ENERGY AND ENVIRONMENTAL ANALYSIS, INC.

Task 2.1 Report:

National Account Sector Energy Profiles

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1. INTRODUCTION

Advanced energy technologies including distributed generation (DG), combined heat and power (CHP) and thermally activated technologies (TAT) offer potentially significant efficiency and economic benefits to energy customers and the nation. In the commercial buildings setting, integrated energy systems (IES) -- also called building cooling, heating and power (BCHP) systems -- that feature the use of waste heat to drive air conditioning and desiccant dehumidification equipment offer additional advantages such as peak electric load reduction and ability to downsize building cooling capacity.

National-level energy customers (national account customers) represent a potentially attractive market for advanced energy technologies because such customers operate facilities in states across the country and make many types of decisions on a centralized basis. The multiple project, unit marketing and sales approach that is possible with this structure is a much more efficient way to increase the penetration of advanced systems than the labor-intensive site-by-site alternative. However, drivers, challenges, and economics of advanced systems, especially in IES configurations, vary greatly across the spectrum of national account market segments. Developing suitable advanced systems and packages, and devising effective market and policy strategies to promote their use, requires an understanding of the unique characteristics of each of these market segments.

This study explores the central characteristics of five target national account market sectors: healthcare (hospitals and nursing homes), supermarkets, lodging (hotels and motels), restaurants and "big box" retail. For each sector, we: 1) describe current business and market conditions, recent past trends, and present the outlook and projections for the sector; 2) characterize decision-making processes and criteria as they relate to energy equipment and systems; and 3) profile typical energy equipment and systems in use and typical thermal and electric loads.

A sister report completes the evaluation of IES in national account customer facilities by assessing the applicability of innovative thermally activated technologies in integrated system configurations in the five target segments.

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2. HEALTH CARE SECTOR PROFILE

2.1 HOSPITAL SEGMENT OVERVIEW

2.1.1 Industry Structure

There are 5,810 hospitals operating in the United States. About 3,000 of these are non-government and not-for-profit facilities; about 1,900 are local, state or federal facilities; and almost 800 are investor-owned (for-profit) facilities.[1,2] Table 2-1 shows the breakdown by type of hospital.

TABLE 2-1
TYPES OF HOSPITALS

Type of Hospital	No. of Hospitals
General (full service)	5,810
-Non-Government/Not-For-Profit	3,003
-State/Local Government	1,163
-Investor-Owned/For-Profit	749
-Federal Government facilities	245
-Non-Federal Long-Term Care Hospitals	631
-Hospital Units at Institutions (e.g., Prisons, Colleges, Infirmaries)	19

Source: American Hospital Association; U.S. Dept. of Energy/Energy Information Administration; Gas Research Institute; American Gas Association.

The American Hospital Association (AHA) defines two types of hospital systems: multi-hospital systems (two or more hospitals owned, leased or managed by a single central organization); and diversified single hospital systems (a single free-standing hospital with associated non-hospital organizations). The number of community hospitals (non-federal, short-term general and other special hospitals) that belong to one of these systems is 2,217 out of 4,915, or about 45%. The country's largest hospital systems are part of an integrated healthcare delivery network that typically consists of several hospitals, nursing homes, home care agencies, hospices and ambulatory care units, and other affiliated healthcare entities.

Not-for-profit providers dominate the hospital population. Not-for-profit hospital systems or freestanding institutions run about 80% of the beds in hospitals. The largest for-profit system in the country is HCA Inc., followed by Tenet. Appendix 2-A lists the top not-for-profit hospital chains as well the top for-profit hospital systems. The largest sector of the not-for-profit hospital community has been the large Catholic systems, which over the past five or six years have consolidated many smaller systems or freestanding institutions. The largest Catholic system totals about $6 billion in revenues and comprises about 50 hospitals. Of the 25 top health care systems in the country (measured by size of revenue base), 18 are not-for-profit, and of those 11

are Catholic systems and seven are nondenominational not-for-profit systems. Only three for-profit systems are among the top 25.[3]

The decade of the 1990s brought major restructuring of the healthcare industry. This can be seen in the dramatic changes in traditional ownership and management of healthcare services and facilities that occurred. For example, formerly independent hospitals formed partnerships and associations with other facilities in their region to achieve economies of scale and streamline administrative costs. The latter half of the 1990s also saw the emergence of mega-management firms, many of which own or share ownership in the facilities they manage. Mergers, acquisitions and consolidations were brisk throughout the last half of the past decade.

Changes in hospital and healthcare organizations include:

- Development and expansion of large regional healthcare networks of hospitals, ambulatory facilities, physicians, insurance companies, and virtually all other components of the industry.
- Expansion of for-profit, proprietary hospital chains. There has been substantial expansion of large for-profit hospital chains through acquisition and management contracts. Two of the largest for-profit hospital chains are HCA and Tenet Healthcare Corporation.
- Expansion of not-for-profit hospital chains through acquisition, merger, and management agreement. Catholic Healthcare, Sutter Health and Kaiser Permanente are large not-for-profit hospital chains.
- Expansion of larger hospitals with smaller hospitals being acquired, merged or closed. Smaller hospitals have had less access to capital for growth and an inability to attract and compensate staff to deal with new regulations, marketing, competition and other issues related to rapid restructuring.

2.1.2 Trends

For the majority of the 1990s, there was a decline in the frequency and length of patient stays at general hospitals. This is attributed to improved surgical techniques, improved drug therapies, increased managed care health plan membership, and the growth of outpatient surgical and rehabilitative medical facilities. As competition increased, full service hospitals struggled to reduce costs and diversify their portfolio of services to generate additional revenues. Hospitals actively market their services and compete vigorously with other medical facilities in their market area. For the latter part of the 1990s, energy related market opportunities in the hospital sector were primarily in remodeling and renovations that increased patient comfort, addressed specific medical needs, and reduced operating costs.

In the near-term, the projected trends are very different than conditions that existed in the preceding decade. The surprising challenge of the early 21st century will be coping with rising demand and capacity constrains.[4] After years of decline, inpatient admissions are rising, pushing new construction. As shown in Table 2-2, estimated healthcare expenditures climbed to $1.3

trillion in 2000, an increase of 8.3% over 1999. Expenditures are projected to increase to $2.0 trillion before 2010. Volume indicators are trending upward for both inpatient and ambulatory services. The downsizing and consolidation that occurred in the preceding years have produced a capacity shortage in many facilities, especially in hospitals in growth locations, "must-have" hospitals popular with consumers, and safety-net hospitals serving the poor. Now hospitals are scrambling to develop new building plans and find the capital to create capacity.

TABLE 2-2
NATIONAL HEALTH EXPENDITURES

	1997	1998	1999	2000 (projected)
National Health Expenditures ($ billions)	$1,094	$1,146	$1,210	$1,311
Change from Previous Year	-	4.8%	5.6%	8.3%
% Gross Domestic Product (GDP)	3.2%	13.0%	13.0%	13.1%

Source: Centers for Medicare and Medicaid Services (*www.cms.gov*).

Today, hospitals are trying to cope with a booming demand for critical care beds, surgical block times, and emergency services. The drivers behind this demand are population growth, an aging population, and technology. For the past three years, hospital admissions have grown about 1% per year, and have been projected to rise to 2 - 3% per year. This would result in total hospital occupancy in the 68 - 72% range over the next ten years.[5] Nearly all hospital volume statistics showed growth for 2000: inpatient admissions rose 2.6%, births rose 3.2%, emergency room visits grew 3.7%, and total outpatient services grew 5.3%. At the same time the number of hospitals dropped by 1.4%. [6]

2.1.3 Financial Situation

Most hospitals experienced improved financial performance in 2001 as compared to the previous year. Overall, hospital average operating margins were at 5.2% at the end of the second quarter of 2001.[7] Capital investment in healthcare facilities has been flat over the past three years, at approximately $17 billion annually. However, projections now call for a major construction boom driven by capacity shortfalls.

Meeting a project capacity crunch and upgrading facilities and information systems requires capital. Access to capital will be a key challenge for facilities, with capital outlays for energy improvements continuing to compete for funding with medical technologies and information systems. During the years of mergers, acquisitions and consolidation, significant changes in the capital-related decision making process and in financial performance were clear. First-cost (up-front capital investment) hurdles and aggressive return on investment (ROI) expectations were the norm rather than long-term thinking based on life-cycle costs and five- to ten-year ROI. Management organizations of both for-profit and non-for-profit hospitals remain very first-cost sensitive.

While capital was scarce during the 1990s, the need for capital in the future should drive financial turnarounds and reclaimed profitability, especially among integrated healthcare delivery networks. The financial community's perspective on prospects in healthcare should improve in the next two to three years, assuming hospitals can convert increased volume and higher gross revenue into an improved bottom line.

2.1.4 Energy Situation

Hospitals are large users of both electrical and thermal energy on a continuous basis. Their operation is year-round and 24 hours per day, and they are highly energy intensive. Total energy consumption for healthcare buildings in 1999 was 258 trillion Btu.[8] This is approximately 13% of total commercial consumption. Natural gas is used in more than half of the buildings. These buildings with natural gas account for 76% of healthcare floor space.

Space heating energy sources are shown in Table 2-3. Natural gas is the dominant space heating energy source, heating 49.6% of healthcare buildings and 61.4% of healthcare floor space. Electricity for space heating accounts for 61.4% of the buildings and 45.7% of the floor space.

Table 2-4 lists space cooling energy sources. Electricity is the dominant source for cooling. Non-electric cooling sources serve substantially buildings that have substantially more floor space than those in which electricity is the source. Direct use of natural gas use for cooling is very limited. However, district chilled water used for cooling may be produced with either electricity or natural gas.

As shown in Table 2-5, natural gas is the major water heating fuel in healthcare buildings. Natural gas heats water in 43.3% of healthcare buildings. These buildings account for 56.5% of all healthcare floor space. Electricity is used for water heating in 52.8% of buildings and 21.2% of floor space. District heating is used in 2.4% of buildings but 24.4% of floor space

Other energy needs at healthcare facilities include laundry equipment and cooking equipment. A significant portion of healthcare facilities feature laundry-drying equipment. Overall, three-fourths of this is natural gas equipment. Almost all healthcare facilities have cooking and baking equipment in place with almost two-thirds fueled by natural gas and one-third by electricity.

2.1.5 Growth and Renewal

As described previously, the years of downsizing facilities are over. Hospitals are now playing catch-up for the lack of facilities planning in the 1990s when managed care cost pressures squeezed capital budgets. Many hospitals are launching long-overdue construction of new inpatient capacity. During the consolidation of the 1990s, energy-related market opportunities were primarily in remodeling and renovation projects. The prevalence of expansion plans now appears to offer new opportunities in the area of new construction.

TABLE 2-3
HEALTHCARE SPACE HEATING ENERGY SOURCES

	Buildings (1000's)	Percent of Buildings	Floorspace (MM sq. ft.)	Percent of Floorspace
All Buildings with Space Heating	127	100.0%	2,918	100.0%
Natural Gas	63	49.6%	1,793	61.4%
Electricity	78	61.4%	1,335	45.7%
District Heat	3	2.4%	736	25.2%

Note: Some buildings have multiple space heating energy sources, so subcategories add to more than the "All buildings with space heating" totals.
Source: EIA, *Commercial Buildings Energy Consumption Survey 1999*.

TABLE 2-4
HEALTHCARE SPACE COOLING ENERGY SOURCES

	Buildings (1000's)	Percent of Buildings	Floor Space (MM sq. ft.)	Percent of Floor Space
All Buildings with Space Cooling	127	100.0%	2,918	100.0%
Natural Gas	*	*	*	*
Electricity	125	98.4%	2,537	86.9%
District Chilled	2	1.6%	433	14.8%

* row standard error greater than 50% or fewer than 20 buildings sampled.
Note: Some buildings have multiple space cooling energy sources, so subcategories add to more than the "All buildings with space cooling" totals.
Source: EIA, *Commercial Buildings Energy Consumption Survey 1999*.

TABLE 2-5
HEALTHCARE WATER HEATING ENERGY SOURCES

	Buildings (1000's)	Percent of Buildings	Floor Space (MM sq. ft.)	Percent of Floor Space
All Buildings with Water Heating	127	100.0%	2,918	100.0%
Natural Gas	55	43.3%	1,649	56.5%
Electricity	67	52.8%	619	21.2%
District Heat	3	2.4%	713	24.4%

Note: Some buildings have multiple water heating energy sources, so subcategories add to more than the "All buildings with water heating" totals.
Source: EIA, *Commercial Buildings Energy Consumption Survey 1999*.

Construction projects in the 1990s may be categorized into three types:

1. Renovate/retrofit current building spaces;
   - Improvements in electrical, HVAC, communications, fire/life safety, and medical gases.
   - Improvement in patient comfort and amenities for competitive reasons.
   - Modification in space function due to changes in patient care needs.
   - Upgrades in laboratories, administration space and provider space to maintain accreditation.
2. Convert existing underutilized space to a different facility function:
   - Retrofit portions of buildings to outpatient clinics, offices, skilled nursing facilities, or assisted living development.
3. Build new hospital space either in new location or added on to existing facility:
   - New general hospitals in growing suburban and rural regions.
   - Specific niche service facilities co-located with existing hospital facility.
   - Space for outpatient surgery and rehabilitative services co-located with hospital facility.

The *2002 Futurescan Survey and Forecast of Healthcare Trends* forecasts a tremendous growth in hospital construction and capital investment in the next five years as a growing number of hospitals experience increased demand and capacity problems. While capital investment in healthcare facilities has been flat over the past few years, a new wave of health facilities is on the drawing board.[9] However, the lag between planning and construction is masking the upturn in capital investment that is pending. Across the nation, healthcare construction costs jumped 20% with fewer but more expensive projects. Spending on specialty hospitals, especially for children and women, climbed 27%. An increasing number of hospitals and health systems are acquiring land for expansion, with immediate plans for ambulatory care facilities and medical office buildings to anchor the locations for future growth.

2.1.6 Energy Equipment Decision Making

General Characteristics

A study of decision makers responsible for almost 3,000 chain health care facilities nationwide found that responsibility for energy equipment-related decisions for the majority of floor space is split between national headquarters and individual locations.[10] Decisions are made exclusively at national headquarters for about 25% of floor space, and exclusively at individual sites for 20% (Table 2-6). The same group of decision makers is typically responsible for all equipment decisions, regardless of equipment application. The group or individual with the most important role is most commonly a member of the engineering department, for both new construction and renovation/replacement activities.

TABLE 2-6
ENERGY EQUIPMENT DECISION MAKING AMONG HEALTHCARE CHAINS

Decision-Making Characteristics		Percent of National Floor Space	
Locus of decision making	National HQ	23%	
	Individual locations	19%	
	Regional HQ	3%	
	Responsibilities split between national HQ and indiv. location	56%	
Same or different decision makers by equipment type?	Same for all equipment	89%	
		Chain with Centralized Decision Making	*Chain with Decision Making at Individual Locations*
Most important decision makers	Engineering	47%	52%
• Overall	Purchasing	16%	2%
	Facility management	15%	20%
	Senior management	8%	9%
• New construction	Engineering		
• Renovation/replacement	Engineering		
Guidelines	No formal guidelines/Don't know	26%	44%
	Have guidelines	74%	56%
	- Lowest operating cost	37%	13%
	- Lowest purchase/installation cost	37%	13%
	- Payback	16%	2%
	- Preferred vendor	6%	39%
	- Meets gov't requirements	2%	9%
	- Corp. specifications book	1%	24%
	- Energy efficiency	1%	7%
Information sources (multiple sources apply)	Manufacturer representatives	78%	13%
	Consulting engineers	49%	19%
	Trade shows	43%	3%
	Energy services companies	20%	2%
	Trade journals	18%	4%
	Experience	2%	23%
	Company staff	2%	19%

Source: Opinion Dynamics Corp.

Decisions for about three-quarters of the chain floor space represented are guided by established equipment selection guidelines, with operating cost, first cost and payback dominating as decision criteria. In this study, health care industry decision makers most often reported relying on manufacturer representatives, consulting engineers and trade journals to obtain information about energy equipment and systems.

Insights from Industry Participants

A recent information-gathering effort among national account customers reveals additional information about their priorities and outlooks on energy issues.[11] Top of mind for these customers is the need for clean, reliable and high quality power, low operating costs, and contained and predictable energy costs. Their top-ranked concerns include environmental permitting requirements, energy price volatility, the high cost of testing and verifying new technologies, and the high cost of new energy equipment.

Structure and Process

Our conversations with industry participants revealed that in some hospitals, there is an executive committee reporting to the board of directors whose activities include oversight of major new construction, expansion and renovation activities. In these cases, projects are initiated by staff, then explored and developed with oversight from the committee. The committee makes a recommendation to the board of directors, which renders the final decision. One ESCO noted that with this structure, the decision-making can become highly politicized, especially if the facility is a publicly owned hospital. The ESCO further noted that "You need a champion on the inside, especially when issues such as potential liabilities crop up." The composition of the board can also become important, with member backgrounds and perspectives playing key roles. "A good rapport with the board of directors weighs in the project's favor," said the ESCO. "It also helps to be perceived as relatively objective."

In other cases, as suggested by Table 2-6, corporate headquarters makes energy equipment decisions, or provides varying levels of guidance to individual facilities. "I don't like to issue directives," one corporate-level energy manager said. "I prefer to visit individual facilities and make suggestions."

Guidelines and Criteria

With many hospital chains having guidelines in place, the nature of the guidance and how rigorously it is adhered to are clearly important. As one ESCO pointed out, a criterion that mandates acceptance of lowest-cost bid means that the types of energy projects that go in can depend upon the level of detail and specificity in the request for proposals. If a CHP system is not specifically solicited, for example, A/E firms with off-the-shelf non-CHP designs that are cheaper up front than CHP can easily come in as lowest bidder and win the contract.

One interviewee confirmed that energy-related projects with the shortest paybacks are implemented first. In this case, energy efficiency is often a key consideration but "may be outweighed by others." According to the manager, acceptable paybacks range up to one year for

lighting projects and two to three years for other types of energy projects. In new construction, this chain is striving for designs that lead to the lowest possible operating costs.

Other rules may be more informal but just as critical. One investor-owned hospital chain told us, for example, that they cannot enter into exclusive arrangements with energy equipment manufacturers, regardless of the terms, as exclusivity suggests to the shareholders that the hospital will end up paying more than it should. Instead, the manager interviewed says he is seeking to establish "preferred provider" relationships, where a bid process is still used but preference is given to the preferred provider when bid prices vary. "We must always be able to say that we are doing the best for the shareholders," he noted.

Information Sources

Our conversations reflected the fact that, as suggested by the survey, hospital decision makers look to consulting engineers and manufacturers for information about energy systems. "We have our own architecture, engineering and construction staff, but we also use outside firms," one manager said. This manager noted that pilot projects are often the best way for the company to understand the features, benefits and operating characteristics of equipment well enough to make a good decision about future specification.

2.2 HOSPITAL FACILITY CHARACTERISTICS

2.2.1 Buildings

Almost two-thirds of total healthcare floor space is in single, freestanding buildings, where one organization occupies all the space. Almost all other healthcare floor space is in multi-building establishments, where one organization occupies all the space. Table 2-7 shows the average sizes (square footage) for various healthcare facilities.[12] The individual chain facility size is consistent with the average size of an inpatient healthcare facility of 168,200 square feet in the *1999 EIA Commercial Buildings Energy Consumption Survey*.

TABLE 2-7
AVERAGE SQUARE FOOTAGE OF HEALTHCARE FACILITIES

	All Facilities	Independent Facilities	Individual Chain Facilities	Chain Headquarters
Avg. Square Footage	70,000	55,000	142,000	124,000

Source: Opinion Dynamics Corp.

Hospitals are located in every state, with concentration generally mirroring population patterns. Appendix 2-B lists the number of major hospitals in each state (hospitals with annual electricity usage in excess of 500 MWh). California, Texas and New York are the leaders, together holding just over 20% of all such hospitals. The top 11 states contain half of all such hospitals.

2.2.2 Hospital Energy Equipment

Health care is an energy-intensive, energy-dependent enterprise. Hospital facilities operate 24 hours a day year-round, require sophisticated backup systems in case of utility shutdowns, use large quantities of outside air to combat odors and dilute microorganisms, and must deal with problems of infection and solid waste disposal. Similarly, large quantities of energy are required to power diagnostic, therapeutic, and monitoring equipment and support services such as food storage, preparation, and service and laundry facilities.

Space Conditioning

Hospital air conditioning assumes a more important role than just the promotion of comfort. In many cases, proper air conditioning is a factor in patient therapy; in some instances, it is the major treatment. The application of air conditioning to health facilities presents many problems not encountered in the usual comfort conditioning system.

The best data to be found on the distribution of types of equipment used at healthcare facilities is a 1998 study conducted by Opinion Dynamics Inc., co-sponsored by the Gas Research Institute (GRI) and the American Gas Association (AGA), entitled *Commercial Market Segmentation Study – National Healthcare Sector*. That study surveyed over 1,500 individuals involved in energy-related equipment decision. These individuals represented over 38,000 facilities. Table 2-8 presents the distribution of equipment by current fuel from that survey.

The basic differences between hospitals and other buildings are:

- The need to restrict air movement in and between various areas.
- Ventilation and filtration to dilute and remove odors, airborne microorganisms, and hazardous chemical substances.
- Many areas that require 100% outdoor air with specified air changes.
- The need for different temperatures and humidities in areas for both infection control, patient therapy and comfort.
- The design sophistication needed to permit accurate control of environmental conditions.

Divisions within a general hospital typically include surgery and critical care, nursing, ancillary services, administration, diagnosis and treatment, sterilization and supply, and services. The environmental requirements of each of the departments/spaces within these divisions differ to some degree according to their function and the procedures carried out.

Table 2-9 shows the distribution of space cooling equipment from the AGA/GRI report, while Table 2-10 shows the distribution of space heating equipment from the same report. Due to the wide variations in the heating, ventilation and air conditioning (HVAC) requirements of the different divisions, most mechanical cooling systems in medium and large hospitals are indirect, using steam boilers and a centralized chilled/hot water distribution to the various air handlers serving the different departments. These chillers and the boilers may be located in one central

TABLE 2-8
DISTRIBUTION OF EQUIPMENT TYPE AND CURRENT FUEL FOR CHAIN HEALTHCARE FACILITIES

Space Heating	**Percent of National Floor Space (%)**
Electricity	24.4
Natural Gas	70.4
Fuel Oil	1.6
Propane	0.2
Purchased Steam/Water	4.4
Other	0.2
Space Cooling	
Electricity	92.2
Natural Gas	1.2
Purchased Steam/Water	6.0
Dehumidification (35% of Total)	
Electricity	91.7
Natural Gas	8.3
Water Heating	
Electricity	25.9
Natural Gas	69.7
Fuel Oil	1.3
Propane	0.2
Purchased Steam/Water	2.2
Other	0.7
Laundry Drying (69% of Total)	
Electricity	13.0
Natural Gas	84.6
Other	3.2
Cooking & Baking (91% of Total)	
Electricity	25.1
Natural Gas	72.0
Propane	0.4
Other	2.6

Source: Opinion Dynamics Corp.

TABLE 2-9
DISTRIBUTION OF SPACE COOLING EQUIPMENT IN HEALTHCARE CHAIN FACILITIES

Cooling Equipment	Percent of National Floor Space (%)
Central Chiller	57.3
Electric Motor	83.6
Natural Gas Engine	2.9
Natural Gas Absorption	3.9
Steam Absorption	9.8
Packaged Rooftop Units	18.2
Residential-type AC	9.3
Window/Wall Units	5.7
Heat Pump	8.0
Purchased Chilled Water	0.0
Other	1.5

Source: Opinion Dynamics Corp.

TABLE 2-10
DISTRIBUTION OF SPACE HEATING EQUIPMENT IN HEALTHCARE CHAIN FACILITIES

Heating Equipment	Percent of National Floor Space %)
Central Furnace	16.8
Central Boiler	43.8
Heat Pump	10.1
Packaged Roof-top	9.8
Electric Baseboard	0.9
Window/Wall Units	6.3
Infrared Units	0.0
Other	12.3

Source: Opinion Dynamics Corp.

plant, in individual buildings, or a combination of the two in older facilities that have gone through numerous expansions. Hospitals that have grown over time may have several mechanical rooms located in different buildings. The hot and chilled water piping may or may not be interconnected. Special areas, such as the operating suite, may be served by separate systems.

Dehumidification

Indoor air quality is an important issue. Health care facilities are designed according to strict state and/or local agency guidelines to maintain a controlled environment to provide comfort, a healing therapy, and to minimize the spread of infectious diseases. Humidity control is an important part of the overall indoor air quality strategy. Thirty-five percent of healthcare space features dehumidification equipment. This is primarily electric-based equipment with gas-fired equipment used in only 10% of this space.[13]

Surgical suites usually only operate a portion of each day, and typically use 100% outdoor air with 15 or more air changes per hour. Surgeons prefer very cool space temperatures for comfort and to reduce microorganisms. This preference, when coupled with the need for increased surgical protective wear, exacerbates the challenge of conditioning operating suites, especially in regions where latent loads (i.e., the humidity or the amount of moisture in the air) are high relative to sensible loads (i.e., the temperature of the air: the warmer the air, the greater the sensible load). Desiccant system alternatives to electric systems are under investigation at numerous sites.

Water Heating

Domestic hot water needs are included in the several segments using it, and can amount to 5% of total thermal energy use. Typically about half of a hospital's water consumption is heated. Daily consumption of hot water can be quite varied depending on the type of hospital, size, and occupancy factor. Available data indicates daily consumption ranging from 25 to 90 gallons per bed, with the maximum hour's consumption ranging from seven to 22 gallons per hour-bed. Water temperature requirements depend on application: for clinical uses (shower and bathing facilities), not to exceed 120°F; for most dietary uses, 120°F, with booster heating where needed; and for most laundry procedures, 140°F, again with booster heating where needed.

As steam is used in hospitals for heating, dietary and sterilization purposes, it is typically also used for service water heating. Often steam-to-hot-water heat exchangers and storage tanks are strategically located in various areas that use large amounts of hot water (kitchens, laundries, etc.). In addition to lavatory uses, hot water uses include service sinks, general cleaning, and hydrotherapy.

More than three-quarters of hospitals use centralized water heating systems (e.g., storage tanks) while less than 20% use distributed or point-of-use water heating systems. Table 2-11 shows the distribution of water heating equipment from the AGA/GRI study.

TABLE 2-11
DISTRIBUTION OF WATER HEATING EQUIPMENT IN HEALTHCARE CHAIN FACILITIES

Water Heating Equipment	Percent of National Floor Space (%)
Central Boiler	70.1
Standard Tank Type	25.7
Instantaneous (Tankless)	2.0
Heat Pump	0.2
Heat Recovery	1.0
Other	0.9

Source: Opinion Dynamics Corp.

Refrigeration

Hospitals can contain cafeterias, restaurants or fast food operations, as well as morgues and other facilities requiring mechanical refrigeration. Closed cases or cabinets account for the largest number of healthcare buildings with refrigeration equipment.

Cooking and Baking

Hospitals can contain cafeterias, restaurants or fast food operations. Institutional food service facilities frequently pose comfort conditioning problems including:

- Extreme variable loads with high peaks in energy demand.
- High sensible and latent heat gains due to people, food preparation and presentation, and gas venting requirements.
- Potential for unbalanced air flow conditions in areas adjacent to kitchens.
- Kitchens needing to be separate from other areas to avoid odor contamination and heat migration.

Commercial cooking facilities are available in less than one-quarter of healthcare buildings, but these buildings account for 70% of healthcare floor space. Natural gas is the predominant energy source.[14]

Maintenance and Repair

Larger hospitals with engineering departments have technicians who perform regular maintenance and repairs on all equipment including backup generators. They are familiar with engine systems. Smaller facilities outsource their maintenance and repair needs to generator sales/service contractors.

Backup Power

Generator use at hospitals is almost universal. Code, licensing and accreditation organizations require emergency backup generation for hospitals' critical systems. Onsite generation ranges from less than 100 kW to several megawatts. Most systems are part of the facility's central plant and service the hospital's critical loads. Installed capacity is primarily comprised of diesel-fueled synchronous generators. Most are isolated from the grid and dedicated to circuits serving critical loads. Several electric utilities are providing financial assistance to their hospital customers to retrofit their emergency generators with controls that allow the utility to activate them during peak power hours.

2.2.3 Hospital Electric, Thermal and Dehumidification Loads

Hospitals are large users of both electrical and thermal energy on a continuous basis. These demands lead to several opportunities to recover waste energy for useful purposes. A hospital's high thermal load factor represents a significant opportunity for traditional CHP that can be sized closer to the peak electric load than is the case for facilities in other national account sectors. Central chillers make up the largest share of cooling on a square foot basis (45%). This may create an opportunity for innovative integrated energy systems that are packaged with absorption cooling.

Electric Loads

The electric loads of hospitals are largely lighting, HVAC, elevators, special equipment (e.g., CATscan, MRI), and floor loads for computers, copiers and other office equipment. Backup onsite generation is required for essential services, as described in the previous section. Table 2-12 presents the breakdown of electricity use in a typical hospital. The peak electric load in healthcare facilities is typically in the 500 to 1,400 kW range.

TABLE 2-12
HOSPITAL ELECTRICITY USE[15]

End Use	Percent of Hospital Electricity Use
Indoor Lighting	14.%
Outdoor Lighting	1%
Air Conditioning	32%
Refrigeration	1%
Space Heating	4%
Cooking	2%
Water Heating	4%
Miscellaneous	42%
Total	100%

Source: Clark Energy.

Thermal Loads

Thermal loads include space heating, laundry, and food service, hydrotherapy, sterilizers and other miscellaneous loads. With regard to space heating, boilers and district heat account for the largest portion of healthcare space heating on a square foot basis. The breakdown of thermal loads for a typical hospital is shown in Table 2-13.

TABLE 2-13
HOSPITAL THERMAL LOADS[16]

End Use	Percent of Hospital Thermal Energy Use
HVAC	79%
Laundry	10%
Food Service	5%
Hydro Therapy	3%
Sterilizers	1%
Miscellaneous	2%
Total	100%

Source: Clark Energy.

Dehumidification Loads

Humidity control systems include both conventional vapor-compression technology and desiccant systems. Desiccant dehumidification systems have had a long success for niche applications where good control of humidity and/or very low humidity is required, such as in laboratory space for sensitive equipment and clean rooms in hospitals. Desiccant cooling systems can be particularly attractive for applications that require a large amount of dehumidification in comparison to the sensible cooling required. Surgical suites using desiccant dehumidification may lower humidity levels more cost effectively than overcooling to dehumidify, which causes occupant discomfort.

Electric and Gas Load Curves

The figures in Appendix 2-C present typical load curves for a 140,000 ft^2 hospital located in two opposite types of climates, the Southwest and the Northeast (New England). Table 2-14 below presents key energy consumption figures for these representative stores. The base electric load is approximately 525 kW. The base thermal load is about 50 million Btu per day. A CHP system sized to meet the base thermal load would be about 750 kW.

TABLE 2-14
ELECTRIC AND GAS ENERGY LOADS REPRESENTATIVE
140,000 FT^2 HOSPITAL, SOUTHWEST AND NEW ENGLAND

Southwest Hospital		
Electricity Use	5,430,200	kWh/year
Peak Load	737.4	kW
Load Factor	84.06	%
Minimum Monthly Gas Use	310	MMBtu
Total Annual Gas Use	23,620	MMBtu
New England Hospital		
Electricity Use	5,060,900	kWh/year
Peak Load	796.6	kW
Load Factor	72.52	%
Minimum Monthly Gas Use	430	MMBtu
Total Annual Gas Use	33,120	MMBtu

Sources: EEA; Energy Design Resources, *eQuest2002 Database*; Regional Economic Research, Inc., *eShapes 2001 National Database*.

2.3 LONG-TERM CARE SEGMENT OVERVIEW

2.3.1 Industry Structure

Long-term care providers serve one of the fastest growing segments of the population - persons 65 years of age and over. In the United States, approximately 12.4% of the population in 2000 was aged 65 or older, and the projected annual growth rate for persons over 65 is projected to be 1.8% (2.6% for persons over 85) during the period ending 2020. In 2000, approximately 2.1 million or 5.9% of all persons aged 65 and over were living in a nursing facility as compared to 5.0% in 1990. That percentage is expected to increase to 8.4% by 2050, when the population aged 65 or older is expected to be 20% of the total population in the United States.[17]

The long-term (post-acute) care industries encompass a variety of facilities and types of care: nursing facilities (also called nursing homes, skilled nursing and extended care facilities), hospital-based facilities, assisted living, intermediate care, and home health services. The nursing facility industry comprises the largest part of the long-term care business, with spending of $92.2 billion in 2000. For-profit entities own approximately 66% of nursing facility beds, with the remainder owned by not-for-profit organizations or government agencies. The industry is very fragmented, with no dominant providers.

Some facilities offer a hybrid of services designated as catered living or supportive living that allow independent living residents to access selected assistance with activities of daily living. Although these various facilities may appear to cater to a distinct need, there is actually a

considerable amount of overlap among services. Adding to already strong competition is the entrance of hospitals that are opting to offer these services themselves rather than giving a courtesy referral to an unrelated third party.

Within the assisted living sector, a variety of facilities have been built over the past decade offering varying levels of personal assistance services to the elderly, such as 24-hour oversight, housekeeping and meal services. Given the alternative forms of assisted living facilities or communities, it is difficult to quantify both the growth in and current number of assisted living facilities in the U.S. A 2001 report from the National Academy for State Health Policy indicated that there are over 32,800 licensed assisted living facilities with over 795,000 units. The largest concentration of assisted living centers (36%) is in the states of California, Florida and Pennsylvania. Since 1998 the number of assisted living facilities has increased 30%, with the majority of the increase in the states of Delaware, Iowa, New Jersey and Wisconsin.

Appendix 2-D contains the 2001 American Seniors Housing Association (ASHA) 25 owners list, which shows the 25 largest seniors housing owners by number of units.[18] Almost half of the firms appearing on the list are public entities.

2.3.2 Trends

With the aging of the general population, trends in the lifestyles and needs of seniors have shaped the senior housing market. Assisted living residences have developed to fill the gap between independent living and skilled nursing. Until their development, there were no institutions to help seniors with the transition. Seniors had one of three options:

- Living in a traditional home or apartment and purchasing home health care if needed.
- Living in some form of congregate care facility providing meals and recreation but no assistance with medication or other activities of daily living.
- Living in a traditional nursing home with 24-hour care.

Even with heavy competition among corporations specializing in assisted living services, perhaps the greatest competition for market share is between the assisted living industry and the nursing home industry. The nursing home industry currently serves approximately 1.5 million residents. Even as the population of those aged 85 years and older has increased, the number of beds available in nursing facilities has remained flat whereas the number of units available in assisted living facilities has increased significantly.[19]

Assisted living is currently a private-pay service. The majority of those receiving skilled nursing care are federally subsidized through Medicaid and Medicare. Nationally, Medicaid pays for about 70% of the skilled nursing patient days, while Medicare pays for 8%, with only 23% from private pay sources. Some have predicted that managed care and government entitlements will soon fund a large portion of the assisted living expenses in the low-income market, but greater accountability at the federal level will make it difficult for two senior market sectors to both receive funding. Medicaid currently focuses on providing funding for the care of seniors who

have a relatively high acuity profile, and Medicaid waivers are limited in number. Strategic planning for assisted living currently focuses on private-pay rather than entitlement sources.

2.3.3 Growth and Renewal

As mentioned, despite the growth in persons aged 65 or older, the number of nursing facilities has remained flat for some time.[20] However, other segments within healthcare have experienced rapid growth. For example, the number of rehabilitation hospitals grew 152% from 1986 to 1998 and the number of hospital-based nursing facilities increased 108% over the same time period (from 1,145 to 2,385 facilities).

Assisted living construction comprised 39% of all seniors housing properties built in 2001, compared to previous years when this category represented more than three-fourths of all new seniors housing.[21] While assisted living makes up the largest share of new construction, new construction for all seniors housing has been on a declining trend for the past three years. There are growing signs that supply is outstripping demand. The construction boom of the last five years has slowed dramatically. According to the ASHA *Seniors Housing Construction Report 2001*, 964 units are being built in 230 seniors housing properties in 37 states. This is the lowest number of units being built since ASHA began tracking this data in 1996. It is 18% less than last year (35,305) and is less than half of the number of units built just three years ago (65,879).

The continued decline in new seniors housing construction is not surprising given the amount of new product, particularly assisted living residences, built in the mid-to-late 1990s, and the increased availability of existing properties for acquisition. The report by ASHA looks at six distinct property types: seniors apartments, congregate seniors housing without assisted living, congregate seniors housing with assisted living, free-standing assisted living, assisted living with skilled nursing or specialty care units, and continuing care retirement communities. Of the six types of properties covered in the report, only seniors apartment construction has grown, up 146% from 2000 to 2001. One of the conclusions of the ASHA report is that seniors housing providers are continuing to focus on the operation of their current portfolios and are placing significantly less emphasis on growth through development.

For the third consecutive year, California has the most seniors housing properties (39) under construction, followed by Michigan (15) and Wisconsin (12). Los Angeles is the metropolitan area with the most properties under construction (14).

2.4 NURSING HOME FACILITY CHARACTERISTICS

2.4.1 Buildings

Nursing homes average over 100 beds (typically 60-75 rooms). Over 80% are one-story buildings or multiple one-story buildings employing simple HVAC systems and commercial water heaters/boilers for domestic hot water. Homes of less than ten beds are often little more than expanded residential dwellings that meet federal requirements by bringing in nursing and elder care services.

There were approximately 15,000 skilled nursing facilities in 2000.[22] Appendix 2-E lists by state the number of facilities with electricity usage of more than 250 MWh annually. These are the facilities most likely to be part of a national chain, and to be potential candidates for integrated CHP systems.

2.4.2 Energy Equipment

Nursing homes are relatively energy-intensive operations. They have significant HVAC, water heating, and food preparation loads. They have energy equipment and loads similar to both hospitals and residential facilities.

Space Conditioning

Functionally, these buildings have five main areas that are of concern:

- Administrative and supportive areas, inhabited by the staff.
- Patient areas that provide direct normal daily services.
- Treatment areas that provide special medical services.
- Clean workrooms for storage and distribution of clean supplies.
- Soiled workrooms for collection of soiled and contaminated supplies and for sanitization of non-laundry items.

Nursing home and extended care facility occupants are usually frail and many are incontinent. While some are ambulatory, others are bedridden, with many suffering from illnesses in advanced stages. The selected HVAC system must control conditions carefully for these residents. It must dilute and control odors and should not cause drafts. Local climatic conditions, costs, and preferences usually determine the extent and degree of air conditioning and humidification. Odor control may be with large volumes of outside air and some form of heat recovery. For energy conservation, odor control with activated carbon or potassium permanganate-impregnated activated alumina filters may be used instead.

Temperature control is usually done on an individual room basis. Odor control, filtration, and airflow control is necessary between certain areas. Provisions for maintenance of minimum humidity levels in winter depend on the severity of the climate. For individual room control, closed-loop water-loop or heat pumps systems are often selected. Larger facilities with central chilled/hot water systems may use room fan-coil units. Low-rise buildings usually use rooftop gas/electric or heat pump packages for the public spaces and for ventilation air.

