult for the following reasons : (1) the scarcity of detailed measured data - typical surveys provide only yearly or monthly aggregate totals, while detailed hourly data, particularly end-use data, exists only for very few buildings; (2) the large variations of energy use among any collection of buildings - surveys often show differences by factors of 5 or more, making it difficult to perform a meaningful calibration; (3) the multiple degrees of freedom in the calibration - there are so many building inputs that can be modified that the end result might be completely serendipitous. For example, a building's HVAC load can be lowered by increasing the system efficiency, changing the thermostat setting, or shortening its hours of operation.

3.2 Available Prototypical Building Descriptions

The prototypes can be evaluated in terms of the basis and the level of detail for their building descriptions. For various reasons, the building descriptions are progressively more difficult going down the three categories listed earlier (physical characteristics, system characteristics, and usage patterns). The physical characteristics of a building are static, observable, and relatively straightforward to record and verify. The characteristics of the HVAC system, in comparison, are much harder to define since they are greatly affected by their control, operations, and maintenance. The usage patterns within the building are the most difficult to determine, and impossible to verify without detailed on-site monitoring. However, they have the greatest impact on a building's energy usage.

3.2.1 Physical Characteristics of Available Prototypes

With the exception of the SP-41 study, the prototypes in the other studies are synthetic buildings derived from survey samples of buildings ranging from as few as three to as many as 650 survey responses. Survey data are useful for defining general characteristics such as floor area, number of floors, window area, roof and wall insulation level, and window properties, but provide little information on more detailed aspects of the building such as its architectural layout or internal zoning.

In the hypothetical prototypes, the architectural layouts are extremely simplified, and often four-sided boxes, with at most an aspect-ratio multiplier to increase the surface-to-volume ratio of the building. In one study, a quasi-realistic floor plan was developed for a primary school (Webster et al. 1986). In two other studies (NEOS 1994, United Industries 1988), very schematic "floor plans" were developed by floor and building function.

In the LBNL/GR1 study, the amounts of wall or roof in different areas was adjusted to reflect typical conditions without defining unnecessarily specific building geometries. This same approach was adopted in a subsequent LBNL study (Akbari et al. 1994).

With the exception of the office and retail, other commercial building types have multiple usage patterns within one building. In the simplest prototypes (Synergic Resources 1986b, 1987a), such variations are ignored. In most studies, however, such distinctions are recognized and percentages of the building floor area assigned by function or usage. These are indicated in Column G in Tables 2 through 9. As with the architectural layout, this zoning by building use is based on engineering judgment, rather than rigorous statistical data, and differ widely from study to study. For example, in the LBNL/GR1 study, the zoning for the hospital prototype was simplified from that of the SP-41 hospital, and that for the restaurant from general principles.

In contrast, the architectural layout and zoning of the SP-41 prototypes are taken from actual building plans, and quite detailed, with as many as 26 zones in the hospital and 16 in the large hotel prototypes. There is no indication whether this zoning is representative, and the extra detail, in light of other uncertainties, actually hinders analysis of the results.

3.2.2 System Characteristics of Available Prototypes

Compared to the descriptions of the physical building, defining HVAC systems for the prototypical buildings is more problematic. The survey data at most identify only the basic system configuration or fuel type, e.g., constant versus variable-air volume, gas versus electric boiler, etc., with no information on system efficiencies or operations. Moreover, even if more detailed information were available, it would be difficult to apply to a hypothetical building since, unlike building size, window area, wall R-values, etc., it is impossible to calculate a statistically-averaged HVAC system.

In most of the studies, several typical HVAC systems were selected, often by building vintage, e.g., pre- or post-1980's. The system description is generally even simpler than that of the physical building. Even when multiple zones are described, often the same HVAC system is modeled in all zones. One study (XEnergy 1987c) used a novel approach of simulating an assortment of the most common equipment types in a single prototypical building to represent the mix in the building stock. In the LBNL/GRl study, semi-realistic mixes of systems were chosen by engineering judgment based on the vintage and the functions in each zone. The same approach was also taken in two subsequent studies (Akbari et al. 1994, NEOS 1994).

3.2.3 Internal Conditions of Available Prototypes

The internal conditions of the prototypical buildings are the most difficult to assign, yet simulations have shown that they have the largest impact on the calculated building energy use. These conditions include the intensity and hourly schedules for lighting, equipment, people, set points and hours of operation of the HVAC system, and ventilation. The statistical data available on these factors are generally reported, not monitored, responses, at a building aggregate level, e.g., hours of operation or typical temperature set point, and not separated by time of day, zone, or end use. Because of the scarcity of information, the end-use intensities, schedules, and set points in the prototypes are generally based on engineering estimates or design values. This deficiency applies both to the hypothetical as well as the SP-41 building prototypes, since even there the building plans contain no information on the actual building usage.

Two LBNL studies (Akbari et al. 1989, 1994) combined computer simulations of prototypical buildings with measured aggregate hourly electricity data to extract average end-use intensities and load-shapes by building type. However, when compared to metered end-use data that were later available, the results were inconclusive.

3.3 Calibration of Available Prototypes

The 17 studies differed greatly in the amount of effort used to compare or calibrate the simulation results to measured data. In several studies (NEOS 1994, PNL 1983), the prototype development ended with the engineering descriptions, and no comparisons were made of the simulated energy use to measured data. In most of the other studies (Huang et al. 1991, UIC 1988, Synergic Resources 1986b, 1987a, Hunn et al. 1985, etc.) comparisons were made against simple indices like measured total annual energy use or fuel/electric ratio, and ad hoc adjustments made. Column J in Tables 2 through 9 indicate what efforts were made to compare the calculated energy usage of the prototype buildings to measured data.

Most of these calibration efforts were not documented, and pertained only to rough aggregate indicators such as the total energy use intensity of the building. In contrast, the primary objective of the two LBNL load-research projects (Akbari et al. 1989, 1994) was to develop reconciled end-use intensities and load shapes, for which the prototypes served only as a means to an end. Thus, considerable effort was spent in reconciling the simulation to the measured total energy uses, and then extracting reconciled end-use load shapes from the simulation results. However, no attempt was made to incorporate the reconciled end-use load shapes back into the prototypical building descriptions.

3.4 Availability of Computer Files

A practical matter about the usability of existing commercial building prototypes is whether or not the computer input files are available. Converting a set of building descriptions, no matter how detailed, to a functional input file for a building simulation program such as DOE-2 requires a great deal of work and entails numerous modeling decisions. Thus, a prototypical building that exists only as a set of descriptions on paper is much less useful to other researchers as a tool for continued research.

Column K in Tables 2 through 9 indicate whether a computer input file was ever developed for that prototype, the simulation program for which it was written, and the availability of that computer input. On the tables, the term “avail.” indicates that copies of the input files are available in the Energy Analysis Department at LBNL in either electronic or paper form. The term “avail?” indicates that input files are available at LBNL but permission may be required for transfer. The term “unknown” indicates that input files should be available elsewhere but no attempt has been made to obtain them; the term “doubtful” indicates that inputs are probably lost or not worth obtaining.

3.5 Assessment of Available Prototype Descriptions

For the majority of the projects reviewed, the process by which prototypical buildings were developed was quite similar, utilizing survey information to rough out a building's physical characteristics, select an average HVAC system, and then relying increasingly on engineering judgment in defining its internal layout, zoning, internal end-uses, and operations. Due to the large uncertainty in the defining the input values for the prototypical building, and that of the simulation program itself, comparisons of the simulated energy usage of the prototypical building to measured data is critical. However, because of the large degree of freedom in "tweaking" the input parameters, this calibration process is haphazard and consequently not documented in any of the studies. Two LBNL studies (Akbari et al. 1989, 1994) expended a great deal of effort in reconciling prototypical buildings' hourly load profiles to measured hourly data, but it is unclear what advantages there are to such complex load shapes, or whether they could be extended beyond the building population from which the data was extracted.

The weakest part of the prototypical buildings lie in the characterization of their internal conditions, i.e., their thermal zoning, internal load conditions, and operating schedules. Whereas the physical dimensions of the prototypical buildings can be traced to survey or statistical data, the same cannot be said for the internal conditions. In the simplest one-zone or one-use prototypes, the building's internal conditions are lumped into generic schedules or end-use intensities. In the more evolved prototypes, separate schedules and end-use intensities are defined by function or use, but with little explanation of how they were derived, and the inference that they were based on "professional judgment".

If further work is done to refine the descriptions of prototypical commercial buildings, the emphasis should be placed on better characterization of their internal conditions. Secondly, more work should be done on developing better descriptions of non-office commercial buildings such as hospitals, hotels, restaurants, etc., which are more complex than the rather uniform offices and retail stores. Since a rigorous statistical approach to determine the internal loads and schedules of such buildings would require a large amount of monitoring or data gathering, a more effective approach might be to combine spot measurements or surveys with consultation with people familiar with a selected building type, e.g., architects, engineers, and building managers.

4. SELECTED COMMERCIAL BUILDING PROTOTYPES

Following the review of the various prototypical building studies, the project team decided for both technical and pragmatic reasons to use the LBNL/GRI prototypes as the basis for the simulations, but to incorporate modeling assumptions or techniques from other studies judged to be better documented or an improvement over the LBNL work. The technical reasons for keeping the basic framework of the LBNL/GRI prototypes is that they were developed with a relatively consistent methodology based on national data, i.e., CBECS, and have input assumptions that, as their original authors, are easy to trace and modify as needed. The pragmatic reasons are that the DOE-2 input files are readily available, understandable, and structured for parametric simulations. It should also be emphasized that the LBNL/GRI prototypes were not built from scratch, but rather synthesized the findings of many earlier studies (see Huang et al. 1991). This synthesis continued into this project in which the

LBNL/GRI prototypes are compared to the other available building descriptions and various modifications made.

This project grouped the entire commercial building stock into the following twelve building types :

Large Offices	Large Hotels
Small Offices	Small Hotels
Large Retail Stores	Fast-foods Restaurants
Small Retail Stores	Sit-down Restaurants
Schools	Food Stores (Supermarkets)
Hospitals	Warehouses

For each building type, either two or four prototypical buildings were defined, depending on the quality of data in the 1989 CBECS.[2] For 9 of the 12 building types, the basic framework of the prototypical buildings, including their interior conditions, operating schedules, thermal zoning, and even the DOE-2 input file structure, are taken from the existing LBNL/GRl set of prototypes. For the remaining three building types (small office, small retail, and warehouse), new building prototypes have been described for a DOE project to develop input data for the COMMEND forecasting model (Sezgen et al. 1995). For all building types, the project defined prototypical buildings of two vintages (Pre- and Post-1980) based on statistical analysis of the 1989 CBECS to determine the average building conditions (size, levels of insulation, window type and area, etc.) within that building population. For the following building types with sufficient number of observations - office, retail, school, and warehouse - the project also developed separate building prototypes for two broad geographical regions - North and South. The distribution of these two regions are shown in Figure 1. The total number of building prototypes defined is 36 (6 buildings x 2 vintages x 2 regions + 6 building types x 2 vintages).

The final prototypical building conditions used for this project are shown in Tables 10 through 17. The overall basis of the buildings, such as their thermal zoning, geometry, and most of their internal conditions and operating schedules, are taken from the earlier LBNL/GRI work, to which readers should refer for more details on the building modeling. The size, shell conditions, and some of the more important end-use intensities, however, have been updated based on the 1989 Commercial Building Energy Consumption Survey (EIA 1992) and shown on Tables 10 through 17. To calculate building component loads, the prototypical buildings are simulated with a fictitious system (DOE-2 terminology *SUM*) that only maintained the set point temperatures and provided the minimum outside air required for health purposes. To calculate the System and Plant Factors, the same prototypes are simulated with a typical HVAC system and plant based on the type, vintage, and location of the building. These are briefly described on the lower half of Tables 10 through 17.

Although the LBNL/GRl study defined building shell variations for four U.S. regions, and varied the building size for 13 cities based on construction survey data (Dodge 1989), this level of specificity is not warranted given the limitations of the CBECS database.

[2] The prototype descriptions were developed in 1994 using the 1989 CBECS. However, the aggregation to regional and national totals were revised in 1998 using the 1992 CBECS.

5. COMMERCIAL BUILDING POPULATIONS

The 1992 CBECS is used to determine the total floor area for each building type and vintage in the five climate zones based on the number of heating and cooling degree-days. The geographical extent of these five climate zones are shown in Figure 2. For each zone, a representative location has been selected for use in the DOE-2 simulations.

Climate Zone	Region	Heating Degree-days (65°F)	Cooling Degree-days (65°F)	Representative city
1	North	above 7,000	below 2,000	Minneapolis
2	North	5,500 - 7,000	below 2,000	Chicago
3	North/South	4,000 - 5,499	below 2,000	Washington
4	South	below 4,000	below 2,000	Los Angeles
5	South	below 4,000	above 2,000	Houston

Since Climate Zone 3 straddle the North-South division shown in Figure 1 used to define building characteristics, it was necessary to simulate both prototypes using the Washington climate, and then combine the results.

The 1992 CBECS database has been analyzed to determine the total floor area, percentages of floor area heated or cooled, and total energy use by building type, vintage, and climate zone. The net heated or cooled floor area represented by each prototype is derived as (total area x percent heated or cooled). These are summarized in Appendix B, and shown in column four in Tables 18 through 23, and column three in Tables 32 through 37, where they are used to compute the aggregate loads and fuel uses by building prototype and location (see Section 7 of this report). CBECS estimates of the total fuel and electricity use by building type are compared to the aggregated fuel usage predicted by this study in Section 9.

6. BUILDING COMPONENT LOADS DATABASE

This project follows an earlier residential component load study (Hanford and Huang 1992) in content but not in approach. There are several reasons why defining component loads for commercial buildings is more difficult than for residential buildings. The heating and cooling loads of residential buildings are largely determined by heat losses and gains through the building shell. Moreover, residential buildings are occupied throughout the day without any off-hours or weekends. Therefore, we have found it possible to calculate component loads by changing the thermal characteristics of a certain building component, e.g., wall R-value or window shading coefficient, and recording the resultant change in building loads. Commercial building loads, however, are largely driven by internal gains. Furthermore, most are not occupied around the clock. Buildings such as large offices or retail stores have large volumes and small exterior surface areas, so that their loads are more sensitive to the zone balance temperature, and less to the ambient air conditions. The interactions between the thermal components in the zone can significant alter the zone's balance temperature and its need for heating or cooling. Because of this sensitivity, we find it difficult to extract meaningful component loads through sensitivity analysis varying building characteristics.

The DOE-2 program was used to perform a more rigorous analysis to break down the component loads directly from the base case building simulation instead of backing out the loads from comparative runs. To accomplish this in DOE-2 is not a simple task. In the DOE-2 program, component loads are approximated using a constant zone design temperature. At the component level, the final corrected load values are never calculated. The program adjusts the original calculation as a lumped sum and does not determine corrected loads for the individual components. To determine component loads using DOE-2, a set of four user-defined functions were developed to modify the DOE-2 program. The functions adjust the DOE-2 determined component loads using the actual zone temperatures and component UA values. The process followed to calculate the loads are outlined below. The source listing for these user-functions are given in Appendix D.

6.1 Recording the Actual Zone Temperature

Two DOE-2 simulations were done for each prototypical building. In the first pass, the simulation was carried through the LOADS and SYSTEM modules to determine the actual zone temperatures of each zone. The hourly values are written to a binary report file. In the second pass, the LOADS module was simulated again, but this time with the functions to adjust the calculated component loads determined by LOADS.

6.2 Loading the Zone Temperatures

The function READDATE reads the binary report file and stores the zone temperatures in a DOE-2 variable array. Values for the infiltration + outdoor air rate and zone heat/cool extraction rate are also stored since they are needed for the component load calculations.

6.3 Determining Zone UA Values

The loads for the envelope components (walls, windows, roof, and floor) are dependent on the zone temperature. Thus, it is only the envelope component loads that need to be adjusted using the actual zone temperature. The adjustment is based on the component UA and zone-ambient temperature difference. The envelope UA values for walls, roof, and windows in the zone are determined by the functions EXTWALL-UA and WIN-UA. The values are stored in DOE-2 variables and passed to the component load function.

6.4 Calculating and Summing Component Loads

The ambient temperature, zone temperature, the wall, roof, and window UA values passed from EXTWALL-UA and WIN-UA, and the DOE-2 variables for floor UA are used to adjust the envelope component loads in the function COMP. COMP is accessed every hour for every zone. COMP records loads for fourteen building components: walls, window (solar and conduction), roof, slab, doors, interior walls, infiltration, outdoor ventilation air, people, lighting system, task lights, equipment, and sources.

The next step in determining component loads is to sum the hourly loads and check the total loads against the DOE-2 extraction rates for heating and cooling. Although the envelope loads have been adjusted to correct for the actual zone temperature, summing the loads does not necessarily equal the DOE-2 determined load values. DOE-2 uses weighing factors to account for the building capacitance and the delayed effect loads may have on the zones need for heating or cooling. A binning method has been developed that produces total loads that are generally very close to the DOE-2 values. The routine bins the loads based on the value of the zone extraction rate and the zone temperature. If the extraction rate is positive (cooling), the load is added to the cooling total. If the extraction rate is negative (heating), the load is added to the heating total. If the extraction rate is zero, the load is added to a heating or cooling bin depending on the zone temperature. When the extraction rate becomes non-zero, the binned loads are added to the heating or cooling total depending on the extraction value. The binning method is included as part of the COMP function.

6.5 Normalizing Component Loads to DOE-2 System Loads

When the components loads calculated using the above procedure are summed over the year, the resulting heating and cooling loads are quite close to those calculated by DOE-2 System subprogram using a fictitious SUM system, and often within 5%. However, in the milder climates there can be some discrepancies due mostly to the misassignment of component loads to the heating or cooling category during the morning pick-up or evening cool-down periods. To avoid inconsistency between the component loads and the building loads calculated by DOE-2, a final normalization is done by first adjusting for any misassigned loads, and then scaling the remaining differences to the DOE-2-calculated heating and cooling loads.

7. RESULTS

The results from the component load analysis are presented in Tables 18 through 23, and summarized by building type in Table 24. The same data are also presented as pie charts in Figures 3 through 15 showing the aggregated component loads for each commercial building type. Detailed pie charts of "specific component loads" for each building type and vintage in three of the five representative locations are presented in Appendix C.

7.1 Explanation of Tables

Tables 18 through 23 give the component loads per ft^2 of floor area for the 120 building subsectors studied (12 building types x 2 vintages x 5 climates). For each building subsector, the tables indicate the size of the prototypical building modeled, and the total floor area represented by that prototype. Due to the data limitations in CBECS, there are some anomalous results such as the zero floor areas in Tables 20 and 22 for new small hotels and hospitals in Climate Zone 1 represented by Minneapolis. The estimated floor areas for heating and cooling differ because CBECS shows different percentages of floor area heated or cooled depending on building and climate (see Appendix B). Table 22 gives a floor area for cooling less than half that for heating in old schools in Climate Zone 1 (Minneapolis) because many of them are not air-conditioned. The following twelve columns on the tables give the component loads in kBtu per ft^2 of floor area for the following components :

Wndw	=	Conduction through *windows*
Wall	=	Conduction through exterior *walls*
Roof	=	Conduction through *roofs*
Floor	=	Conduction through *floors* over unconditioned spaces, e g. basements or crawl spaces
Grnd	=	Conduction through the *ground* or floor slab
Eqp	=	Internal heat gain from *electrical equipment*
Src	=	Internal heat gain from *non-electrical equipment*

Peop	=	Internal heat gain from *occupants*
Infl	=	Convection through *infiltration* (does not include outside air introduced by system)
Lights	=	Internal heat gain from *lights*
Solar	=	*Solar* heat gain through windows and skylights
Outdr. Air	=	Convection through *outside air* introduced by system to meet health requirements (does not include outside air from economizers or due to limitations in air-handling system).

The last column gives the net load in kBtu per ft^2 of floor area for the entire building, i.e., the building's heating or cooling load as computed by DOE-2.

Following standard DOE-2 terminology, heat gains are given as positive, and heat losses as negative. Therefore, a positive number in a heating row, such as Lights or Solar, indicates free heat gain that lowers the net heating load of the building. Similarly, a negative number in a cooling row, such as window or wall conduction, indicates a heat loss or "free cooling" that offsets the building cooling load.[3]

It should be emphasized that these loads are the theoretical thermodynamic loads of the building in order to maintain the thermostat set points. As will be discussed in Section 8, the actual energy requirement of the HVAC system to meet these loads can often be several times larger due to inefficiencies and losses in the air-heating system, heating and cooling equipment, and central plant.

7.2 Explanation of Pie Charts

In the previous study of residential component loads, the pie charts show only the contributing component loads and ignored the offsetting loads (Hanford and Huang 1992). Since some components like windows have both positive heating loads from conduction as well as offsetting loads from solar heat gain, such pie charts can give misleading impressions about the conservation potential of those components. This presentation problem is accentuated in large commercial buildings, where most of the heating load is offset by high internal gains.

To overcome this problem, a new format was devised to show both heat gains and losses on the same pie chart. Each pie chart consists of three pies - heating, cooling, and total – whose areas are scaled by the size of the load. On the heating and cooling pies, the heat gains are shown as crosshatched pie slices and the heat losses as hatched pie slices. The remaining exploded pie slice shows the imbalance between the heat gains and losses and represents the net heating or cooling load that must be supplied by the building's HVAC system. On the heating pies the heat losses (or loads) are plotted on the top half and the heat gains (or "free heat") on the bottom half. On the cooling pies, the heat gains (or loads) are plotted on the top half and the heat losses (or "free cooling") on the bottom half. On the total pies, the shading convention is modified, with the crosshatched areas representing net contributing loads, and the hatched areas the counterbalancing or "free" loads. Because the efficiencies and energy costs of heating and cooling systems can vary greatly, these total pies should be viewed with

[3] In actuality, if the system has an economizer, most of this "free cooling" effect will be neutralized by the building system itself. The impact of economizers on building loads is addressed in a later section.

caution, but they do show qualitatively which building components are the greatest sources of space conditioning loads. To indicate the relative magnitudes of the component loads, all the pies on each chart are plotted on the same scale.

Table 24 and Figure 3 show the aggregate component loads for the entire commercial building stock in Quads (Quadrillion Btu's) derived by multiplying the kBtu/ft^2 components loads by the total floor area represented for all 120 prototypical building types. The results (0.42 Quads for heating, 0.88 Quads for cooling) cannot be compared directly to the heating and cooling energy use estimated by other forecasting studies since these component loads do not include the inefficiencies of the HVAC system and plant. These effects will be discussed in Section 9. Figures 4 through 15 show the aggregate component loads for each building type, also expressed in Quads (Quadrillion Btu's). The building sectors ranked in order of magnitude are: Large Office, Hospital, Small Retail, Large Retail, Small Office, School, Large Hotel, Fast-food Restaurants, Supermarkets, Sit-down Restaurants, Small Hotel, and Warehouse.

Detailed pie charts of the specific component loads per kBtu/ft^2 by building type, vintage, and location are included in Appendix C. For brevity, pie charts are shown for only three of the five representative locations (Minneapolis, Washington, and Houston). Because of the large differences in their load intensity the pie charts have been plotted using three different scales depending on the building type (large for the hospital and restaurants, medium for the supermarket, and low for the rest). These scales are indicated by the scales on the lower right of each figure with circles showing the same amount of load.

Several points are apparent on the table and the pie charts: (1) cooling loads are clearly dominant in all the large building types, and of that, more than half is due to lights and equipment and a third to solar heat gain through the windows; with conduction and infiltration generally providing "free cooling", (2) heating loads are appreciable in the smaller buildings and the schools due to their large amounts of wall and window area; windows, walls, and infiltration are roughly comparable in contributing to the total commercial heating loads, although nearly 60% of the window heat losses are offset by their solar heat gain; (3) restaurants are characterized by both high heating and cooling loads, the former because of the large amounts of outdoor air required for the kitchen, the latter because of the internal heat gain from the cooking equipment; and (4) supermarkets have relatively high cooling loads, almost all of it due to their high lighting levels.

8. SYSTEM AND PLANT FACTORS

At first glance, the computed loads from this study appear small compared to other estimates of the energy consumption of commercial buildings for space heating and cooling. However, such a comparison would be misleading since the computed building loads do not account for the interactions with the building system and plant, or their efficiency. Sezgen et al. (1995) at LBNL recently developed the terminology of System and Plant Factors to indicate the ratio between the building heating or cooling load and the actual energy consumed by the system and plant to meet that load. The System Factor accounts for the efficiencies of the air-handling system in consuming more (or in a few instances less) heating or cooling energy than needed by the building, as well as the energy used by system fans and pumps, and lost due to the inefficiencies of the duct delivery system. The Plant Factor accounts for the thermal efficiencies of the boilers, furnaces, chiller, cooling towers, and the energy expended by their associated fans and pumps.

In this study, System and Plant Factors have been calculated for each prototypical building by modeling it with a prototypical HVAC system and plant, and then comparing the resulting system loads and energy consumption at the system or plant level to the building loads described in Section 7. The system and plant equipment assumed for each prototypical building are based on the earlier LBNL/GRI study, and reflect engineering judgments of the equipment most likely to be installed by building type, vintage, and location. Conventional descriptions of the modeled equipment are shown in the bottom half of the prototype building descriptions in Tables 10 through 17.

The resultant system and plant factors are shown in Tables 25 through 30. The tables are arranged similar to the component load tables on Tables 18 through 24. The table columns, beginning at the third from the left, give the following : C. net building loads repeated from the component load tables, D. system factor, E. system load, F. plant factors by fuel type, G. plant energy consumption by equipment, and H. the overall efficiency of the system and plant.

The System Factor is defined as the ratio between the Building Load, i.e., what the building requires, and the System Load, i.e., the amount of heating or cooling the system has to provide to meet the building load. System Factors can vary from very low values less than 0.10) in extreme cases such as a large building with minimal heating needs, to slightly over 1.00 in heating due to "free heating" from the fans and the effects of the throttling range, and well over 1.00 in cooling due to the "free cooling" provided by window venting or an economizer cycle. In general, however, System Factors are significantly less than 1.00 due to either the inefficiencies or other operational requirements for the air-handling system.

Table 31 summarizes the average heating and cooling System Factors for the 12 major building types. The heating System Factors for the older vintage large buildings are low because they have constant-volume systems that cannot be modulated in response to the actual building load. In many cases, there is substantial zone-level reheating while the central system provides cooling to the warmer zones. Since reheating reflects an inefficiency of the cooling system, this system-induced heating load is added to the cooling load on Tables 25-27, 29 and 31. Although this tabulation mixes space conditioning processes and fuel sources used to meet the loads, it does give a general sense of the impact of reheating on cooling system efficiencies. Equally importantly, it eliminates the misattribution of reheating to the efficiency of the heating system. The actual amount of reheating can be determined by looking at the amount of gas consumption shown in the "cool" rows of Tables 25 through 31. In the older large offices, the amount of gas consumption for reheating is nearly equally to that consumed for space heating. In the newer offices, the amount of reheating varies from 2% in Minneapolis to over 50% in Los Angeles.

In some instances, the System Factors reflect the operational requirements of the buildings. The System Factors for the fast-food restaurants and hospitals are low not because their systems are inefficient, but because they require large amount of outside air. The fast-food restaurants are assumed to require 10 air-changes in the kitchens, and the hospitals operated with 100% outside air. In these cases, System Factors for heating can drop below 0.30, while those for cooling vary depending on the climate and building characteristics. The additional loads due to the outside air are simulated in the System routine of DOE-2, so they do not appear in the component loads calculation. However, since such outside air requirements are determined by the building use, it may be more appropriate to consider them as part of the Building Loads instead. On the other hand, the cooling System Factors in older small hotels (Motels) and schools are very high because these buildings have been modeled with unit ventilators with no cooling equipment. The System Factors are high because the cooling loads are not being met.

In building types such as small offices and retail stores with packaged systems and no additional need for outside air beyond that for health reasons (which is included in the calculation of the Building Loads), the System Factors are slightly above 1.0 for heating and slightly below 1.0 for cooling.

The System Loads (E) represent the heating and cooling outputs that the system must provide to meet the heating and cooling loads of the building, and are equivalent to the Building Loads multiplied by the System Factors. To meet the System Loads, the heating and cooling plant in turn consume varying amounts of fuel or electricity depending on the efficiency of the boiler, chiller, cooling tower, fan, pumps, etc., shown in G. The ratio between the system loads and the plant consumption are presented as Plant Factors. These factors are given by fuel type because of the large differences in efficiency and cost between fuel and electricity. For example, the Plant Factors for gas in the large buildings are around 0.65, reflecting the seasonal efficiencies of boilers. The Plant Factors for electric heating are 1.00, indicating resistance heating, while for cooling they vary from 2.50 to nearly 5.00 depending on the seasonal efficiency of the chiller and cooling tower.

In addition to the energy consumed by the heating and cooling equipment, there is also the energy used by auxiliary equipment such as fans and pumps. This energy consumption is not included in the Plant Factors for neither gas nor electricity. The third Plant Factor ("Net") attempts to give an overall efficiency of the heating and cooling plant by including all the energy expended, with a source-to-site multiplier of 3 for electricity. Net Plant Factors in commercial buildings average 0.44 in heating and 0.79 in cooling.

The differences in system and plant efficiencies between the heating and cooling modes, and between the old and new vintage HVAC equipment often overwhelm the original differences in building loads. In new large offices, for example, the building loads in the five representative locations vary from 0.1 to 9.4 kBtu/ft^2 for heating and from 25.3 to 45.0 kBtu/ft^2 for cooling. However, to meet these loads, the plant consumption for heating are increased by factors of three or more (4.5 to 28.9 kBtu/ft^2 for gas, plus 1.3 to 5.3 kBtU/ft^2 for electric auxiliaries), while conversely for cooling they are reduced by factors of 2 or more (10.2 to 21.8 kBtu/ft^2 for chiller, auxiliaries, and reheat). Even when the higher cost for electricity is taken into account, the relative significance of the heating load is increased compared to the cooling load.

In the older large offices, the building loads are higher than those of new offices by no more than 10%, but due to the inefficiency of their constant-volume air-handling systems, their plant energy consumption as calculated by DOE-2 are nearly doubled due to reheating and tripled for cooling. These system inefficiencies are reflected in their cooling System and Plant Factors when reheating is added, which are 30% lower at the system level and compared to those in new office buildings. Such drastic differences in system and plant factors occur mostly in large buildings with central air-handling systems and plants. In the smaller buildings that have packaged HVAC systems, the differences in system and plant factors are smaller comparing either between HVAC modes or equipment vintages.

9. TOTAL COMMERCIAL BUILDING ENERGY USE

The above section and Tables 25 through 31 indicate that the building load is an important, but certainly not the only, determinant of building energy use. This is particularly true in the larger buildings where the shell loads are relatively small and the system and plant characteristics can boost or reduce the loads by many times. The component loads shown on Tables 18 through 25 and Figures 3 through 15 should be regarded as theoretical minimum limits that rarely correspond to the actual energy consumed or even the amounts of heating or cooling delivered in an actual building. To place these loads into better context, they need to be multiplied by the System and Plant Factors calculated in Section 8 to derive the actual energy consumption of the 120 prototypical buildings. This helps to not only reveal the true energy impacts of the calculated component loads, but also provide a way to validate the prototype models against measured energy usage.

Tables 32 through 37 multiply the specific energy consumption from Tables 25 through 30 by the floor areas represented by each building prototype. Non-space-conditioning energy uses such as lighting, equipment, service hot water, etc., have been also considered to facilitate comparison to measured whole-building energy use data. The aggregated energy consumption represented by each prototype is shown on the three columns on the right of each table, identified as "Site Gas", "Site Elec", and "Source Total". The first two columns show site energies in trillion (10^{12}) Btus. The last column combines the two to a single source energy usage calculated with a multiplier of three for electricity. The non-space conditioning energy uses are assumed to occur in all buildings and multiplied across each row by the total floor area listed as "other". The heating energy uses are multiplied across each row by the amount of floor area with heating listed as "heat", and the cooling energy uses are multiplied by the amount of floor area with cooling listed as "cool".

The two columns labeled as "Total Gas" and "Total Elec" give the average total specific energy use by fuel type for that building sector. As with the aggregated energy consumptions, these average energy consumptions are prorated by the percentages of floor area heated and cooled, so that they are smaller than the sum of the energy consumptions by end-use.

With the aggregated energy consumptions on Tables 32 through 37, it is now possible to compare the simulation results to measured energy data to determine the accuracy of the building prototypes and the modeling technique. Table 38 and Figure 17 compare the total energy consumption of the commercial building types covered in this study to the entire commercial building sector reported by the 1992 CBECS. The 12 building types included in this study represents 74% of the building floor area and 79% of the energy use of the commercial buildings reported in the 1992 CBECS. Not covered are assembly buildings, parking garages, public order, and buildings listed as "other".

When compared at the aggregate level for all 12 building types, the electricity consumption derived by this study is 11 % higher than estimated by the 1992 CBECS (2.4 versus 2.1 Quads), while the fuel consumption is lower by 17% (1.4 versus 1.7 Quads) considering only natural gas, or by 38% (1.4 versus 2.3 Quads) if other fuels tabulated by CBECS are also included. The prototypical building descriptions only assume natural gas is used as the fuel source, while CBECS reports other fuels such as fuel oil and district heating. When compared by building sector, this study agrees well with CBECS in total energy consumption in the largest or best understood commercial sectors such as office and mercantile (1.0 versus 1.2 Quads, and 0.9 versus 0.9 Quads, respectively). For the smaller and less well-understood building sectors, there are larger differences between the Component Study and the 1992 CBECS. The largest discrepancies are found for the lodging sector, for which the Component Study showed only half the energy consumption estimated by the 1992 CBECS. Such a large discrepancy suggests that more work is needed in refining the description of the prototypical buildings, their system characteristics, and operations.

Table 39 compares the total commercial energy consumption for space conditioning and by fuel type estimated by this project to those from three other sources - the 1992 and 1995 CBECS (EIA 1992, 1998), the 1993 and 1995 estimates from the 1995 and 1997 *Annual Energy Outlook* (EIA 1995, 1996) and the 1993 and 1995 estimates from the 1995 and 1997 GRI Baseline Projection Data Book (Gas Research Institute 1995, 1997). Since this study covers only 74% of the entire commercial building stock, the total energy consumption estimated by this study has been multiplied by 1.28.

The six estimates, two each from the three sources, show substantial differences, with CBECS lower than the other two by 20% for 1992/1993, and by over 30% for 1995. Although the *Annual Energy Outlook* and the GRI forecasts are in close agreement in total energy use by fuel type, they differ substantially in their end-use estimates. The *Annual Energy Outlook* estimates 30% less space heating than does GRI (and actually quite close to CBECS) but makes up the difference with 70-100% more energy use for other end-uses than does GRI. In space cooling, there is a factor of nearly three between the six estimates, from 0.34 Quads for 1995 CBECS to 0.92 Quads for 1995 GRI.

Compared to these six estimates, the heating energy consumption and total fuel energy use derived in this study are the lowest of all., the cooling energy consumption roughly consistent with the CBECS and *Annual Energy Outlook* but half that of the GRI estimates, and the electricity use somewhat higher than CBECS and similar to the *Annual Energy Outlook* and GRI estimates. The fact that the electricity use estimated by this study is within the range of values from the other six studies may provide some comfort in “safety in numbers”. However, the low estimates of heating energy use warrants further study.

The differences could be due to either an misinterpretation of the "percent heated" and “percent cooled” values in CBECS, or problems with the specific energy use calculated by the DOE-2 simulations. A logical process to determine the sources of discrepancies, and perhaps more importantly, what are the true energy consumption, would be to first validate at the individual building level against measured Energy Intensities for a representative set of buildings, ideally submetered by end-use, and then determine if the stock characteristics of numbers of building, percent conditioned, etc., are correct. If the Energy Intensities are seriously in disagreement, there are still many modeling assumptions that can be adjusted, such as thermostat settings, hours of operation, system and plant efficiencies, shell characteristics, etc. just as one example, all the prototypes have been modeled with minimal shading from neighboring buildings or interior drapes. This would overestimate solar heat gain, leading to lower heating and higher cooling loads, which seems to confirm the observation that this study may underestimate heating and overestimate cooling loads. However, in the absence of hard data on building conditions and submetered energy use, “tweaking” the prototypes to match national estimates from other studies is of limited use.

10. CONCLUSIONS

The original intent of this project was to determine the relative contributions of different building components to the heating and cooling loads of commercial buildings. Although the effort proved to be more difficult than originally conceived, this has been achieved to the degree of accuracy of the simulation model. However, in the course of extracting the component loads, it has become more apparent that commercial building loads are so intertwined with and affected by the operational characteristics of the system and plant that it becomes difficult and almost academic to separate out a “pure” building load. Furthermore, the analysis showed that in many cases, variations in system and plant efficiencies can swamp the differences in building loads.

The recognition of this fact, however, does not necessarily reduce the significance of the component loads calculated and presented in this report. By indicating the true scale and make-up of commercial building loads, this information can lead to realistic estimates of the conservation potentials in these building components, the cost-benefit of DOE programs in these areas compared to each other, and to system, plant, and operational improvements.

The comparison of the bottoms-up aggregated building energy use for all commercial buildings to the estimates published by other government organizations and industry revealed significant differences, both with this study and between each other. The difficulty of reconciling the prototypes results with one selected system and plant type per building, and the large impact of the system and plant performance on building energy use, suggests that if there are efforts to continue this work in the future, more emphasis should be placed on defining the mix and distribution of system and plant configurations for each prototypical building, and then making parametric simulations of all combinations of building shell, system, and plant. Further evaluation and calibration of the computed Energy-use Intensities (EUI's) of the prototypical commercial buildings should go beyond the use of CBECS to obtaining detailed metered end-use data that would provide much more clues as to which of the dozen or so key input parameters should best be modified.

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Table 1. Existing building prototypes

(see Appendix A for coding of data sources, number in parenthesis indicate vintage, equipment, or location variations)

Bldg Type	National	Northeast	North Central	South	West
Office					
General	PNL(20)	-	-	-	-
Large	EPRI(2),SP41	NEU1(4),NEU2, ConEd,Cogen(12)	MEOS(2), Cogen(12)	FPL, Cogen(12)	SCE(2),PGE(2), Cogen(16),BPA(2), CCIG(2)
Medium	SP41	NEU1(4),NEU2	-	-	-
Small	EPRI(2),SP41	NEU1(2),NEU2	MEOS	FPL	SCE(2),PGE(2) BPA(2),CCIG(2)
Health					
General	EPRI(2)	-	-	-	-
Hospital	SP41	NEU3,ConEd Cogen(6)	MEOS Cogen(6)	FPL Cogen(6)	PGE(2),SCE(2), Cogen(8),BPA(2), CCIG(2)
Nursing Home	Gard	NEU3	-	-	PGE(2),CCIG(2)
Doctor's Office	-	NEU3(2)	-	-	-
Lodging					
General	EPRI(2)	-	-	-	-
Large Hotel	SP41	ConEd, Cogen(6)	MEOS Cogen(6)	FPL Cogen(6)	PGE(2),BPA(2), Cogen(8),CCIG(2)
Sm.Hotel / Motel	SP41	Cogen(6)	MEOS,Cogen(6)	Cogen(6)	PGE(2),Cogen(8), CCIG(2)
Restaurant					
Fast-foods	EPRI(2),Cogen	-	MEOS	-	SCE(2),PGE(2), BPA(2),CCIG(2)
Sit-down	SP41	Cogen(3)	Cogen(3)	FPL,Cogen(3)	PGE(2),SCE(2), Cogen(4),CCIG(2)
Food Store					
Supermarket	EPRI,Cogen(2)	ConEd	MEOS	-	BPA(2)
Small	-	-	-	-	PGE(2),SCE(2), CCIG(2)
Retail					
General	EPRI(2)	-	-	-	-
Large	SP41	ConEd, Cogen(6)	MEOS(2), Cogen(6)	FPL,Cogen(6) -	SCE(2),PGE(2), Cogen(8),BPA(2) CCIG(2)
Small	SP41	-	MEOS	UTA	SCE(2),BPA(2), CCIG(2)
Education					
General	EPRI(2),SP41	-	MEOS	-	BPA(2)
College	-	-	-	-	CCIG(2)
Secondary	LBNLS	ConEd,NEU3(4), Cogen(6)	Cogen(6)	FPL,Cogen(6)	PGE(2),Cogen(8), CCIG(2)
Primary	-	NEU3	-	-	PGE(2),CCIG(2)
Warehouses					
General	EPRI(2),SP41	-	MEOS	-	BPA(2)
Refrigerated	-	-	-	-	SCE(2),CCIG(2)
Nonrefrigerated	-	-	-	-	SCE(2),CCIG(2)

Table 2. Summary of Existing Office Prototypes (Part 1)

A. Study	B. Proto	C. Vintage	D. Size(ft^2)	E. Floors	F. Zones	H. System *	I. Basis for prototype	J. Calibration	K. Input file
Cogen (1991)	Large	pre-, post-80	149,000-557,000	7-9	5	PMZS+ZRH(pre), PSZ+VAV(post)	previous studies	annual (83 NBECS)	DOE-2.1E (avail.)
PGE (1993)	Large	pre- post-78	99,600	5	5	PMZS+SZRH(pre), PSZ+VAV(post)	onsite sv. 70 bldgs, mail sv. 300 bldgs	load shapes (PGE data)	DOE-2 (pre-calibration, avail?)
	Small	pre-, post-78	3,900	1	1	PSZ(pre & post)	onsite sv. 75 bldgs, mail sv. 650 bldgs		
SCE (1989)	Large	all	66,147	12	5	PSZ+SZRH	survey 15 bldgs	load shapes (SCE data)	DOE-2 (pre-calib., avail?)
	Small	all	3,800	1	1	PSZ	survey 70 bldgs		
CCIG (1994)	Large	pre-75,79-82, post-91	175,000	10	15	CVRH(pre), VAV(rest)	previous studies, Cal utility surveys	no	DOE-2.1E (unknown)
	Small	pre-75,79-82, post-91	10,000	2	10	PSZ(all)			
ConEd (1987)	Office	all	215,840	27	?	SZ+MZ+VAV +DD+IND+FC	survey of 54 customers		
EPRI (1988)	Large	pre-, post-A90	91,000	7	35	VAV(both)	ASHRAE-90 stds	no	DOE-2.1 (doubtful)
	Small	pre-, post-A90	19,993	2	10	PSZ(both)	ASHRAE-90 stds		
MEOS (1987)	Large Small	new,exist. new	146,685 3,780	7 1	1 1	? ?	survey 39 bldgs survey 25 bldgs	annual (Mich data)	ADM2 (doubtful)

* coding for system types = CVRH = Constant volume reheat, DD = Dual duct, ER = Electric heat, FC, FPFC = Fan coil, Four-pipe fan coil, IND = Induction, PSZ = Packaged single-zone, PMSZ = Packaged multi-zone, PVAVS = Packaged variable air volume, SZRH = Single-zone reheat, VAV = Central variable air volume, WSHP = Water-source heat-pump.

Table 2. Summary of Existing Office Prototypes (Part 2)

A. Study	B. Proto	C. Vintage	D. Size(ft^2)	E. Floors	F. Zones	H. System *	I. Basis for prototype	J. Calibration	K. Input file
NEU1 (1985)	Large	new+computer	100,165	6	4	VAV	average 4 bldgs	annual (NE data)	BHLM (fr. SRC, doubtful)
	Large	new	159,910	7	4	VAV	average 6 bldgs		
	Large	exist+computer	88,782	4.5	4	FPFC	average 4 bldgs		
	Large	exist.	83,947	3.5	4	FPFC	average 4 bldgs		
	Medium	new+computer	31,768	2	4	VAV	average 3 bldgs		
	Medium	new	25,687	2	4	VAV	average 4 bldgs		
	Medium	exist+computer	23,903	2	4	FPFC	average 3 bldgs		
	Medium	exist.	22,609	2	4	FPFC	average 5 bldgs		
	Small	all	3,366	1	1	ER	average 5 bldgs		
	Small	all	4,488	1	1	non-ER	average 3 bldgs		
NEU2 (1987)	Large	all	645,421	6	?	non-VAV	utility data	annual (NE data)	DOE-2 (avail.)
	Medium	all	32,645	3	?	non-VAV	utility data		
	Small	all	5,037	2	?	Furn/DX	utility data		
SP41 (1983)	Large	1981	684,000	18	11		actual building	no	DOE-2 (avail.)
	Medium	1973	49,500	3	1	WSHP	actual building		
	Small	1981	2,500	1	1	PVAVS	actual building		
BPA (1988)	Large	pre-, post-80	408,000	24	9	CVRH(pre), VAV(post)	util. surveys, prev. SRC study	annual (NW data)	DOE-2.1B (unknown)
	Small	pre-, post-80	4,880	1	5	PSZ(both)			

* coding for system types = CVRH = Constant volume reheat, DD = Dual duct, ER = Electric heat, FC, FPFC = Fan coil, Four-pipe fan coil, IND = Induction, PSZ = Packaged single-zone, PMSZ = Packaged multi-zone, PVAVS = Packaged variable air volume, SZRH = Single-zone reheat, VAV = Central variable air volume, WSHP = Water-source heat-pump.

Table 3. Summary of Existing Retail Prototypes

A. Study	B. Proto	C. Vintage	D. Size (ft^2)	E. Floors	F. Zones	G. Uses	H. System *	I. Basis for prototype	J. Calibration	K. Input file
Cogen (1991)	Large	pre-, post-80	27,000-140,000	2	2-3	Sales	SZRH(pre), VAV(post)	previous studies,	annual (83 NBECS)	DOE-2.1E (avail.)
PGE (1994)	Large	pre-78 post-78	97,000	1	5	Sales	PSZ+SZRH, PSZ+VAV	onsite sv. 26 bldgs, mail sv. 303 bldgs,	ld shape (PGE data)	DOE-2 (pre-calib, avail?)
SCE (1989)	Large	all	67,628	1	5	Sales	PSZ+SZRH	survey 13 bldgs.	ld shape (SCE data)	DOE-2 (pre-calib., avail?)
	Small	all	4,360	1	1	Sales	PSZ	survey 65 bldgs.		
CCIG (1994)	Large	pre-75,79-82, post-91	120,000	2	5	Sales,Stor, Off	CVRH(pre), VAV(rest)	previous studies,, Cal. util. surveys	no	DOE-2.1E (unknown)
	Small	pre-75,79-82, post-91	8,000	1	1	Sales	PSZ(all)			
ConEd (1987)	Large	all	149,000	7	?	1	SZ+MZ+DD	survey 40 bldgs.		
EPRI (1987)	Large	all	25,000	1	6	Sales	PSZ	ASHRAE-90 stds	no	DOE-2.1 (doubtful)
MEOS (1987)	Large	new, exist.	105,000	2	1	1	?	survey 50 bldgs.	annual (Mich data)	ADM2 (doubtful)
	Small	new	4,980	1	1	1	?	survey 14 bldgs.		
SP41 (1987)	Large	1975	164,000	2	1	1	?	actual bldg	no	DOE-2 (avail.)
	Small	1978	11,760	1	1	1	?	actual bldg		
UTA (1983)	Small	1983	2,540	1	1	Sales	PSZ	survey 48 bldgs.	annual (util data)	DOE-2 (avail.)
BPA (1988)	Large	1983	120,000	2	3		TPFC,PSZ	util. surveys prev. SRC study	annual (NW data)	DOE-2.1B (unknown)
	Small	1983	13,125	1	2		PSZ,PSZ			

* coding for system types = CVRH = Constant volume reheat, DD = Dual duct, FC, FPFC = Fan coil, Four-pipe fan coil, IND = Induction, PSZ = Packaged single-zone, PMSZ = Packaged multi-zone, PVAVS = Packaged variable air volume, SZRH = Single-zone reheat, VAV = Central variable air volume, WSHP = Water-source heat-pump.

Table 4. Summary of Existing Lodging Prototypes

A. Study	B. Hotel	C. Vintage	D. Size(ft^2)	E. Floors	F. Zones	G. Uses	H. System *	I. Basis for prototype	J. Calibration	K. Input file
Cogen (1991)	Large Hotel	pre-80 post-80	113,000-489,000	6-10	3	Lobby,Rms, Kit	SZRH+FPFC VAV+FPFC+ +SZRH	previous studies	annual (83 NBECS)	DOE-2.1E (avail.)
	Sm Hot/ Motel	pre-80 post-80	20,000-46,000	2	3	Lobby,Rms, Kit	PSZ+PTAC PVAVS+PTAC			
PGE (1994)	Large Hotel	pre-78 post-78	205,000	10	3	Lobby,Rms, Kit	SZRH+FPFC VAVS+FPFC	onsite sv. 12 bldgs, mail sv. 100 bldgs int cond fr Cogen	load shapes (PGE data)	DOE-2 (pre-calib., avail?)
	Sm Hot/ Motel	pre-78 post-78	20,000	2	3	Lobby,Rms, Kit	PSZ+PTAC PVAVS+PTAC	onsite sv. 22 bldgs, mail sv. 94 bldgs int cond fr Cogen		
CCIG (1994)	Hotel	pre-75,79-82, post-91	200,000	8	12	Rms,Corr, Off,Laundry, Lobby,Res,Lge	FPFC+VAV+ PSZ(all)	previous studies, Cal. util. surveys	no	DOE-2.1E (unknown)
	Motel	pre-75,79-82, post-91	30,000	2	15	Rms,Corr, Off,Laun	PTAC+ +ER(pre), +HP(rest)			
ConEd (1987)	Hotel		250,497	22	?	1	SZ+MZ+FC	survey 19 bldgs.		
EPRI (1988)	Lodging	all	60,000	3	12	1	WSHP	ASHRAE-90 stds	no	DOE-2.1 (doubtful)
MEOS (1987)	Hotel/ Motel	exist.	17,280	3	1	1	?	survey 38 bldgs.	annual (Mich data)	ADM2 (doubtful)
SP41 (1983)	Large Hotel	1981	315,000	10	16	?	FPFC	actual buildings	no	DOE-2 (avail.)
	Small Hotel	1981	49,584	2?	10	10?	FPFC+VAV			
BPA (1988)	Large Hotel	pre-, post-80	277,200	22	11	Lobby,Conf, Kit,Laundry, Mech,Rms	CVRF+ TPFC		annual (NW data)	DOE-2.1B (unknown)

* coding for system types : CVRF = Constant-volume reheat fan, FC, TPFC, FPFC = Fan-coil, Two- or Four-pipe fan coil, PSZ = Packaged single-zone, ER = Electric resistance, PVAVS = Packaged variable air volume, PTAC = Packaged terminal air conditioner, SZRH = Single-zone reheat, VAV = Central variable air volume, WSHP = Water-source heat-pump.

Table 5. Summary of Existing Restaurant Prototypes

A. Study	B. Restaurant	C. Vintage	D. Size (ft^2)	E. Floors	F. Zones	G. System *	H. Basis for prototype	I. Calibration	J. Input file
Cogen (1991)	Sit-down	all	3,080-7,700	1	2 (Din,Kit)	PSZ,PVAVS	previous studies	annual (83 NBECS)	DOE-2.1E (avail.)
	Fast-Foods	all	2,500	1	2 (Din,Kit)	PSZ,PVAVS			
PGE (1994)	Sit-down	pre-, post-78	3,000	1	2 (Din,Kit)	PSZ,PSZ	onsite sv. 65 bldgs, mail sv. 375 bldgs int cond fr Cogen	ld shapes (PGE data)	DOE-2 (pre-calib., avail?)
	Fast-Foods	pre-, post-78	1,700	1	2 (Din,Kit)	PSZ,PSZ	onsite sv. 22 bldgs, mail sv. 84 bldgs int cond fr Cogen		
SCE (1989)	Sit-down	all	5,252	1	2 (Din,Kit)	PSZ	survey 64 bldgs	ld shape (SCE data)	DOE-2 (pre-calib., avail?)
	Fast-Foods	all	1,391	1	2 (Din,Kit)	PSZ	survey 22 bldgs		
CCIG (1994)	Sit-down	pre-75,79-82, post-92	4,000	1	4 (Din,Kit, Ent,WC)	PSZ(all)	previous studies, Cal. util. surveys	no	DOE-2.1E (unknown)
	Fast-food	pre-75,79-82, post-92	2,000	1	4 (Din,Kit, Ent,WC)	PSZ(all)			
EPRI (1988)	Fast-Foods	all	4,000	1	4 (Off,Din,Kit Kit,Lavs)	PSZ	ASHRAE-90 stds	no	DOE-2.1 (doubtful)
MEOS (1987)	Fast-Foods	new	1,764	1	1	PSZ	survey 8 bldgs.	annual (Mich data)	ADM2 (doubtful)
SP41 (1983)	Restaurant	1975	9,060	2	6	MZS+SZRH	actual building	no	DOE-2 (avail.)
BPA (1988)	Fast-Foods	all	2,624	1	2	PSZ,PSZ	util. surveys, prev. SRC study	annual (NW data)	DOE-2.1B (unknown)

Table 6. Summary of Existing Health Building Prototypes

A. Study	B. Proto	C. Vintage	D. Size (ft^2)	E. Floors	F. Zones	G. Uses	H. System *	I. Basis for prototype	J. Calibration	K. Input file
Cogen (1991)	Hospital	pre-80, post-80	250,000-386,000	4-7	5	Clin,Core, Per,Kit,Hall	DD+FPFC+SZRH+ CVRH(pre) VAV(post)	previous studies	annual (83 NBECS)	DOE-2.1E (avail.)
PGE (1994)	Hospital	pre-78, post-78	132,000	7	5	Clin,Core, Per,Kit,Hall	DD+FPFC+SZRH+ CVRH(pre) VAV(post)	onsite sv. 54 bldgs, mail sv. 117 bldgs, int cond from Cogen	load shapes (PGE data)	DOE-2 (pre-calib., avail?)
	Nursing Home	pre-78, post-78	38,400	1	3	Multi-Pur, Rooms,Kit	PTAC+ PSZ(pre) PVAV(post)	onsite sv. 10 bldgs, mail sv. 120 bldgs		
CCIG (1994)	Hospital	pre-75,79-82, post-91	250,000	3	7	Lab,Nurs, Ward,Off,Eng, IntCare,Kit	RHFC+FPFC+ PSZ	previous studies, Cal. util. surveys	no	DOE-2.1E (unknown)
ConEd (1987)	Hospital	all	320,480	11	?	1	SZ+MZ +DD+VAV	survey 24 bldgs		
EPRI (1988)	Health	all	168,000	4	35	Rms,Kit,Off, Rec,Laundry,Hall	VAV	?	no	DOE-2.1 (doubtful)
MEOS (1987)	Hospital	new	127,787	6	1	1	?	survey 25 bldgs	annual (Mich data)	ADM2 (doubtful)
NEU3 (1986)	Hospital Nurs. Home Medical Off Lg Medical Off Sm	new new new new	466,129 45,628 46,877 4,725	5 2 4 1	4 4 4 1	1 1 1 1	MZ TPFC PMZ PSZ	survey 11 bldgs survey 8 bldgs survey 8 bldgs survey 14 bldgs	annual (NE data)	ADM2 (doubtful)
SP41 (1983)	Hospital	1981	127,787	4	26	many	DD+FPIU+ SZRH+CVRH	actual hospital	no	DOE-2 (avail.)
BPA (1988)	Hospital	pre-, post-80	272,000	5	9	Admin,Stor Mech,Kit,Care Lab,OutP, Pat,Lob	RHFS(all)	surveys 23, 12 bldgs, interviews,	annual (NW data)	DOE-2.1B (unknown)

* coding for system types = CVRH = Constant volume reheat, DD = Dual duct, FPFC = Four-pipe fan coil, PPIU = Four-pipe induction unit, PSZ = Packaged single-zone, MS = Multi-zone, PTAC = Packaged terminal air-conditioner, PVAV = Packaged variable air volume, SZ, SZRH = Single-zone, Single-zone reheat, VAV = Central variable air volume,

Table 7. Summary of Existing Education Prototypes

A. Study	B. School type	C. Vintage	D. Size (ft^2)	E. Floors	F. Zones	G. Uses	H. System *	I. Basis for prototype	J. Calibration	K. Input file
Cogen (1991)	Second.	pre-, post-80	170,000-242,000	3	6	Clas,Lib,Gym Aud,Kit,Din	HVS(pre) PMSZ(post)	previous studies	annual (83 NBECS)	DOE-2.1E (avail.)
PGE (1994)	Primary	pre-, post-78	35,000	1	3	Class,Lib, Kit	PSZ (all)	onsite sv. 51 bldgs, mail sv. 54 bldgs,	load shape (PGE data)	DOE-2 (pre-calib., avail?)
	Second.	pre-, post-78	100,000	3	6	Clas,Lib,Gym Aud,Kit,Din	PMSZ(pre) PSZ(post)	onsite sv. 3 bldgs, mail sv. 130 bldgs, int cond from Cogen		
CCIG (1994)	Primary School	pre-75,79-82, post-91	50,000	1	7	ClRms,Adm, Kit,Caf,Gym	PSZ(all)	previous studies, Cal. util. surveys	no	DOE-2.1E (unknown)
	Second. School	pre-75,79-82, post-91	150,000	2	13	ClRms,Gym Off,Shop Caf,Kit	TPFC+PSZ (all)			
	College (2 bldgs)	pre-75,79-82, post-91	300,000	3+2	16	ClRms,Dorm Off,Shop Caf,Kit	FPFC+VAV +PSZ(all)			
ConEd (1987)		all	237,100	6	?	1	SZ+MZ+ DD+IND	survey 26 bldgs		
EPRI (1988)		all	67,600	1	15	?	VAV	ASHRAE-90 stds	no	DOE-2.1 (doubtful)
MEOS (1987)		exist.	54,289	1	2	Off,Sch	?	survey 52 bldgs	annual (Mich data)	ADM2 (doubtful)
NEU3 (1986)	Primary Secondary College Dorm Classrm / Adm Student Ctr Voc/Technical	exist. exist. exist. exist. exist. exist.	40,956 171,800 35,852 88,381 51,915 85,615	2 3 4 3 2 2	4 4 4 4 4 4	1 1 1 1 1 1	TPFC CV CV PMZ CVMZ CV	survey 28 bldgs survey 24 bldgs survey 5 bldgs survey 14 bldgs survey 4 bldgs survey 10 bldgs	annual (NE data)	ADM2 (doubtful)
SP41 (1983)		1982	123,666	1	2	ClRms,Gym Off,Sch,Fd	VAV	actual bldg	no	DOE-2 (avail.)
LBLS (1986)	Second. School	all	125,330	3	20	11	UV		no	BLAST (doubtful)
BPA (1988)		all	67,784	1	8		2 UV	util. surveys, prev. SRC study	annual (NW data)	DOE-2.1B (unknown)

* coding for system types = CVRH = Constant volume reheat, DD = Dual duct, IND = Induction, PSZ = Packaged single-zone, PMSZ = Packaged multi-zone, PVAVS = Packaged variable air volume, VAV = Central variable air volume, SZ = Single-zone, HVS = Heating ventilation system, UV = Unit ventilator.

