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Intelligent Building Series, Volume 2: Grocery and Convenience Stores

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ABSTRACT

Today's grocery and convenience stores are facing intense competition from nontraditional food retailers such as wholesale retailers, mass merchandisers, and pharmacy and dollar stores. This competition is forcing grocery and convenience stores to seek ways to attract new customers, reduce operating costs, and retain their employees.

This report examines the grocery and convenience store segment in terms of market trends, energy use, and the potential for demand response implementation. Electric loads that can be curtailed in grocery and convenience stores are explored along with barriers to demand response implementation and suggestions for overcoming them.

Keywords
Demand response
Electricity load reduction
Grocery and convenience stores
Refrigeration and lighting

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1
INTRODUCTION TO GROCERY AND CONVENIENCE STORES

The food marketing system in the United States has undergone an evolution over the past 80 years. Before the introduction of large grocery stores (also known as "supermarkets") in the 1930s, people purchased food from small neighborhood stores, which were usually family-owned businesses. When supermarkets entered the marketplace, they had an immediate advantage through economies of scale and were able to charge customers less and still earn a greater profit. Many neighborhood stores went out of business, but in their wake, convenience stores entered the marketplace to offer customers easy access to a smaller offering of products. Since convenience stores also tend to operate 24 hours a day, they made goods available when the supermarkets were closed. Over time, gas service stations began operating these convenience stores on site as well.

Today, grocery and convenience stores are facing intense competition from nontraditional food retailers such as wholesale retailers (e.g. Costco, Sam's Club), mass merchandisers (e.g. Target, Wal-Mart), and other retailers (e.g. Walgreens, CVS, Dollar Tree, 99-Cent stores). This competition is forcing grocery and convenience stores to seek ways to attract new customers, reduce operating costs, and retain their employees.

This report examines the grocery and convenience store segment in terms of market trends, energy use, and the potential for demand response implementation.

Definitions of Grocery and Convenience Stores

The North American Industry Classification System (NAICS) uses the following definitions for grocery and convenience stores:[1]

- NAICS code 445110 – Supermarkets and Other Grocery (except Convenience) Stores: "This industry comprises establishments generally known as supermarkets and grocery stores primarily engaged in retailing a general line of food, such as canned and frozen foods; fresh fruits and vegetables; and fresh and prepared meats, fish, and poultry. Included in this industry are delicatessen-type establishments primarily engaged in retailing a general line of food."
- NAICS code 445120 – Convenience Stores: "This industry comprises establishments known as convenience stores or food marts (except those with fuel pumps) primarily engaged in retailing a limited line of goods that generally includes milk, bread, soda, and snacks."
- NAICS code 447110 – Gas Stations with Convenience Stores: "This industry comprises establishments engaged in retailing automotive fuels (e.g., diesel fuel, gasohol, gasoline) in

[1] The NAICS definitions are available online at: http://www.census.gov/cgi-bin/sssd/naics/naicsrch?chart=2007

combination with convenience store or food mart items. These establishments can either be in a convenience store (i.e., food mart) setting or a gasoline station setting. These establishments may also provide automotive repair services."

In accordance with the above definition, the terms "grocery store" and "supermarket" are used synonymously throughout this report.

Grocery Stores

Grocery stores can be found in every area of the United States, but their number in any particular location depends on the size of the local population. As a result, the states with the most grocery store establishments are also the states with the largest population. According to the 2009 Economic Census conducted by the U.S. Census Bureau, there were over 63,000 grocery stores in the country. New York led the list with 8,792 stores, followed by California (7,813), Florida (3,621), Texas (3,342), and Illinois (2,720). Figure 1-1 shows the ten states that have the most grocery store establishments.

Examples of national grocery store chains that currently operate in the United States are Safeway, Albertsons, Ralphs, and Trader Joe's. There are numerous regional and local grocery store chains in addition to the national chains.

States	# of Establishments
New York	8,792
California	7,813
Florida	3,621
Texas	3,342
Illinois	2,720
Pennsylvania	2,509
New Jersey	2,486
Michigan	2,116
Ohio	2,099
North Carolina	1,785