Dehumidification

Humidity control in nursing homes is an even more important part of the whole indoor air quality strategy than is true for hospitals. When designing facilities for seniors, HVAC engineers should pay special attention to humidity control because of its impact on comfort, potential mold and mildew growth, and the bottom line.

The key to satisfying residents' and workers' divergent comfort requirements is to provide a higher dry bulb temperature and lower dew point than might be more commonly specified for other commercial space conditioning applications.[23] This view is supported by Lew Harriman, lead author of the recently published *Humidity Control Design Guide for Commercial and Institutional Buildings* (ASHRAE 2001). He suggests that the standard design point of 75°F/50% relative humidity (55°F dew point) probably is not appropriate for nursing homes and that 78°F with a dew point of 50°F might be a more suitable target condition. At a lower dew point, the active body releases heat more efficiently through fast evaporation of perspiration. At a higher dry bulb temperature, the older, less active, and less responsive body is more comfortable.

Lower relative humidity also helps improve indoor air quality and occupant health. Nursing home living spaces are cleaned and disinfected on a regular basis to reduce odors caused by incontinence, minimize microbial growth, and reduce the risk of infection. This frequent cleaning adds to internal latent loads that, along with large outdoor ventilation air volumes and infiltration, can cause relative humidity to rise, especially during spring and summer. Humidity levels above 60% relative humidity promote growth of mold and mildew, which release odors and mycotoxins as well as other particulate matter. These are believed to create and/or aggravate allergies and other health problems in susceptible individuals, especially the elderly who have reduced respiratory capacity.

Water Heating

Most water heating is done separately from the building heating system using direct resistance or gas heaters; and in some cases, point-of-use heaters. Some buildings use central distribution systems with storage and constant recirculation where it is desirable to have hot water available continuously at the fixtures. Rural area locations may use fuel oil or propane fired water heaters. Residential care homes may use individual heaters to meter use.

Refrigeration

Like most healthcare facilities, nursing homes contain cafeterias, restaurants or fast food operations, as well as morgues and other facilities requiring mechanical refrigeration. Closed cases or cabinets account for the largest number of healthcare buildings with refrigeration equipment.

Cooking and Baking

Like hospitals, many nursing homes contain cafeterias or full-service dining operations. Natural gas is the predominant energy source.

Maintenance and Repair

Most nursing homes of 25 beds or more, whether part of a large chain/system or independently operated, will employ on-site engineering/maintenance staff 24 hours a day. Site facilities usually report directly to the location’s management (e.g., general manager, administrator, etc.). If the facility is part of a chain organization, the site staff may also report indirectly to a central

director of facilities/plant engineering. Larger projects are the responsibility of the chain headquarters. Many of the chains rely on outside professional architect and consulting engineering services for more complex design projects. The larger nursing homes employ full-time, on-site engineering staff to operate HVAC, maintain electrical systems, and maintain medical equipment. Their decision-making structure more closely resembles that of a hospital.

Backup Power

Like hospitals, skilled nursing homes are required to have emergency back-up power capability for egress lighting, life-safety systems and room heating. According to the Gas Technology Institute (GTI), over 75% of skilled nursing homes use generators.[24] Most are synchronous engine generator sets fueled by diesel or gasoline.

2.4.3 Electric, Thermal and Dehumidification Loads

Like the entire healthcare sector, nursing homes are users of both electrical and thermal energy on a continuous basis. These demands lead to several opportunities to recover waste energy for useful purposes. Their high thermal load factor represents a significant opportunity for traditional CHP and there may be an opportunity for innovative integrated energy systems that feature waste heat use in regenerated desiccant dehumidification systems. Central chillers make up the largest share of cooling on a square foot basis (45%) in the healthcare center. This may create an opportunity for innovative integrated energy systems that are packaged with absorption cooling.

Electric Loads

The electric loads of nursing homes are largely lighting, HVAC, elevators, special medical equipment and floor loads for computers, copiers and other office equipment in administrative areas. Backup onsite generation is required.

Thermal Loads

Hot water is required for tubs and showers, washbasins, service sinks, kitchen equipment, and general cleaning. Other equipment may include heavy laundry and hydrotherapy. The domestic hot water uses are usually restricted to temperatures as low as 105ºF.

With regard to space heating, boilers and district heat account for the largest portion of healthcare space heating on a square foot basis.

Dehumidification Loads

The industry's standard HVAC design has featured use of conventional or heat pump packaged terminal air conditioners (PTACs) in resident rooms with either rooftop direct expansion (DX) units or split systems for corridors, dining rooms, lounges, and other service areas. In large facilities with central chiller and heater plants, the approach is similar, with fan coil units in resident rooms and remote air handlers serving common areas. Ventilation air has been introduced primarily through rooftop or central air handling unit, with dampers set as high as 75% or more open, supplemented by individual PTACs set at 10% outside air.

Electric and Gas Load Curves

The figures in Appendix 2-F present typical load curves for a representative 40,000 ft^2 skilled nursing home located in two opposite types of climates, the Southwest and the Northeast (New England).

Table 2-15 following presents key energy consumption figures for these representative facilities. The base electric load is just less than 65 kW. The base thermal load is approximately four million Btu per day. A CHP system sized to meet the base thermal load would be about 90 kW.

TABLE 2-15
ELECTRIC AND GAS ENERGY LOADS FOR REPRESENTATIVE 40,000 FT^2 NURSING HOME -- SOUTHWEST AND NEW ENGLAND

Southwest Nursing Home		
Electricity Use	843,950	kWh/year
Peak Load	181.4	KW
Load Factor	53.11	%
Minimum Monthly Gas Use	121.0	MMBtu
Total Annual Gas Use	1,828.3	MMBtu
New England Nursing Home		
Electricity Use	643,750	kWh/year
Peak Load	182.0	KW
Load Factor	40.38	%
Minimum Monthly Gas Use	166.9	MMBtu
Total Annual Gas Use	3,173.6	MMBtu

Source: EEA; Energy Design Resources, eQuest2002 Database; Regional Economic Research, Inc., *eShapes, 2001 National Database*.

GLOSSARY

Alternate Delivery System – Provision of health services in settings that are more cost-effective than an inpatient, acute-care hospital, such as skilled and intermediary nursing facilities, hospice programs, and in-home services.

Assisted Living – A type of living arrangement in which personal care services such as meals, housekeeping, transportation, and assistance with activities of daily living are available as needed to people who still live on their own in a residential facility. A long-term care alternative for seniors who need more assistance than is available in a retirement community, but who do not require the heavy medical and nursing care provided in a nursing facility. Assisted living services can be provided in freestanding residences, near or integrated with skilled nursing homes or hospitals, as components of continuing care retirement communities, or at independent housing complexes. Assisted living residences offer a multifaceted residential setting that provides personal care services, 24-hour supervision and assistance, activities and health-related services.

Extended Care Facility – (See Nursing Facility and Skilled Nursing Facility). A skilled nursing facility that provides post-hospital (post-acute care) services.

Integrated Delivery System – An entity that usually includes a hospital, a large medical group, and an insurance vehicle (such as a health maintenance organization or a preferred provider organization). Typically, all provider revenues flow through the organization.

Intermediate Care Facility – (See Nursing Facility). Provides mainly maintenance services, such as homes for the aged and rest homes.

Long-Term Care Facility – Facility that provides ongoing health services for individuals who need assistance on a continuing basis because of physical or mental disability.

Nursing Facility – (Also referred to as nursing home, extended care facility, and skilled nursing facility). An institution that provides skilled nursing care and rehabilitation services to injured, functionally disabled or sick persons. Today's nursing facilities serve the young and old alike, both those who expect to recover fully as well as those in need of extended long term care services. The goal of care in a nursing facility is to help individuals meet their daily physical, social, medical, and psychological needs and to return home whenever possible. Formerly, distinctions were made between intermediate care facilities and skilled nursing facilities. The Omnibus Budget Reconciliation Act of 1987 eliminated this distinction effective October 1, 1990 by requiring all nursing facilities to meet skilled nursing facility requirements.

Nursing Home – (See Nursing Facility). Nursing homes serve as permanent residences for people who are too frail or sick to live at home or as a temporary facility during a recovery period.

GLOSSARY (Continued)

Skilled Nursing Facility – (See Nursing Facility). 1) Provides registered nursing services around the clock. 2) An institution that has a transfer agreement with one or more hospitals, provides primarily inpatient skilled nursing care and rehabilitative services, and meets other specific certification requirements.

NOTES

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2. GRI Final Report, Commercial Building Market Sector Profile and Needs Assessment, Report No. GRI-98/0045.
3. Ed Shapoff, Goldman Sachs, Conference Transcripts of Seventh Annual Wall Street Comes to Washington Conference, June 11, 2002.
4. Futurescan 2002: A Forecast of Healthcare Trends 2002-2006, Health Administration Press, American College of Healthcare Executives, 2002.
5. Gary Taylor of Banc of America Securities; AHA Annual Survey of Hospitals 2001.
6. AHA Annual Survey of Hospitals 2001.
7. Futurescan 2002: A Forecast of Healthcare Trends 2002-2006, Health Administration Press, American College of Healthcare Executives, 2002.
8. *Commercial Buildings Energy Consumption Survey*, EIA, 1999.
9. Modern Healthcare's Annual Construction and Design Survey.
10. Opinion Dynamics Corp, *Commercial Market Segmentation Study – National Healthcare Sector*. Gas Research Institute/American Gas Association, 1998.
11. Energetics, Inc., *National Accounts Energy Alliance Survey*, May 2002.
12. Opinion Dynamics Corp.
13. GRI Final Report, *Commercial Building Market Sector Profile and Needs Assessment*, Report No. GRI-98/0045.
14. Ibid.
15. Clark Energy Cooperative, "Hospitals," www.clarkenergy.com/BIZ/bizwiz/sch.htm: July 2002.
16. Ibid.
17. Centers for Medicare and Medicaid Services, *Health Care Industry Market Update*, February 2002.
18. 2001 American Senior Housing Association 25 Owners.
19. *National Supply Estimates of Senior Housing and Care Properties*, 2000.
20. Ibid.
21. American Senior Housing Association, *Senior Housing Construction Report*, 2001.
22. National Center for Assisted Living website, www.ncal.org
23. *Humidity Control Design Guide for Commercial and Institutional Buildings*, ASHRAE, 2001.
24. GRI Report, *Commercial Market Segment Opportunities for Small-Scale Power Generation Peakshaving*, 1999.

APPENDIX 2-A: TOP HOSPITAL CHAINS

TABLE 2A-1
FOR-PROFIT HOSPITAL CHAINS

Hospital Chains	No. of Hospitals	2001 Annual Revenues ($MM)
HCA Inc.	184	$17,953
Tenet Healthcare Corporation	115	11,270
Universal Health Services	63	3,440
Triad Hospitals, Inc.	48	2,670
Community Health Systems, Inc.	59	1,694
LifePoint Hospitals Inc.	23	619

Source: Company websites, *Modern Healthcare*.

TABLE 2A-2
NOT-FOR-PROFIT HOSPITAL SYSTEMS

System	2000 Patient Revenues ($MM)	No. of Hospitals
US Department of Veterans Affairs	22,383	172
Ascension Health	5,800	65
Catholic Health Initiatives	5,016	70
Catholic Healthcare West	4,502	47
New York City Health and Hospitals Corp.	3,481	11
Trinity Health	3,436	28
Mayo Foundation	3,054	18
New York-Presbyterian Healthcare System	3,030	16
UPMC Health System	2,652	17
Sutter Health	2,585	27
Adventist Health System	2,365	25
North Shore-Long Island Jewish Health System	2,310	13
Providence Health System	2,276	21
Catholic Healthcare Partners	2,239	31
Sisters of Mercy Health System	2,218	20

Source: Company Websites, *Modern Healthcare*.

APPENDIX 2-B: GEOGRAPHICAL DISTRIBUTION OF HOSPITALS WITH ANNUAL ELECTRICITY CONSUMPTION > 500 MWH

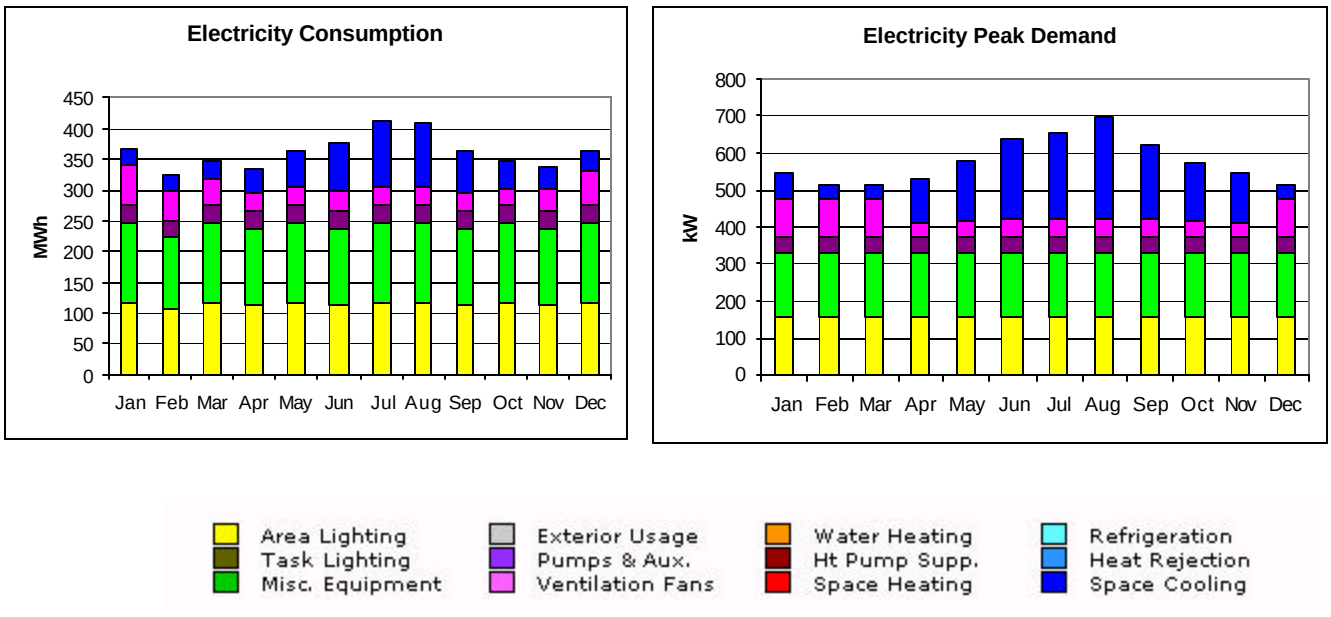
State	No. of Hospitals	% of Total Hospitals	Cumulative %
California	526	8.4	8.4
Texas	438	7.0	15.4
New York	321	5.1	20.5
Florida	308	4.9	25.4
Pennsylvania	295	4.7	30.1
Illinois	251	4.0	34.1
Ohio	235	3.8	37.9
Georgia	202	3.2	41.1
Michigan	195	3.1	44.2
Missouri	165	2.6	46.8
Wisconsin	162	2.6	49.4
Tennessee	161	2.6	52.0
North Carolina	157	2.5	54.5
Indiana	148	2.4	56.9
Louisiana	135	2.2	59.1
Virginia	133	2.1	61.2
Alabama	129	2.1	63.3
New Jersey	126	2.0	65.3
Minnesota	126	2.0	67.3
Washington	125	2.0	69.3
Iowa	122	2.0	71.3
Kentucky	122	2.0	73.3
Kansas	118	1.9	75.2
Massachusetts	115	1.8	77.0
Oklahoma	106	1.7	78.7
Mississippi	104	1.7	80.4
Nebraska	95	1.5	81.9
Colorado	90	1.4	83.3
Arizona	87	1.4	84.7
South Carolina	83	1.3	86.0
Maryland	81	1.3	87.3
Arkansas	81	1.3	88.6
West Virginia	75	1.2	89.8
Oregon	70	1.1	90.9
South Dakota	57	0.9	91.8
Montana	51	0.8	92.6
Maine	50	0.8	93.4
Connecticut	50	0.8	94.2
New Mexico	49	0.8	95.0
Idaho	45	0.7	95.7
North Dakota	45	0.7	96.4
Utah	41	0.7	97.1
Nevada	40	0.6	97.7
New Hampshire	34	0.5	98.2
Wyoming	26	0.4	98.6
Rhode Island	22	0.4	99.0
Washington, DC	16	0.3	99.3
Vermont	16	0.3	99.6
Delaware	12	0.2	99.8
Total	6,241	100.0	100.0%

Source: Dun & Bradstreet Sales and Marketing Solutions, *MarketPlace Jul-Sep 2002*.

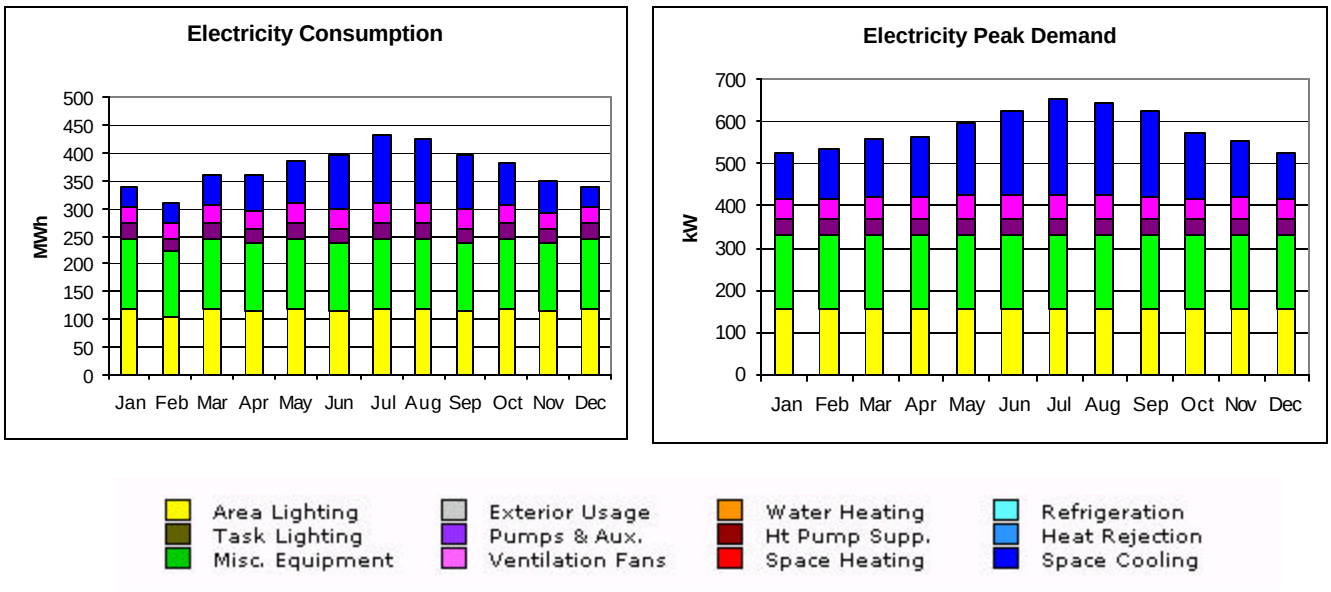
APPENDIX 2-C: TYPICAL HOSPITAL ELECTRIC AND GAS LOAD CURVES

FIGURE 2C-1
ELECTRIC CONSUMPTION AND DEMAND FOR REPRESENTATIVE 140,000 FT^2 HOSPITAL

Representative Northeast (Hartford, CT) Hospital



Representative Southwest (Phoenix, AZ) Hospital

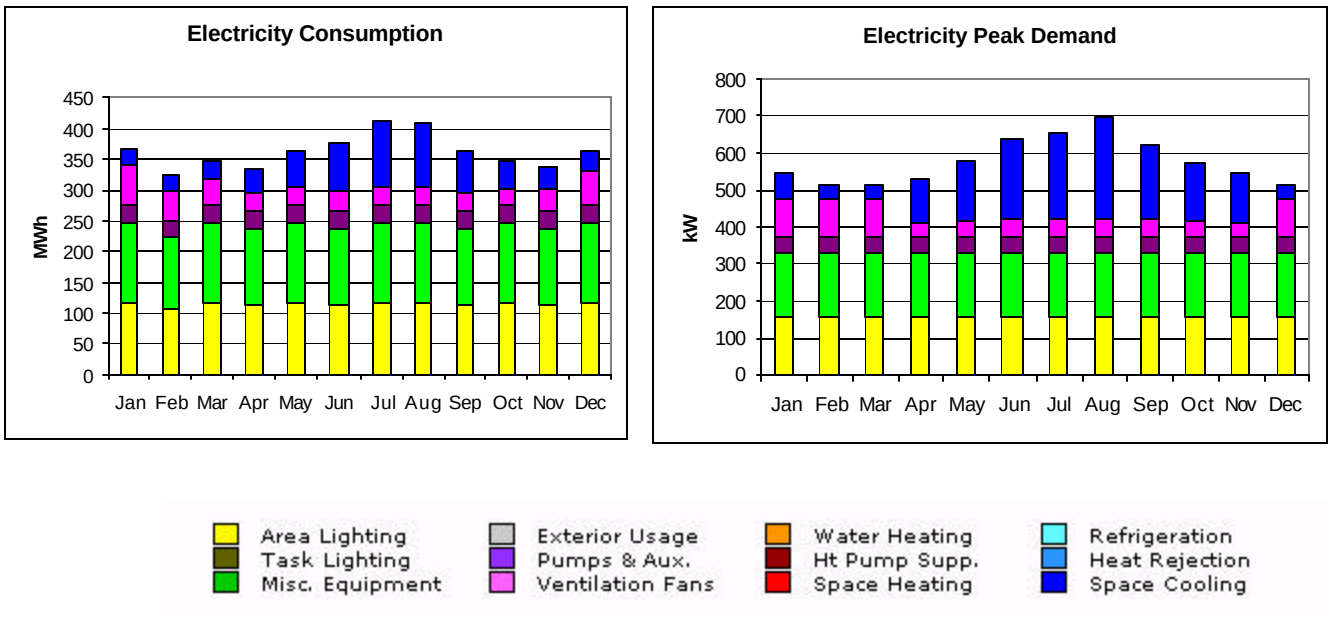


Source: EEA; Energy Design Resources, eQuest2002 Database; Regional Economic Research, Inc., *eShapes, 2001 National Database.*

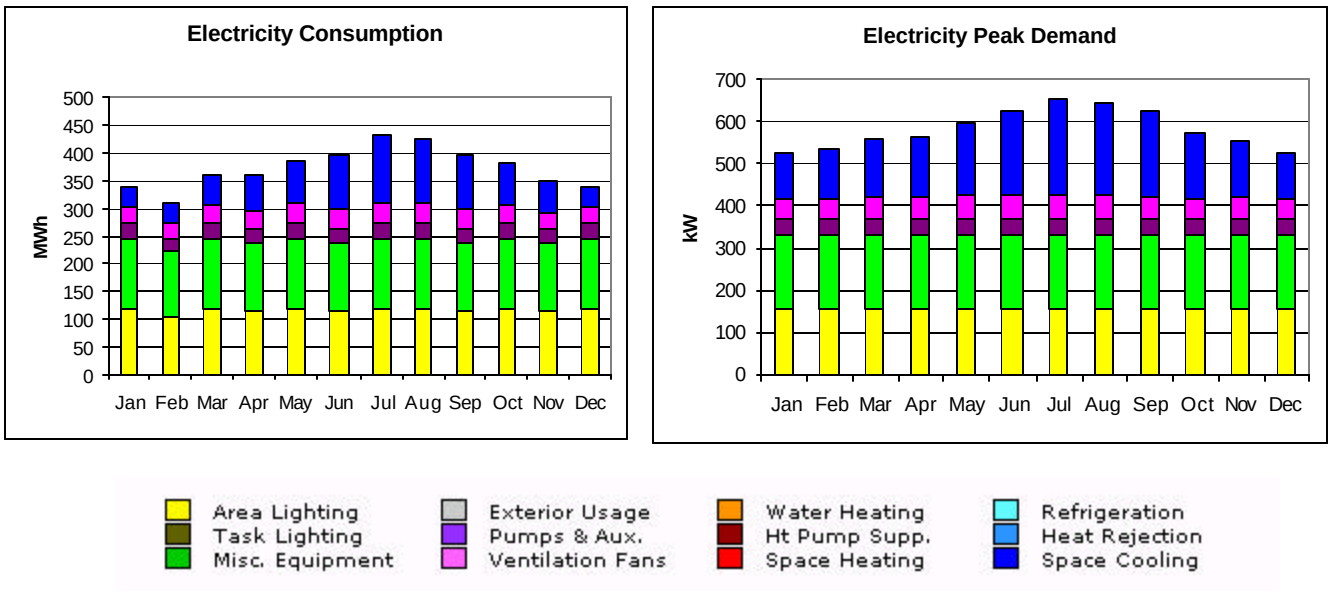
APPENDIX 2-C: TYPICAL HOSPITAL ELECTRIC AND GAS LOAD CURVES

FIGURE 2C-1
ELECTRIC CONSUMPTION AND DEMAND FOR REPRESENTATIVE 140,000 FT^2 HOSPITAL

Representative Northeast (Hartford, CT) Hospital



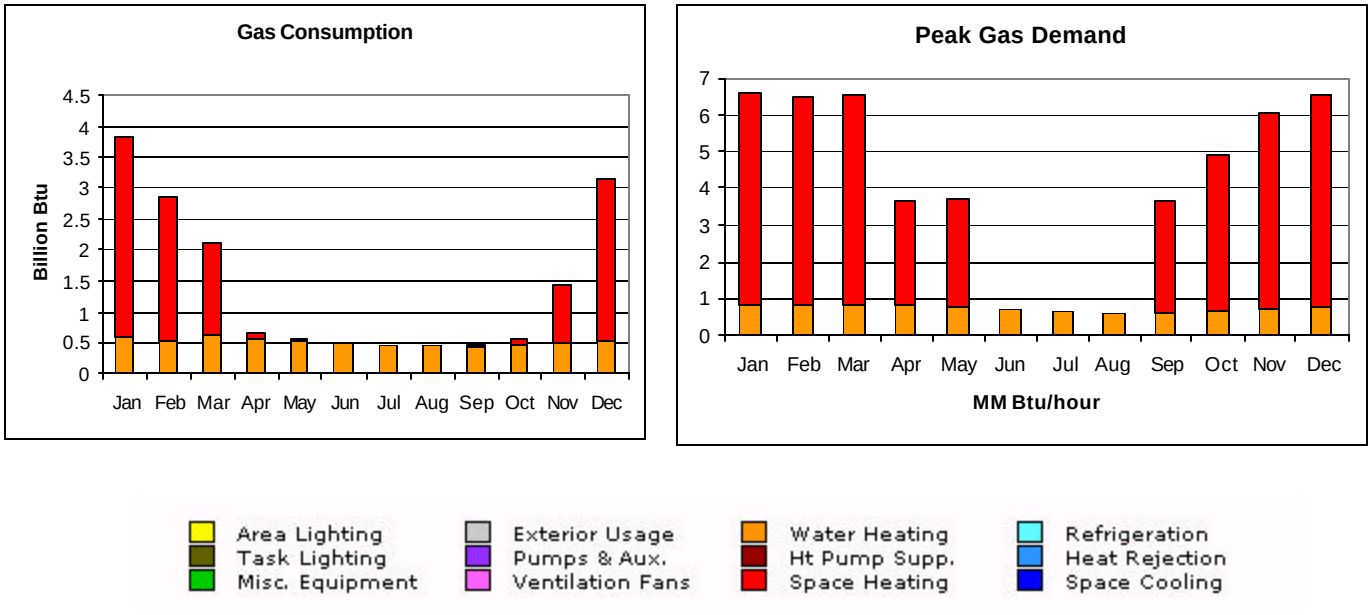
Representative Southwest (Phoenix, AZ) Hospital



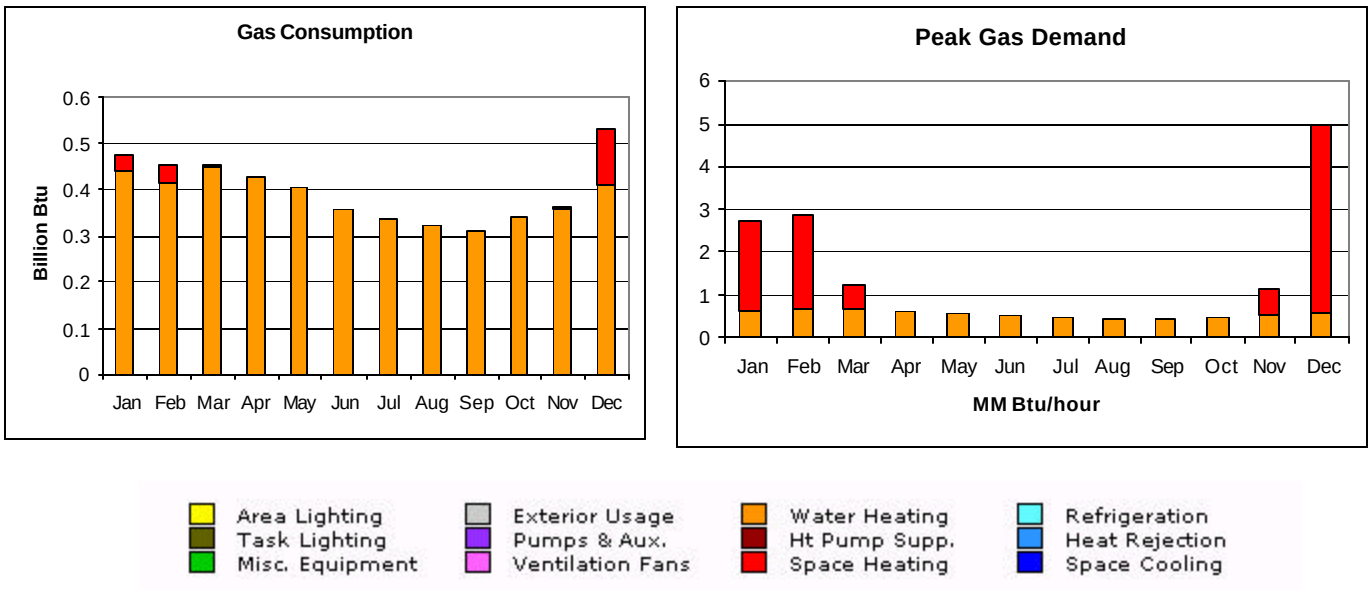
Source: EEA; Energy Design Resources, eQuest2002 Database; Regional Economic Research, Inc., *eShapes, 2001 National Database*.

FIGURE 2C-2
GAS CONSUMPTION AND DEMAND FOR REPRESENTATIVE
140,000 FT^2 HOSPITAL

Representative Northeast (Hartford, CT) Hospital



Representative Southwest (Phoenix, AZ) Hospital



Source: EEA; Energy Design Resources, eQuest2002 Database; Regional Economic Research, Inc., *eShapes, 2001 National Database.*

APPENDIX 2-D: TOP SENIOR HOUSING OWNERS

2001 American Seniors Housing Association Top 25 Owners*							
2001 Rank	**2000 Rank**	**Company**	**Headquarters**	**2001 Units**	**2001 Properties**	**2000 Units**	**2000 Properties**
1	1	Colson & Colson/Holiday Retirement Corp.	Salem, OR	29,445	246	27,427	229
2	2	Alterra Healthcare	Milwaukee, WI	11,846	243	21,119	453
3	7	Sunrise Assisted Living	McLean, VA	10,587	136	7,966	120
4	6	Healthcare REIT, Inc.	Toledo, OH	10,090	148	8,066	128
5	3	Nationwide Health Properties, Inc.	Newport Beach, CA	9,719	132	11,529	125
6	-	Brookdale Living Communities, Inc.	Chicago, IL	8,789	67	-	-
7	4	Atria, Inc.	Louisville, KY	8,493	90	9,704	100
8	5	Senior Lifestyle Corp.	Chicago, IL	7,981	60	9,646	62
9	8	Crestline Capital Corp.	Bethesda, MD	7,491	31	7,497	31
10	9	Health Care Property Investors, Inc.	Newport Beach, CA	6,893	89	7,297	92
11	13	Classic Residence by Hyatt/ Encore Senior Living	Chicago, IL	6,599	49	6,354	53
12	16	Marriott Senior Living Services	Bethesda, MD	6,249	49	5,400	43
13	14	ACTS Retirement-Life Communities, Inc.	West Point, PA	6,128	16	6,095	16
14	17	Merrill Gardens, LLC	Seattle, WA	5,900	59	5,195	52
15	-	Capital Senior Living Corp.	Dallas, TX	5,338	39	-	-
16	10	American Retirement Corp.	Brentwood, TN	5,061	23	7,217	41
17	19	Leisure Care, Inc.	Bellevue, WA	4,970	35	4,807	33
18	-	GFB-AS Investors, LLC	Jericho, NY	4,734	34	-	-
19	18	First Centrum, LLC	Sterling, VA	4,697	83	5,079	84
20	22	Senior Housing Properties Trust	Newton, MA	4,637	20	4,040	15
21	-	Life Centers of America/ American Lifestyles	Cleveland, TN	4,532	36	-	-
22	11	Assisted Living Concepts	Portland, OR	4,509	115	7,148	185
23	23	National Benevolent Association	St. Louis, MO	4,270	16	3,955	14
24	20	Fountains Retirement Properties, Inc.	Tucson, AZ	4,157	15	4,719	17
25	-	Hearthstone Assisted Living, Inc.	Houston, TX	4,000	33	-	-

* 25 largest U.S. seniors housing owners as of June 1, 2001.

Notes:

- The minimum threshold for inclusion in the ASHA 25 owners list jumped 14% from 3,510 units in 2000 to 4,000 units in 2001
- Brookdale Living Communities became a privately held company between the 2000 and 2001 rankings
- Public companies include Alterra Healthcare Corporation; Sunrise Assisted Living, Inc; Health Care REIT, Inc.; Nationwide Health Properties, Inc.; Crestline Capital Corporation; Health Care Property Investors, Inc.; Marriott Senior Living Services (a division of Marriott International); Capital Senior Living, Inc.; American Retirement Corporation; Senior Housing Properties Trust; and Assisted Living Concepts.[17]

Source: American Seniors Housing Association.

APPENDIX 2-E: DISTRIBUTION OF NURSING HOMES WITH ANNUAL ELECTRICITY USAGE > 250 MWH

State	SIC (8051-SNF, 8052-ICF, 8059-ONPF)			TOTAL	% TOTAL	Cumulative %
	8051	8052	8059			
California	1038	107	611	1756	7.7%	7.7%
Texas	954	206	418	1578	6.9%	14.6%
Ohio	824	149	299	1272	5.6%	20.2%
Pennsylvania	645	219	317	1181	5.2%	25.4%
Florida	724	124	274	1122	4.9%	30.4%
New York	650	124	273	1047	4.6%	35.0%
Illinois	638	172	185	995	4.4%	39.3%
North Carolina	359	88	298	745	3.3%	42.6%
Michigan	364	51	254	669	2.9%	45.5%
Missouri	450	63	142	655	2.9%	48.4%
Minnesota	378	80	191	649	2.9%	51.3%
Massachusetts	464	57	119	640	2.8%	54.1%
Indiana	320	112	195	627	2.8%	56.8%
Georgia	382	87	124	593	2.6%	59.4%
Wisconsin	414	37	114	565	2.5%	61.9%
Iowa	266	133	115	514	2.3%	64.2%
Washington	319	37	114	470	2.1%	66.3%
Tennessee	271	104	93	468	2.1%	68.3%
New Jersey	324	48	86	458	2.0%	70.3%
Oklahoma	260	65	133	458	2.0%	72.3%
Kansas	201	125	116	442	1.9%	74.3%
Louisiana	232	62	143	437	1.9%	76.2%
Virginia	251	65	110	426	1.9%	78.1%
Kentucky	220	67	77	364	1.6%	79.7%
Arkansas	256	25	66	347	1.5%	81.2%
South Carolina	210	50	84	344	1.5%	82.7%
Colorado	222	39	75	336	1.5%	84.2%
Alabama	246	28	60	334	1.5%	85.6%
Maryland	233	41	57	331	1.5%	87.1%
Connecticut	178	20	108	306	1.3%	88.4%
Oregon	150	66	82	298	1.3%	89.8%
Nebraska	157	26	79	262	1.2%	90.9%
Arizona	179	18	58	255	1.1%	92.0%
Mississippi	158	16	49	223	1.0%	93.0%
West Virginia	96	49	35	180	0.8%	93.8%
Maine	91	55	27	173	0.8%	94.6%
New Mexico	123	13	23	159	0.7%	95.3%
Rhode Island	89	11	47	147	0.6%	95.9%
South Dakota	83	17	33	133	0.6%	96.5%
Utah	84	22	23	129	0.6%	97.1%
North Dakota	75	15	28	118	0.5%	97.6%
New Hampshire	63	27	24	114	0.5%	98.1%
Idaho	78	7	25	110	0.5%	98.6%
Montana	70	5	15	90	0.4%	99.0%
Nevada	36	6	14	56	0.2%	99.2%
Delaware	31	9	14	54	0.2%	99.4%
Vermont	35	5	10	50	0.2%	99.7%
Wyoming	22	3	12	37	0.2%	99.8%
Washington, D.C.	11	2	10	23	0.1%	99.9%
Alaska	7	1	2	10	0.0%	100.0%
Hawaii	4	1	3	8	0.0%	100.0%
TOTAL	**13935**	**2959**	**5864**	**22758**	**100.0%**	

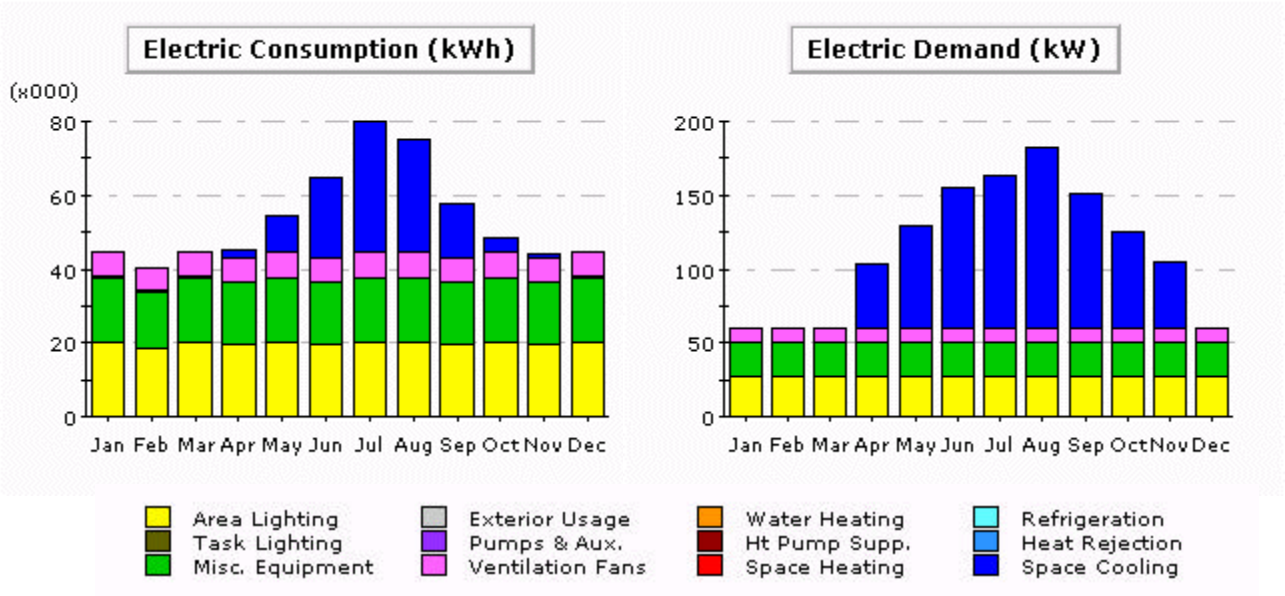
Source: Dun & Bradstreet Sales and Marketing Solutions, *MarketPlace Jul-Sep 2002*.