Table 8. Summary of Existing Food Store Prototypes

A. Study	B. Proto	C. Vintage	D. Size(ft^2)	E. Floors	F. Zones	G. Uses	H. System *	I. Basis for prototype	J. Calibration	K. Input file
Cogen (1991)	Super-market	pre-, post-80	21,000	1	5	Sales,Deli Bak,Of,Stor	PSZ(pre), PVAVS(post)	previous studies	annual (83 NBECS)	DOE-2.1E (avail.)
PGE (1994)	Food Store	pre-, post-78	4,400	1	5	Sales,Deli Bak,Of,Stor	PSZ (all)	onsite sv. 90 bldgs, mail sv. 336 bldgs, int cond from Cogen	ld shape (PGE data)	DOE-2 (pre-calib., avail?)
SCE (1989)	Food Store	all	5,627	1	1	Sales	PSZ	survey 79 bldgs	ld shape (SCE data)	DOE-2 (pre-calib., avail?)
CCIG (1994)	Grocery	pre-75,79-82, post-91	15,000	1	5	Bak,Off, Cash,Stor, Sales	PSZ(all)	previous studies, Cal. util. surveys	no	DOE-2.1E (unknown)
ConEd (1987)	Food Store		19,497	1	?	1	PSZ	survey 21 bldgs		
EPRI (1988)	Food Store	all	52,650	1	9	Sales,Deli, Bak,Stor / Ware,Off	PSZ	ASHRAE-90 stds	no	DOE-2.1 (doubtful)
MEOS (1987)	Food Store	new	21,216	1	1	1	?	survey 11 bldgs	annual (Mich data)	ADM2 (doubtful)
BPA (1988)	Food Store	all	26,052	1	2		PSZ,PSZ	util. surveys, prev. SRC study	annual (NW data)	DOE-2.1B (unknown)

* coding for system types = MZS = Multi-zone, PSZ = Packaged single-zone, PVAVS = Packaged variable air volume, SZRH = Single-zone reheat,

Table 9. Summary of Existing Warehouse Prototypes

A. Study	B. Warehouse	C. Vintage	D. Size (ft^2)	E. Floors	F. Zones	G. Uses	H. System *	I. Basis for prototype	J. Calibration	K. Input file
SCE (1989)	Refrigerated	all	18,980	1	1	Stor	PSZ	survey 5 bldgs.	load shape (SCE data)	DOE-2 (pre-calib., avail?)
	Non-Ref.	all	25,702	1	1	Stor	PSZ	survey 14 bldgs.		
CCIG (1894)	Refrigerated	pre-75,79-82, post-91	50,000	1	5	Off,Dock, Frez,Deli, Produce	PSZ(all)	previous studies, Cal. util. surveys	no	DOE-2.1E (unknown)
	Non-refrigerated	pre-75,79-82, post-91	70,000	1	3	Stor,Off, Serv	PSZ(all)			
EPRI (1988)	Warehouse	all	13,500	1	2	Off,Stor	PSZ	ASHRAE-90 stds	no	DOE-2.1 (doubtful)
MEOS (1987)	Warehouse	new	125,198	1	2	Off,	?	survey 20 bldgs.	annual (Mich data)	ADM2 (doubtful)
SP41 (1983)	Warehouse	1975	40,752	1	2	Off,	HVS	actual bldg.	no	DOE-2
BPA (1988)	Warehouse	all	18,025	0.5	2	1	2 UHs	util. suveys, prev. SRC study	annual (NW data)	DOE-2.1B (unknown)

* coding for system types = PSZ = Packaged single-zone, MZS = Multi-zone, PVAVS = Packaged variable air volume, SZRH = Single-zone reheat, UH = Unit heater.

Table 10. Stock, Climate, Shell, Operation, Lighting and System Characteristics of Modeled Office Prototype

	Large Offices >=25,000 ft^2				Small Offices >=25,000 ft^2			
	Old		New		Old		New	
	North U.S.	South U.S.	North U.S.	South U.S.	North U.S.	South U.S.	North U.S.	South U.S.
STOCK FLOOR AREA DATA *								
Total area (million of ft^2) *	2,706	1,593	1,117	2,805	1,747	1,593	234	711
% of total U.S. office area	23	13	9	24	15	13	2	6
LOCATION WEIGHT FACTORS								
Minneapolis	10	0	11	0	21	0	17	0
Chicago	52	0	66	0	56	0	93	0
Washington	41	21	50	13	31	12	17	14
Los Angeles	0	54	0	55	0	43	0	51
Houston	0	19	0	20	0	37	0	26
FLOOR-AREA WEIGHTED AVERAGES								
Building area (ft^2)	103,000	96,000	137,000	90,000	5,500	5,800	6,400	6,600
Floors	7	6	7	6	2	2	2	1
SHELL								
Percent glass	40		50		20		15	
Window R-value	1.44	1.39	1.71	1.67	1.76	1.34	1.99	1.58
Window shading coefficient	0.80	0.77	0.69	0.71	0.79	0.82	0.71	0.75
Wall R-value	2.5	2.5	4.6	6.0	4.9	3.9	6.3	5.6
Roof R-value	9.1	11.2	9.1	12.6	11.9	10.5	13.3	12.6
Wall material	masonry				masonry			
Roof material	built-up				built-up			
OCCUPANCY								
Average occupancy (ft^2/pers)	460		390		420		470	
Weekday hours (hrs/day)	12				11			
Weekend hours (hrs/day)	5				4			
EQUIPMENT								
Average power density (W/ft^2)	0.75				0.50			
Full equipment hours (hrs/year)	3,580				3,360			
LIGHTING								
Average power density (W/ft^2)	1.8		1.3		2.2		1.7	
Full lighting hours (hrs/year)	4,190				3,340			
SYSTEM AND PLANT CHARACTERISTICS								
System type	Constant volume reheat fan		Variable-air-volume with economizer		Packaged single-zone		Packaged single-zone with economizer	
Heating plant	Gas boiler				Gas furnace			
Cooling plant	Hermetic centrifugal chiller				Direct expansion			
Service hot water	Gas boiler				Gas			

* stock data based on 1989 CBECS.

Table 11. Stock, Climate, Shell, Operation, Lighting, and System Characteristics of Modeled Retail Prototype

	Large Retail >=25,000 ft^2				Small Retail < 25,000 ft^2			
	Old		New		Old		New	
	North U.S.	South U.S.	North U.S.	South U.S.	North U.S.	South U.S.	North U.S.	South U.S.
STOCK FLOOR AREA DATA *								
Total area (million of ft^2)	2,344	2,354	453	727	2,359	2,885	599	685
% of total U.S. retail area	19	19	4	6	19	23	5	6
LOCATION WEIGHT FACTORS								
Minneapolis	26	0	12	0	22	0	23	0
Chicago	64	0	76	0	52	0	53	0
Washington	20	15	22	12	32	21	25	15
Los Angeles	0	31	0	56	0	38	0	46
Houston	0	44	0	26	0	36	0	38
FLOOR-AREA WEIGHTED AVERAGES								
Building area (ft^2)	80,000		79,000		5,300		6,400	
Floors	2				1			
SHELL								
Percent glass	15		15		15		15	
Window R-value	1.54	1.39	1.71	1.67	1.24	1.39	1.71	1.67
Window shading coefficient	0.78	0.79	0.74	0.76	0.86	0.85	0.85	0.84
Wall R-value	3.1	3.3	6.4	4.8	3.4	2.5	6.6	4.8
Roof R-value	10.6	11.5	14.0	12.0	10.2	9.5	13.2	12.0
Wall material	masonry				masonry			
Roof material	built-up				built-up			
OCCUPANCY								
Average occupancy (ft^2/pers)	460		390		2,085		1,635	
Weekday hours (hrs/day)	12				12			
Weekend hours (hrs/day)	5				4			
EQUIPMENT								
Average power density (W/ft^2)	0.40				0.50			
Full equipment hours (hrs/year)	4,750		5,850		3,480			
LIGHTING								
Average power density (W/ft^2)	2.1		1.6		2.2		1.7	
Full lighting hours (hrs/year)	4,500		5,245		3,786		4,412	
SYSTEM AND PLANT CHARACTERISTICS								
System type	Constant volume reheat fan		Variable-air-volume with economizer		Packaged single-zone		Packaged single-zone with economizer	
Heating plant	Gas boiler				Gas boiler North, Gas furnace South			
Cooling plant	Hermetic centrifugal chiller				Direct expansion			
Service hot water	Gas boiler				Gas boiler			

* stock data based on 1989 CBECS.

Table 12. Stock, Climate, Shell, Operation, Lighting, and System Characteristics of Modeled of Modeled Hotel Prototypes

	Large Hotels		Small Hotels	
	Old	New	Old	New
STOCK FLOOR AREA DATA *				
Total area (million of ft^2)	1,214	472	956	241
% of total U.S. lodging area	42	16	33	8
LOCATION WEIGHT FACTORS				
Minneapolis	4	18	8	15
Chicago	47	30	19	4
Washington	11	1	18	15
Los Angeles	21	7	27	17
Houston	17	44	28	49
FLOOR-AREA WEIGHTED AVERAGES				
Building area (ft^2)	120,000	250,000	11,000	12,000
Floors	6	10	2	2
SHELL				
Percent glass	29	35	24	21
Window R-value	1.39	1.67	1.44	1.71
Window shading coefficient	0.82	0.74	0.82	0.76
Wall R-value	3.6	6.2	3.4	5.3
Roof R-value	11.8	14.0	9.8	13.2
Wall material	masonry			
Roof material	built-up		shingle/siding	
OCCUPANCY				
Average occupancy (ft^2/pers)	210	210	120	120
Weekday hours (hrs/day)	24	24	24	24
Weekend hours (hrs/day)	24	24	24	24
EQUIPMENT				
Average power density (W/ft^2)	0.72	0.72	0.69	0.69
Full equipment hours (hrs/year)	2,722	2,722	2,826	2,826
LIGHTING				
Average power density (W/ft^2)	1.18	1.18	1.06	1.06
Full lighting hours (hrs/year)	5,157	5,157	3,443	3,443
SYSTEM AND PLANT CHARACTERISTICS				
Number of systems	3 (rooms, dining/kitchen, lobby/public)		2 (rooms, lobby/public)	
System type	4-pipe fan-coil in rooms, single-zone reheat in other spaces	4-pipe fan-coil in rooms, single-zone reheat in kitchen/dining, VAV in lobby	Packaged single-zone	Packaged single-zone with economizer
Heating plant	Gas boiler		Gas boiler North, Gas furnace South	
Cooling plant	Hermetic centrifugal chiller		Direct expansion	
Service hot water	Gas boiler		Gas boiler	

* stock data based on 1989 CBECS.

Table 13. Stock, Climate, Shell, Operation, Lighting, and System Characteristics of Modeled Restaurant Prototype

	Fast Food		Sit Down	
	Old	New	Old	New
STOCK FLOOR AREA DATA *				
Total area (million of ft^2)	495	91	495	91
% of total U.S. restaurant area	42	8	42	8
LOCATION WEIGHT FACTORS				
Minneapolis	16	8	16	8
Chicago	39	14	39	14
Washington	12	3	12	3
Los Angeles	14	41	14	41
Houston	19	34	19	34
FLOOR-AREA WEIGHTED AVERAGES				
Building area (ft^2)	2,500		5,250	
Floors	1		1	
SHELL				
Percent glass	30	20	20	15
Window R-value	1.54	1.49	1.54	1.49
Window shading coefficient	0.80	0.80	0.80	0.80
Wall R-value	3.4	4.9	3.4	4.9
Roof R-value	10.9	13.2	10.9	13.2
Wall material	masonry		masonry	
Roof material	built-up		built-up	
OCCUPANCY				
Average occupancy (ft^2/pers)	65		50	
Weekday hours (hrs/day)	17		17	
Weekend hours (hrs/day)	17		17	
EQUIPMENT				
Average power density (W/ft^2)	2.5		2.0	
Full equipment hours (hrs/year)	2,352		2,280	
LIGHTING				
Average power density (W/ft^2)	2.1		2.1	
Full lighting hours (hrs/year)	6,576		7,033	
SYSTEM AND PLANT CHARACTERISTICS				
Number of systems	2 (dining, kitchen)		2 (dining, kitchen)	
System type	Packaged single-zone	Packaged single-zone with economizer	Packaged single-zone	Packaged single-zone with economizer
Heating plant	Gas furnace		Gas furnace	
Cooling plant	Direct expansion		Direct expansion	
Service hot water	Gas		Gas	

* stock data based on 1989 CBECS.

Table 14. Stock, Climate, Shell, Operation, Lighting, and System Characteristics of Modeled Hospital Prototype

	Old	New
STOCK FLOOR AREA DATA *		
Total area (million of ft^2)	1,428	209
% of total U.S. hospital area	87	13
LOCATION WEIGHT FACTORS		
Minneapolis	6	5
Chicago	29	30
Washington	42	33
Los Angeles	12	9
Houston	11	23
FLOOR-AREA WEIGHTED AVERAGES		
Building area (ft^2)	66,200	155,800
Floors	6	12
SHELL		
Percent glass	25	
Window R-value	1.79	1.96
Window shading coefficient	0.71	0.66
Wall R-value	4.3	6.9
Roof R-value	12.3	11.5
Wall material	masonry	
Roof material	built-up	
OCCUPANCY		
Average occupancy (ft^2/pers)	190	
Weekday hours (hrs/day)	24	
Weekend hours (hrs/day)	24	
EQUIPMENT		
Average power density (W/ft^2)	2.2	
Full equipment hours (hrs/year)	6,962	
LIGHTING		
Average power density (W/ft^2)	2.1	
Full lighting hours (hrs/year)	6,752	
SYSTEM AND PLANT CHARACTERISTICS		
System type	4-pipe fan-coil in rooms, reheat fan in lobby and core, single-zone reheat in kitchen, dual-duct in clinic	4-pipe fan-coil in rooms, VAV in lobby and core, single-zone reheat in kitchen, dual-duct in clinic
Heating plant	Gas boiler	
Cooling plant	Hermetic centrifugal chiller	
Service hot water	Gas	

* stock data based on 1989 CBECS.

Table 15. Stock, Climate, Shell, Operation, Lighting, and System Characteristics of Modeled School Prototype

	Old		New	
	North U.S.	South U.S.	North U.S.	South U.S.
STOCK FLOOR AREA DATA *				
Total area (million of ft^2)	3,993	3,549	161	434
% of total U.S. school area	49	44	2	5
LOCATION WEIGHT FACTORS				
Minneapolis	16	0	56	0
Chicago	69	0	114	0
Washington	36	24	16	2
Los Angeles	0	27	0	24
Houston	0	26	0	42
FLOOR-AREA WEIGHTED AVERAGES				
Building area (ft^2)	47,000	22,000	26,000	16,000
Floors	2	2	2	2
SHELL				
Percent glass	27		18	
Window R-value	1.60	1.39	1.71	1.67
Window shading coefficient	0.80	0.83	0.71	0.73
Wall R-value	2.7	3.4	5.3	5.7
Roof R-value	10.9	10.1	12.6	13.3
Wall material	masonry			
Roof material	built-up			
OCCUPANCY				
Average occupancy (ft^2/pers)	105			
Weekday hours (hrs/day)	see schedules			
Weekend hours (hrs/day)	see schedules			
EQUIPMENT				
Average power density (W/ft^2)	0.8			
Full equipment hours (hrs/year)	1,136			
LIGHTING				
Average power density (W/ft^2)	1.8			
Full lighting hours (hrs/year)	2,436			
SYSTEM AND PLANT CHARACTERISTICS				
Number of systems	6 (classrooms, gym, auditorium,dining, kitchen)		1 central system	
System type	Unit ventilators		packaged multi-zone with economizer	
Heating plant	Gas boiler			
Cooling plant	Hermetic centrifugal chiller			
Service hot water	Gas boiler			

* stock data based on 1989 CBECS.

Table 16. Stock, Climate, Shell, Operation, Lighting, and System Characteristics of Modeled Supermarket Prototype

	Old	New
STOCK FLOOR AREA DATA *		
Total area (million of ft^2)	623	171
% of total U.S. food store area	78	22
LOCATION WEIGHT FACTORS		
Minneapolis	15	0
Chicago	23	21
Washington	36	23
Los Angeles	8	20
Houston	18	36
FLOOR-AREA WEIGHTED AVERAGES		
Building area (ft^2)	21,300	
Floors	1	
SHELL		
Percent glass	15	15
Window R-value	1.51	1.60
Window shading coefficient	0.82	0.79
Wall R-value	3.3	5.8
Roof R-value	9.2	11.8
Wall material	masonry	
Roof material	shingle/siding	
OCCUPANCY		
Average occupancy (ft^2/pers)	227	
Weekday hours (hrs/day)	18	
Weekend hours (hrs/day)	18	
EQUIPMENT		
Average power density (W/ft^2)	1.2	
Full equipment hours (hrs/year)	5,168	
LIGHTING		
Average power density (W/ft^2)	2.4	
Full lighting hours (hrs/year)	7,816	
SYSTEM AND PLANT CHARACTERISTICS		
Number of systems	5 (office, storage, bakery, deli, sales)	
System type	Packaged constant-volume single-zone	Packaged variable air-volume single-zone
Heating plant	Gas furnace	
Cooling plant	Direct expansion	
Service hot water	Gas	

* stock data based on 1989 CBECS.

Table 17. Stock, Climate, Shell, Operation, Lighting, and System Characteristics of Modeled Warehouse Prototype

	Old		New	
	North U.S.	South U.S.	North U.S.	South U.S.
STOCK FLOOR AREA DATA *				
Total area (million of ft^2)	4,489	4,820	855	1,373
% of total U.S. school area	48	52	9	15
LOCATION WEIGHT FACTORS				
Minneapolis	18	0	29	0
Chicago	54	0	49	0
Washington	31	13	28	18
Los Angeles	0	40	0	25
Houston	0	45	0	54
FLOOR-AREA WEIGHTED AVERAGES				
Building area (ft^2)	159,000	136,000	159,000	136,000
Floors	1	1	1	1
SHELL				
Percent glass	6		3	
Window R-value	1.39	1.39	1.71	1.67
Window shading coefficient	0.83	0.85	0.80	0.82
Wall R-value	3.2	2.4	4.6	4.0
Roof R-value	7.8	7.6	10.1	10.6
Wall material	masonry			
Roof material	metal surfacing			
OCCUPANCY				
Average occupancy (ft^2/pers)	2,085		1,635	
Weekday hours (hrs/day)	12			
Weekend hours (hrs/day)	4			
EQUIPMENT				
Average power density (W/ft^2)	0.3			
Full equipment hours (hrs/year)	6,462			
LIGHTING				
Average power density (W/ft^2)	0.8			
Full lighting hours (hrs/year)	3,638			
SYSTEM AND PLANT CHARACTERISTICS				
Number of systems	2 (office, refrigerated storage)			
System type	Constant volume, no economizer		Variable air-volume with economizer	
Heating plant	Gas furnace			
Cooling plant	Hermetic centrifugal chiller			
Service hot water	Gas			

* stock data based on 1989 CBECS.

Table 18. Component Loads for Office Prototypes

Location	Proto. size 10^3 ft^2	HVAC mode	Total area 10^6 ft^2	Component Loads (kBtu/ft^2) Wndw	Wall	Roof	Floor	Grnd	Eqp	Src	Peop	Infl	Light	Solar	Outd. Air	Net
Large Office New																
Minneapolis	137.0	heat	95.1	-11.9	-3.4	-1.5	-0.3	0.0	1.9	0.0	0.3	-1.5	4.0	4.5	-1.5	-9.4
		cool	76.6	-5.2	-0.7	-0.1	-0.4	0.0	6.5	0.0	1.2	-2.0	12.8	15.4	-2.2	25.3
Chicago	137.0	heat	705.0	-8.7	-2.4	-1.0	-0.2	0.0	1.4	0.0	0.2	-1.4	3.1	3.8	-1.0	-6.2
		cool	657.6	-5.0	-0.6	0.0	-0.4	0.0	6.7	0.0	1.3	-1.7	13.3	16.3	-1.7	28.0
Washington	124.2	heat	556.4	-4.8	-1.3	-0.4	-0.1	0.0	0.7	0.0	0.1	-0.5	1.6	2.0	-0.5	-3.2
		cool	535.2	-4.9	-0.3	0.0	-0.5	0.0	7.3	0.0	1.4	-1.6	14.6	17.6	-1.4	32.1
Los Angeles	90.0	heat	686.3	-0.2	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	-0.1
		cool	701.9	-10.2	-0.9	-0.2	-0.8	0.0	8.8	0.0	1.6	-1.3	17.7	31.5	-1.2	45.0
Houston	90.0	heat	548.1	-1.0	-0.2	-0.1	0.0	0.0	0.2	0.0	0.0	-0.1	0.4	0.5	-0.1	-0.4
		cool	548.7	-5.3	-0.2	0.1	-0.8	0.0	8.6	0.0	1.6	-1.4	17.3	24.8	-0.3	44.5
Large Office Old																
Minneapolis	103.0	heat	239.4	-12.2	-6.4	-1.3	-0.2	0.0	1.8	0.0	0.2	-1.5	5.3	4.9	-1.3	-10.6
		cool	185.4	-4.8	-1.0	-0.2	-0.4	0.0	6.4	0.0	1.0	-2.4	17.7	15.9	-1.8	30.4
Chicago	103.0	heat	1621.5	-8.9	-4.6	-0.8	-0.2	0.0	1.4	0.0	0.2	-1.4	4.1	4.0	-0.8	-7.0
		cool	1360.6	-4.8	-0.9	-0.1	-0.4	0.0	6.8	0.0	1.1	-2.1	18.6	16.9	-1.5	33.5
Washington	100.6	heat	1745.3	-4.6	-2.4	-0.3	-0.1	0.0	0.7	0.0	0.1	-0.5	2.1	1.9	-0.4	-3.5
		cool	1761.8	-4.6	-0.6	-0.1	-0.5	0.0	7.4	0.0	1.2	-1.8	20.4	17.1	-1.3	37.1
Los Angeles	96.0	heat	996.2	-0.2	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	-0.1
		cool	983.2	-8.5	-1.4	-0.2	-0.8	0.0	8.7	0.0	1.3	-1.3	24.3	26.2	-1.0	47.4
Houston	96.0	heat	428.8	-0.9	-0.5	-0.1	0.0	0.0	0.2	0.0	0.0	-0.1	0.5	0.5	-0.1	-0.5
		cool	324.7	-4.4	-0.2	0.1	-0.8	0.0	8.6	0.0	1.3	-1.5	24.1	20.5	-0.2	47.6
Small Office New																
Minneapolis	6.4	heat	30.8	-10.3	-14.7	-5.4	-1.6	0.0	3.0	0.0	0.6	-8.2	10.3	5.9	-2.9	-23.4
		cool	30.6	-1.1	0.2	0.2	-0.8	0.0	2.0	0.0	0.5	-1.0	6.7	7.5	-0.1	14.0
Chicago	6.4	heat	150.9	-7.6	-10.7	-3.9	-1.3	0.0	2.4	0.0	0.5	-6.2	8.3	4.7	-2.0	-15.7
		cool	149.1	-1.3	0.3	0.3	-0.9	0.0	2.4	0.0	0.6	-1.1	7.9	8.5	-0.1	16.5
Washington	6.5	heat	214.3	-5.5	-7.2	-5.9	-2.2	0.0	2.5	0.0	0.5	-5.2	8.5	3.7	-1.7	-12.6
		cool	216.0	-0.8	0.8	1.4	-1.8	0.0	2.6	0.0	0.6	-1.0	8.5	6.9	0.0	17.2
Los Angeles	6.6	heat	349.7	-0.4	-0.5	-0.5	-0.3	0.0	0.2	0.0	0.0	-0.5	0.8	0.4	-0.1	-0.8
		cool	344.5	-1.3	1.0	1.5	-2.2	0.0	3.0	0.0	0.7	-1.3	9.7	8.7	-0.1	19.7
Houston	6.6	heat	276.7	-1.6	-1.9	-1.8	-1.1	0.0	0.9	0.0	0.1	-1.7	3.3	1.5	-0.4	-2.6
		cool	272.3	-0.6	1.4	2.2	-3.1	0.0	3.7	0.0	0.8	-1.0	12.3	8.4	0.2	24.4
Small Office Old																
Minneapolis	5.5	heat	319.4	-14.6	-16.0	-5.3	-1.4	0.0	2.6	0.0	0.6	-7.4	11.6	7.7	-2.9	-25.0
		cool	265.6	-2.4	-0.3	0.0	-0.8	0.0	2.2	0.0	0.6	-1.4	9.4	13.0	-0.2	20.0
Chicago	5.5	heat	661.8	-10.2	-11.1	-3.6	-1.1	0.0	2.0	0.0	0.4	-5.3	8.8	5.7	-1.9	-16.4
		cool	582.7	-2.7	-0.2	0.1	-1.0	0.0	2.6	0.0	0.7	-1.5	11.0	14.6	-0.3	23.3
Washington	5.7	heat	536.6	-8.7	-8.8	-2.8	-1.1	0.0	1.9	0.0	0.4	-4.3	8.7	5.9	-1.4	-10.2
		cool	473.1	-3.3	-0.1	0.3	-1.3	0.0	3.2	0.0	0.8	-1.9	13.6	16.5	-0.2	27.4
Los Angeles	5.8	heat	591.4	-0.4	-0.4	-0.1	-0.1	0.0	0.1	0.0	0.0	-0.2	0.4	0.3	0.0	-0.5
		cool	592.6	-5.4	0.2	0.3	-1.4	0.0	3.9	0.0	1.0	-2.8	16.5	25.0	-0.4	36.8
Houston	5.8	heat	525.8	-1.7	-1.7	-0.4	-0.3	0.0	0.4	0.0	0.1	-0.9	1.7	1.3	-0.2	-1.6
		cool	524.1	-1.9	2.2	0.9	-1.5	0.0	4.0	0.0	1.0	-1.4	16.9	20.0	0.3	40.6

Table 19. Component Loads for Retail Prototypes

Location	Proto. size 10^3 ft^2	HVAC mode	Total area 10^6 ft^2	Component Loads (kBtu/ft^2) Wndw	Wall	Roof	Floor	Grnd	Eqp	Src	Peop	Infl	Light	Solar	Outd. Air	Net
Large Retail New																
Minneapolis	80.0	heat	188.3	-3.8	-3.5	-4.0	-1.0	0.0	2.6	0.0	1.2	-5.6	9.9	1.5	-3.8	-6.5
		cool	177.0	-1.6	-1.0	-0.9	-1.3	0.0	4.5	0.0	2.3	-1.8	16.3	4.6	-1.7	19.4
Chicago	80.0	heat	745.6	-2.1	-1.8	-2.1	-0.6	0.0	1.4	0.0	0.7	-3.4	5.6	0.9	-1.8	-3.3
		cool	546.2	-1.2	-0.5	-0.3	-1.3	0.0	4.6	0.0	2.4	-1.1	16.7	4.6	-1.3	22.8
Washington	80.0	heat	178.5	-0.5	-0.4	-0.6	-0.2	0.0	0.3	0.0	0.1	-1.0	1.3	0.2	-0.3	-1.1
		cool	173.6	-0.7	0.0	0.4	-1.4	0.0	4.9	0.0	2.6	-0.1	17.6	4.8	-1.0	27.1
Los Angeles	80.0	heat	230.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		cool	201.3	-2.3	-0.7	-0.2	-2.2	0.0	7.3	0.0	3.8	-2.9	26.7	8.4	-1.9	36.1
Houston	80.0	heat	409.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		cool	368.4	-0.9	0.2	0.7	-2.1	0.0	7.0	0.0	3.7	-1.1	25.6	6.5	-0.4	39.0
Large Retail Old																
Minneapolis	80.0	heat	345.9	-5.1	-5.7	-5.9	-1.3	0.0	2.9	0.0	1.0	-8.8	14.6	2.3	-3.1	-9.1
		cool	243.8	-2.0	-1.6	-1.3	-1.3	0.0	3.7	0.0	1.5	-3.2	18.2	4.8	-1.1	17.7
Chicago	80.0	heat	806.8	-3.1	-3.4	-3.5	-0.9	0.0	1.8	0.0	0.6	-5.7	9.2	1.5	-1.6	-5.1
		cool	381.9	-1.3	-0.7	-0.4	-1.3	0.0	3.6	0.0	1.5	-2.0	17.5	4.7	-0.7	20.9
Washington	80.0	heat	1162.0	-0.8	-0.9	-0.9	-0.3	0.0	0.5	0.0	0.1	-1.9	2.5	0.3	-0.3	-1.7
		cool	924.6	-0.5	0.3	0.8	-1.2	0.0	3.5	0.0	1.5	-0.2	17.0	4.5	-0.4	25.3
Los Angeles	80.0	heat	752.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		cool	686.4	-2.5	-0.9	-0.3	-2.2	0.0	5.9	0.0	2.4	-4.5	28.8	8.7	-1.0	34.4
Houston	80.0	heat	477.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.1	0.0	0.0	-0.1
		cool	412.3	-0.9	0.1	0.6	-2.0	0.0	5.5	0.0	2.3	-1.8	27.0	6.6	-0.1	37.3
Small Retail New																
Minneapolis	6.4	heat	71.5	-11.2	-9.6	-9.7	-2.6	0.0	2.4	0.0	1.9	-9.4	10.7	4.3	-6.8	-29.9
		cool	26.2	-1.2	-0.1	0.4	-1.5	0.0	1.9	0.0	1.9	-1.0	8.1	7.5	-0.3	15.7
Chicago	6.4	heat	189.1	-8.1	-6.5	-6.7	-2.2	0.0	1.8	0.0	1.4	-7.1	8.4	3.5	-4.3	-19.9
		cool	158.9	-1.4	-0.1	0.5	-1.9	0.0	2.3	0.0	2.4	-1.2	9.9	8.8	-0.3	19.0
Washington	6.4	heat	331.6	-6.6	-4.9	-4.7	-2.2	0.0	1.7	0.0	1.2	-6.0	8.2	3.7	-2.7	-12.3
		cool	221.6	-1.9	0.0	0.9	-2.5	0.0	3.0	0.0	2.9	-1.8	12.6	10.6	-0.3	23.6
Los Angeles	6.4	heat	259.7	-0.5	-0.3	-0.3	-0.2	0.0	0.1	0.0	0.1	-0.4	0.6	0.4	-0.1	-0.5
		cool	187.8	-3.1	-0.6	0.7	-2.7	0.0	3.7	0.0	3.9	-2.1	15.5	16.3	-0.9	30.7
Houston	6.4	heat	273.5	-1.8	-1.2	-1.1	-0.6	0.0	0.5	0.0	0.4	-1.4	2.5	1.4	-0.7	-2.0
		cool	192.8	-0.7	1.2	2.0	-2.8	0.0	3.6	0.0	3.6	-0.9	15.0	12.6	0.8	34.3
Small Retail Old																
Minneapolis	5.3	heat	528.3	-15.4	-14.2	-11.6	-2.6	0.0	2.3	0.0	1.9	-9.0	13.0	4.9	-7.0	-37.6
		cool	287.0	-1.5	-0.2	0.4	-1.4	0.0	1.8	0.0	1.8	-1.0	9.2	8.5	-0.3	17.5
Chicago	5.3	heat	1470.2	-11.1	-9.6	-7.9	-2.1	0.0	1.8	0.0	1.4	-6.8	10.0	3.9	-4.5	-24.9
		cool	955.1	-1.7	-0.1	0.6	-1.8	0.0	2.2	0.0	2.2	-1.2	11.3	10.0	-0.3	21.2
Washington	5.3	heat	929.1	-8.2	-7.0	-5.7	-2.2	0.0	1.8	0.0	1.3	-5.9	10.3	4.4	-2.8	-14.0
		cool	619.0	-2.6	-0.3	0.9	-2.5	0.0	3.0	0.0	2.9	-2.0	15.5	12.4	-0.3	27.1
Los Angeles	5.3	heat	892.8	-0.5	-0.4	-0.3	-0.2	0.0	0.1	0.0	0.1	-0.5	0.7	0.6	-0.1	-0.5
		cool	569.4	-3.9	-1.1	0.5	-3.0	0.0	4.0	0.0	4.1	-2.7	20.1	19.2	-1.0	36.3
Houston	5.3	heat	803.2	-1.8	-1.6	-1.2	-0.6	0.0	0.5	0.0	0.4	-1.4	2.9	1.5	-0.6	-2.0
		cool	511.8	-1.0	1.4	2.1	-2.9	0.0	3.7	0.0	3.7	-1.1	19.0	14.6	0.7	40.1

Table 20. Component Loads for Hotel Prototypes

Location	Proto. size 10^3 ft^2	HVAC mode	Total area 10^6 ft^2	Component Loads (kBtu/ft^2) Wndw	Wall	Roof	Floor	Grnd	Eqp	Src	Peop	Infl	Light	Solar	Outd. Air	Net
Large Hotel New																
Minneapolis	250.0	heat	18.6	-10.2	-3.8	-0.7	-0.2	0.0	2.8	0.2	1.7	-3.3	4.0	4.0	-5.7	-11.1
		cool	18.5	-2.9	-0.5	0.0	-1.4	0.0	3.0	0.2	2.5	-0.9	12.6	12.3	-3.5	21.4
Chicago	250.0	heat	39.8	-7.1	-2.6	-0.5	0.0	0.0	1.4	0.0	1.3	-2.3	2.4	3.0	-2.5	-6.9
		cool	34.7	-2.7	-0.3	0.1	-1.7	0.0	4.1	0.3	2.8	-0.9	14.4	13.2	-4.4	24.6
Washington	250.0	heat	21.4	-4.5	-1.6	-0.3	0.0	0.0	1.0	0.0	1.0	-1.4	1.7	2.0	-1.6	-3.7
		cool	15.7	-2.7	-0.1	0.1	-1.8	0.0	4.6	0.3	3.2	-0.9	15.7	14.2	-3.8	28.8
Los Angeles	250.0	heat	234.2	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	-0.1	-0.1
		cool	218.7	-6.2	-0.5	0.1	-2.2	0.0	6.5	0.4	4.7	-2.4	20.9	24.4	-5.0	40.6
Houston	250.0	heat	156.0	-0.5	-0.2	-0.1	0.0	0.0	0.1	0.0	0.1	-0.2	0.2	0.3	-0.2	-0.4
		cool	153.2	-2.1	0.5	0.2	-2.1	0.0	6.2	0.4	4.5	-0.9	20.0	18.7	-1.5	43.8
Large Hotel Old																
Minneapolis	120.0	heat	98.1	-10.3	-6.1	-1.5	-0.2	0.0	3.1	0.2	1.9	-3.5	4.3	4.3	-6.1	-14.0
		cool	79.7	-2.7	-0.7	0.1	-1.4	0.0	2.9	0.2	2.4	-0.8	12.4	11.1	-3.3	20.1
Chicago	120.0	heat	221.0	-7.6	-4.4	-1.1	-0.1	0.0	2.5	0.1	1.5	-2.6	3.5	3.5	-4.4	-9.0
		cool	92.5	-2.7	-0.5	0.1	-1.6	0.0	3.3	0.2	2.7	-0.9	13.7	12.1	-3.2	23.3
Washington	120.0	heat	125.6	-4.6	-2.6	-0.7	0.0	0.0	1.1	0.0	1.1	-1.5	1.8	2.2	-1.7	-4.9
		cool	20.3	-2.4	-0.1	0.2	-1.7	0.0	4.4	0.3	3.1	-0.8	15.2	12.9	-3.6	27.6
Los Angeles	120.0	heat	117.8	-0.2	-0.1	-0.1	0.0	0.0	0.1	0.0	0.1	-0.1	0.1	0.1	-0.1	-0.1
		cool	134.1	-5.6	-0.6	0.1	-2.2	0.0	6.3	0.4	4.5	-2.2	20.3	22.5	-4.8	38.7
Houston	120.0	heat	294.1	-0.7	-0.4	-0.1	0.0	0.0	0.2	0.0	0.2	-0.2	0.4	0.4	-0.3	-0.6
		cool	302.4	-1.8	0.9	0.4	-2.0	0.0	6.0	0.3	4.3	-0.8	19.3	17.2	-1.3	42.5
Small Hotel New																
Minneapolis	12.0	heat	0.0	-11.6	-11.7	-3.8	0.0	-6.4	3.2	0.1	5.2	-13.4	6.1	8.2	0.0	-24.1
		cool	0.0	-2.2	-0.4	0.0	0.0	-3.1	2.1	0.1	3.1	-1.2	3.7	10.3	0.0	12.3
Chicago	12.0	heat	4.4	-8.7	-8.6	-2.7	0.0	-4.4	2.6	0.0	4.4	-9.7	5.1	6.7	0.0	-15.2
		cool	4.4	-2.3	-0.3	0.1	0.0	-3.2	2.4	0.1	3.6	-1.2	4.4	11.5	0.0	15.1
Washington	12.0	heat	15.7	-5.1	-5.1	-1.6	0.0	-2.2	1.7	0.0	3.0	-5.5	3.4	3.8	0.0	-7.5
		cool	17.4	-2.9	-0.4	0.2	0.0	-3.8	3.2	0.1	4.8	-1.6	5.8	13.6	0.0	19.0
Los Angeles	12.0	heat	55.9	-0.1	-0.1	0.0	0.0	0.0	0.1	0.0	0.1	-0.1	0.1	0.1	0.0	-0.1
		cool	55.8	-6.0	-1.4	-0.2	0.0	-4.7	4.4	0.1	6.4	-4.1	8.1	23.6	0.0	26.3
Houston	12.0	heat	66.7	-0.6	-0.6	-0.2	0.0	-0.3	0.2	0.0	0.5	-0.6	0.5	0.5	0.0	-0.6
		cool	67.5	-2.6	0.7	0.4	0.0	-7.3	4.4	0.1	6.6	-0.2	8.1	18.3	0.0	28.4
Small Hotel Old																
Minneapolis	11.0	heat	103.3	-14.7	-14.7	-4.6	0.0	-4.7	3.2	0.1	5.2	-13.3	6.1	9.7	0.0	-27.6
		cool	94.8	-2.8	-0.5	0.1	0.0	-2.7	2.1	0.1	3.1	-1.2	3.7	12.8	0.0	14.6
Chicago	11.0	heat	89.1	-11.0	-10.8	-3.3	0.0	-3.2	2.6	0.0	4.4	-9.6	5.1	8.0	0.0	-17.7
		cool	73.0	-3.0	-0.3	0.2	0.0	-2.7	2.4	0.1	3.6	-1.2	4.3	14.2	0.0	17.5
Washington	11.0	heat	67.8	-6.4	-6.4	-2.0	0.0	-1.6	1.7	0.0	3.0	-5.4	3.4	4.4	0.0	-9.2
		cool	62.5	-3.8	-0.5	0.3	0.0	-3.1	3.2	0.1	4.8	-1.7	5.8	16.8	0.0	21.8
Los Angeles	11.0	heat	130.9	-0.2	-0.2	-0.1	0.0	0.0	0.1	0.0	0.1	-0.1	0.1	0.1	0.0	-0.1
		cool	146.2	-7.1	-1.2	0.0	0.0	-3.7	4.2	0.1	6.0	-3.8	7.6	28.3	0.0	30.3
Houston	11.0	heat	177.7	-0.9	-0.9	-0.3	0.0	-0.2	0.3	0.0	0.6	-0.7	0.6	0.7	0.0	-0.9
		cool	177.2	-3.4	0.8	0.6	0.0	-6.0	4.4	0.1	6.5	-0.3	8.0	22.4	0.0	33.2

Table 21. Component Loads for Restaurant Prototypes

Location	Proto. size 10^3 ft^2	HVAC mode	Total area 10^6 ft^2	Component Loads (kBtu/ft^2) Wndw	Wall	Roof	Floor	Grnd	Eqp	Src	Peop	Infl	Light	Solar	Outd. Air	Net
Fast Foods Restaurant New																
Minneapolis	2.5	heat	2.4	-19.1	-13.0	-10.2	0.0	-12.0	5.2	0.6	8.1	-1.1	20.5	12.6	-52.5	-60.8
		cool	1.7	-1.2	-2.8	-0.5	0.0	-8.7	13.6	1.6	10.4	-0.3	25.4	12.6	-6.8	43.3
Chicago	2.5	heat	35.4	-15.3	-8.8	-7.2	0.0	-8.0	3.0	0.4	6.3	-1.0	16.1	11.6	-39.5	-42.2
		cool	32.4	-1.1	-3.2	-0.7	0.0	-8.6	15.7	1.9	12.0	-0.3	29.5	13.5	-7.2	51.6
Washington	2.5	heat	19.6	-11.1	-4.8	-4.5	0.0	-4.5	0.9	0.1	4.4	-0.5	11.1	9.2	-26.9	-26.7
		cool	23.6	-0.9	-3.2	-0.4	0.0	-8.1	18.2	2.1	14.2	-0.3	35.0	15.1	-7.0	64.8
Los Angeles	2.5	heat	21.5	-3.4	-0.6	-1.2	0.0	-1.1	0.0	0.0	1.3	-0.1	3.8	4.2	-6.6	-3.8
		cool	24.1	-2.2	-1.6	1.0	0.0	-7.0	19.0	2.2	16.0	-0.2	38.5	23.6	-8.9	80.3
Houston	2.5	heat	12.9	-3.7	-1.0	-1.2	0.0	-1.5	0.0	0.0	1.5	-0.2	3.9	4.0	-7.9	-6.0
		cool	12.3	-0.2	0.4	1.8	0.0	-13.1	19.5	2.3	17.1	-0.3	42.1	21.2	0.3	91.3
Fast Foods Restaurant Old																
Minneapolis	2.5	heat	38.2	-28.1	-14.3	-12.2	0.0	-12.4	6.2	0.7	8.6	-1.1	21.6	17.7	-52.9	-66.1
		cool	32.6	-2.2	-2.7	-0.2	0.0	-8.3	12.7	1.5	10.0	-0.2	24.5	20.1	-6.6	48.5
Chicago	2.5	heat	203.3	-22.3	-9.8	-8.7	0.0	-8.3	4.0	0.5	6.7	-1.1	17.1	16.0	-39.6	-45.4
		cool	178.7	-2.1	-3.1	-0.2	0.0	-8.2	14.7	1.7	11.6	-0.3	28.3	21.6	-6.9	57.2
Washington	2.5	heat	144.2	-16.0	-5.1	-5.5	0.0	-4.6	1.4	0.2	4.5	-0.6	11.6	12.4	-26.6	-28.2
		cool	128.1	-1.6	-3.4	0.0	0.0	-7.7	17.5	2.1	13.8	-0.3	33.7	23.4	-6.5	71.1
Los Angeles	2.5	heat	102.2	-4.5	-0.5	-1.3	0.0	-0.9	0.0	0.0	1.0	-0.1	3.2	5.0	-5.6	-3.6
		cool	97.5	-4.1	-2.1	1.1	0.0	-7.2	19.0	2.2	16.4	-0.2	39.3	37.5	-10.4	91.5
Houston	2.5	heat	99.2	-5.0	-0.9	-1.4	0.0	-1.4	0.1	0.0	1.3	-0.2	3.6	4.9	-7.1	-6.1
		cool	90.8	-0.7	0.1	2.2	0.0	-13.1	19.4	2.3	17.2	-0.3	42.2	32.9	-0.2	102.0
Sit-down Restaurant New																
Minneapolis	5.2	heat	2.4	-7.8	-12.4	-11.8	0.0	-9.2	6.2	1.6	9.3	-2.1	28.2	4.9	-60.3	-53.4
		cool	1.7	-0.8	-0.2	0.9	0.0	-4.6	8.8	2.3	8.2	-0.3	20.6	5.6	-7.3	33.2
Chicago	5.2	heat	35.4	-6.1	-9.3	-9.0	0.0	-6.6	4.8	1.3	7.8	-1.7	24.3	4.4	-45.7	-35.8
		cool	32.4	-0.8	-0.2	1.0	0.0	-4.4	10.0	2.7	9.6	-0.3	23.9	6.1	-7.7	39.8
Washington	5.2	heat	19.6	-4.4	-6.2	-6.5	0.0	-4.1	2.8	0.7	6.0	-1.3	20.0	3.4	-31.1	-20.7
		cool	23.6	-0.6	0.3	1.8	0.0	-3.9	11.9	3.1	11.0	-0.3	27.0	6.4	-6.4	50.5
Los Angeles	5.2	heat	21.5	-0.7	-0.7	-1.1	0.0	-0.5	0.1	0.0	0.8	-0.3	3.6	0.7	-3.4	-1.5
		cool	24.1	-1.5	0.1	2.4	0.0	-4.2	14.1	3.7	14.4	-0.4	34.9	10.5	-13.5	60.5
Houston	5.2	heat	12.9	-1.1	-1.3	-1.6	0.0	-1.0	0.4	0.1	1.4	-0.4	5.7	1.1	-6.7	-3.4
		cool	12.3	-0.3	1.6	2.9	0.0	-8.1	14.5	3.8	15.2	-0.3	39.4	9.0	-0.7	77.0
Sit-down Restaurant Old																
Minneapolis	5.2	heat	38.2	-10.3	-14.9	-13.6	0.0	-9.3	6.5	1.7	9.5	-2.1	28.4	6.5	-60.7	-58.4
		cool	32.6	-1.0	-0.2	1.1	0.0	-4.5	8.4	2.2	8.0	-0.3	20.2	7.5	-6.7	34.9
Chicago	5.2	heat	203.3	-8.2	-11.2	-10.4	0.0	-6.7	5.1	1.3	8.0	-1.7	24.6	5.8	-46.2	-39.4
		cool	178.7	-1.0	-0.1	1.3	0.0	-4.3	9.7	2.5	9.3	-0.3	23.3	8.1	-7.0	41.7
Washington	5.2	heat	144.2	-5.9	-7.6	-7.5	0.0	-4.2	3.1	0.8	6.2	-1.3	20.4	4.6	-31.7	-23.0
		cool	128.1	-0.7	0.5	2.2	0.0	-3.8	11.6	3.0	10.7	-0.3	26.6	8.6	-5.7	52.7
Los Angeles	5.2	heat	102.2	-1.0	-0.9	-1.4	0.0	-0.6	0.2	0.1	0.9	-0.4	4.0	1.0	-3.7	-1.8
		cool	97.5	-1.8	0.4	3.0	0.0	-4.0	13.8	3.6	14.0	-0.3	34.0	13.9	-12.8	63.8
Houston	5.2	heat	99.2	-1.5	-1.6	-1.9	0.0	-1.0	0.4	0.1	1.5	-0.4	5.7	1.4	-6.7	-4.0
		cool	90.8	-0.4	2.0	3.5	0.0	-8.0	14.3	3.8	15.1	-0.3	39.1	12.1	-0.4	80.6

Table 22. Component Loads for Hospital and School Prototypes

Location	Proto. size 10^3 ft^2	HVAC mode	Total area 10^6 ft^2	Component Loads (kBtu/ft^2) Wndw	Wall	Roof	Floor	Grnd	Eqp	Src	Peop	Infl	Light	Solar	Outd. Air	Net
Hospital New																
Minneapolis	162.3	heat	0.0	-5.0	-2.9	-0.4	0.0	0.0	1.5	0.0	1.5	0.0	3.5	1.8	-6.9	-6.9
		cool	0.0	-5.7	-4.2	-1.0	0.0	0.0	55.7	0.0	8.4	0.0	47.3	12.1	-18.2	94.4
Chicago	162.3	heat	85.7	-3.6	-2.0	-0.3	0.0	0.0	1.2	0.0	1.1	0.0	2.8	1.5	-5.0	-4.3
		cool	84.4	-5.5	-3.5	-0.8	0.0	0.0	57.4	0.0	9.0	0.0	49.7	12.9	-16.2	103.1
Washington	162.3	heat	42.7	-1.4	-0.8	-0.1	0.0	0.0	0.5	0.0	0.5	0.0	1.0	0.5	-1.9	-1.7
		cool	42.4	-4.7	-2.5	-0.5	0.0	0.0	60.5	0.0	9.9	0.0	53.8	13.8	-13.8	116.6
Los Angeles	162.3	heat	43.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		cool	34.5	-6.8	-1.5	-0.1	0.0	0.0	68.5	0.0	12.3	0.0	63.0	22.2	-14.8	142.8
Houston	162.3	heat	8.6	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	-0.2	-0.1
		cool	8.6	-2.9	-0.1	0.1	0.0	0.0	63.6	0.0	11.3	0.0	58.3	16.4	-6.4	140.3
Hospital Old																
Minneapolis	68.4	heat	71.1	-8.3	-6.2	-1.0	0.0	0.0	2.8	0.0	2.4	0.0	8.0	3.2	-12.5	-11.4
		cool	46.6	-3.8	-3.5	-1.1	0.0	0.0	45.4	0.0	6.5	0.0	36.9	10.7	-11.7	79.3
Chicago	68.4	heat	324.4	-5.6	-3.8	-0.7	0.0	0.0	1.5	0.0	1.8	0.0	4.4	2.6	-7.2	-7.0
		cool	285.7	-4.3	-3.6	-0.9	0.0	0.0	48.1	0.0	7.3	0.0	41.1	11.9	-12.3	87.3
Washington	68.4	heat	199.9	-2.9	-1.9	-0.3	0.0	0.0	1.0	0.0	1.1	0.0	2.5	1.2	-3.8	-3.2
		cool	152.1	-4.1	-2.7	-0.6	0.0	0.0	50.9	0.0	8.2	0.0	44.8	12.9	-10.7	98.7
Los Angeles	68.4	heat	390.4	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1
		cool	389.3	-5.8	-1.6	-0.1	0.0	0.0	56.2	0.0	10.1	0.0	52.5	20.7	-11.7	120.4
Houston	68.4	heat	117.6	-0.3	-0.2	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.2	0.1	-0.4	-0.3
		cool	123.9	-2.4	0.1	0.2	0.0	0.0	54.3	0.0	9.6	0.0	50.3	15.8	-4.8	123.1
School New																
Minneapolis	26.0	heat	102.6	-9.0	-13.6	-5.7	0.0	-4.3	1.6	0.1	3.0	-18.1	8.9	5.1	-11.6	-43.6
		cool	85.7	-0.6	-0.1	0.2	0.0	-0.8	1.0	0.3	0.8	-1.1	3.1	2.8	-0.4	5.2
Chicago	26.0	heat	228.4	-7.2	-10.4	-4.3	0.0	-3.3	1.4	0.1	2.7	-14.5	7.9	4.8	-8.8	-31.8
		cool	185.2	-0.7	0.0	0.3	0.0	-0.9	1.1	0.4	1.0	-1.1	3.7	3.1	-0.5	6.3
Washington	23.3	heat	172.2	-5.5	-7.7	-3.2	0.0	-2.4	1.2	0.1	2.2	-10.7	6.7	4.5	-6.4	-21.2
		cool	169.4	-0.8	0.2	0.6	0.0	-1.1	1.4	0.4	1.4	-1.5	4.9	4.0	-0.5	8.9
Los Angeles	16.0	heat	206.8	-2.6	-1.9	-1.0	0.0	-1.6	0.5	0.0	0.8	-5.1	2.5	3.9	-1.3	-5.7
		cool	206.4	-0.8	0.1	0.8	0.0	-0.8	1.4	0.4	1.8	-0.7	5.7	4.0	-1.2	10.7
Houston	16.0	heat	189.8	-2.3	-2.5	-1.0	0.0	-2.0	0.5	0.0	0.9	-4.2	2.5	3.1	-1.6	-6.5
		cool	188.5	-0.8	1.0	0.9	0.0	-3.6	2.0	0.5	2.5	-1.0	8.2	6.5	-0.2	15.9
School Old																
Minneapolis	47.0	heat	486.4	-10.4	-15.1	-6.3	0.0	-4.6	1.6	0.1	3.0	-18.1	9.0	6.1	-11.7	-46.3
		cool	226.9	-0.8	-0.1	0.3	0.0	-1.0	1.0	0.3	0.8	-1.2	3.1	3.6	-0.4	5.7
Chicago	47.0	heat	2352.1	-8.4	-11.6	-4.8	0.0	-3.5	1.5	0.1	2.7	-14.5	8.0	5.6	-8.9	-33.8
		cool	1034.1	-0.9	-0.1	0.3	0.0	-1.0	1.1	0.4	1.0	-1.3	3.7	4.1	-0.5	6.9
Washington	37.7	heat	1828.2	-6.9	-8.7	-3.7	0.0	-2.4	1.2	0.1	2.3	-10.7	6.8	5.5	-6.5	-23.1
		cool	964.1	-1.2	0.2	0.7	0.0	-1.4	1.4	0.4	1.3	-1.6	4.9	5.6	-0.5	9.9
Los Angeles	22.0	heat	1582.7	-3.2	-2.2	-1.3	0.0	-1.3	0.5	0.0	0.8	-5.1	2.5	4.4	-1.4	-6.2
		cool	1511.6	-1.3	0.1	1.0	0.0	-0.8	1.4	0.4	1.8	-0.8	5.8	5.8	-1.2	12.2
Houston	22.0	heat	1116.0	-3.0	-2.9	-1.2	0.0	-1.7	0.5	0.0	0.9	-4.2	2.6	3.7	-1.7	-7.0
		cool	1048.5	-1.2	1.0	1.1	0.0	-3.5	2.0	0.5	2.5	-1.3	8.3	8.9	-0.2	18.2