Key: SNF=Skilled Nursing Facility, ICF=Intermediate Care Facility, ONPC=Other Nursing or Personal Care Facility.

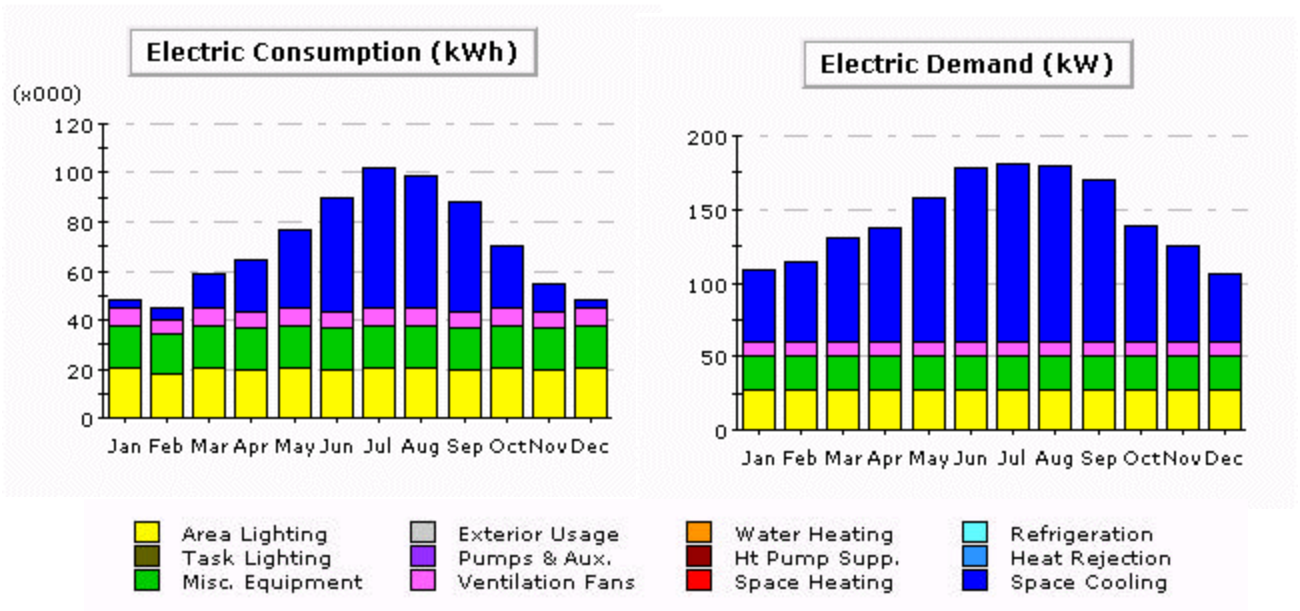
APPENDIX 2-F: TYPICAL NURSING HOME ELECTRIC AND GAS LOAD CURVES

FIGURE 2F-1
ELECTRIC CONSUMPTION AND DEMAND FOR REPRESENTATIVE 40,000 FT^2 NURSING HOME

Representative Northeast (Hartford, CT) Nursing Home



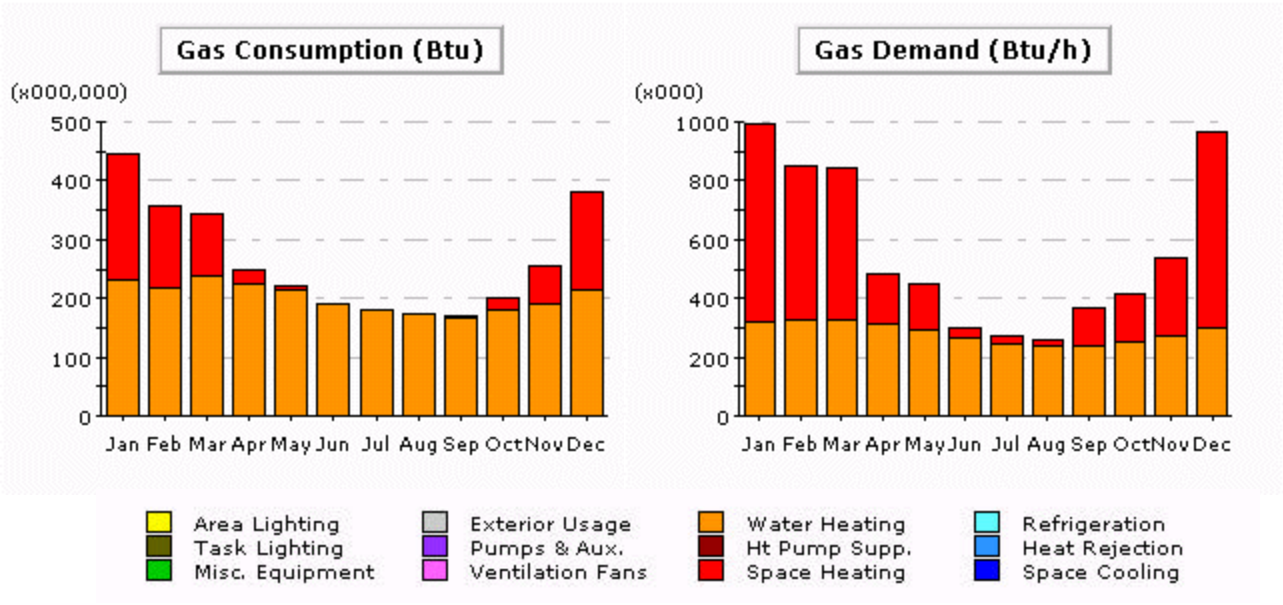
Representative Southwest (Phoenix, AZ) Nursing Home



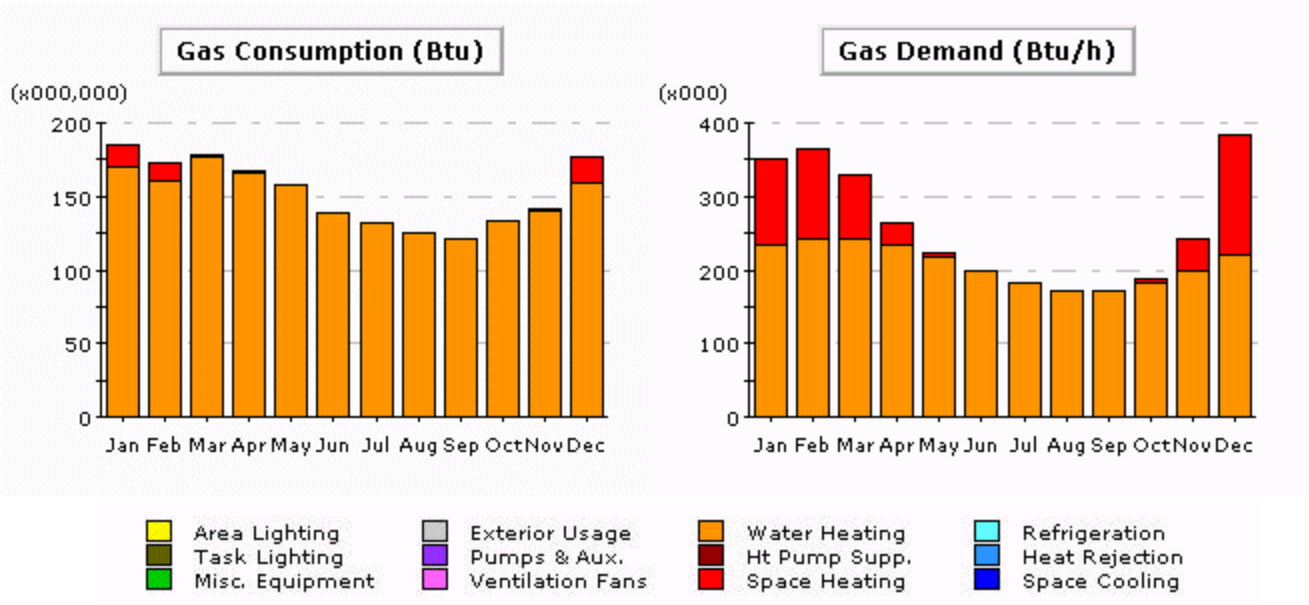
Source: EEA; Energy Design Resources, eQuest2002 Database; Regional Economic Research, Inc., *eShapes, 2001 National Database*

FIGURE 2F-2
GAS CONSUMPTION AND DEMAND FOR REPRESENTATIVE
40,000 FT^2 NURSING HOME

Representative Northwest (Hartford, CT) Nursing Home



Representative Southwest (Phoenix, AZ) Nursing Home



Source: EEA; Energy Design Resources, eQuest2002 Database; Regional Economic Research, Inc., *eShapes, 2001 National Database.*

3. SUPERMARKET SECTOR PROFILE

3.1 INDUSTRY OVERVIEW

3.1.1 Structure

As of 2001, there were 158,371 grocery stores in the U.S., of which 32,265 were supermarkets (stores generating at least $2 million in sales annually). Total grocery store sales in 2001 were $517.5 billion. While only 65% (21,108) of all supermarkets are stores belonging to a chain (defined as a company owning at least 11 stores), they represent about 82% of total supermarket sales. Supermarket sales in 2001 totaled $398.2 billion, with chain store sales accounting for $326.2 billion. [1]

Concentration in the industry is substantial: the top five supermarket chains claim 40% of total supermarket sales and 25% of all supermarket stores, with the number one company, The Kroger Co., representing almost 12% of total sales and 7.5% of all locations. The top eight chains account for half of total industry sales and over a third of all stores. Concentration has accelerated dramatically over the past six to seven years: the top five firms' share of total sales in 1995 was just 26%.[2] Appendix 3-A lists the top 25 chains along with their 2001 sales and the number of stores they operate. Appendix 3-B lists the brands owned by each of the top eight chains and store locations.

3.1.2 Trends

The rise of warehouse clubs (e.g., Sam's, BJ's), followed by supercenters (e.g., Wal-Mart), has been the predominant trend in the past decade (along with consolidation). Supercenters are in the 120,000-200,000 ft^2 range and typically devote about one-third of their floor space to supermarket-type merchandise. Estimates put food sales at 40-50% of total supercenter sales figures.[3] Supercenters and other non-traditional grocery store formats continue to challenge conventional stores, both chains and independents alike. Another trend is the proliferation of dollar discount stores, claiming territory at the lowest end of the scale. Table 3-1 shows the breakdown of 2001 sales and locations by supermarket format.

The addition of gas station convenience stores to supermarket and mass merchandisers' portfolios is a new trend projected to intensify rapidly. In 2000, these companies owned 1,250 gas stations with 3% of national sales; by 2005, they are expected to claim 16% of retail gasoline sales. Three percent of new supermarkets in a 2001 survey featured a gas pump/convenience store installation in front of the supermarket.[4] On the merchandising side, trends include increasing emphasis on perishables, private labels, prepared entrees/ready-to-eat meals and natural/organic products.

TABLE 3-1
SUPERMARKETS BY FORMAT

	Stores		Sales	
Store Format	**Number**	**% of Total**	**$ Billions**	**% of Total**
Conventional	17,210	53.3%	$142.4	35.8%
Superstore/Combo	10,700	33.2	198.0	49.7
Supercenter	1,555	4.8	39.2	9.8
Ltd. Assortment	2,000	6.2	9.1	2.3
Warehouse	800	2.5	9.5	2.4

Source: Progressive Grocer, *69th Annual Report of the Grocery Industry*, April 2002.

Distribution Chain

Historically, manufacturers and wholesalers controlled the distribution chain to supermarkets, with goods "pushed" into the system by manufacturers. However, warehouse clubs and supercenters with concentrated purchasing power now form a large cluster of "power purchasers" who buy in bulk and reap economies of scale, employing advanced transportation and information technology. Power buyers use information technology to link with and buy directly from manufacturers, negotiating lower costs since the middleman (wholesaler/broker) is cut out. Manufacturers are now in the position of operating under a customer-driven "pull" approach when dealing with the power buyers, while continuing to operate under the traditional manufacturer "push" model with smaller retailers. Manufacturers must carry inventory and maintain distribution facilities to serve the smaller retailers, but cannot spread the costs of doing so to power buyers, who don't need and won't pay for those services. [5]

3.1.3 Financial Situation

Sales in the industry increased on the order of three to four percent annually during the 1990s, with chain supermarket sales increasing 3.8% in 2001 versus only 2.2% for independent stores. However, supermarkets operate on very slim margins: in 2001, net income as a percentage of sales for U.S. stores averaged only 3.3% before taxes, with net profit after taxes for chains averaging 1.25% of sales.[6]

Nationally, labor costs dominate grocery store operating budgets, claiming 53% of operating expenses and 13% of sales revenues.[7] Decision makers at centrally managed chains report that energy costs run about 15% of their stores' operating budget. [8, 9]

A 2001 Food Marketing Institute (FMI) survey[10] reported that 85% of supermarkets are leased, noting that this is representative of a past and continuing trend toward leasing rather than owning stores. This trend is confirmed by a 1998 study of over 1,000 grocery store decision makers, which concluded that slightly more than half of the floor space occupied by grocery stores is owned by the grocery company in the space.[11] This figure dropped to about 40% for chain stores, with independents owning about two-thirds of their floor space. The declining number of

independent stores is clearly one of the factors underlying the increasing rarity of company-owned buildings.

3.1.4 Energy Situation

Virtually all grocery stores pay their own utility bills.[12] On average, chain supermarket managers say they spend $56,400 per year, $43,100 on electricity and $8,000 on natural gas. According to the U.S. Energy Information Administration (EIA), food sales buildings have the third highest intensity of energy use relative to other commercial buildings, at about 215,000 Btu per square foot (only food service and healthcare are more energy-intense).[13] However, looking only at electricity use, the grocery sector is by far the most intense user: EIA reports that at 184,700 Btu/ft^2, the food sales sector electricity intensity is almost four times the commercial building average. Intensity of electric use in large stores is currently about 50-65 kWh/ft^2 per year, a figure that reflects an upward trend since 1995.[14,15] Combined with the recent fluctuations in energy prices, it is thus not surprising that 83% of respondents to the 2001 FMI survey indicated that building energy efficient stores is now a top priority.[16]

3.1.5 Growth and Renewal

New Construction

As of 2000, most of the construction activity in the supermarket sector has been in new building construction (91.5%) rather than retrofits of existing structures (8.5%), with one of the top chains averaging 100 new stores per year.[17,18] A striking departure is the Northeast, with only 57% of added floor space being new buildings. The median new supermarket store size in 2000 was 44,072 square feet, the smallest size in the past five years but still 10% bigger than the median store built ten years ago. These stores typically dedicate 67-76% of the store to selling space, and require about 40 weeks to build. Trends in new stores include a large emphasis on fresh perishables, with nine out of ten stores featuring fresh seafood, a deli department, a floral/plant shop and fresh prepared takeout foods. New store trends and statistics are shown in Table 3-2 below.

TABLE 3-2
NEW SUPERMARKET FEATURES

New Store Characteristics*	**1990**	**2000**
Size (ft^2)	40,288	44,072
Cost to build ($/ft^2)	$81.32	$98.26
Refrigeration equipment investment		$8.10 million
HVAC equipment investment		$1.58 million
Department	**Percent of Stores Featuring**	
Greeting cards	51%	93%
Wine	30%	69%
Pharmacy	31%	59%

** Figures shown are median statistics.*
Source: Food Marketing Institute, *Facts About Store Development 2001*.

The four largest departments in new stores are bakery (both scratch and bake-off); fast- food sit-down section, either sublet or company-operated; deli; and natural foods.

At $98.26 per square foot, the cost of constructing a new store is down from five years ago, but is refrigeration equipment in a new store in 2000 was $8,104,430, with HVAC equipment cost at $1,583,320. The median amount store operators spent on engineering and architectural fees for a new store was $85,000.[19]

Remodeling/Renovation

In 2000, 5.5% of all stores underwent major remodeling. The median time span between remodels went down sharply between 1999 and 2000, from nine years to five years.[20] This phenomenon appears to be caused by the intensive consolidation that has occurred in the past few years, as stores are almost always closed, sold or reformatted when a merger or acquisition occurs. Another explanation may be that store operators see remodeling as a solution to remaining competitive in the current era of rapid change.

A typical remodel not involving any expansion cost $1,607,000 or $35 per square foot in 2000, up 33% from the amount it cost in 1996 and an impressive four times the typical remodel cost in 1990. Where expansion was involved, the median investment was $4,469,204, or $83 per square foot. The typical investment in HVAC during a remodel was $200,000, with refrigeration costing $694,000.[21] Some equipment is usually changed out when a store is remodeled, but not in all cases.[22]

Trends in remodeling include addition of an in-store bank, a separate natural foods section, an in-store pharmacy, and fresh prepared takeout foods.

3.1.6 Energy Equipment Decision Making

Typical Characteristics

A study of decision makers responsible for over 20,000 grocery stores nationwide found that energy equipment-related decisions for the majority of floor space is made at the national headquarters level, as shown in Table 3-3, with regional headquarters assuming this role for 14% of total floor space.[22] While the same group of decision makers is typically responsible for all equipment decisions (regardless of equipment application), separate decision makers are most often involved for cooking/baking, water heating and refrigeration equipment.

The group or individual with the most important role is most commonly the engineering department, with maintenance and construction the next most commonly cited key group. Decisions for about three-quarters of the chain floor space represented were guided by established equipment selection guidelines, with operating cost, first cost and payback dominating as decision criteria. Supermarket industry decision makers most often reported relying on manufacturer representatives, trade journals, consulting engineers and past experience to obtain information about energy equipment and systems.

TABLE 3-3
ENERGY EQUIPMENT DECISION MAKING IN SUPERMARKET CHAINS

Item	Characteristic	Percent of National Floorspace
Locus of decision making (national chains only)	National HQ Regional HQ	48% 14%
Same or different decision makers by equipment type?	Same for all equipment Separate For: - cooking & baking - water heating - refrigeration - HVAC & dehumid.	72% 28% 23% 13% 8% 5%
Most important decision makers • Overall • New construction • Renovation/replacement	 Engineering Maintenance & construction Facility management Senior management Company owner Engineering Facility management	 50% 17% 13% 10% 6%
Primary guidelines	Have no formal guidelines/DK Have guidelines - Lowest operating cost - Lowest purchase/installation cost - Return on investment - Payback - Replace with like equipment	26% 74% 55% 44% 25% 13% 9%
Information sources	Manufacturer/representatives Trade journals Consulting engineers Past experience Trade shows Company staff Electric utilities Natural gas utilities	38% 35% 33% 30% 20% 18% 18% 11%

Source: Opinion Dynamics Corp.

Insights from Industry Participants

A survey conducted among national account customers within the past year reveals additional information about supermarket sector priorities and outlooks on energy issues.[23] Top of mind for these companies is the need to gain empowerment at the individual store level to manage power demand, operating costs and onsite power capability. High-priority concerns include energy price levels and volatility, uncertain regulatory framework, lack of corporate priority for reducing energy costs, lack of competition among energy suppliers, and lack of understanding of their own energy cost drivers.

Our conversations with industry participants provided the following in-depth perspectives.

Structure and Process

The model in use at one of the largest chains for energy system decision-making is a cross-cutting internal committee with representatives from corporate engineering, merchandising, energy management, interior design and other departments. This committee ultimately controls all design and specification decisions, according to the chain's corporate energy manager. While the company has their own in-house engineers, they also involve a variety of outside firms in the design and specification process. The typical procedure is for the internal staff to draw up detailed specifications and provide bid packages to a limited list of bidders.

This chain, like others, buys equipment directly from manufacturers. The firm's exclusive arrangement with refrigeration equipment manufacturers "makes sense because there are only three or four suppliers," while contracts for HVAC components get re-bid and contracts re-awarded much more often, as there are significantly more suppliers. They want to have direct contact with manufacturers on design issues. "The (refrigeration equipment) manufacturer representatives are always in our stores helping out," the energy manager told us.

Guidelines and Criteria

One of the largest national chains performs internal rate of return (IRR) calculations for proposed energy projects. Proposed investments must reach at least the threshold level of IRR to be considered. This criteria holds strictly for retrofit projects but is loosened somewhat in the case of new store design.

With the very low margins in the industry, projects that reduce operating cost can be very important to survival, as suggested by Table 3-3 where "lowest operating cost" is listed as the predominant guideline for energy equipment decision making.

Information Sources

Our discussions in the supermarket sector pointed to pilot projects of new systems as the best source for supplying the information and data considered critical for making energy equipment specification decisions. This makes sense in view of the emphasis placed on minimizing operating costs. Because operating cost is very sensitive to how stores are designed and

operated, supermarket decision makers appear to place more importance on testing equipment in their own stores, and in stores in different regions, than is the case in other sectors.

3.2 FACILITY CHARACTERISTICS

3.2.1 Buildings

The average size of today's new supermarket is 44,072 square feet, up 10% from the median of 40,288 square feet in 1990 but a decline from the high of 57,064 seen in 1998.[24] About two-thirds of grocery square footage nationally is in single, freestanding buildings occupied solely by the grocery store, with most of the remaining space located in strip shopping centers. Centrally managed chains, however, show a more even distribution, with 55% of store space in strips and 43% in freestanding buildings.[25]

Supermarket chain stores are found in every state, with concentration generally mirroring population patterns. However, the top chains, with the exception of Wal-Mart, are not in every state (as depicted in Appendix 3-B). For example, The Kroger Co. has stores in 32 states.

Appendix 3-C lists the number of stores, by state, where electricity usage exceeds 1,000 MWh annually. This screen of the total number of grocery stores serves to include only those most likely to be national chain supermarkets and to be potential candidates for integrated CHP systems. California, Texas and Florida are the leaders, together holding nearly 24% of all these supermarkets. The top 11 states contain half of all such stores.

3.2.2 Energy Equipment

Supermarkets normally own most of their own energy-using equipment, whether they own the building they occupy or lease it. However, HVAC equipment in leased stores is likely to be provided and owned by the building owner, not the supermarket owner.

Regardless of building type, almost all refrigeration and space cooling equipment is electric. The Northeast and the Midwest lead other regions in the use of natural gas for these applications. Natural gas is most likely to be used in stores that occupy freestanding buildings.[26]

Energy management systems are present in almost 90% of chain store grocery space. Centrally managed chains are most likely to use energy management systems in stores larger than 30,000 square feet, with the systems controlling refrigeration, space conditioning and water heating equipment. In-house personnel, chain headquarters staff, or outside contracts may manage the systems.

Space Conditioning

The predominant type of space cooling equipment in the grocery sector is a packaged rooftop unit, with chain stores using this equipment for over 80% of their floor space. Residential-type cooling units are found in about 8% of chain store floor space, more commonly in the South than anywhere else. Split systems, in which the condenser equipment is on the roof and the air

conditioning coil is inside the building, with refrigerant piped between, are also in use in some stores.

Natural gas equipment supplies space heating for 56% of centrally managed chain store floor space. Packaged rooftop units for space heating are usually found in larger stores and chain establishments, with furnaces typically used only in stores of less than 30,000 square feet. Some stores also report using reclaimed condenser heat with auxiliary gas heaters for space heating.[27]

Dehumidification

More than 25% of grocery floor space nationwide employs dehumidification equipment, most of which is electric. The small amount of natural gas dehumidification equipment that is in place is almost entirely in centrally managed chain stores. Natural gas dehumidification is accomplished with desiccant systems that remove humidity from the air before it is conditioned. Electric dehumidification may also be accomplished with a desiccant system using heat from the refrigeration condenser for regeneration, or with electric heat pipe heat exchangers integrated with the HVAC system.

Several types of enhanced HVAC systems are also used in supermarkets to help control humidity. One type of enhancement, a bypass design, cools a small volume of air to a lower temperature than normal and then mixes it with the remaining air that has bypassed the cooling coil. Another type features a dual-path electric system with two cooling coils for separate conditioning of incoming outdoor and return air. Incoming air is cooled to lower than normal temperatures in the primary coil, while the secondary coil provides sensible cooling of return air. The two air streams are then mixed and supplied to the building.

Water Heating

88% of grocery floor space has water heating equipment in place. Standard commercial storage tank units dominate, particularly in the Northeast. However, chains with centralized decision making use heat recovery (reclaim) from hot refrigerant in the refrigeration system for water heating in more than one-third of their floor space, almost exclusively in facilities over 30,000 square feet, and most commonly in the Midwest.

Natural gas-fueled water heating equipment is present in about 45% of centrally managed chain store space. A typical store of a leading chain, for example, features three water heater tanks, one of which is fueled by natural gas and two of which are fueled by reclaimed heat. The refrigeration system supplier characteristically provides the linkage to the water heating system rather than the water heating equipment supplier.

Refrigeration

Supermarkets use refrigerated display cases maintained at various temperatures to store and preserve food and make it accessible to shoppers. Back room operations feature walk-in and other types of coolers and freezers for dairy products, meats, fish, and frozen foods; icemakers; and low temperature meat cutting rooms. Closed or cabinet-type refrigerated cases are present in the majority of grocery floor space, along with walk-in cases, with open cases/cabinets typically

found in the largest stores. Most chains utilize reach-in, coffin, and vertical meat and dairy cases, with self-contained units popular for spot merchandising on the store floor.[28,29]

The refrigerated display and storage cases are connected to mechanical refrigeration machines with a range of refrigerant temperatures. Most supermarkets use air-cooled condensing with low-ambient control for operation at the lowest possible condensing pressure to accommodate expansion valves, hot gas defrosting and refrigerant heat reclaim. A central plant may operate all the refrigerators in the store, the system may be multi-plexed, or a single compressor and associated controls may be connected to each refrigerator. The most common form of multiplexed system is an unequal parallel rack system that has compressors of appropriate size for each temperature range. Parallel rack systems are also used, and many stores have a combination of individual compressors and parallel racks. Total refrigeration horsepower is typically in the 120-320 hp range.[30,31]

The majority of refrigeration systems in chain stores have roof-mounted air-cooled condensers, with evaporatively cooled systems used only in the Southwest. Most chains reclaim heat from the hot refrigerant fluid and have installed floating head pressure controls to reduce compressor horsepower requirements. However, many of these floating head pressure systems boost condenser head pressure when reclaim heat is called for, essentially defeating the energy saving aspects of the system.

A number of stores use mechanical subcooling, using small vapor compression systems to cool the condensers of the low temperature refrigerant circuits. Mechanical subcooling is an effective method of cooling liquid refrigerant below its saturation pressure in order to increase system capacity and improve efficiency. Energy savings are estimated to be as much as 25%. Mechanical subcooling could be accomplished using absorption chillers running off the waste heat of a combined heat and power system.

Cooking and Baking

Cooking and baking equipment is present in 74% of grocery stores. Equipment such as ovens, broilers, griddles, fryers, range tops, steamers and convection ovens serves the cooking and baking needs. Natural gas supplies cooking and baking equipment in about 40% of centrally managed chain store space.

Maintenance and Repair

Most centrally managed chains (84% of all chain floor space) rely on outside service contractors for energy equipment maintenance and repair, and use in-house personnel as well (58% of all chain floor space). Preventive maintenance is more likely to be performed when a company has in-house maintenance staff, with contractors called only when equipment breaks down.[5] Service contracts for refrigeration systems may run in the $900-$1,500 range on a monthly basis, with HVAC system service contracts costing $100-$200 per month.[32]

Backup Power

Grocery stores are under mandate to install backup power for emergency exit lighting and some safety systems. The majority of existing supermarkets use uninterruptible power supply (UPS) systems to feed the emergency lighting/sprinkler/fire alarm and, often, computer systems (such as cash registers) when grid power is temporarily lost. However, the installation of emergency generators, mostly diesel, appears to be on the rise in large new stores, especially in the Northeast and the Midwest. For example, the stores of one national chain feature relatively small (30-50 kW) backup engine generator sets that drive front-end lighting and cash registers. Each cash register has its own battery that can sustain the register for one minute while the backup generator kicks in, and each emergency light has battery backup as well.

Stores in the 30,000-50,000 ft^2 range have sized backup generators at 30-80 kW to cover the required emergency loads. Units that also cover general lighting and equipment that allows shoppers to continue with their purchasing are in the 160-320 kW range. Refrigerated cases are almost never covered by the backup power system, as the cost to do so is generally prohibitive.[33]

3.3.3 Electric, Thermal and Dehumidification Loads

In supermarkets, spill-over cold air from refrigeration cases interacting with the HVAC system presents special challenges to keeping display cases clear, products in good shape, and shoppers comfortable.

Electric Loads

The breakdown of electricity use in a typical supermarket is shown in Table 3-4 below.

TABLE 3-4
SUPERMARKET ELECTRICITY USE

Load	Percent of Store Electricity Usage
Refrigeration	55%
Compressors	72%
Case fans & lights	17%
Case anti-sweat heaters	11%
Lighting	25%
Sales areas	76%
Backroom	24%
HVAC	15%
Heating	47%
Blower	29%
Air conditioning	24%
Other	5%
Total	100%

Source: Quantum Consulting.

The peak electric load in supermarkets is typically in the 400-700 kW range. A sample store with peak demand in the 400-500 kW range drops to the high 300s at night, when HVAC systems are off. Refrigeration loads are on the system around the clock.

Thermal Loads

Thermal loads in supermarkets include space heating, water heating, and cooking and baking.

- Uses for hot water include employee hand washing, cleaning, food preparation and food service. While not a major energy use, it is growing as more stores incorporate in-demand food preparation and service functions. Hot water peak use typically occurs in the evening/night time period, when store clean-up takes place.
- The cooking and baking function, like hot water heating, uses relatively little energy but is increasing as stores turn to in-store food service and preparation to attract and retain customers. Some baking is done on a "bake-off" basis, where ready-to-bake goods are delivered to the store and finished on-site.
- Stores require space heating both for customer and employee comfort, and to maintain ideal conditions for perishables and other stocked items. Cold air spilling over from refrigerator cases presents year-round challenges in terms of shopper comfort, sometimes requiring heating even in summer.

Dehumidification Loads

Humidity control in supermarkets receives relatively more attention than in many other types of commercial buildings, as high humidity levels cause frost buildup on refrigeration evaporators and fogged or frosted display cases. Customers cannot see items and refrigeration equipment is burdened. Anti-sweat heaters, which are generally used to combat frost buildup on case doors, must also work longer when high humidity conditions are present. Conversely, humidity levels that are too low cause produce to wilt. Humidity in the 40-45% range appears optimum in the supermarket setting (other types of retail businesses operate with 50-55% humidity).

Conventional air conditioning systems accomplish humidity control relatively inefficiently by overcooling the air to remove moisture. To avoid overcooling the store, this over-cooled air (40-45°F) may be reheated before being introduced into the supermarket. Such reheating is often accomplished using waste heat reclaimed from the refrigeration system.

A recent study of humidity impacts on refrigerated display cases documents the improved performance and energy use characteristics of cases when ambient relative humidity is decreased from 55% to 35%. Decreasing indoor relative humidity dramatically lowered the latent load of each of the four main case types studied, which in turn decreased compressor power consumption. Fog recovery time was also much quicker under lower humidity conditions so anti-condensate heater operating time dropped significantly. Both of these improvements reduce refrigeration case energy loads.[34]

Electric and Gas Load Curves

The figures in Appendix 3-D present typical load curves for a 45,000 ft^2 supermarket located in two opposite types of climates, the Southwest and the Northeast (New England). Table 3-5 following presents key energy consumption figures for these representative stores.

The base electric load for the stores is just under 200 kW. The base thermal load is about 6 million Btu per day. A CHP system sized to meet the base thermal load would be only about 60 kW. However, as previously described, it may be possible to increase the size of a CHP system while still maintaining high thermal utilization by using absorption for subcooling and adding in store heat as well.

TABLE 3-5
ELECTRIC AND GAS ENERGY LOADS REPRESENTATIVE
45,000 FT^2 SUPERMARKET - SOUTHWEST AND NEW ENGLAND

Southwest All-Electric Store*		
Electricity Use	2,264,055	kWh/year
Peak Load	389	kW
Load Factor	66.5%	
Southwest Gas Heat Store		
Electricity Use	1,996,003	kWh/year
Peak Load	358	kW
Load Factor	63.7%	
Minimum Daily Gas Use	5,896*	kBtu/Day
Maximum Daily Gas Use	10,360	kBtu/Day
New England All-Electric Store		
Electricity Use	2,905,116	kWh/year
Peak Load	698	kW
Load Factor	47.5%	
New England Gas Heat Store*		
Electricity Use	2,148,950	kWh/year
Peak Load	385	kW
Load Factor	63.7%	
Minimum Daily Gas Use	6,001	kBtu/Day
Maximum Daily Gas Use	35,436	kBtu/Day

* Excluding Thanksgiving and Christmas, when the store is assumed to be closed.

Source: EEA; Regional Economic Research, Inc., *eShapes, 2001 National Database*.

GLOSSARY

Grocery Store – Any retail store selling a line of dry grocery, canned goods or nonfood items plus some perishable items

Supermarket – Any full-line self-service grocery store generating a sales volume of $2 million or more annually

Chain – An operator of 11 or more retail stores

Independent – An operator of fewer than 11 retail stores

Conventional Supermarket - The original supermarket format offering a full line of groceries, meat and produce, and having at least $2 million in annual sales. These stores typically carry approximately 15,000 items, offer a service deli and frequently a service bakery.

Superstore – A larger version of the conventional supermarket with at least 40,000 square feet in total selling area and 25,000 items. Superstores offer an expanded selection of non-foods.

Food/Drug Combo – A combination of superstore and drug store under a single roof, with common checkouts. These stores also have a pharmacy.

Supercenters – A large food/drug combination store and mass merchandiser under a single roof. The supercenters offer a wide variety of food, as well as non-food merchandise. These stores average more than 170,000 ft2 and typically devote as much as 40% of the space to grocery items, e.g., Wal-Mart, Kmart, Super Target, Meijer and Fred Meyer.

Hypermarket – A very large food and general merchandise with approximately 180,000 ft^2 of selling space. While these stores typically devote as much as 75% of the selling area to general merchandise, the food-to-general-merchandise sales ratio is typically 60/40, e.g., Bigg's.

Warehouse Store – A low-margin grocery store offering reduced variety, lower service levels, minimal décor, and a streamlined merchandising presentation, along with an aggressive pricing. Generally, warehouse stores don't offer specialty departments.

Limited Assortment Store – A "bare-bones," low-priced grocery store that provides very limited services and carries fewer than 2,000 items with limited, if any, perishables, e.g., Aldi, Sav-A-Lot.

Source: Food Marketing Institute, *Facts and Figures*, June 2002. *www.fmi.org/facts_figs/superfact.htm*: 7/11/2002.

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32. FMI *Facts About Store Development.*

33. Energystics.

34. GARD Analytics.

APPENDIX 3-A: TOP 25 SUPERMARKET CHAINS

				% of All	% of All
		Sales	No. of	Supermarket	Supermarket
Rank	Company Name	($ millions)	Stores	Sales	Stores
1	The Kroger Co.	46,726	2,429	11.7%	7.5%
2	Safeway, Inc.	31,451	1,568	7.9%	4.9%
3	Albertson's, Inc.	30,207	1,713	7.6%	5.3%
4	Wal-Mart (supercenters)	28,247	1,103	7.1%	3.4%
5	Ahold USA, Inc.	24,104	1,245	6.1%	3.9%
	Subtotal Top 5	**160,735**	**8,058**	**40.4%**	**25.0%**
6	Delhaize America	15,231	1,464	3.8%	4.5%
7	Publix Super Markets, Inc.	14,624	687	3.7%	2.1%
8	Winn-Dixie Stores, Inc.	13,012	1,141	3.3%	3.5%
9	Great Atlantic & Pacific Tea Co.	8,540	519	2.1%	1.6%
10	Supervalu, Inc. (co-owned)	7,396	550	1.9%	1.7%
	Subtotal Top 10	**219,538**	**12,419**	**55.1%**	**38.5%**
11	H-E-B Grocery	7,057	278	1.8%	0.9%
12	Shaw's Supermarkets, Inc.	4,320	187	1.1%	0.6%
13	Meijer, Inc.	3,939	153	1.0%	0.5%
14	Pathmark Stores, Inc.	3,906	142	1.0%	0.4%
15	Defense Commissary Agency	3,616	196	0.9%	0.6%
	Subtotal Top 15	**242,376**	**13,375**	**60.9%**	**41.5%**
16	Hy-Vee Food Stores	3,536	187	0.9%	0.6%
17	Aldi USA, Inc.	3,197	755	0.8%	2.3%
18	Raley's Supermarkets	3,069	149	0.8%	0.5%
19	Giant Eagle, Inc.	2,985	120	0.7%	0.4%
20	Wegman's Food Markets	2,678	62	0.7%	0.2%
	Subtotal Top 20	**257,841**	**14,648**	**64.8%**	**45.4%**
21	Stater Brothers Markets	2,671	155	0.7%	0.5%
22	Price Chopper/Golub Corp.	2,399	100	0.6%	0.3%
23	Penn Traffic Co.	2,304	221	0.6%	0.7%
24	Super Kmart Centers	2,264	123	0.6%	0.4%
25	Ingles Markets, Inc.	2,247	205	0.6%	0.6%
	Subtotal Top 25	**269,726**	**15,452**	**67.7%**	**47.9%**
	Subtotal Top 50	**302,518**	**17,943**	**76.0%**	**55.6%**
	Total All Supermarkets	**398,200**	**32,265**	**100.0%**	**100.0%**
	Total Supermarket Chains	**326,200**	**21,108**		

Source: Progressive Grocer, *69th Annual Report of the Grocery Industry*.

APPENDIX 3-B: TOP EIGHT SUPERMARKET CHAINS' STORES

Supermarket Chain Brands	Main Locations
The Kroger Co.	32 states
- Kroger, City Market, Dillons, Gerbes, Hilander, Jay C, King Soopers, Owen's Pay Less	East
- Bell Markets, Cala Foods, Food 4 Less, Fred Meyer, Fry's, Ralphs, Quality Food Center, Smiths	West
Safeway, Inc.	
- Safeway	MidAtlantic: DC, MD, VA Southwest: AZ West: AK, CA, CO, OR, WA
- Von's	West: CA
- Randalls, Tom Thumb	Southwest: TX
- Genuardi's	MidAtlantic: PA
- Dominick's	Midwest: IL
Albertson's	33 states
- Acme, Jewel, Max Foods, Super Saver Food	
Wal-Mart	50 states
- Wal-Mart, Sam's Club	
Ahold, USA, Inc.	16 states
- Bi-Lo	Southeast: AL, GA, NC, SC, TN
- Stop 'N Shop	New England: CT, MA, NJ, NY, RI
- Giant	MidAtlantic: MD, PA, VA, WV
- Tops	OH, NY, PA
Delhaize America	17 states
- Food Lion	Southeast/MidAtlantic: DE, FL, GA, KY, MD, NC, PA, SC, TN, VA, WV
- Hannaford, Shop 'n Save	Northeast: ME, MA, NH, NY, VT
- Kash n' Karry	South: FL
Publix Super Markets, Inc.	4 states Southeast: AL, FL, GA, SC
Winn-Dixie, Inc.	12 states Southeast : AL, FL, GA, KY, LA, MS, NC, SC, TN, VA Midwest : IN, OH

Source: Progressive Grocer; company websites.

APPENDIX 3-C: GEOGRAPHICAL DISTRIBUTION OF SUPERMARKETS WITH ANNUAL ELECTRICITY CONSUMPTION > 1,000 MWH

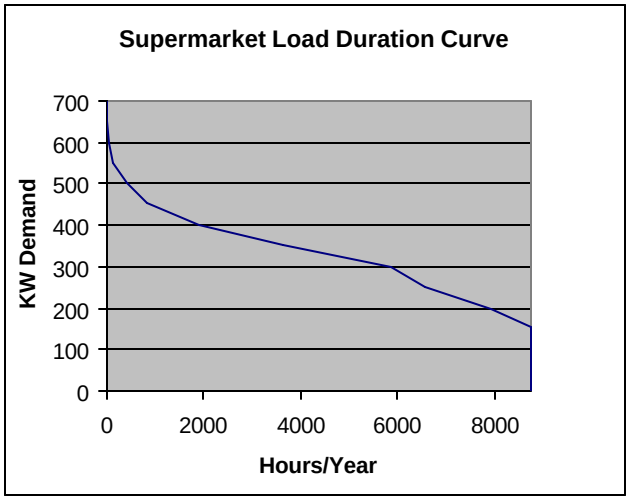
State	No. of Stores	% of Total Stores	Cumulative %
California	2,237	11.7	11.7
New York	1,253	6.6	18.3
Florida	1,236	6.5	24.8
Pennsylvania	1,017	5.3	30.1
North Carolina	898	4.7	34.8
Texas	784	4.1	38.9
Ohio	730	3.8	42.7
Michigan	684	3.6	46.3
Virginia	632	3.3	49.6
Georgia	614	3.2	52.8
Washington	602	3.1	55.9
Illinois	595	3.1	59.0
New Jersey	587	3.1	62.1
Tennessee	453	2.4	64.5
Wisconsin	428	2.2	66.7
Massachusetts	414	2.2	68.9
Maryland	409	2.1	71.0
South Carolina	405	2.1	73.1
Indiana	364	1.9	75.0
Alabama	358	1.9	76.9
Oregon	316	1.7	78.6
Minnesota	300	1.6	80.2
Colorado	288	1.5	81.7
Kentucky	288	1.5	83.2
Arizona	260	1.4	84.6
Missouri	244	1.3	85.9
Iowa	237	1.2	87.1
Louisiana	229	1.2	88.3
Connecticut	216	1.1	89.4
West Virginia	176	0.9	90.3
Mississippi	170	0.9	91.2
Utah	161	0.8	92.0
Kansas	133	0.7	92.7
Maine	133	0.7	93.4
Oklahoma	127	0.7	94.1
Nebraska	122	0.6	94.7
Nevada	122	0.6	95.3
New Mexico	118	0.6	95.9
Idaho	117	0.6	96.5
Arkansas	114	0.6	97.1
New Hampshire	94	0.5	97.6
Montana	84	0.4	98.0
Vermont	79	0.4	98.4
Delaware	56	0.3	98.7
North Dakota	54	0.3	99.0
Rhode Island	50	0.3	99.3
Wyoming	48	0.3	99.6
South Dakota	43	0.2	99.8
Washington, D.C.	36	0.2	100.0
Total	19,115	100.0	

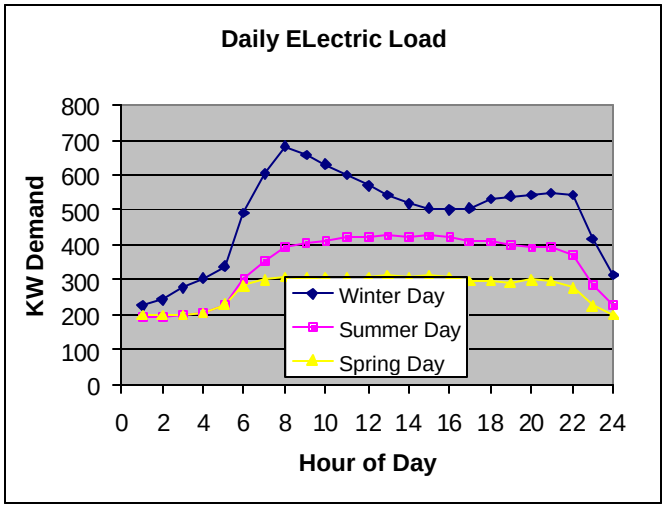
Source: Dun & Bradstreet Sales and Marketing Solutions, *MarketPlace Jul-Sep 2002*.

APPENDIX 3-D: TYPICAL SUPERMARKET ELECTRIC AND GAS LOAD CURVES

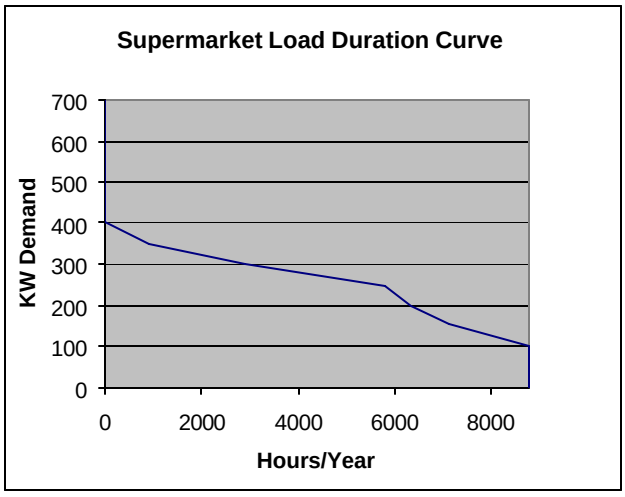
FIGURE 3D-1
ELECTRIC CONSUMPTION AND DEMAND FOR ALL-ELECTRIC 45,000 FT^2 SUPERMARKET

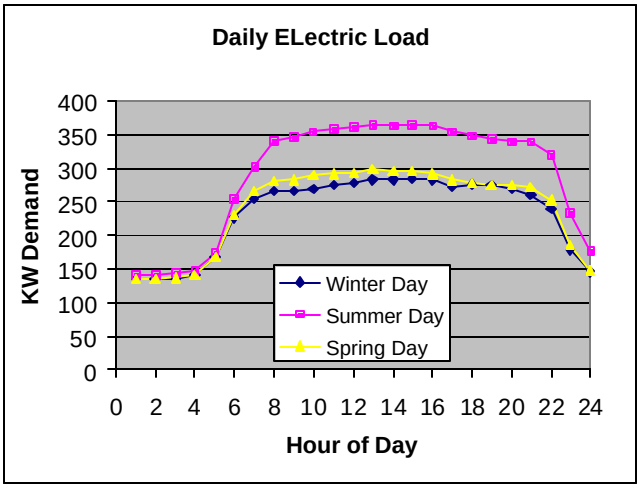
Representative Northeast (Hartford, CT) Supermarket: All-Electric





Representative Southwest (Phoenix, AZ) Supermarket: All-Electric

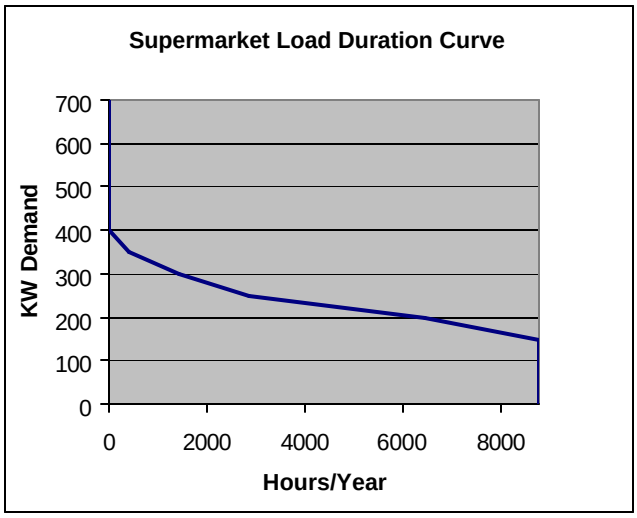


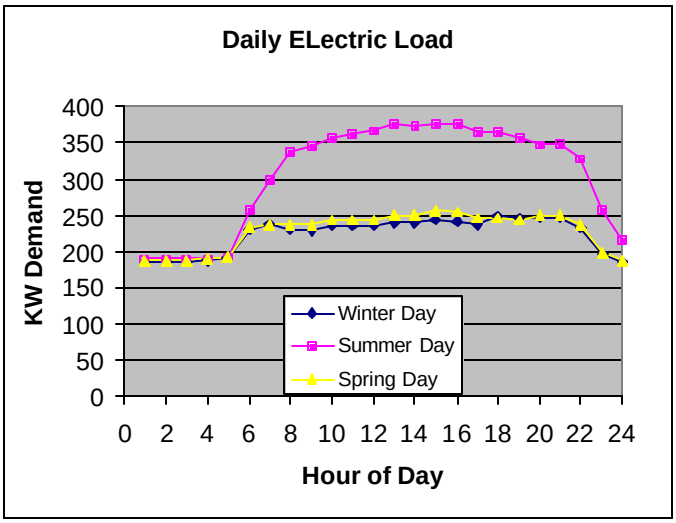


Source: EEA; Regional Economic Research, Inc., *eShapes, 2001 National Database*.

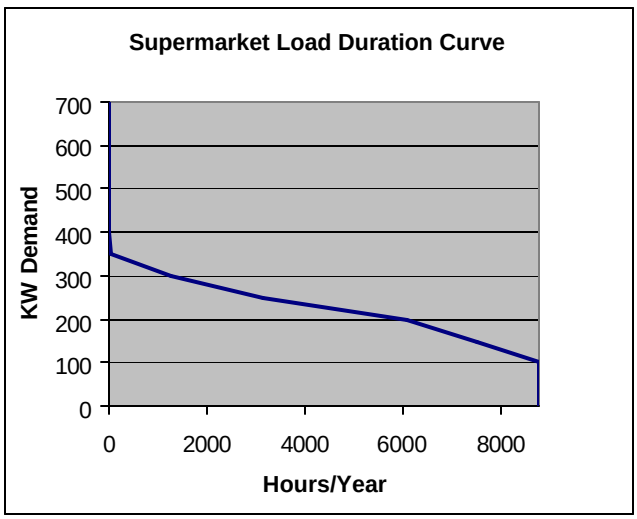
FIGURE 3D-2
ELECTRIC CONSUMPTION AND DEMAND FOR NATURAL GAS-HEATED 45,000 FT^2 SUPERMARKET

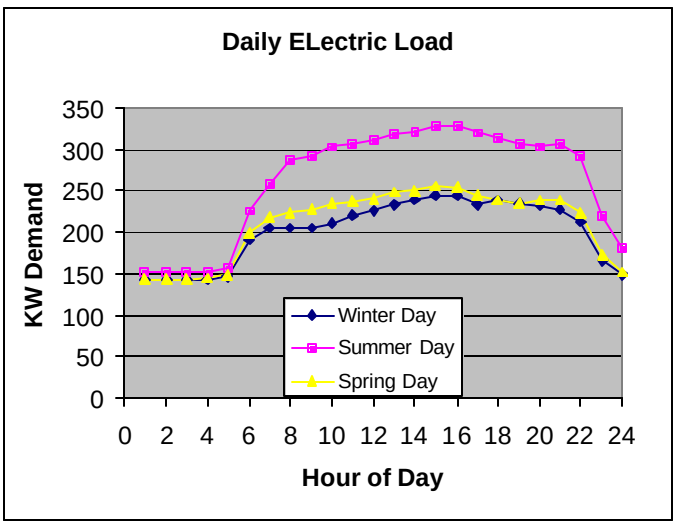
Representative Northeast (Hartford, CT) Supermarket: Gas Heat





Representative Southwest (Phoenix, AZ) Supermarket: Gas Heat

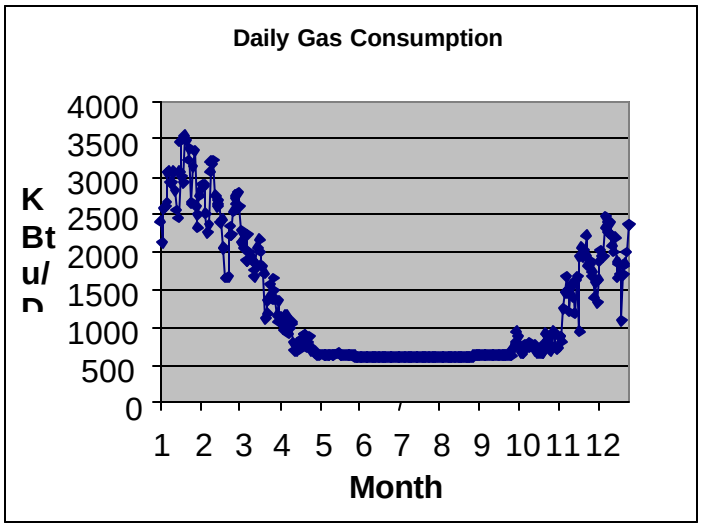




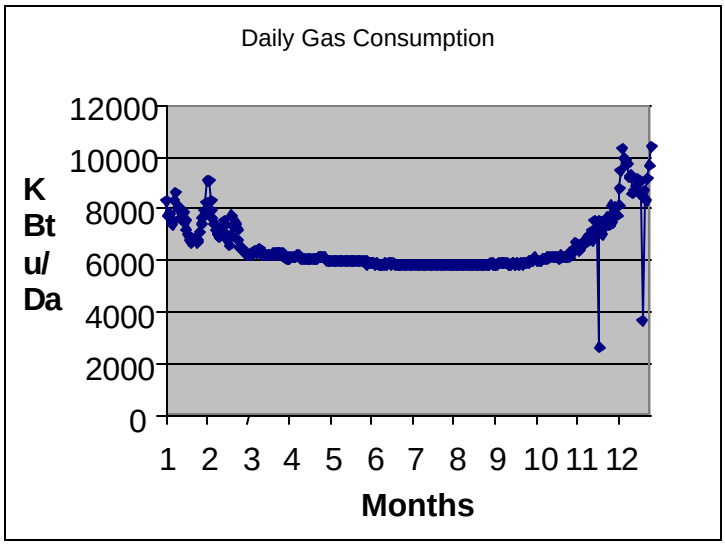
Source: EEA; Regional Economic Research, Inc., *eShapes, 2001 National Database*.

FIGURE 3D-3
NATURAL GAS CONSUMPTION AND DEMAND FOR NATURAL GAS-HEATED 45,000 FT^2 SUPERMARKET

Representative Northeast (Hartford, CT) Supermarket: Gas Heat



Representative Southwest (Phoenix, AZ) Supermarket: Gas Heat



Note: Dips in consumption in November and December result from store closing on Thanksgiving Day and Christmas Day respectively.

Source: EEA; Regional Economic Research, Inc., *eShapes, 2001 National Database*.

4. HOTEL/MOTEL SECTOR PROFILE

4.1 INDUSTRY OVERVIEW

4.1.1 Structure

As of 2000, there were 53,500 domestic lodging properties, comprising 4.1 million rooms and generating $108.5 billion in sales annually.[1] Slightly more than half of these properties are under 75 rooms, with about one-third in the 75-299 room range. Table 4-1 shows the general location pattern of these properties and rooms by five main categories, while Table 4-2 shows the breakdown by number of rooms.

TABLE 4-1
HOTEL/MOTEL PROPERTY LOCATIONS

Location	Percent of All Properties	Percent of All Rooms
Highway	4.2%	31.0%
Suburban	33.6	30.4
Urban	10.2	16.0
Airport	7.7	10.2
Resort	6.3	12.4

Source: American Hotel & Lodging Association, *2001 Lodging Industry Profile.*

TABLE 4-2
HOTEL/MOTEL PROPERTY SIZE

No. of Rooms	Percent of All Properties	Percent of All Rooms
Under 75	51.5%	22.5
75-149	33.5	35.1
150-299	10.9	21.3
300-500	2.8	9.9
Over 500	1.3	11.2

Source: American Hotel & Lodging Association, *2001 Lodging Industry Profile.*

Though distinctions blur across categories, the full service/hotel segment may be characterized as consisting of establishments that feature foodservice and tend toward the luxurious, with guest rooms, lobbies, dining rooms/kitchens/restaurants, lounges, conference and meeting rooms, exhibit halls and ballrooms, pools, spas and health clubs on premises. In the limited service/motel segment, establishments tend toward the economical, with guest rooms, lobbies,

continental breakfast rooms, pool and perhaps a small workout area and spa. Affiliated restaurants are usually in buildings adjacent to the motel and are separately owned and operated.

Companies in the industry may develop properties, own properties, manage properties, operate through franchise arrangements, or perform some combination of these activities. Some top companies are structured as real estate investment trusts (REITs) that buy, own and lease hotels. For example, FelCor Lodging Trust, the largest REIT nationally by room count, holds a diversified portfolio that includes independent single properties along with nationally branded full-service hotels that are managed by the brand owners, including Hilton Hotels, Six Continents Hotels and Starwood Hotels & Resorts. FelCor activities include renovating, redeveloping and re-branding properties that it purchases.

There are a handful of large property management firms that focus on operating properties for the owner(s). It is increasingly common that these companies also hold an equity or financial position in the properties they manage. The companies sign contracts with owners to operate their hotels, taking in return a percentage of the property's gross revenue plus an incentive fee on profits above a certain level.

About 70% of all motel and hotel rooms are associated with franchises and national chains.[2] Most of the largest companies in the industry own and/or operate, directly or more commonly through franchise arrangements, a number of different brands. For example, Cendant Corporation, ranked the leading U.S. company in terms of number of room, owns the Days Inn, Super 8, Howard Johnson, Travelodge, Wingate, Ramada, Knights, Amerihost, and Village brands, and franchises all of them. While the majority of lodging facilities are affiliated with a national brand, the majority are also independently owned and operated.[3]

Brand concentration in the industry as measured by rooms is significant, with the top seven companies' brands representing more than 50% of all domestic rooms and 35% of all U.S. properties.[4] Appendix 4-A lists the top 40 hotel companies ranked by number of domestic rooms. Appendix 4-B lists the brands owned by each of the top ten companies.

4.1.2 Trends

The lodging industry grew steadily from a low point at the beginning of the 1990s through 2000, posting record pretax profits of $23 billion in 2000, up 9% from 1999 and double the 1996 level.[5] The tragic events of September 11, however, wreaked havoc with this pattern, resulting in 2001 profits of only $16.7 billion. Many companies aggressively cut costs and controlled expenses as business and leisure travel fell off, with the result that profits of $17.2 billion are now expected in 2002.[6]

Occupancy rate, a key indicator of lodging industry positioning, dropped 7.5% from 2000 to 2001, averaging 66.2% in 2001, and is projected to average only 61.3% in 2002, a level lower than in all but 14 of the past 75 years.[7] Revenue per available room (RevPAR), another key indicator, is forecast to drop to $49.68 in 2002, down from $50.83 in 2001 and significantly less than the industry high of $55 reached in 2000. Room demand fell 3.5% in 2001 but is projected to grow a bit over 1% in 2002.

Erosion of consumer confidence, forecasts for a continuing weak economy, and lack of a significant rebound in travel are all restraining lodging demand growth in 2002. Industry executives polled at the beginning of 2002 indicated that their top concern is surviving the current down cycle until travel can be restimulated. Also cited among the top concerns was the unavailability of capital to the lodging industry.[8] Many lenders have stopped financing new hotel construction because of high rates of activity in the late 1990s, uncertain economic conditions, and the aftereffects of September 11. Only owners and developers with very solid balance sheets have access to capital, and projects that previously looked feasible are being re-evaluated in view of tighter lending terms. High-end hotels, having suffered the greatest occupancy losses, also account for the greatest number of projects postponed or cancelled.[9]

All of the above trends are expected to improve somewhat in 2003, with fuller recovery in 2004. In the meantime, hotel owners and managers continue to look for ways to add new sources of revenue or improve the profitability of existing areas. An ongoing trend in this area has been the addition of new or expansion of existing spa facilities, sometimes through a leasing arrangement with a brand name in the spa industry.[10] Another continuing trend is the addition and use of on-line services. These include:

- High-speed internet access in guest rooms.
- On-line procurement of products such as furniture and food. Such consortium arrangements can generate cost efficiencies and possibly reduce the need for administrative staff.
- On-line reservation systems that lower the cost of reservation operations due to reduced labor costs.[11]

4.1.3 Financial Situation

Virtually all lodging floor space is owned by the establishment occupying the space, and most pay all of their own utility bills.[12] On average, centrally managed chains report devoting 8% of annual operating budgets to energy, with an average annual energy bill of $97,300. Electricity averages 63% of total utility expenses, and fuels including natural gas average 16%.[13] On the revenue side, guest room rates generate about 71% of total lodging industry revenues and food sales generate 22%.

For properties that are separately owned and managed, minor capital improvement projects are usually funded through the management company by directing a percentage of gross revenues into an escrow account, typically three to five percent. This account covers room redecoration, recarpeting and other smaller-budget efforts. Major capital improvement initiatives, such as example replacing a roof, an elevator or a chiller, are paid for directly by the owners via "special allocation" line items. This arrangement tends to favor minor, cosmetic projects over mechanical and structural improvements, and thus poses a considerable challenge when it comes to consideration of CHP system installation in existing buildings. In addition, there is no central procurement for energy equipment. Each property and each project are bid out separately.[14]

4.1.4 Energy Situation

Based on the most recent Department of Energy figures (1999 CBECS), buildings with the principal activity of lodging rank second in (gross) intensity of energy use among all 12 major commercial building types on a per-building basis, but only seventh when measured on a Btu/ft^2 basis.[15] Total consumption in 1999 was 450 trillion Btu, or 7.8 % of total commercial energy consumption. Natural gas serves 68% of lodging buildings or 78% of national lodging floor space. In a major 1998 industry survey, among centrally managed chain floor space, 95% had natural gas service.[16]

Table 4-3 shows space heating, space cooling and water heating energy sources among centrally managed chain floor space as identified in the 1998 survey. Electricity is the dominant fuel source for space conditioning, while natural gas dominates in water heating. Table 4-4 shows the same statistics for all lodging space nationally according to the 1999 CBECS.

TABLE 4-3
FUEL SOURCES IN CENTRALLY MANAGED
HOTEL/MOTEL CHAINS

	Fuel Source by Percentage of National Floor Space*			
Application	Electricity	Natural Gas	Fuel Oil/ Propane	Other
Space heating	71%	27%	1%	1%
Space cooling	98%	-	-	2%
Water heating	8%	86%	3%	3%

* primary source only
Source: Opinion Dynamics Corp.

TABLE 4-4
FUEL SOURCES IN LODGING ESTABLISHMENTS

	Fuel Source by Percentage of Total Floorspace*			
Application	Electricity	Natural Gas	District Heat/ Chilled Water	Propane
Space heating	66%	55%	12%	--
Space cooling	86%	--	5%	--
Water heating	16%	70%	12%	6%

* more than one source may apply
Source: EIA, *Commercial Buildings Energy Consumption Survey 1999*.

Besides space conditioning and water heating, other major energy uses at lodging facilities include pool/spa/sauna heating, cooking and baking, and laundry drying. Over two-thirds of lodging establishments by floor space feature cooking and baking equipment, which in centrally managed chains is predominantly (84%) natural gas-fired. Laundry drying, present in almost 90% of lodging space, is also mostly natural gas-fired (90% among centrally managed chains). Over 40% of centrally managed chain floor space features an energy management system, which is in most cases controlled by staff at the individual property. The system typically controls space conditioning and water heating equipment.[17]

4.1.5 Growth and Renewal

New Construction

The industry added 3.5 million new rooms between 1998 and 2000, about 1 million more than in the previous 20-year period. With capital currently constrained, many projects are now on hold. Hotel construction is projected to total $127 billion in 2002, down over 12% from 2001. Fewer rooms are under construction currently than at any time in the past three years, with supply growth in 2002 projected at 1.5% versus the 2.4% in 2001.[18]

A specific trend in the past ten years has been the inclusion of (expanded) spa facilities and exercise/health club space in both new and renovation projects. The percentage of hotels featuring fitness facilities climbed from 36% in 1988 to 48% in 1998.[19] A more general, continuing trend is segmentation of customers by type of traveler, with the result that hotels focused on serving specific types of travelers are being designed and built. For example, Matrix Corp. is developing "eSuites Hotels" to serve technology-savvy travelers, and InternettINNS is pursuing a similar concept. These hotels feature such amenities as a flat-screen computer with high-speed internet access and a printer/copier/fax machine in every guest room. In addition, eSuites will feature exercise equipment in a percentage of guestrooms.[20]

Remodeling/Renovation

Minor remodeling and renovation projects are funded yearly, typically through escrow accounts held by the management company. Projects include recarpeting, new wall and window treatments, furnitures and fixtures, and the like. Structural and mechanical projects are considered major renovation projects and are paid for by owners. Examples of these projects include re-roofing, new windows, energy equipment replacement, and guestroom room/public space expansions. Table 4-5 below shows the range of average time spans between major renovations undertaken by owners.

4.1.6 Energy Equipment Decision Making

Typical Characteristics

A study of decision makers responsible for almost 7,000 chain lodging facilities nationwide found that energy equipment-related decisions for the majority of floor space is made at the national headquarters level, as shown in Table 4-6, with responsibilities split between headquarters and individual locations for 15% of total floor space.[21] The same group of decision makers is typically responsible for all equipment decisions, regardless of equipment application.

TABLE 4-5
HOTEL/MOTEL MAJOR RENOVATION ACTIVITY

Renovations undertaken:	% of respondents
Every 2-3 years	8%
Every 3-5 years	5%
Every 5-7 years	30%
Every 7-10 years	17%
Every 10 or more years	10%

Source: American Hotel & Lodging Association.

TABLE 4-6
ENERGY EQUIPMENT DECISION MAKING AMONG LODGING CHAINS

Item	**Characteristic**	**Percent of National Floor Space**	
Locus of decision making	National HQ	69%	
	Individual locations	9%	
	Regional HQ	7%	
	Responsibilities split, nat'l/indiv.	15%	
		Nat'l Chain	*Ind. Chain*
Same or different decision makers by equipment type?	Same for all equipment	97%	77%
Most important decision makers			
• Overall	Engineering	42%	48%
	Facility management	36%	17%
	Senior management	16%	12%
	Company owner	6%	19%
• New construction	Engineering/outside consultant		
• Renovation/replacement	Engineering		
Primary guidelines	Have no formal guidelines/DK	52%	50%
	Have guidelines	48%	50%
	- Lowest purchase/installation cost	50%	19%
	- Lowest operating cost	29%	29%
	- Preferred vendor	9%	14%
	- Return on investment	7%	16%
	- Replace w/ like equipment	5%	9%
	- Payback	1%	12%
Information sources	Past experience	39%	31%
	Manufacturer representatives	38%	18%
	Trade journals	38%	12%
	Consulting engineers	32%	14%
	Trade shows	20%	7%
	Electric utilities	19%	4%
	Company staff	19%	22%
	Distributors/dealers/suppliers	17%	11%
	Contractors/plumbers	2%	16%

Source: Opinion Dynamics Corp.

The group or individual with the most important role is most often in the engineering department, with facility managers the next most commonly cited key group. Decisions for about half of the chain floor space represented were guided by established equipment selection guidelines, with installation and operating cost dominating as decision criteria. Hotel/motel chain decision makers most often reported relying on past experience, manufacturer representatives, trade journals and consulting engineers to obtain information about energy equipment and systems.

Insights

A survey conducted in 2002 among national account customers revealed additional information about lodging sector priorities and outlooks on energy issues.[22] Top of mind among these customers are the need to understand their own energy cost and use drivers, to see contained and predictable energy costs, and to gain assured power quality and reliability.

Our conversations with industry participants provided detailed looks at several aspects of energy equipment decision-making in the sector, as follows.

Structures and Processes

As described previously, the hotel industry is among the more complex in terms of ownership and management structures. As a further complication to decision-making, there is also significant turnover from year to year of ownership and management contracts. One of the largest companies signs contracts with owners to operate their hotel properties, taking in return a percentage of the property's gross revenues plus an incentive fee on profits above a pre-defined level. Three to five percent of the gross revenue goes into an escrow account to be applied to capital improvements that are primarily cosmetic, such as room upgrades, new carpeting, and other aesthetic enhancements and amenity additions.

There are norms in the industry for how often cosmetic-type improvements need to be made, and since they typically pay for themselves quickly by enhancing the property's ability to generate revenue, management and owners' interests are aligned. However, the owner must pay directly for replacement of major building systems (e.g., the roof, the chiller, elevator banks), projects that reduce operating costs but are not credited with producing revenue. Projects that generate revenue benefit both parties and are thus more agreeable and attractive than projects that, by reducing operating costs, benefit only the management company.

With separation of management and ownership, and owners responsible for major capital projects, management's recommendations may be overlooked or ignored by owners. Among owners' competing uses for capital is construction of additional (revenue-generating) properties.

It is standard in the industry for construction of each new property and implementation of each capital project to be bid out separately. Owners typically rely on consulting engineers to draw up project specifications, which are provided to competing contractors during the procurement phase. When equipment is involved, contractors procure it and add their own mark-up,

negatively affecting the economics of systems and components. In this way, decision-making can become quite localized and heavily dependent upon the consulting engineer(s) involved.

Guidelines and Criteria

As mentioned, capital improvements receiving top priority are projects that result in improvements visible to customers, such as new floor coverings, redecoration and remodeling of guest and meeting rooms, addition of amenities such as exercise facilities and spas, and others. As one interviewee put it, "The 'back of the house' operations are very low priority. Our decisions are cost-driven and based on rate of return, but capital for equipment systems is at the end of the priority list." Financial criteria are focused on short-term recovery of investment, particularly in the post-September 11 era of reduced rates and occupancy levels. Decisions are heavily oriented toward capital cost considerations, followed distantly by operating costs.

In general, maintenance requirements are less of a critical criterion for companies involved with larger, more upscale properties than for those managing smaller, more downscale facilities. Larger, luxury facilities tend to employ skilled and experienced equipment professionals. However, newer or less common types of equipment and systems that require periodic maintenance will still pose challenges and perceived risks that may be unacceptable without outside support.

4.2 FACILITY CHARACTERISTICS

4.2.1 Buildings

According to1999 CBECS figures, there are about 153,000 buildings with the principle activity of lodging. The median age of these buildings is almost 30 years. The distribution by total floor space is shown below in Table 4-7.

TABLE 4-7
HOTEL/MOTEL SIZE DISTRIBUTION

	5,001-10,000 ft^2	10,001-25,000 ft^2	25,001-50,000 ft^2	50,001-100,000 ft^2	100,001-200,000 ft^2	200,001-500,000 ft^2
Percent of National Hotel Floor Space	6%	10%	25%	17%	12%	18%

Source: EIA, *Commercial Buildings Energy Consumption Survey 1999*.

According to the 1998 national industry survey, more than two-thirds of national lodging floor space is located in single, free-standing buildings, and almost one-third is found in multiple buildings. Among centrally managed chains, however, fully 90% of floor space is in single, free standing buildings totally occupied by the chain. The average size of these chain facilities is

66,000 ft^2, compared to 36,000 ft^2 for single independent establishments. Smaller properties (under 300 rooms) are generally two- to three-story buildings.

Appendix 4-C lists the number of lodging establishments in each state where the daily electric demand is at least 10 kW. These facilities are more likely than smaller facilities to be part of a national chain and to be good candidates for integrated CHP systems.

4.2.2 Energy Equipment

Table 4-8 shows the major types of space cooling, space heating and water heating equipment in place in centrally managed chain facility floor space. The majority of air conditioning is supplied by window/wall (packaged terminal air conditioning or PTAC) units, with central chiller equipment serving about one-quarter of floor space. Window/wall units also dominate for space heating purposes.

TABLE 4-8
ENERGY EQUIPMENT IN CENTRALLY MANAGED LODGING CHAINS

Percent of Floor Space by Application*		
Space Heating	**Space Cooling**	**Water Heating**
Window/wall units: 43%	Window/wall units: 48%	Standard tank-type: 52%
Heat pump: 16%	Central chiller: 23%	Central boiler: 37%
Central boiler: 14%	Heat pump: 14%	Tankless (instant): 7%
Central furnace: 8%	Packaged rooftop: 11%	Heat recovery: 2%
Electric baseboard: 7%		

* Primary source only.
Source: Opinion Dynamics Corp.

Table 4-9 shows energy equipment information for the lodging sector overall as contained in the 1999 CBECS data.

TABLE 4-9
ENERGY EQUIPMENT IN LODGING ESTABLISHMENTS

Percent of Floor Space by Application*		
Space Heating	**Space Cooling**	**Water Heating**
Boilers: 40%	Individual units: 46%	Central: 79%
PTACs: 37%	PTACs: 43%	Distributed: -
Indiv. Space heaters: 37%	Central chiller: 22%	Combination: 12%
Heat pumps: 24%	Heat pump: 22%	
Furnaces: 14%	Res.-type CAC: 16%	
District heat: 12%	District chilled water: 5%	

* Floor space may feature more than one type of equipment per application
Source: EIA, *Commercial Building Energy Consumption Survey 1999*.

Space Conditioning

For guest room conditioning, central chilled and hot water plants serving individual room fan-coil units and duct-mounted coils are common among larger facilities. Units are typically located in the outer wall, over the bathroom or hallway, or in the wall between the bathroom and the bedroom. PTACS, packaged terminal heat pumps (PTHPs), and water-loop heat pump units are frequently used to condition guest rooms in smaller facilities, with packaged rooftop units often serving common areas such as hallways and lobby. Bathrooms require outdoor air supplied at a minimum of 35 cfm, and may feature supplementary heat.

Common areas such as ballrooms and large meeting rooms may be served by either the central plant or an individual system. High generation of smoke and odors in such spaces demands ample supplies of outdoor air. Due to internal heat gain from occupants, these public areas may require cooling even during the heating season.

Some very large facilities (over 500 rooms), and smaller luxury properties featuring several pools, restaurants and a large laundry load, have opted to use a larger steam boiler with absorption cooling. The thermal loads in these facilities support this arrangement well.

Dehumidification

Approximately 25% of national lodging floor space is served by dehumidification equipment, most of which is electric. Decision makers responsible for about one-third of centrally managed chain floor space report using natural gas-fired desiccant equipment. Humidity control in guestrooms and common areas is critical in preventing or slowing mildewing of wallpaper, bedding and carpeting, and areas such as fitness clubs and swimming pools require special treatment.

Conventional indoor pool ventilation systems feature removal of high humidity indoor air and introduction of lower humidity outdoor air. This outdoor air must be heated or cooled before being introduced into the space. However, pool dehumidifier systems commonly used today cool air to remove moisture and then reheat it before it is distributed to the pool area. Some of the heat is directed to maintaining the pool temperature. Remote air-cooled condensers are required to maintain full dehumidification when excess heat is generated in this process.[23]

Water Heating

Conventional gas or electric water heaters are most common, with hot water stored in insulated tanks until needed. Multi-boiler arrangements are present in some larger properties. Large tanks with the electric heater element programmed for off-peak operation may also be used. Central distribution systems with storage and constant recirculation are typical among hotels to ensure the continuous availability of hot water from fixtures.

Cooking and Baking

About 25% of all lodging buildings and over 50% of all lodging by floor space features cooking and baking equipment. Among chains, most is natural-gas fueled. These full-service

establishments may feature a central kitchen, one or more dining rooms, cafes and restaurants that provide sit-down, carry out and room service meals. In smaller properties, these may be branches of an established restaurant or part of a branded concept, and feature restaurant-grade equipment. The kitchen and restaurants found in larger hotels are likely to employ heavy grade/hotel-duty equipment.

Backup Power

Many larger properties have diesel generator sets to provide emergency back-up power in case of electric grid outages, and some use uninterruptible power supply (UPS) systems to supply computers and facility control systems (emergency exits, fire, alarms) in outage situations. Energy managers have indicated that a back-up unit that could operate as a peak-shaving unit as well would be attractive.

Maintenance and Repair

In the 1998 industry survey, decision makers responsible for over 90% of centrally managed chain floor space reported relying on in-house personnel for energy equipment maintenance and repair, while over three-quarters reported using outside contractors, over 10% relied on utilities, and 2% used energy services companies (multiple sources apply). Thus, most chains use a combination of in-house and contractor services. In terms of CHP systems, in-house equipment maintenance staff often may not have the level of training or the background necessary to be able to understand, operate and maintain such systems.[24]

4.2.3 Electric, Thermal and Dehumidification Loads

Electric Loads

The major electric loads of lodging facilities include HVAC, laundries, elevators, and foodservice operations.

Thermal Loads

Domestic hot water supplies guest bathrooms, kitchens, general cleaning functions, laundry rooms, and fitness facilities. Guest room shower use typically creates a one- to two-hour period of peak demand for hot water in the early morning, with use dropping off sharply afterward.

Dehumidification Loads

In addition to influencing guest comfort, humidity plays a critical role in mildewing of furniture and fixtures in guest rooms. In warm and humid climates such as Florida, the average frequency of renovation due to such mildewing has been estimated at seven years. Attempts to control humidity in ballrooms and meeting rooms by lowering the temperature result in spaces that are over-cooled, with uncomfortable occupants.

Pools and fitness clubs have special dehumidification needs. In indoor pool areas, humidity levels that are too low chill wet patrons and lead to pool water evaporation and higher pool heating needs. Levels that are too high increase corrosion, condensation problems and user

discomfort. Fitness facilities require relatively low humidity levels and low temperatures to accommodate varying levels of activities throughout open hours. Ventilation requirements are substantial to dilute odors and replenish oxygen.

Electric and Gas Load Curves

The figures in Appendix 4-D present typical electric and gas load curves for a representative 180,000 ft^2 hotel and a representative 10,000 ft^2 motel, each located in two opposite types of climates, the Southwest and the Northeast (New England). Table 4-10 on the following page presents key energy consumption figures for these representative facilities.