Table 23. Component Loads for Supermarket and Warehouse Prototypes

Location	Proto. size 10^3 ft^2	HVAC mode	Total area 10^6 ft^2	Component Loads (kBtu/ft^2) Wndw	Wall	Roof	Floor	Grnd	Eqp	Src	Peop	Infl	Light	Solar	Outd. Air	Net
Supermarket New																
Minneapolis	21.3	heat	3.4	-6.3	-8.7	-6.7	0.0	-3.4	3.2	0.0	4.6	-3.2	22.7	3.1	-25.1	-19.9
		cool	3.4	-1.1	-2.0	-0.8	0.0	-5.4	14.5	0.0	6.3	-0.7	28.6	6.6	-4.8	41.2
Chicago	21.3	heat	60.9	-4.4	-5.3	-4.0	0.0	-1.7	1.9	0.0	3.3	-2.1	16.0	2.4	-17.0	-11.1
		cool	60.9	-1.3	-2.2	-0.8	0.0	-5.3	15.7	0.0	7.4	-0.8	33.5	7.3	-5.2	48.3
Washington	21.3	heat	57.8	-2.0	-2.1	-1.7	0.0	-0.6	0.7	0.0	1.5	-1.1	7.9	1.0	-8.0	-4.3
		cool	53.4	-1.0	-1.7	-0.3	0.0	-4.7	16.6	0.0	8.3	-0.7	37.6	7.8	-4.0	57.9
Los Angeles	21.3	heat	35.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		cool	37.7	-3.4	-3.0	-1.1	0.0	-5.4	19.4	0.0	12.4	-1.6	54.9	13.6	-12.7	73.1
Houston	21.3	heat	30.2	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0	0.1	-0.1	0.4	0.0	-0.4	-0.2
		cool	26.2	-1.3	-0.5	0.6	0.0	-7.8	19.2	0.0	12.0	-0.9	54.1	10.8	-4.0	82.2
Supermarket Old																
Minneapolis	21.3	heat	62.4	-7.0	-12.9	-8.7	0.0	-3.7	3.8	0.0	5.1	-3.3	24.9	3.5	-26.7	-25.1
		cool	63.9	-1.1	-2.3	-0.6	0.0	-5.1	13.9	0.0	6.1	-0.7	27.6	6.7	-4.4	40.1
Chicago	21.3	heat	104.3	-5.0	-8.8	-6.0	0.0	-2.3	2.7	0.0	3.9	-2.4	19.2	2.8	-18.7	-14.5
		cool	94.0	-1.2	-2.2	-0.4	0.0	-4.8	15.1	0.0	7.0	-0.7	31.6	7.3	-4.5	47.2
Washington	21.3	heat	100.8	-2.6	-3.6	-2.6	0.0	-0.8	1.0	0.0	2.1	-1.3	10.2	1.4	-9.9	-6.2
		cool	89.2	-1.0	-2.1	-0.1	0.0	-4.5	16.4	0.0	8.1	-0.8	36.8	7.9	-3.6	57.1
Los Angeles	21.3	heat	85.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
		cool	86.8	-3.3	-3.7	-0.9	0.0	-5.2	19.1	0.0	12.1	-1.3	53.3	13.8	-11.8	72.1
Houston	21.3	heat	134.1	-0.2	-0.2	-0.2	0.0	0.0	0.0	0.0	0.1	-0.1	0.7	0.1	-0.7	-0.4
		cool	119.6	-1.1	-0.3	1.1	0.0	-7.5	18.9	0.0	11.7	-0.8	52.7	11.0	-3.2	82.5
Warehouse New																
Minneapolis	15.9	heat	168.3	-0.8	-2.1	-2.7	-0.6	-10.6	1.6	0.0	0.3	-1.0	3.5	0.8	-0.9	-12.6
		cool	88.4	0.0	0.1	0.3	-0.1	-0.9	0.3	0.0	0.1	0.0	1.0	0.2	0.0	0.9
Chicago	15.9	heat	329.6	-0.6	-1.6	-2.1	-0.5	-7.6	1.4	0.0	0.3	-0.8	3.1	0.7	-0.7	-8.5
		cool	90.4	0.0	0.1	0.4	-0.1	-1.2	0.4	0.0	0.1	0.0	1.4	0.4	0.0	1.5
Washington	14.2	heat	693.1	-0.5	-1.3	-1.5	-0.4	-5.0	1.2	0.0	0.2	-0.6	2.7	0.6	-0.5	-5.2
		cool	277.6	0.0	0.3	0.6	-0.3	-1.6	0.8	0.0	0.2	0.0	2.1	0.6	0.0	2.8
Los Angeles	13.6	heat	588.2	-0.2	-0.3	-0.5	-0.2	-1.5	0.5	0.0	0.1	-0.2	1.0	0.3	-0.1	-1.1
		cool	193.2	0.0	0.2	0.8	-0.2	-1.4	0.7	0.0	0.2	0.0	2.4	0.8	0.0	3.5
Houston	13.6	heat	306.8	-0.2	-0.4	-0.5	-0.3	-3.0	0.8	0.0	0.1	-0.3	1.6	0.4	-0.2	-1.9
		cool	232.1	0.1	0.3	0.7	-0.2	-2.2	0.6	0.0	0.2	0.0	2.0	0.5	0.1	2.1
Warehouse Old																
Minneapolis	15.9	heat	769.3	-1.8	-2.5	-3.4	-0.5	-10.4	1.6	0.0	0.2	-1.0	3.4	1.6	-0.7	-13.5
		cool	233.8	0.0	0.1	0.4	-0.1	-1.2	0.3	0.0	0.1	0.0	1.1	0.6	0.0	1.4
Chicago	15.9	heat	2465.1	-1.4	-1.9	-2.6	-0.5	-7.4	1.4	0.0	0.2	-0.8	3.0	1.3	-0.5	-9.2
		cool	476.0	0.0	0.2	0.6	-0.2	-1.5	0.5	0.0	0.1	0.0	1.5	0.9	0.0	2.1
Washington	15.5	heat	1481.1	-1.0	-1.4	-1.9	-0.4	-4.7	1.2	0.0	0.2	-0.6	2.5	1.1	-0.4	-5.6
		cool	540.6	0.0	0.3	0.9	-0.3	-1.9	0.8	0.0	0.1	0.0	2.2	1.2	0.0	3.4
Los Angeles	13.6	heat	771.7	-0.3	-0.4	-0.7	-0.2	-1.3	0.5	0.0	0.1	-0.2	0.9	0.5	-0.1	-1.2
		cool	377.7	-0.1	0.3	1.3	-0.3	-1.6	0.8	0.0	0.2	0.0	2.4	1.8	0.0	4.8
Houston	13.6	heat	696.8	-0.4	-0.5	-0.7	-0.3	-2.7	0.7	0.0	0.1	-0.2	1.4	0.7	-0.1	-2.0
		cool	547.7	0.2	0.6	1.3	-0.3	-3.2	0.8	0.0	0.2	0.1	2.4	1.4	0.1	3.4

Table 24. Aggregate Component Loads for Commercial Buildings

Location	HVAC mode	Total area 10^6 ft^2	Component Loads (kBtu/ft^2) Wndw	Wall	Roof	Floor	Grnd	Eqp	Src	Peop	Infl	Light	Solar	Outd. Air	Net
Large Office	heat	7622.1	-36.6	-16.4	-3.3	-0.8	0.0	5.7	0.0	0.8	-5.0	15.6	15.9	-3.5	-27.6
	cool	7135.7	-41.7	-5.3	-0.6	-4.1	0.0	54.5	0.0	9.2	-12.0	135.7	145.5	-8.8	272.2
Small Office	heat	3657.4	-20.4	-22.6	-8.5	-3.1	0.0	4.8	0.0	1.0	-11.7	19.9	12.5	-3.9	-32.2
	cool	3450.6	-9.0	2.0	2.3	-5.2	0.0	11.0	0.0	2.8	-5.7	43.9	53.3	-0.4	95.0
Large Retail	heat	5296.7	-7.6	-7.8	-8.3	-2.2	0.0	4.6	0.0	1.7	-13.7	21.7	3.3	-4.8	-13.2
	cool	4115.5	-5.4	-1.5	0.3	-6.7	0.0	20.0	0.0	9.2	-7.5	87.6	24.1	-3.3	116.9
Small Retail	heat	5749.0	-39.1	-33.7	-28.2	-8.7	0.0	7.3	0.0	5.6	-26.3	40.0	16.8	-15.9	-82.2
	cool	3729.6	-7.8	-0.1	3.4	-8.8	0.0	11.1	0.0	11.1	-6.0	54.6	47.5	-0.9	104.3
Large Hotel	heat	1326.6	-4.2	-2.3	-0.6	0.0	0.0	1.2	0.0	0.8	-1.4	1.8	1.9	-2.2	-4.8
	cool	1069.8	-3.7	0.0	0.2	-2.1	0.0	5.9	0.4	4.3	-1.4	19.7	19.6	-3.3	39.7
Small Hotel	heat	711.5	-3.3	-3.3	-1.0	0.0	-1.0	0.8	0.0	1.4	-2.9	1.5	2.3	0.0	-5.5
	cool	698.8	-2.9	-0.2	0.2	0.0	-3.1	2.6	0.1	3.8	-1.2	4.7	14.2	0.0	18.1
Fast-Foods Restaurant	heat	678.9	-9.8	-3.9	-3.7	0.0	-3.5	1.4	0.2	2.9	-0.4	7.6	7.5	-17.5	-19.1
	cool	621.8	-1.2	-1.5	0.3	0.0	-5.4	10.6	1.2	8.7	-0.2	21.1	15.8	-3.9	45.4
Sit-down Restaurant	heat	678.9	-3.5	-4.7	-4.6	0.0	-2.8	2.0	0.5	3.6	-0.8	11.5	2.6	-19.9	-16.0
	cool	621.8	-0.6	0.3	1.3	0.0	-3.0	7.3	1.9	7.1	-0.2	17.9	6.0	-4.2	33.8
Hospital	heat	1283.9	-3.4	-2.3	-0.4	0.0	0.0	1.0	0.0	1.1	0.0	2.8	1.5	-4.6	-4.2
	cool	1167.5	-5.5	-2.7	-0.5	0.0	0.0	62.5	0.0	10.5	0.0	56.1	18.5	-13.4	125.6
School	heat	8265.2	-50.3	-63.2	-27.0	0.0	-21.1	8.7	0.5	15.9	-84.1	47.3	41.1	-47.5	-179.7
	cool	5620.4	-6.1	1.5	4.2	0.0	-8.8	8.1	2.3	9.1	-6.6	31.2	32.1	-3.6	63.8
Supermarket	heat	674.5	-1.7	-2.6	-1.8	0.0	-0.7	0.8	0.0	1.3	-0.8	6.2	0.9	-6.3	-4.8
	cool	635.1	-1.0	-1.3	-0.1	0.0	-3.5	10.8	0.0	5.9	-0.6	26.6	6.0	-3.6	39.3
Warehouse	heat	8270.0	-7.7	-11.4	-15.5	-3.3	-45.6	9.4	0.0	1.5	-5.0	19.9	8.0	-3.4	-53.4
	cool	3057.5	0.1	0.9	2.6	-0.7	-5.8	2.0	0.0	0.5	0.1	6.1	3.2	0.1	9.0
Total Commercial	heat	44214.7	-187.6	-174.2	-103.0	-18.2	-74.8	47.7	1.3	37.5	-152.1	196.0	114.2	-129.4	-442.7
	cool	31924.1	-84.8	-7.7	13.6	-27.6	-29.5	206.6	5.9	82.2	-41.3	505.2	385.8	-45.3	963.0

Table 25. System and Plant Factors for Office Prototypes

A. Location	B. HVAC mode	C. Bldg Load (kBtu/ft²)	D. System Factor	E. System Load (kBtu/ft²)	F. Plant Factors Gas	F. Plant Factors Elec	F. Plant Factors Net†	G. Plant Consumption (kBtu/ft²) HVAC* Gas	G. HVAC* Elec	G. Aux* Elec	H. Overall Source Efficiency†
Large Office New											
Minneapolis	heat	9.4	0.47	19.9	0.65	1.00	0.45	28.9	1.1	4.2	0.21
	cool	25.3	1.11	22.7	0.65	4.36	0.77	0.6	5.1	4.5	0.86
Chicago	heat	6.2	0.41	15.0	0.66	1.00	0.44	21.7	0.8	3.4	0.18
	cool	28.0	1.06	26.4	0.66	4.30	0.77	1.0	6.0	5.2	0.82
Washington	heat	3.2	0.28	11.2	0.65	1.00	0.43	16.2	0.6	2.7	0.12
	cool	32.1	0.94	34.2	0.65	4.34	0.80	1.5	7.6	6.3	0.75
Los Angeles	heat	0.1	0.03	3.1	0.61	1.00	0.31	4.7	0.2	1.6	0.01
	cool	45.0	0.99	45.5	0.61	4.30	0.76	2.7	10.2	9.2	0.75
Houston	heat	0.4	0.13	3.0	0.63	1.00	0.33	4.5	0.2	1.4	0.04
	cool	44.5	0.80	55.4	0.63	4.45	0.87	1.6	12.2	8.7	0.70
Large Office Old											
Minneapolis	heat	10.6	0.54	19.5	0.63	1.00	0.44	29.0	1.2	4.0	0.24
	cool	30.4	0.32	95.7	0.63	4.82	0.88	25.8	16.2	14.0	0.28
Chicago	heat	7.0	0.44	15.9	0.63	1.00	0.43	23.7	1.0	3.5	0.19
	cool	33.5	0.36	92.2	0.63	4.84	0.88	20.9	16.1	13.7	0.32
Washington	heat	3.5	0.28	12.7	0.65	1.00	0.43	18.5	0.7	3.1	0.12
	cool	37.1	0.40	93.6	0.65	4.85	0.89	18.0	16.8	13.9	0.35
Los Angeles	heat	0.1	0.01	7.5	0.63	1.00	0.38	11.1	0.4	2.4	0.01
	cool	47.4	0.50	94.9	0.63	4.95	0.89	11.2	17.7	15.4	0.44
Houston	heat	0.5	0.08	6.0	0.63	1.00	0.36	8.9	0.4	2.1	0.03
	cool	47.6	0.53	90.0	0.63	4.77	0.89	9.4	17.5	14.1	0.47
Small Office New											
Minneapolis	heat	23.4	1.15	20.4	0.60	0.00	0.47	33.7	0.0	3.1	0.55
	cool	14.0	0.99	14.1	-	3.75	0.80	0.0	3.8	2.1	0.79
Chicago	heat	15.7	1.18	13.3	0.56	0.00	0.43	23.8	0.0	2.3	0.51
	cool	16.5	0.98	16.8	-	3.71	0.76	0.0	4.5	2.9	0.74
Washington	heat	12.6	1.20	10.5	0.58	0.00	0.45	18.3	0.0	1.7	0.54
	cool	17.2	0.91	19.0	-	3.68	0.77	0.0	5.2	3.1	0.70
Los Angeles	heat	0.8	1.81	0.5	0.16	0.00	0.14	2.9	0.0	0.1	0.26
	cool	19.7	1.03	19.1	-	3.68	0.64	0.0	5.2	4.7	0.66
Houston	heat	2.6	1.39	1.9	0.37	0.00	0.31	5.0	0.0	0.3	0.44
	cool	24.4	0.86	28.3	-	3.51	0.76	0.0	8.1	4.4	0.65
Small Office Old											
Minneapolis	heat	25.0	1.17	21.4	0.59	0.00	0.46	36.4	0.0	3.4	0.54
	cool	20.0	0.85	23.6	-	3.14	0.70	0.0	7.5	3.7	0.59
Chicago	heat	16.4	1.21	13.5	0.54	0.00	0.42	25.2	0.0	2.3	0.51
	cool	23.3	0.85	27.3	-	3.11	0.68	0.0	8.8	4.7	0.58
Washington	heat	10.2	1.29	7.9	0.47	0.00	0.37	17.0	0.0	1.4	0.48
	cool	27.4	0.85	32.4	-	3.09	0.67	0.0	10.5	5.7	0.56
Los Angeles	heat	0.5	2.04	0.2	0.04	0.00	0.04	5.2	0.0	0.0	0.09
	cool	36.8	0.85	43.5	-	3.13	0.67	0.0	13.9	7.7	0.57
Houston	heat	1.6	1.54	1.1	0.16	0.00	0.15	6.6	0.0	0.2	0.23
	cool	40.6	0.84	48.4	-	2.99	0.69	0.0	16.2	7.1	0.58

* HVAC Gas includes boilers and furnaces, HVAC Elec resistance heating, chiller and cooling towers, Aux. Elec fans and pumps.
† Net Plant Factor and Overall Source Efficiency have a multiplier of 3 to convert site electricity to source energy use.

Table 26. System and Plant Factors for Retail Prototypes

A. Location	B. HVAC mode	C. Bldg Load (kBtu/ft^2)	D. System Factor	E. System Load (kBtu/ft^2)	F Plant Factors Gas	F Plant Factors Elec	F Plant Factors Net†	G. Plant Consumption (kBtu/ft^2) HVAC* Gas	G. HVAC* Elec	G. Aux* Elec	H. Overall Source Efficiency†
Large Retail New											
Minneapolis	heat	6.5	0.46	14.1	0.67	1.00	0.45	20.2	0.7	3.1	0.20
	cool	19.4	0.94	20.7	0.67	4.27	0.77	0.2	4.8	4.1	0.72
Chicago	heat	3.3	0.33	10.0	0.65	1.00	0.42	14.6	0.6	2.5	0.14
	cool	22.8	0.94	24.4	0.65	4.22	0.75	0.4	5.7	5.0	0.70
Washington	heat	1.1	0.17	6.4	0.62	1.00	0.39	9.7	0.4	1.9	0.07
	cool	27.1	0.85	31.9	0.62	4.29	0.78	0.7	7.3	6.2	0.66
Los Angeles	heat	0.0	0.00	0.3	0.60	1.00	0.07	0.4	0.0	1.0	0.00
	cool	36.1	1.06	34.0	0.60	3.86	0.70	0.1	8.8	7.3	0.75
Houston	heat	0.0	0.04	0.9	0.63	1.00	0.20	1.4	0.1	1.0	0.01
	cool	39.0	0.78	49.7	0.63	4.37	0.85	0.4	11.3	8.1	0.66
Large Retail Old											
Minneapolis	heat	9.1	0.33	27.2	0.64	1.00	0.47	40.2	1.6	4.2	0.16
	cool	17.7	0.36	49.0	-	4.82	0.98	0.0	10.2	6.5	0.35
Chicago	heat	5.1	0.24	21.2	0.62	1.00	0.45	32.0	1.4	3.6	0.11
	cool	20.9	0.41	50.5	-	4.86	0.96	0.0	10.4	7.0	0.40
Washington	heat	1.7	0.12	15.0	0.63	1.00	0.44	22.5	0.9	3.0	0.05
	cool	25.3	0.48	53.0	-	4.75	0.94	0.0	11.1	7.6	0.45
Los Angeles	heat	0.0	0.00	3.6	0.60	1.00	0.35	5.6	0.3	1.4	0.00
	cool	34.4	0.65	52.7	-	4.91	0.90	0.0	10.7	8.9	0.58
Houston	heat	0.1	0.02	5.1	0.62	1.00	0.37	7.7	0.3	1.7	0.01
	cool	37.3	0.63	59.0	-	4.71	0.92	0.0	12.5	8.8	0.58
Small Retail New											
Minneapolis	heat	29.9	1.09	27.5	0.67	0.00	0.53	41.3	0.0	3.6	0.58
	cool	15.7	0.83	19.0	-	3.12	0.74	0.0	6.1	2.5	0.61
Chicago	heat	19.9	1.14	17.5	0.65	0.00	0.50	27.1	0.0	2.6	0.57
	cool	19.0	0.83	22.8	-	3.08	0.71	0.0	7.4	3.4	0.59
Washington	heat	12.3	1.22	10.1	0.62	0.00	0.49	16.3	0.0	1.5	0.59
	cool	23.6	0.79	29.8	-	3.09	0.71	0.0	9.7	4.3	0.56
Los Angeles	heat	0.5	1.79	0.3	0.18	0.00	0.16	1.6	0.0	0.1	0.29
	cool	30.7	0.93	32.9	-	3.14	0.67	0.0	10.5	5.9	0.63
Houston	heat	2.0	1.44	1.4	0.42	0.00	0.36	3.3	0.0	0.2	0.52
	cool	34.3	0.74	46.2	-	2.95	0.72	0.0	15.7	5.8	0.53
Small Retail Old											
Minneapolis	heat	37.6	1.10	34.2	0.67	0.00	0.53	51.3	0.0	4.5	0.58
	cool	17.5	0.74	23.7	-	3.11	0.74	0.0	7.6	3.1	0.54
Chicago	heat	24.9	1.14	21.8	0.65	0.00	0.50	33.6	0.0	3.2	0.58
	cool	21.2	0.75	28.2	-	3.07	0.71	0.0	9.2	4.1	0.53
Washington	heat	14.0	1.23	11.4	0.61	0.00	0.48	18.6	0.0	1.7	0.59
	cool	27.1	0.75	35.9	-	3.08	0.71	0.0	11.7	5.2	0.53
Los Angeles	heat	0.5	1.78	0.3	0.15	0.00	0.14	1.8	0.0	0.0	0.25
	cool	36.3	0.79	46.1	-	3.16	0.72	0.0	14.6	6.8	0.57
Houston	heat	2.0	1.45	1.4	0.39	0.00	0.34	3.5	0.0	0.2	0.50
	cool	40.1	0.72	55.5	-	2.96	0.72	0.0	18.8	6.8	0.52

* HVAC Gas includes boilers and furnaces, HVAC Elec resistance heating, chiller and cooling towers, Aux. Elec fans and pumps.

† Net Plant Factor and Overall Source Efficiency have a multiplier of 3 to convert site electricity to source energy use.

Table 27. System and Plant Factors for Hotel Prototypes

A. Location	B. HVAC mode	C. Bldg Load ($kBtu/ft^2$)	D. System Factor	E. System Load ($kBtu/ft^2$)	F Plant Factors Gas	F Plant Factors Elec	F Plant Factors Net†	G. Plant Consumption ($kBtu/ft^2$) HVAC* Gas	G. HVAC* Elec	G. Aux* Elec	H. Overall Source Efficiency†
Large Hotel New											
Minneapolis	heat	11.1	0.75	14.8	0.63	1.00	0.49	22.1	0.9	1.8	0.37
	cool	21.4	0.89	24.0	-	3.50	0.93	0.0	6.8	1.7	0.83
Chicago	heat	6.9	0.73	9.4	0.62	1.00	0.45	14.2	0.6	1.7	0.33
	cool	24.6	0.89	27.6	-	3.45	0.93	0.0	8.0	1.9	0.82
Washington	heat	3.7	0.78	4.7	0.62	1.00	0.36	7.1	0.3	1.6	0.28
	cool	28.8	0.82	35.0	-	3.47	0.94	0.1	10.1	2.2	0.77
Los Angeles	heat	0.1	0.48	0.1	0.60	1.00	0.03	0.2	0.0	1.4	0.01
	cool	40.6	1.05	38.6	-	3.60	0.95	0.0	10.7	2.8	1.00
Houston	heat	0.4	0.80	0.5	0.62	1.00	0.08	0.7	0.0	1.8	0.06
	cool	43.8	0.76	57.3	-	3.71	1.05	0.0	15.5	2.7	0.81
Large Hotel Old											
Minneapolis	heat	14.0	0.71	19.9	0.63	1.00	0.50	29.5	1.2	2.1	0.35
	cool	20.1	0.84	24.1	0.63	3.44	0.91	0.1	7.0	1.9	0.76
Chicago	heat	9.0	0.71	12.8	0.62	1.00	0.47	19.2	0.8	1.9	0.33
	cool	23.3	0.83	27.9	0.62	3.40	0.90	0.1	8.2	2.1	0.75
Washington	heat	4.9	0.81	6.1	0.62	1.00	0.39	9.2	0.4	1.8	0.31
	cool	27.6	0.78	35.5	0.62	3.39	0.92	0.1	10.4	2.4	0.71
Los Angeles	heat	0.1	0.62	0.2	0.60	1.00	0.05	0.3	0.0	1.4	0.03
	cool	38.7	0.94	41.0	0.60	3.53	0.95	0.0	11.6	2.7	0.90
Houston	heat	0.6	0.89	0.7	0.63	1.00	0.10	1.0	0.0	1.9	0.09
	cool	42.5	0.74	57.8	0.63	3.62	1.03	0.0	16.0	2.7	0.76
Small Hotel New											
Minneapolis	heat	24.1	0.64	37.8	0.64	1.00	0.58	56.6	1.9	0.9	0.37
	cool	12.3	0.63	19.7	-	2.31	0.70	0.0	8.5	0.9	0.44
Chicago	heat	15.2	0.59	25.6	0.63	1.00	0.57	38.6	1.3	0.7	0.34
	cool	15.1	0.64	23.4	-	2.27	0.69	0.0	10.3	0.9	0.45
Washington	heat	7.5	0.52	14.3	0.60	1.00	0.55	22.5	0.8	0.4	0.29
	cool	19.0	0.58	32.6	-	2.31	0.71	0.0	14.1	1.2	0.41
Los Angeles	heat	0.1	0.08	1.0	0.06	0.00	0.06	15.7	0.0	0.0	0.01
	cool	26.3	0.81	32.2	-	2.18	0.66	0.0	14.8	1.4	0.54
Houston	heat	0.6	0.27	2.2	0.12	0.00	0.12	17.4	0.0	0.1	0.03
	cool	28.4	0.53	53.9	-	2.31	0.73	0.0	23.4	1.3	0.38
Small Hotel Old											
Minneapolis	heat	27.6	0.82	33.5	0.65	1.00	0.59	49.5	1.5	1.1	0.48
	cool	14.6	9.70	1.5	-	3.05	0.58	0.0	0.5	0.4	5.63
Chicago	heat	17.7	0.79	22.3	0.63	1.00	0.57	33.5	1.0	0.9	0.45
	cool	17.5	9.39	1.9	-	3.05	0.68	0.0	0.6	0.3	6.41
Washington	heat	9.2	0.75	12.2	0.61	1.00	0.53	19.0	0.6	0.8	0.40
	cool	21.8	8.24	2.6	-	3.04	0.75	0.0	0.9	0.3	6.21
Los Angeles	heat	0.1	0.21	0.7	0.02	0.00	0.02	33.7	0.0	0.2	0.00
	cool	30.3	12.07	2.5	-	3.07	0.59	0.0	0.8	0.6	7.08
Houston	heat	0.9	0.53	1.6	0.05	0.00	0.05	34.9	0.0	0.2	0.02
	cool	33.2	7.74	4.3	-	2.95	0.70	0.0	1.5	0.6	5.41

* HVAC Gas includes boilers and furnaces, HVAC Elec resistance heating, chiller and cooling towers, Aux. Elec fans and pumps.

† Net Plant Factor and Overall Source Efficiency have a multiplier of 3 to convert site electricity to source energy use.

Table 28. System and Plant Factors for Restaurant Prototypes

A.	B.	C.	D.	E.	F			G.			H.
								Plant Consumption ($kBtu/ft^2$)			
Location	HVAC mode	Bldg Load ($kBtu/ft^2$)	System Factor	System Load ($kBtu/ft^2$)	Plant Factors Gas	Plant Factors Elec	Plant Factors Net†	HVAC* Gas	HVAC* Elec	Aux* Elec	Overall Source Efficiency†
Fast Foods Restaurant New											
Minneapolis	heat	60.8	0.29	210.2	0.64	0.00	0.56	326.8	0.0	16.0	0.16
	cool	43.3	0.72	60.2	-	3.66	0.96	0.0	16.4	4.6	0.69
Chicago	heat	42.2	0.28	148.4	0.63	0.00	0.54	234.2	0.0	13.8	0.15
	cool	51.6	0.73	71.1	-	3.60	0.90	0.0	19.8	6.6	0.65
Washington	heat	26.7	0.29	91.7	0.62	0.00	0.52	147.1	0.0	9.6	0.15
	cool	64.8	0.65	100.2	-	3.64	0.88	0.0	27.6	10.5	0.57
Los Angeles	heat	3.8	0.18	20.9	0.52	0.00	0.39	40.3	0.0	4.2	0.07
	cool	80.3	1.02	78.8	-	3.59	0.70	0.0	22.0	15.8	0.71
Houston	heat	6.0	0.26	22.7	0.54	0.00	0.47	42.1	0.0	2.1	0.12
	cool	91.3	0.48	191.0	-	3.63	0.91	0.0	52.6	17.6	0.43
Fast Foods Restaurant Old											
Minneapolis	heat	66.1	0.30	217.2	0.64	0.00	0.56	337.7	0.0	17.7	0.17
	cool	48.5	0.69	70.0	-	3.05	0.82	0.0	22.9	5.7	0.57
Chicago	heat	45.4	0.30	153.8	0.63	0.00	0.53	242.6	0.0	15.2	0.16
	cool	57.2	0.70	81.8	-	3.00	0.77	0.0	27.2	8.1	0.54
Washington	heat	28.2	0.30	95.2	0.62	0.00	0.51	153.8	0.0	10.5	0.15
	cool	71.1	0.63	112.0	-	3.03	0.76	0.0	37.0	12.3	0.48
Los Angeles	heat	3.6	0.17	21.1	0.52	0.00	0.40	40.6	0.0	4.0	0.07
	cool	91.5	0.93	98.5	-	3.01	0.64	0.0	32.7	18.8	0.59
Houston	heat	6.1	0.26	23.1	0.54	0.00	0.47	42.8	0.0	2.2	0.12
	cool	102.0	0.49	208.7	-	3.02	0.78	0.0	69.1	19.8	0.38
Sit-down Restaurant New											
Minneapolis	heat	53.4	1.01	52.9	0.62	0.00	0.50	84.6	0.0	6.9	0.51
	cool	33.2	0.66	50.4	-	3.76	0.84	0.0	13.4	6.6	0.55
Chicago	heat	35.8	1.09	33.0	0.60	0.00	0.48	54.6	0.0	4.9	0.52
	cool	39.8	0.67	59.6	-	3.69	0.80	0.0	16.1	8.8	0.53
Washington	heat	20.7	1.23	16.8	0.57	0.00	0.46	29.6	0.0	2.3	0.57
	cool	50.5	0.63	80.7	-	3.71	0.82	0.0	21.7	11.2	0.51
Los Angeles	heat	1.5	1.73	0.8	0.20	0.00	0.18	4.2	0.0	0.1	0.32
	cool	60.5	0.79	76.9	-	3.77	0.77	0.0	20.4	12.9	0.61
Houston	heat	3.4	1.48	2.3	0.35	0.00	0.32	6.6	0.0	0.2	0.48
	cool	77.0	0.56	137.5	-	3.66	0.90	0.0	37.6	13.1	0.51
Sit-down Restaurant Old											
Minneapolis	heat	58.4	1.01	57.7	0.63	0.00	0.51	91.9	0.0	7.3	0.51
	cool	34.9	0.60	58.2	-	3.12	0.74	0.0	18.7	7.4	0.45
Chicago	heat	39.4	1.08	36.5	0.61	0.00	0.48	60.0	0.0	5.2	0.52
	cool	41.7	0.61	68.1	-	3.06	0.71	0.0	22.2	9.7	0.43
Washington	heat	23.0	1.23	18.7	0.57	0.00	0.47	32.7	0.0	2.5	0.57
	cool	52.7	0.59	90.0	-	3.08	0.73	0.0	29.2	12.1	0.43
Los Angeles	heat	1.8	1.79	1.0	0.23	0.00	0.21	4.5	0.0	0.2	0.37
	cool	63.8	0.68	93.6	-	3.13	0.71	0.0	29.9	13.9	0.49
Houston	heat	4.0	1.49	2.7	0.37	0.00	0.34	7.1	0.0	0.3	0.50
	cool	80.6	0.54	149.1	-	3.03	0.78	0.0	49.2	14.2	0.42

* HVAC Gas includes boilers and furnaces, HVAC Elec resistance heating, chiller and cooling towers, Aux. Elec fans and pumps.

† Net Plant Factor and Overall Source Efficiency have a multiplier of 3 to convert site electricity to source energy use.

Table 29. System and Plant Factors for Hospital and School Prototypes

A. Location	B. HVAC mode	C. Bldg Load (kBtu/ft^2)	D. System Factor	E. System Load (kBtu/ft^2)	F Plant Factors Gas	Plant Factors Elec	Plant Factors Net†	G. Plant Consumption (kBtu/ft^2) HVAC* Gas	HVAC* Elec	Aux* Elec	H. Overall Source Efficiency†
Hospital New											
Minneapolis	heat	6.9	0.42	16.4	0.62	1.00	0.40	24.7	1.0	4.3	0.17
	cool	94.4	1.52	62.3	0.62	4.10	0.80	0.1	15.2	10.8	1.21
Chicago	heat	4.3	0.35	12.1	0.62	1.00	0.38	18.3	0.8	3.7	0.13
	cool	103.1	1.43	72.3	0.62	4.08	0.82	0.1	17.7	11.7	1.17
Washington	heat	1.7	0.26	6.6	0.61	1.00	0.31	10.0	0.4	3.2	0.08
	cool	116.6	1.24	93.8	0.61	4.12	0.88	0.0	22.8	12.8	1.09
Los Angeles	heat	0.0	0.01	1.0	0.61	1.00	0.10	1.5	0.1	2.8	0.00
	cool	142.8	1.41	100.9	0.61	3.99	0.86	0.0	25.3	13.9	1.21
Houston	heat	0.1	0.08	1.9	0.62	1.00	0.15	2.9	0.1	3.1	0.01
	cool	140.3	0.95	148.3	0.62	4.33	1.03	0.0	34.2	13.8	0.97
Hospital Old											
Minneapolis	heat	11.4	0.22	51.3	0.66	1.00	0.48	73.9	2.7	8.4	0.11
	cool	79.3	1.20	66.0	0.66	4.25	0.86	5.5	14.6	9.6	1.03
Chicago	heat	7.0	0.17	41.9	0.65	1.00	0.47	60.8	2.2	7.3	0.08
	cool	87.3	1.14	76.9	0.65	4.20	0.86	6.9	17.2	10.9	0.98
Washington	heat	3.2	0.11	30.2	0.66	1.00	0.46	43.5	1.6	5.9	0.05
	cool	98.7	1.01	97.5	0.66	4.23	0.90	7.4	21.9	12.6	0.91
Los Angeles	heat	0.1	0.01	10.5	0.65	1.00	0.37	15.2	0.6	3.9	0.00
	cool	120.4	1.16	104.1	0.65	4.11	0.85	9.5	23.7	14.6	0.99
Houston	heat	0.3	0.03	12.0	0.64	1.00	0.38	17.7	0.7	3.9	0.01
	cool	123.1	0.80	153.0	0.64	4.40	1.00	8.6	33.4	15.0	0.81
School New											
Minneapolis	heat	43.6	0.82	53.1	0.69	0.00	0.52	77.4	0.0	8.1	0.43
	cool	5.2	0.74	7.0	-	2.33	0.57	0.0	3.0	1.1	0.42
Chicago	heat	31.8	0.84	37.9	0.68	0.00	0.51	55.8	0.0	6.0	0.43
	cool	6.3	0.77	8.1	-	2.31	0.56	0.0	3.5	1.3	0.44
Washington	heat	21.2	0.85	25.0	0.66	0.00	0.50	38.1	0.0	4.1	0.42
	cool	8.9	0.71	12.5	-	2.46	0.59	0.0	5.1	2.0	0.42
Los Angeles	heat	5.7	0.60	9.5	0.55	0.00	0.41	17.2	0.0	2.0	0.25
	cool	10.7	0.80	13.4	-	2.24	0.51	0.0	6.0	2.8	0.40
Houston	heat	6.5	0.74	8.7	0.54	0.00	0.43	16.3	0.0	1.3	0.32
	cool	15.9	0.63	25.1	-	2.62	0.63	0.0	9.6	3.7	0.40
School Old											
Minneapolis	heat	46.3	1.04	44.4	0.62	1.00	0.58	66.9	2.8	0.3	0.61
	cool	5.7	0.00	0.0	-	0.00	0.00	0.0	0.0	0.8	0.00
Chicago	heat	33.8	1.05	32.2	0.62	1.00	0.58	48.3	2.0	0.3	0.61
	cool	6.9	0.00	0.0	-	0.00	0.00	0.0	0.0	0.6	0.00
Washington	heat	23.1	1.07	21.6	0.63	1.00	0.59	32.0	1.3	0.2	0.63
	cool	9.9	0.00	0.0	-	0.00	0.00	0.0	0.0	0.4	0.00
Los Angeles	heat	6.2	1.17	5.2	0.61	1.00	0.56	8.0	0.3	0.1	0.65
	cool	12.2	0.00	0.0	-	0.00	0.00	0.0	0.0	0.1	0.00
Houston	heat	7.0	1.13	6.2	0.62	1.00	0.56	9.4	0.4	0.2	0.63
	cool	18.2	0.00	0.0	-	0.00	0.00	0.0	0.0	0.2	0.00

* HVAC Gas includes boilers and furnaces, HVAC Elec resistance heating, chiller and cooling towers, Aux. Elec fans and pumps.

† Net Plant Factor and Overall Source Efficiency have a multiplier of 3 to convert site electricity to source energy use.

Table 30. System and Plant Factors for Supermarket and Warehouse Prototypes

A. Location	B. HVAC mode	C. Bldg Load (kBtu/ft²)	D. System Factor	E. System Load (kBtu/ft²)	F Plant Factors Gas	Elec	Net†	G. Plant Consumption (kBtu/ft²) HVAC* Gas	HVAC* Elec	Aux* Elec	H. Overall Source Efficiency†
Supermarket New											
Minneapolis	heat	19.9	1.42	14.0	0.58	0.00	0.36	24.2	0.0	4.8	0.51
	cool	41.2	0.88	46.6	-	3.17	0.51	0.0	14.7	16.1	0.45
Chicago	heat	11.1	1.69	6.5	0.52	0.00	0.34	12.5	0.0	2.3	0.57
	cool	48.3	0.88	54.9	-	3.12	0.50	0.0	17.6	18.9	0.44
Washington	heat	4.3	2.70	1.6	0.36	0.00	0.27	4.5	0.0	0.5	0.73
	cool	57.9	0.81	71.9	-	3.12	0.55	0.0	23.1	20.9	0.44
Los Angeles	heat	0.0	0.00	0.0	0.00	0.00	0.00	1.7	0.0	0.0	0.00
	cool	73.1	1.00	73.0	-	3.21	0.55	0.0	22.7	21.2	0.55
Houston	heat	0.2	7.67	0.0	0.02	0.00	0.02	1.7	0.0	0.0	0.13
	cool	82.2	0.70	117.1	-	3.05	0.66	0.0	38.4	21.1	0.46
Supermarket Old											
Minneapolis	heat	25.1	1.40	17.9	0.60	0.00	0.37	30.1	0.0	6.2	0.51
	cool	40.1	0.87	46.2	-	3.16	0.50	0.0	14.6	16.0	0.44
Chicago	heat	14.5	1.62	9.0	0.55	0.00	0.35	16.4	0.0	3.2	0.56
	cool	47.2	0.86	54.8	-	3.11	0.50	0.0	17.6	19.2	0.43
Washington	heat	6.2	2.34	2.6	0.43	0.00	0.31	6.2	0.0	0.8	0.72
	cool	57.1	0.79	72.0	-	3.11	0.54	0.0	23.1	21.7	0.43
Los Angeles	heat	0.0	0.00	0.0	0.00	0.00	0.00	1.7	0.0	0.0	0.00
	cool	72.1	1.00	72.4	-	3.20	0.54	0.0	22.6	22.4	0.53
Houston	heat	0.4	5.25	0.1	0.04	0.00	0.04	1.8	0.0	0.0	0.23
	cool	82.5	0.70	117.9	-	3.04	0.64	0.0	38.7	22.3	0.45
Warehouse New											
Minneapolis	heat	62.9	1.22	51.4	0.68	0.00	0.52	75.9	0.0	7.6	0.64
	cool	4.6	0.82	5.6	-	3.49	0.77	0.0	1.6	0.8	0.63
Chicago	heat	42.7	1.25	34.3	0.67	0.00	0.51	51.3	0.0	5.3	0.64
	cool	7.7	0.97	7.9	-	3.55	0.76	0.0	2.2	1.2	0.74
Washington	heat	25.8	1.25	20.7	0.63	0.00	0.45	33.0	0.0	4.3	0.56
	cool	13.9	0.95	14.7	-	3.58	0.69	0.0	4.1	3.0	0.65
Los Angeles	heat	5.4	1.58	3.4	0.42	0.00	0.28	8.2	0.0	1.3	0.44
	cool	17.5	1.15	15.3	-	3.58	0.50	0.0	4.3	6.0	0.57
Houston	heat	9.4	1.43	6.6	0.52	0.00	0.36	12.7	0.0	1.8	0.52
	cool	10.3	0.82	12.7	-	3.31	0.57	0.0	3.8	3.5	0.47
Warehouse Old											
Minneapolis	heat	67.7	1.23	54.9	0.68	0.00	0.52	81.1	0.0	8.5	0.63
	cool	6.8	0.80	8.5	-	2.91	0.67	0.0	2.9	1.3	0.53
Chicago	heat	46.1	1.25	37.0	0.67	0.00	0.50	55.5	0.0	6.2	0.62
	cool	10.5	0.90	11.7	-	2.95	0.66	0.0	4.0	1.9	0.59
Washington	heat	27.9	1.26	22.1	0.65	0.00	0.44	35.3	0.0	4.8	0.56
	cool	17.2	0.89	19.4	-	2.97	0.60	0.0	6.5	4.2	0.53
Los Angeles	heat	5.9	1.63	3.6	0.42	0.00	0.30	8.6	0.0	1.2	0.49
	cool	24.1	0.90	26.8	-	2.99	0.51	0.0	9.0	8.5	0.46
Houston	heat	9.9	1.43	6.9	0.52	0.00	0.36	13.3	0.0	2.0	0.51
	cool	17.2	0.85	20.1	-	2.80	0.52	0.0	7.2	5.8	0.44

* HVAC Gas includes boilers and furnaces, HVAC Elec resistance heating, chiller and cooling towers, Aux. Elec fans and pumps.
† Net Plant Factor and Overall Source Efficiency have a multiplier of 3 to convert site electricity to source energy use.

Table 31. Average System and Plant Factors for Commercial Buildings

A. Location	B. HVAC mode	Floor Area (10^6 ft^2)	C. Bldg Load (kBtu/ft^2)	D. System Factor	E. System Load (kBtu/ft^2)	F. Plant Factors Gas	F. Plant Factors Elec	F. Plant Factors Net†	G. Plant Consumption (kBtu/ft^2) HVAC* Gas	G. HVAC* Elec	G. Aux* Elec	H. Overall Source Efficiency†
Large Office	heat	7622.1	3.6	0.32	11.2	0.64	1.00	0.42	16.4	0.6	2.8	0.13
	cool	7135.7	38.2	0.51	74.3	0.64	4.75	0.84	11.7	14.0	11.8	0.43
Small Office	heat	3657.4	8.8	1.23	7.2	0.48	1.00	0.39	15.0	0.0	1.2	0.47
	cool	3450.6	27.5	0.86	31.9		3.17	0.69	0.0	10.1	5.4	0.59
Large Retail	heat	5296.7	2.5	0.22	11.5	0.63	1.00	0.43	17.1	0.7	2.5	0.09
	cool	4115.5	28.4	0.62	45.8	0.63	4.65	0.89	0.1	9.8	7.3	0.55
Small Retail	heat	5749.0	14.3	1.16	12.4	0.63	1.00	0.50	19.7	0.0	1.8	0.57
	cool	3729.6	28.0	0.76	36.6		3.06	0.71	0.0	12.0	5.2	0.55
Larrge Hotel	heat	1326.6	3.6	0.73	5.0	0.63	1.00	0.37	7.5	0.3	1.7	0.27
	cool	1069.8	37.1	0.84	44.3		3.59	0.99	0.0	12.3	2.5	0.83
Small Hotel	heat	711.5	7.7	0.76	10.1	0.31	1.00	0.29	31.7	0.4	0.5	0.22
	cool	698.8	25.9	2.36	11.0		2.39	0.70	0.0	4.6	0.7	1.64
Fast Foods Restaurant	heat	678.9	28.2	0.29	97.3	0.62	1.00	0.52	156.3	0.0	9.9	0.15
	cool	621.8	73.1	0.66	110.7		3.09	0.76	0.0	35.9	12.7	0.50
Sit-down Restaurant	heat	678.9	23.6	1.12	21.2	0.59	1.00	0.47	36.1	0.0	2.9	0.53
	cool	621.8	54.4	0.61	89.6		3.15	0.75	0.0	28.5	11.6	0.45
Hospital	heat	1283.9	3.3	0.14	23.5	0.65	1.00	0.44	34.1	1.3	5.2	0.06
	cool	1167.5	107.6	1.10	97.8	0.65	4.19	0.87	7.0	22.2	13.0	0.96
School	heat	8265.2	21.7	1.03	21.1	0.63	1.00	0.57	31.7	1.2	0.6	0.59
	cool	5620.4	11.3	5.44	2.1		2.44	0.47	0.0	0.9	0.6	2.56
Supermarket	heat	674.5	7.1	1.66	4.3	0.49	1.00	0.33	8.6	0.0	1.5	0.54
	cool	635.1	61.9	0.82	75.7		3.11	0.56	0.0	24.3	20.5	0.46
Warehouse	heat	8270.0	6.5	1.26	5.1	0.64	1.00	0.48	8.0	0.0	0.9	0.60
	cool	3057.5	3.0	0.90	3.3		3.03	0.57	0.0	1.1	0.8	0.51
All Commercial	heat	44214.7	10.0	0.75	13.3	0.64	1.00	0.44	26.1	0.1	1.2	0.33
	cool	31924.1	30.2	0.72	41.6	0.64	3.89	0.79	2.9	10.2	6.4	0.57

* HVAC Gas includes boilers and furnaces, HVAC Elec resistance heating, chiller and cooling towers, Aux. Elec fans and pumps.

† Net Plant Factor and Overall Source Efficiency have been calculated using a multiplier of 3 to convert site electricity to source energy use.

Table 32. Total Site Energy Consumption for Office Prototypes

Location	HVAC mode	floor area (10^6 ft^2)	Specific Site Energy Consumption (kBtu/ft^2) HVAC Gas	HVAC Elec	Aux. Elec	Light Elec	Misc Elec	Source Gas	DHW Gas	Total Gas	Total Elec	Aggr. energy (10^{12} Btu) Site Gas	Site Elec	Source All
Large Office New														
	other	95.1				18.6	13.0	0.0	1.9			0.18	3.01	9.20
Minneapolis	heat	95.1	28.9	1.1	4.2					31.4	46.6	2.75	0.50	4.25
	cool	76.6	0.6	5.1	4.5							0.04	0.74	2.26
	other	733.1				18.6	13.0	0.0	1.8			1.33	23.17	70.85
Chicago	heat	705.0	21.7	0.8	3.4					24.5	47.0	15.32	2.97	24.22
	cool	657.6	1.0	6.0	5.2							0.63	7.36	22.71
	other	626.8				18.6	12.9	0.0	1.7			1.05	19.74	60.27
Washington	heat	556.4	16.2	0.6	2.7					19.5	48.7	9.04	1.83	14.54
	cool	535.2	1.5	7.6	6.3							0.83	7.46	23.21
	other	782.5				18.6	12.9	0.0	1.6			1.23	24.64	75.15
Los Angeles	heat	686.3	4.7	0.2	1.6					9.0	52.6	3.24	1.22	6.91
	cool	701.9	2.7	10.2	9.2							1.91	13.59	42.69
	other	578.8				18.6	12.9	0.0	1.7			0.98	18.23	55.66
Houston	heat	548.1	4.5	0.2	1.4					7.8	54.0	2.48	0.89	5.14
	cool	548.7	1.6	12.2	8.7							0.89	11.46	35.27
Large Office Old														
	other	243.9				25.8	13.0	0.0	1.6			0.40	9.45	28.76
Minneapolis	heat	239.4	29.0	1.2	4.0					56.5	74.2	6.95	1.24	10.68
	cool	185.4	25.8	16.2	14.0							4.79	5.60	21.60
	other	1770.1				25.8	13.0	0.0	1.5			2.71	68.61	208.54
Chicago	heat	1621.5	23.7	1.0	3.5					46.1	73.1	38.39	7.28	60.23
	cool	1360.6	20.9	16.1	13.7							28.48	40.61	150.30
	other	2032.5				25.8	12.9	0.0	1.4			2.91	78.56	238.57
Washington	heat	1745.3	18.5	0.7	3.1					37.9	73.1	32.32	6.61	52.16
	cool	1761.8	18.0	16.8	13.9							31.68	54.06	193.87
	other	1084.0				25.8	12.9	0.0	1.3			1.44	41.90	127.13
Los Angeles	heat	996.2	11.1	0.4	2.4					23.7	74.6	11.08	2.85	19.64
	cool	983.2	11.2	17.7	15.4							11.06	32.54	108.67
	other	481.8				25.8	12.9	0.0	1.4			0.69	18.62	56.56
Houston	heat	428.8	8.9	0.4	2.1					19.8	72.8	3.82	1.07	7.04
	cool	324.7	9.4	17.5	14.1							3.06	10.27	33.88
Small Office New														
	other	30.8				19.3	7.9	0.0	2.8			0.09	0.84	2.60
Minneapolis	heat	30.8	33.7	0.0	3.1					36.5	36.2	1.04	0.09	1.32
	cool	30.6	0.0	3.8	2.1							0.00	0.18	0.54
	other	151.7				19.3	7.9	0.0	2.6			0.40	4.13	12.78
Chicago	heat	150.9	23.8	0.0	2.3					26.4	36.9	3.59	0.34	4.62
	cool	149.1	0.0	4.5	2.9							0.00	1.10	3.31
	other	234.0				19.3	5.7	0.0	2.4			0.56	5.87	18.16
Washington	heat	214.3	18.3	0.0	1.7					20.6	35.0	3.91	0.37	5.01
	cool	216.0	0.0	5.2	3.1							0.00	1.78	5.34
	other	370.8				19.3	5.7	0.0	2.2			0.80	9.30	28.69
Los Angeles	heat	349.7	2.9	0.0	0.1					5.1	35.1	1.02	0.04	1.14
	cool	344.5	0.0	5.2	4.7							0.00	3.41	10.23
	other	296.6				19.3	5.7	0.0	2.3			0.68	7.44	22.99
Houston	heat	276.7	5.0	0.0	0.3					7.3	37.8	1.40	0.08	1.64
	cool	272.3	0.0	8.1	4.4							0.00	3.40	10.19
Small Office Old														
	other	353.8				25.0	7.9	0.0	3.3			1.16	11.64	36.09
Minneapolis	heat	319.4	36.4	0.0	3.4					39.7	47.6	11.62	1.08	14.87
	cool	265.6	0.0	7.5	3.7							0.00	2.99	8.96
	other	742.7				25.0	7.9	0.0	3.0			2.26	24.44	75.58
Chicago	heat	661.8	25.2	0.0	2.3					28.2	48.7	16.65	1.53	21.25
	cool	582.7	0.0	8.8	4.7							0.00	7.85	23.54
	other	554.8				25.0	7.9	0.0	2.7			1.49	18.25	56.23
Washington	heat	536.6	17.0	0.0	1.4					19.7	50.5	9.11	0.75	11.35
	cool	473.1	0.0	10.5	5.7							0.00	7.65	22.95
	other	639.3				25.0	7.9	0.0	2.5			1.58	21.03	64.66
Los Angeles	heat	591.4	5.2	0.0	0.0					7.7	54.6	3.09	0.02	3.16
	cool	592.6	0.0	13.9	7.7							0.00	12.81	38.43
	other	570.9				25.0	7.9	0.0	2.6			1.50	18.78	57.83
Houston	heat	525.8	6.6	0.0	0.2					9.2	56.3	3.45	0.08	3.69
	cool	524.1	0.0	16.2	7.1							0.00	12.20	36.59

Table 33 Total Site Energy Consumption for Retail Prototypes

Location	HVAC mode	floor area (10^6 ft^2)	Specific Site Energy Consumption (kBtu/ft^2) HVAC Gas	HVAC Elec	Aux. Elec	Light Elec	Misc Elec	Source Gas	DHW Gas	Total Gas	Total Elec	Aggr. energy (10^{12} Btu) Site Gas	Site Elec	Source All
Large Retail New														
	other	188.3				29.6	11.7	0.0	0.6			0.11	7.77	23.43
Minneapolis	heat	188.3	20.2	0.7	3.1					20.9	54.0	3.80	0.72	5.96
	cool	177.0	0.2	4.8	4.1							0.03	1.58	4.76
	other	770.7				29.6	11.7	0.0	0.5			0.41	31.82	95.88
Chicago	heat	745.6	14.6	0.6	2.5					15.5	55.1	10.86	2.31	17.79
	cool	546.2	0.4	5.7	5.0							0.23	5.86	17.80
	other	277.0				29.6	11.7	0.0	0.5			0.14	11.44	34.45
Washington	heat	178.5	9.7	0.4	1.9					10.9	57.0	1.72	0.41	2.94
	cool	173.6	0.7	7.3	6.2							0.13	2.34	7.14
	other	232.7				29.6	11.7	0.0	0.5			0.11	9.61	28.93
Los Angeles	heat	230.6	0.4	0.0	1.0					1.0	58.5	0.09	0.24	0.82
	cool	201.3	0.1	8.8	7.3							0.03	3.24	9.75
	other	450.9				29.6	11.7	0.0	0.5			0.23	18.62	56.08
Houston	heat	409.4	1.4	0.1	1.0					2.3	61.8	0.56	0.45	1.92
	cool	368.4	0.4	11.3	8.1							0.17	7.16	21.64
Large Retail Old														
	other	408.3				32.2	9.5	0.0	0.4			0.18	17.03	51.27
Minneapolis	heat	345.9	40.2	1.6	4.2					40.7	64.2	13.92	2.02	19.97
	cool	243.8	0.0	10.2	6.5							0.00	4.06	12.19
	other	919.2				32.2	9.5	0.0	0.4			0.37	38.34	115.39
Chicago	heat	806.8	32.0	1.4	3.6					32.4	64.1	25.78	4.00	37.79
	cool	381.9	0.0	10.4	7.0							0.00	6.66	19.97
	other	1444.2				32.2	9.5	0.0	0.4			0.55	60.24	181.26
Washington	heat	1162.0	22.5	0.9	3.0					22.9	64.3	26.15	4.54	39.78
	cool	924.6	0.0	11.1	7.6							0.00	17.29	51.87
	other	915.2				32.2	9.5	0.0	0.3			0.32	38.17	114.84
Los Angeles	heat	752.3	5.6	0.3	1.4					6.0	62.9	4.23	1.23	7.91
	cool	686.4	0.0	10.7	8.9							0.00	13.44	40.33
	other	650.3				32.2	9.5	0.0	0.4			0.24	27.12	81.61
Houston	heat	477.3	7.7	0.3	1.7					8.1	65.1	3.68	0.95	6.55
	cool	412.3	0.0	12.5	8.8							0.00	8.80	26.41
Small Retail New														
	other	80.0				25.6	5.9	0.0	3.0			0.24	2.52	7.80
Minneapolis	heat	71.5	41.3	0.0	3.6					44.3	43.7	2.95	0.26	3.72
	cool	26.2	0.0	6.1	2.5							0.00	0.22	0.67
	other	213.3				25.6	5.9	0.0	2.8			0.60	6.72	20.77
Chicago	heat	189.1	27.1	0.0	2.6					29.9	44.9	5.12	0.49	6.58
	cool	158.9	0.0	7.4	3.4							0.00	1.71	5.13
	other	368.4				25.6	5.9	0.0	2.6			0.95	11.61	35.79
Washington	heat	331.6	16.3	0.0	1.5					18.9	47.0	5.40	0.49	6.86
	cool	221.6	0.0	9.7	4.3							0.00	3.10	9.31
	other	293.4				25.6	5.9	0.0	2.4			0.70	9.25	28.44
Los Angeles	heat	259.7	1.6	0.0	0.1					4.0	47.9	0.41	0.01	0.45
	cool	187.8	0.0	10.5	5.9							0.00	3.07	9.21
	other	333.5				25.6	5.9	0.0	2.5			0.84	10.51	32.38
Houston	heat	273.5	3.3	0.0	0.2					5.8	53.2	0.91	0.05	1.05
	cool	192.8	0.0	15.7	5.8							0.00	4.14	12.43
Small Retail Old														
	other	529.5				31.3	5.9	0.0	3.5			1.86	19.70	60.95
Minneapolis	heat	528.3	51.3	0.0	4.5					54.8	52.4	27.09	2.35	34.15
	cool	287.0	0.0	7.6	3.1							0.00	3.08	9.23
	other	1608.0				31.3	5.9	0.0	3.3			5.27	59.82	184.73
Chicago	heat	1470.2	33.6	0.0	3.2					36.9	53.7	49.46	4.70	63.57
	cool	955.1	0.0	9.2	4.1							0.00	12.73	38.20
	other	1099.1				31.3	5.9	0.0	3.0			3.34	40.89	126.00
Washington	heat	929.1	18.6	0.0	1.7					21.7	55.8	17.31	1.55	21.95
	cool	619.0	0.0	11.7	5.2							0.00	10.47	31.40
	other	871.9				31.3	5.9	0.0	2.8			2.43	32.43	99.74
Los Angeles	heat	892.8	1.8	0.0	0.0					4.6	58.7	1.58	0.04	1.69
	cool	569.4	0.0	14.6	6.8							0.00	12.19	36.58
	other	825.5				31.3	5.9	0.0	3.0			2.44	30.71	94.57
Houston	heat	803.2	3.5	0.0	0.2					6.5	62.9	2.80	0.13	3.21
	cool	511.8	0.0	18.8	6.8							0.00	13.08	39.23

Table 34. Total Site Energy Consumption for Hotel Prototypes

Location	HVAC mode	floor area $(10^6 ft^2)$	Specific Site Energy Consumption ($kBtu/ft^2$) HVAC Gas	HVAC Elec	Aux. Elec	Light Elec	Misc Elec	Source Gas	DHW Gas	Total Gas	Total Elec	Aggr. energy (10^{12} Btu) Site Gas	Site Elec	Source All
Large Hotel New														
	other	18.6				20.7	10.2	8.1	12.9			0.39	0.57	2.11
Minneapolis	heat	18.6	22.1	0.9	1.8					43.1	42.1	0.41	0.05	0.56
	cool	18.5	0.0	6.8	1.7							0.00	0.16	0.48
	other	41.9				20.7	10.2	8.1	12.4			0.86	1.29	4.74
Chicago	heat	39.8	14.2	0.6	1.7					34.7	43.1	0.57	0.09	0.84
	cool	34.7	0.0	8.0	1.9							0.00	0.35	1.04
	other	21.7				20.7	10.2	8.1	11.8			0.43	0.67	2.44
Washington	heat	21.4	7.1	0.3	1.6					27.1	45.2	0.15	0.04	0.28
	cool	15.7	0.1	10.1	2.2							0.00	0.19	0.58
	other	249.7				20.7	10.2	8.1	11.4			4.86	7.70	27.97
Los Angeles	heat	234.2	0.2	0.0	1.4					19.7	45.7	0.05	0.32	1.02
	cool	218.7	0.0	10.7	2.8							0.00	2.95	8.85
	other	175.9				20.7	10.2	8.1	11.9			3.52	5.43	19.80
Houston	heat	156.0	0.7	0.0	1.8					20.7	50.8	0.11	0.28	0.95
	cool	153.2	0.0	15.5	2.7							0.00	2.78	8.33
Large Hotel Old														
	other	98.3				20.7	10.2	8.1	13.5			2.12	3.03	11.22
Minneapolis	heat	98.1	29.5	1.2	2.1					51.2	43.0	2.89	0.33	3.87
	cool	79.7	0.1	7.0	1.9							0.01	0.70	2.12
	other	225.5				20.7	10.2	8.1	13.0			4.75	6.96	25.62
Chicago	heat	221.0	19.2	0.8	1.9					40.3	43.9	4.23	0.60	6.04
	cool	92.5	0.1	8.2	2.1							0.01	0.95	2.87
	other	129.0				20.7	10.2	8.1	12.4			2.64	3.98	14.58
Washington	heat	125.6	9.2	0.4	1.8					29.8	45.9	1.16	0.27	1.98
	cool	20.3	0.1	10.4	2.4							0.00	0.26	0.78
	other	151.0				20.7	10.2	8.1	11.9			3.02	4.66	16.99
Los Angeles	heat	117.8	0.3	0.0	1.4					20.3	46.6	0.04	0.17	0.55
	cool	134.1	0.0	11.6	2.7							0.00	1.92	5.76
	other	310.2				20.7	10.2	8.1	12.5			6.38	9.57	35.09
Houston	heat	294.1	1.0	0.0	1.9					21.6	51.4	0.29	0.56	1.98
	cool	302.4	0.0	16.0	2.7							0.01	5.63	16.90
Small Hotel New														
	other	0.0				12.5	6.7	3.6	19.8			0.00	0.00	0.00
Minneapolis	heat	0.0	56.6	1.9	0.9					80.0	31.3	0.00	0.00	0.00
	cool	0.0	0.0	8.5	0.9							0.00	0.00	0.00
	other	4.4				12.5	6.7	3.6	18.7			0.10	0.08	0.35
Chicago	heat	4.4	38.6	1.3	0.7					61.0	32.4	0.17	0.01	0.20
	cool	4.4	0.0	10.3	0.9							0.00	0.05	0.15
	other	19.3				12.5	6.7	3.6	17.6			0.41	0.37	1.52
Washington	heat	15.7	22.5	0.8	0.4					43.7	35.6	0.35	0.02	0.41
	cool	17.4	0.0	14.1	1.2							0.00	0.27	0.80
	other	56.0				12.5	6.7	3.6	16.6			1.13	1.07	4.35
Los Angeles	heat	55.9	15.7	0.0	0.0					35.8	35.4	0.87	0.00	0.88
	cool	55.8	0.0	14.8	1.4							0.00	0.91	2.72
	other	67.6				12.5	6.7	3.6	17.8			1.45	1.29	5.33
Houston	heat	66.7	17.4	0.0	0.1					38.9	43.9	1.16	0.00	1.17
	cool	67.5	0.0	23.4	1.3							0.00	1.67	5.00
Small Hotel Old														
	other	104.8				12.5	6.7	3.6	19.8			2.45	2.00	8.47
Minneapolis	heat	103.3	49.5	1.5	1.1					72.9	22.5	5.12	0.26	5.90
	cool	94.8	0.0	0.5	0.4							0.00	0.08	0.24
	other	89.1				12.5	6.7	3.6	18.7			1.99	1.70	7.10
Chicago	heat	89.1	33.5	1.0	0.9					55.8	22.0	2.99	0.17	3.51
	cool	73.0	0.0	0.6	0.3							0.00	0.07	0.20
	other	69.4				12.5	6.7	3.6	17.6			1.47	1.33	5.45
Washington	heat	67.8	19.0	0.6	0.8					40.2	21.6	1.29	0.09	1.56
	cool	62.5	0.0	0.9	0.3							0.00	0.07	0.22
	other	150.6				12.5	6.7	3.6	16.6			3.04	2.88	11.68
Los Angeles	heat	130.9	33.7	0.0	0.2					53.9	20.7	4.41	0.02	4.48
	cool	146.2	0.0	0.8	0.6							0.00	0.21	0.63
	other	187.1				12.5	6.7	3.6	17.8			4.02	3.58	14.75
Houston	heat	177.7	34.9	0.0	0.2					56.4	21.4	6.21	0.04	6.32
	cool	177.2	0.0	1.5	0.6							0.00	0.36	1.09

Table 35. Total Site Energy Consumption for Restaurant Prototypes

Location	HVAC mode	floor area (10^6 ft^2)	HVAC Gas	HVAC Elec	Aux. Elec	Light Elec	Misc Elec	Source Gas	DHW Gas	Total Gas	Total Elec	Site Gas	Site Elec	Source All
			Specific Site Energy Consumption (kBtu/ft^2)									Aggr. energy (10^{12} Btu)		
Fast Foods Restaurant New														
	other	2.4				48.8	59.2	47.1	34.1			0.19	0.26	0.97
Minneapolis	heat	2.4	326.8	0.0	16.0					408.0	145.0	0.78	0.04	0.90
	cool	1.7	0.0	16.4	4.6							0.00	0.04	0.11
	other	38.7				48.8	59.2	47.1	34.1			3.14	4.18	15.69
Chicago	heat	35.4	234.2	0.0	13.8					315.4	148.3	8.29	0.49	9.76
	cool	32.4	0.0	19.8	6.6							0.00	0.86	2.57
	other	23.6				48.8	59.2	47.1	34.1			1.92	2.55	9.57
Washington	heat	19.6	147.1	0.0	9.6					228.3	155.7	2.88	0.19	3.45
	cool	23.6	0.0	27.6	10.5							0.00	0.90	2.70
	other	24.3				48.8	59.2	47.1	34.1			1.97	2.63	9.85
Los Angeles	heat	21.5	40.3	0.0	4.2					121.5	150.0	0.87	0.09	1.14
	cool	24.1	0.0	22.0	15.8							0.00	0.91	2.73
	other	12.9				48.8	59.2	47.1	34.1			1.05	1.39	5.23
Houston	heat	12.9	42.1	0.0	2.1					123.3	180.3	0.54	0.03	0.62
	cool	12.3	0.0	52.6	17.6							0.00	0.86	2.59
Fast Foods Restaurant Old														
	other	42.9				48.8	59.2	47.1	34.1			3.48	4.63	17.39
Minneapolis	heat	38.2	337.7	0.0	17.7					418.9	154.3	12.90	0.67	14.93
	cool	32.6	0.0	22.9	5.7							0.00	0.93	2.80
	other	216.3				48.8	59.2	47.1	34.1			17.56	23.37	87.67
Chicago	heat	203.3	242.6	0.0	15.2					323.8	158.5	49.31	3.08	58.56
	cool	178.7	0.0	27.2	8.1							0.00	6.31	18.93
	other	165.1				48.8	59.2	47.1	34.1			13.41	17.84	66.92
Washington	heat	144.2	153.8	0.0	10.5					235.0	167.8	22.18	1.51	26.70
	cool	128.1	0.0	37.0	12.3							0.00	6.32	18.95
	other	112.9				48.8	59.2	47.1	34.1			9.17	12.20	45.76
Los Angeles	heat	102.2	40.6	0.0	4.0					121.8	163.5	4.15	0.41	5.38
	cool	97.5	0.0	32.7	18.8							0.00	5.02	15.05
	other	107.8				48.8	59.2	47.1	34.1			8.75	11.65	43.69
Houston	heat	99.2	42.8	0.0	2.2					124.0	199.2	4.24	0.22	4.89
	cool	90.8	0.0	69.1	19.8							0.00	8.07	24.22
Sit-down Restaurant New														
	other	2.4				50.4	59.3	45.6	59.6			0.25	0.26	1.04
Minneapolis	heat	2.4	84.6	0.0	6.9					189.9	136.6	0.20	0.02	0.25
	cool	1.7	0.0	13.4	6.6							0.00	0.03	0.10
	other	38.7				50.4	59.3	45.6	59.6			4.07	4.25	16.81
Chicago	heat	35.4	54.6	0.0	4.9					159.8	139.5	1.93	0.17	2.45
	cool	32.4	0.0	16.1	8.8							0.00	0.81	2.42
	other	23.6				50.4	59.3	45.6	59.6			2.48	2.59	10.25
Washington	heat	19.6	29.6	0.0	2.3					134.9	145.0	0.58	0.05	0.72
	cool	23.6	0.0	21.7	11.2							0.00	0.78	2.33
	other	24.3				50.4	59.3	45.6	59.6			2.56	2.67	10.56
Los Angeles	heat	21.5	4.2	0.0	0.1					109.5	143.2	0.09	0.00	0.10
	cool	24.1	0.0	20.4	12.9							0.00	0.80	2.41
	other	12.9				50.4	59.3	45.6	59.6			1.36	1.42	5.60
Houston	heat	12.9	6.6	0.0	0.2					111.8	160.7	0.08	0.00	0.09
	cool	12.3	0.0	37.6	13.1							0.00	0.62	1.87
Sit-down Restaurant Old														
	other	42.9				50.4	59.3	45.6	59.6			4.52	4.71	18.64
Minneapolis	heat	38.2	91.9	0.0	7.3					197.2	143.2	3.51	0.28	4.35
	cool	32.6	0.0	18.7	7.4							0.00	0.85	2.55
	other	216.3				50.4	59.3	45.6	59.6			22.77	23.73	93.97
Chicago	heat	203.3	60.0	0.0	5.2					165.2	146.9	12.19	1.06	15.36
	cool	178.7	0.0	22.2	9.7							0.00	5.71	17.13
	other	165.1				50.4	59.3	45.6	59.6			17.38	18.12	71.73
Washington	heat	144.2	32.7	0.0	2.5					138.0	153.6	4.72	0.36	5.80
	cool	128.1	0.0	29.2	12.1							0.00	5.29	15.88
	other	112.9				50.4	59.3	45.6	59.6			11.88	12.39	49.05
Los Angeles	heat	102.2	4.5	0.0	0.2					109.8	153.7	0.46	0.02	0.51
	cool	97.5	0.0	29.9	13.9							0.00	4.28	12.83
	other	107.8				50.4	59.3	45.6	59.6			11.35	11.83	46.83
Houston	heat	99.2	7.1	0.0	0.3					112.4	173.4	0.71	0.03	0.78
	cool	90.8	0.0	49.2	14.2							0.00	5.76	17.27

Table 36. Total Site Energy Consumption for Hospital and School Prototypes

Location	HVAC mode	floor area (10^6 ft^2)	HVAC Gas	HVAC Elec	Aux. Elec	Light Elec	Misc Elec	Source Gas	DHW Gas	Total Gas	Total Elec	Site Gas	Site Elec	Source All
			Specific Site Energy Consumption (kBtu/ft^2)									Aggr. energy (10^{12} Btu)		
Hospital New														
Minneapolis	other	0.0				48.1	58.6	7.8	49.8			0.00	0.00	0.00
	heat	0.0	24.7	1.0	4.3					82.4	138.1	0.00	0.00	0.00
	cool	0.0	0.1	15.2	10.8							0.00	0.00	0.00
Chicago	other	86.1				48.1	58.6	7.8	46.7			4.69	9.19	32.27
	heat	85.7	18.3	0.8	3.7					72.9	140.7	1.57	0.39	2.73
	cool	84.4	0.1	17.7	11.7							0.01	2.48	7.45
Washington	other	42.7				48.1	58.6	7.8	43.5			2.19	4.56	15.87
	heat	42.7	10.0	0.4	3.2					61.3	146.0	0.43	0.16	0.89
	cool	42.4	0.0	22.8	12.8							0.00	1.51	4.52
Los Angeles	other	43.5				48.1	58.6	7.8	40.6			2.11	4.64	16.04
	heat	43.5	1.5	0.1	2.8					50.0	148.9	0.07	0.13	0.45
	cool	34.5	0.0	25.3	13.9							0.00	1.35	4.06
Houston	other	8.6				48.1	58.6	7.8	44.2			0.45	0.92	3.20
	heat	8.6	2.9	0.1	3.1					54.9	158.0	0.02	0.03	0.11
	cool	8.6	0.0	34.2	13.8							0.00	0.41	1.24
Hospital Old														
Minneapolis	other	73.5				48.1	57.1	7.8	50.2			4.26	7.73	27.46
	heat	71.1	73.9	2.7	8.4					137.3	140.5	5.25	0.78	7.60
	cool	46.6	5.5	14.6	9.6							0.26	1.13	3.64
Chicago	other	324.7				48.1	57.1	7.8	47.1			17.83	34.16	120.31
	heat	324.4	60.8	2.2	7.3					122.6	142.9	19.71	3.10	29.00
	cool	285.7	6.9	17.2	10.9							1.98	8.03	26.08
Washington	other	199.9				48.1	57.1	7.8	43.8			10.32	21.03	73.42
	heat	199.9	43.5	1.6	5.9					102.5	147.1	8.69	1.49	13.15
	cool	152.1	7.4	21.9	12.6							1.12	5.24	16.85
Los Angeles	other	391.6				48.1	57.1	7.8	41.0			19.11	41.20	142.71
	heat	390.4	15.2	0.6	3.9					73.5	148.0	5.94	1.74	11.15
	cool	389.3	9.5	23.7	14.6							3.70	14.93	48.50
Houston	other	130.1				48.1	57.1	7.8	44.6			6.82	13.69	47.88
	heat	117.6	17.7	0.7	3.9					78.7	158.3	2.08	0.54	3.70
	cool	123.9	8.6	33.4	15.0							1.07	6.00	19.08
School New														
Minneapolis	other	103.0				14.5	3.2	0.0	6.8			0.70	1.82	6.17
	heat	102.6	77.4	0.0	8.1					84.1	29.9	7.94	0.83	10.44
	cool	85.7	0.0	3.0	1.1							0.00	0.35	1.04
Chicago	other	231.7				14.5	3.2	0.0	6.5			1.52	4.10	13.83
	heat	228.4	55.8	0.0	6.0					62.4	28.5	12.75	1.37	16.86
	cool	185.2	0.0	3.5	1.3							0.00	0.89	2.67
Washington	other	172.2				14.5	3.2	0.0	6.4			1.11	3.05	10.25
	heat	172.2	38.1	0.0	4.1					44.5	28.9	6.55	0.70	8.66
	cool	169.4	0.0	5.1	2.0							0.00	1.21	3.62
Los Angeles	other	215.2				14.5	3.2	0.0	6.2			1.33	3.81	12.76
	heat	206.8	17.2	0.0	2.0					23.4	28.6	3.56	0.42	4.81
	cool	206.4	0.0	6.0	2.8							0.00	1.83	5.48
Houston	other	189.8				14.5	3.2	0.0	6.4			1.22	3.36	11.29
	heat	189.8	16.3	0.0	1.3					22.7	32.3	3.09	0.24	3.83
	cool	188.5	0.0	9.6	3.7							0.00	2.51	7.52
School Old														
Minneapolis	other	493.6				14.5	3.2	0.0	6.8			3.34	8.74	29.55
	heat	486.4	66.9	2.8	0.3					73.6	21.7	32.52	1.54	37.15
	cool	226.9	0.0	0.0	0.8							0.00	0.19	0.56
Chicago	other	2390.5				14.5	3.2	0.0	6.5			15.66	42.31	142.59
	heat	2352.1	48.3	2.0	0.3					54.9	20.6	113.68	5.42	129.95
	cool	1034.1	0.0	0.0	0.6							0.00	0.61	1.83
Washington	other	1919.1				14.5	3.2	0.0	6.3			12.15	33.97	114.05
	heat	1828.2	32.0	1.3	0.2					38.4	19.6	58.57	2.79	66.93
	cool	964.1	0.0	0.0	0.4							0.00	0.38	1.15
Los Angeles	other	1615.0				14.5	3.2	0.0	6.1			9.85	28.59	95.61
	heat	1582.7	8.0	0.3	0.1					14.1	18.3	12.63	0.75	14.87
	cool	1511.6	0.0	0.0	0.1							0.00	0.18	0.54
Houston	other	1163.7				14.5	3.2	0.0	6.3			7.33	20.60	69.12
	heat	1116.0	9.4	0.4	0.2					15.7	18.4	10.45	0.64	12.37
	cool	1048.5	0.0	0.0	0.2							0.00	0.16	0.49

Table 37. Total Site Energy Consumption for Supermarket and Warehouse Prototypes

		floor	Specific Site Energy Consumption (kBtu/ft^2)									Aggr. energy (10^{12} Btu)		
	HVAC	area	HVAC	HVAC	Aux.	Light	Misc	Source	DHW	Total	Total	Site	Site	Source
Location	mode	(10^6 ft^2)	Gas	Elec	Elec	Elec	Elec	Gas	Gas	Gas	Elec	Gas	Elec	All
Supermarket New														
	other	3.4				63.0	20.4	0.0	1.3			0.00	0.28	0.86
Minneapolis	heat	3.4	24.2	0.0	4.8					25.4	119.0	0.08	0.02	0.13
	cool	3.4	0.0	14.7	16.1							0.00	0.10	0.31
	other	63.2				63.0	20.4	0.0	1.2			0.08	5.27	15.89
Chicago	heat	60.9	12.5	0.0	2.3					13.7	122.1	0.76	0.14	1.17
	cool	60.9	0.0	17.6	18.9							0.00	2.22	6.66
	other	62.2				63.0	20.4	0.0	1.1			0.07	5.19	15.63
Washington	heat	57.8	4.5	0.0	0.5					5.6	127.8	0.26	0.03	0.34
	cool	53.4	0.0	23.1	20.9							0.00	2.35	7.04
	other	41.8				63.0	20.4	0.0	1.0			0.04	3.49	10.50
Los Angeles	heat	35.3	1.7	0.0	0.0					2.7	127.3	0.06	0.00	0.06
	cool	37.7	0.0	22.7	21.2							0.00	1.66	4.97
	other	30.2				63.0	20.4	0.0	1.1			0.03	2.52	7.59
Houston	heat	30.2	1.7	0.0	0.0					2.8	142.8	0.05	0.00	0.05
	cool	26.2	0.0	38.4	21.1							0.00	1.56	4.67
Supermarket Old														
	other	72.8				63.0	20.4	0.0	1.3			0.09	6.07	18.31
Minneapolis	heat	62.4	30.1	0.0	6.2					31.4	120.2	1.88	0.39	3.04
	cool	63.9	0.0	14.6	16.0							0.00	1.95	5.86
	other	121.7				63.0	20.4	0.0	1.2			0.14	10.15	30.60
Chicago	heat	104.3	16.4	0.0	3.2					17.6	123.4	1.71	0.33	2.70
	cool	94.0	0.0	17.6	19.2							0.00	3.46	10.38
	other	112.0				63.0	20.4	0.0	1.1			0.12	9.34	28.15
Washington	heat	100.8	6.2	0.0	0.8					7.3	129.0	0.62	0.08	0.86
	cool	89.2	0.0	23.1	21.7							0.00	4.00	11.99
	other	108.0				63.0	20.4	0.0	1.0			0.11	9.01	27.13
Los Angeles	heat	85.3	1.7	0.0	0.0					2.7	128.4	0.14	0.00	0.14
	cool	86.8	0.0	22.6	22.4							0.00	3.91	11.72
	other	152.0				63.0	20.4	0.0	1.1			0.17	12.68	38.20
Houston	heat	134.1	1.8	0.0	0.0					2.9	144.5	0.24	0.00	0.25
	cool	119.6	0.0	38.7	22.3							0.00	7.30	21.91
Warehouse New														
	other	206.9				9.9	5.7	0.0	3.3			0.68	3.24	10.39
Minneapolis	heat	168.3	15.2	0.0	1.5					18.5	17.7	2.56	0.26	3.33
	cool	88.4		0.3	0.2							0.00	0.04	0.13
	other	515.9				9.9	5.7	0.0	3.1			1.58	8.08	25.81
Chicago	heat	329.6	10.3	0.0	1.1					13.3	17.4	3.38	0.35	4.43
	cool	90.4		0.4	0.2							0.00	0.06	0.19
	other	880.3				9.9	5.7	0.0	3.0			2.64	13.78	43.98
Washington	heat	693.1	6.6	0.0	0.9					9.6	17.9	4.58	0.59	6.35
	cool	277.6		0.8	0.6							0.00	0.40	1.19
	other	851.3				9.9	5.7	0.0	2.8			2.37	13.33	42.35
Los Angeles	heat	588.2	1.6	0.0	0.3					4.4	18.0	0.96	0.16	1.43
	cool	193.2		0.9	1.2							0.00	0.39	1.18
	other	778.8				9.9	5.7	0.0	3.0			2.34	12.19	38.92
Houston	heat	306.8	2.5	0.0	0.4					5.5	17.5	0.78	0.11	1.12
	cool	232.1		0.8	0.7							0.00	0.34	1.03
Warehouse Old														
	other	712.1				9.9	5.7	0.0	3.3			2.33	11.15	35.77
Minneapolis	heat	769.3	16.2	0.0	1.7					19.5	18.2	12.48	1.31	16.40
	cool	233.8		0.6	0.3							0.00	0.20	0.59
	other	2258.0				9.9	5.7	0.0	3.1			6.91	35.35	112.95
Chicago	heat	2465.1	11.1	0.0	1.2					14.2	18.1	27.36	3.04	36.48
	cool	476.0		0.8	0.4							0.00	0.56	1.69
	other	1738.1				9.9	5.7	0.0	3.0			5.21	27.21	86.84
Washington	heat	1481.1	7.1	0.0	1.0					10.1	18.8	10.47	1.44	14.78
	cool	540.6		1.3	0.8							0.00	1.16	3.49
	other	2041.5				9.9	5.7	0.0	2.8			5.68	31.96	101.55
Los Angeles	heat	771.7	1.7	0.0	0.2					4.5	19.4	1.33	0.18	1.86
	cool	377.7		1.8	1.7							0.00	1.32	3.97
	other	1521.3				9.9	5.7	0.0	3.0			4.58	23.81	76.02
Houston	heat	696.8	2.7	0.0	0.4					5.7	18.7	1.86	0.28	2.69
	cool	547.7		1.4	1.2							0.00	1.42	4.27

Table 38. Comparison of Component Loads Analysis Project commercial building energy use to 1992 CBECS

	1992 CBECS							Component loads study			
	Floor	Energy use			Specific energy use			Energy use		Specific energy	
	(10^6 ft^2)	Elec	Nat Gas	Other	Elec	Nat Gas	Other	Elec	Nat Gas	Elec	Nat Gas
Assembly	4547	173	100	37	38.0	21.9	8.2				
Education	9004	280	329	130	31.1	36.6	14.4				
Schools *	8494	235	291	111	27.6	34.3	13.1	174	316	20.4	37.2
Food sales*	767	113	24	1	146.7	31.3	1.0	96	7	125.6	8.7
Food service*	1494	138	157	13	92.1	104.9	8.8	230	270	154.2	180.7
Health care	2498	174	256	91	69.7	102.5	36.4				
Hospitals *	1301	115	154	73	88.7	118.6	56.1	188	120	144.9	92.6
Lodging*	2170	153	126	66	70.3	58.0	30.3	82	78	37.7	35.7
Mercantile*	12479	444	381	67	35.6	30.5	5.4	676	226	54.1	18.1
Office*	12374	704	388	156	56.9	31.3	12.6	719	295	58.1	23.8
Parking garage	1630	39	9	4	23.7	5.7	2.3				
Public order	831	28	37	26	33.6	44.8	30.7				
Warehouses	11504	253	196	78	22.0	17.0	6.7				
Non-refrig*	11074	231	188	72	20.9	17.0	6.5	202	100	18.3	9.0
Worship	3790	32	65	12	8.3	17.1	3.2				
Vacant	4396	47	61	24	10.6	13.9	5.4				
Other	614	32	46	3	52.9	75.1	5.5				
All buildings	68098	2609	2174	707	38.3	31.9	10.4				
Component loads	50153	2132	1708	559	42.5	34.1	11.1	2368	1411	34.8	20.7
fraction of CBECS	0.74	0.82	0.79	0.79							

* subsector represented by LBNL prototypes

Table 39 . Comparison of Component Loads Analysis to Other Projections of Commercial Building Energy Use

	Component Loads Analysis *	1992 CBECS	1995 CBECS	1995 AEO for 1993	1997 AEO for 1995	1995 GRI for 1993	1997 GRI for 1995
Space Heating	**1.37**	**1.92**	**1.69**	**1.73**	**1.61**	**2.71**	**2.67**
Natural Gas	1.31		1.09	1.33	1.30	1.63	1.79
Fuel Oil			0.15	0.31	0.20	0.69	0.58
District Heat			0.34				
Electricity	0.05		0.11	0.09	0.11	0.39	0.30
Space Cooling	**0.42**	**0.46**	**0.34**	**0.30**	**0.61**	**0.84**	**0.92**
Natural Gas	0.00		(under Other)	0.01	0.03	0.09	0.13
Electricity	0.42		0.34	0.29	0.58	0.75	0.79
Ventilation	**0.43**	**0.17**	**0.16**	**0.30**	**0.17**	(not reported)	**0.18**
Water Heating	**0.38**	**0.86**	**0.57**	**0.41**	**0.71**	**0.66**	**0.69**
Natural Gas	0.38		0.52	0.35	0.48	0.39	0.43
Fuel Oil				0.03	0.06	0.14	0.12
Electricity			0.05	0.03	0.17	0.13	0.14
Lighting	**1.45**	**1.16**	**1.20**	**1.06**	**1.21**	**1.25**	**1.28**
Other End-Uses	**0.80**	**0.93**	**0.93**	**2.94**	**2.49**	**1.43**	**1.41**
Natural Gas	0.12		0.33	1.29	1.35	0.89	0.79
Fuel Oil			-0.15	0.46	0.15	0.00	0.05
Electricity	0.68		0.75	1.19	0.99	0.54	0.57
Total Energy Use	**4.84**	**5.49**	**4.89**	**6.75**	**7.15**	**6.90**	**7.15**
Natural Gas	1.81	2.17	1.95	2.98	3.16	3.00	3.14
Fuel Oil		0.27		0.80	0.41	0.84	0.74
District Heat		0.43	0.34				
Electricity	3.04	2.61	2.61	2.96	3.23	3.07	3.26
Other				0.01	0.35		

* scaled by 1.28 to account for building types not included based on energy use ratio from 1992 CBECS.

Figure 1. North and South Regions

Figure 2. U.S. Climate Zones

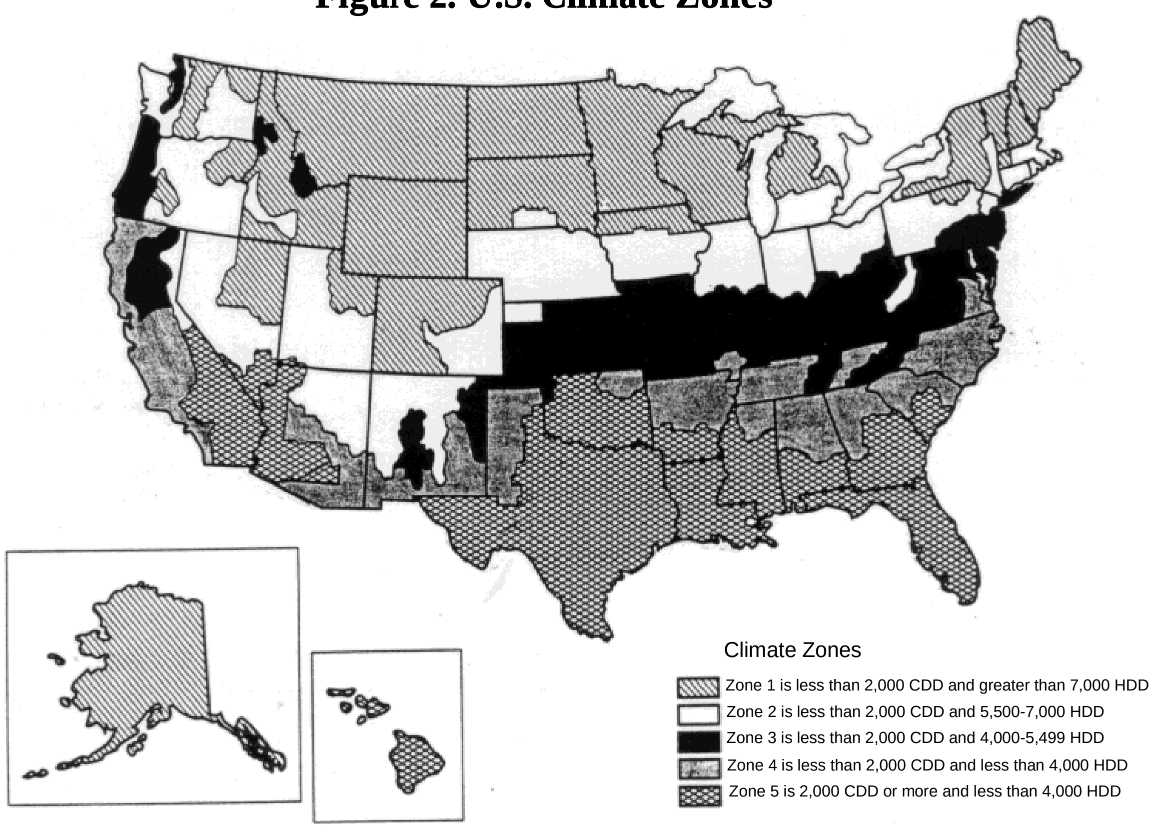
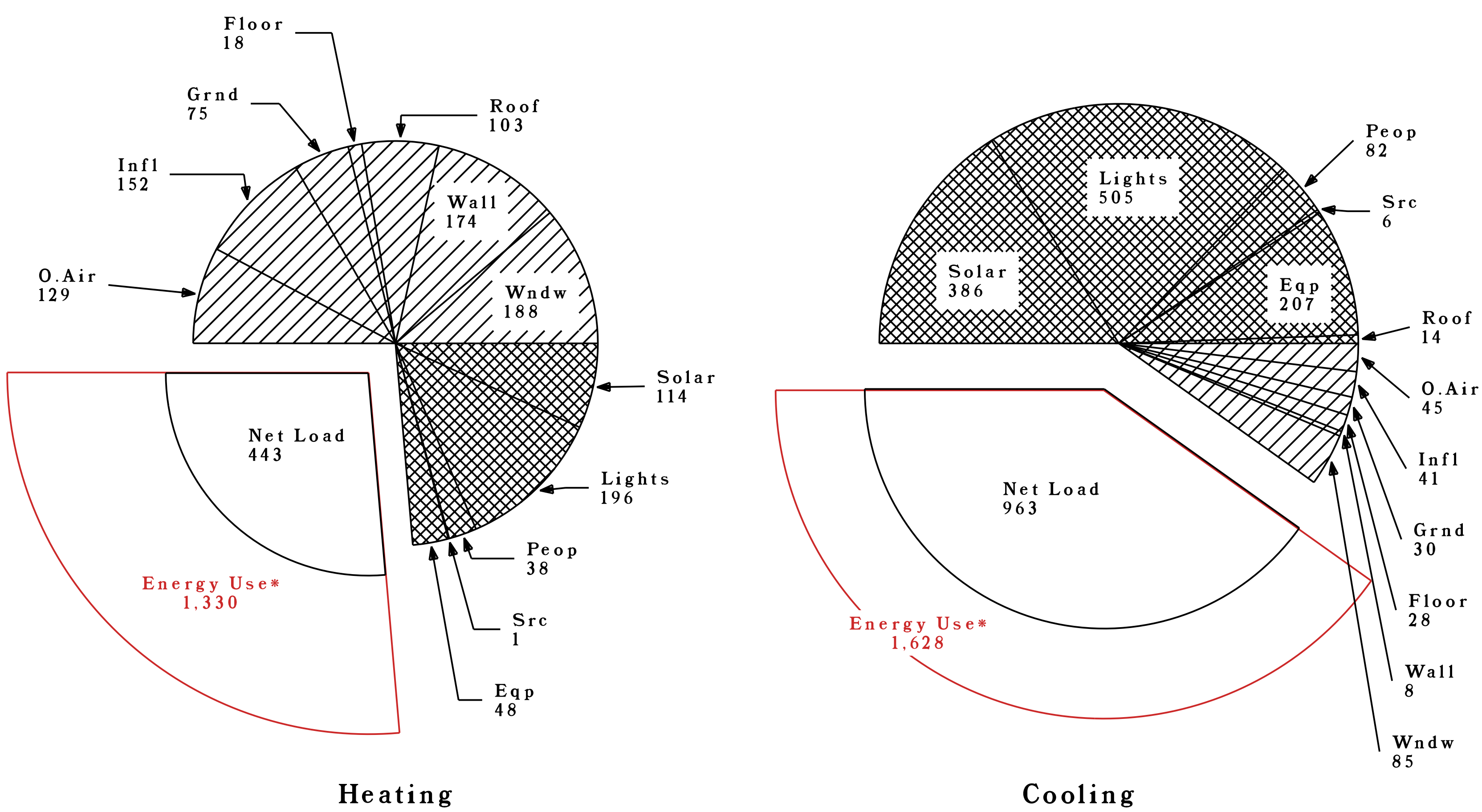
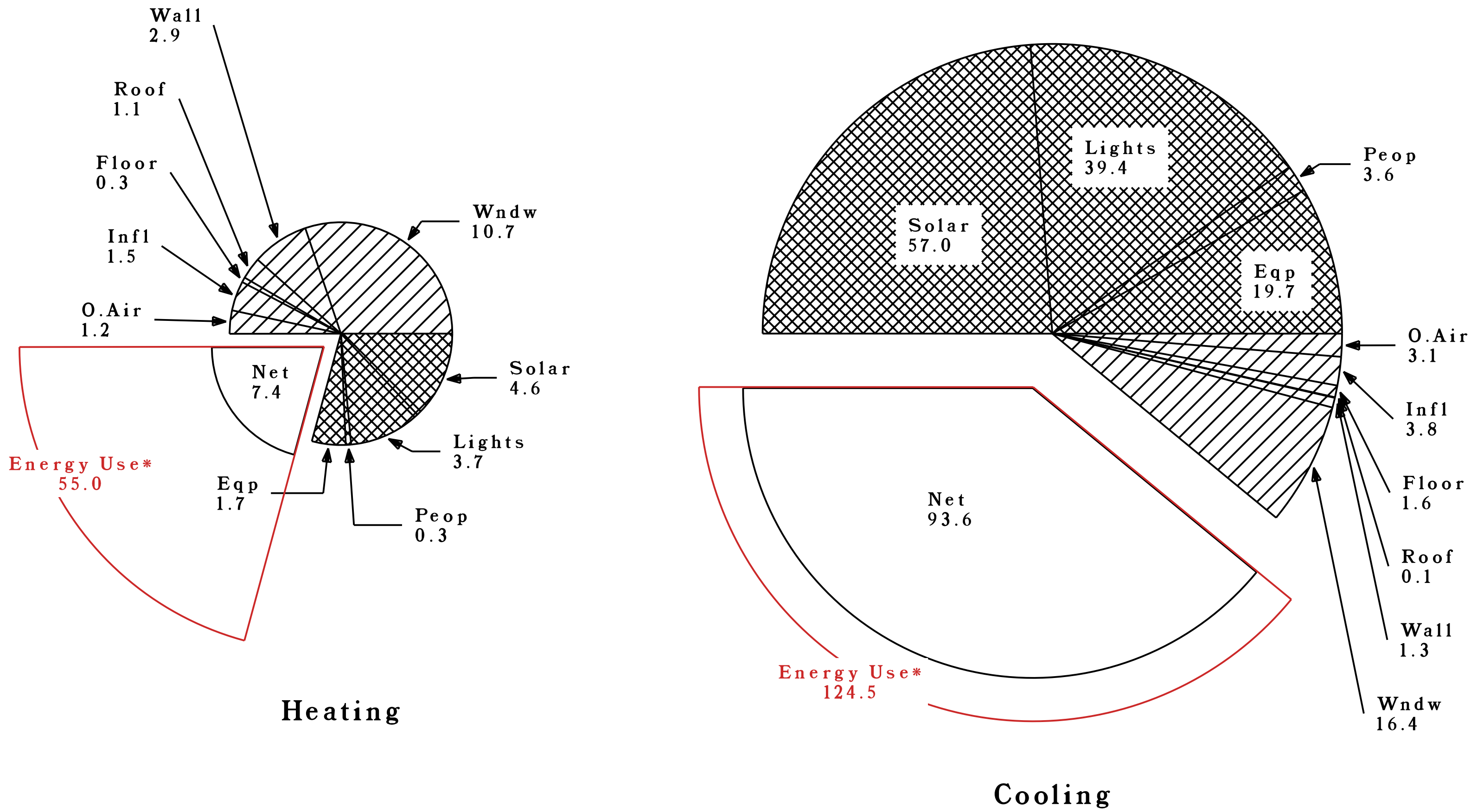


Figure 3. Aggregate Component Loads for All Commercial Buildings (Trillion Btu's)



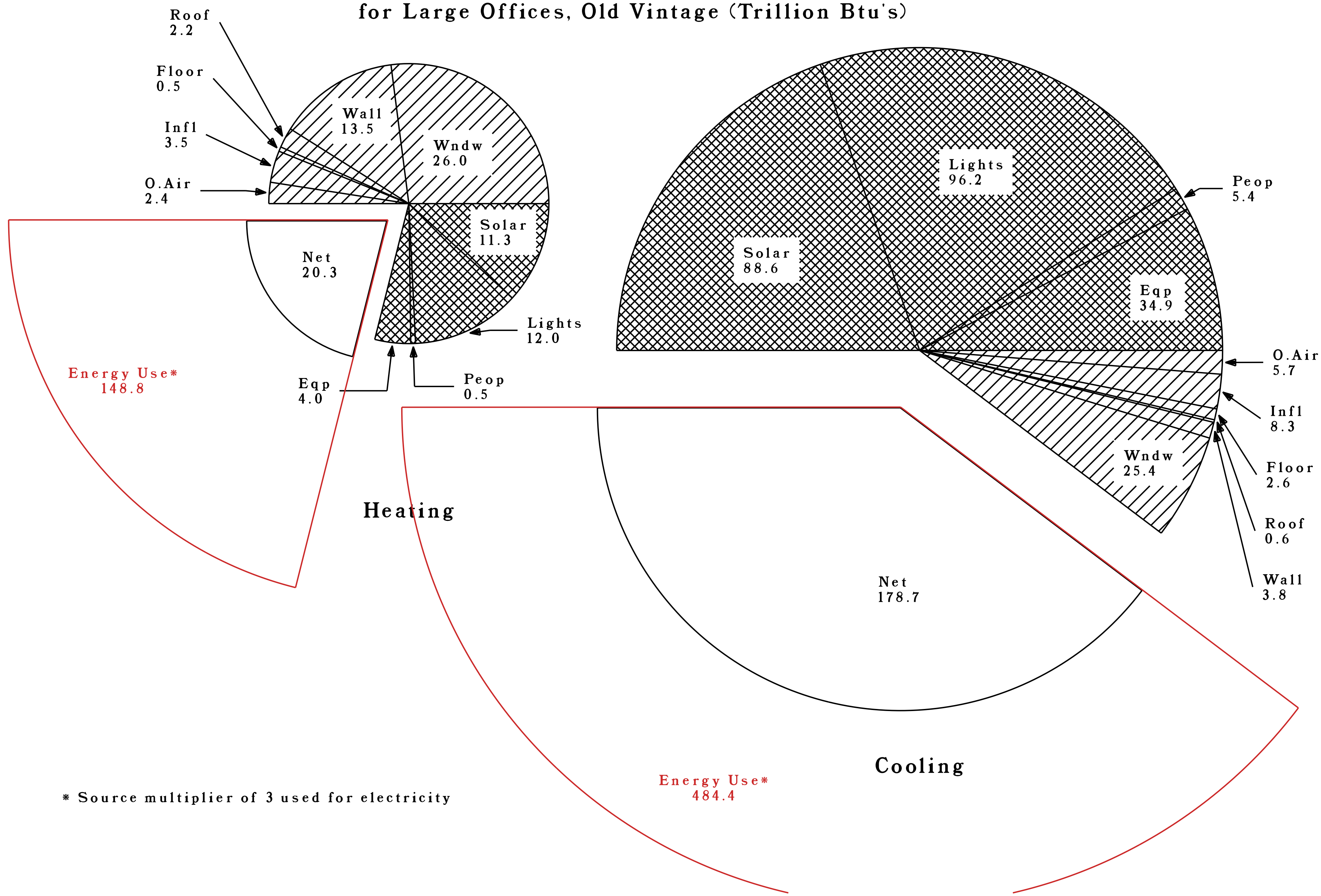
* Source multiplier of 3 used for electricity

Figure 4. Aggregate Component Loads for Large Offices, New Vintage (Trillion Btu's)



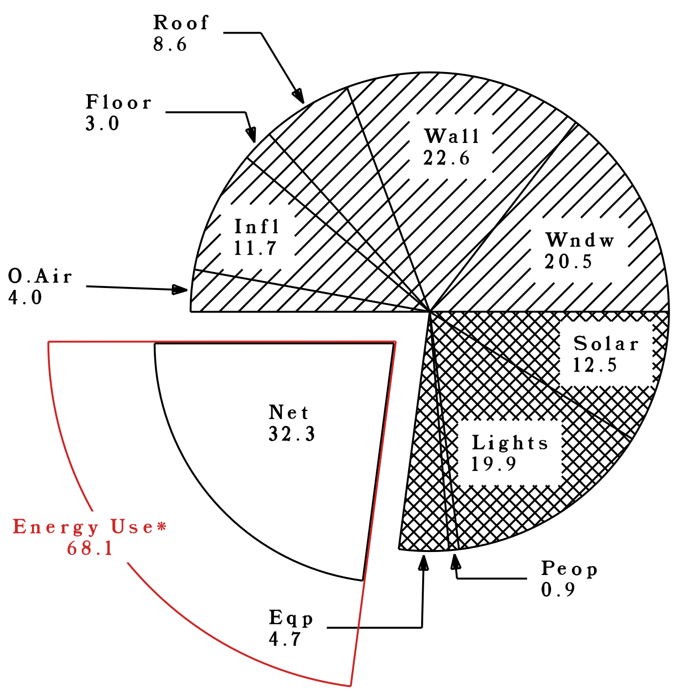
* Source multiplier of 3 used for electricity

Figure 5. Aggregate Component Loads for Large Offices, Old Vintage (Trillion Btu's)

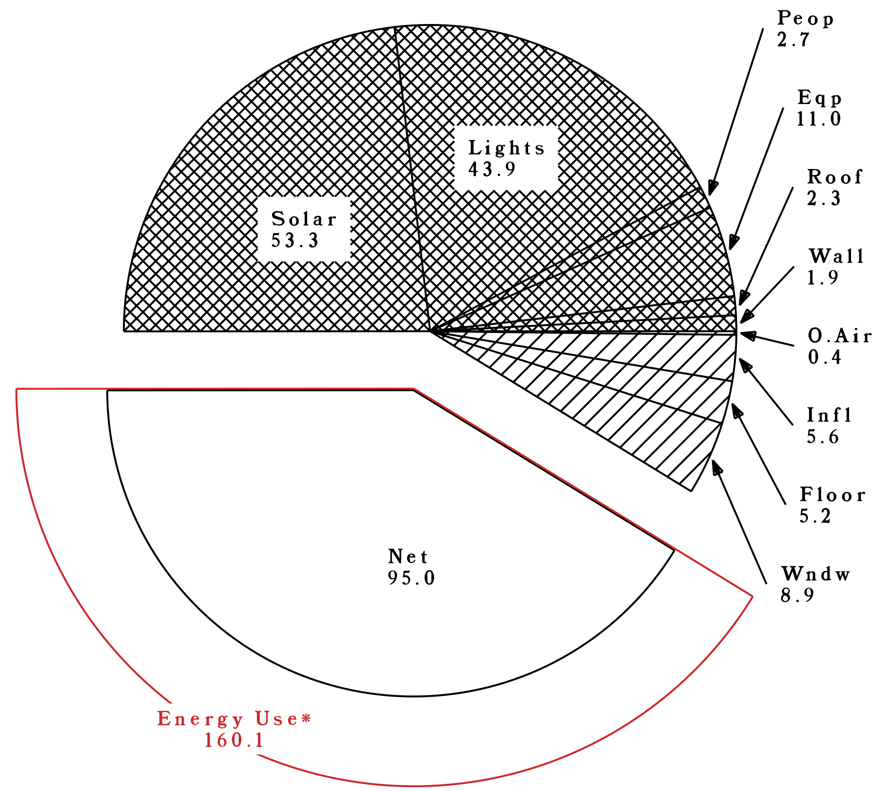


* Source multiplier of 3 used for electricity

Figure 6. Aggregate Component Loads for Small Offices (Trillion Btu's)



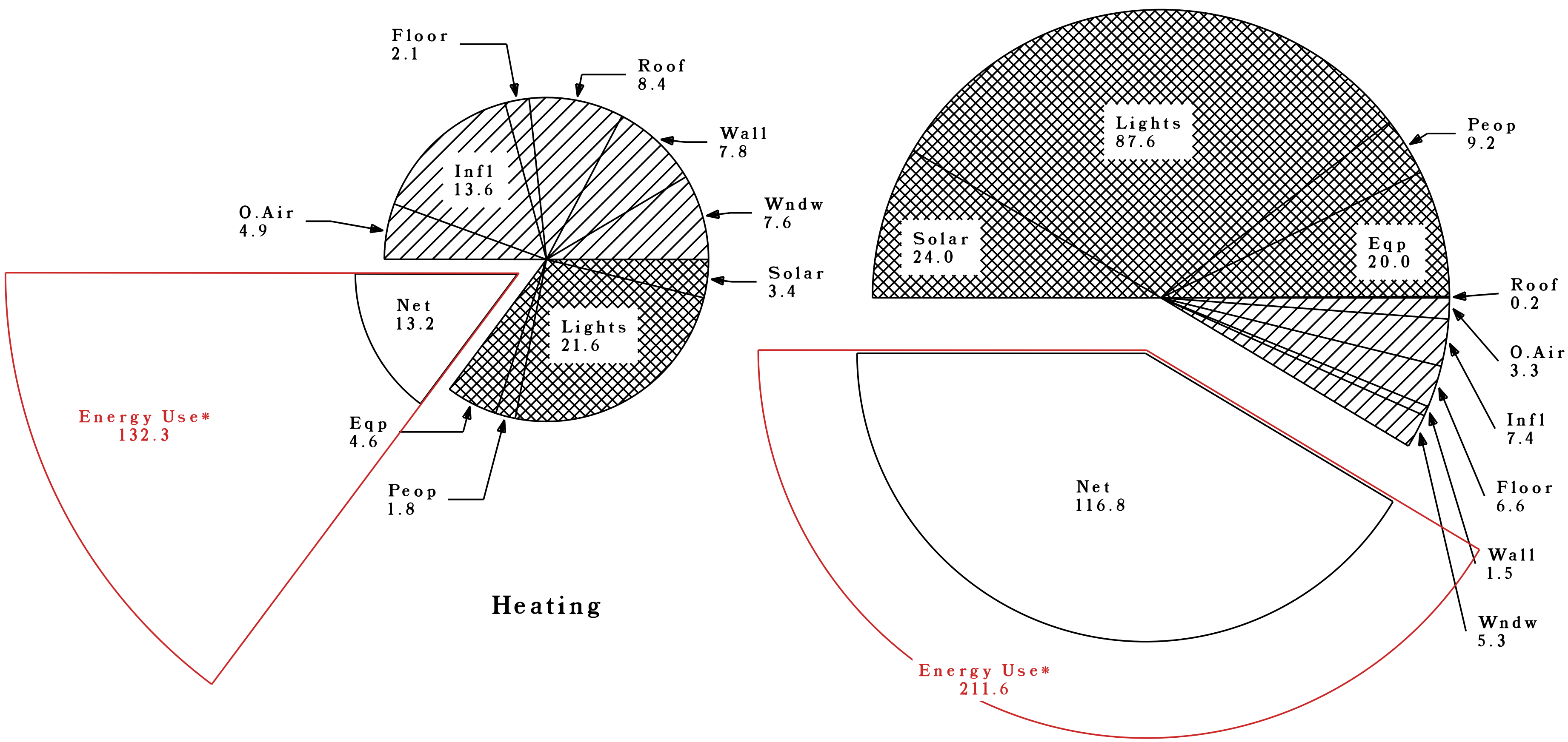
Heating



Cooling

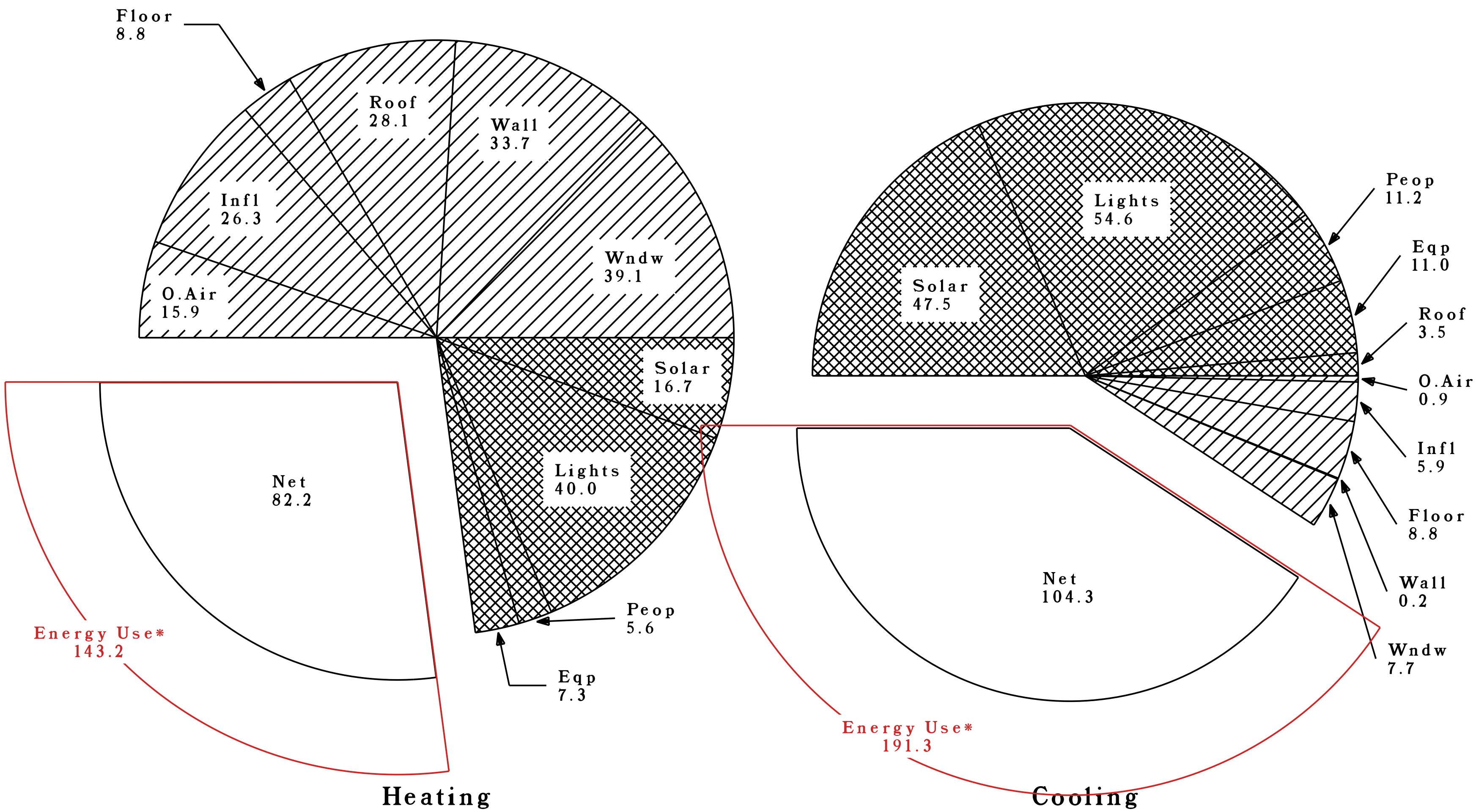
* Source multiplier of 3 used for electricity