TABLE 4-10
ELECTRIC AND GAS ENERGY LOADS FOR REPRESENTATIVE HOTEL AND MOTEL -- SOUTHWEST AND NEW ENGLAND

180,000 ft^2 Hotel		
Southwest		
Electricity Use	2,718,100	kWh/year
Peak Load	635.9	kW
Load Factor	48.8%	
Minimum Daily Gas Use	6,737	kBtu/Day
Maximum Daily Gas Use	3,220	kBtu/Day
New England		
Electricity Use	1,981,400	kWh/year
Peak Load	654.4	kW
Load Factor	34.6%	
Minimum Daily Gas Use	9,211	kBtu/Day
Maximum Daily Gas Use	8,440	kBtu/Day
10,000 ft^2 Motel		
Southwest		
Electricity Use	94,010	kWh/year
Peak Load	65.6	kW
Load Factor	16.4	
Minimum Daily Gas Use	91	kBtu/Day
Maximum Daily Gas Use	40.8	kBtu/Day
New England		
Electricity Use	105,250	kWh/year
Peak Load	106.7	kW
Load Factor	11.3%	
Minimum Daily Gas Use	126	kBtu/Day
Maximum Daily Gas Use	55.6	kBtu/Day

Source: EEA; Energy Design Resources, eQuest2002 Database;
Regional Economic Research, Inc., *eShapes, 2001 National Database*.

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APPENDIX 4-A: TOP 25 HOTEL/MOTEL COMPANIES

Rank	Name	No. of Rooms	Domestic Properties	% of Total U.S. Rooms	Cum % Rooms	% of Total U.S. Props
1	Cendant Corporation	506,830	6,083	12.4%	12.4%	11.4%
2	Hilton Hotels Corporation	333,433	1,981	8.1%	20.5%	3.7%
3	Marriott International	332,114	1,945	8.1%	28.6%	3.6%
4	Six Continents Hotels	321,524	2,386	7.8%	36.4%	4.5%
5	Choice Hotels International	303,115	3,735	7.4%	43.8%	7.0%
6	Best Western International	184,658	2,120	4.5%	48.3%	4.0%
7	Accor	136,730	1,231	3.3%	51.7%	2.3%
8	Starwood Hotels & Resorts Worldwide, Inc.	128,167	383	3.1%	54.8%	0.7%
9	Carlson Companies, Inc.	77,082	499	1.9%	56.7%	0.9%
10	Hyatt Hotels Corp	55,409	111	1.4%	58.0%	0.2%
11	FelCor Lodging Trust	46,961	177	1.1%	59.2%	0.3%
12	MeriStar Hotels & Resorts	46,758	229	1.1%	60.3%	0.4%
13	U.S. Franchise Systems, Inc.	41,252	501	1.0%	61.3%	0.9%
14	LaQuinta Inns, Inc.	39,280	303	1.0%	62.3%	0.6%
15	Wyndham International, Inc.	35,514	151	0.9%	63.1%	0.3%
16	Oakwood Worldwide	33,033	92	0.8%	63.9%	0.2%
17	Prime Hospitality Corp.	32,041	242	0.8%	64.7%	0.5%
18	Hospitality Properties Trust	31,486	230	0.8%	65.5%	0.4%
19	Interstate Hotels	29,823	146	0.7%	66.2%	0.3%
20	Mandalay Resort Group	27,303	16	0.7%	66.9%	0.0%
21	MeriStar Hospitality Corp.	26,404	99	0.6%	67.5%	0.2%
22	Tharaldson Lodging Corp.	24,239	349	0.6%	68.1%	0.7%
23	Marcus Corp.	23,335	219	0.6%	68.7%	0.4%
24	Walt Disney World Resorts	22,961	18	0.6%	69.3%	0.0%
25	Choice Hotels Canada, Inc.	19,913	232	0.5%	69.7%	0.4%

Source: EEA; American Hotel & Lodging Association.

APPENDIX 4-B: TOP TEN HOTEL/MOTEL COMPANIES' BRANDS

1. **Cendant Corp.**
   - Days Inn Worldwide
   - Super 8 Motels
   - Ramada Franchise Systems
   - Howard Johnson International
   - Travelodge Hotels
   - Knights Franchise System
   - Village Franchise Systems
   - Wingate Inns
   - AmeriHost Franchise Systems, Inc.

2. **Hilton Hotels Corp.**
   - Hampton Inns
   - Hilton Hotels
   - Doubletree Guest Suites & Hotels
   - Embassy Suites
   - Hilton Garden Inns
   - Homewood Suites by Hilton
   - Red Lion Hotels & Inns
   - Harrison Conference Centers

3. **Marriott International**
   - Marriott Hotels, Resorts & Suites/ Ritz Carlton
   - Courtyard by Marriott
   - Fairfield Inns by Marriott
   - Residence Inn by Marriott
   - Renaissance Hotels and Resorts/ Ramada Intl.
   - TownePlace Suites by Marriott
   - Spring Hill Suites by Marriott
   - Marriott Conference Centers

4. **Six Continents Hotels**
   - Holiday Inn
   - Holiday Inn Express
   - Crowne Plaza
   - Inter-Continental Hotels & Resorts
   - Holiday Inn Select
   - Holiday Inn Garden Court
   - Holiday Inn Sunspree Resort
   - Forum Hotels & Resorts
   - Staybridge Suites by Holiday Inn

5. **Choice Hotels International**
   - Comfort Inns, Suites
   - Quality Inns, Suites & Hotels
   - Sleep Inns, Clarion Inns
   - Econolodge
   - Flag Hotels, Suites & Inns
   - Rodeway Inns
   - MainStay Suites
   - Friendship Inns

6. **Best Western International**
   - Best Western

7. **Accor**
   - Motel 6
   - Novotel
   - Red Roof Inns
   - Mercure Hotels
   - Sofitel
   - Accor North America

8. **Starwood Hotels & Resorts Worldwide, Inc.**
   - Sheraton Hotels, Inns & Resorts
   - Westin Hotels & Resorts
   - Four Points Hotels
   - St. Regis/Luxury Collection
   - W Hotels

9. **Carlson Companies, Inc.**
   - Radisson Hotels Worldwide
   - Country Inns & Suites by Carlson

10. **Hyatt Hotels Corp.**
    - Hyatt

Source: Company websites.

APPENDIX 4-C: GEOGRAPHICAL DISTRIBUTION OF HOTELS AND MOTELS WITH DAILY ELECTRIC DEMAND >= 10 KW

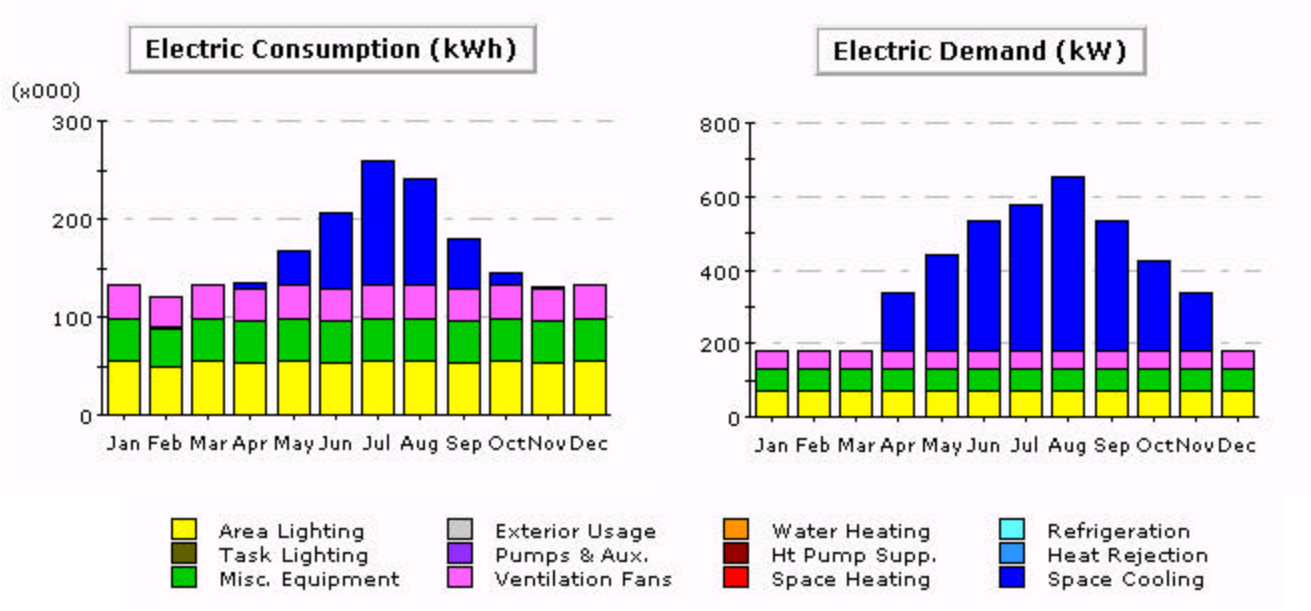
State	No. of Hotels/Motels	% Total	Cumulative % of Total
California	4,210	11.7	11.7
Florida	2,886	8.0	19.7
Texas	2,463	6.9	26.6
New York	1,435	4.0	30.6
Georgia	1,322	3.7	34.3
North Carolina	1,200	3.3	37.6
Tennessee	1,084	3.0	40.6
Illinois	1,073	3.0	43.6
Virginia	1,060	3.0	46.6
Ohio	1,043	2.9	49.5
Pennsylvania	1,038	2.9	52.4
Michigan	939	2.6	55.0
South Carolina	822	2.3	57.3
Missouri	821	2.3	59.6
Washington	806	2.2	61.8
New Jersey	777	2.2	64.0
Colorado	755	2.1	66.1
Arizona	748	2.1	68.2
Wisconsin	698	1.9	70.1
Oregon	664	1.9	72.0
Indiana	615	1.7	73.7
Minnesota	607	1.7	75.4
Alabama	576	1.6	77.0
Massachusetts	567	1.6	78.6
Louisiana	567	1.6	80.2
Kentucky	506	1.4	81.6
Maryland	474	1.3	82.9
Nevada	454	1.3	84.2
Mississippi	452	1.3	85.5
New Mexico	436	1.2	86.7
Oklahoma	416	1.2	87.9
Iowa	407	1.1	89.0
Arkansas	383	1.1	90.1
Utah	360	1.0	91.1
Montana	356	1.0	92.1
Kansas	343	1.0	93.1
South Dakota	283	0.8	93.9
Connecticut	281	0.8	94.7
Maine	256	0.7	95.4
Nebraska	246	0.7	96.1
West Virginia	223	0.6	96.7
Idaho	196	0.5	97.2
Wyoming	191	0.5	97.7
Vermont	177	0.5	98.2
New Hampshire	168	0.5	98.7
Washington, D.C.	154	0.4	99.1
North Dakota	143	0.4	99.5
Delaware	104	0.3	99.8
Rhode Island	86	0.2	100.0
Total	35,871	100.0	

Source: Dun & Bradstreet Sales and Marketing Solutions, *MarketPlace Jul-Sep 2002*; EEA.

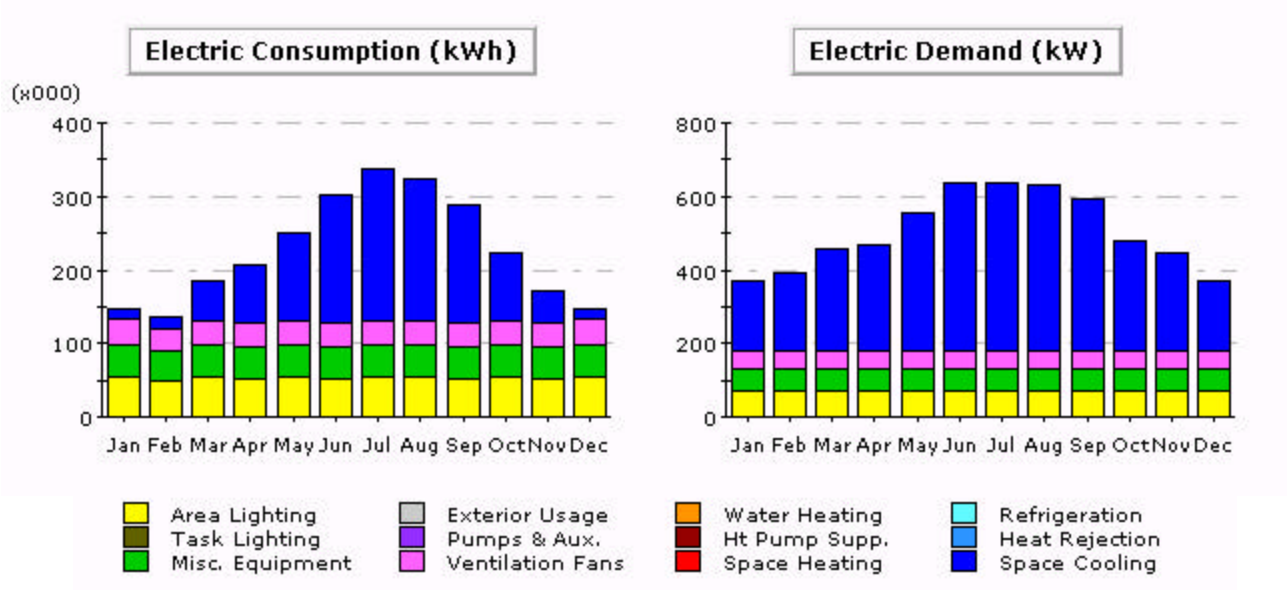
APPENDIX 4-D: TYPICAL HOTEL/MOTEL ELECTRIC AND GAS LOAD CURVES

FIGURE 4D-1
ELECTRIC CONSUMPTION AND DEMAND FOR 180,000 FT^2 HOTEL

Representative Northeast (Hartford, CT) Hotel



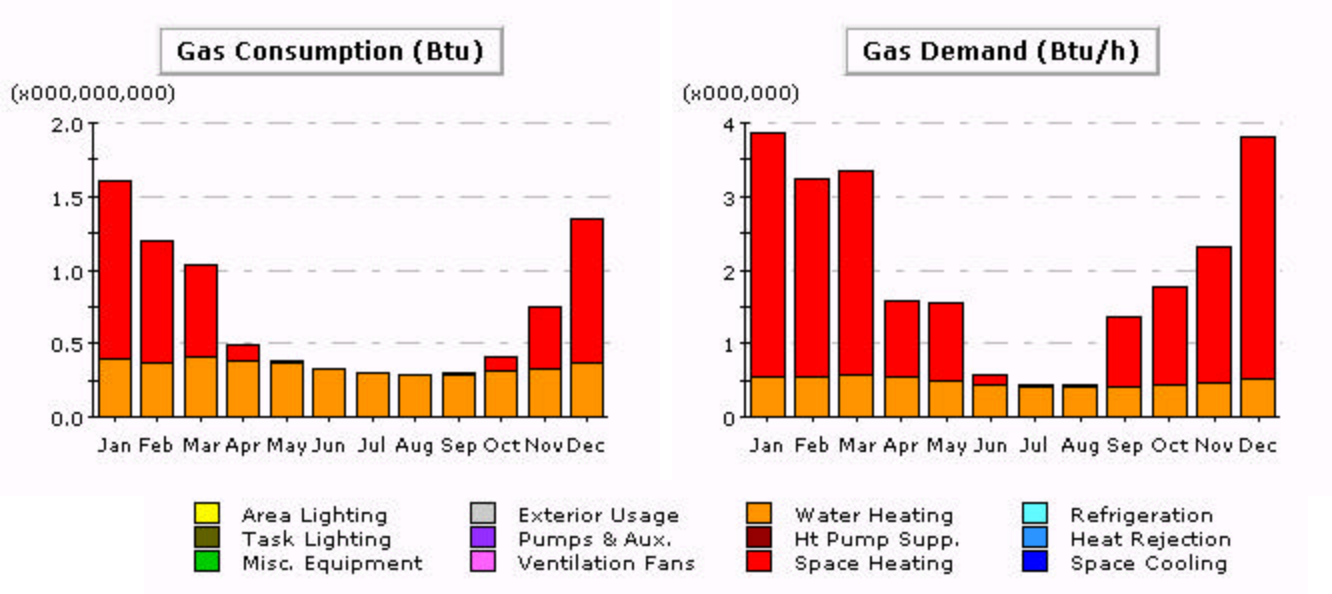
Representative Southwest (Phoenix, AZ) Hotel



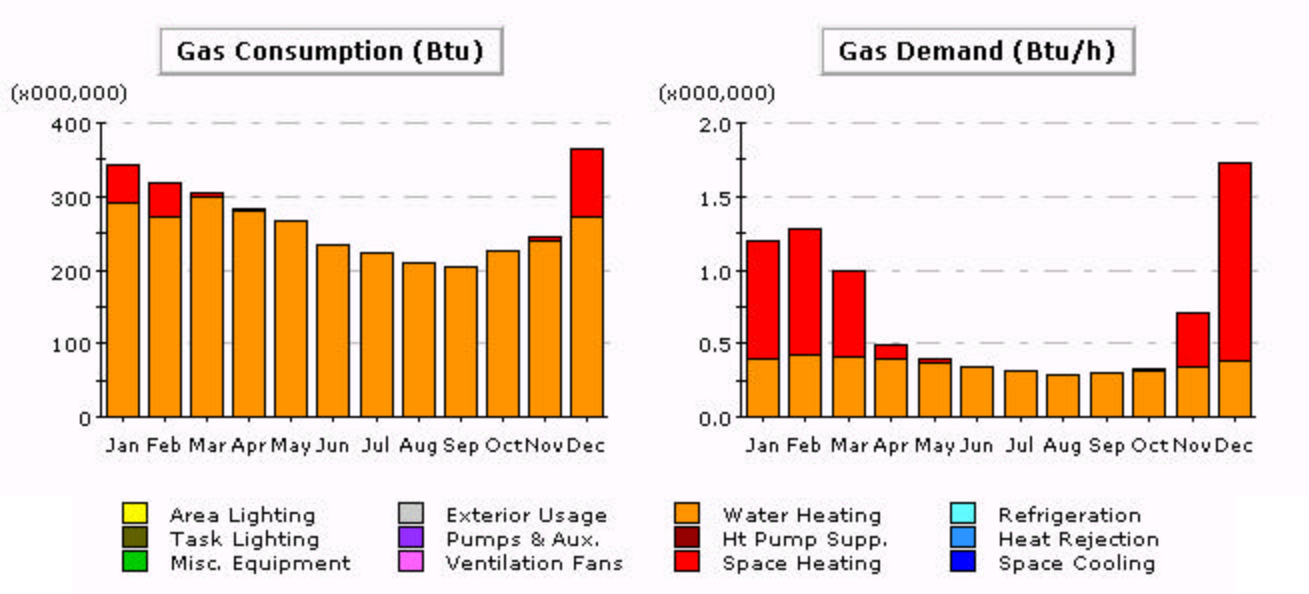
Source: EEA; Energy Design Resources, eQuest2002 Database; Regional Economic Research, Inc., *eShapes, 2001 National Database.*

FIGURE 4D-2
GAS CONSUMPTION AND DEMAND FOR 180,000 FT^2 HOTEL

Representative Northeast (Hartford, CT) Hotel



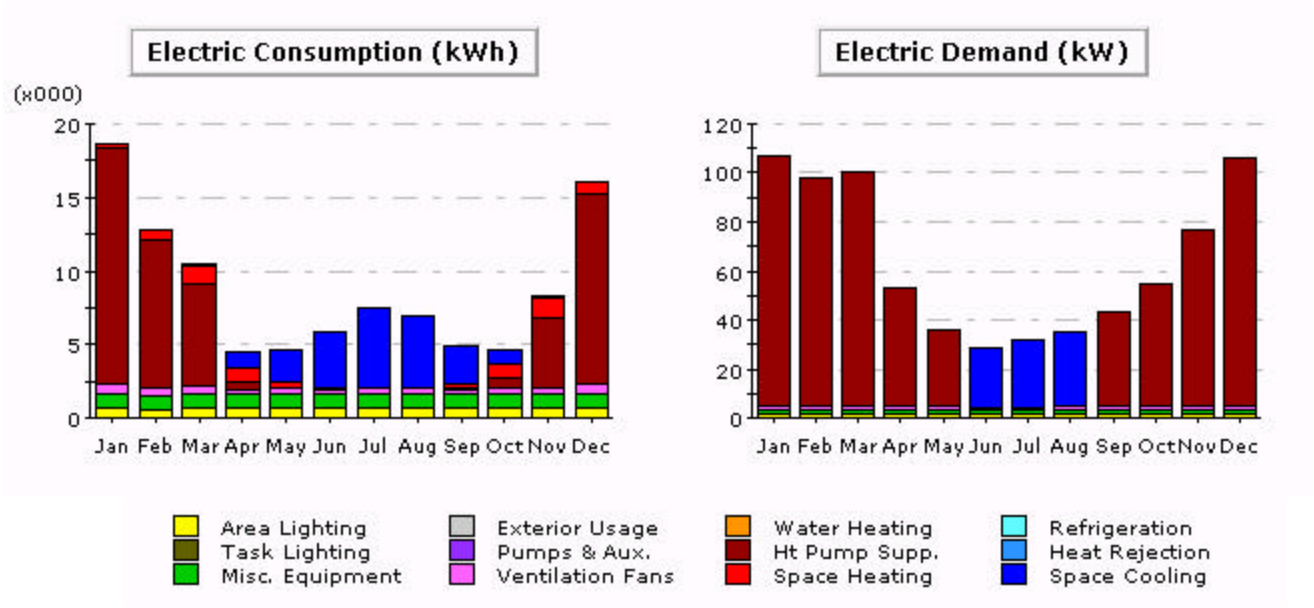
Representative Southwest (Phoenix, AZ) Hotel



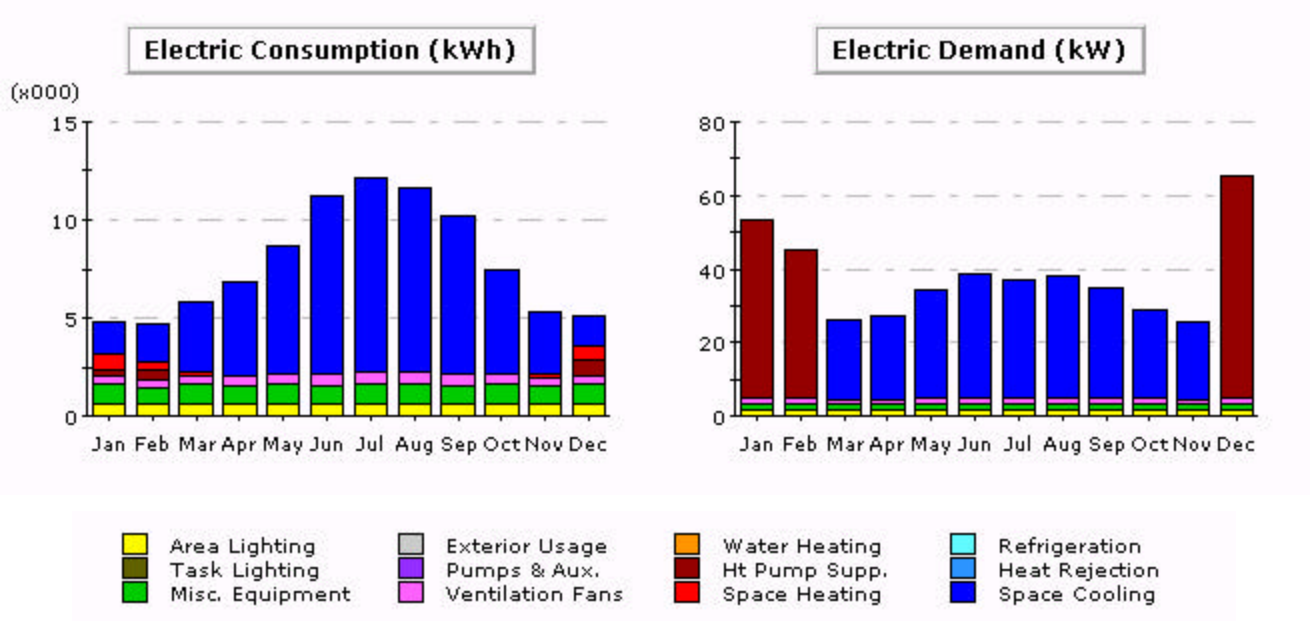
Source: EEA; Energy Design Resources, eQuest2002 Database; Regional Economic Research, Inc., *eShapes, 2001 National Database.*

FIGURE 4D-3
ELECTRIC CONSUMPTION AND DEMAND FOR 10,000 FT^2 MOTEL

Representative Northeast (Hartford, CT) Motel



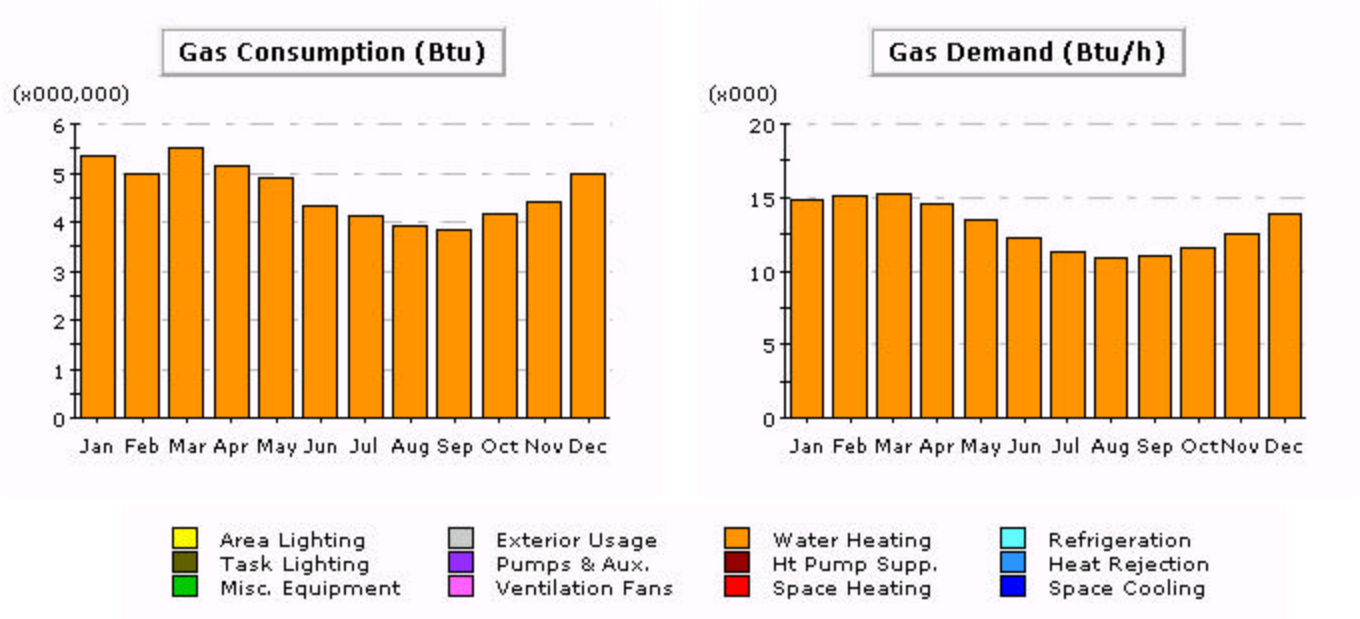
Representative Southwest (Phoenix, AZ) Motel



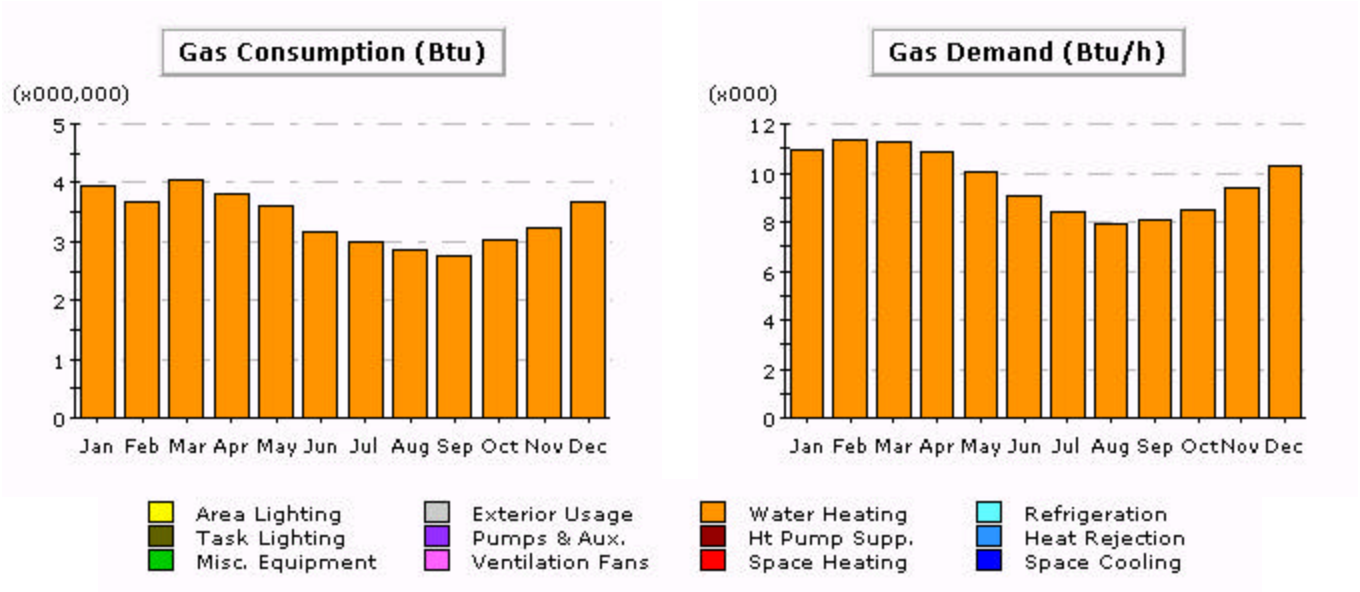
Source: EEA; Energy Design Resources, eQuest2002 Database; Regional Economic Research, Inc., *eShapes, 2001 National Database*

FIGURE 4D-4
GAS CONSUMPTION AND DEMAND FOR 10,000 FT^2 MOTEL

Representative Northeast (Hartford, CT) Motel



Representative Southwest (Phoenix, AZ) Motel



Source: EEA; Energy Design Resources, eQuest2002 Database; Regional Economic Research, Inc., *eShapes, 2001 National Database.*

5. RESTAURANT SECTOR PROFILE

5.1 INDUSTRY OVERVIEW

5.1.1 Structure

The restaurant industry is the nation's largest private-sector employer: its 11.6 million employees represent 9% of all U.S. workers.[1] Sales in 2002 are anticipated to reach a record $407.8 billion ($1.1 billion daily), a real growth rate of 1.4% over the 2001 level of $392.5 billion. There are an estimated 858,000 foodservice locations in the U.S., including commercial, institutional and military units. The commercial category includes eating places (restaurants), drinking places (bars and nightclubs), managed services (food service contractors), hotel/motel restaurants and a multitude of stand-alone kiosks, street vendor stands and other very small units. Commercial establishments accounted for over 90% of 2001 industry sales.[2]

Table 5-1 below shows 2002 projected industry sales by category.

TABLE 5-1
2002 RESTAURANT INDUSTRY SALES PROJECTIONS

Category	Sales ($ Billions)
Commercial	$372
Eating Places	$283
Drinking Places	$ 13
Managed Services	$ 27
Hotel/Motel Restaurants	$ 18
Retail Vending, Recreation, Mobile	$ 32
Other	$ 35
Total	$408

Source: National Restaurant Association.

Restaurants are classified into full service (sit-down) and limited service (fast food) segments. Full service categories are dinner houses (typically don't serve breakfast; 60% serve alcohol), family restaurants (open for breakfast; many do not serve alcohol) and grill/buffet restaurants, while fast food is generally subdivided into sandwich, pizza and chicken stores.[3] Full service restaurants generated about 40% of 2001 commercial restaurant sales while quick service accounted for over 30%.[4]

- More than eight out of ten full service restaurants are independent, single-unit establishments.[5] While chains of ten or more establishments account for only 10% of all full service restaurants, they represent about 28% of sales. According to the most recent U.S. Census Bureau figures, the 50 largest full service chains, at 7% of total units, accounted for 20% of sales; the top four chains, 7%.

- In 2001, there were about 222,000 quick service restaurant locations with sales totaling more than $125 billion.[6] Many of these locations are branded chain units operated by a franchisee or parent company. Franchisees pay the chain franchiser a percentage of sales revenue, and receive in return use of the brand and some amount of support for local activities such as advertising, training, operating guidelines, recruitment and other types of assistance. Franchisees typically bear the burden of acquiring land, buildings, equipment and systems, although some of the largest chains hold ownership of land and buildings.[7] In a 2000 study, over two-thirds of quick service store operators leased both land and building while one-third owned both.[8]

As shown in Table 5-2 below, the industry is fragmented, showing little concentration when viewed by foodservice sales of individual brands.

TABLE 5-2
RESTAURANT INDUSTRY CONCENTRATION BY FOODSERVICE SALES IN 2001[9,10]

Segment	2001 Foodservice Sales ($ millions)	% of Industry Foodservice Sales	No. of Stores/Units
Top chain (McDonald's)	$ 20,051.0	5.1%	13,099
Top 25	95,434.1	24.3%	97,902
Top 50	121,342.9	55.2%	146,151
Top 100	145,360.1	37.0%	172,772
Top 200	156,996.0	40.0%	198,471
Total Industry	392,490.0	100.0%	858,000

Source: *Nation's Restaurant News*.

Appendix 5-A lists the top 50 restaurant chains by the dollar amount of foodservice sales generated by all outlets, also noting the percentage of the chain's stores that are franchise operations. This percentage varies from zero to 100%, depending upon the particular chain's business approach.

There is somewhat more concentration when companies are ranked by size of foodservice revenues, as many companies own multiple brands. Appendix 5-B shows the top 25 corporations ranked by foodservice revenues and lists which brands or divisions of the corporation generate this revenue.

5.1.2 Trends

Short-Term

The restaurant industry is highly competitive. Growth in the industry over the past few years has been most robust in the South and West, reflecting the rapid pace of economic expansion in those regions.[11] This trend is expected to continue in the short term. Full service restaurants

anticipate 2002 sales of $146.7 billion and real growth of 2.0%. Limited service (fast food) restaurants project 2002 sales of $115.2 billion and real growth of 1.3% over 2001.

The fastest-growing concept currently is the "quick casual" operation, which offers the type of higher-quality food found in full service restaurants in a fast-food format. The current leader in sales growth is Panera Bread Co., which posted a 54% increase in sales from 2000 to 2001, about ten times the average growth rate among the top 100 restaurant chains.[12] Quizno's, another quick-casual chain, ranked 4th, with a 40% growth rate. In comparison, McDonald's and Burger King ranked 42nd and 55th respectively, with growth rates of 2.4% and 1.0%. Corporations such as McDonalds are also participating in the quick casual market: McDonald's acquired both Chipotle and Boston Market at the close of the 1990s.

Franchising has become more popular over the past several decades. Full service franchises, for example, claimed 21% of total full service sales in 1997, up from 8% in 1987.[13] Meanwhile, recruiting and retaining employees continues to be the number one concern among operators of both full and quick service restaurants. Restaurateurs are providing cross-training, increasing hours worked, and improving kitchen equipment and conditions in their efforts to find and keep workers.

Longer-Term (2010)

Restaurant additions generally follow geographic population and economic expansion patterns. According to a major industry trends survey, about 150,000 new locations are anticipated between 2000 and 2010, bringing the number of foodservice sites to over one million by 2010. Projections of population growth point to California and Texas as the leading growth states, with the populations of Alaska, Arizona, Idaho, Nevada and Utah each anticipated to balloon by 30 to 40% between 1995 and 2010. [14]

By 2010, consumers are projected to spend 53% of their food dollar away from home. However, with competition anticipated to become ever more intense, restaurateurs expect to focus on enhancing food quality and service levels, for both in-house and takeout food. Projections call for takeout and delivery sales to increase at a faster rate than on-premise dining, as consumer demand for convenience escalates. Chains are projected to assume a steadily increasing share of sales and to further diversify their offerings through the use of multiple concepts. Also, due to increasingly expensive and scarce prime locations, the industry will likely look to incorporate multiple brands in one location more frequently.

Chain restaurateurs plan to continue centralization of accounting, purchasing and R&D, with marketing and other functions becoming more decentralized. They also foresee the need to increase their per-seat investment, as meeting sophisticated new food safety regulations will require high-tech equipment. Labor costs are widely projected to escalate significantly due to competition for workers, with wages, benefits and training expenses all rising.

In terms of design, chains are expected to offer a greater variety of standard design plans to satisfy local market needs, and will focus on flexibility so concepts can be changed rapidly and dual/multiple concepts accommodated. Smaller pad sites will be more common to accommodate

more takeout concepts. Safety and risk management concerns are expected to figure more prominently in future restaurant design. Steam cleaning is expected to predominate over chemical cleaning.

Finally, restaurateurs foresee significant incorporation of higher technology into the industry. This technology will serve to help control costs, increase efficiency and employee productivity, enhance communications, and monitor and enhance food safety.

5.1.3 Financial Situation

Costs of food and beverage sold constitute the largest items in restaurant operating budgets, followed closely by labor, as shown in Table 5-3 below. [15] Pre-tax income stood at 4% and 7% for full service and limited service companies respectively in 2001.

TABLE 5-3
MAJOR RESTAURANT BUDGET ITEMS

	Percent of Total Sales[11]	
Budget Item	**Full service**	**Limited Service**
Cost of food and beverages sold	36%	35%
Labor (salaries, wages & benefits)	35%	31%

Source: National Restaurant Association.

Centrally managed chain restaurant companies nationally own about 70% of their floor space and lease about 30%.[16]

5.1.4 Energy Situation

Almost all restaurants are responsible for paying their own utility bills, regardless of whether they own or lease the space they occupy.[17] On average, centrally managed chains report devoting 6% of their total operating budget to energy expenditures, less than half the percentage reported by other types of foodservice establishments.

Consumption

According to the most recent data available from DOE, foodservice buildings are the most energy-intensive of all commercial buildings, averaging consumption of close to 250,000 Btu per square foot.[18] Electricity consumption alone falls in the 50-120 kWh/ft^2 range.[19] Fast food restaurants are especially intense users, often exceeding 140 kWh/ft2/year.[20] Estimates of energy consumption attribute 50% of an average restaurant's energy use to the preparation and storage of food.[21]

5.1.5 Growth and Renewal

The restaurant industry in quite dynamic: chain restaurant companies continually remodel, re-brand, and add new stores. A majority of respondents to a 2000 survey, for example, reported

that they had remodeled their dining area in the past 5 years.[22] One major family restaurant chain with whom we spoke completely replaces stores every ten to 20 years, rebuilds (i.e., completes "back of the house" improvements) in two to three percent of stores annually, completes a myriad of cosmetic improvements, and is adding new stores at the rate of 30 to 35 each year.

Expenditures on design and décor reflect an increasing emphasis on physical surroundings, with investment by full service restaurant operators to create a particular setting ranging from $100,000 to $400,000, or $1,000 - $3,000 per seat, on average.[23] At the same time, investment in kitchen equipment and systems for a full service restaurant averages $150,000 to $250,000, with capital investment in buildings in the $500,000 - $1 million range.

New restaurant units are projected to open at the rate of over 40 a day for the next ten years.

5.1.6 Energy Equipment Decision Making

Typical Characteristics

The 1998 study of decision makers responsible for over 41,000 chain restaurants nationwide found that while decisions for over half the total floor space represented are made at the corporate headquarters level, about 25% divide responsibilities between national headquarters and individual locations, as shown in Table 5-4. The same group of decision makers is usually responsible for all equipment decisions, especially at the individual location level. A notable exception is that different decision makers are often involved in centrally managed chains when cooking and baking equipment is the topic.

Among centrally managed chains, the group or individual with the most important role is either the facility management or senior management department. About three-quarters of centralized chains at the time of the study had established equipment selection guidelines, with operating cost, first cost and preferred vendor products most often cited as key criteria. Restaurant chain decision makers most often reported relying on manufacturer representatives, trade shows and past experience to obtain information about energy equipment and systems.

Insights

A survey conducted in 2002 among national account customers revealed additional information about restaurants' priorities and outlooks on energy issues. Restaurateurs are thinking about their capabilities to manage energy demand and indoor air quality, and to remain open during grid failure conditions so that guests' dining experiences can be optimized.

Our conversations with industry participants provided the following in-depth look at several areas of energy equipment decision-making, as follows.

TABLE 5-4
ENERGY EQUIPMENT DECISION MAKING AMONG CHAIN RESTAURANTS

Item	Characteristic	% of Nat'l Floorspace	
Locus of decision making (national chains only)	National HQ	65%	
	Individual locations	4%	
	Regional HQ	4%	
	Responsibilities split, nat'l/indiv.	27%	
		Cen. Chain	*Ind. Chain*
Same or different decision makers by equipment type?	Same for all equipment	62%	86%
	Separate	38%	
	- For: cooking & baking	31%	
Most important decision makers	Facility management	42%	21%
	Senior management	32%	25%
	Maintenance & construction	9%	6%
	Company owner	7%	38%
Primary guidelines	Have no formal guidelines/DK	25%	53%
	Have guidelines	75%	47%
	- Lowest operating cost	38%	14%
	- Lowest purchase/installation cost	27%	14%
	- Preferred vendor	23%	19%
	- Replace w/ like equipment	14%	10%
	- Payback	9%	2%
	- Return on investment	7%	7%
Information sources	Manufacturer representatives	52%	13%
	Trade shows	46%	3%
	Past experience	45%	27%
	Trade journals	21%	4%
	Company staff	21%	23%
	Electric utilities	10%	1%
	Distributors/dealers/suppliers	4%	12%

Source: Opinion Dynamics Corp.

Structures and Processes

Decision-making differs among national accounts depending on whether stores are company-owned and operated, franchised, or a mix of the two. One company we interviewed owns and operates a number of different restaurant concepts, each of which makes its own energy equipment decisions based primarily on corporate analysis and guidance. Each concept does look to learn from the others, however, so if an energy project performs favorably in one concept, the others are "likely to adopt it."

This company used to have dedicated energy services department that resided in the design/construction division. Staff analyzed and recommended energy efficiency and conservation measures and worked with concept management to implement them. As the company focused more and more on the cost-saving opportunities presented on the commodity side by deregulation, the department was moved first to purchasing, where it took on commodity buying, and then disbanded entirely. Once the knowledgeable individuals left, "no one understood the value of energy investments. We were not successful in educating concept management about the benefits of energy investments."

Another major company with whom we spoke owns and operates all their stores under one brand. The half-dozen regional facilities managers sit on a committee that brings proposed projects to the construction division and works closely with construction staff to make equipment decisions. For foodservice equipment, they work with one manufacturer representative; for HVAC and water heating, they do business directly with the factory. In the case of remodeling projects, they assemble a budget for the coming year based on their past experience with stores, then inform manufacturers of their needs. They attempt to keep the number of manufacturers with whom they deal to a minimum.

Guidelines and Criteria

In general, industry decision-makers focus on paybacks of several years for equipment and systems. In the case of the multi-concept company we interviewed, corporate guidelines and concept management demand paybacks of less than one year. The single-chain company in some cases tolerates paybacks of up to five years for major systems. Because energy costs represent just three to four percent of the typical restaurant's operating budget, projects that impact labor costs and other higher-share budget items take priority. And, even in companies with plenty of cash on hand, the industry's almost exclusive focus on a project's impact on the profit and loss statement means that "even though there are some projects with extremely attractive cash flows after an initial two or three year payback, these will not be implemented."

Maintenance requirements influence decisions as well. In the multi-brand company, individual store managers earn bonuses that are based on bottom-line financial performance. Equipment maintenance expenses reduce the bonus base, while capital expenses do not. This arrangement, combined with the fact that no skilled in-house maintenance staff are employed, encourages only the installation of equipment that needs little if any maintenance.

In-house staff perform the routine, standard equipment maintenance for restaurants in the single-chain company, so maintenance considerations play less of a role. For anything complicated or out of the ordinary, however, the company does not perform maintenance in-house, looking instead to the manufacturer to provide field support and maintenance services. Maintenance considerations in this case are important. In fact, the company noted that one reason they stopped specifying building control systems was that the manufacturer "didn't know how to fix them."

Finally, as one manager noted, perceptions can play a key role as unofficial criteria. Paybacks may look "too good to be true." New technology such as fuel cells that receive a lot of attention from the media may be perceived as better than older technologies and thus worth a wait.

5.2 FACILITY CHARACTERISTICS

5.2.1 Buildings

According to preliminary figures from the most recent Department of Energy Commercial Building Energy Consumption Survey, there are about 349,000 buildings for which the principal activity is foodservice.[24] The 1998 industry survey found that more than 80% of chain restaurant space nationally is located in single, free-standing buildings, with most of the rest (14%) found in strip shopping centers and a small amount (4%) in office or retail complexes. The average square footage of a centrally managed chain restaurant is about 3,200 feet. Close to 90% of quick service locations occupy less than 5,000 square feet while over 75% of full service units are less than 7,500 square feet.

5.2.2 Energy Equipment

Almost all chain restaurants own their own energy equipment. However, centrally managed chains representing about 9% of all floor space report leasing a small subset of cooking or baking equipment. About one-third (37%) of centrally managed chain floor space is equipped with an energy management system. Systems typically control space heating, with some also controlling space cooling, and 20% controlling water heating. Responsibility for controlling the system usually rests with staff at the individual restaurant, although some chains have centralized control and others rely on an outside contractor.

Space Conditioning

Almost all chain restaurant floor space that is heated and cooled uses packaged rooftop units for space conditioning. Electric units supply most of the cooling, but there is a large preponderance of gas-fired units for space heating, and some use of furnaces. Restaurants that are part of a larger building may be tied in to the buildings chilled/hot water system, but due to operating hour considerations, have their own separate systems in place as well.

Water Heating

About 80% of chain restaurant floor space nationally employs standard tank-type water heating units, with 88% of this fueled by natural gas. Booster water heaters, which help bring water for

warewashing operations up to required high temperatures, are present in about one-fourth of national restaurant floor space, and are typically fueled by natural gas.

Cooking and Baking

There is a wide variety of cooking and baking equipment with specialized functions in place in virtually all of today's restaurants, operating via conduction, convection or radiation of energy. Fryers, grills and convection ovens are the most commonly found equipment in centrally managed chain restaurants, with less than half using broilers, cooktops and steamers. Natural gas fuels fryers and grills in over 75% of floor space nationally, convection ovens in over one-third of floor space, broilers in over 90% and cooktops in almost 70%, with electricity supplying steamers in 80% of restaurant floor space.

Refrigeration

Most restaurants use a combination of refrigerators and freezers of the reach-in and walk-in varieties. These may be cooled using one or more compressors, usually with air-cooled condensers. Units either stand alone or are arranged in racked banks.

Dehumidification

While conditions in customer seating and possibly kitchen areas would seem to suggest a key role for dehumidification equipment, it is scarce among restaurants. This may be due to the extreme sensitivity to up-front costs that dominates the industry: while other industries can accommodate two to three year paybacks on equipment investment, the first cost investment for non-essential, premium-laden equipment such as dehumidification systems must be recouped immediately by reductions in another area of the restaurant's construction budget.

Maintenance and Repair

Restaurant chains rely on both in-house staff and outside service contractors to perform equipment maintenance and repair: chains representing 75% of floor space nationally use contractors and those representing 48% of floor space use in-house technicians. HVAC and cooking equipment maintenance and repair would appear to be critical issues in food service and preparation. For instance, a malfunctioning HVAC system can lead to big drops in worker productivity and even to high turnover. However, budgets are reported to be inadequate for funding an appropriate level of preventive maintenance, with the result that service is typically performed only when something breaks or malfunctions.[25]

Backup Power

Like dehumidification, backup power equipment is seldom found in restaurant locations, its absence most likely attributable to the same avoidance of increased up-front equipment costs.[5,6] Noise and size of equipment also pose potential concerns. Interest in backup power appears to be primarily for locations in which grid interruptions during "prime time" are frequent enough to noticeably impact operations.

5.2.3 Electric, Thermal and Dehumidification Loads

Both full service and fast food restaurants pose significant challenges to HVAC systems: loads are quite variable and "spikey;" the presence of people and the activities of food preparation and presentation creates high sensible and latent heat gain; ventilation air requirements are high; kitchen odors must be isolated; and there are typically large influxes of outdoor air through entrances during peak hours. Large quantities of outdoor air are usually needed to replace air exhausted through kitchen equipment hoods.

Electric Loads

The breakdown of electricity use in a typical full service restaurant is shown in Table 5-5 below.

TABLE 5-5
FULL SERVICE RESTAURANT ELECTRICITY USE

Load	Average kWh per ft^2	% of Total
Air Conditioning	21.52	24.7%
Miscellaneous	21.05	24.2%
Cooking	15.57	17.9%
Refrigeration	14.59	16.7%
Indoor Lighting	8.49	9.7%
Water Heating	2.89	3.3%
Outdoor Lighting	2.68	3.1%
Space heating	0.34	0.4%
Total	87.13	100.0%

Source: Clark Energy Cooperative.

Restaurants typically use natural gas for most of the cooking and baking equipment, with a majority using natural gas for water heating as well.

Thermal Loads

Thermal loads in restaurants include space heating, water heating, and cooking and baking.

- Uses for hot water include washing dishes, employee hand washing, cleaning, food preparation and food service. Public health codes require that rinse water for clean dishes be in the 180-195ºF range to kill bacteria. Since other uses require water in the 140-150 ºF range, booster water heater units connected to the warewashing equipment are usually used to achieve the desired bacteria-killing temperature.
- The cooking and baking function, central to restaurants, employs a variety of specialized equipment for food preparation, with strong preferences for natural gas equipment among many restaurateurs driving this load. Loads depend on what type of equipment is in

place, as well as whether it is a full- or quick-service restaurant, how many meals are served, and hours of operation.

- Stores require space heating both for customer and employee comfort, with different demand in the kitchen and customer seating areas.

Dehumidification Loads

Most restaurants accomplish dehumidification simply by over-cooling air to remove excess moisture.

Electric and Gas Load Curves

Appendix 5-D presents typical load curves for both a 5,000 ft^2 full service restaurant and a 2,500 ft^2 limited service (fast food) restaurant located in two opposite types of climates, the Southwest and the Northeast (New England).

Table 5-6 below presents key energy consumption figures for these representative restaurants.

TABLE 5-6
ELECTRIC AND GAS ENERGY LOADS REPRESENTATIVE
LIMITED SERVICE AND FULL SERVICE RESTAURANTS

	Limited Service Restaurant		**Full Service Restaurant**	
Representative Store with Natural Gas	**NE**	**SW**	**NE**	**SW**
Building Size (sq. ft.)	1,950	1,950	4,250	4,250
Electricity Use (kWh/yr)	70,708	80,434	112,284	127,269
Peak Load (kW)	12.8	13.1	23.4	24.7
Load Factor (%)	63.1%	70.3%	54.8%	58.8%
Annual Gas Use (MMBtu/yr)	403	667	1,086	809
Minimum Daily Gas Use (kBtu/day)*	1,800	1,800	2,018	2,016
Maximum Daily Gas Use (kBtu/day)	3,137	2,002	5,712	3,006
Representative All-Electric Store				
Electricity Use (kWh/yr)	233,540	229,153	332,329	293,601
Peak Load (kW)	46	37	72	51
Load Factor (%)	58.1%	69.9%	52.4%	65.6%

* excluding Thanksgiving day and Christmas day when store is assumed closed.
Source: EEA; Regional Economic Research, Inc., *eShapes 2001 National Database*.

GLOSSARY

Restaurant Industry – Encompasses all meals and snacks prepared outside the home.

Eating and Drinking Places – This category covers full and limited service restaurants, commercial cafeterias, ice cream, frozen custard and yogurt stands; social caterers; and bars and taverns. The U.S. Census Bureau includes contractors providing restaurant service in this category, while the National Restaurant Association does not. The NRA dollar sales estimates in this category only include establishments with payroll.

Full Service (Sit-Down) Restaurants – Establishments engaged in serving prepared food and beverages. These establishments provide waiter/waitress service while the patron is seated. The patron pays after consuming the meal. These establishments often serve alcoholic beverages. Establishments at which the sale of alcoholic beverages for consumption on the premises exceed sales of food and nonalcoholic beverages are classified as drinking places.

Limited Service (Fast Food) Restaurants – Establishments selling limited lines of refreshments and prepared food for consumption either on or near the premises, or for take home consumption. The patron pays before consuming the meal. Such establishments do not provide waiter/waitress service where the patron's order is taken while the patron is seated at a table, booth or counter. Generally, patrons pick up their orders at a counter or drive-thru window.

Managed Restaurant Services (Contract) – Operate for-profit restaurant services under contract for others in such facilities as manufacturing and industrial plants, commercial and office buildings, hospitals and nursing homes, colleges and universities, primary and secondary schools, airlines, and recreation and sports centers. The contracting company, institution, etc., may provide the facilities and personnel for these establishments, but the management must always be supplied by the contractor.

Source: National Restaurant Educational Foundation, *Industry Definitions. www.nrael.org*: July 31, 2002.

NOTES

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NOTES (Continued)

22. *Restaurant Industry Operations Report 2001*.

23. Ibid.

24. U.S. Energy Information Administration, Department of Energy, *Commercial Buildings Energy Consumption Survey 1999* (preliminary data). *www.eia.doe.gov/emeu/cbecs*: July 2002.

25. Energystics, Inc.

APPENDIX 5-A: TOP 50 RESTAURANT CHAINS
RANKED BY FOODSERVICE SALES

Rank	Chain	2001 Foodservice Sales	No. of Stores/ Units	% of Total Foodservice Sales	Cum. %	% of Units Fran-chised
1	McDonalds	$20,051.0	13,099	5.1%	5.1%	85%
2	Burger King	8,823.0	8,248	2.2%	7.4%	93%
3	Wendy's	6,241.0	5,315	1.6%	8.9%	79%
4	Pizza Hut	5,000.0	7,719	1.3%	10.2%	77%
5	Taco Bell	4,900.0	6,444	1.2%	11.5%	80%
6	KFC	4,700.0	5,399	1.2%	12.7%	76%
7	Aramark Global Food	4,509.0	3,172	1.1%	13.8%	0%
8	Subway	4,480.0	13,247	1.1%	15.0%	100%
9	Applebee's	2,870.0	1,354	0.7%	15.7%	77%
10	Domino's Pizza	2,816.7	4,813	0.7%	16.4%	89%
11	Arby's	2,564.9	3,198	0.7%	17.1%	100%
12	Dunkin Donuts	2,500.0	3,500	0.6%	17.7%	100%
13	Starbucks	2,415.0	3,515	0.6%	18.3%	23%
14	Red Lobster	2,285.0	636	0.6%	18.9%	0%
15	Denny's	2,227.5	1,677	0.6%	19.5%	64%
16	Dairy Queen	2,210.0	4,957	0.6%	20.0%	99%
17	Outback Steakhouse	2,156.0	667	0.5%	20.6%	17%
18	Jack in the Box	2,121.0	1,762	0.5%	21.1%	19%
19	Hardee's	2,004.4	2,390	0.5%	21.6%	69%
20	Chili's Grill & Bar	2,000.0	742	0.5%	22.1%	15%
21	Sonic Drive-In	1,971.0	2,358	0.5%	22.6%	83%
22	Olive Garden	1,835.0	490	0.5%	23.1%	0%
23	Papa John's Pizza	1,747.0	2,589	0.4%	23.5%	77%
24	T.G.I. Friday's	1,678.2	512	0.4%	24.0%	53%
25	LSG Sky Chefs	1,328.4	99	0.3%	24.3%	0%

APPENDIX 5-A (Continued)

Rank	Chain	2001 Foodservice Sales	No. of Stores/ Units	% of Total Foodservice Sales	Cum. %	% of Units Fran-chised
26	Cracker Barrel Old Country Stores	1,324.9	437	0.3%	24.7%	0%
27	Intl House of Pancakes/IHOP Rstrnts.	1,322.0	1,006	0.3%	25.0%	93%
28	Sodexho Corporate Services	1,299.7	1,925	0.3%	25.3%	0%
29	Sodexho Healthcare Services	1,272.4	1,575	0.3%	25.6%	0%
30	Chick-fil-A	1,241.9	1,014	0.3%	26.0%	17%
31	7-Eleven	1,223.0	5,330	0.3%	26.3%	69%
32	Canteen Services	1,221.1	22,000	0.3%	26.6%	0%
33	Popeyes	1,179.3	1,327	0.3%	26.9%	93%
34	Sodexho Education Services	1,164.2	920	0.3%	27.2%	0%
35	Ruby Tuesday	1,135.0	583	0.3%	27.5%	32%
36	Little Caesars Pizza	1,110.5	3,220	0.3%	27.8%	81%
37	Carl's Jr.	1,103.1	969	0.3%	28.0%	54%
38	Marriott Hotels, Resorts & Suites	1,087.4	279	0.3%	28.3%	38%
39	Eurest Dining Services	1,054.7	1,500	0.3%	28.6%	0%
40	Golden Corral	1,029.8	465	0.3%	28.8%	74%
41	Hilton Hotels	973.0	230	0.2%	29.1%	74%
42	Sheraton Hotels	935.5	232	0.2%	29.3%	80%
43	Gate Gourmet	927.4	57	0.2%	29.6%	0%
44	Bob Evans Restaurants	845.0	486	0.2%	29.8%	0%
45	Perkins Restaurant and Bakery	802.3	482	0.2%	30.0%	68%
46	Ryan's Family Steakhouse	785.0	335	0.2%	30.2%	7%
47	Long John Silver's	735.0	1,225	0.2%	30.4%	39%
48	Church's Chicken	721.1	1,242	0.2%	30.6%	68%
49	Disney Theme Parks, Hotels & Resorts	708.5	23	0.2%	30.7%	0%
50	Waffle House	707.0	1,387	0.2%	30.9%	53%
	Top 25	95,434.1	97,902	24.3%		
	Top 50	121,342.9	146,151	55.2%		
	Top 100	145,360.1	172,772	37.0%		
	Top 200	156,996.0	198,471	40.0%		
	All Foodservice	392,490.0	858,000	100.0%		

Source: Nation's Restaurant News, *Top 100 Report – 29th Edition*. June 24, 2002.

APPENDIX 5-B: TOP 25 RESTAURANT COMPANIES RANKED BY FOODSERVICE REVENUES

Rank	Company	Brands/Divisions
1	McDonald's Corp.	McDonald's, Chipotle, Donatos Pizza, Boston Market, Pret a Manger
2	Yum! Brands Inc.	Pizza Hut, Taco Bell, KFC
3	Aramark Corp.	Aramark Global Food Services, Aramark Leisure Services
4	Darden Restaurants Inc.	Red Lobster, Olive Garden, Bahama Breeze, Smokey Bones BBQ & Sports Bar
5	Sodexho	Corporate, Healthcare, Education, School, The Wood Co.
6	Compass Group PLC	Eurest, Canteen, Flik Int., Chartwells, Restaurant Assoc., Morrison
7	Brinker International Inc.	Chili's, On The Border, Maggiano's Little Italy, Romano's Macaroni Grill, Corner Bakery
8	Outback Steakhouses Inc.	Outback Steakhouse, Carrabba's Italian Grill, Roy's, Fleming's, Zazarac, Bonefish Grill
9	Starbucks Corp.	Starbucks
10	Jack in the Box Inc.	Jack in the Box
11	Marriott International Inc.	Marriott, Ritz-Carlton, Renaissance, Ramada Hotels
12	Wendy's International Inc.	Wendy's, Tim Hortons
13	CBRL Group Inc.	Cracker Barrel Old Country Store, Logan's Roadhouse
14	Advantica Restaurant Group Inc.	Denny's, Cocos, Carrow's
15	Lufthansa AG	LSG/Sky Chefs
16	Autogrill SpA	HMSHost Corp. (Burger King, Taco Bell, Cinnabon, Starbucks, Chili's 2, …)
17	Chick-fil-A Inc.	Chick-fil-A
18	CKE Restaurants Inc.	Hardee's, Carl's Jr./Green Burrito
19	Host Marriott Corp.	Marriott, Ritz-Carlton, Hyatt, Swissotel, Four Seasons
20	Carlson Cos. Inc.	TGI Friday's, Radisson Hotels, Italianni's, Friday's American Bar, Front Row Sports Grill
21	Caxton-Iseman Capital	Old Country Buffet, HomeTown Buffet, Orig. Roadhouse Grill, Tahoe Joe's
22	SAir Group	Gate Gourmet
23	Diageo PLC	Burger King Corp., Haagen-Dazs
24	Bob Evans Farms Inc.	Bob Evans Restaurants, Bob Evans General Stores, Owens Family Restaurant
25	Ruby Tuesday Inc.	Ruby Tuesday

APPENDIX 5-C: GEOGRAPHICAL DISTRIBUTION OF RESTAURANTS WITH ANNUAL ELECTRICITY CONSUMPTION > 50 MWH

Fast Food Chain Establishments

State	No. of Businesses	% of Total	No. of Employees	Sales ($000)
California	3,383	12.0	97,662	6,780.600
Texas	2,282	8.1	58,569	1,293.200
Florida	2,034	7.2	57,652	1,436.100
Ohio	1,528	5.4	48,686	3,861.600
Illinois	1,283	4.5	42,769	18,826.500
Georgia	1,156	4.1	36,177	1,947.700
New York	1,090	3.9	35,297	1,696.000
Pennsylvania	1,030	3.6	32,734	563.100
Michigan	1,005	3.6	35,173	717.800
Virginia	991	3.5	27,959	420.100
Indiana	898	3.2	27,673	988.700
North Carolina	885	3.1	27,267	1,185.100
Tennessee	836	3.0	22,320	1,180.800
Missouri	684	2.4	21,494	941.600
Arizona	551	1.9	14,388	273.000
Washington	542	1.9	15,056	285.500
South Carolina	536	1.9	14,597	246.100
Kentucky	532	1.9	18,023	9,111.800
Minnesota	502	1.8	16,353	332.100
Alabama	462	1.6	13,366	347.200
Wisconsin	460	1.6	18,956	452.000
Colorado	458	1.6	15,164	649.100
New Jersey	457	1.6	12,952	314.400
Louisiana	454	1.6	13,643	292.800
Maryland	418	1.5	12,982	254.300
Massachusetts	368	1.3	11,891	226.200
Iowa	320	1.1	9,763	178.500
Kansas	320	1.1	9,478	172.200
Oklahoma	314	1.1	9,405	603.200
Mississippi	270	1.0	8,386	199.500
Oregon	269	1.0	7,864	143.300
Arkansas	222	0.8	6,275	156.700
Connecticut	215	0.8	6,536	143.300
West Virginia	186	0.7	5,422	120.000
Nevada	185	0.7	5,159	119.500
New Mexico	185	0.7	5,461	127.800
Utah	149	0.5	6,189	147.500
Nebraska	100	0.4	2,763	162.500
New Hampshire	95	0.3	2,765	46.600
South Dakota	85	0.3	2,403	69.900
Montana	80	0.3	2,254	62.700
Rhode Island	74	0.3	2,111	34.800
Maine	72	0.3	2,378	74.400
North Dakota	70	0.2	1,992	49.400
Idaho	69	0.2	1,949	76.800
Delaware	58	0.2	2,231	35.500
Wyoming	58	0.2	1,651	26.200
Washington, D.C.	47	0.2	1,235	7.100
Vermont	24	0.1	945	20.900
Alaska	1	0.0	60	3.500
Total/Avg	**28,293**	**100.0**	**853,478**	**57,405.200**

APPENDIX 5-C (Continued)

Family Restaurant Chain Establishments

State	No. of Businesses	% of Total	No. of Employees	Sales ($000)
California	1,353	7.9	45,070	2,270.8
Oklahoma	983	5.7	33,991	1,696.3
Rhode Island	971	5.6	30,166	944.8
Georgia	931	5.4	30,524	476.3
Utah	883	5.1	26,269	1,587.5
North Carolina	843	4.9	29,442	746.6
Minnesota	820	4.8	27,192	423.2
Indiana	789	4.6	22,505	420.1
Idaho	641	3.7	19,872	1,292.9
Michigan	523	3.0	16,734	658.9
Wisconsin	492	2.9	13,689	269.3
Iowa	477	2.8	16,783	734.7
New Mexico	465	2.7	14,951	551.2
Texas	442	2.6	16,567	6,146.5
North Dakota	433	2.5	11,027	479.2
Washington	383	2.2	13,654	187.7
Mississippi	375	2.2	13,157	582.6
Washington, D.C.	355	2.1	10,974	219.5
Montana	348	2.0	12,705	248.3
Arizona	324	1.9	11,272	650.8
South Dakota	310	1.8	9,170	3,161.1
Colorado	309	1.8	9,539	731.3
Alabama	306	1.8	8,841	89.9
Pennsylvania	279	1.6	7,207	305.5
Massachusetts	274	1.6	9,810	199.7
Kansas	271	1.6	7,584	115.1
Louisiana	253	1.5	8,310	153.5
Connecticut	251	1.5	6,420	93.0
Maine	180	1.0	6,844	79.9
Oregon	172	1.0	4,737	61.5
Missouri	168	1.0	4,900	33.0
Kentucky	149	0.9	4,037	898.2
Arkansas	147	0.9	4,095	97.9
West Virginia	127	0.7	4,019	30.2
Nevada	123	0.7	4,446	57.0
Vermont	123	0.7	3,820	52.3
Maryland	120	0.7	3,089	58.0
Nebraska	114	0.7	3,027	194.4
New Jersey	107	0.6	3,417	58.8
New York	88	0.5	2,446	37.9
Illinois	80	0.5	2,156	20.0
South Carolina	79	0.5	2,372	44.0
Tennessee	67	0.4	1,827	40.0
New Hampshire	66	0.4	2,370	49.9
Ohio	64	0.4	1,921	49.4
Delaware	56	0.3	2,115	53.8
Wyoming	55	0.3	1,534	35.3
Virginia	44	0.3	945	17.4
Florida	18	0.1	1,204	8.8
Alaska	0	0.0	0	0.0
Total/Avg	**17,231**	**100.0**	**548,746**	**27,414.0**

APPENDIX 5-C (Continued)

Total Chain Eating Establishments

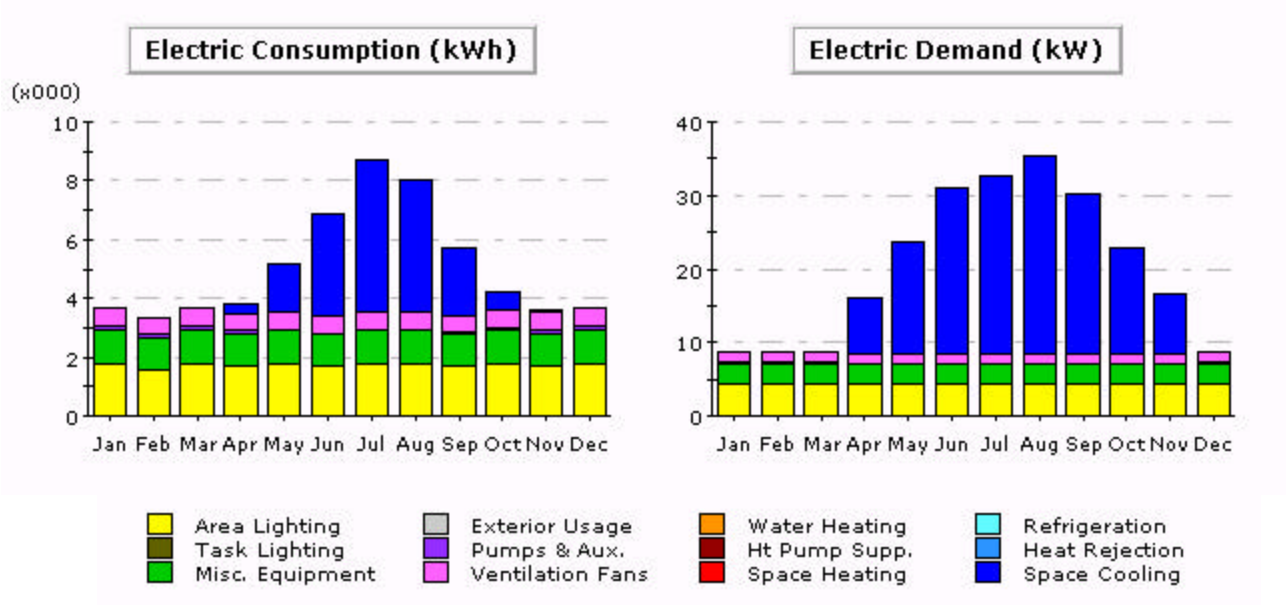
State	No. of Businesses	% of Total	No. of Employees	Sales ($000)
California	4,736	10.4	142,732	9,051.4
Texas	2,724	6.0	75,136	7,439.7
Georgia	2,087	4.6	66,701	2,424.0
Florida	2,052	4.5	58,856	1,444.9
North Carolina	1,728	3.8	56,709	1,931.7
Indiana	1,687	3.7	50,178	1,408.8
Ohio	1,592	3.5	50,607	3,911.0
Michigan	1,528	3.4	51,907	1,376.7
Illinois	1,363	3.0	44,925	18,846.5
Minnesota	1,322	2.9	43,545	755.3
Pennsylvania	1,309	2.9	39,941	868.6
Oklahoma	1,297	2.8	43,396	2,299.5
New York	1,178	2.6	37,743	1,733.9
Rhode Island	1,045	2.3	32,277	979.6
Virginia	1,035	2.3	28,904	437.5
Utah	1,032	2.3	32,458	1,735.0
Wisconsin	952	2.1	32,645	721.3
Washington	925	2.0	28,710	473.2
Tennessee	903	2.0	24,147	1,220.8
Arizona	875	1.9	25,660	923.8
Missouri	852	1.9	26,394	974.6
Iowa	797	1.8	26,546	913.2
Alabama	768	1.7	22,207	437.1
Colorado	767	1.7	24,703	1,380.4
Idaho	710	1.6	21,821	1,369.7
Louisiana	707	1.6	21,953	446.3
Kentucky	681	1.5	22,060	10,010.0
New Mexico	650	1.4	20,412	679.0
Mississippi	645	1.4	21,543	782.1
Massachusetts	642	1.4	21,701	425.9
South Carolina	615	1.4	16,969	290.1
Kansas	591	1.3	17,062	287.3
New Jersey	564	1.2	16,369	373.2
Maryland	538	1.2	16,071	312.3
North Dakota	503	1.1	13,019	528.6
Connecticut	466	1.0	12,956	236.3
Oregon	441	1.0	12,601	204.8
Montana	428	0.9	14,959	311.0
Washington, D.C.	402	0.9	12,209	226.6
South Dakota	395	0.9	11,573	3,231.0
Arkansas	369	0.8	10,370	254.6
West Virginia	313	0.7	9,441	150.2
Nevada	308	0.7	9,605	176.5
Maine	252	0.6	9,222	154.3
Nebraska	214	0.5	5,790	356.9
New Hampshire	161	0.4	5,135	96.5
Vermont	147	0.3	4,765	73.2
Delaware	114	0.3	4,346	89.3
Wyoming	113	0.2	3,185	61.5
Alaska	1	0.0	60	3.5
Total/Avg	**45,524**	**100.0**	**1,402,224**	**84,819.2**

Source: Dun & Bradstreet Sales and Marketing Solutions, *MarketPlace Jul-Sep 2002*; EEA.

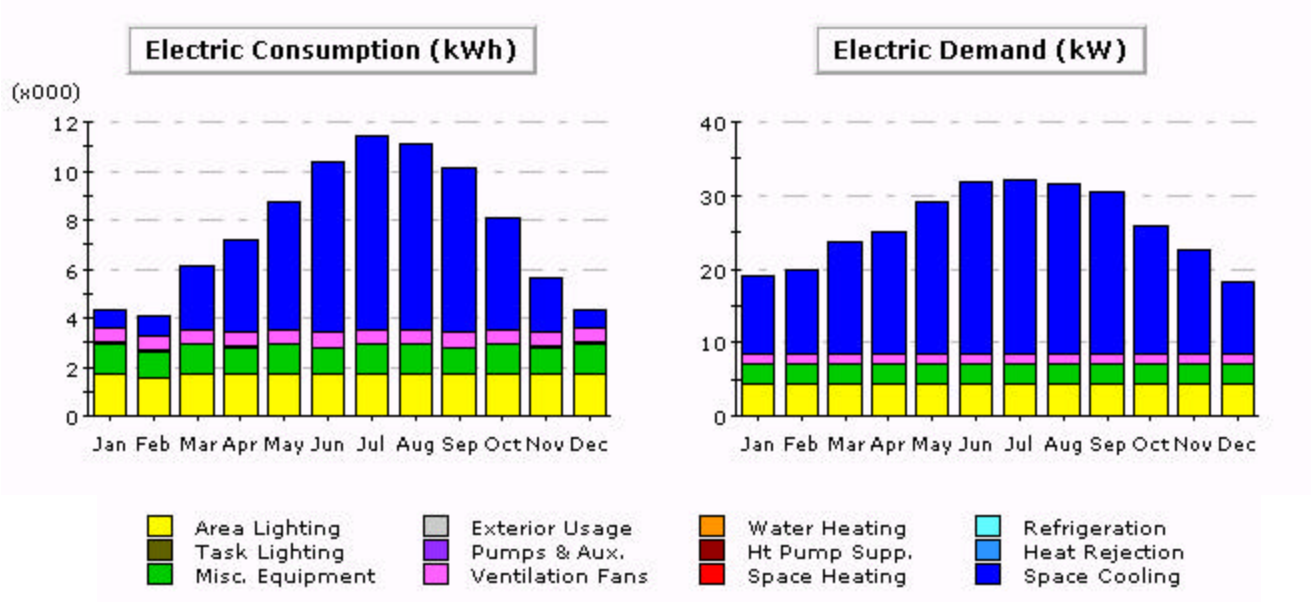
APPENDIX 5-D: TYPICAL RESTAURANT ELECTRIC AND GAS LOAD CURVES

FIGURE 5D-1
ELECTRIC CONSUMPTION AND DEMAND FOR 5,000 FT^2 FULL SERVICE RESTAURANT

Representative Northeast (Hartford, CT) Full Service Restaurant



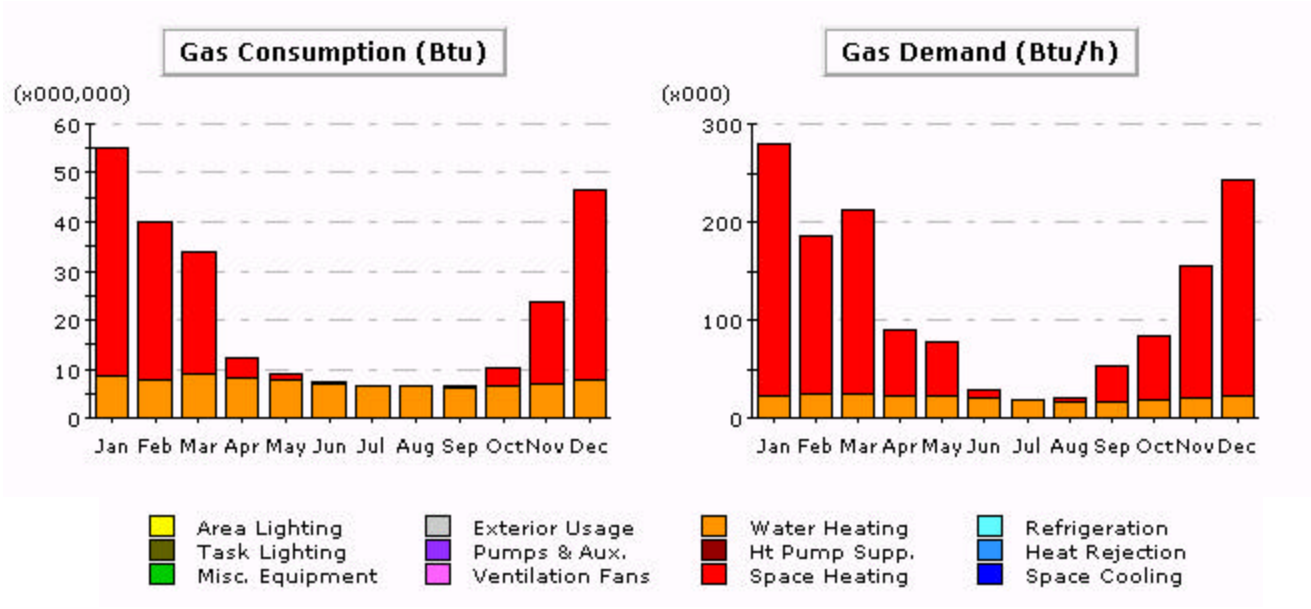
Representative Southwest (Phoenix, AZ) Full Service Restaurant



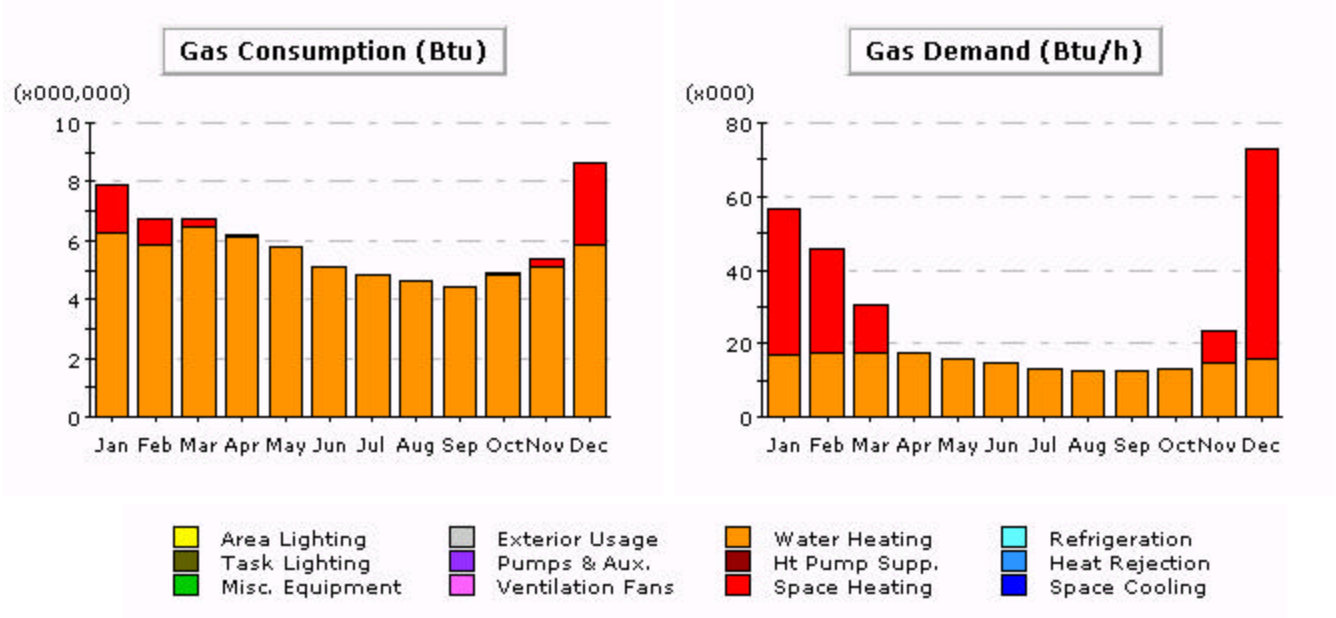
Source: EEA; Energy Design Resources, eQuest2002 Database; Regional Economic Research, Inc., *eShapes, 2001 National Database*