Figure 7. Aggregate Component Loads for Large Retails (Trillion Btu's)



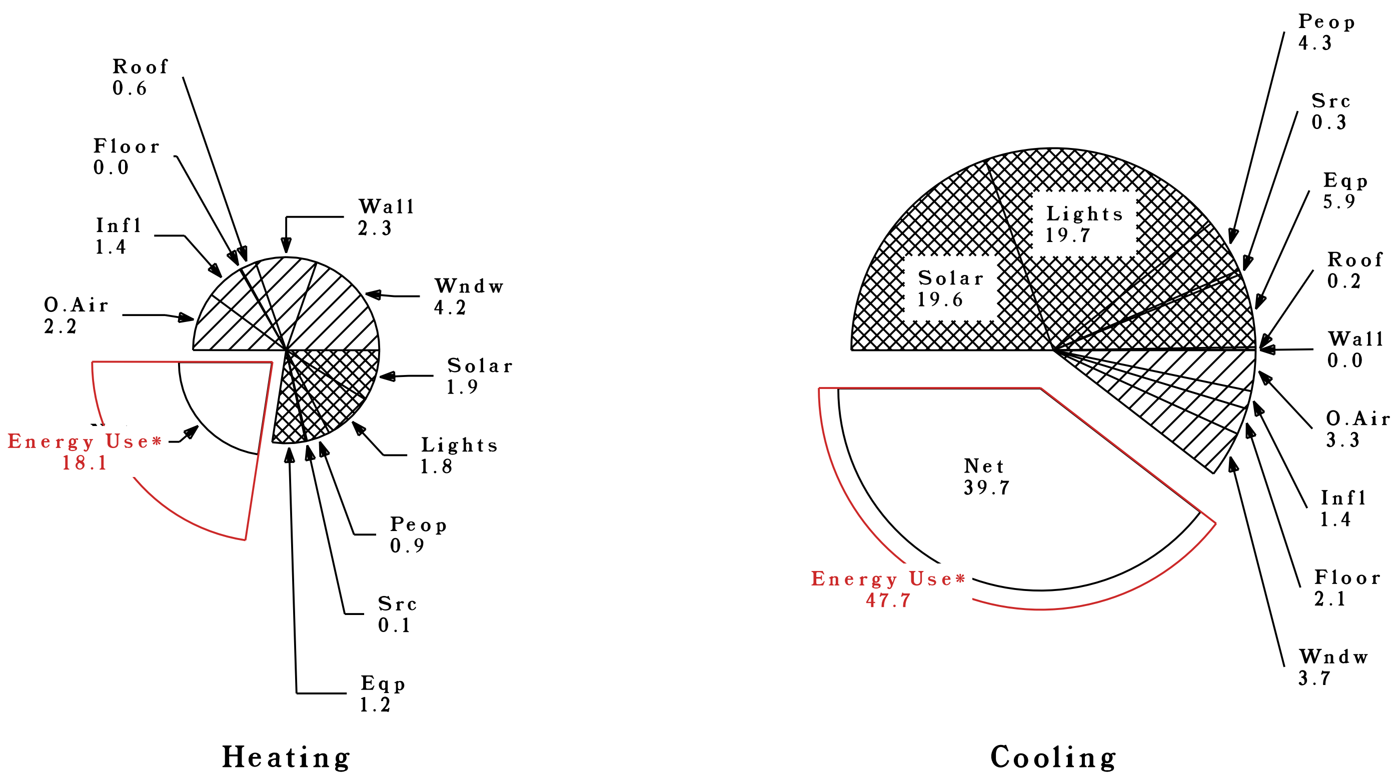
* Source multiplier of 3 used for electricity

Figure 8. Aggregate Component Loads
for Small Retails (Trillion Btu's)



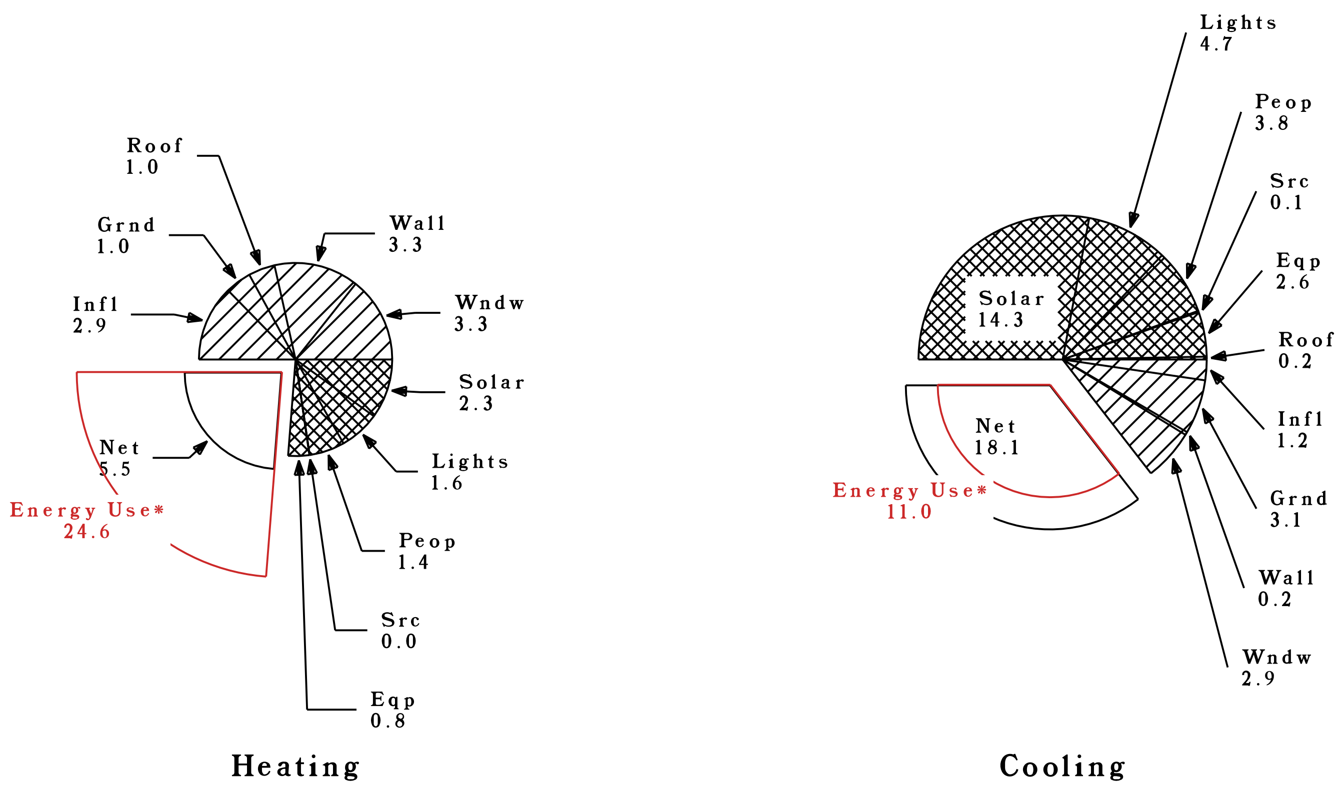
* Source multiplier of 3 used for electricity

Figure 9. Aggregate Component Loads for Large Hotels (Trillion Btu's)



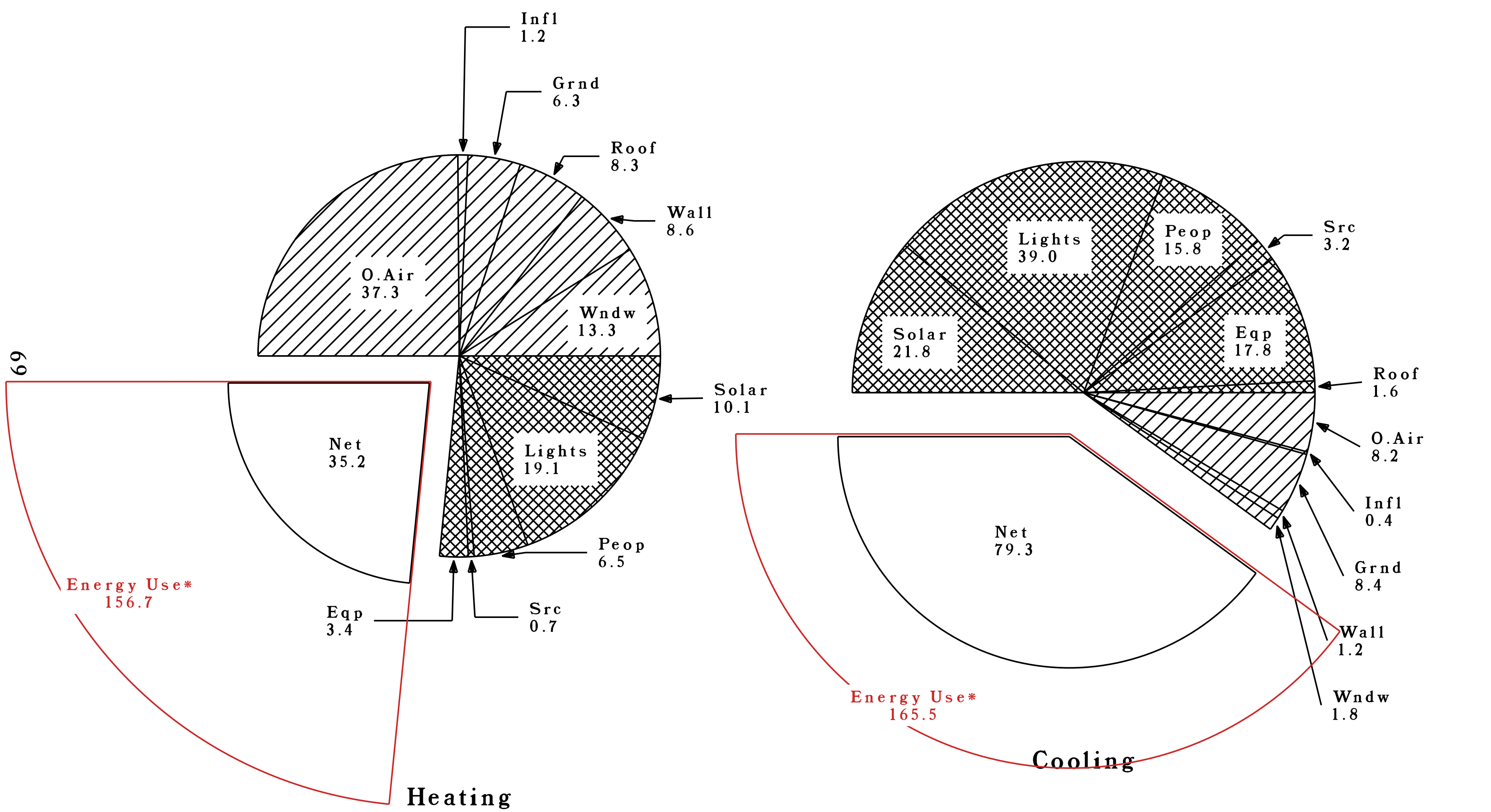
* Source multiplier of 3 used for electricity

Figure 10. Aggregate Component Loads for Small Hotels, Old Vintage (Trillion Btu's)



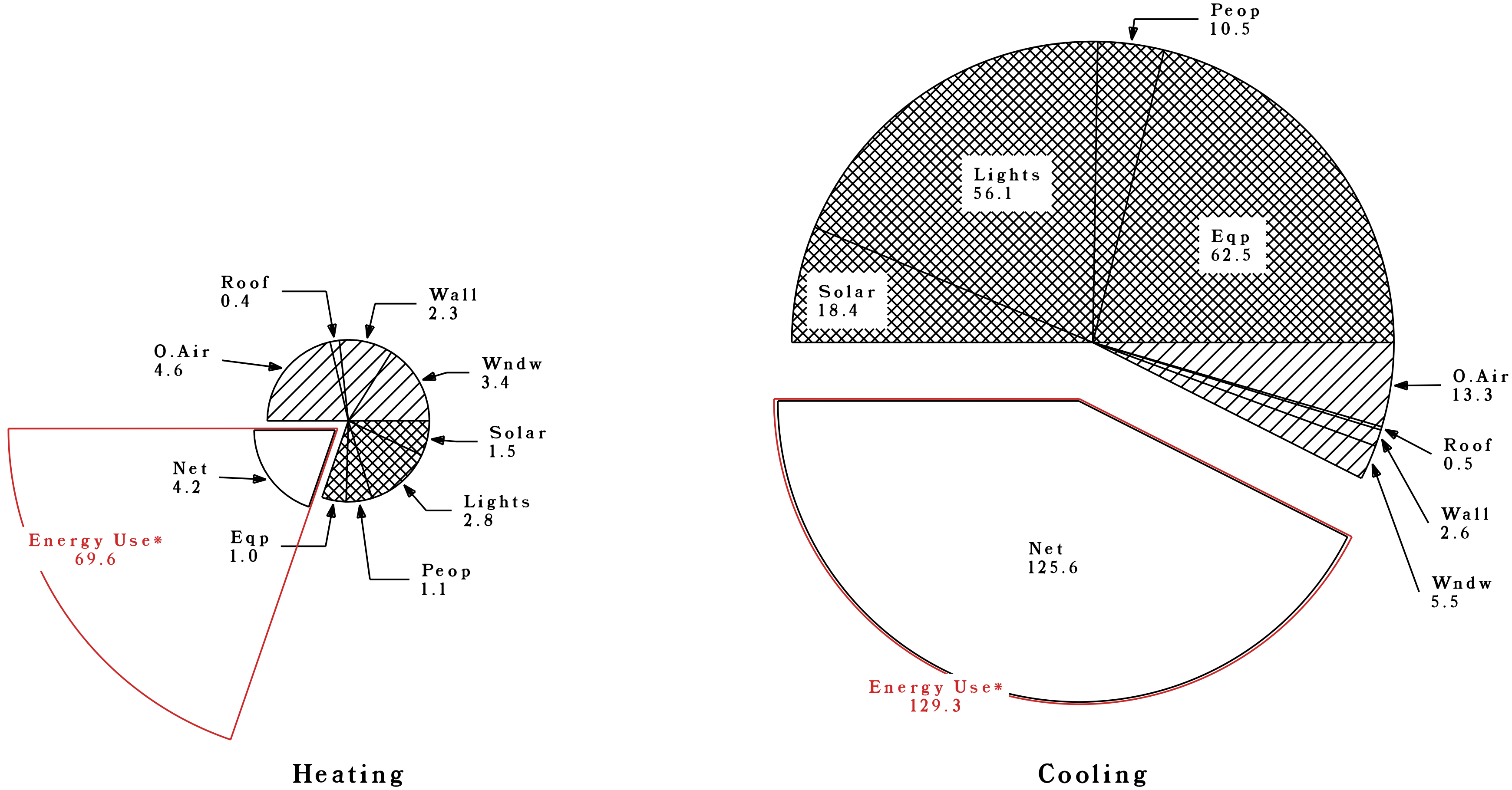
* Source multiplier of 3 used for electricity

Figure 11. Aggregate Component Loads for Restaurants (Trillion Btu's)



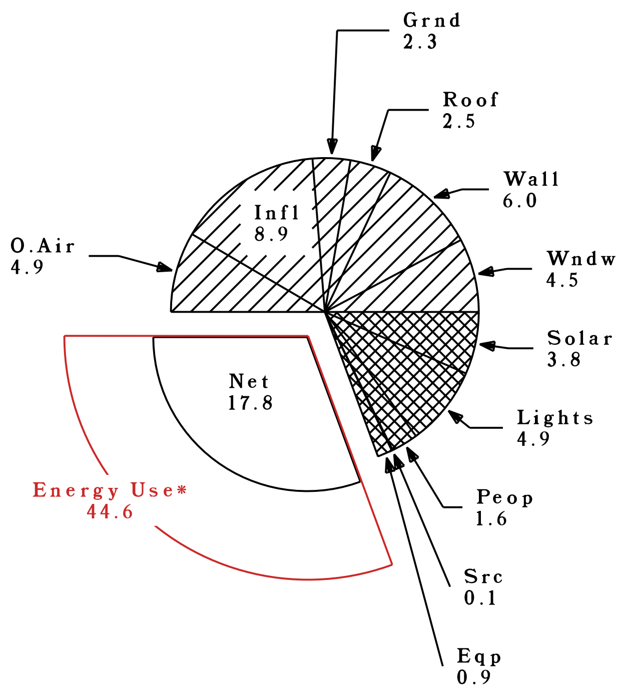
* Source multiplier of 3 used for electricity

Figure 12. Aggregate Component Loads for Hospitals (Trillion Btu's)

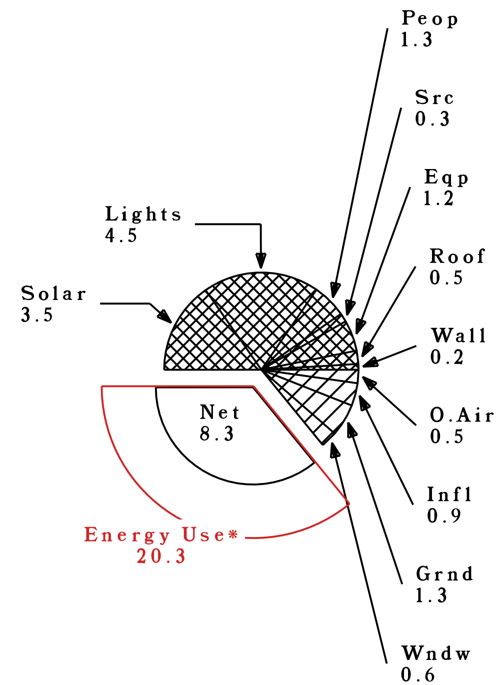


* Source multiplier of 3 used for electricity

Figure 13. Aggregate Component Loads for Schools, New Vintage (Trillion Btu's)



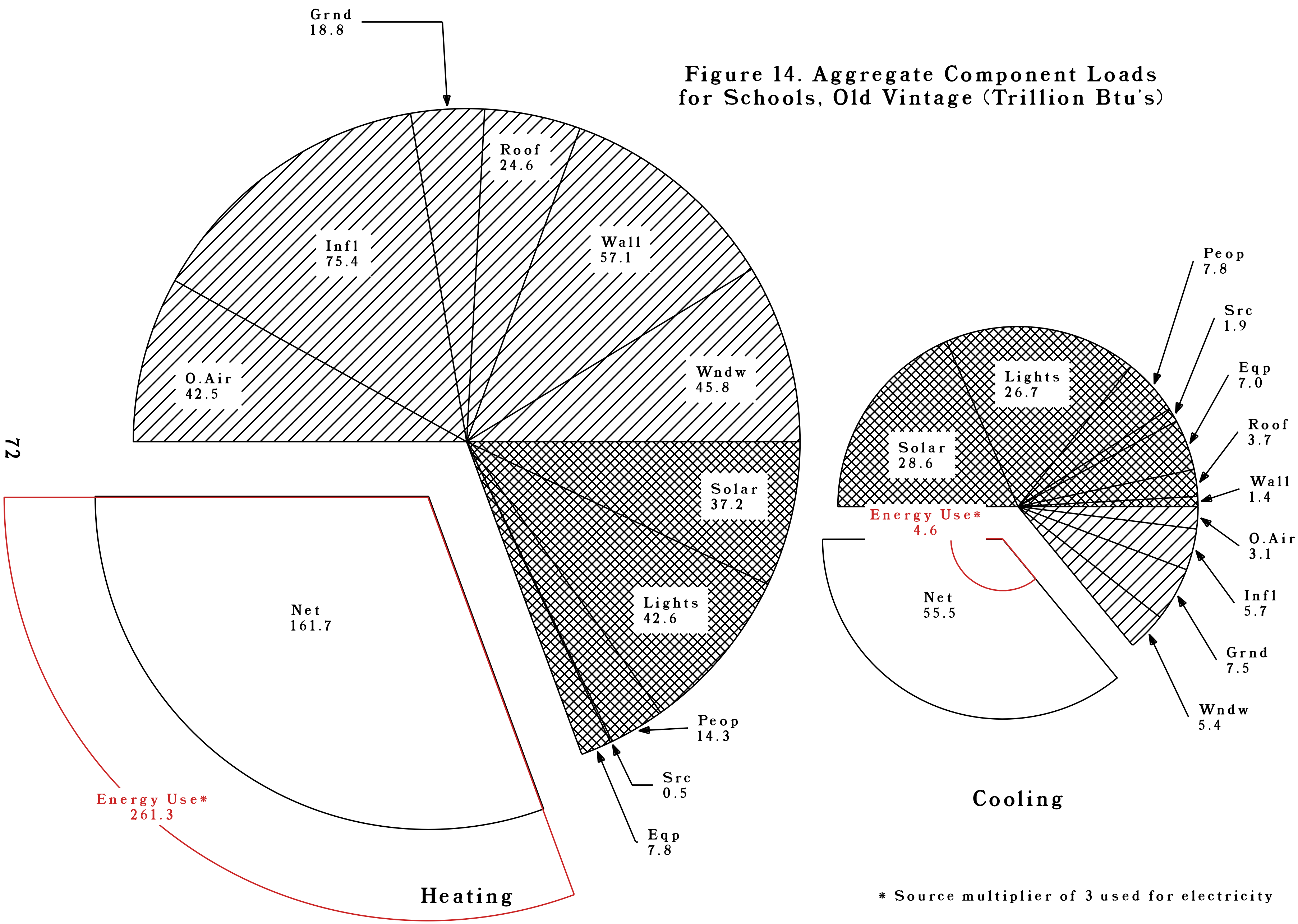
Heating



Cooling

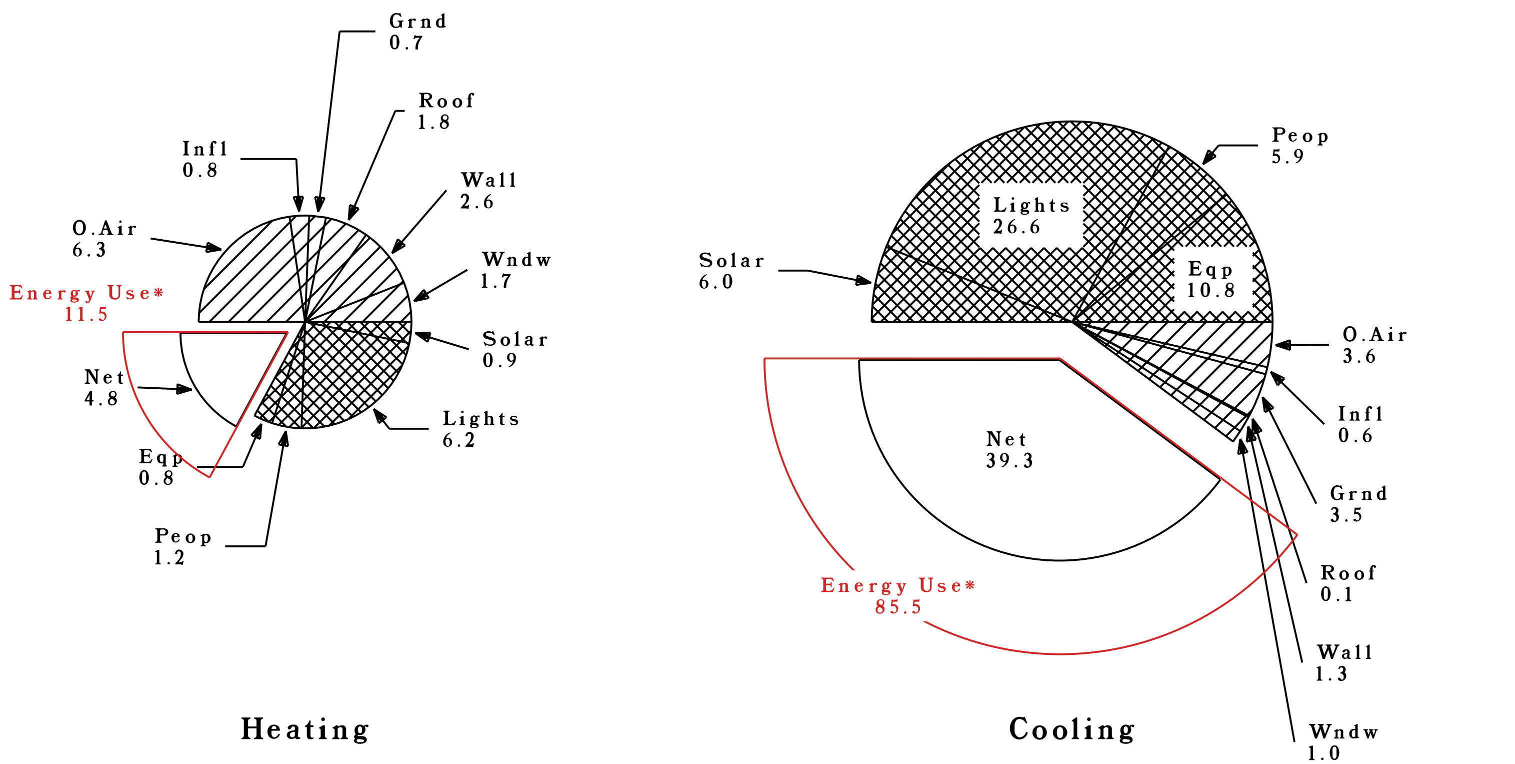
* Source multiplier of 3 used for electricity

Figure 14. Aggregate Component Loads for Schools, Old Vintage (Trillion Btu's)



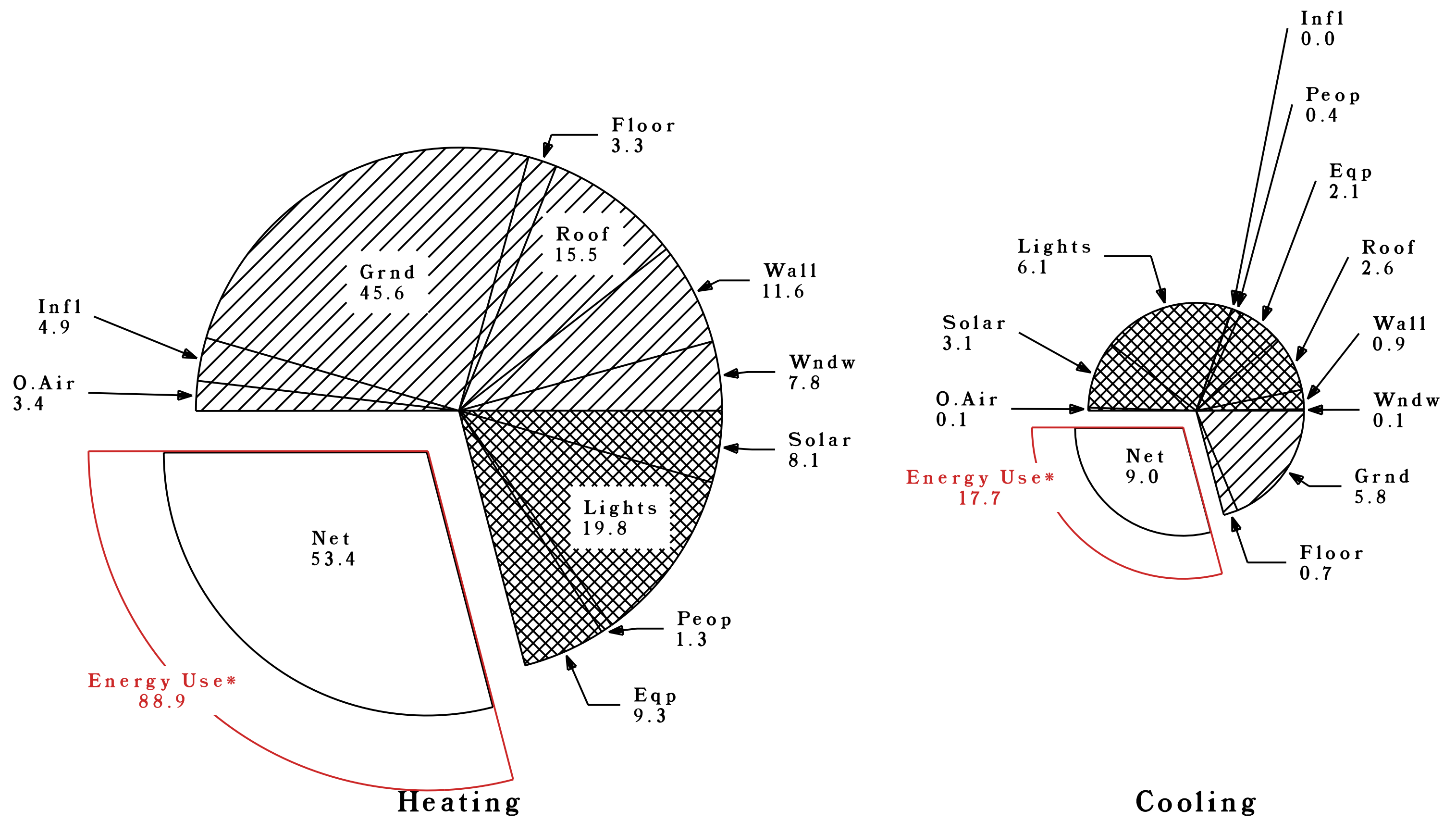
* Source multiplier of 3 used for electricity

Figure 15. Aggregate Component Loads for Supermarkets (Trillion Btu's)



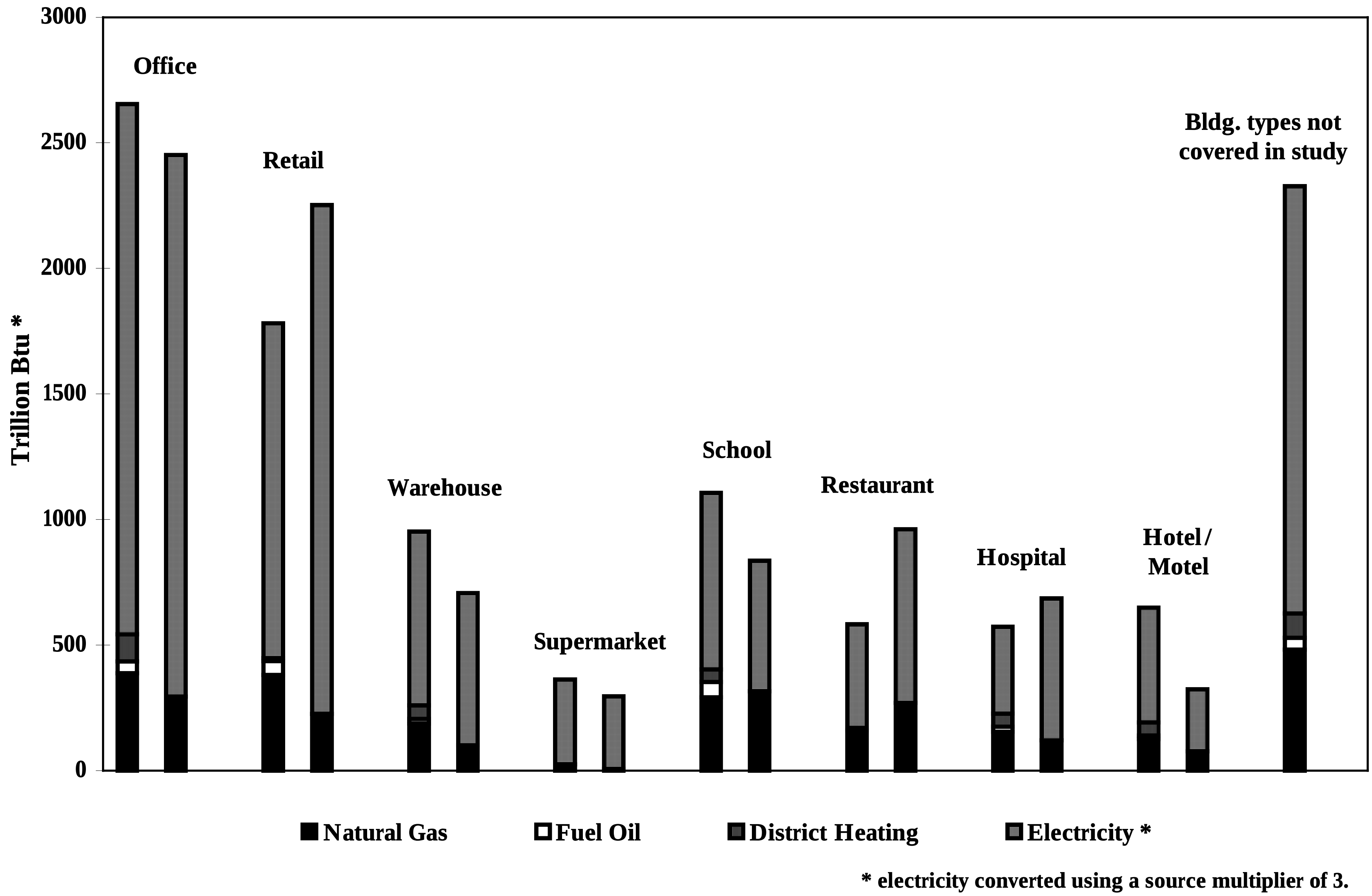
* Source multiplier of 3 used for electricity

Figure 16. Aggregate Component Loads for Warehouses (Trillion Btu's)



* Source multiplier of 3 used for electricity

Figure 17. Comparison of Component Loads Analysis Project Commercial Building Primary Energy Use to 1992 CBECS (CBECS on left bars, Component Study on right bars)



APPENDIX A. DESCRIPTIONS OF ENGINEERING STUDIES REVIEWED

The following lists the existing building prototypes reviewed in Section 3 of this report. Table 1 shows the prototypes by building type and geographical location, with the projects or studies identified by short acronyms shown below.

1. *BPA : United Industries Corporation 1988, "DOE-2 Commercial Building Prototype Review and Revision", done for the Bonneville Power Administration.* This study developed ten prototypical buildings of two vintages for the Pacific Northwest building on the results from an earlier commercial sector conservation analysis done by Synergic Resources Corporation (SRC) in 1983. The building types covered are : large and small office, large and small retail, fast food restaurant, grocery, hotel, school warehouse, and hospital. Two vintages were considered for pre- and post-1980 construction. Simulations were done using the DOE-2.1B program and the results correlated to measured energy consumption data from utility surveys. The UIC prototypes were also used in a 1991 study by the Northwest Power Planning Council (NWPCC).

2. *CCIG : NEOS Corporation 1994, "Technology Energy Savings, Volume II : Building Prototypes", done for the California Conservation Inventory Group.* This draft report describes 16 prototypical buildings (large and small offices, large and small retail stores, sit-down and fast-food restaurants, grocery store, refrigerated and non-refrigerated warehouses, hospital, nursery home, primary and high schools, college, hotel, and motel) developed for use in analyzing the conservation potentials in California buildings. The report defines the size and general layout of the buildings, insulation levels, window areas, and lighting intensities based on utility survey data.

3. *Cogen : Huang, Y.J. et al., Lawrence Berkeley National Laboratory, 1991, "481 Prototypical Commercial Buildings for Twenty Urban Market Areas", done for the Gas Research Institute.* The objective of this project was to evaluate the potential for cogeneration in commercial buildings in twenty large urban areas comprised of 13 cities. Prototypical buildings were defined for 13 large or energy-intensive building types judged to be good candidates for cogeneration (12 and 24 hour offices, hospital, 18 or 24 hour supermarkets, fast-food and sit-down restaurants, secondary school, prison, large apartment, large retail, large hotel, and hotel/motel). For each prototype, 13 city variations and 3 vintage/equipment combinations were considered, combining for a total of 481 prototypical buildings. The building descriptions were based on review of previous studies, and roughly calibrated to the 1983 NBECS data base for total building energy use and fuel/electric ratio.

4. *ConEd : XEnergy, Inc. 1987c, "Study of energy end uses and conservation potential in selected segments of the commercial class", done for the Consolidated Edison Company of New York.* DOE-2.1 prototypes were developed for 6 building types - large offices, large hotels, hospitals, retail, supermarkets, and schools - and 7 end-uses - heating, cooling, lighting, DHW, cooking, refrigeration, and others. The building parameters are based on a survey of 184 buildings in ConEd's service territory.

5. *EPRI : XEnergy, Inc. 1988, "TAG™ Technical Assessment Guide", done for the Electric Power Research Institute.* This study developed prototypes of two vintages (ASHRAE 90-75 and ASHRAE 90.1) for 9 building types : low-rise (medium) and high-rise (large) offices,

restaurants, retail, grocery, warehouse, school, health, and lodging. The prototypes are not city or regionally specific but have been simulated for El Paso, Lake Charles, Madison, Seattle, and Washington.

6. *FPL : Synergic Resources Corp., 1986a, "Cool Storage Market Assessment in Florida Power and Light's Service Area", done for Florida Power and Light.* Prototype buildings were developed for 11 building types and 8 end-uses. The building types are : Large and small offices, retail, school, higher education, hospital, hotel, restaurant, civic center, movie, and church. The end-use estimates are based on a large on-site data collection effort involving about 1200 buildings.

7. *Gard : Chamberlain GARD 1990, "Simulation and analysis of integrated gas-fired desiccant dehumidification and mechanical and absorption cooling systems for commercial buildings", done for the Gas Research Institute.* 15 prototypical buildings were defined and modeled on DOE-2 for the following building types : apartment, church, bar/lounge, health club, hospital, hotel, large, medium, and small offices, nursing home, retail, restaurant, school, strip store, and warehouse. All prototypes are based on actual building plans; most were taken from previous input files developed by PNL in ASHRAE SP-41 (see ref.).

8. *LBNLS : T. Webster et al. 1985 ."Passive Solar Opportunities in Educational Buildings",* This study done primarily at Lawrence Berkeley Laboratory investigated the energy conservation potentials in schools. A prototypical secondary school was described, including building geometry, architectural layout, operating and end-use schedules.

9. *MEOS : Synergic Resources Corp. 1987a, done for the Michigan Energy Options Study.* Building prototypes were defined and ADM-2 input files developed for ten building types - large and small offices, large and small retail, supermarket, fast foods restaurant, school, hospital, warehouse, and hotel/motel. Two vintages were defined for the large office and large retail, and a single vintage defined for the others. The prototypes were based on utility survey data for over 320 buildings, supplemented with engineering reports and incorporation of local energy standards.

10. *NEU1 : Synergic Resources Corp. 1985, "New office buildings end-use energy consumption survey", done for the Northeast Utilities Service Company* Prototype descriptions for large, medium, and small new office buildings were developed from an on-site survey of 61 office buildings of various sizes. Ten prototypical office buildings were defined for three sizes (large, medium, and small), two vintages (new and existing), and differing internal load conditions (with and without a computer).

11. *NEU2 : Applied Management Sciences, Inc. 1987b, "End-use energy consumption survey for office buildings--conservation analysis", done for the Northeast Utilities Service Company.* This source provides prototype descriptions for large, medium and small stock office buildings developed from an on-site survey.

12. *NEU3 : Synergic Resources Corp. 1986b, "Education and health buildings end-use energy consumption survey", done for the Northeast Utilities Service Company.* ADM-2 prototypes were developed for 10 buildings types (primary school, secondary school, college dormitory, college classroom/administration building, college student center/dining, vocational/ technical school, hospital, nursing home, large and small physician's office)

and 8 end uses (heating, cooling, ventilation, lighting, water heating, refrigeration, cooking, miscellaneous). The input data to this study are from 60 ICP buildings and supplementary on-site survey of 62 buildings.

13. *PGE : Akbari, H. et al.. Lawrence Berkeley Laboratory, 1994, "Integrated Estimation of Commercial Sector End-Use Load Shapes and Energy Use Intensities", done for the Pacific Gas and Electric Company.* This project is very similar to a previous 1989 study for SCE (Akbari et al. 1989) except it was done for the Pacific Gas and Electric Utility Company. The methodology included developing prototypical buildings of two vintages (pre- and post-1983) for Northern California based on on-site survey data. These prototypical buildings were then simulated using DOE-2, and the resultant load shapes compared to measured electricity consumption. The final results are detailed hourly load shapes by end-use and building type that are reconciled to measured whole-building load shapes. As of 1994, the reconciled end-use load shapes have not been incorporated into the original prototype descriptions. The study covered the following building types - small and large offices, large retail, sit-down and fast-foods restaurants, food store, primary and secondary schools, hospital, nursing home - and the following end uses - lighting, lighting, miscellaneous electric equipment, cooking, water heating, ventilation, and cooling (?).

14. *PNL : Briggs et al., Pacific Northwest Laboratories, 1989, "Analysis and Categorization of the Office Building Stock", done for the Gas Research Institute.* Building characteristics were defined and DOE-2 prototypes developed for 20 offices based on cluster analysis of U.S. office building stock. The characteristics were developed through analysis of the 1983 NBECS survey data of commercial buildings

15. *SCE : Akbari, H., et al., Lawrence Berkeley Laboratory 1989, "Integrated estimation of commercial sector end-use load shapes and energy use intensities", done for the Southern California Edison Company and the California Energy Commission.* The objective of this study was to develop end-use load shapes and intensities by building sector for use in utility and commission forecasts. The methodology included developing prototypical buildings for Southern California based on on-site survey data. These prototypical buildings were then simulated using DOE-2, and the resultant load shapes compared to measured electricity consumption. The final results are detailed hourly load shapes by end-use and building type that are reconciled to measured whole-building load shapes. The study covered the following building types - small office, large office, small retail, large retail, food store (supermarket), sit-down restaurant, fast-food restaurant, refrigerated warehouse, and non-refrigerated warehouse - and the following end uses - indoor lighting, outdoor lighting, miscellaneous electric equipment, cooking, water heating, ventilation, and cooling.

16. *SP-41 : Pacific Northwest Laboratories 1983, "Recommendations for energy conservation standards and guidelines for new commercial buildings", done for the U.S. Department of Energy and the American Society of Heating, Refrigeration, and Air-Conditioning Engineers. (ASHRAE).* This report describes DOE-2 prototypes developed by PNL for ASHRAE SP-41 in support of commercial building energy standards. The building types covered include offices (small, medium, and large), retail (small, large), schools (elementary, high school), apartment, hotel, warehouse, church, school, restaurant, and hospital. Actual buildings were selected as representative of that building type and modeled using the DOE-2 program. Most of the prototypes were also used in the GARD study (see ref.).

17. *UTA : Hunn, Akbari et al., University of Texas at Austin, 1985, "Technology Potential for Electric Energy Conservation and Peak Demand Reduction in Texas Buildings", done for the Public Utility Commission of Texas.* This report documents an assessment of conservation potentials in buildings for the Public Utility Commission of Texas. The commercial portion of the study includes three prototypical office, retail, and educational buildings modified from the original ASHRAE SP-41 prototypes (see ref.).

APPENDIX B. FLOOR AREA BY BUILDING SECTOR

source : 1992 Commercial Building Energy Consumption Survey (EIA 1995)

Vinage	Region	Heating Area by Climate Zone (million ft²)					Cooling Area by Climate Zone (million ft²)				
		1 (Min)	2 (Chi)	3 (Was)	4 (LA)	5 (Hou)	1 (Min)	2 (Chi)	3 (Was)	4 (LA)	5 (Hou)
Large Office											
Old	North	200.9	1333.8	949.5	0.0	0.0	146.9	1096.0	855.5	0.0	0.0
New	North	95.1	610.0	276.4	0.0	0.0	76.6	562.8	257.9	0.0	0.0
Old	South	38.5	287.7	795.8	996.2	428.8	38.5	264.6	906.3	983.2	324.7
New	South	0.0	95.0	280.0	686.3	548.1	0.0	94.8	277.3	701.9	548.7
Small Office											
Old	North	236.5	601.9	388.7	0.0	0.0	201.3	522.8	344.5	0.0	0.0
New	North	30.8	134.6	109.7	0.0	0.0	30.6	132.8	118.1	0.0	0.0
Old	South	82.9	59.9	147.9	591.4	525.8	64.3	59.9	128.6	592.6	524.1
New	South	0.0	16.3	104.6	349.7	276.7	0.0	16.3	97.9	344.5	272.3
Large Retail											
Old	North	274.9	776.4	620.3	0.0	0.0	242.9	351.7	557.6	0.0	0.0
New	North	188.3	671.9	63.9	0.0	0.0	177.0	492.1	61.8	0.0	0.0
Old	South	71.0	30.4	541.7	752.3	477.3	0.9	30.2	367.0	686.4	412.3
New	South	0.0	73.7	114.6	230.6	409.4	0.0	54.1	111.8	201.3	368.4
Small Retail											
Old	North	461.1	1296.2	529.4	0.0	0.0	241.5	817.9	357.1	0.0	0.0
New	North	71.5	188.2	194.9	0.0	0.0	26.2	158.0	145.0	0.0	0.0
Old	South	67.2	174.0	399.7	892.8	803.2	45.5	137.2	261.9	569.4	511.8
New	South	0.0	0.9	136.7	259.7	273.5	0.0	0.9	76.6	187.8	192.8
Large Hotel											
Old	U.S.	98.1	221.0	125.6	117.8	294.1	79.7	92.5	20.3	134.1	302.4
New	U.S.	18.6	39.8	21.4	234.2	156.0	18.5	34.7	15.7	218.7	153.2
Small Hotel											
Old	U.S.	103.3	89.1	67.8	130.9	177.7	94.8	73.0	62.5	146.2	177.2
New	U.S.	0.0	4.4	15.7	55.9	66.7	0.0	4.4	17.4	55.8	67.5
Hospital											
Old	U.S.	71.1	324.4	199.9	390.4	117.6	46.6	285.7	152.1	389.3	123.9
New	U.S.	0.0	85.7	42.7	43.5	8.6	0.0	84.4	42.4	34.5	8.6
School											
Old	North	470.2	2217.8	1249.8	0.0	0.0	217.2	958.9	537.3	0.0	0.0
New	North	33.3	186.1	125.2	0.0	0.0	32.0	139.9	123.2	0.0	0.0
Old	South	16.2	134.3	578.4	1582.7	1116.0	9.7	75.2	426.8	1511.6	1048.5
New	South	69.3	42.3	47.0	206.8	189.8	53.7	45.3	46.2	206.4	188.5
Restaurant											
Old	U.S.	76.4	406.7	288.5	204.3	198.3	65.3	357.4	256.2	195.1	181.5
New	U.S.	4.8	70.7	39.1	43.0	25.8	3.4	64.8	47.2	48.3	24.7
Food Store (Supermarket)											
Old	U.S.	62.4	104.3	100.8	85.3	134.1	63.9	94.0	89.2	86.8	119.6
New	U.S.	3.4	60.9	57.8	35.3	30.2	3.4	60.9	53.4	37.7	26.2
Warehouse											
Old	North	712.1	2019.6	849.4	0.0	0.0	224.4	457.3	214.2	0.0	0.0
New	North	166.8	292.6	486.2	0.0	0.0	88.4	86.7	147.6	0.0	0.0
Old	South	57.2	445.5	631.7	771.7	696.8	9.4	18.7	326.4	377.7	547.7
New	South	1.5	37.0	206.9	588.2	306.8	0.0	3.7	130.0	193.2	232.1