FIGURE 5D-2
GAS CONSUMPTION AND DEMAND FOR 5,000 FT^2 FULL SERVICE RESTAURANT

Representative Northeast (Hartford, CT) Full Service Restaurant



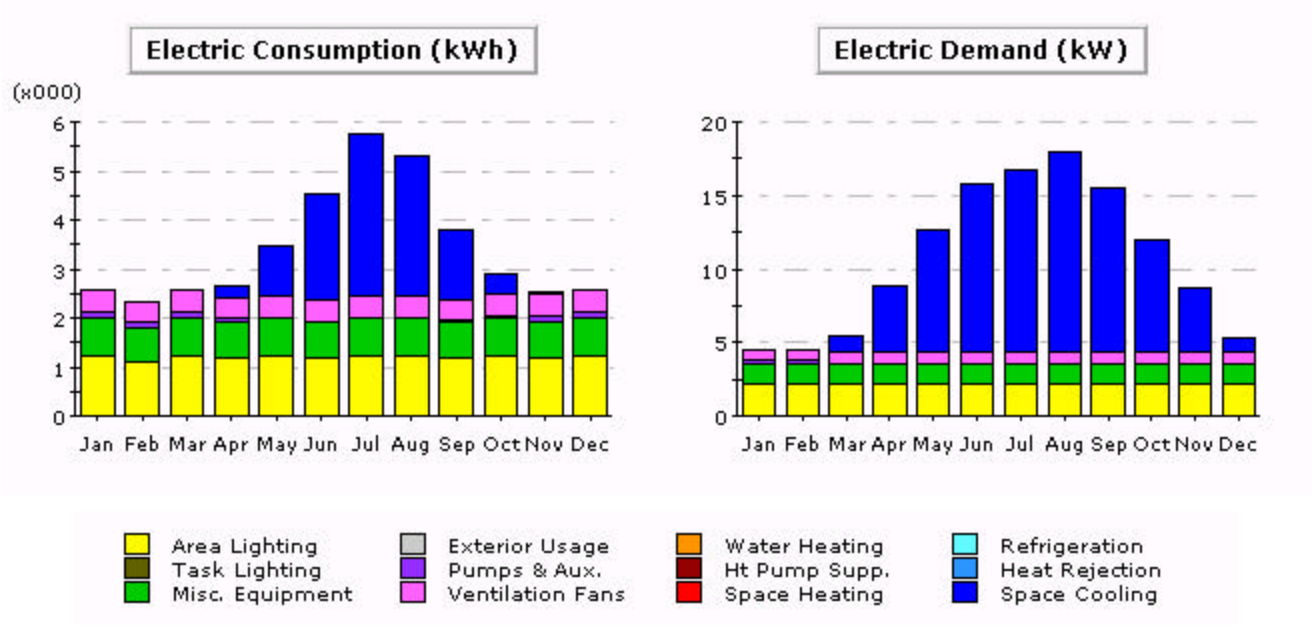
Representative Southwest (Phoenix, AZ) Full Service Restaurant



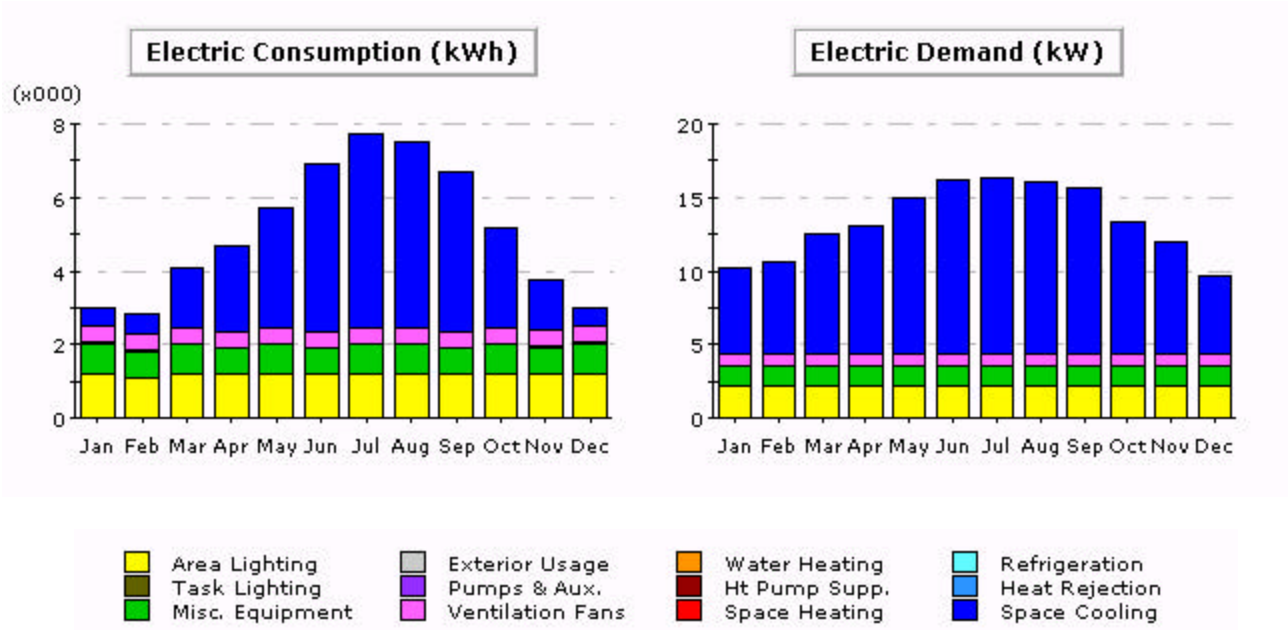
Source: EEA; Energy Design Resources, eQuest2002 Database; Regional Economic Research, Inc., *eShapes, 2001 National Database*

FIGURE 5D-3
ELECTRIC CONSUMPTION AND DEMAND FOR
2,500 FT^2 QUICK SERVICE RESTAURANT

Representative Northeast (Hartford, CT) Quick Service Restaurant



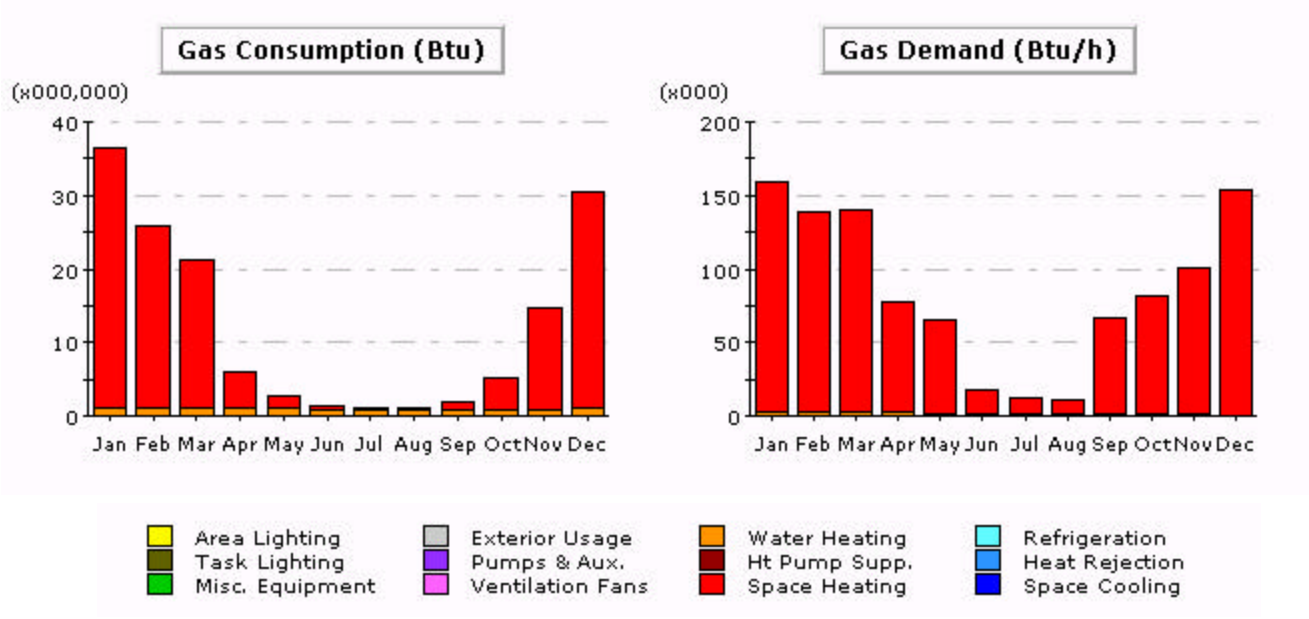
Representative Southwest (Phoenix, AZ) Quick Service Restaurant



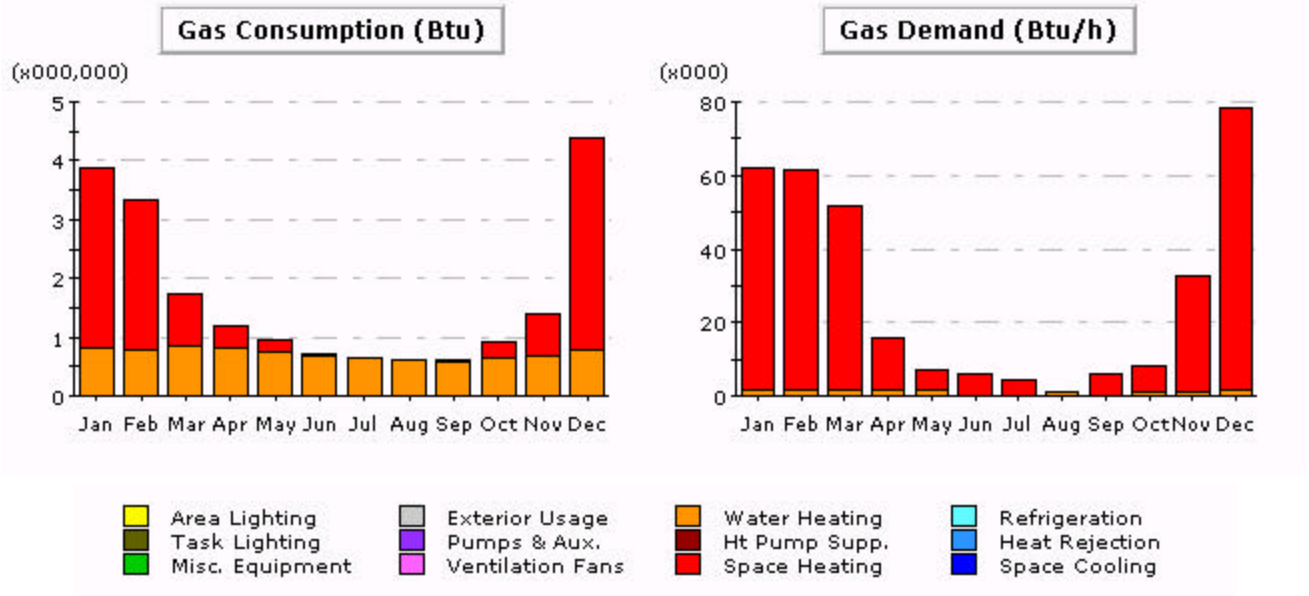
Source: EEA; Energy Design Resources, eQuest2002 Database; Regional Economic Research, Inc., *eShapes, 2001 National Database*

FIGURE 5D-4
NATURAL GAS CONSUMPTION AND DEMAND FOR
2,500 FT^2 QUICK SERVICE RESTAURANT

Representative Northeast (Hartford, CT) Quick Service Restaurant



Representative Southwest (Phoenix, AZ) Quick Service Restaurant



Source: EEA; Energy Design Resources, eQuest2002 Database; Regional Economic Research, Inc., *eShapes, 2001 National Database*

6. BIG-BOX RETAIL SECTOR OVERVIEW

6.1 INDUSTRY OVERVIEW

Big-box retail, a phenomenon that arose to prominence during the early 1990s, features establishments that are characterized by: 1) large, windowless, rectangular, single-story buildings; 2) square footage typically in the 50,000 – 200,000 ft^2 range, depending on product category; 3) standardized facades; 4) ample surface parking reflecting near-total reliance on auto-borne shoppers; 5) no-frills site development; and 6) favored location near highway exits and interchanges (see Glossary for definition of related retail terms). A defining feature of big-box stores is that they are at least several times the size of a traditional outlet in their product category (e.g., department store, bookstore, pharmacy).[1] These large sizes support the big-box business model of profits based on high sales volumes rather than price-markups.

Table 6-1 below presents average size ranges for big-box operations in four different product categories.

TABLE 6-1
BIG-BOX OPERATIONS BY PRODUCT CATEGORY

Product Category	Size Range of Big-Box Operation
Warehouse club (e.g., B.J's)	120,000 ft^2
Supermarket/grocery	50,000-100,000 ft^2
Bookstore	25,000-50,000 ft^2
Eyeglasses	5,000 ft^2

Source: Center for Study of Commercial Activity.

While big-box retailers offer both low price and convenience to shoppers, controversy has arisen in communities around the country regarding their impact on local economies and landscapes. Local sales tax revenues and job ranks swell when big-box retail moves in, but smaller merchants may be driven out of business, traffic problems created, and environmental aesthetics affronted. In cases where the big-box operation relocates or closes, as has occurred frequently in the retail glut of the past few years, communities can be left with large empty facilities, unemployment and suddenly decreased tax revenues.

Both the retail industry as a whole and the big-box segment is dominated by Wal-Mart, whose annual sales revenues of $220 billion are four times those of second-place Home Depot. This sales revenue figure is cited as the highest single-year take for any corporation in history, earning it the No. 1 spot on Fortune's Global 500 list of the world's largest corporations.[2] Total retail industry revenues are estimated in excess of $3 trillion. Appendix 6-A lists the top 50 retail companies, highlighting companies that are primarily big-box retailers.

6.1.2 Trends

The rise of superstores, beginning with warehouse clubs (e.g., Sam's, BJ's) and followed by discount department stores, category killers, outlets and supercenters (e.g., Wal-Mart, Target), has been the predominant retail trend of the 1990s. By 1994, superstores provided 80% of all new retail space in the U.S.[3] The high-volume, low-cost business model employed by these types of companies is a main driver of growth in what is now known as the value segment of the retail industry.

Historically, manufacturers and wholesalers controlled the distribution chain to retail outlets, with goods "pushed" into the system by manufacturers. However, in the value segment, warehouse clubs and superstores with concentrated purchasing power now form a large cluster of "power purchasers" who buy in bulk and reap economies of scale, employing advanced transportation and information technology. Power buyers use information technology to link with and buy directly from manufacturers, negotiating lower costs since the middleman (wholesaler/broker) is cut out.

In recent years, there has been an accelerating trend towards the opening of supercenter versions of the discount department stores (e.g., SuperTarget, Wal-Mart Supercenter). These supercenters feature more square footage and the addition of a complete grocery section. Target, for example, operates about 75 SuperTargets, representing about 6% of all stores, with each SuperTarget occupying an average 175,000 ft^2 rather than the standard Target store area of 126,000 ft^2. Wal-Mart, with supercenters composing over one-third of Wal-Mart brand stores, is much farther down the supercenter path. Wal-mart's supercenter design encompasses 200,000 ft^2. Companies may close down one or more older stores when opening a supercenter in a new building that is sometimes only a few miles away from the old location.

Wal-Mart has driven much of the growth and set the trends in the past decade or more. It is the leading retailer in any merchandise category that it wants to be, and is the entity against whom the giants in the department store and, increasingly, the grocery store and drugstore segments compete. Among the trends that Wal-Mart is currently in the process of setting are:

- Adding extended grocery/pantry sections to its stores. Food in the store increases the frequency with which shoppers visit, which results in increased sales. Among the top ten retailers, only three do not have significant grocery operations.
- Replacing some service businesses, such as hair and nail salons, with mail and copy centers, candy stores and boutiques featuring name brand apparel.
- Leasing space, either in current stores or at abandoned store facilities, to foods sales or other retail companies.
- Upgrading its line of jewelry.
- Adding diesel fuel pumps at fuel centers.
- Selling used cars in selected markets.

More general trends in big-box retail development include value malls, de-malls, and drive-through pharmacies, as described below.

- *Value malls* combine various value-oriented retail establishments, such as outlets, category killers and large specialty retailers, in a single, integrated development. The development is usually enclosed, with storefronts facing onto walkways.
- *De-malls, or de-malling*, describes a retail operation that features store fronts facing outwards, towards parking areas. De-malls are typically found near existing malls but often do not compete with them due to different product offerings.
- *Drive-through pharmacies* have sprouted over the last four years, showing tremendous growth through such chains as Rite Aid and Eckerd. This is typically a feature of new stores only, as it is difficult for existing locations to accommodate the remodeling requirements.[4]

Finally, while big-box developments such as value malls continue to spring up in rural and suburban locations, there is also a growing trend towards big-box developments in urban areas. This is due to over-expansion or increased saturation in many suburban markets, and to the potential represented by under-served urban communities. Accompanying this trend is the appearance of stores with architectural, siting and landscaping modifications to accommodate local ordinances or concerns about aesthetics, "fit" with the community, traffic and other issues. Big-box retail chains have also experimented with scaled-down versions to serve urban and smaller communities. Examples include Wal-Mart's Neighborhood Markets, Home Depot's Village's Hardware, Staples Express, and Kohl's new prototype 62,000 ft^2 store that is 26,000 ft^2 smaller than a typical Kohl's facility.[5]

6.1.3 Financial Situation

Nationally, three-fourths of all centrally managed retail chain floor space is leased by the occupant, but many big-box companies own and occupy their facilities. Companies pay virtually all the utility bills for their space, whether they lease or own.[6] In the case of leased facilities, landlords bear some risk of big-box operations going out of business or relocating. Whether by landlord or by big-box owner, re-leasing large empty boxes takes time, and redevelopment requires significant capital, hence much of the community concern and negative press about big boxes standing empty for extended periods of time.

The retail industry overall spent $13.1 billion on energy in 1999, about 90% of which went towards electricity and 10% towards natural gas.[7] Energy costs represent about 9% of a centrally managed retail chain's operating budget. According to industry sources, energy costs can amount to the single largest expense for retailers after payroll, and ranks among the top five expenses in most companies.[8,9]

6.1.4 Energy Situation

According to Department of Energy data, total U.S. retail consumption of primary energy in 1999 was 2,297 trillion Btu (site energy consumption of 1,245 trillion Btu), or 15% of total commercial primary energy consumption (14% of total site consumption).[10] Natural gas serves

over 65% of retail buildings and almost 76% of national retail floor space Retail establishments are not very energy intensive, consuming slightly less electricity and natural gas per square foot than the average commercial building.[11]

While intensity of consumption is about average, the very large square footages associated with big box facilities often lead to high total consumption and expenditures. Thus, retailers have in the past five to ten years become more educated and focused on managing energy. Strategies of interest to retailers include centralized collection of energy data, centralized billing, aggregated commodity purchases, and an array of traditional energy efficiency measures such as lighting, energy management systems and peak load reduction techniques.

Table 6-2 shows space heating, space cooling and water heating energy sources among centrally managed retail chain floor space as identified in a 1998 survey.[12] Electricity is the dominant fuel source for space conditioning, while natural gas predominates in water heating. Table 6-3 shows the same statistics for all retail space nationally according to the 1999 DOE data.

TABLE 6-2
FUEL SOURCES IN CENTRALLY MANAGED RETAIL CHAINS

	Fuel Sources by Percentage of Floor Space Served*			
Application	Electricity	Natural Gas	Fuel Oil/Propane	Other
Space heating	81%	66%	3%	--
Space cooling	99%	--	--	--
Water heating	45%	52%	--	--

* floor space may be served by more than fuel per application type, e.g., by both electric and natural gas-fueled space heating equipment.
Source: Opinion Dynamics Corp.

TABLE 6-3
FUEL SOURCES IN RETAIL ESTABLISHMENTS

	Fuel Sources by Percentage of Floor Space Served*			
Application	Electricity	Natural Gas	Fuel Oil/ Propane	District Htg/Clg
Space heating	59%	62%	9%	--
Space cooling	95%	4%	--	--
Water heating	57%	37%	--	--

* floor space may be served by more than fuel type per application, e.g., by both electric and natural gas-fueled space heating equipment.
Source: EIA, *Commercial Buildings Energy Consumption Survey 1999*.

6.1.5 Growth and Renewal

New Construction

Top big-box retailers opened large numbers of new stores in 2001 and have aggressive expansion plans for 2002 and the next few years, as illustrated in Table 6-4 below. Industry leader Wal-

Mart is adding over 68 million ft^2 of space in 2002, opening 310 new stores over half of which are supercenters. Industry reports suggest that Wal-Mart's soon to be announced plans for 2003 will feature a capital budget of over $10 million that will include the construction of at least 190 new supercenters. According to Wal-Mart, the main challenge of opening the supercenters lies in preparing an adequate number of store managers, (not in community opposition to big-box development as commonly supposed). In fact, Wal-Mart claims they would be opening even more stores if not for this constraint.

TABLE 6-4
TOP BIG-BOX COMPANIES' EXPANSION

Company	2001 Expansion	2002 Expansion
Wal-Mart	61.1 million ft^2 382 stores $8.5 billion capital expenditure	68.5 million ft^2. 310 new stores: 50 discount stores, 185 Supercenters, 55 Sam's Clubs, 20 Neighborhood Markets. $9-10 billion annual capital budget
Home Depot	22 million ft^2 200 stores $3.5 billion	19.2 million ft^2. 200 new stores each year through 2004 $3 billion
Target	11 million ft^2 $3.0 billion	9.8 million ft^2, 25-40% of which will be SuperTargets $2.8 billion
Costco	5.9 million ft^2 $1.2 billion	6.2 million ft^2. 32 new warehouse clubs. $1.2 billion
Lowe's	12.7 million ft^2 105 new stores $2.4 billion	11.5 million ft^2. 123 new stores $2.0 billion

Source: *DSN Retailing Today; c*ompany websites.

Table 6-5 on the following page summarizes recent new construction trends and statistics according to a recent survey of big-box retailers.[13] As shown, the average construction time is a short four months, although the additional permitting associated with urban construction can extend this to six months or longer. Retailers minimize construction costs by building cookie-cutter facilities and limiting the number of different store prototypes.

TABLE 6-5
BIG-BOX STORE NEW CONSTRUCTION

Measure	Big-Box Company Average
New stores opened in 2001	26
New stores planned to open in 2002	25
Expansion ratio (new stores planned as % of stores in operation)	6.6%
Building schedule (days to complete)	
Total time	162 days
- shell construction	90 days
- inside preparation	72 days
Size of existing stores	79,619 ft^2
$/$ft^2$ to erect building shell	$32.85
$/$ft^2$ for HVAC system	$1.50

Source: *Chain Store Age*/Leo J. Shapiro & Associates.

Remodeling/Renovation

Along with new store openings, companies in the big-box category have aggressive remodeling plans. For example, Sam's Clubs planned to complete 100 remodeling projects in 2002, not including expansions of existing facilities. The average time to remodel among big-box facilities is estimated at 7.5 years, with the average number of stores remodeled per company in 2001 at 17.[14]

6.1.6 Energy Equipment Decision Making

Typical Characteristics

A study of decision makers responsible for over 31,000 chain retail facilities (representing 1.9 billion square feet of retail space) nationwide found that most make energy equipment-related decisions at the corporate headquarters level, as shown in Table 6-6. The same group of decision makers is typically responsible for all equipment decisions, regardless of equipment application. The group or individual with the most important role was in the facility management, maintenance and construction or senior management department, with engineering seldom playing this role (unlike other national account sectors).

About three-quarters of centralized chains at the time of the study had established equipment selection guidelines, with first cost, operating cost and preferred vendor products sharing the spotlight. Firms that manage retail properties cited first cost as the most important criteria for all equipment, with operating cost and reliability secondary concerns.

TABLE 6-6
ENERGY EQUIPMENT DECISION MAKING AMONG RETAIL CHAINS

Item	Characteristic	% of Nat'l Floorspace
Locus of decision making (national chains only)	National HQ	84%
	Responsibilities split, nat'l/indiv.locs.	15%
Same or different decision makers by equipment type?	Same for all equipment	97%
Most important decision maker		
	Facility management	35%
	Maintenance & construction	33%
	Senior management	25%
	Engineering	7%
Primary guidelines	Have no formal guidelines/DK	27%
	Have guidelines	73%
	- Lowest purchase/installation cost	26%
	- Lowest operating cost	21%
	- Preferred vendor	17%
Information sources	Company staff	32%
	Contractors/plumbers	30%
	Manufacturer representatives	30%
	Consulting engineers	26%
	Past experience	20%
	Trade journals	13%
	Other	21%

Source: Opinion Dynamics Corp.

Retail chain decision makers most often reported relying on company staff, contractors and plumbers, manufacturer representatives and consulting engineers to obtain information about energy equipment and systems. Property managers were most apt to rely on contractors and plumbers, with consulting engineers and company experience cited less often.

Insights

A survey conducted within the last year among national account customers provides additional information about big-box retailer priorities and outlooks on energy issues.[15] These customers are focusing on containment and predictability of energy costs; assurance of power quality and reliability; ability to compare utility usage and rates across the nation; and more cost-effective methods for capturing, monitoring and analyzing their stores' energy usage information. Customers expressed most concern about the level and volatility of energy prices and understanding their own energy use patterns.

Our discussions with industry participants furnished in-depth insight in the following areas.

Structures and Processes

With the boom in big box retailing, companies are opening dozens of new locations each year. The majority of these are new construction projects, so the focus of decision-making interviews tends to be new facilities rather than renovation projects. One chain we interviewed, for example, carried out 75 capital projects in the most recent fiscal year, 60 of which were completely new stores and 15 of which were expansions, relocations or remodeling of existing stores. This chain, with over $20 billion in annual revenue, has a corporate staff of three to handle energy management and utility issues in new construction. They provide input on energy equipment during the facility planning process. The retail operations group makes the final decisions on energy equipment.

Companies typically have a number of basic prototype stores, differing perhaps by merchandise type or along other dimensions, with a building prototype committee responsible for designs. "Changes are not made that often to the prototype store designs," said one interviewee. Within each type there may be different sizes and variations in other features. The prototype stores of a chain with whom we spoke are designed for one of three climate zones, with energy systems selected accordingly. For example, in the coldest zone, gas furnaces are almost always specified, while electric heat pumps or even electric resistance systems serve buildings in climates requiring minimal heating.

Guidelines and Criteria

One company interviewed focuses primarily on energy efficiency in new construction projects. According to the energy manager, "Efficiency is a main goal. For many years we have specified only the very highest efficiency (cooling EER) rooftop units that can be purchased. Furnace efficiencies are in the 81-82 percent range." This company has an exclusive supplier arrangement with one manufacturer of rooftop units. When opening a store in a middle climate zone, the company decides on gas or electric heating by determining which will be cheapest to operate.

Guidelines often focus on both payback and life-cycle cost, and can be project-specific with respect to renovation initiatives. In general, big-box retailers seek quick paybacks (two years) on projects in existing buildings, as the capital needed for these projects competes with the capital for opening new stores. However, paybacks may range as high as five years depending on specific project. Noise can be a criteria, along with size of location of equipment, especially for space that is leased.

6.2 FACILITY CHARACTERISTICS

6.2.1 Buildings

As of 1999, there were about 667,000 buildings with the principal activity of retail representing over 10 billion ft^2 of floor space.[16] Twenty percent of the buildings were in strip or enclosed malls. According to the industry1998 survey, about half of national centrally managed retail chain floor space is located in strip shopping centers, with 17% in enclosed shopping malls and 25% in single, free-standing buildings.

Wal-Mart has stores in most states, and most of the other top big-box outfits are found in a majority of states as well. Appendix 6-B lists the number of retail facilities by state in big-box retail product categories that have at least 250 MWh of annual electricity consumption. These stores are more likely than smaller facilities to belong to a national chain and to be good candidates for integrated CHP systems.

6.2.2 Energy Equipment

Big-box retailers own virtually all of their energy equipment, even in leased space. In malls, the mall developer typically builds the facility's structural shell and provides the tenant retailers with an allowance for HVAC and water heating systems, which large stores usually design and install themselves. Wal-Mart and other national chains have pre-specified construction plans that cover HVAC, hot water, lighting and other systems.

Table 6-7 shows the major types of space cooling, space heating and water heating equipment in place in centrally managed retail chain floor space. Packaged rooftop units supply the large majority (over 80%) of air conditioning, with central chiller equipment serving about 12% of floor space. Packaged rooftop units also dominate for space heating purposes, with central boilers and furnaces playing a role in 9% and 3% of floor space respectively.

TABLE 6-7
ENERGY EQUIPMENT IN CENTRALLY MANAGED RETAIL CHAINS

Percent of floor space by application		
Space Heating	**Space Cooling**	**Water Heating**
Packaged roof top unit: 80%	Packaged rooftop unit: 82%	Standard tank-type: 88%
Central boiler: 9%	Central chiller: 12%	Central boiler: 9%
Central furnace: 3%	Residential-type central system: 5%	Instantaneous (tankless): 2%
Heat pump: 2%	Other: 1%	Heat pump: 1%
Other: 6%		

Source: Opinion Dynamics Corp.

Table 6-8 shows energy equipment information for the mercantile sector overall as contained in the 1999 DOE data.

Space Conditioning

The predominant type of space heating and cooling for big-box stores is a packaged rooftop unit featuring either electric heat pumps or a gas heating/electric cooling package. Air-cooled condensers are common, but these large stores are also able to accommodate the expense associated with the cooling towers that may accompany the use of water-cooled condensing. Using multiple single-zone units involves less ductwork and can maintain shopper comfort in the face of partial equipment failure. Separate ducted HVAC systems serve office areas, with office, warehouse storage and service garage areas separately zoned.

TABLE 6-8
ENERGY EQUIPMENT IN MERCANTILE ESTABLISHMENTS

Percent of Floor Space by Application*					
Space Heating		**Space Cooling**		**Water Heating**	
Packaged unit: 64%		Packaged unit:	77%	Central system:	41%
Indiv. space heater:	24%	Indiv. unit:	14%	Distributed system:	30%
Furnace:	22%	Heat pump:	13%	Combination:	12%
Heat pump:	13%	Chiller:	12%		
Boiler:	12%	Residential-type central system:	10%		
Other:	7%	Swamp cooler:	4%		

* Floor space may feature more than one type of equipment per application.
Source: EIA, *Commercial Building Energy Consumption Survey 1999*.

Central furnaces are typically found only in facilities of 100,000 ft^2 or less. Stores featuring central station air conditioning employ a central electric chiller with air handling units using chilled water cooling coils, hot water heating coils, fans, and filters. Food service areas may be served by a separate air conditioning system.

The single-story windowless big-box model typically shows a high sensible heat gain relative to the total heat gain; equipment present must be capable of removing this. The heat in the lighting system may offsets the roof heat loss in cold weather so the store interior typically could require cooling all year long during business hours. Because some stores, such as supercenters, are open 24 hours a day, this characteristic becomes a critical design factor. Indoor temperatures especially in perimeter areas need to be adjusted for variations in outdoor temperatures to avoid temperature shocks as customers enter and exit the store.

Dehumidification

Shopper comfort, particularly in dressing rooms and refrigerated/frozen grocery aisles, is important to enhancing customer dwell time in store areas. Design guidelines suggest relative humidity of 50% or below at a dry bulb temperature of 78°F to retard shopper perspiration in dressing rooms and eliminate musty odors. While many stores may accomplish dehumidification by overcooling air before introducing it into conditioned space, others, such as Wal-Mart, have experimented successfully with desiccant units that remove humidity from the air before it is conditioned.

Water Heating

Most big-box stores feature standard tank-type water heating systems, with some use of instantaneous point-of-use heaters. A central boiler system with storage and constant recirculation may be used if there is a need to have hot water available continuously at fixtures.

Natural gas fuels slightly over half of water heating systems among centrally managed retail chains.[17]

Refrigeration

In 1999, about 54% of retail space nationally housed some type of refrigeration equipment.[18] Grocery and food service operations featuring refrigeration equipment are found in big-box supermarkets and supercenters. Occasionally, companies in other big-box product categories, IKEA for example, feature food service of some type in their stores. Refrigerated display cases maintained at various temperatures store and preserve food and make it accessible to shoppers. Back room operations feature walk-in and other types of coolers and freezers for dairy products, meats, fish, and frozen foods; icemakers; and low temperature meat cutting rooms. Closed or cabinet-type refrigerated cases are present in the majority of grocery floor space, along with walk-in cases, with open cases/cabinets typically found in the largest stores. Most grocery chains utilize reach-in, coffin, and vertical meat and dairy cases, with self-contained units popular for spot merchandising on the store floor.[19,20]

Most restaurant operations use a combination of refrigerators and freezers of the reach-in and walk-in varieties. These may be cooled using one or more compressors, usually with air-cooled condensers. Units either stand alone or are arranged in racked banks.

The majority of refrigeration systems in large supermarkets have roof-mounted air-cooled condensers, with evaporatively cooled systems used only in the Southwest. Most stores reclaim heat from the hot refrigerant fluid and have installed floating head pressure controls to reduce compressor horsepower requirements. However, many of these floating head pressure systems boost condenser head pressure when reclaim heat is called for, essentially defeating the energy saving aspects of the system.

A number of stores use mechanical subcooling, using small vapor compression systems to cool the condensers of the low temperature refrigerant circuits. Mechanical subcooling is an effective method of cooling liquid refrigerant below its saturation pressure in order to increase system capacity and improve efficiency. Energy savings are estimated to be as much as 25%. Mechanical subcooling could be accomplished using absorption chillers running off the waste heat of a combined heat and power system.

Cooking and Baking

Cooking and baking equipment is present in about 10% of retail floor space nationally.[21] Among big-box product categories, supermarket and supercenter formats are likely to include in-house food preparation and service equipment. Equipment such as ovens, broilers, griddles, fryers, range tops, steamers and convection ovens serves the cooking and baking needs. Natural gas supplies cooking and baking equipment in about 60% of centrally managed retail chain store space.[22]

Backup Power

Supermarkets are under mandate to install backup power for emergency exit lighting and some safety systems. The majority of existing supermarkets use uninterruptible power supply (UPS) systems to feed the emergency lighting/sprinkler/fire alarm and, often, computer systems (such as cash registers) when grid power is temporarily lost. However, the installation of emergency generators, mostly diesel, appears to be on the rise in large new stores, especially in the Northeast and the Midwest. Supercenters as well appear to be recognizing the benefits of installing grid-parallel emergency generation systems for power reliability. They may use these systems for peak load reduction purposes as well.

Other types of big-box retailers may have emergency generators on-site to supply backup power for emergency lighting and sales support systems.

Energy Management System

As of 1998, over 50% of centrally managed chain floor space was served by an energy management system.[23] These systems typically control space conditioning equipment and occasionally water heating equipment as well. Company staff at central headquarters, along with outside contractors, is most likely to control the system. Supercenters generally require a centralized control system to accommodate fire and smoke control requirements, security, remote monitoring, centralized billing, and maintenance and building operations control needs.

Maintenance and Repair

Centrally managed retail chains depend primarily on outside contractors to maintain and repair energy equipment, with in-house personnel, utilities and property management companies also providing services in 15-20% of facilities.

6.2.3 Electric, Thermal and Dehumidification Loads

Electric Loads

Electric loads in big-box stores vary depending on product category. Loads in discount department stores such as Target and category killers such as Toys "R" Us are comprised primarily of lighting and HVAC, while in supercenters and supermarket big-boxes, major refrigeration loads are present.

Thermal Loads

Like electric loads, thermal loads in big box stores vary across product categories. Primary thermal loads in discount department stores, for example, are space heating and water heating. Supermarkets and supercenters have higher water heating loads and carry cooking and baking loads as well for in-store food preparation.

- Uses for hot water include employee hand washing, store cleaning, food preparation and food service. While not a major energy use, it is growing as more stores incorporate food

preparation and service functions. Hot water peak use typically occurs in the evening/night time period, when store clean up takes place.

- The cooking and baking function is increasing in supermarkets as they turn to in-store food service and preparation to attract and retain customers. Some baking is done on a "bake-off" basis, where ready-to-bake goods are delivered to the store and finished on-site.
- Stores require space heating both for customer and employee comfort, and to maintain ideal conditions for perishables and other stocked items. Cold air spilling over from refrigerator cases in grocery sections presents year-round challenges in terms of shopper comfort, sometimes requiring heating even in summer.

Dehumidification Loads

Humidity control in big-box stores addresses customer and employee comfort and, in grocery sections, the need to prevent frost buildup on refrigeration evaporators and fog or frost on display cases. With humidity too high, customers cannot see refrigerated items, and refrigeration equipment is burdened. Anti-sweat heaters, which are generally used to combat frost buildup on case doors, must also work longer when high humidity conditions are present. Conversely, humidity levels that are too low cause produce to wilt. Humidity in the 40-45% range appears optimum in the supermarket setting, while 50% or lower is ideal for department stores, and 50-55% humidity is preferred in most other retail settings.

Electric and Gas Load Curves

The figures in Appendix 6-C present typical load curves for representative 70,000 ft^2 and 120,000 ft^2 big box stores located in two opposite types of climates, the Southwest and the Northeast (New England). Table 6-8 presents key energy consumption figures for these representative stores.

TABLE 6-8
ELECTRIC AND GAS ENERGY LOADS FOR REPRESENTATIVE BIG-BOX STORES
SOUTHWEST AND NEW ENGLAND

70,000 ft^2 Store		
Southwest		
Annual Electricity Use	1,635,900	kWh
Peak Load	438.8	kW
Load Factor	42.6%	
Min. Monthly Gas Use	9.0	MMBtu
Annual Gas Use	133.21	MMBtu
New England		
Annual Electricity Use	1,288,100	kWh
Peak Load	425.1	kW
Load Factor	34.6%	
Min. Monthly Gas Use	12.4	MMBtu
Annual Gas Use	621.3	MMBtu
120,000 ft^2 Store		
Southwest		
Annual Electricity Use	2,785.2	kWh
Peak Load	744.5	kW
Load Factor	42.7%	
Min. Monthly Gas Use	15.42	MMBtu
Annual Gas Use	228.72	MMBtu
New England		
Annual Electricity Use	2,201.0	kWh
Peak Load	724.1	kW
Load Factor	34.7%	
Min. Monthly Gas Use	21.3	MMBtu
Annual Gas Use	931.74	MMBtu

Source: EEA; Energy Design Resources, *eQuest2002 Database*;
Regional Economic Research, Inc., *eShapes, 2001 National Database*.

GLOSSARY

Big-box – A category of retail development characterized by a large, industrial-style building or store with footprint that generally ranges from 50,000 to 200,000 ft^2. There are four major subgroups in the big-box retail format category: discount department store, category killer, outlet store and warehouse club.

Discount department store – Offers a wide variety of merchandise including automotive parts and services, house wares, home furnishings, apparel and beauty aids. May sell as many as 60,000 distinct items. Store size range is typically 80,000 to 130,000 ft^2. This group includes such retailers as Wal-Mart, Kmart and Target.

Category killer – Offers a large selection of merchandise and low prices in a particular type of product category. Stores range in size from 20,000 to 120,000 ft^2. Examples include Circuit City, Office Depot, Sports Authority, Lowe's, Home Depot and Toys 'R' Us.

Outlet store – The discount arm of major department stores, these stores typically fall into the 20,000 – 80,000 ft^2 category. Nordstrom Rack and J.C. Penny Outlet are examples in this group. In addition, manufacturers such as Nike, Bass Shoes and Burlington Coat Factory have retail outlet stores.

Warehouse club – Offers a variety of goods, often in bulk, at wholesale prices. Product items, including groceries, electronics, clothing, and hardware, are limited in number, typically 5,000 or fewer. Store sizes are typically in the 100,000-170,000 ft^2 range. This group includes retailers such as Costco, Sam's Club, BJ's Wholesale Club and Pace.

Power center – A conglomeration of the various types of big-box retailers, generally containing 250,000 – 1 million ft^2 of retail space.

Regional center – A small grouping of big-box retailers, typically a development of two or more anchor stores. Size range is 400,000 – 800,000 ft^2, generally enclosed with an inward arrangement of stores connected by a walkway.

Shopping center – A group of retail and other commercial establishments that is planned, developed and often managed as a single property, generally configured as enclosed malls and open-air strip plazas.

Supercenter – A large food/drug combination store and mass merchandiser under a single roof. The supercenters offer a wide variety of food, as well as non-food merchandise. These stores average more than 170,000 ft2 and typically devote as much as 40% of the space to grocery items, e.g., Wal-Mart Supercenters, Super Target, Meijer and Fred Meyer.

Superstore – Term used interchangeably with "big-box store." Can exclude outlet stores.

GLOSSARY (Continued)

Value retailer – Term used interchangeably with "big-box retailer." Can include retailers such as dollar stores that are not big-box retailers.

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APPENDIX 6-A: TOP RETAIL CHAINS

Rank	Company	2001 Revenues ($000s)	2001 % of Top 100 Revs.	2001 No. of Stores
1	Wal-Mart Stores Inc.	219,812,000	18.7%	4,414
2	The Home Depot	53,553,000	4.6%	1,333
3	The Kroger Co.	50,098,000	4.3%	3,634
4	Sears, Roebuck and Co.	41,078,000	3.5%	2,185
5	Target Corp.	39,888,000	3.4%	1,381
6	Albertson's	37,931,000	3.2%	2,421
7	Kmart Corp.	36,151,000	3.1%	2,114
8	Costco	34,797,037	3.0%	369
9	Safeway	34,301,000	2.9%	1,773
10	J.C. Penney	32,004,000	2.7%	3,770
11	Dell Computer	31,168,000	2.7%	--
12	Walgreen Co.	24,623,000	2.1%	3,520
13	Ahold USA	23,212,000	2.0%	1,430
14	CVS Corp.	22,241,400	1.9%	4,191
15	Lowe's Corp.	22,111,108	1.9%	744
16	Best Buy	19,597,000	1.7%	1,896
17	Federated Dept. Stores	15,651,000	1.3%	459
18	Publix Super Markets	15,370,019	1.3%	684
19	Rite Aid	15,171,146	1.3%	3,497
20	Delhaize America	14,900,000	1.3%	1,459
21	May Department Stores	14,215,000	1.2%	839
22	Gap Inc.	13,847,873	1.2%	3,097
23	Winn-Dixie	12,903,373	1.1%	1,153
24	Meijer	11,923,000	1.0%	155
25	Office Depot	11,200,000	1.0%	1,002
26	Toys "R" Us	11,019,000	0.9%	1,599
27	A&P	10,973,315	0.9%	702
28	Staples	10,744,373	0.9%	1,436
29	TJX Cos.	10,708,998	0.9%	1,665
30	7-Eleven	9,894,100	0.8%	5,829
31	Circuit City Stores	9,589,803	0.8%	624
32	SuperValu	9,549,068	0.8%	1,260
33	The Limited Inc.	9,363,000	0.8%	4,614
34	H.E. Butt Grocery Co.	9,000,000	0.8%	300
35	Circle K	8,866,440	0.8%	3,933
36	Dillard's	8,154,911	0.7%	338
37	Kohl's Department Store	7,488,654	0.6%	382
38	Army & Air Force Exch.	7,132,000	0.6%	162
39	Gateway	6,079,524	0.5%	277
40	Saks Inc.	6,070,568	0.5%	356
41	Nordstrom	5,634,130	0.5%	156
42	Dollar General	5,322,895	0.5%	5,540
43	BJ's Wholesale Club	5,279,730	0.5%	130
44	Menard	5,200,000	0.4%	160
45	Blockbuster	5,156,700	0.4%	7,981
46	Barnes & Noble	4,870,390	0.4%	1,934
47	AutoZone	4,818,185	0.4%	3,040
48	RadioShack	4,775,700	0.4%	7,246
49	OfficeMax	4,636,024	0.4%	993
50	Shaw's Supermarkets	4,400,000	0.4%	185
	Total Top 50	1,010,482,149	86.1%	49,821
	Total Top 100	1,173,057,562		

Source: EEA; Chain Store Age, "Chain Store Age 100." 9/2002.

APPENDIX 6-B: GEOGRAPHIC DISTRIBUTION OF RETAIL STORES WITH ANNUAL ELECTRICITY CONSUMPTION > 250 MWH

State	SIC (Hardware, Department Stores, Apparel, Furniture Stores, Home Furnishings, Household Appliances, Electronic Stores, Computer and Software Stores, Drug Stores, Sporting Goods, Book Stores)											TOTAL	Percent of Total	Cumula-tive Percent
	5251	5311	5600	5712	5719	5722	5731	5734	5912	5941	5942			
California	199	1134	819	268	227	2	142	66	1304	271	241	4,673	11.9%	11.9%
New York	62	578	829	130	101	3	62	46	770	96	119	2,796	7.1%	19.0%
Florida	61	868	372	178	114	0	78	19	641	76	124	2,531	6.5%	25.5%
Texas	59	1146	328	190	71	0	75	14	210	53	122	2,268	5.8%	31.3%
Illinois	117	572	302	124	67	0	62	10	444	61	86	1,845	4.7%	36.0%
Pennsylvania	67	569	389	115	52	0	36	19	364	60	85	1,756	4.5%	40.5%
Ohio	84	595	280	103	44	0	55	27	326	39	75	1,628	4.2%	44.6%
Michigan	89	487	239	115	52	2	42	12	261	77	76	1,452	3.7%	48.3%
New Jersey	27	260	390	82	72	1	37	8	313	52	51	1,293	3.3%	51.6%
Massachusetts	37	225	303	49	46	0	20	17	359	33	62	1,151	2.9%	54.5%
Georgia	31	435	212	94	59	0	39	12	109	25	50	1,066	2.7%	57.3%
North Carolina	32	414	183	104	50	0	29	12	151	26	49	1,050	2.7%	59.9%
Virginia	23	357	209	87	52	1	26	14	133	30	59	991	2.5%	62.5%
Washington	39	232	134	50	46	2	36	29	247	48	42	905	2.3%	64.8%
Indiana	44	351	110	44	20	2	40	2	185	18	42	858	2.2%	67.0%
Tennessee	17	346	165	59	27	1	29	4	143	13	48	852	2.2%	69.1%
Wisconsin	79	299	105	39	21	2	27	2	201	36	30	841	2.1%	71.3%
Minnesota	52	268	114	60	31	1	28	9	165	38	49	815	2.1%	73.4%
Maryland	31	234	174	52	38	2	24	15	117	28	33	748	1.9%	75.3%
Missouri	40	324	95	55	20	0	21	3	121	21	29	729	1.9%	77.1%
Colorado	33	224	101	44	35	0	26	19	93	54	44	673	1.7%	78.8%
Arizona	26	208	75	45	17	0	29	5	151	23	26	605	1.5%	80.4%
Connecticut	20	126	151	36	35	0	11	7	150	16	22	574	1.5%	81.8%
Alabama	19	255	110	35	19	0	9	1	53	14	32	547	1.4%	83.2%
Louisiana	15	236	60	55	10	0	10	4	126	8	21	545	1.4%	84.6%
Kentucky	16	251	86	36	6	0	15	1	93	9	15	528	1.3%	86.0%

APPENDIX 6-B (Continued)

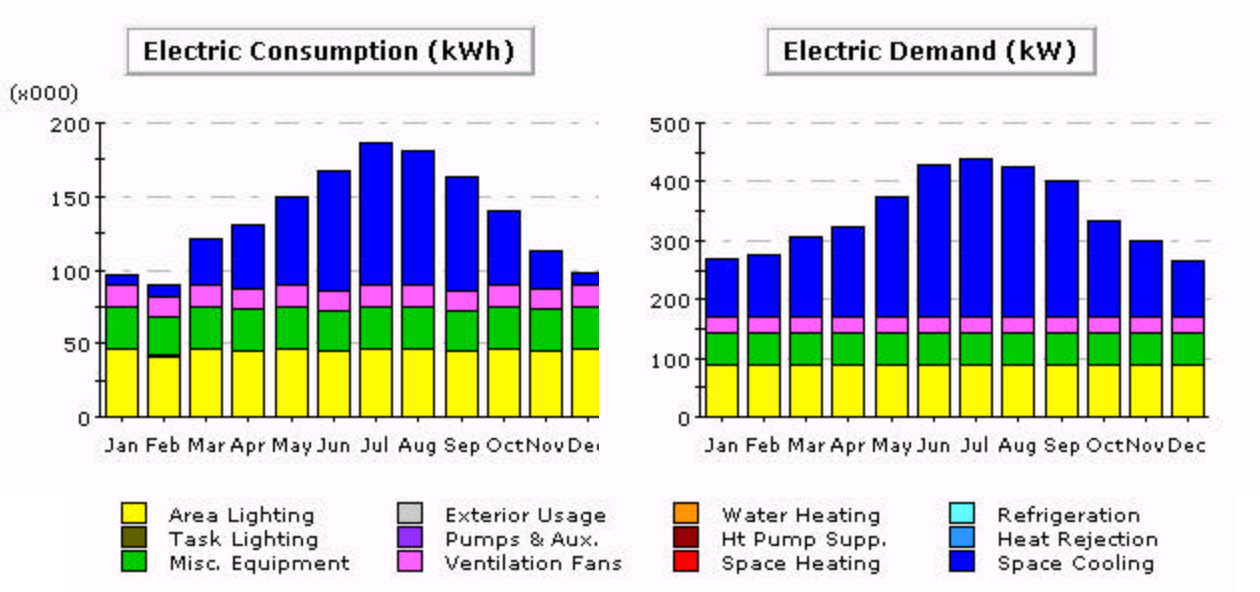
State	5251	5311	5600	5712	5719	5722	5731	5734	5912	5941	5942	TOTAL	Percent of Total	Cumula-tive Percent
Oregon	18	167	67	38	16	0	18	8	102	26	26	486	1.2%	87.2%
South Carolina	15	215	82	32	24	0	5	5	48	11	29	466	1.2%	88.4%
Iowa	34	188	36	25	4	0	12	2	98	11	15	425	1.1%	89.5%
Oklahoma	12	216	46	20	9	0	7	1	32	8	15	366	0.9%	90.4%
Kansas	22	168	50	10	10	0	11	0	36	7	17	331	0.8%	91.3%
Utah	9	117	48	24	14	0	14	1	46	16	30	319	0.8%	92.1%
Mississippi	7	170	37	21	3	0	3	1	45	1	10	298	0.8%	92.8%
Arkansas	7	185	32	16	1	0	5	1	31	5	11	294	0.7%	93.6%
Nevada	15	86	56	23	8	0	10	4	56	11	17	286	0.7%	94.3%
New Hampshire	8	87	62	13	13	0	6	3	47	11	10	260	0.7%	95.0%
Nebraska	11	113	31	17	2	0	8	0	50	8	15	255	0.7%	95.6%
New Mexico	6	86	29	18	5	0	8	1	50	15	19	237	0.6%	96.2%
West Virginia	9	100	32	16	3	0	3	0	25	3	9	200	0.5%	96.7%
Rhode Island	2	43	30	6	8	2	1	0	84	4	6	186	0.5%	97.2%
Maine	6	83	40	7	6	0	4	2	22	6	9	185	0.5%	97.7%
Idaho	8	74	15	10	2	0	4	5	31	9	8	166	0.4%	98.1%
Delaware	9	48	29	14	6	0	3	1	32	6	4	152	0.4%	98.5%
Montana	6	59	10	8	1	0	1	1	9	17	9	121	0.3%	98.8%
South Dakota	10	59	16	8	2	0	5	0	14	3	3	120	0.3%	99.1%
North Dakota	5	49	18	11	3	0	2	2	14	5	3	112	0.3%	99.4%
Vermont	4	32	17	3	2	0	3	0	16	6	6	89	0.2%	99.6%
Washington, D.C.	0	7	29	4	4	0	0	0	17	2	21	84	0.2%	99.8%
Wyoming	6	36	5	0	0	0	1	0	6	2	5	61	0.2%	100.0%
Alaska	0	0	0	0	0	0	0	0	0	0	0	0	0.0%	100.0%
Hawaii	0	0	0	0	0	0	0	0	0	0	0	0	0.0%	100.0%
TOTAL	**6,799**	**18,693**	**12,752**	**8,305**	**7,197**	**5,743**	**6,873**	**6,149**	**14,053**	**7,359**	**7,871**	**39,219**	**100.0%**	

Source: EEA; Dun & Bradstreet Sales and Marketing Solutions, *MarketPlace Jul-Sep 2002*.

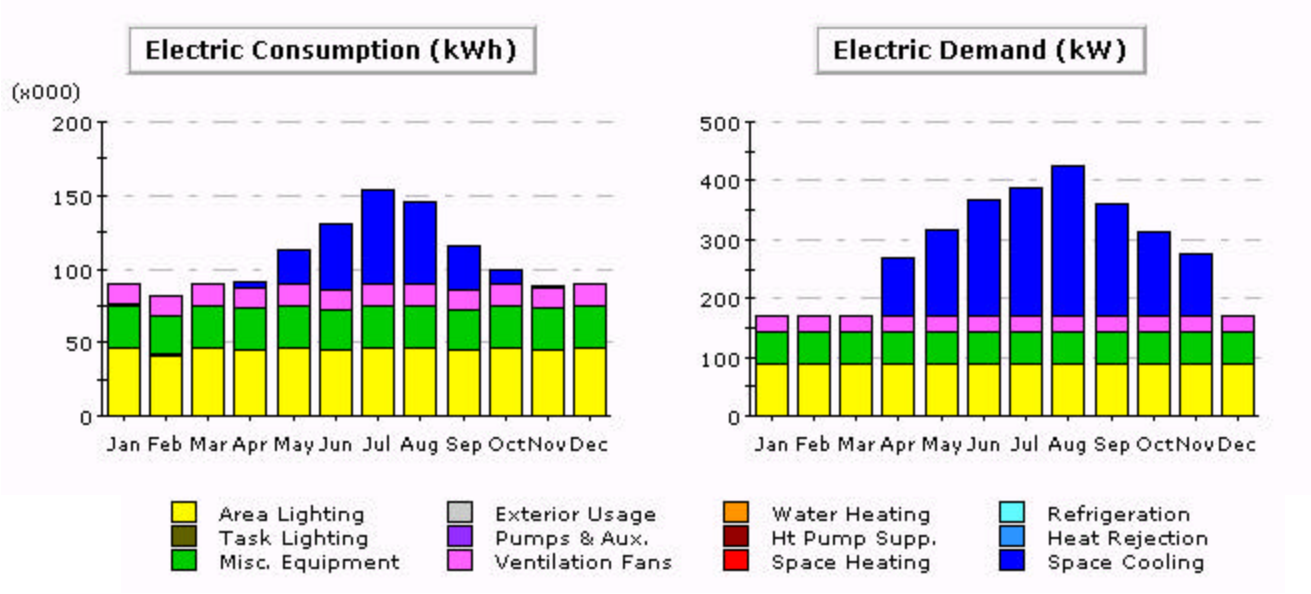
APPENDIX 6-C: TYPICAL BIG-BOX RETAIL STORE ELECTRIC AND GAS LOAD CURVES

FIGURE 6C-1
ELECTRIC CONSUMPTION AND DEMAND FOR 70,000 FT^2 BIG-BOX STORE

Representative Southwest (Phoenix, AZ) Store



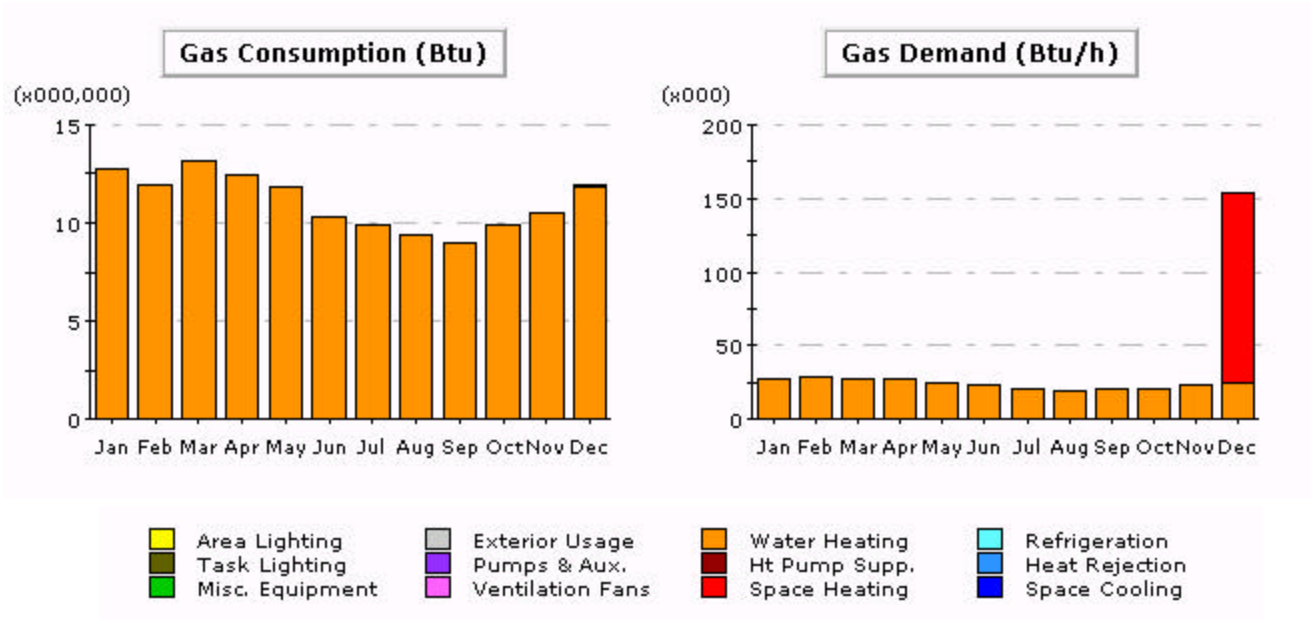
Representative Northeast (Hartford, CT) Store



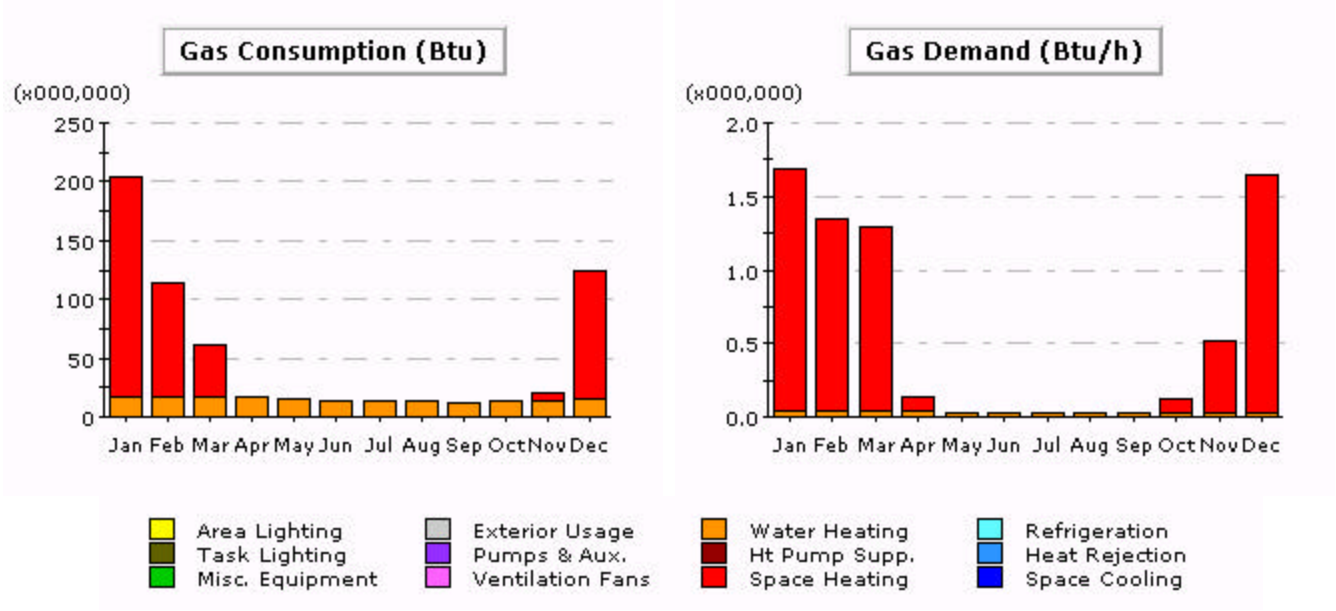
Source: EEA; Energy Design Resources, eQuest2002 Database; Regional Economic Research, Inc., *eShapes, 2001 National Database.*

FIGURE 6C-2
GAS CONSUMPTION AND DEMAND FOR 70,000 FT^2 BIG-BOX STORE

Representative Southwest (Phoenix, AZ) Big-Box Store



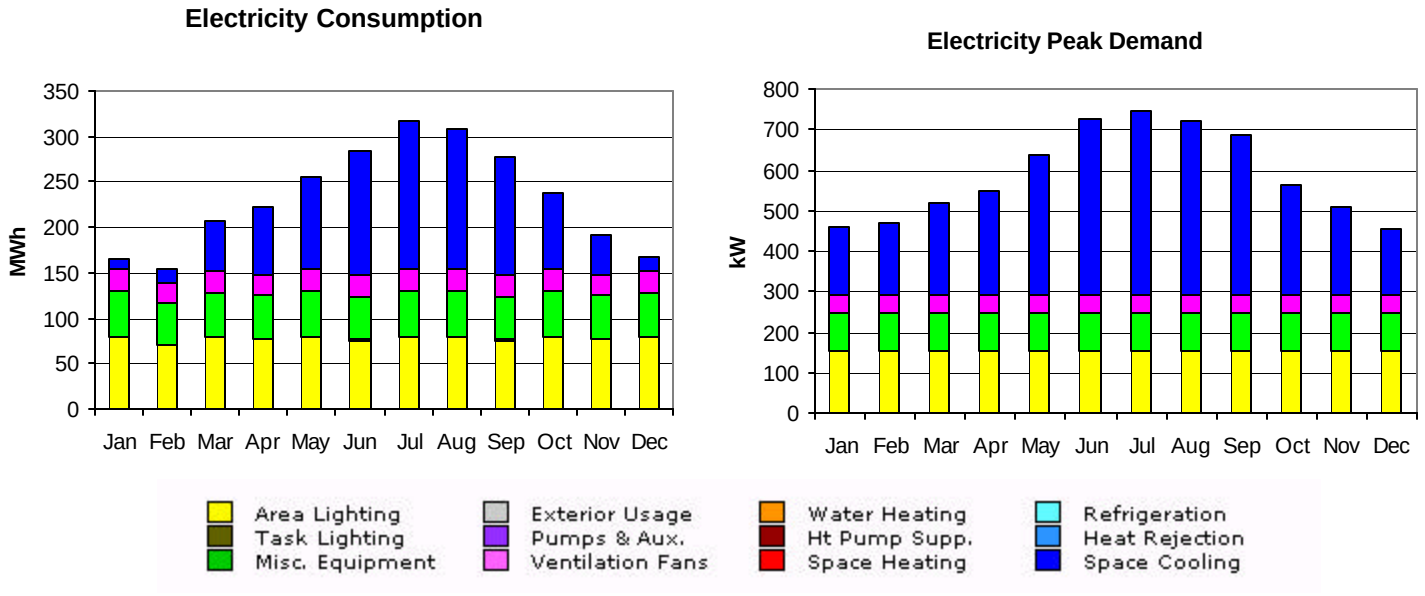
Representative Northeast (Hartford, CT) Store



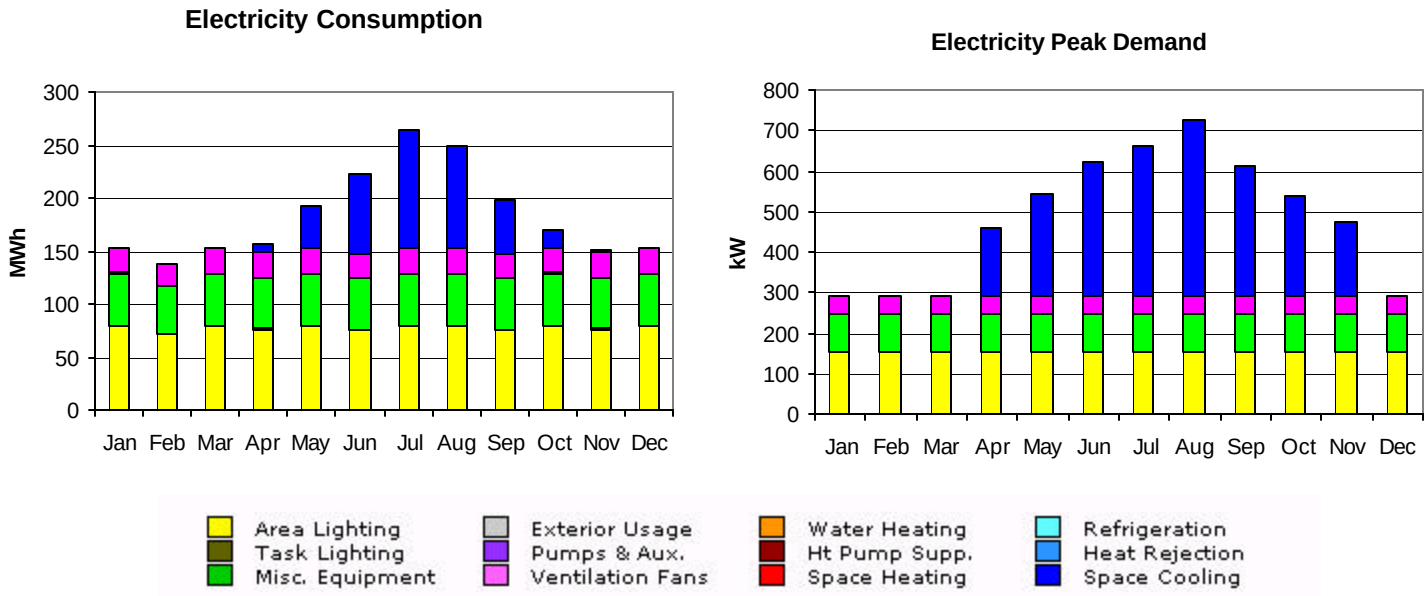
Source: EEA; Energy Design Resources, eQuest2002 Database; Regional Economic Research, Inc., *eShapes, 2001 National Database*.

FIGURE 6C-3
ELECTRIC CONSUMPTION AND DEMAND FOR 120,000 FT^2 BIG-BOX STORE

Representative Southwest (Phoenix, AZ) Store



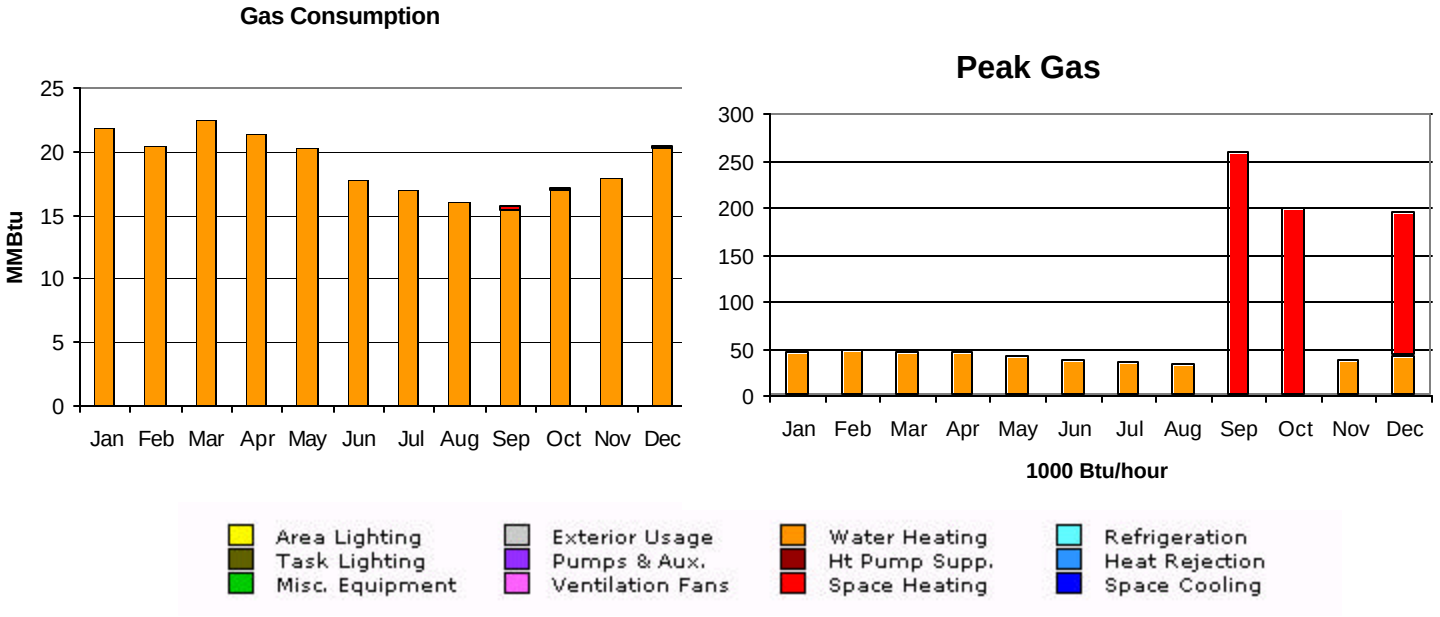
Representative Northeast (Hartford, CT) Store



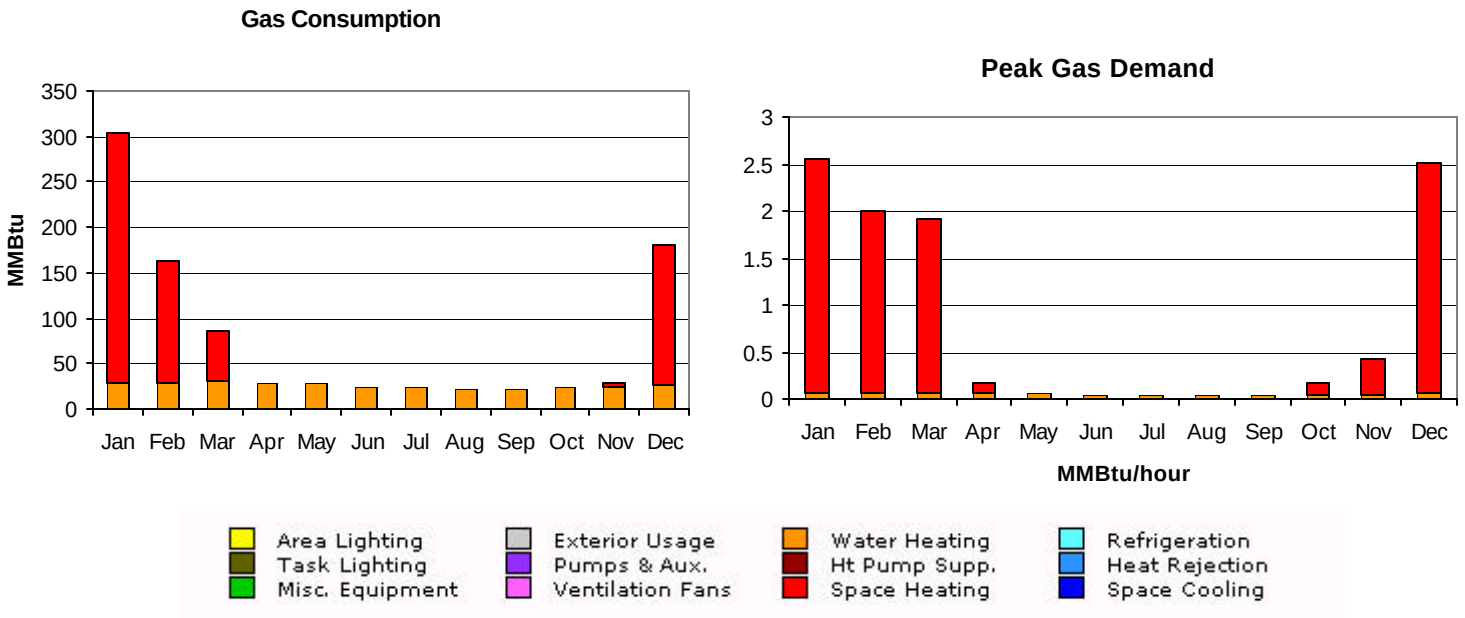
Source: EEA; Energy Design Resources, eQuest2002 Database; Regional Economic Research, Inc., *eShapes, 2001 National Database*.

FIGURE 6C-4
GAS CONSUMPTION AND DEMAND FOR 120,000 FT^2 BIG-BOX STORE

Representative Southwest (Phoenix, AZ) Big-Box Store



Representative Northeast (Hartford, CT) Store



Source: EEA; Energy Design Resources, eQuest2002 Database; Regional Economic Research, Inc., *eShapes, 2001 National Database*.

7. SUMMARY AND CONCLUSIONS

The five national account sectors we have profiled in this report present unique challenges and opportunities for TAT and advanced integrated energy systems. Following are brief summaries and conclusions based on the key information and observations for each sector.[1]

Hospitals and Nursing Homes

Even with some outsourcing of laundry and other thermal loads, the hospital segment features continuing attractive thermal to electric load ratios. Sector experience with CHP and absorption cooling, construction of significant new square footage forecast for the next few years, and the benefits that desiccant dehumidification offers in surgical suite applications appear promising for wider penetration of TAT and IES. Expansion and renovation projects have offered some of the best opportunities for TAT-IES incorporation. In the nursing home segment, the focus on operation of existing facilities, the critical importance of humidity control, and the attractive thermal loads also appear to offer promise.

Among hospitals, decision-making that is split between chain headquarters and individual locations presents some challenges, while the predominant role that engineering plays in both new construction and renovation can be helpful. Input from decision-makers about processes and criteria suggest that identifying and working with a "champion" on the hospital staff can be a key to success, as can the involvement of firms with specialized knowledge and experience in CHP for buildings. It is also important to keep in mind that most centralized chains use some type of guidelines that focus on lowest operating and installation costs and payback, while chains with individual location decision making often turn to the corporate specifications book and relationships with preferred vendors.

Supermarkets

With very high levels of electric energy intensity due to around-the-clock refrigeration loads, the industry focus on building energy-efficient new stores may be an opportunity for innovative TAT-IES systems. Slim margins throughout the industry mean that energy cost savings can play a key role in improving the bottom line. As supermarkets take on new shapes and sizes (e.g., superstores, supercenters) and offer more amenities such as in-house banking and fresh-prepared foods, energy needs may change. Separate decision-makers for refrigeration equipment and the preference for buying directly from manufacturers could make decisions about TAT-IES more complicated. Guidelines that are used by the majority of chains, focusing on lowest operating and up-front cost, quickest payback and highest return on investment, may be restrictive, especially in retrofit applications.

[1] A more definitive exploration of the potential for TAT-IES in the five target sectors may be found in the EEA companion report, *National Accounts TAT Market Potential.*

Hotel/Motel

In this sector, upper-tier properties offer some attractive thermal loads, and there is some use and familiarity with CHP and absorption cooling. However, separation of ownership and operation places the investment decisions with property owners, whose competing uses for capital include acquiring and building new (revenue-generating) properties. Also, projects that are highly visible to hotel patrons receive top priority. Frequent turnover in ownership and management contracts also presents challenges, along with relatively high involvement of senior management in decision-making. On the other hand, assured power quality and reliability are important concerns.

Information and analysis by segment (full service, limited service, luxury) may be a key to widespread penetration in this industry, as buildings within each segment across companies have similar physical and operating characteristics.

Restaurants

With energy costs a small percentage of a typical restaurant's operating budget, energy equipment investments are relatively unimportant to a restaurant chain's success. Lack of thermal load has limited CHP opportunities in the restaurant sector, and the decision- making processes, personnel and criteria typically found further restrict opportunities. Priority for capital expenditures is given to food preparation equipment and projects visible to patrons. Lack of skilled maintenance on-site and disincentives to perform routine maintenance at the restaurant manager level combine to discourage TAT-IES investments. Also, energy cost savings are currently usually sought on the commodity side rather than the equipment side.

The projected trend toward more take-out and more "quick casual" units mean that smaller padsites will predominate, which could limit TAT-IES, along with an increasing emphasis in the full-service segment on expenditures for physical design and décor rather than 'back-of-the-house" features. However, restaurateurs are concerned about their abilities to manage indoor air quality and energy demand issues successfully, and want the ability to remain open and ensure patron comfort during grid failure, two factors that would support interest in TAT-IES.

Big-Box Retail

More than any other sector, the priority use for capital in big-box retail is for construction and opening of new facilities. While thermal loads vary depending on product category, lack of thermal load generally limits CHP opportunities, with low hot water requirements and minimal space heating needs. Year-round cooling loads suggest opportunities for absorption chillers, while customer comfort concerns may offer promise for desiccants. Chains' reliance on prototype store designs could be helpful in promulgating TAT-IES, once incorporated into a design.