APPENDIX C: SPECIFIC OMPONENT LOAD PIE CHARTS

FOR PROTOTYPICAL COMMERCIAL BUILDINGS

IN MINNEAPOLIS, WASHINGTON, AND HOUSTON

Figure C.1 Specific Component Loads (kBtu/ft²) for Large Offices in Minneapolis

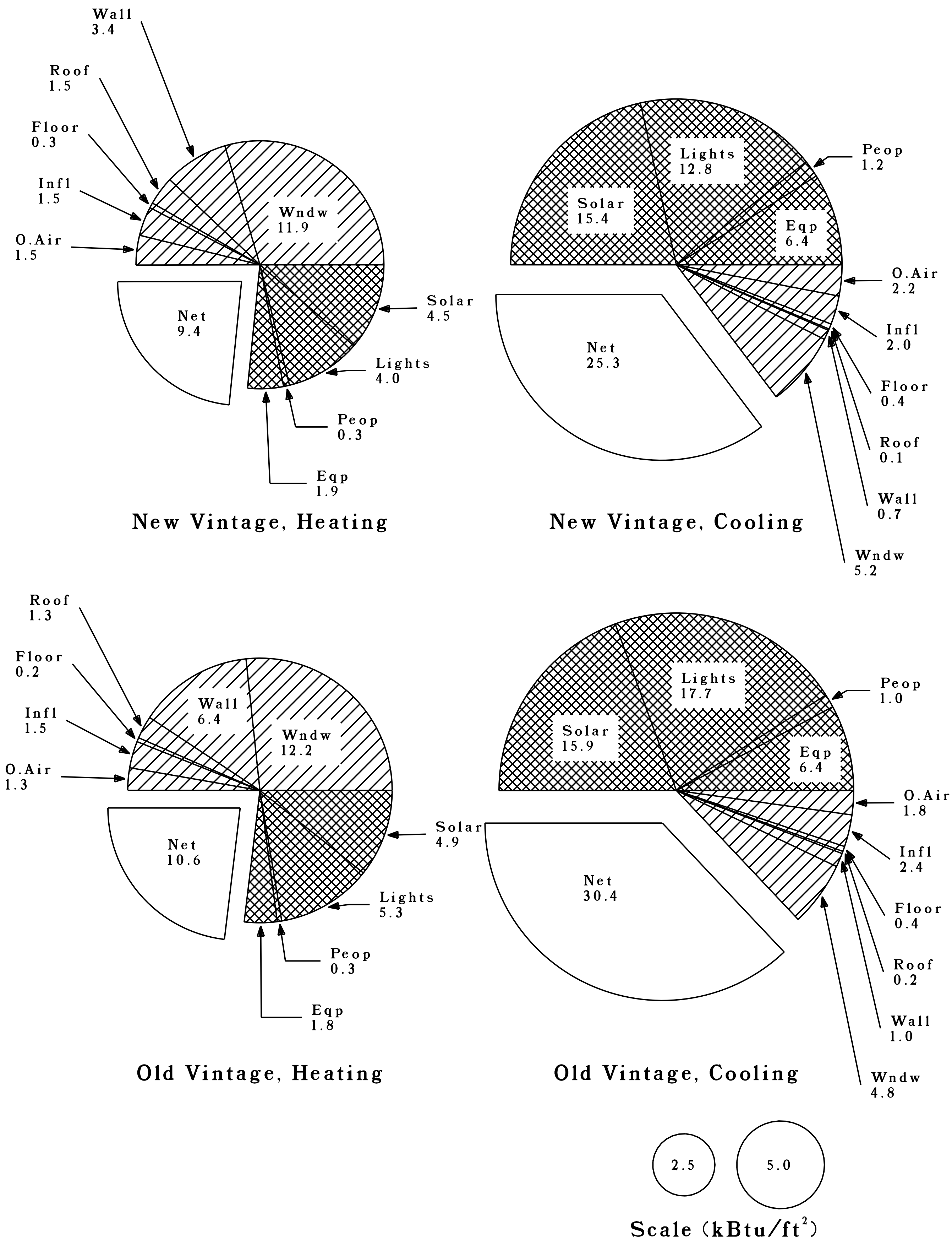


Figure C.2 Specific Component Loads (kBtu/ft^2) for Large Offices in Washington

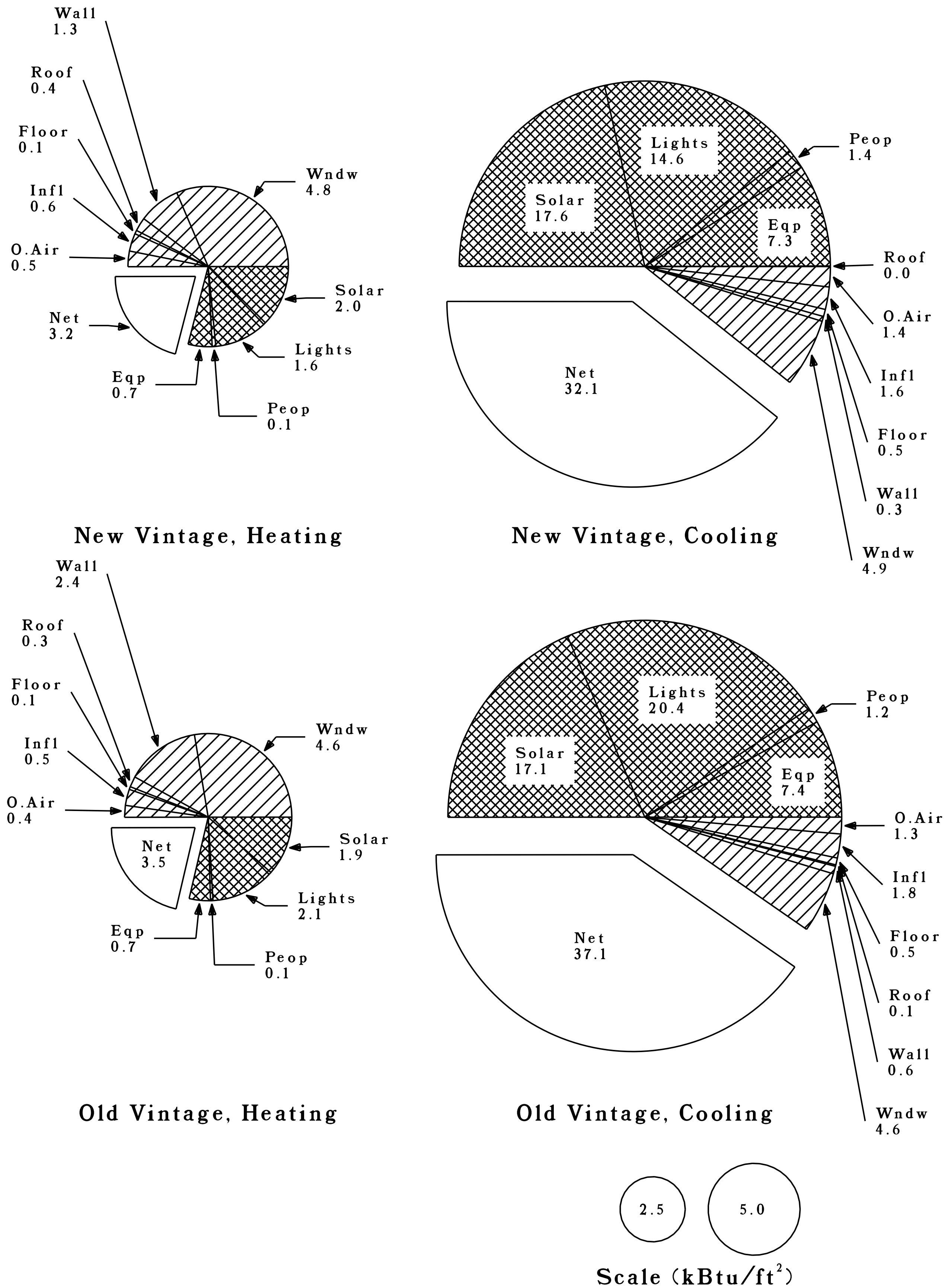


Figure C.3 Specific Component Loads (kBtu/ft²)
for Large Offices in Houston

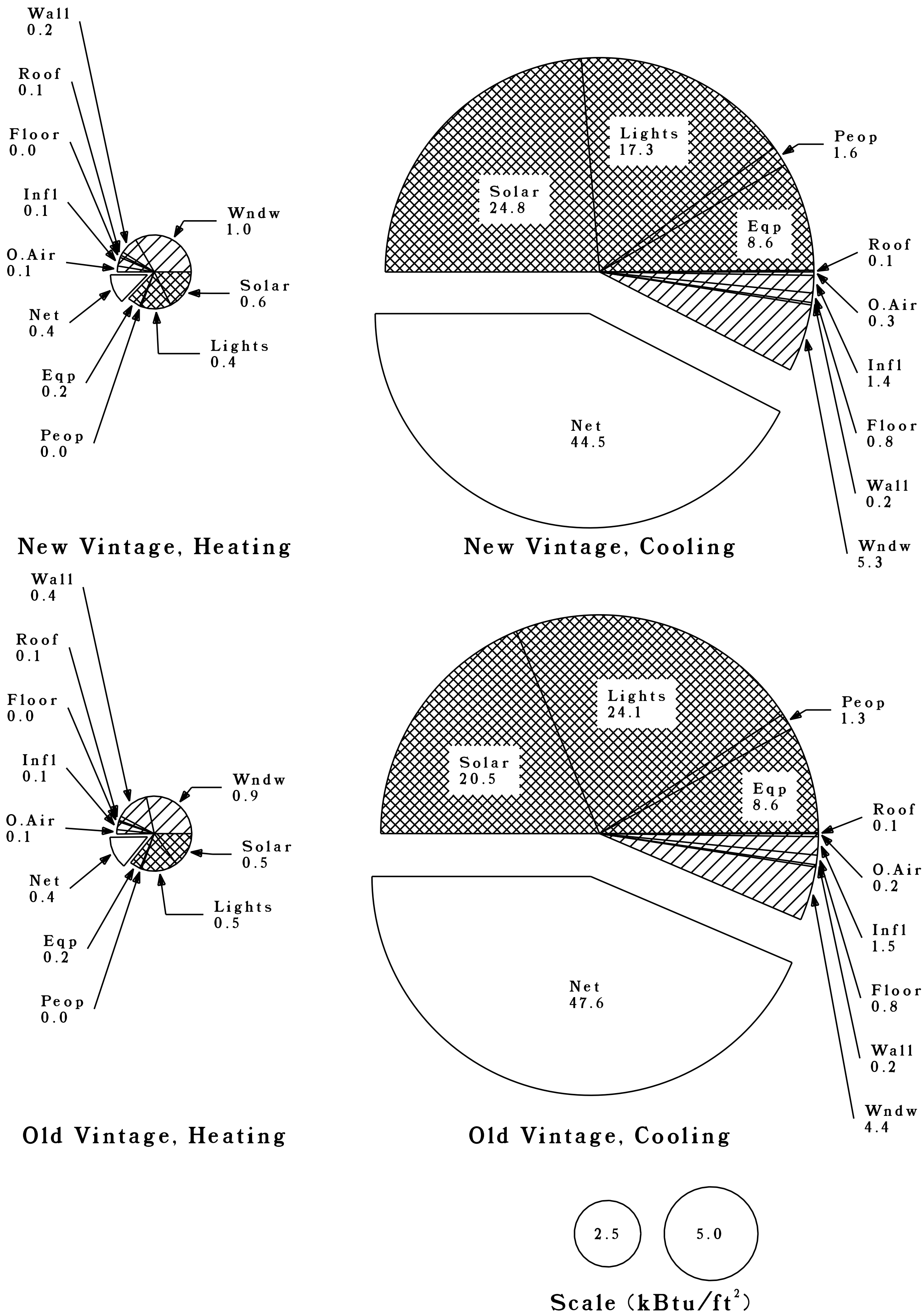


Figure C.4 Specific Component Loads (kBtu/ft^2)
for Small Offices in Minneapolis

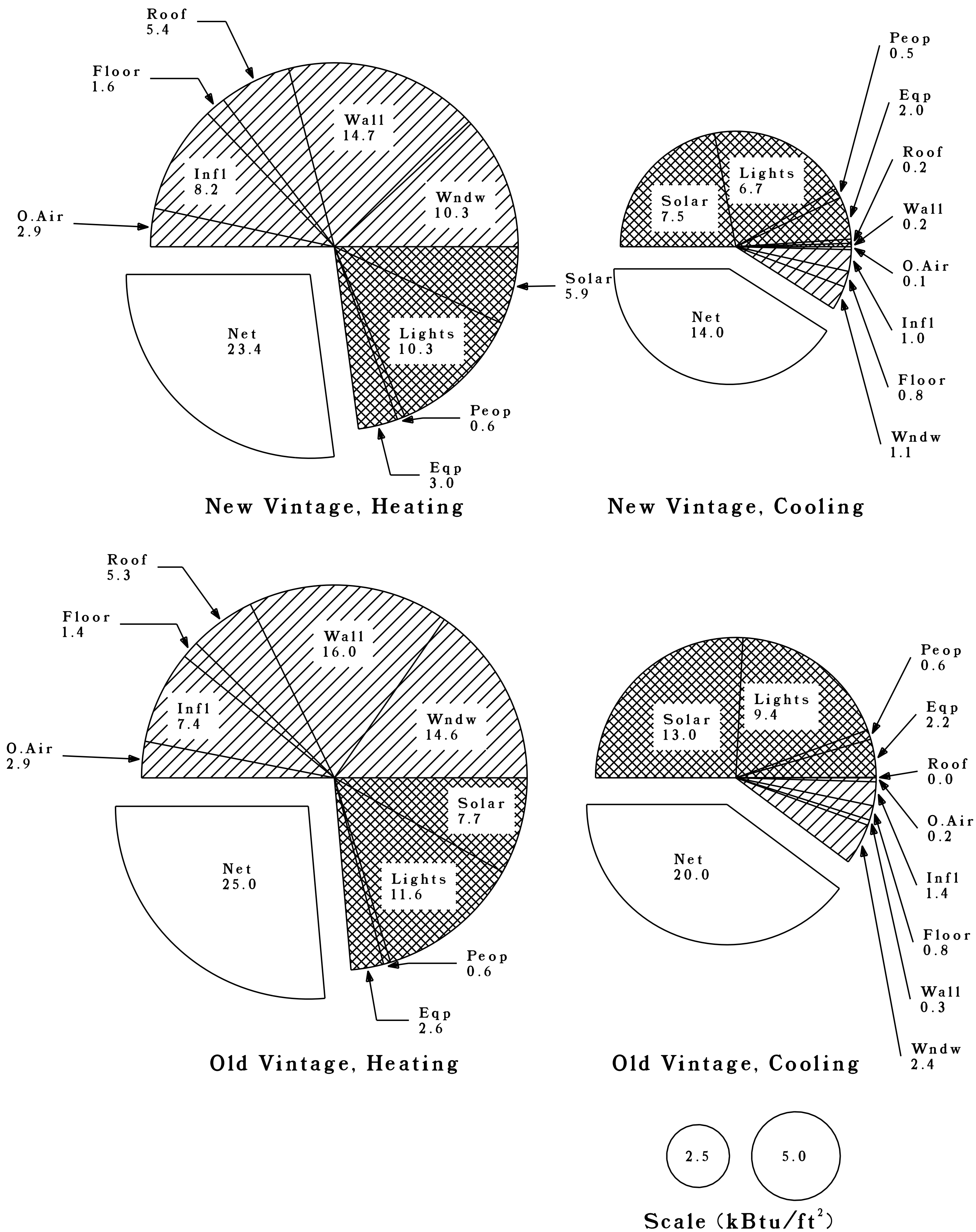


Figure C.5 Specific Component Loads (kBtu/ft^2)
for Small Offices in Washington

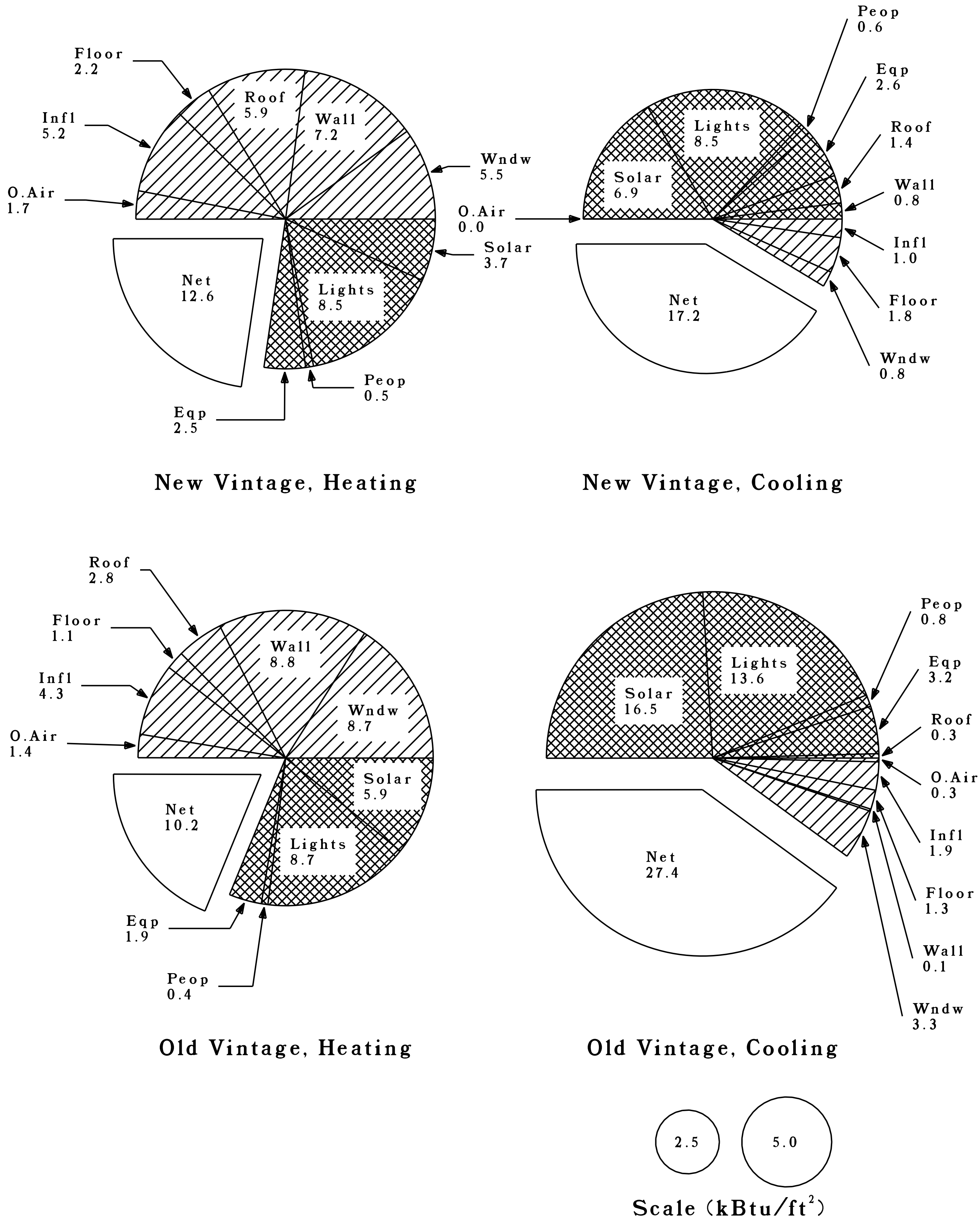


**Figure C.6 Specific Component Loads (kBtu/ft^2)
for Small Offices in Houston**

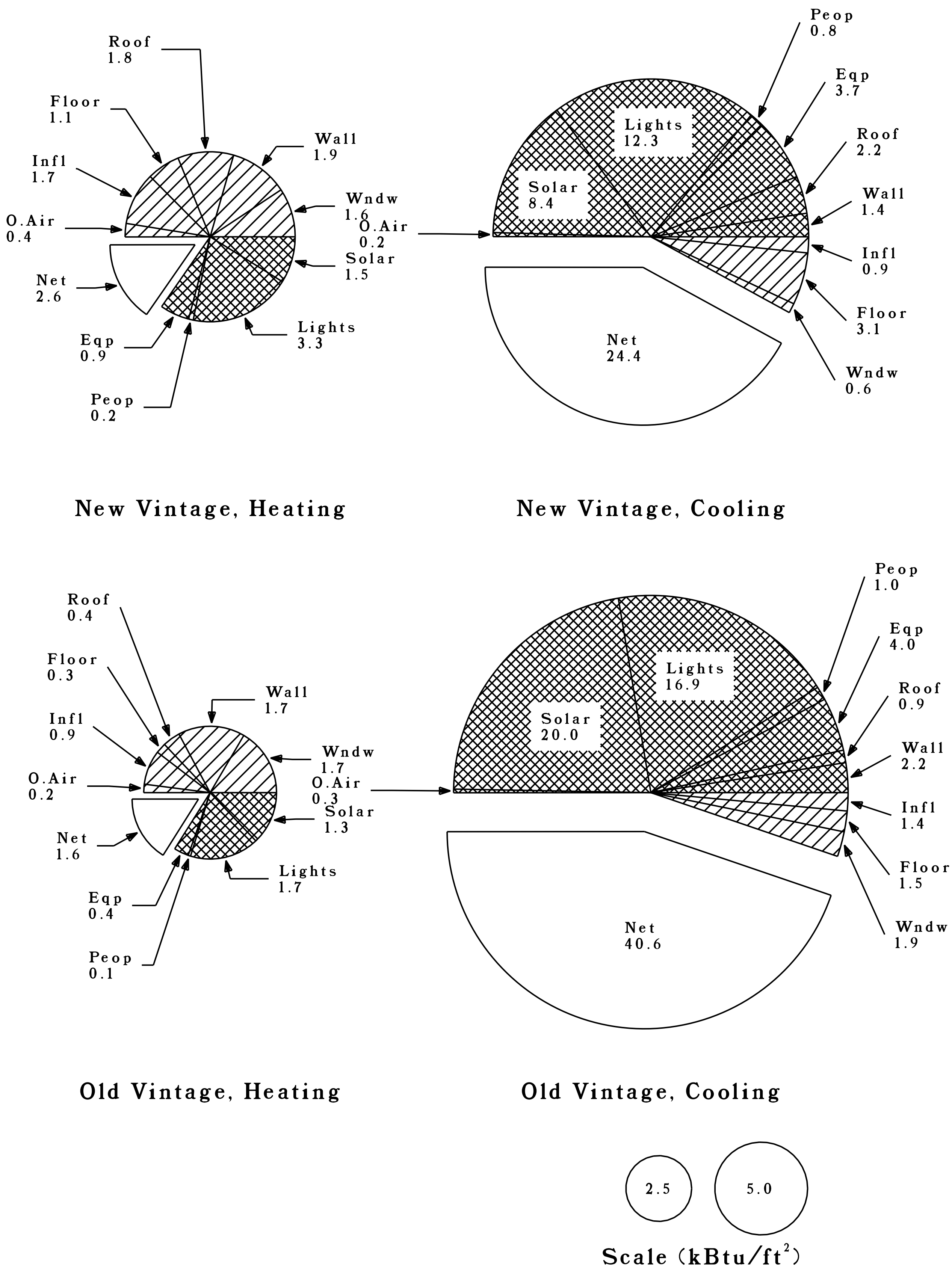


Figure C.7 Specific Component Loads (kBtu/ft^2) for Large Retail Stores in Minneapolis

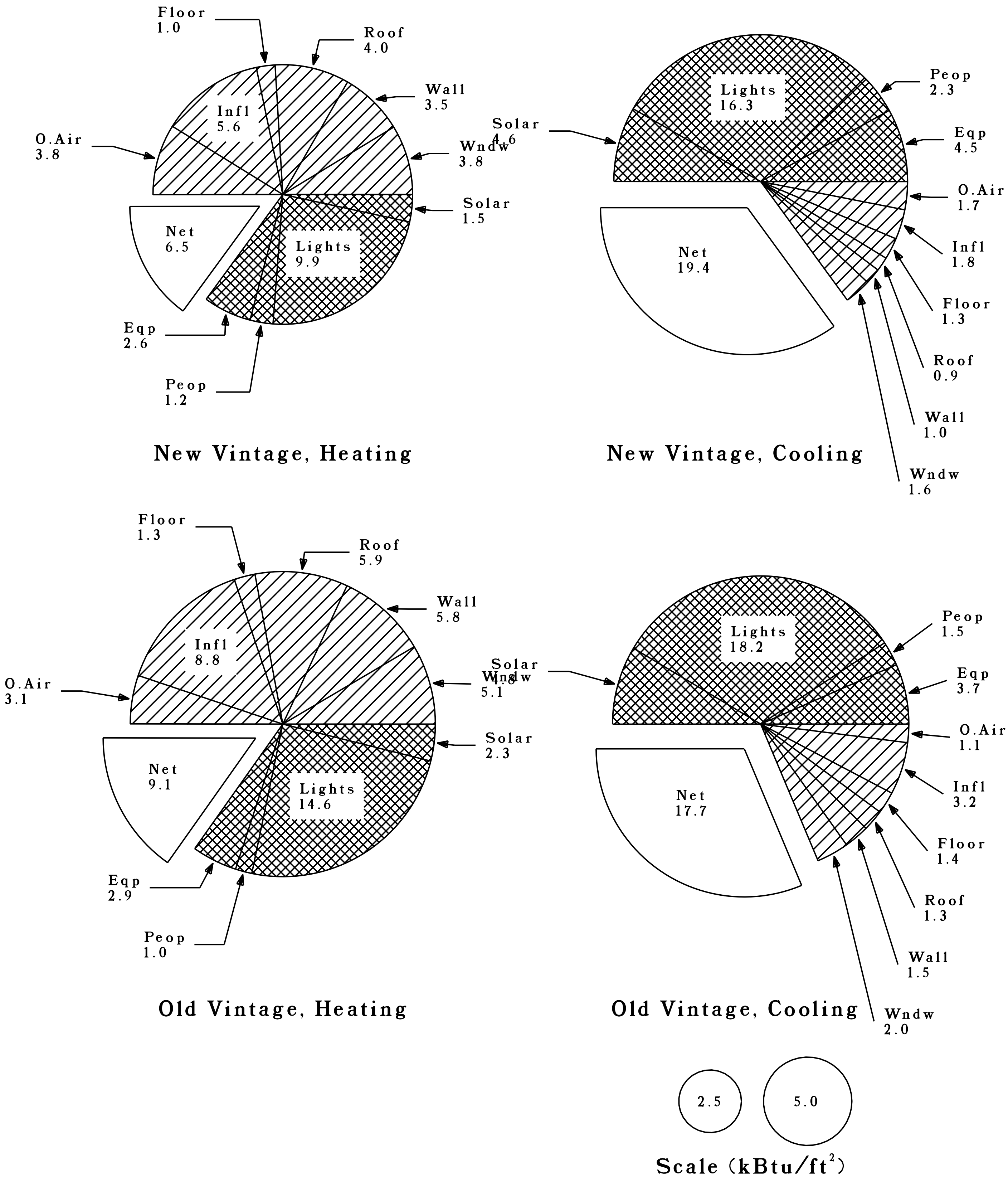


Figure C.8 Specific Component Loads (kBtu/ft^2)
for Large Retail Stores in Washington

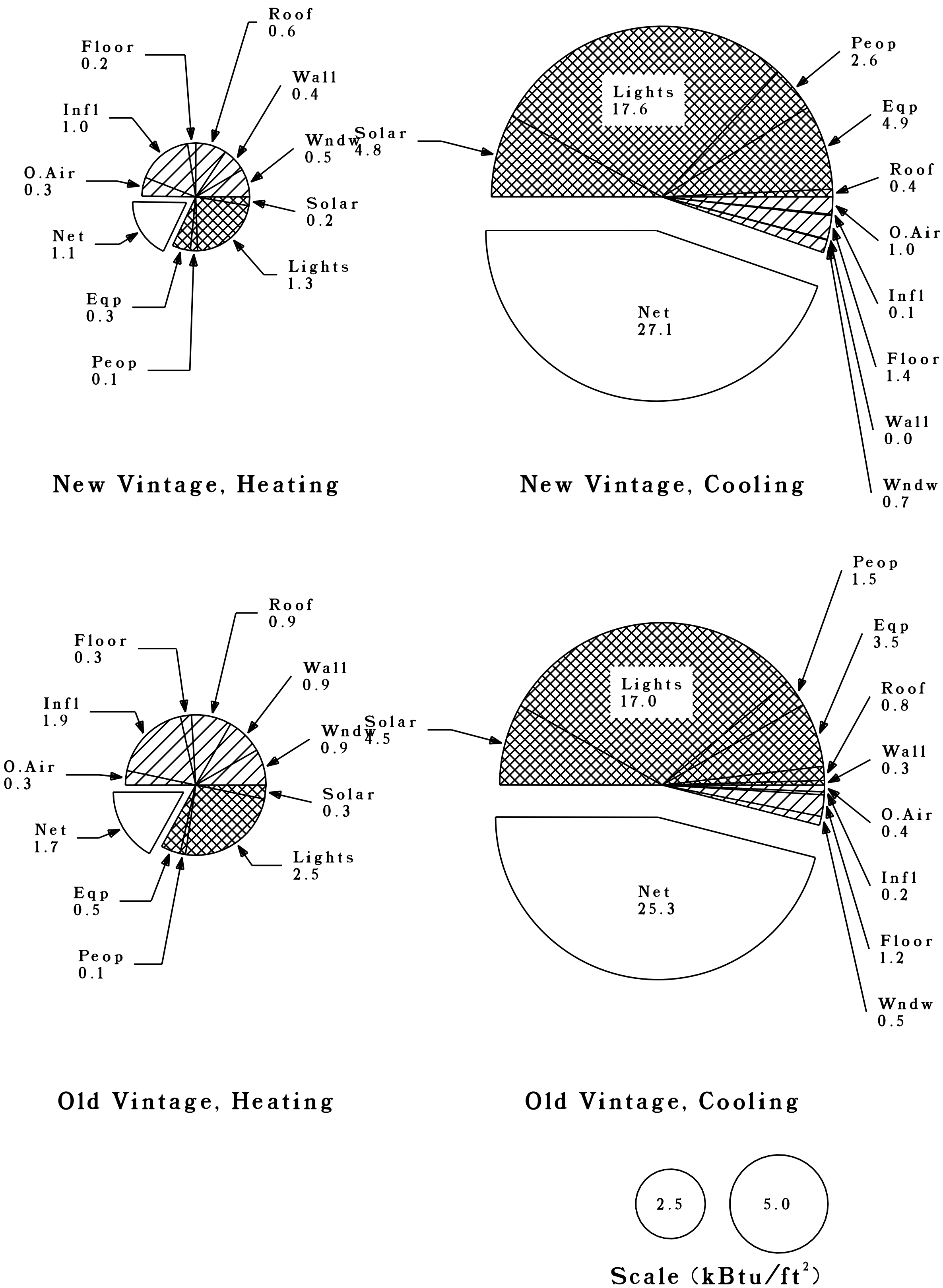


Figure C.9 Specific Component Loads (kBtu/ft^2) for Large Retail Stores in Houston

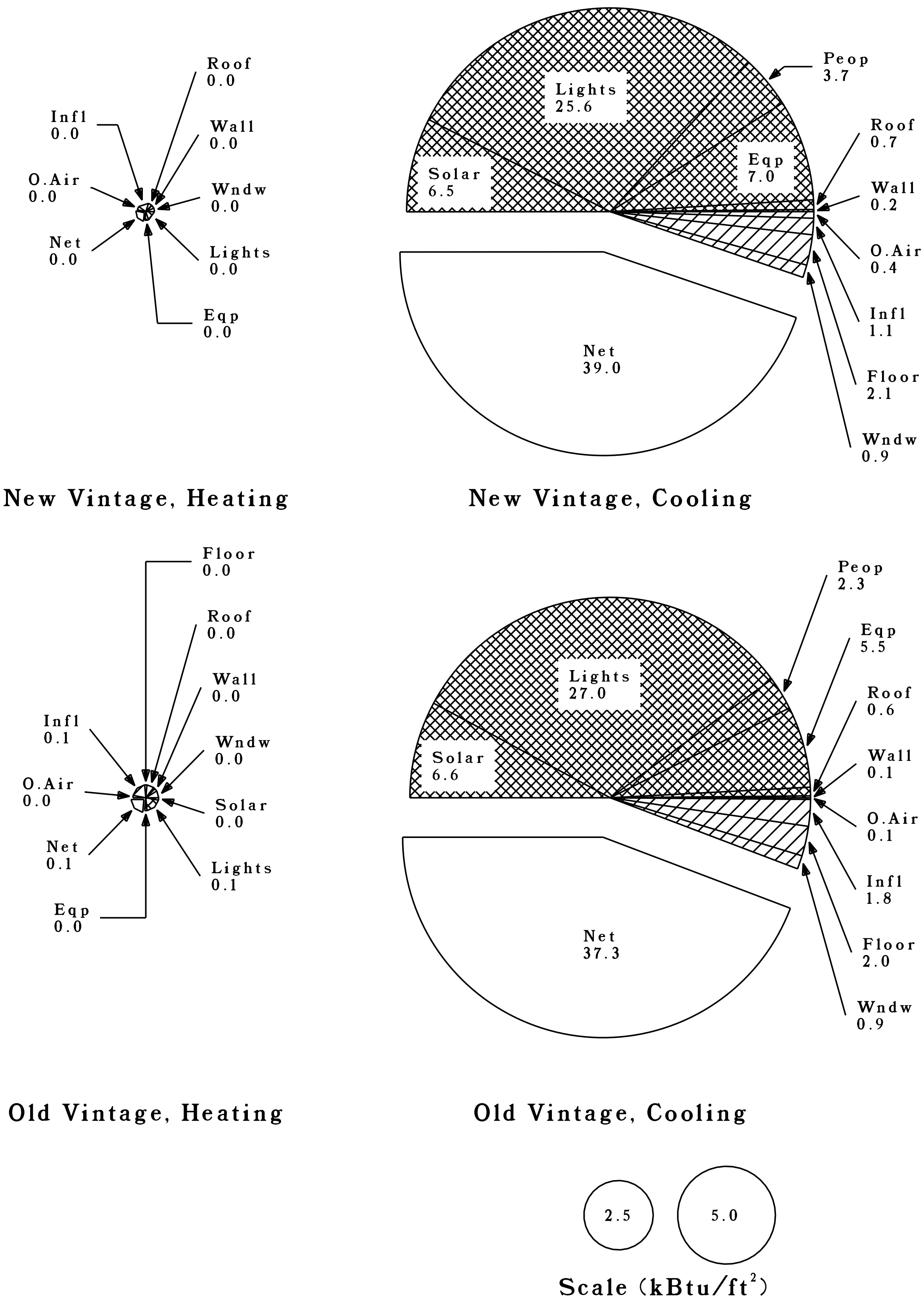


Figure C.10 Specific Component Loads ($kBtu/ft^2$)
for Small Retail Stores in Minneapolis

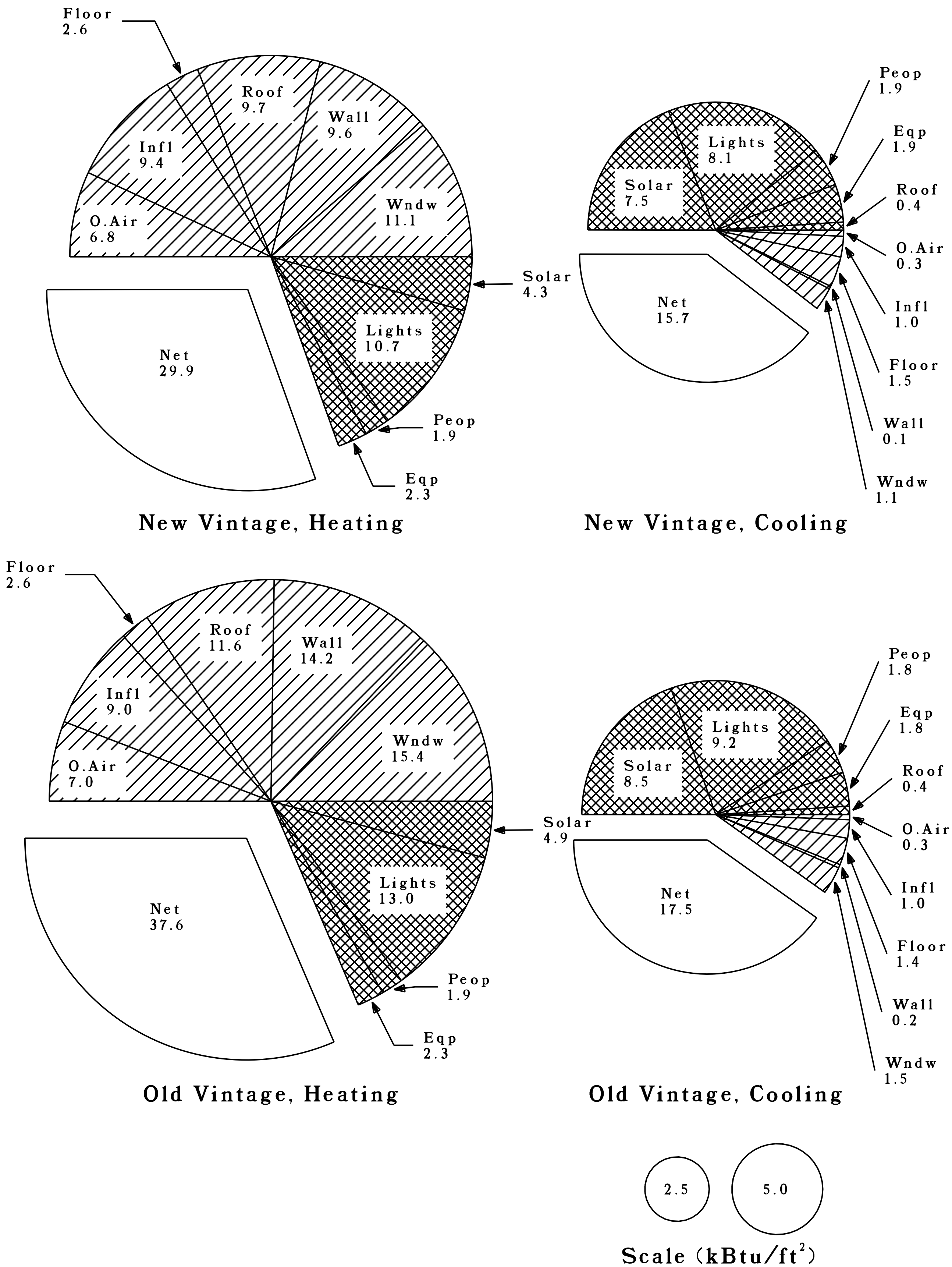


Figure C.11 Specific Component Loads (kBtu/ft^2) for Small Retail Stores in Washington

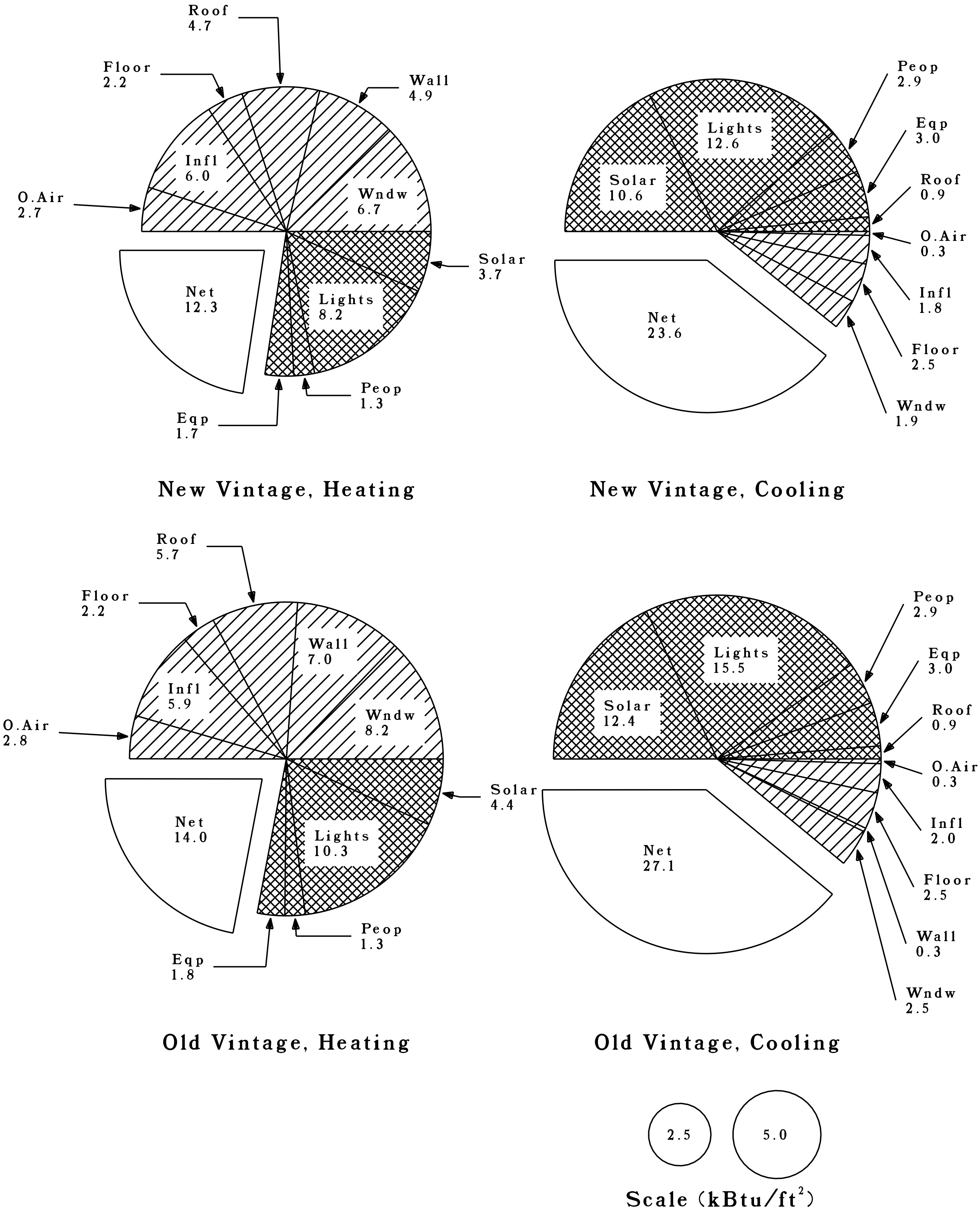


Figure C.12 Specific Component Loads (kBtu/ft^2) for Small Retail Stores in Houston

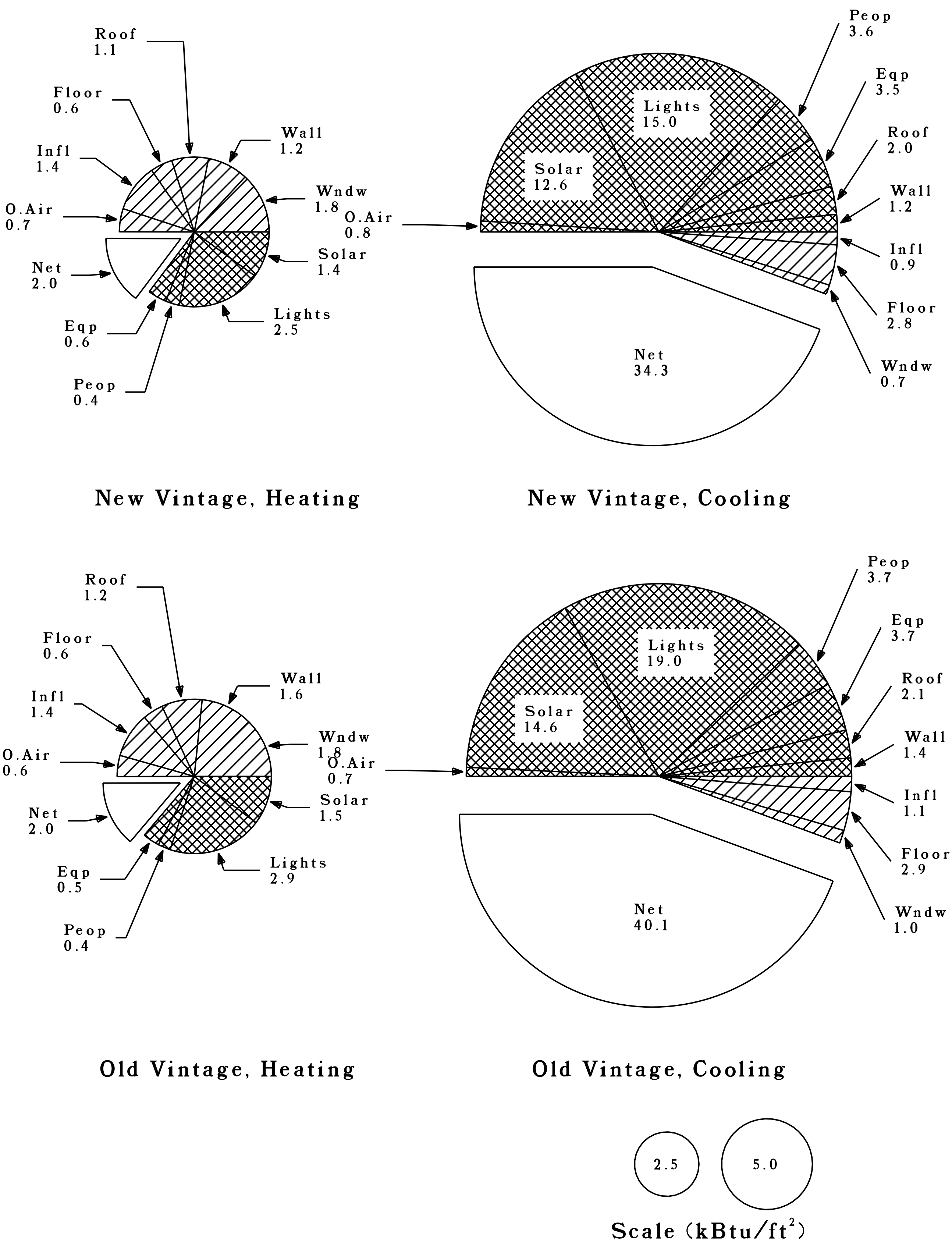


Figure C.13 Specific Component Loads (kBtu/ft^2) for Large Hotels in Minneapolis

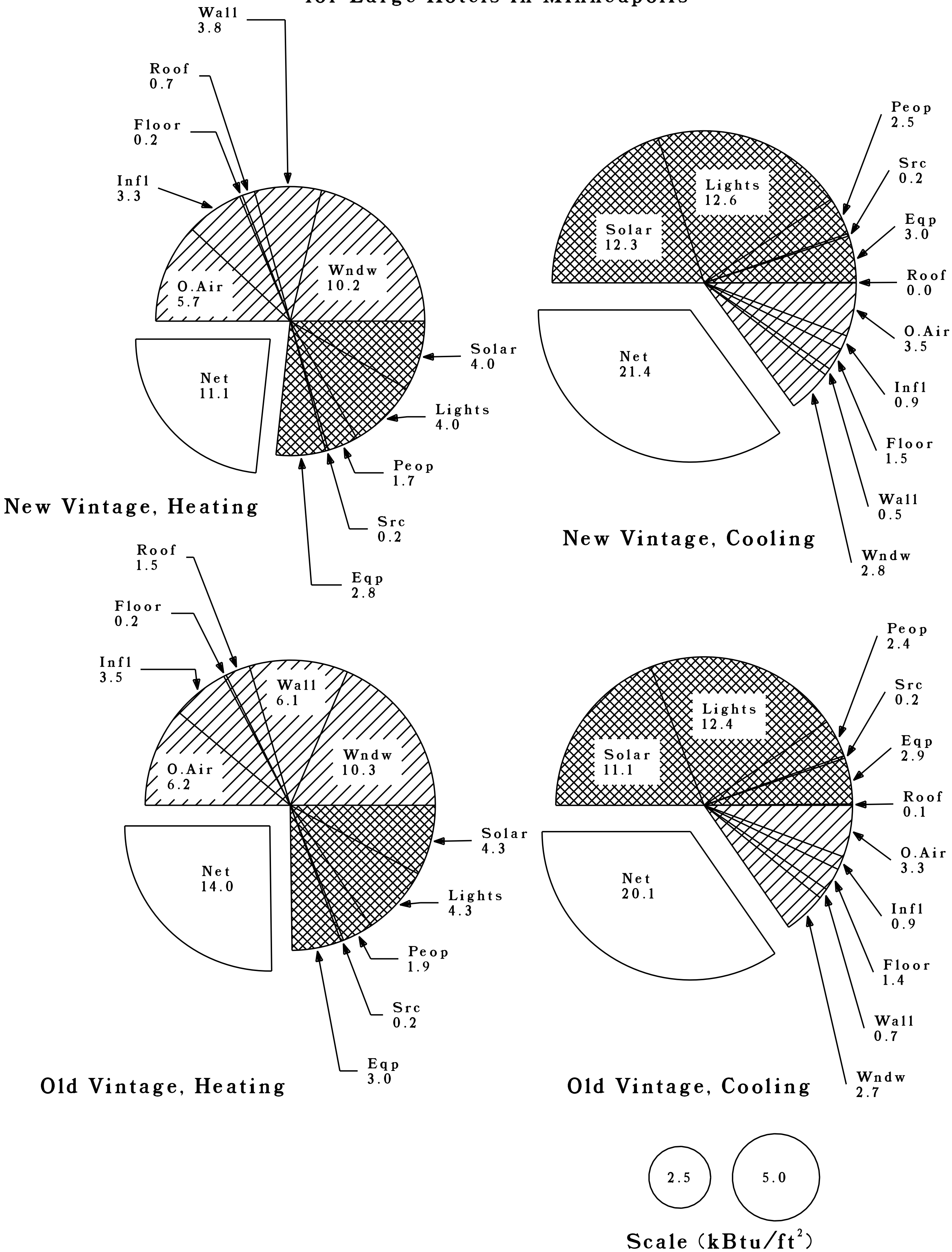


Figure C.14 Specific Component Loads (kBtu/ft^2) for Large Hotels in Washington

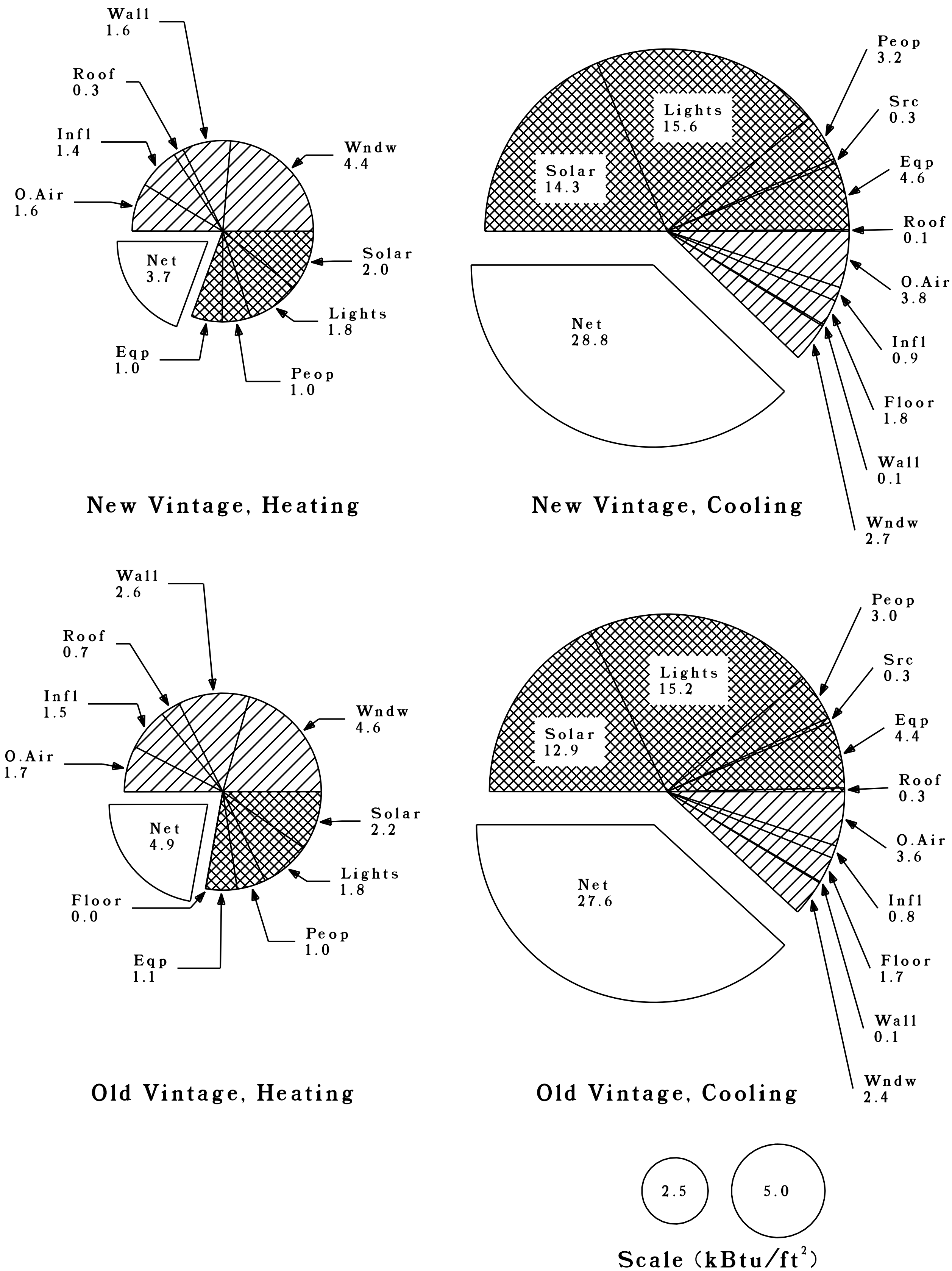


Figure C.15 Specific Component Loads (kBtu/ft^2)
for Large Hotels in Houston

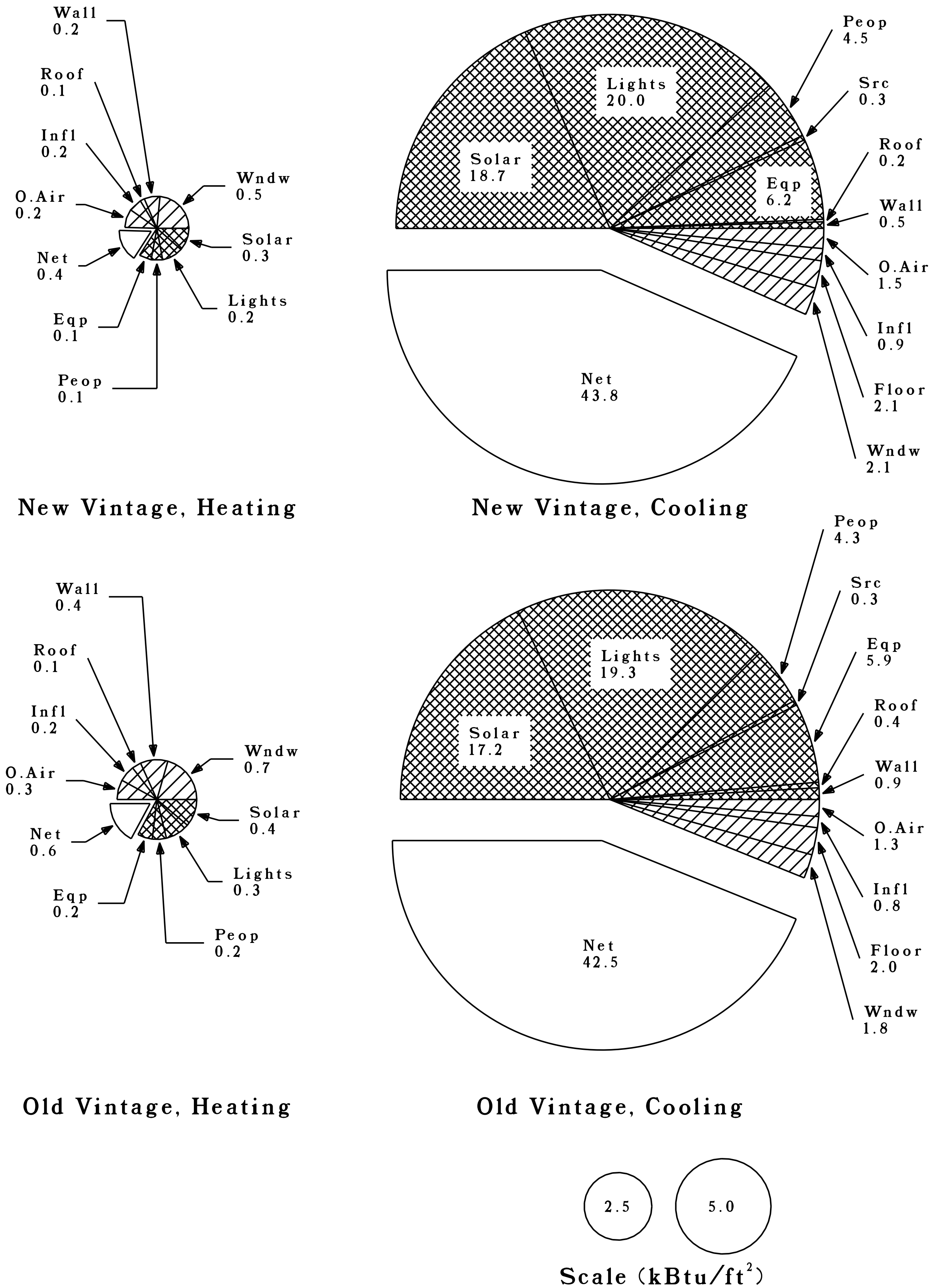


**Figure C.16 Specific Component Loads (kBtu/ft²)
for Small Hotels in Minneapolis**

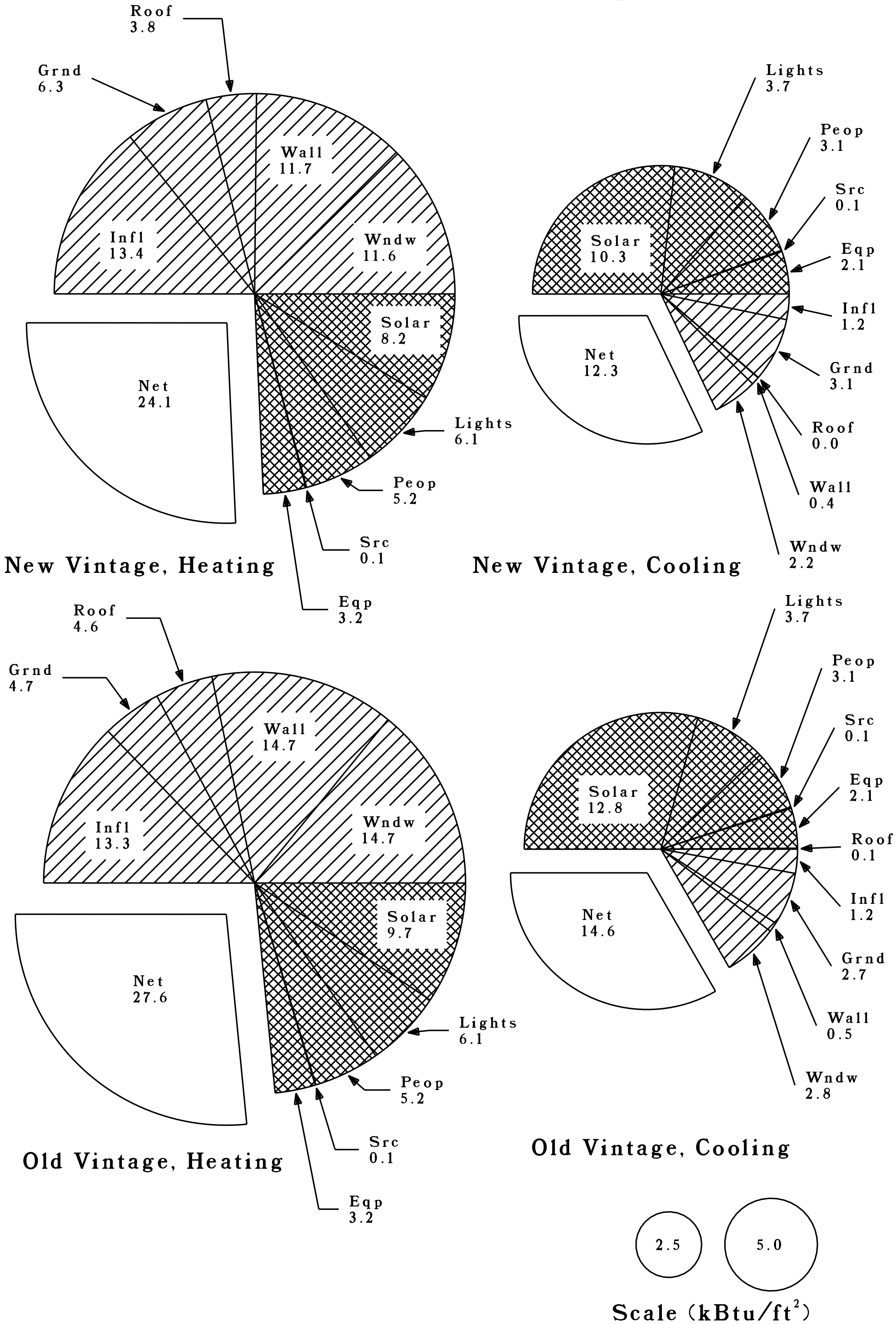


Figure C.17 Specific Component Loads (kBtu/ft^2) for Small Hotels in Washington

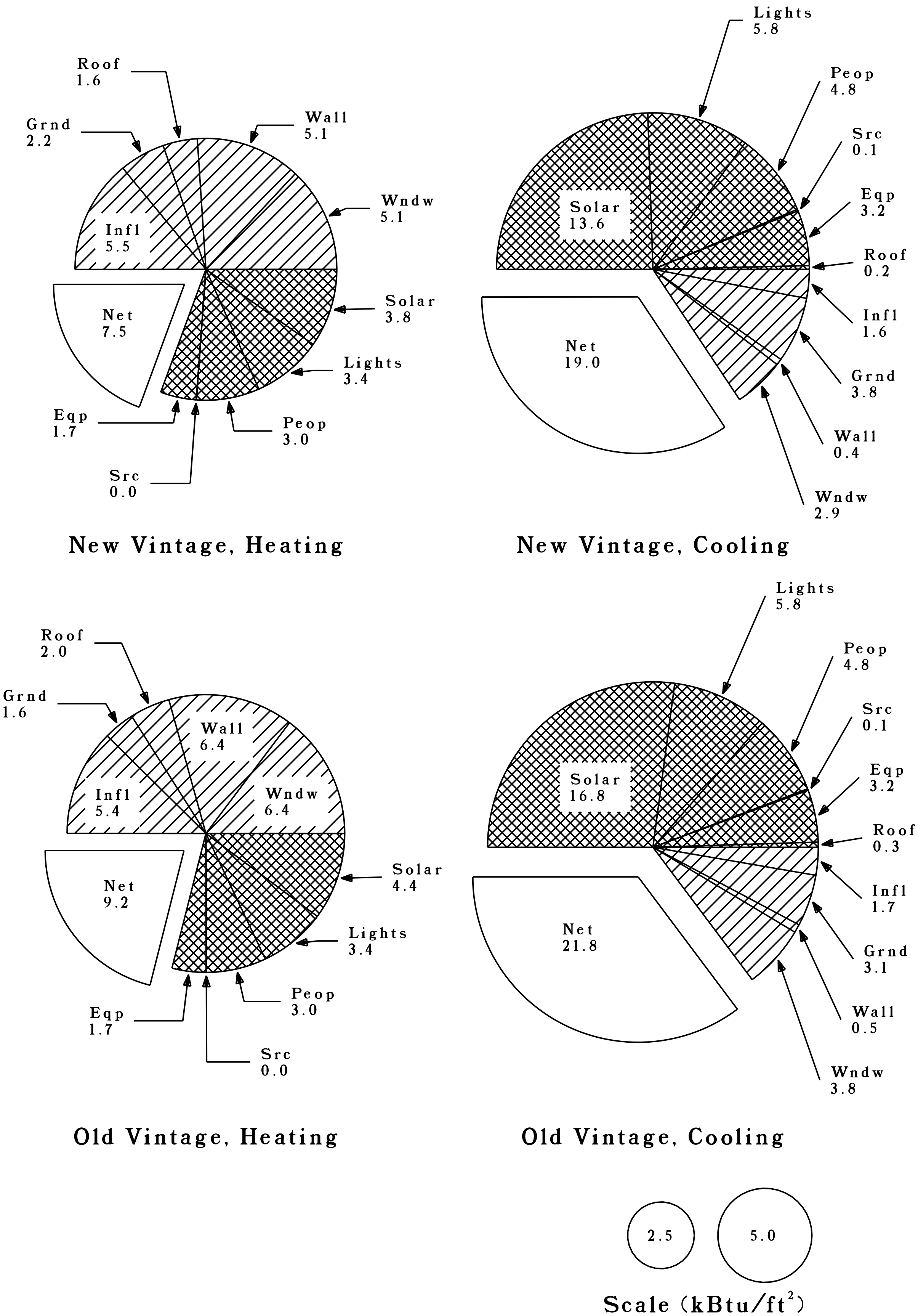


Figure C.18 Specific Component Loads (kBtu/ft^2) for Small Hotels in Houston

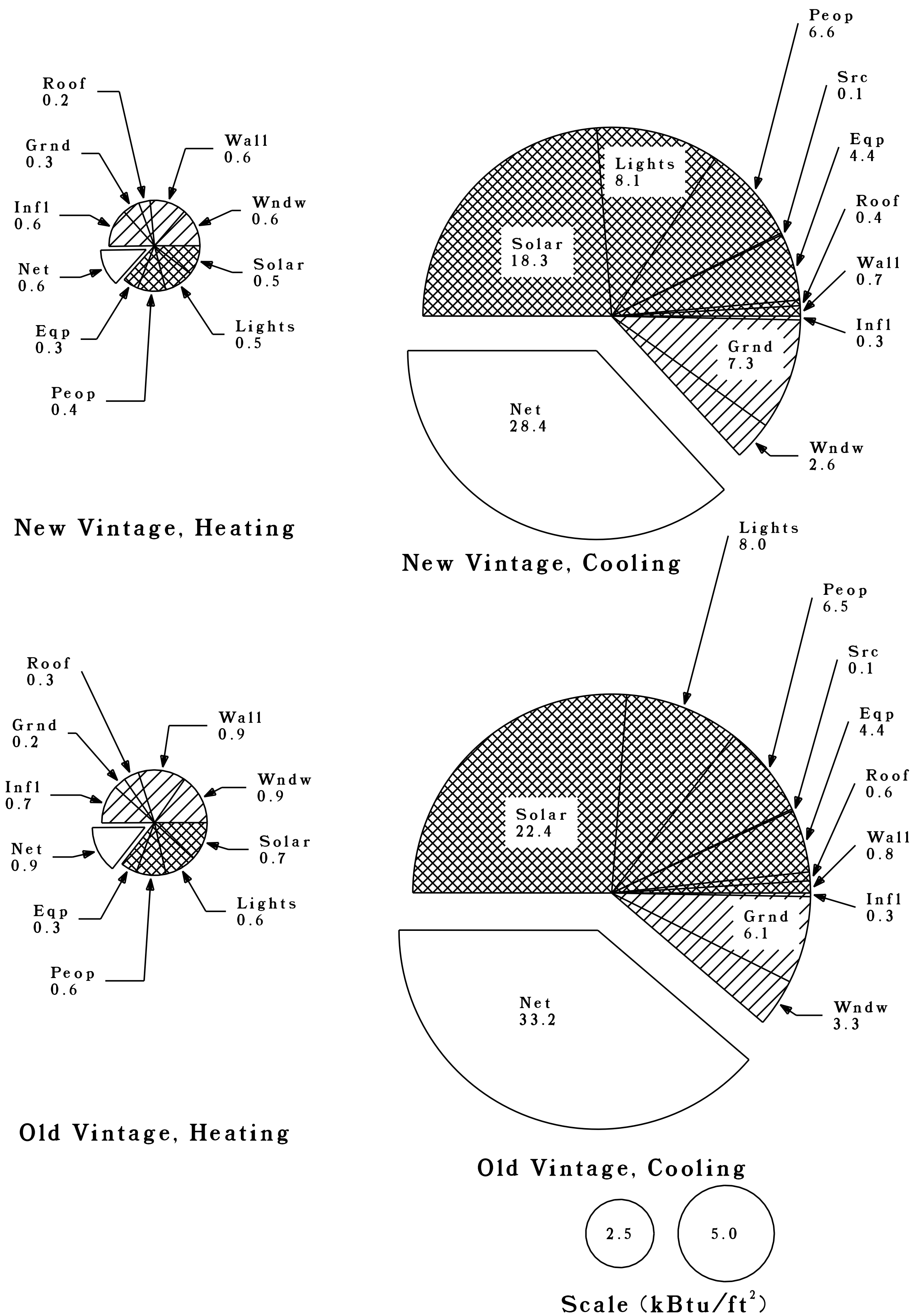


Figure C.19 Specific Component Loads (kBtu/ft^2)
for Fast Food Restaurants in Minneapolis

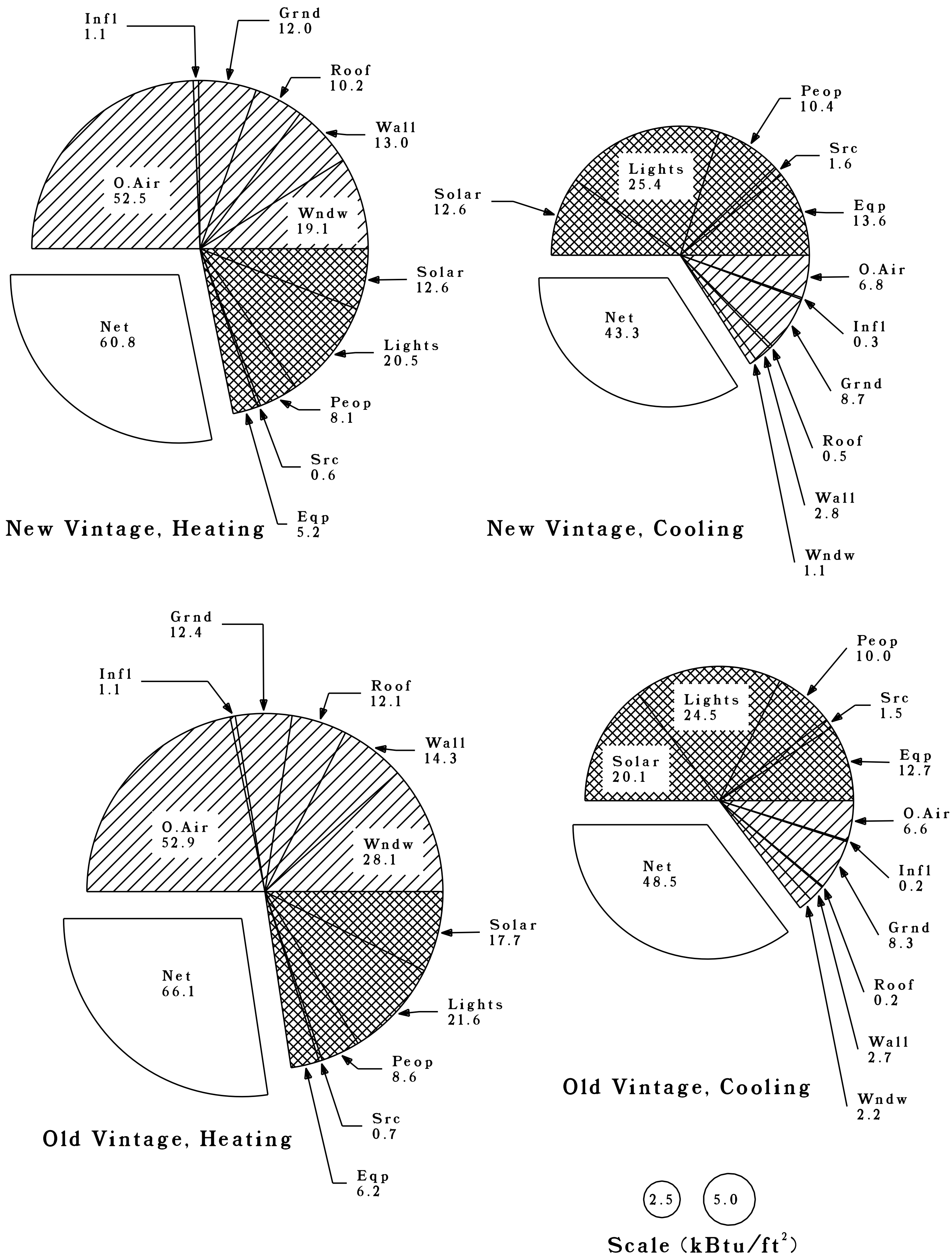


Figure C.20 Specific Component Loads (kBtu/ft^2) for Fast Food Restaurants in Washington

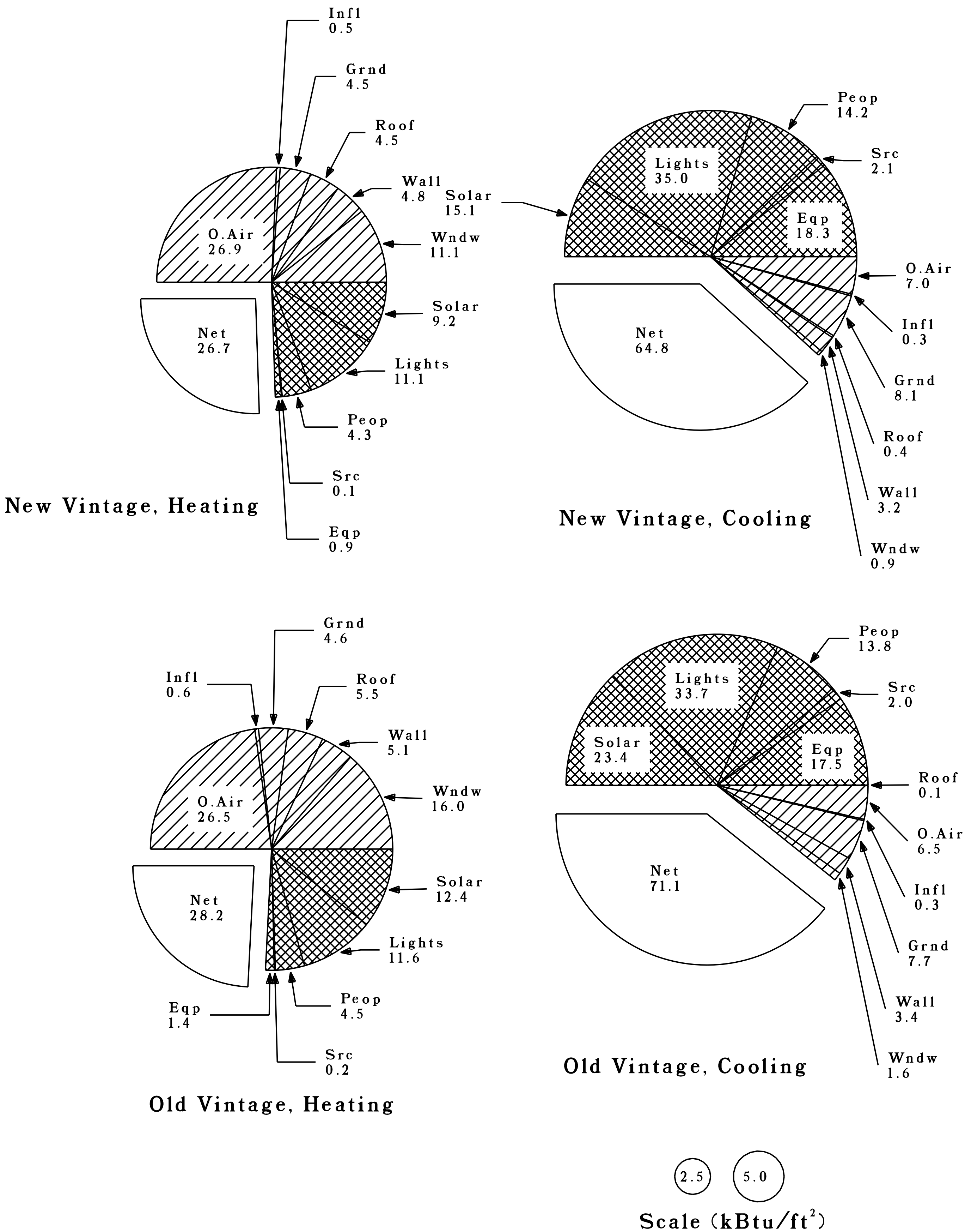
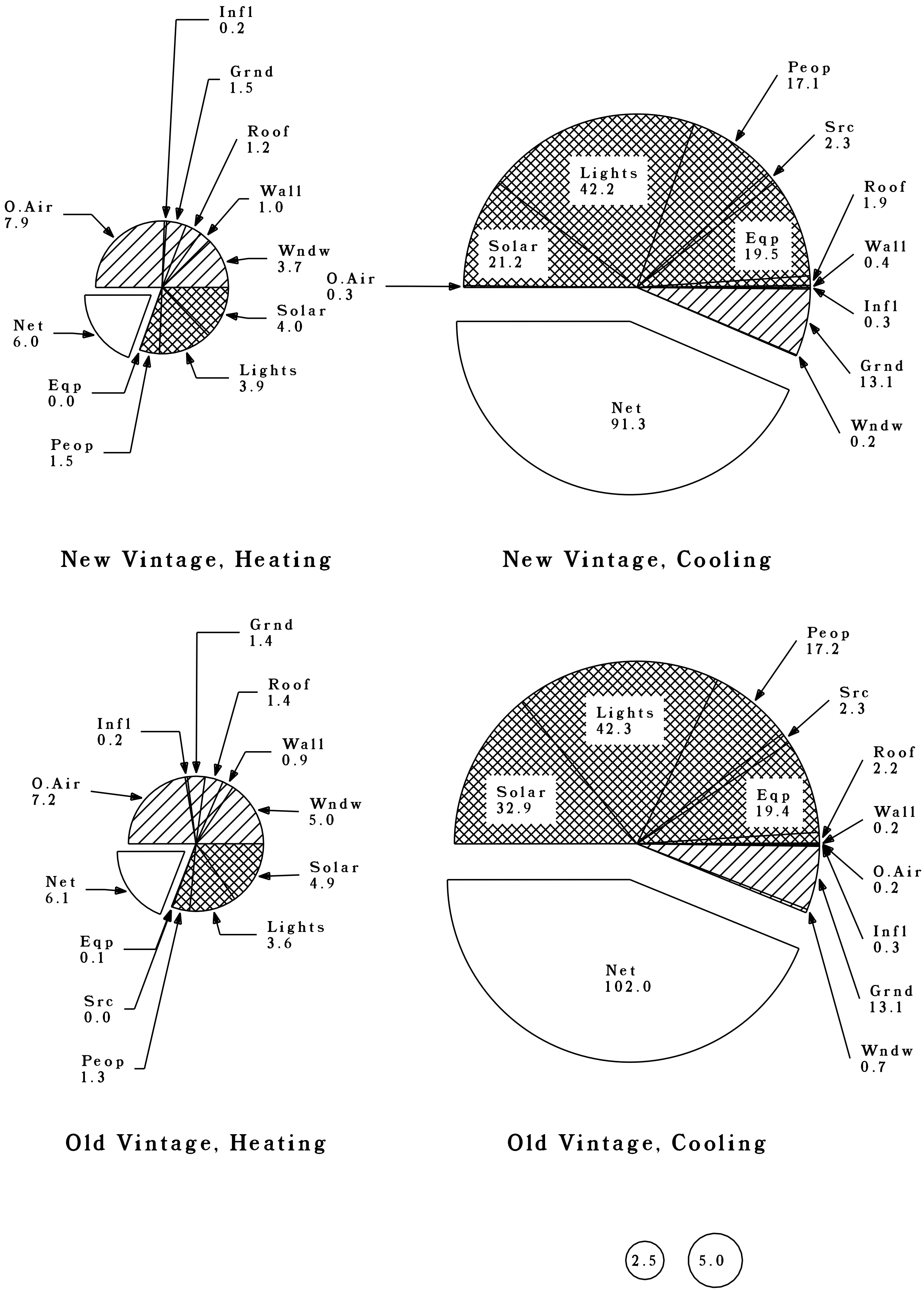


Figure C.21 Specific Component Loads (kBtu/ft^2) for Fast Food Restaurants in Houston



Scale (kBtu/ft^2)

Figure C.22 Specific Component Loads (kBtu/ft^2) for Sit-down Restaurants in Minneapolis

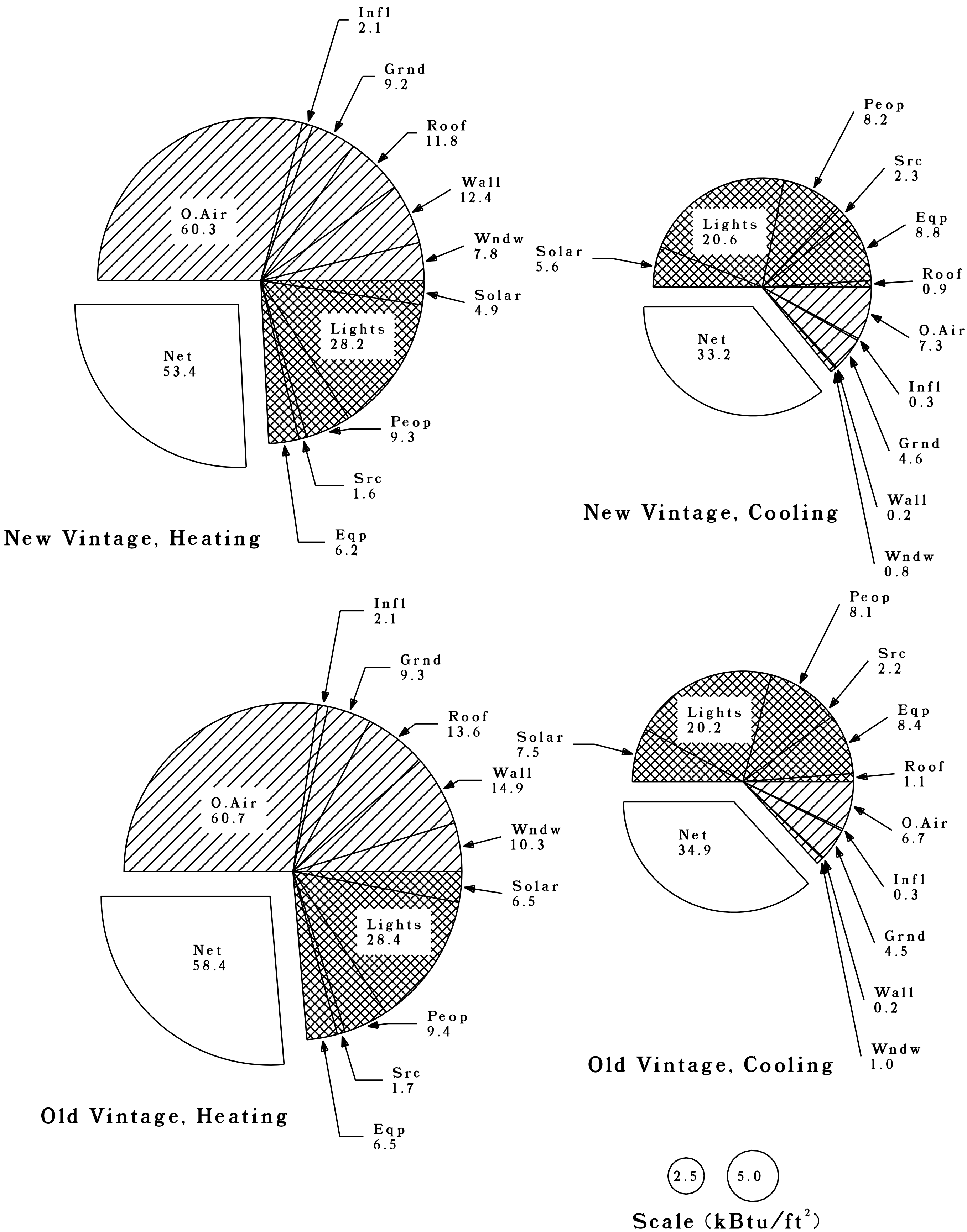
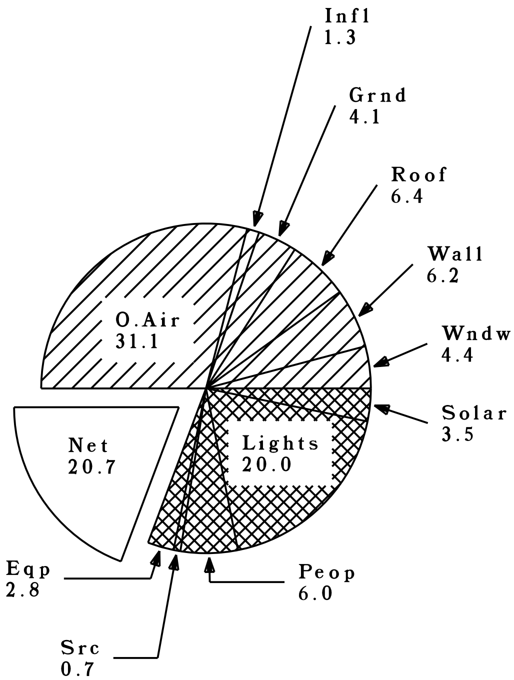
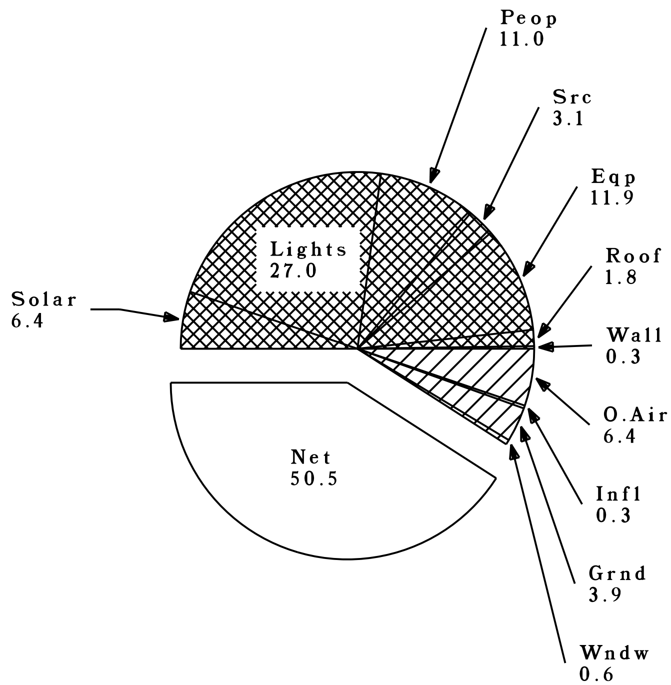


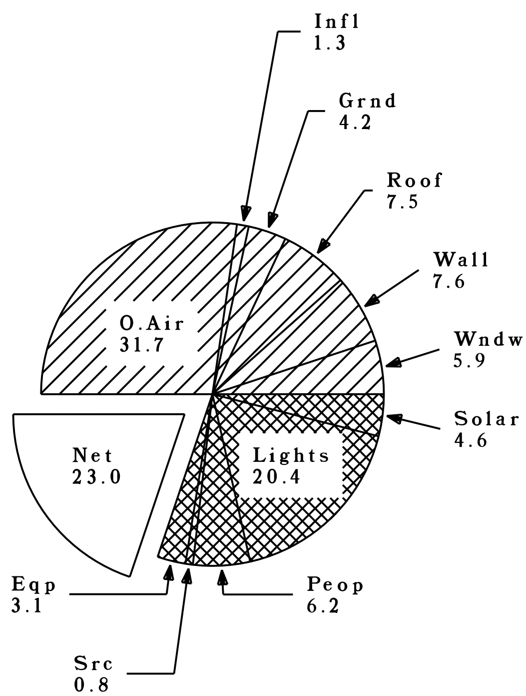
Figure C.23 Specific Component Loads (kBtu/ft^2) for Sit-down Restaurants in Washington

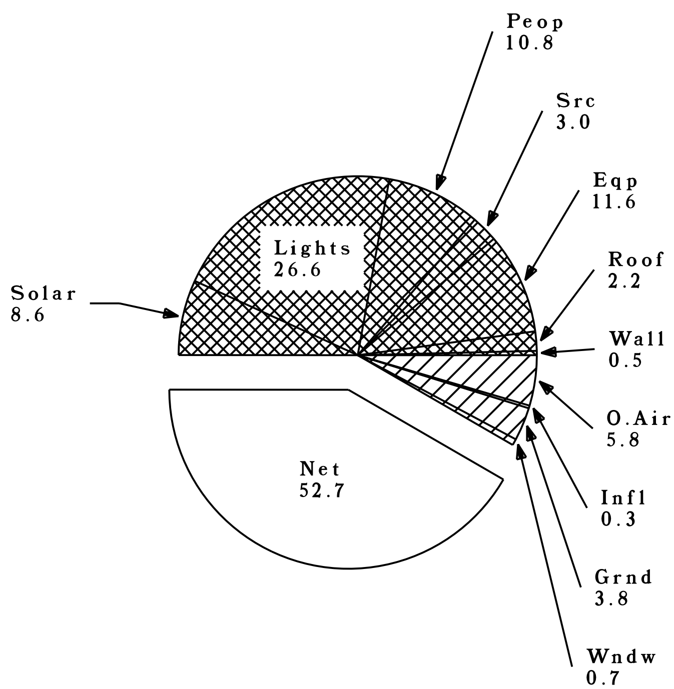


New Vintage, Heating



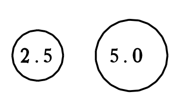
New Vintage, Cooling





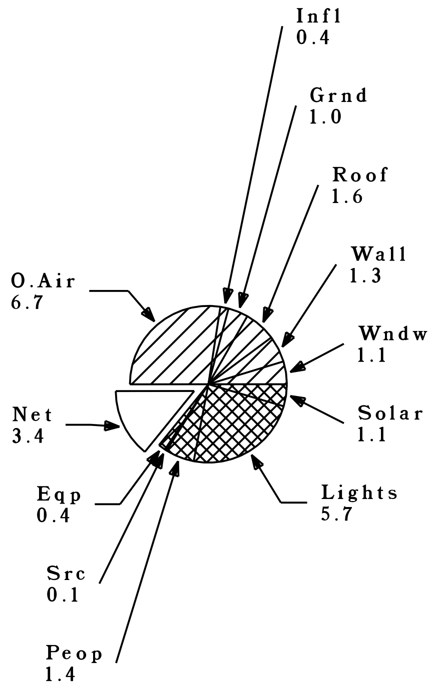
Old Vintage, Cooling

Old Vintage, Heating

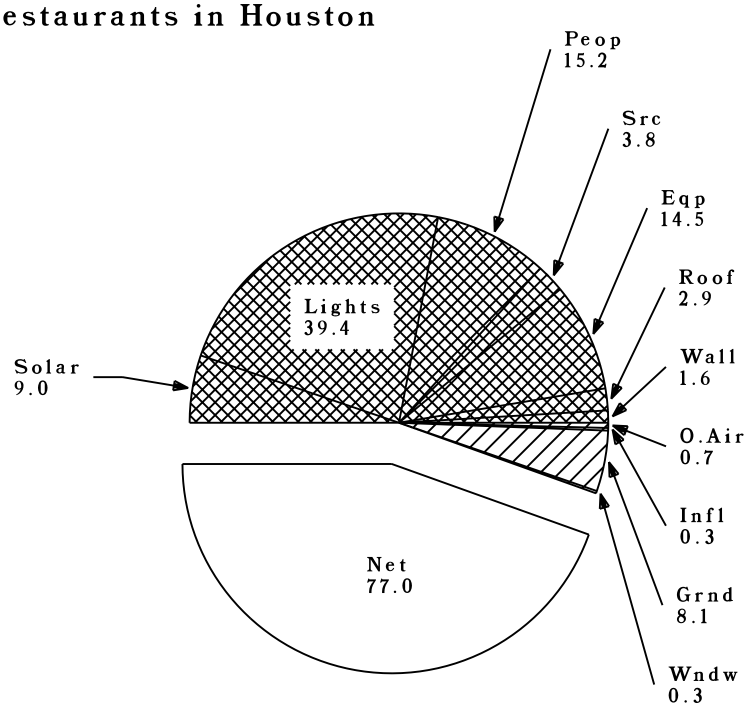


Scale (kBtu/ft^2)

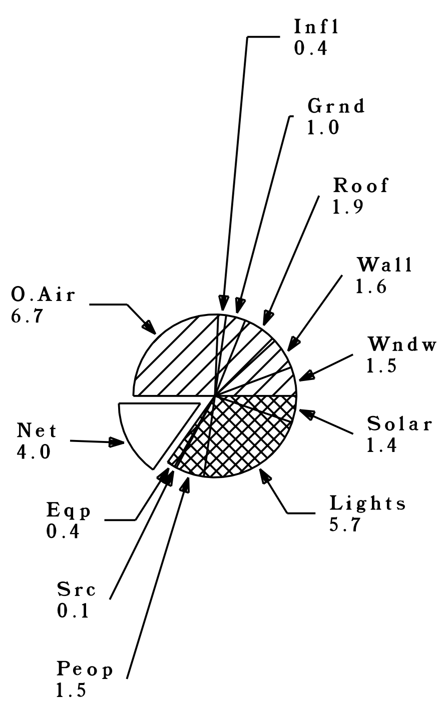
Figure C.24 Specific Component Loads (kBtu/ft^2) for Sit-down Restaurants in Houston



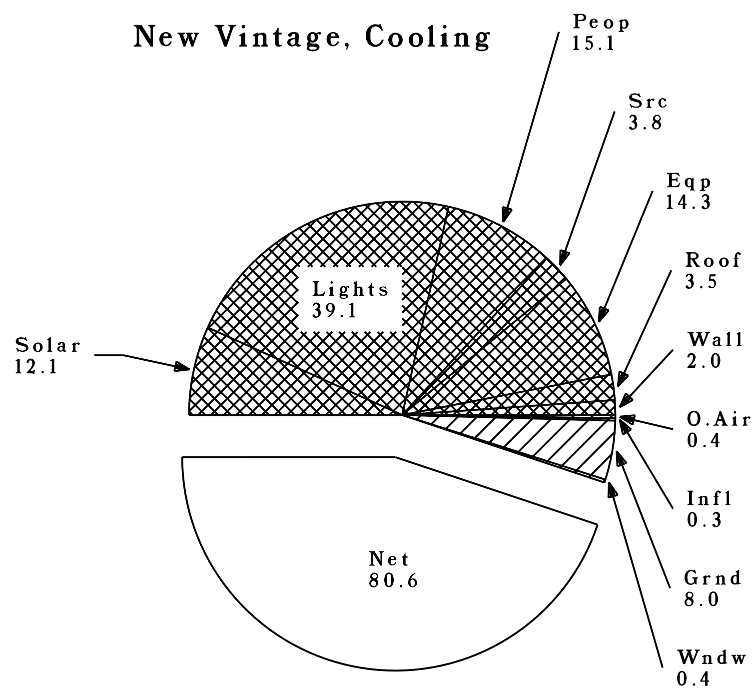
New Vintage, Heating



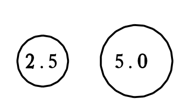
New Vintage, Cooling



Old Vintage, Heating



Old Vintage, Cooling



Scale (kBtu/ft^2)

Figure C.25 Specific Component Loads (kBtu/ft^2) for Hospitals in Minneapolis

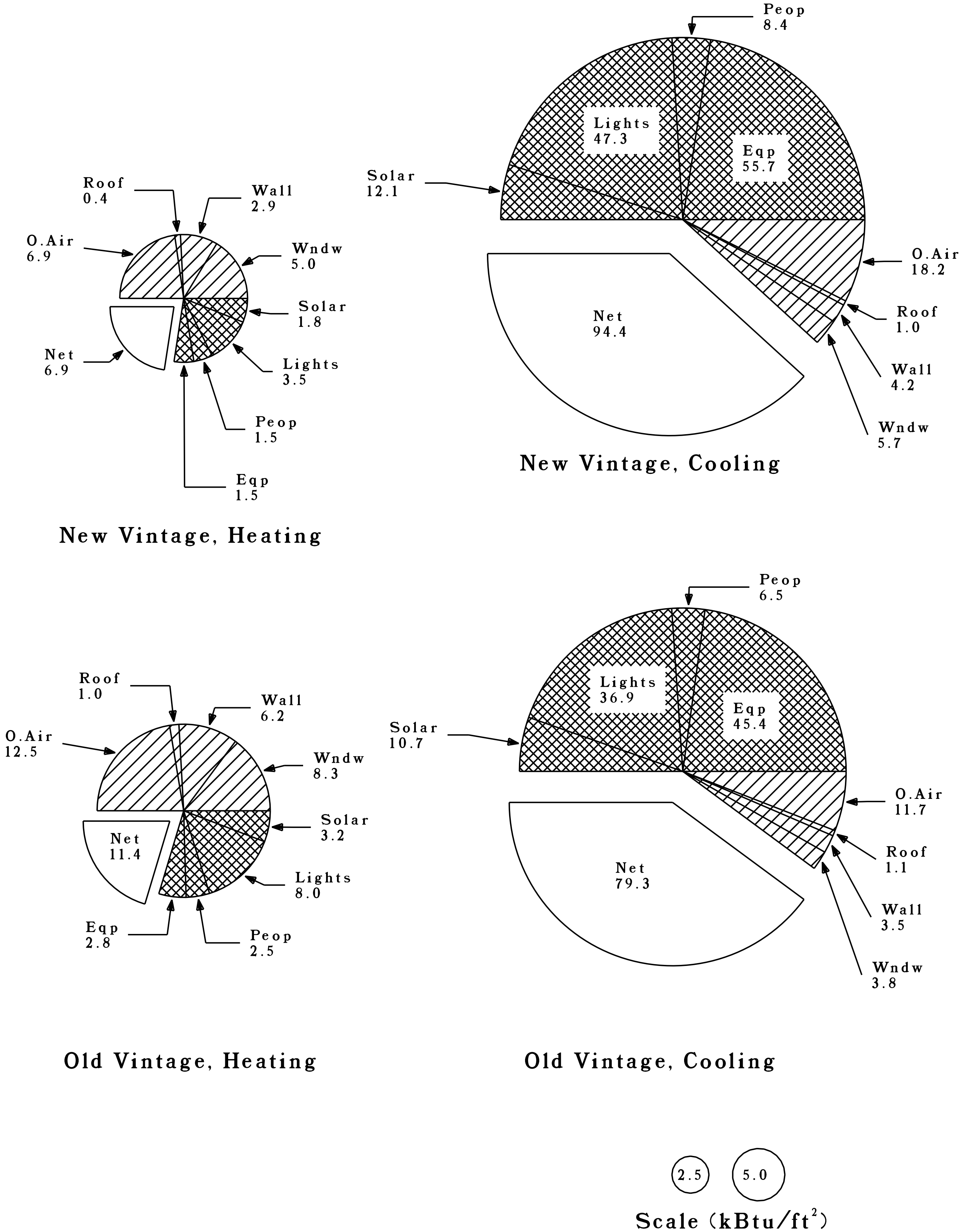


Figure C.26 Specific Component Loads (kBtu/ft^2)
for Hospitals in Washington

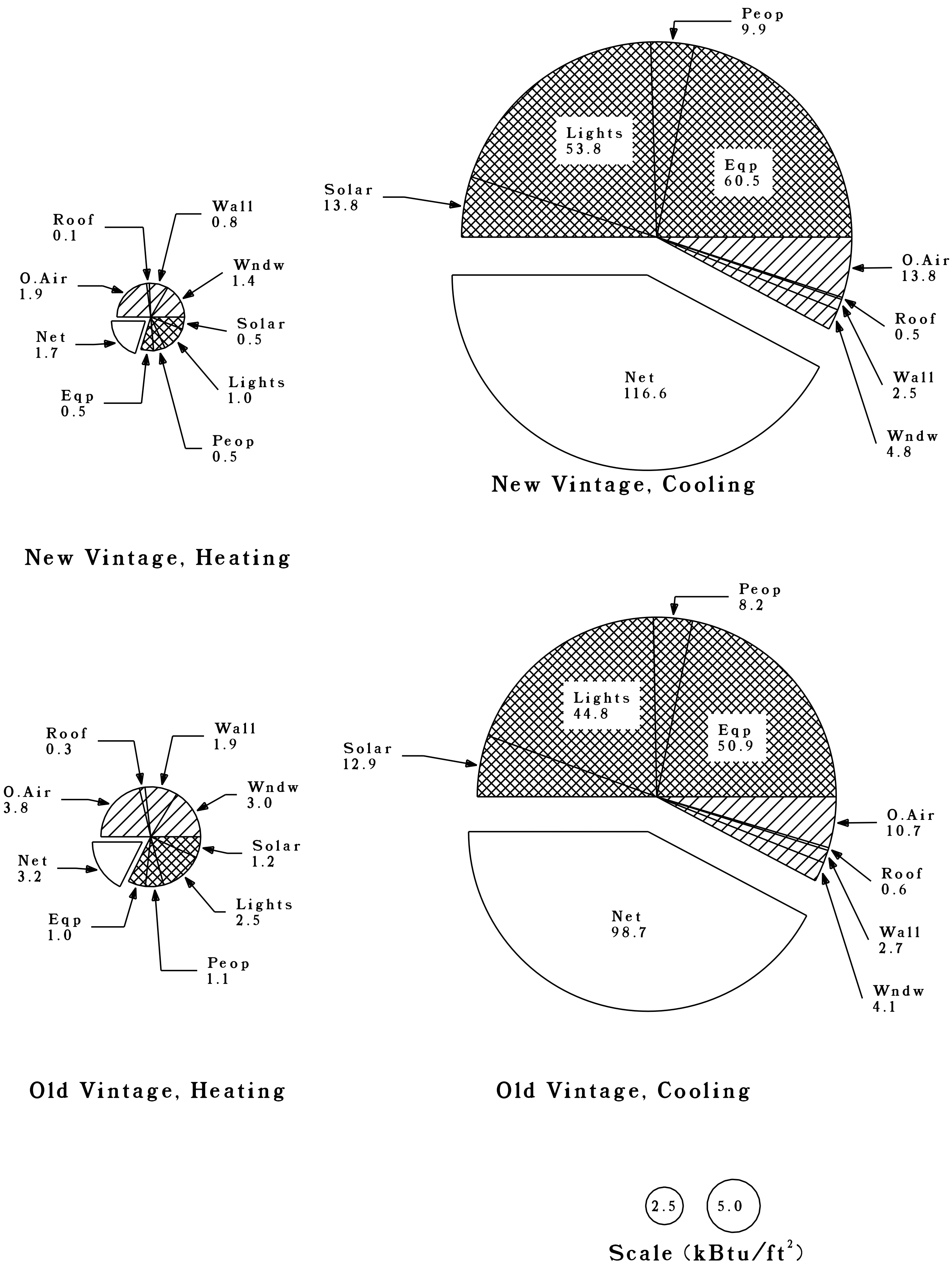


Figure C.27 Specific Component Loads (kBtu/ft²)
for Hospitals in Houston

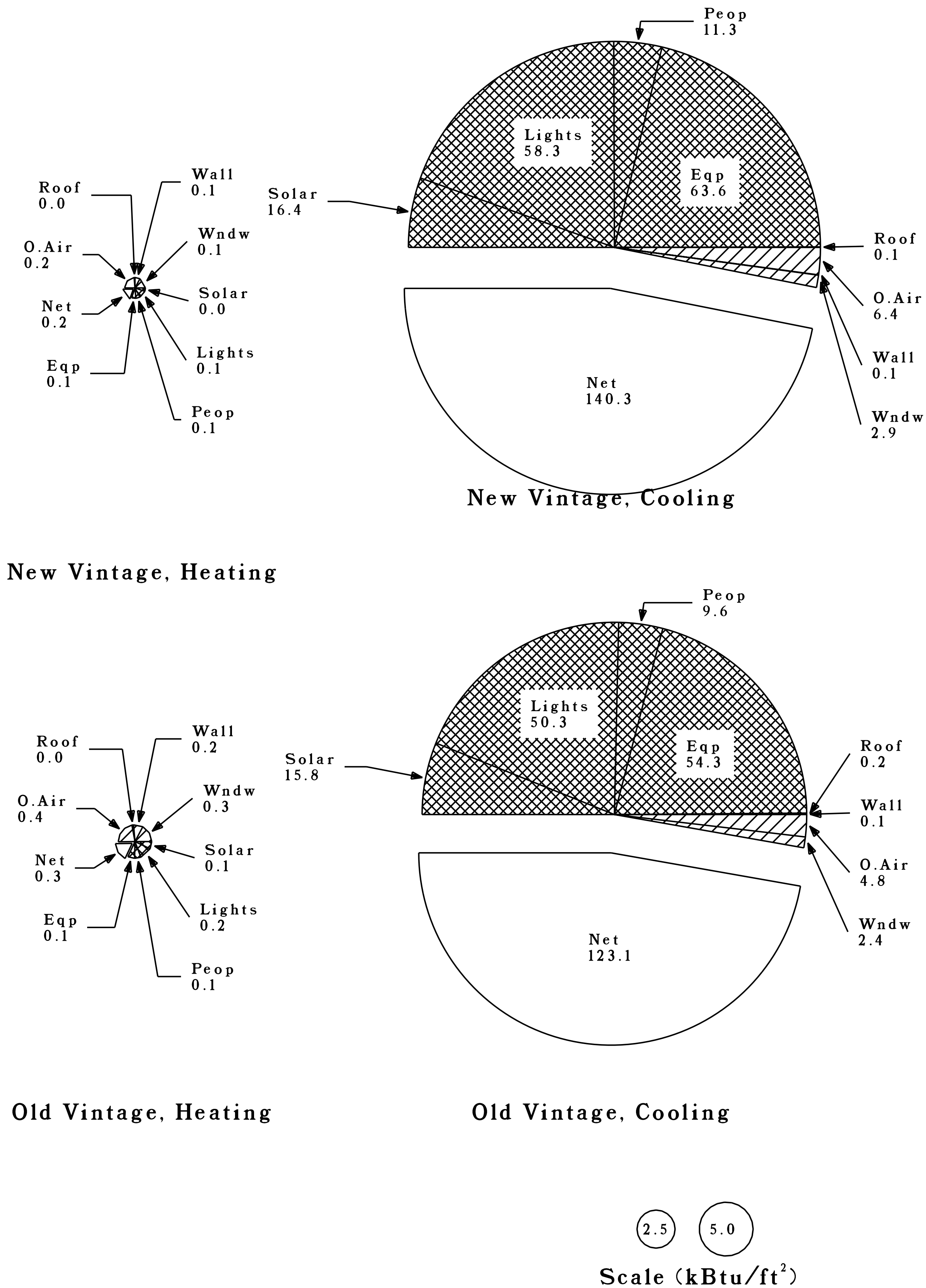


Figure C.28 Specific Component Loads (kBtu/ft²) for Schools in Minneapolis

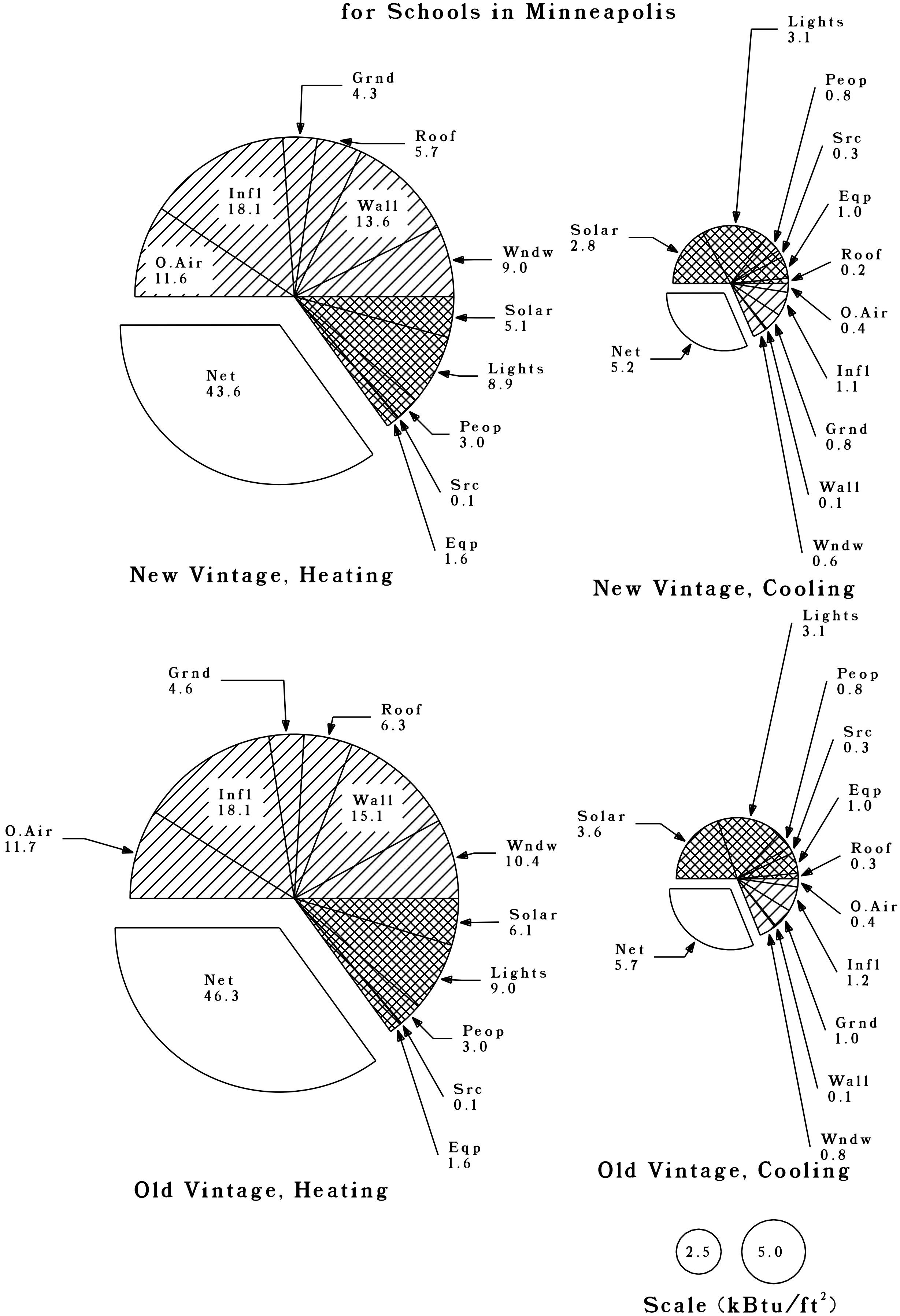


Figure C.29 Specific Component Loads (kBtu/ft²)
for Schools in Washington

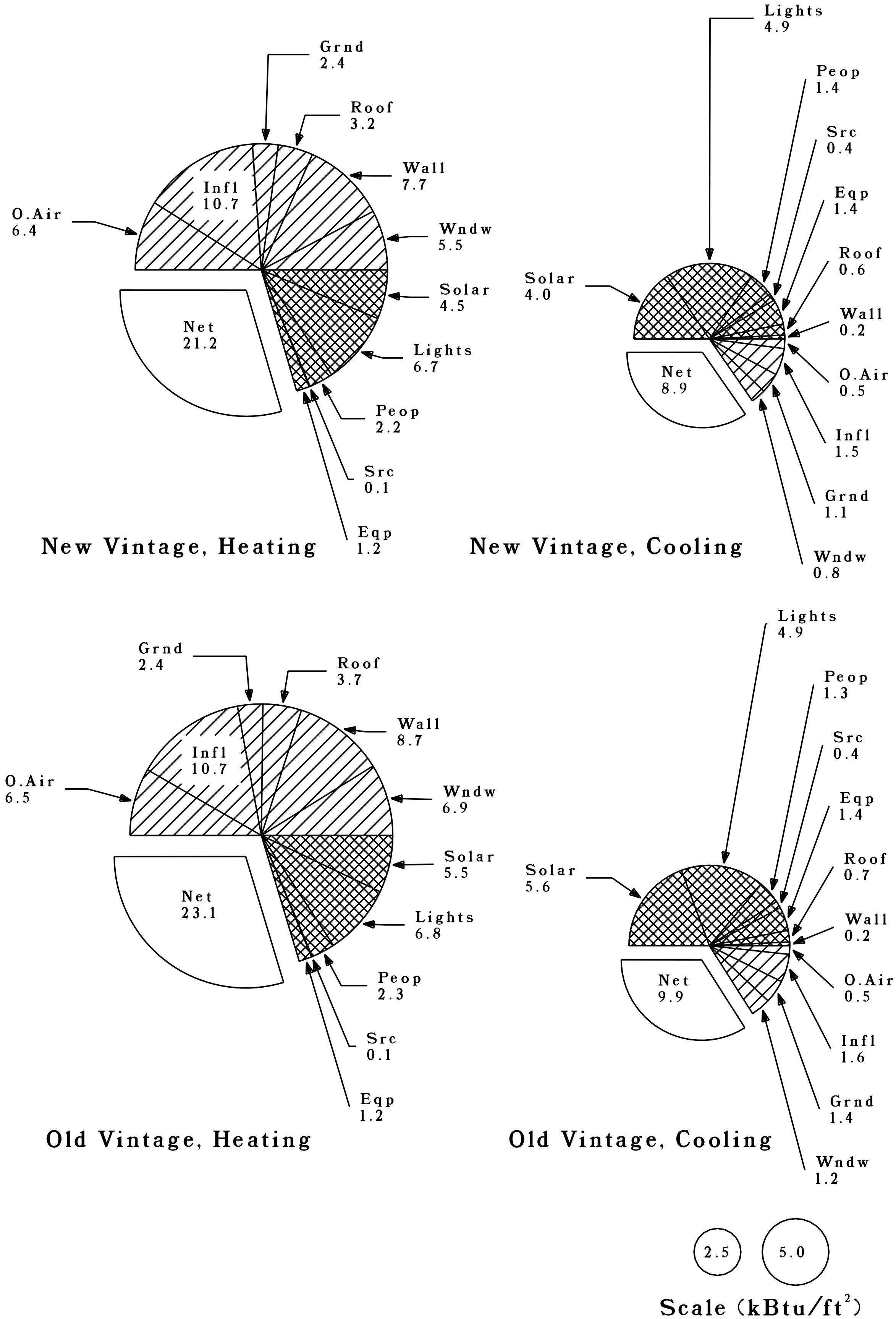
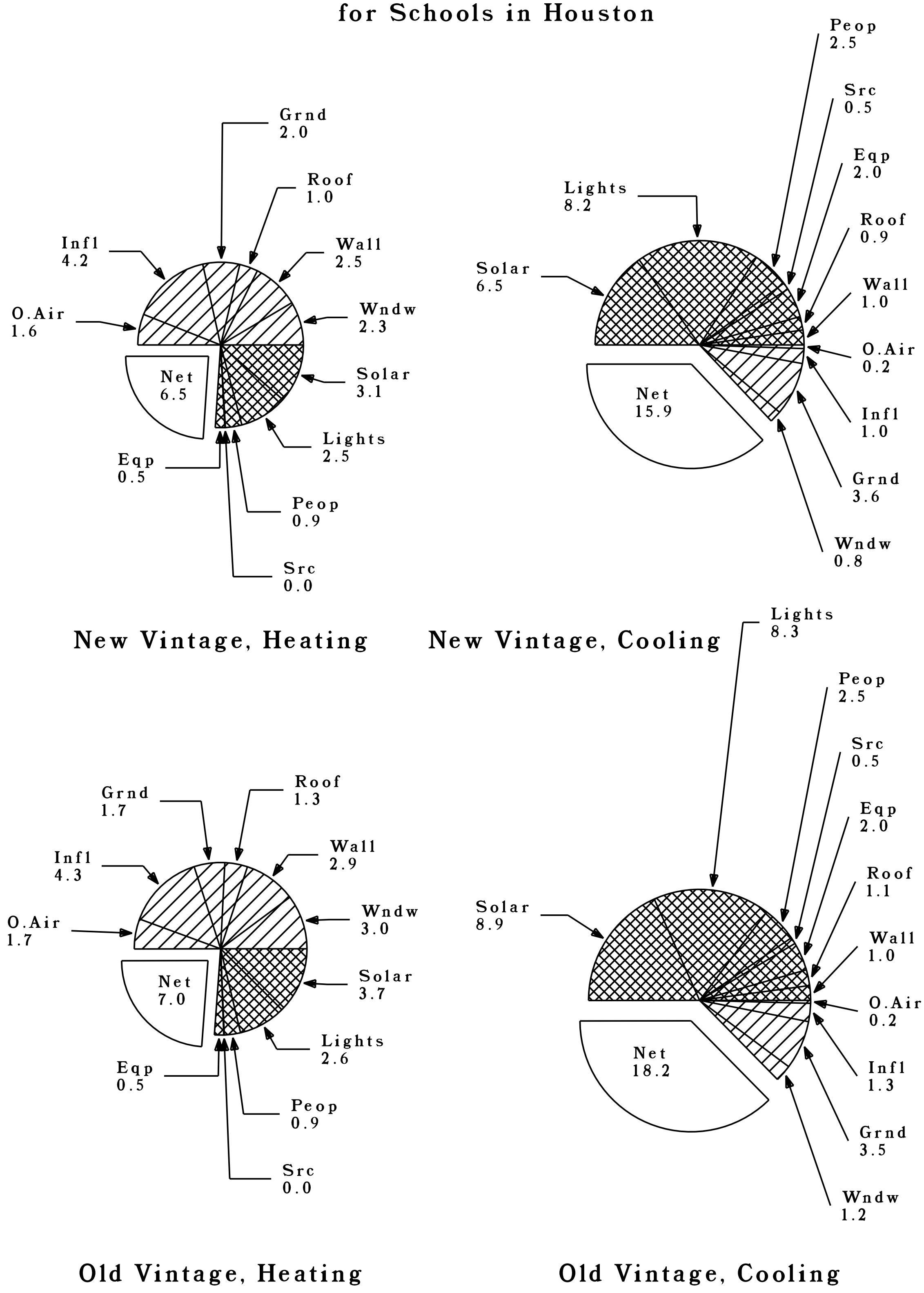
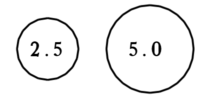


Figure C.30 Specific Component Loads (kBtu/ft^2) for Schools in Houston





Scale (kBtu/ft^2)

Figure C.31 Specific Component Loads (kBtu/ft^2)
for Supermarkets in Minneapolis

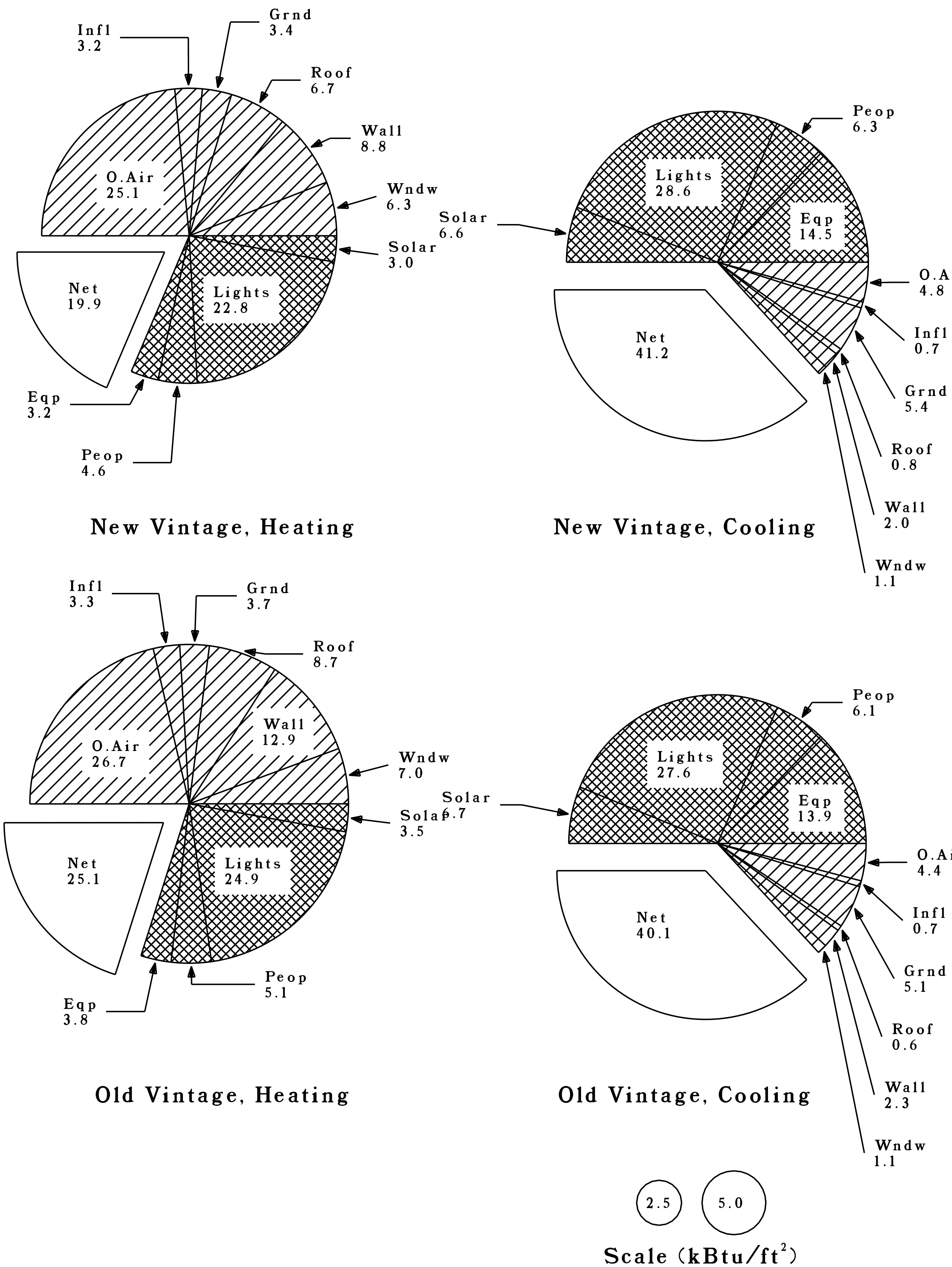


Figure C.32 Specific Component Loads (kBtu/ft²) for Supermarkets in Washington

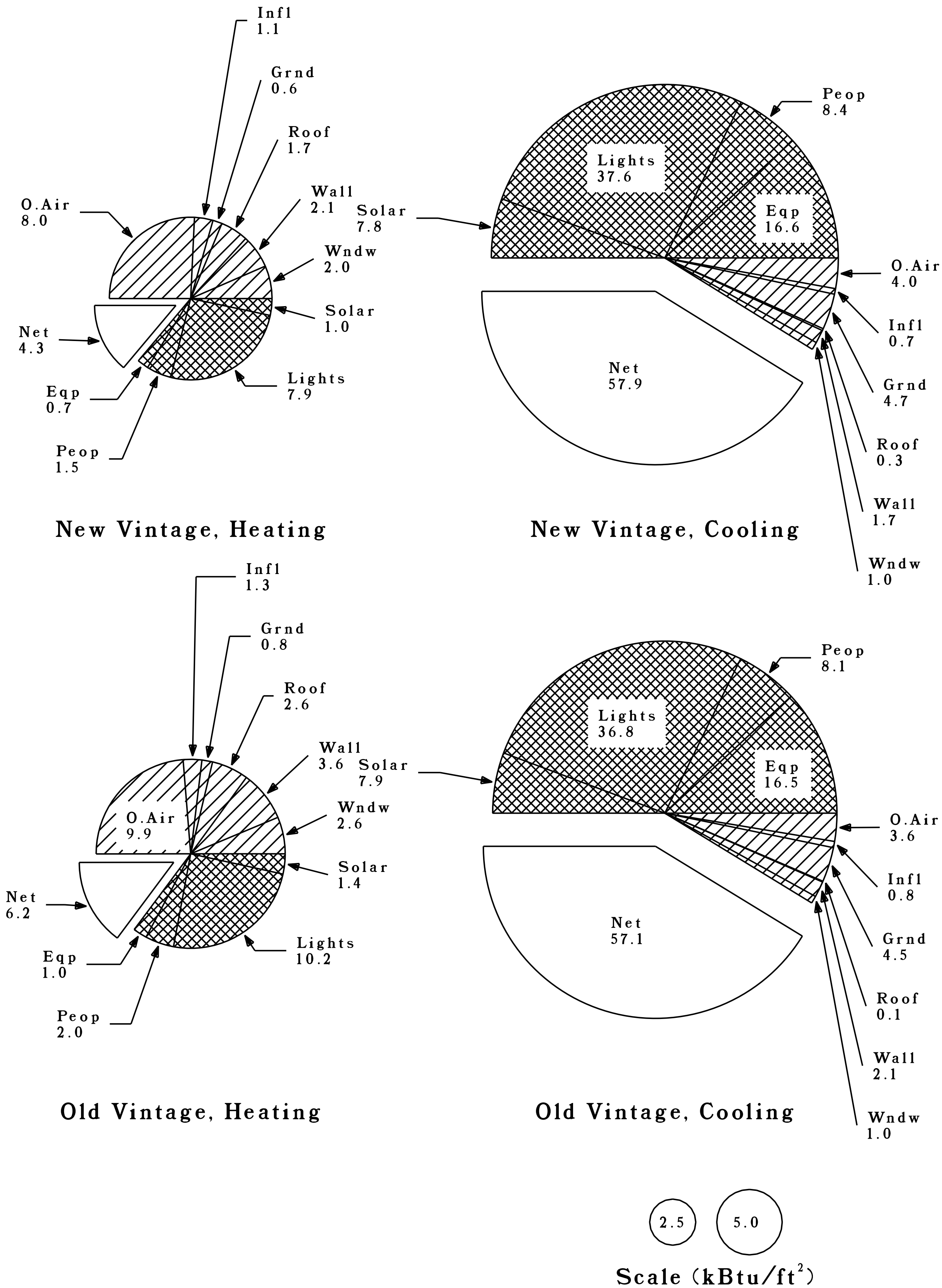


Figure C.33 Specific Component Loads (kBtu/ft²)
for Supermarkets in Houston

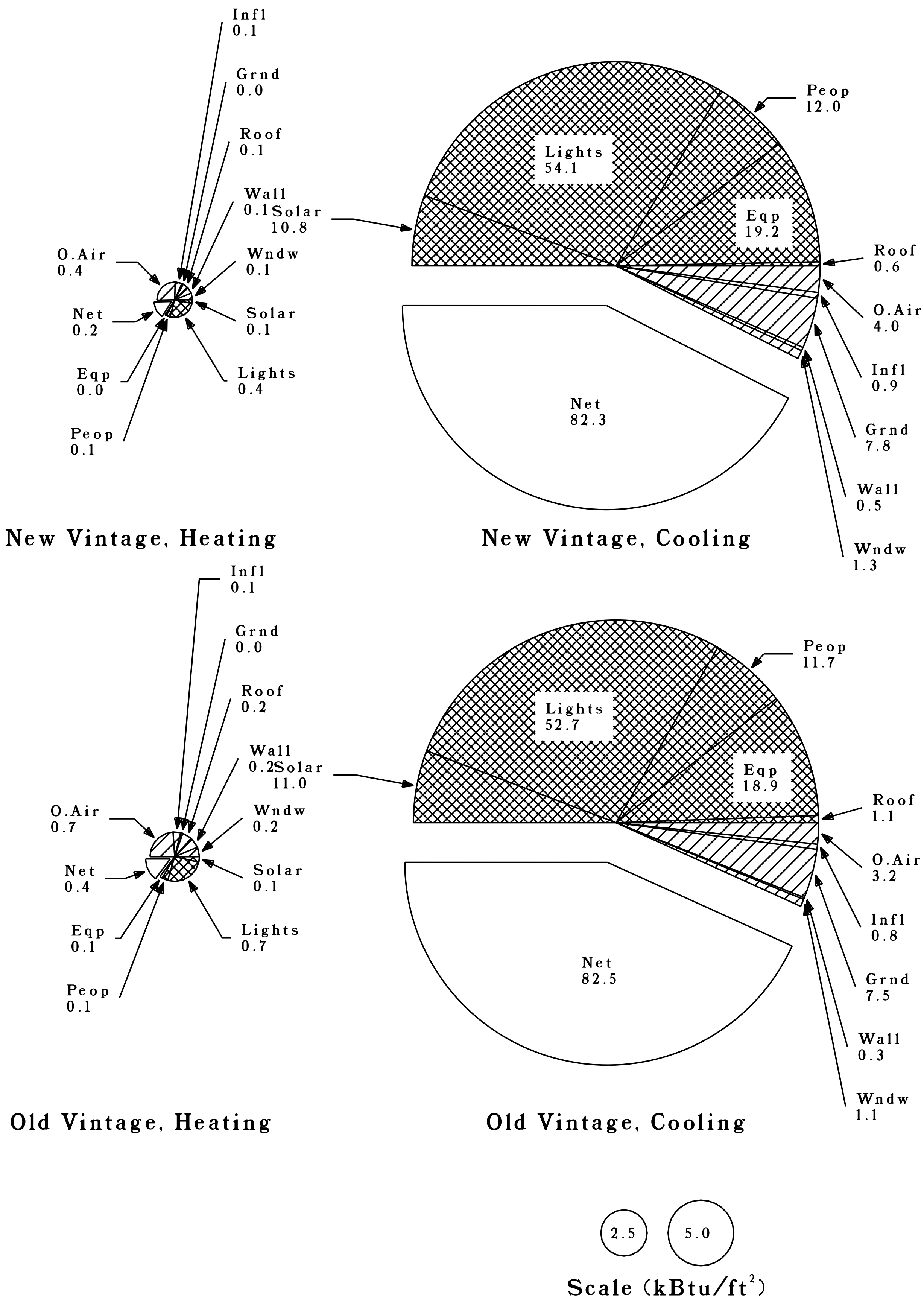
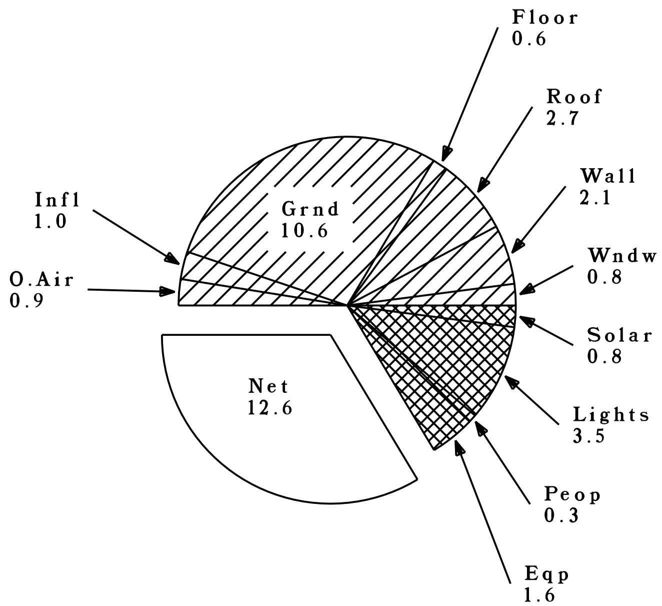
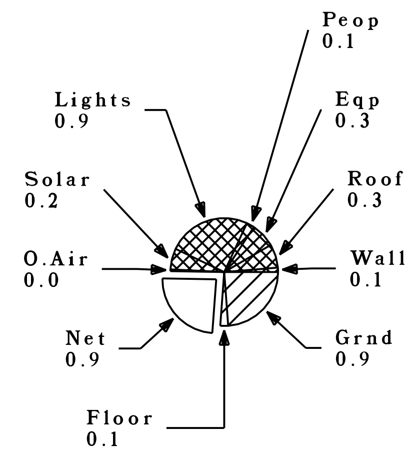


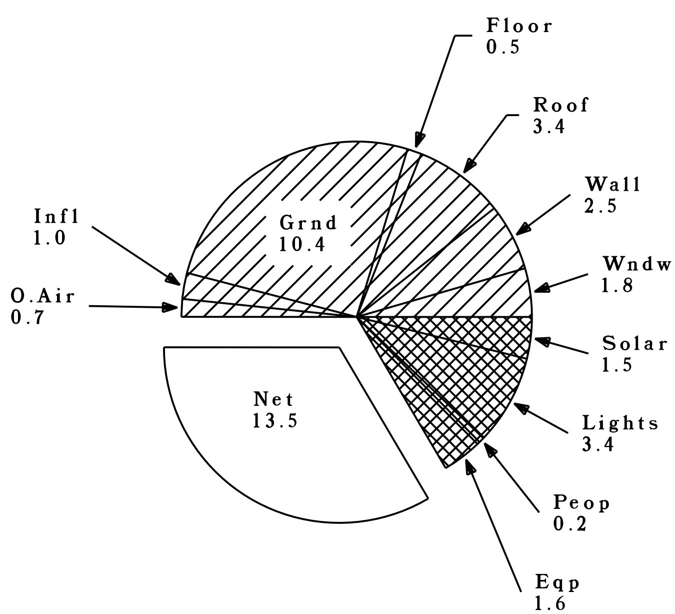
Figure C.34 Specific Component Loads ($kBtu/ft^2$) for Warehouses in Minneapolis



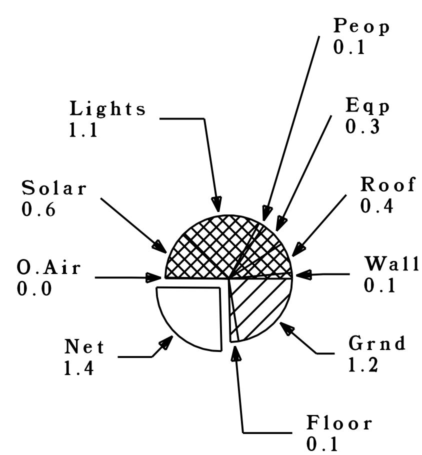
New Vintage, Heating



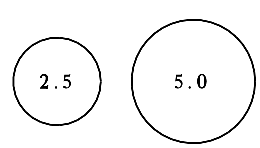
New Vintage, Cooling



Old Vintage, Heating

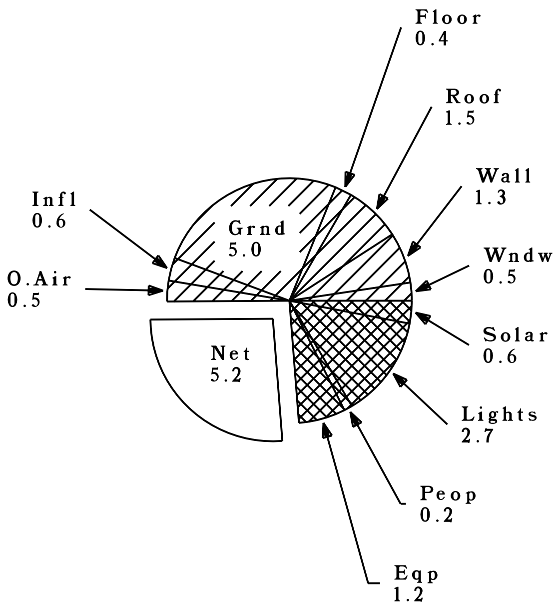


Old Vintage, Cooling

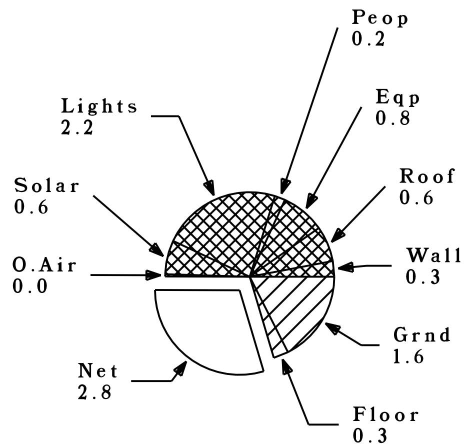


Scale ($kBtu/ft^2$)

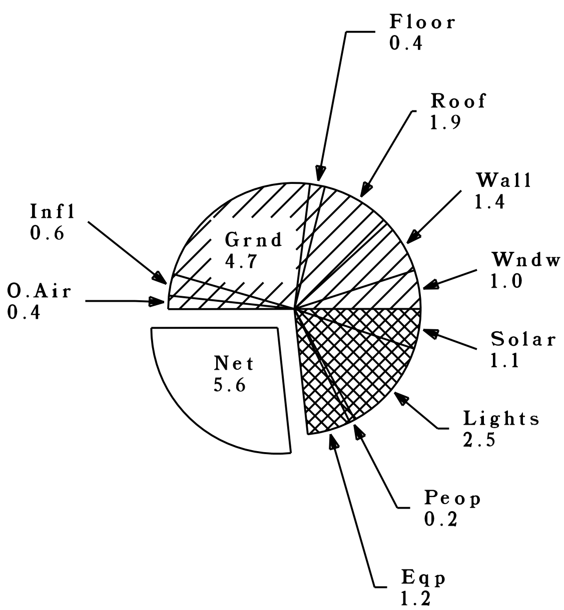
Figure C.35 Specific Component Loads (kBtu/ft^2) for Warehouses in Washington



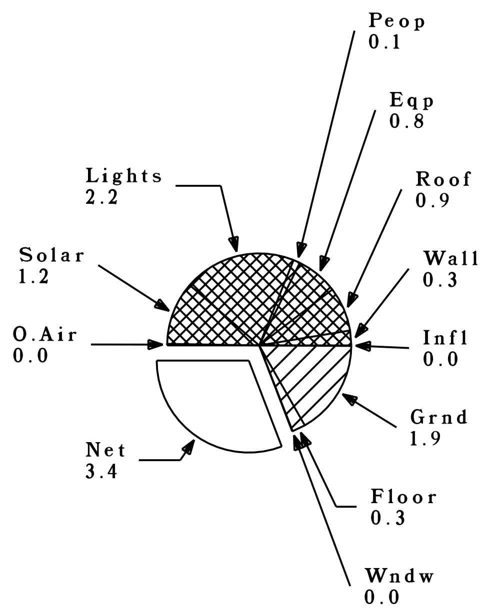
New Vintage, Heating



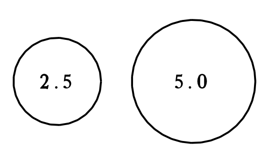
New Vintage, Cooling



Old Vintage, Heating

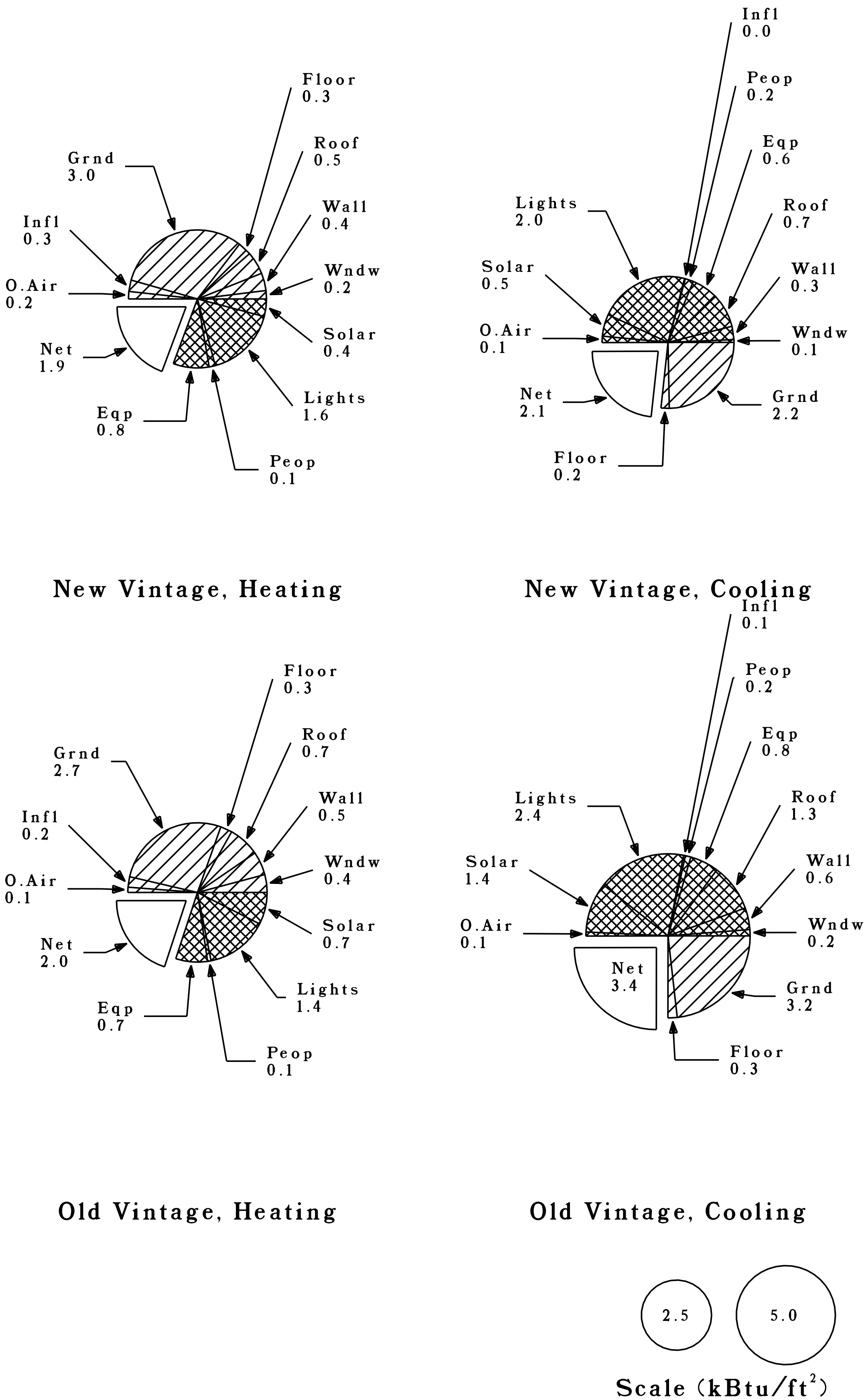


Old Vintage, Cooling



Scale (kBtu/ft^2)

Figure C.36 Specific Component Loads (kBtu/ft^2) for Warehouses in Houston



APPENDIX D : SOURCE LISTING OF USER INPUT FUNCTIONS TO DOE-2 FOR EXTRACTING COMPONENT LOADS

The four functions used to calculate component loads are READDATE, EXTWALL-UA, WIN-UA, and COMP. Because the actual space temperature is calculated in the Systems subprogram, implementing this procedure requires a LOADS/SYSTEM simulation followed by another LOADS simulation. The first LOADS/SYSTEM simulation is used to generate a binary file of hourly system variables for CFMINF, TNOW, and QNOW for each building zone using the standard HOURLY-REPORT feature in DOE-2.

READDATE reads this binary hourly file, and passes the information to COMP. EXTWALL-UA and WIN-UA are functions that calculate the U-values of walls and windows required by COMP to adjust the component loads from LOADS for differences between the load calculation temperature and actual space temperature. COMP takes the temperature and outdoor-air information from READDATE and the U-values from EXTWALL-UA and WIN-UA and computes the corrected component load by zone for each surface type and internal gain source.

Function READDATE

$ This function reads a DOE-2 created binary data file. The
$ file contains hourly values for the system variables
$ CFMINF,TNOW, and QNOW for each building zone.
$ (EMFranconi 12/94)

```
FUNCTION NAME = READDATE ..

ASSIGN
      IHR=IHR
      IDAY=IDAY
      IMON=IMO
      IPRDFL=IPRDFL
      XXX01=XXX01 XXX02=XXX02
      XXX07=XXX07 XXX08=XXX08
      NSP=NSP
..
CALCULATE ..
      IF(IPRDFL .NE. 0) GOTO 20
      IF(IHR+IDAY+IMON .NE. 3) GOTO 5
C     get array space to store system variables and binned loads
      XXX01=GETAA(NSP*12+NSP*120)
C     set number of zones, heat and cooling setpoints
      XXX02=15
      XXX07=70
      XXX08=75
 5    READ(50) RHR,RDAY,RMON,P1T1,P1T2,P1T3,P2T1,P2T2,P2T3,P3T1,
     + P3T2,P3T3,P4T1,P4T2,P4T3,C1T1,C1T2,C1T3,
     + P1F1,P1F2,P1F3,
     + P2F1,P2F2,P2F3,P3F1,P3F2,P3F3,P4F1,P4F2,P4F3,C1F1,C1F2,
     + C1F3,P1I1,P1I2,P1I3,P2I1,P2I2,P2I3,P3I1,P3I2,P3I3,P4I1,
     + P4I2,P4I3,C1I1,C1I2,C1I3
      P1T1=STORE(P1T1,XXX01)
      P1T2=STORE(P1T2,XXX01+4)
      P1T3=STORE(P1T3,XXX01+8)
      P2T1=STORE(P2T1,XXX01+12)
      P2T2=STORE(P2T2,XXX01+16)
      P2T3=STORE(P2T3,XXX01+20)
      P3T1=STORE(P3T1,XXX01+24)
      P3T2=STORE(P3T2,XXX01+28)
```

```
      P3T3=STORE(P3T3,XXX01+32)
      P4T1=STORE(P4T1,XXX01+36)
      P4T2=STORE(P4T2,XXX01+40)
      P4T3=STORE(P4T3,XXX01+44)
      C1T1=STORE(C1T1,XXX01+48)
      C1T2=STORE(C1T2,XXX01+52)
      C1T3=STORE(C1T3,XXX01+56)
      P1F1=STORE(P1F1,XXX01+60)
      P1F2=STORE(P1F2,XXX01+64)
      P1F3=STORE(P1F3,XXX01+68)
      P2F1=STORE(P2F1,XXX01+72)
      P2F2=STORE(P2F2,XXX01+76)
      P2F3=STORE(P2F3,XXX01+80)
      P3F1=STORE(P3F1,XXX01+84)
      P3F2=STORE(P3F2,XXX01+88)
      P3F3=STORE(P3F3,XXX01+92)
      P4F1=STORE(P4F1,XXX01+96)
      P4F2=STORE(P4F2,XXX01+100)
      P4F3=STORE(P4F3,XXX01+104)
      C1F1=STORE(C1F1,XXX01+108)
      C1F2=STORE(C1F2,XXX01+112)
      C1F3=STORE(C1F3,XXX01+116)
      P1I1=STORE(P1I1,XXX01+120)
      P1I2=STORE(P1I2,XXX01+124)
      P1I3=STORE(P1I3,XXX01+128)
      P2I1=STORE(P2I1,XXX01+132)
      P2I2=STORE(P2I2,XXX01+136)
      P2I3=STORE(P2I3,XXX01+140)
      P3I1=STORE(P3I1,XXX01+144)
      P3I2=STORE(P3I2,XXX01+148)
      P3I3=STORE(P3I3,XXX01+152)
      P4I1=STORE(P4I1,XXX01+156)
      P4I2=STORE(P4I2,XXX01+160)
      P4I3=STORE(P4I3,XXX01+164)
      C1I1=STORE(C1I1,XXX01+168)
      C1I2=STORE(C1I2,XXX01+172)
      C1I3=STORE(C1I3,XXX01+176)
C     WRITE (60,10) RHR,RDAY,RMON,P1T1,P1T2,P1T3,P2T1,P2T2,
C    + P2T3,P3T1,P3T2,P3T3,P4T1,P4T2,P4T3,C1T1,C1T2,C1T3
C10   FORMAT(3I2,F12.0,F8.1,F13.0,F12.0,F8.1,F13.0,F12.0,
C    + F8.1,F13.0,F12.0,F8.1,F13.0,F12.0,F8.1,F13.0)
C     WRITE (60,12) RHR,RDAY,RMON,P1F1,P1F2,P1F3,P2F1,P2F2,
C    + P2F3,P3F1,P3F2,P3F3,P4F1,P4F2,P4F3,C1F1,C1F2,C1F3
C12   FORMAT(3I2,F12.0,F8.1,F13.0,F12.0,F8.1,F13.0,F12.0,
C    + F8.1,F13.0,F12.0,F8.1,F13.0,F12.0,F8.1,F13.0)
C     WRITE (60,14) RHR,RDAY,RMON,P1I1,P1I2,P1I3,P2I1,P2I2,
C    + P2I3,P3I1,P3I2,P3I3,P4I1,P4I2,P4I3,C1I1,C1I2,C1I3
C14   FORMAT(3I2,F12.0,F8.1,F13.0,F12.0,F8.1,F13.0,F12.0,
C    + F8.1,F13.0,F12.0,F8.1,F13.0,F12.0,F8.1,F13.0)
 20   CONTINUE
      END
END-FUNCTION ..
```

Function EXTWALL-UA

```
$ File loads_2f.inc
$ This function sums wall and roof UA values (no doors/trombe)
$ in each zone. The UA values are used to correct the Qzone
$ from LOADS based on the actual zone temp (Tnow). The UAs are
$ reset to zero after each space calc in the COMP function
$ (EMFranconi 12/94)
FUNCTION NAME = EXTWALL-UA ..

ASSIGN
      IEWTYPE=IEWTYPE  UFACTR=UFACTR FILMU=FILMU
      XSAREA=XSAREA XSMULT=XSMULT XSTLT=XSTLT
      PIOVR4=PIOVR4
```

```
      XXX03=XXX03 XXX04=XXX04
      IPRDFL=IPRDFL ISPTYPE=ISPTYPE
CALCULATE ..
      IF (IPRDFL .NE. 0) GOTO 30
      IF (ISPTYPE .GT. 1) GOTO 30
      IF (IEWTYPE .GE. 3) GOTO 30
      CONDUA=(UFACTR*FILMU*XSAREA*XSMULT)/(UFACTR+FILMU)
      IF (XSTLT .LT. PIOVR4) GOTO 10
C     SUM WALL UA
      XXX03=XXX03+CONDUA
      GOTO 20
C     SUM ROOF UA
 10   XXX04=XXX04+CONDUA
 20   CONTINUE
C     WRITE (99,25) CONDUA,XXX03,XXX04
C25   FORMAT(' UACond='F8.1,' UAWall='F8.1,' UARoof='F8.1)
 30   CONTINUE
      END
END-FUNCTION ..
```

Function WIN-UA

$ File loads_3f.inc
$ This function sums window UA values
$ in each zone. The UA values are used to correct the Qzone
$ from LOADS based on the actual zone temp (Tnow). The UA is
$ reset to zero after each space calc in the COMP function
$ (EMFranconi 12/94)

```
FUNCTION NAME = WIN-UA ..

ASSIGN
      IEWTYPE=IEWTYPE  UW=UW
      WIAREA=WIAREA GMULT=GMULT XSMULT=XSMULT
      XXX05=XXX05 IPRDFL=IPRDFL ISPTYPE=ISPTYPE
..
CALCULATE ..
      IF (IPRDFL .NE. 0) GOTO 30
      IF (ISPTYPE .GT. 1) GOTO 30
      IF (IEWTYPE .GE. 3) GOTO 20
      WINUA=UW*WIAREA*GMULT*XSMULT
      XXX05=XXX05+WINUA
 20   CONTINUE
C     WRITE (99,25) WINUA,XXX05
C25   FORMAT(' UAWIN='F8.1,' UAWINTOT='F8.1)
 30   CONTINUE
      END
END-FUNCTION ..
```

Function COMP

$ File loads_4f.DBbin
$ Determines component loads from hourly load variables.
$ Bins Qload in hours that Qext=0 when Tzone is
$ outside the dead band. Separates binning between
$ heating and cooling.
$ (EMFranconi 12/94)

```
FUNCTION NAME = COMP ..

ASSIGN
      IHR=IHR IDAY=IDAY IMON=IMO
      IPRDFL=IPRDFL ISPTYPE=ISPTYPE IZNM=IZNM
      IZNUM=IZNUM  XXX01=XXX01 FNTYPE=FNTYPE
```

```
      QSUMW=QSUMW PATM=PATM NSP=NSP
      ZMULT=ZMULT  FMULT=FLOOR-MULT
      XXX02=XXX02 XXX03=XXX03 XXX04=XXX04 XXX05=XXX05
      XXX06=XXX06 HT=XXX07 CT=XXX08
      ZUGWUA=ZUGWUA ZUGFUA=ZUGFUA
      ZCFMI=CFMINF ZCOND=ZCOND
      TZONER=TZONER TOUT=DBT
      QWALQ=QWALQ QCELQ=QCELQ QUGW=QUGW
      QWINC=QWINC QWALD=QWALD QCELD=QCELD
      QUGF=QUGF QEQPS=QEQPS QEQPS2=QEQPS2
      QPPS=QPPS QINFS=QINFS QLITEW=QLITEW
      QSOL=QSOL QTSKL=QTSKL QDOOR=QDOOR
      QINTW=QINTW ZQS=QZS
..
CALCULATE ..
      IF (IPRDFL .NE. 0) GOTO 100
      IF (ISPTYPE .GT. 1) GOTO 100
      IF (FNTYPE .NE. 2) GOTO 100
      IF (IHR+IDAY+IMON .NE. 3) GOTO 2
      IF (IZNUM .NE. 1 ) GOTO 2
      XXX06=XXX01+NSP*12
C     WRITE(99,1) XXX01,XXX06,NSP
C1    FORMAT (2F9.0,F5.1)
 2    MULT=ZMULT*FMULT
      ZCFMTOT=ACCESS(XXX01+(IZNUM-1)*12)
      ZTNOW=ACCESS(XXX01+(IZNUM-1)*12+4)
      ZQEXT=ACCESS(XXX01+(IZNUM-1)*12+8)
C     INFIL AND OUTDOOR AIR HEAT LOSS CALC
      ZQINF=14.4*.00245*PATM*ZCFMI*(TOUT-ZTNOW)
      ZQOA=14.4*.00245*PATM*(ZCFMTOT-ZCFMI)*(TOUT-ZTNOW)
C     CONDUCTION CORRECTION FOR ACTUAL ZONE TEMP
      TZONE=TZONER-460
      DTCZ=TZONE-ZTNOW
      ZQCDT=ZCOND*DTCZ
      UACOND=XXX05+XXX03+XXX04+ZUGWUA+ZUGFUA
C     WRITE (99,3) ZCOND,XXX05,XXX03,XXX04,UACOND
C3    FORMAT(' ZCOND='F8.1,' WIN='F8.1,' WAL=',F8.1,' RF='F8.1,F8.1)
      QWINX=XXX05*DTCZ
      ZQWIN=QWINC+QWINX
      QWALX=XXX03*DTCZ
      ZQWAL=QWALD+QWALQ+QWALX
      QRFX=XXX04*DTCZ
      ZQRF=QCELD+QCELQ+QRFX
      QUGX=(ZUGWUA+ZUGFUA)*DTCZ
      ZQUGF=QUGF+QUGW+QUGX
      ZQC=QWINX+QWALX+QRFX+QUGX
      QSUMX=QWINX+QWALX+QRFX+QUGX
      ZQTOT=QINTW+QDOOR+QEQPS+QEQPS2+QPPS+QLITEW+QSOL
     + +QTSKL+ZQINF+ZQOA+ZQWIN+ZQWAL+ZQRF+ZQUGF
C     WRITE (99,3) ZTNOW,HSET,CSET,ZQEXT
C3    FORMAT(' ZT='F4.1,' HT='F4.1,' CT=',F4.1,' EXT='F10.1)
      IF (ZQEXT .EQ. 0 .AND. ZTNOW .LT. HT) GOTO 10
      IF (ZQEXT .EQ. 0 .AND. ZTNOW .GT. CT) GOTO 10
      IF (ZQEXT .NE. 0) GOTO 20
      GOTO 30
C     Sum ZQTOT load
 10   CONTINUE
C     WRITE (99,12) IMON,IDAY,IHR,IZNM,IZNUM,ZQEXT,ZTNOW
C12   FORMAT('QBH ',3F3.0,A6,F3.0,' ZEXT='F12.0,' TZ='F4.1)
      QBTOT=ZQTOT*MULT+ACCESS(XXX06+(IZNUM-1)*60)
      QBWIN=ZQWIN*MULT+ACCESS(XXX06+(IZNUM-1)*60+4)
      QBWAL=ZQWAL*MULT+ACCESS(XXX06+(IZNUM-1)*60+8)
      QBRF=ZQRF*MULT+ACCESS(XXX06+(IZNUM-1)*60+12)
      QBUGF=ZQUGF*MULT+ACCESS(XXX06+(IZNUM-1)*60+16)
      QBINTW=QINTW*MULT+ACCESS(XXX06+(IZNUM-1)*60+20)
      QBEQPS=QEQPS*MULT+ACCESS(XXX06+(IZNUM-1)*60+24)
      QBEQPS2=QEQPS2*MULT+ACCESS(XXX06+(IZNUM-1)*60+28)
      QBPPS=QPPS*MULT+ACCESS(XXX06+(IZNUM-1)*60+32)
```

```
      QBINFS=ZQINF*MULT+ACCESS(XXX06+(IZNUM-1)*60+36)
      QBLITEW=QLITEW*MULT+ACCESS(XXX06+(IZNUM-1)*60+40)
      QBSOL=QSOL*MULT+ACCESS(XXX06+(IZNUM-1)*60+44)
      QBOA=ZQOA*MULT+ACCESS(XXX06+(IZNUM-1)*60+48)
      QBDOOR=QDOOR*MULT+ACCESS(XXX06+(IZNUM-1)*60+52)
      QBTSKL=QTSKL*MULT+ACCESS(XXX06+(IZNUM-1)*60+56)
C     Store binned loads in array
      QBTOT=STORE(QBTOT,XXX06+(IZNUM-1)*60)
      QBWIN=STORE(QBWIN,XXX06+(IZNUM-1)*60+4)
      QBWAL=STORE(QBWAL,XXX06+(IZNUM-1)*60+8)
      QBRF=STORE(QBRF,XXX06+(IZNUM-1)*60+12)
      QBUGF=STORE(QBUGF,XXX06+(IZNUM-1)*60+16)
      QBINTW=STORE(QBINTW,XXX06+(IZNUM-1)*60+20)
      QBEQPS=STORE(QBEQPS,XXX06+(IZNUM-1)*60+24)
      QBEQPS2=STORE(QBEQPS2,XXX06+(IZNUM-1)*60+28)
      QBPPS=STORE(QBPPS,XXX06+(IZNUM-1)*60+32)
      QBINFS=STORE(QBINFS,XXX06+(IZNUM-1)*60+36)
      QBLITEW=STORE(QBLITEW,XXX06+(IZNUM-1)*60+40)
      QBSOL=STORE(QBSOL,XXX06+(IZNUM-1)*60+44)
      QBOA=STORE(QBOA,XXX06+(IZNUM-1)*60+48)
      QBDOOR=STORE(QBDOOR,XXX06+(IZNUM-1)*60+52)
      QBTSKL=STORE(QBTSKL,XXX06+(IZNUM-1)*60+56)
      GOTO 30
 20   IF (ZQEXT .GT. 0) GOTO 25
C     ADD LOAD TO HEATING
C     WRITE (99,22) IMON,IDAY,IHR,IZNM,IZNUM,ZQEXT,ZTNOW
C22   FORMAT('QHTOT ',3F3.0,A6,F3.0,' ZEXT='F12.0,' TZ='F4.1)
      QHTOT=QHTOT+ZQTOT*MULT+ACCESS(XXX06+(IZNUM-1)*60)
      QHWIN=QHWIN+ZQWIN*MULT+ACCESS(XXX06+(IZNUM-1)*60+4)
      QHWAL=QHWAL+ZQWAL*MULT+ACCESS(XXX06+(IZNUM-1)*60+8)
      QHRF=QHRF+ZQRF*MULT+ACCESS(XXX06+(IZNUM-1)*60+12)
      QHUGF=QHUGF+ZQUGF*MULT+ACCESS(XXX06+(IZNUM-1)*60+16)
      QHINTW=QHINTW+QINTW*MULT+ACCESS(XXX06+(IZNUM-1)*60+20)
      QHEQPS=QHEQPS+QEQPS*MULT+ACCESS(XXX06+(IZNUM-1)*60+24)
      QHEQPS2=QHEQPS2+QEQPS2*MULT+ACCESS(XXX06+(IZNUM-1)*60+28)
      QHPPS=QHPPS+QPPS*MULT+ACCESS(XXX06+(IZNUM-1)*60+32)
      QHINFS=QHINFS+ZQINF*MULT+ACCESS(XXX06+(IZNUM-1)*60+36)
      QHLITEW=QHLITEW+QLITEW*MULT+ACCESS(XXX06+(IZNUM-1)*60+40)
      QHSOL=QHSOL+QSOL*MULT+ACCESS(XXX06+(IZNUM-1)*60+44)
      QHOA=QHOA+ZQOA*MULT+ACCESS(XXX06+(IZNUM-1)*60+48)
      QHDOOR=QHDOOR+QDOOR*MULT+ACCESS(XXX06+(IZNUM-1)*60+52)
      QHTSKL=QHTSKL+QTSKL*MULT+ACCESS(XXX06+(IZNUM-1)*60+56)
      GOTO 28
C     ADD LOAD TO COOLING
 25   CONTINUE
C     WRITE (99,27) IMON,IDAY,IHR,IZNM,IZNUM,ZQEXT,ZTNOW
C27   FORMAT('QCTOT ',3F3.0,A6,F3.0,' ZEXT='F12.0,' TZ='F4.1)
      QCTOT=QCTOT+ZQTOT*MULT+ACCESS(XXX06+(IZNUM-1)*60)
      QCWIN=QCWIN+ZQWIN*MULT+ACCESS(XXX06+(IZNUM-1)*60+4)
      QCWAL=QCWAL+ZQWAL*MULT+ACCESS(XXX06+(IZNUM-1)*60+8)
      QCRF=QCRF+ZQRF*MULT+ACCESS(XXX06+(IZNUM-1)*60+12)
      QCUGF=QCUGF+ZQUGF*MULT+ACCESS(XXX06+(IZNUM-1)*60+16)
      QCINTW=QCINTW+QINTW*MULT+ACCESS(XXX06+(IZNUM-1)*60+20)
      QCEQPS=QCEQPS+QEQPS*MULT+ACCESS(XXX06+(IZNUM-1)*60+24)
      QCEQPS2=QCEQPS2+QEQPS2*MULT+ACCESS(XXX06+(IZNUM-1)*60+28)
      QCPPS=QCPPS+QPPS*MULT+ACCESS(XXX06+(IZNUM-1)*60+32)
      QCINFS=QCINFS+ZQINF*MULT+ACCESS(XXX06+(IZNUM-1)*60+36)
      QCLITEW=QCLITEW+QLITEW*MULT+ACCESS(XXX06+(IZNUM-1)*60+40)
      QCSOL=QCSOL+QSOL*MULT+ACCESS(XXX06+(IZNUM-1)*60+44)
      QCOA=QCOA+ZQOA*MULT+ACCESS(XXX06+(IZNUM-1)*60+48)
      QCDOOR=QCDOOR+QDOOR*MULT+ACCESS(XXX06+(IZNUM-1)*60+52)
      QCTSKL=QCTSKL+QTSKL*MULT+ACCESS(XXX06+(IZNUM-1)*60+56)
 28   CONTINUE
      QBTOT=0
      QBWIN=0
      QBWAL=0
      QBRF=0
```

```
      QBUGF=0
      QBINTW=0
      QBEQPS=0
      QBEQPS2=0
      QBPPS=0
      QBINFS=0
      QBLITEW=0
      QBSOL=0
      QBOA=0
      QBDOOR=0
      QBTSKL=0
C     Flush stored loads
      QBTOT=STORE(QBTOT,XXX06+(IZNUM-1)*60)
      QBWIN=STORE(QBWIN,XXX06+(IZNUM-1)*60+4)
      QBWAL=STORE(QBWAL,XXX06+(IZNUM-1)*60+8)
      QBRF=STORE(QBRF,XXX06+(IZNUM-1)*60+12)
      QBUGF=STORE(QBUGF,XXX06+(IZNUM-1)*60+16)
      QBINTW=STORE(QBINTW,XXX06+(IZNUM-1)*60+20)
      QBEQPS=STORE(QBEQPS,XXX06+(IZNUM-1)*60+24)
      QBEQPS2=STORE(QBEQPS2,XXX06+(IZNUM-1)*60+28)
      QBPPS=STORE(QBPPS,XXX06+(IZNUM-1)*60+32)
      QBINFS=STORE(QBINFS,XXX06+(IZNUM-1)*60+36)
      QBLITEW=STORE(QBLITEW,XXX06+(IZNUM-1)*60+40)
      QBSOL=STORE(QBSOL,XXX06+(IZNUM-1)*60+44)
      QBOA=STORE(QBOA,XXX06+(IZNUM-1)*60+48)
      QBDOOR=STORE(QBDOOR,XXX06+(IZNUM-1)*60+52)
      QBTSKL=STORE(QBTSKL,XXX06+(IZNUM-1)*60+56)
 30   CONTINUE
      IF (IMON .NE. 1) GOTO 34
      IF (IDAY .NE. 1) GOTO 34
      IF (IHR .LE. 5) GOTO 34
      IF (IHR .GE. 11) GOTO 34
      WRITE (99,31) IMON,IDAY,IHR,IZNM,IZNUM,ZTNOW,ZQTOT,MULT,QCTOT,
     + QHTOT,QBTOT,ZQEXT
 31   FORMAT(3F4.0,A6,F3.0,' TZ='F4.1,' ZQ='F12.0,' *X='F3.0,' QCT='
     + F12.0,' QHT='F12.0,' QB='F12.0,' EXT='F12.0)
      WRITE (99,32) ZCOND,XXX05,XXX03,XXX04,UACOND
 32    FORMAT(' ZCOND='F8.1,' WIN='F8.1,' WAL=',F8.1,' RF='F8.1,F8.1)
C32   IF (IDAY .NE. 2) GOTO 34
C     WRITE (99,33) IMON,IDAY,IHR,IZNM,IZNUM,ZTNOW,ZQTOT,MULT,QCTOT,
C    + QHTOT,QBTOT,ZQEXT
C33   FORMAT(3F4.0,A6,F3.0,' TZ='F4.1,' ZQ='F12.0,' *X='F3.0,' QCT='
C    + F12.0,' QHT='F12.0,' QB='F12.0,' EXT='F12.0)
C     WRITE (99,31) ZCOND,XXX05,XXX03,XXX04,ZUGWUA,ZUGFUA,UACOND
C31   FORMAT(' ZCOND='F8.1,' UAWIN='F8.1,' UAWAL=',F8.1,
C    + ' UARF='F8.1,' UAUGW='F8.1,'UAUGF=',F8.1,' UACOND='F8.1)
C     WRITE(99,32) IMON,IDAY,IHR,IZNM,IZNUM,ZQCDT,QSUMX,
C    + ZQWIN,QWINX,ZQWAL,QWALX,ZQRF,QRFX,
C    + ZQUG,QUGX,QINTW,QEQPS,QEQPS2,QPPS,QLITEW,QSOL,ZQINF,ZQOA,
C    + ZQTOT,ZQEXT,ZTNOW,TZONER-460,TOUT,QBTOT
C32   FORMAT(3F4.0,A6,F3.0,' ZCDT='F12.0,' QSUMX='F12.0,
C    + ' WINQ='F12.0,' WINX='F12.0,' WALQ='F12.0,' WALX='F12.0,
C    + ' RFQ='F12.0,' RFX='F12.0, ' QUG='F12.0,' QUGX='F12.0,
C    + ' INT='F12.0,' EQP='F12.0,' SRC='F12.0,' PPL='F12.0,
C    + ' LIT='F12.0,' SOL='F12.0,' INF='F12.0,' OA='F12.0,
C    + ' TOT='F12.0,' EXT='F12.0,' TNOW='F5.1,' TZF='F5.1,
C    + ' TOUT='F6.1,' QBTOT=',F12.0)
C     WRITE(99,32) IMON,IDAY,IHR,IZNM,IZNUM,MULT,ZQWIN,ZQWAL,ZQRF,QINTW,
C    + ZQUGF,QEQPS,QEQPS2,QPPS,ZQINF,QLITEW,QSOL,ZQOA,
C    + QDOOR,QTSKL,ZQTOT,ZQEXT,ZTNOW,TZONEF,TOUT
C32   FORMAT(3F4.0,A12,2F3.0,' WIN='F12.0,' WAL='F12.0,' RF='F12.0,
C    + ' INT='F12.0,' UGF='F12.0,' EQP='F12.0,' SRC='F12.0,' PPL='F12.0,
C    + ' INF='F12.0,' LITE='F12.0,' SOL='F12.0, ' OA='F12.0,' DR='F12.0,
C    + ' TSK='F12.0,' TOT='F12.0,' EXT='F12.0,' TNOW='F5.1,' TZF='F5.1,
C    + ' TOUT='F6.1)
 34   CONTINUE
C     Reset the space component UA values
```

```
      XXX03=0
      XXX04=0
      XXX05=0
      IF (IMON .NE. 12) GOTO 100
      IF (IDAY .NE. 31) GOTO 100
      IF (IHR .NE. 24) GOTO 100
C     WRITE (99,35) IZNUM,XXX02
C35   FORMAT(3F3.0)
      IF (IZNUM .NE. XXX02) GOTO 100
      WRITE(99,40) IMON,IDAY,IHR,IZNUM,QHWIN,QHWAL,QHRF,QHINTW,QHUGF,
     + QHEQPS,QHEQPS2,QHPPS,QHINFS,QHLITEW,QHSOL,QHOA,
     + QHDOOR,QHTSKL,QHTOT
 40   FORMAT('DB_Qheat ',4F3.0,15F13)
      WRITE(99,50) IMON,IDAY,IHR,IZNUM,QCWIN,QCWAL,QCRF,QCINTW,QCUGF,
     + QCEQPS,QCEQPS2,QCPPS,QCINFS,QCLITEW,QCSOL,QCOA,
     + QCDOOR,QCTSKL,QCTOT
 50   FORMAT('DB_Qcool ',4F3.0,15F14)
 100  CONTINUE
      END
END-FUNCTION ..
```