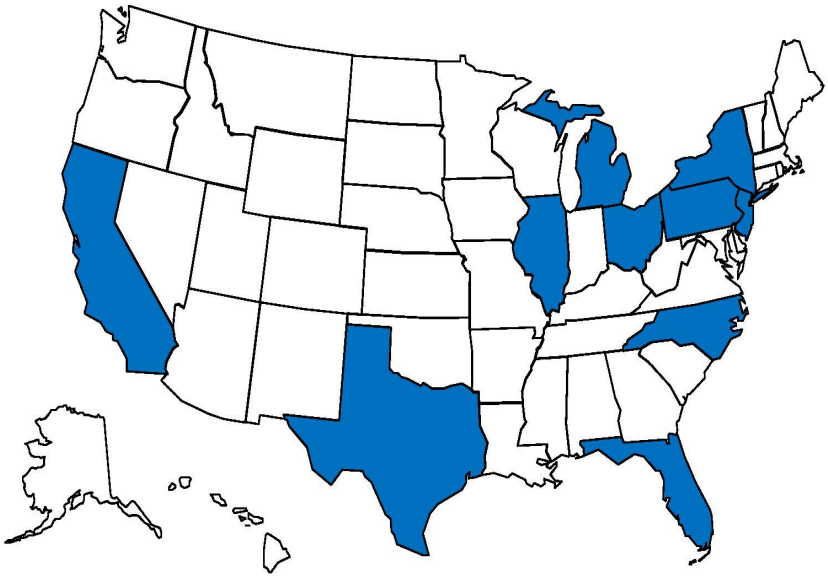

Figure 1-1
Top Ten States for Grocery Stores[2]

[2] Source: U.S. Department of Commerce, United States Census Bureau, 2009 Economic Census data available online at: http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml

Convenience Stores

According to the same 2009 Economic Census, there were over 26,000 convenience stores in the country. Convenience stores can be found throughout the United States, but as with grocery stores, states that have the largest population also have the largest number of convenience stores. Figure 1-2 shows the ten states that have the most convenience store establishments. Texas led the list with 2,501 stores, followed by Florida (2,347), California (2,284), New York (1,859), and New Jersey (1,405).

Convenience stores typically range in size from 800 to 5,000 square feet and usually have a small parking lot.[3] Examples of convenience store chains that currently operate in the United States include 7-Eleven and Circle K. These "traditional" convenience stores typically have a floor area of about 2,500 square feet.

States	# of Establishments
Texas	2,501
Florida	2,347
California	2,284
New York	1,859
New Jersey	1,405
Massachusetts	1,374
Ohio	1,230
Michigan	1,165
Pennsylvania	1,029
Virginia	1,001

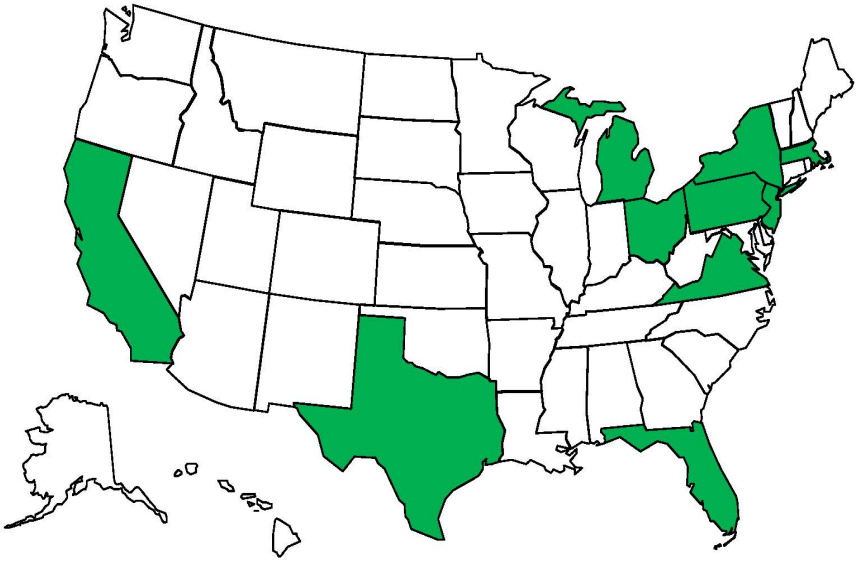

Figure 1-2
Top Ten States for Convenience Stores[4]

Gas Stations with Convenience Stores

The 2009 Economic Census also indicated that there were nearly 94,000 gas stations with convenience stores in the country. This type of gas station can be found throughout the United States, and again, states that have the largest population and amount of roads have the most number of gas stations with convenience stores. Figure 1-3 shows the ten states that have the most gas station establishments. Texas by far has the largest number of establishments at 9,199, followed by California (5,815), Florida (5,432), Georgia (4,717), and North Carolina (4,148).

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[3] National Association of Convenience Stores (NACS), survey conducted in 1995.

[4] Source: U.S. Department of Commerce, United States Census Bureau, 2009 Economic Census data available online at: http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml

Approximately 60% of gas stations with convenience stores are operated by traditional convenience store operators such as 7-Eleven and Circle K. The remaining 40% are operated by petroleum marketers or major oil companies such as Shell, Mobil, and BP.

States	# of Establishments
Texas	9,199
California	5,815
Florida	5,432
Georgia	4,717
North Carolina	4,148
Ohio	3,408
Illinois	3,288
New York	3,193
Michigan	3,162
Tennessee	3,059

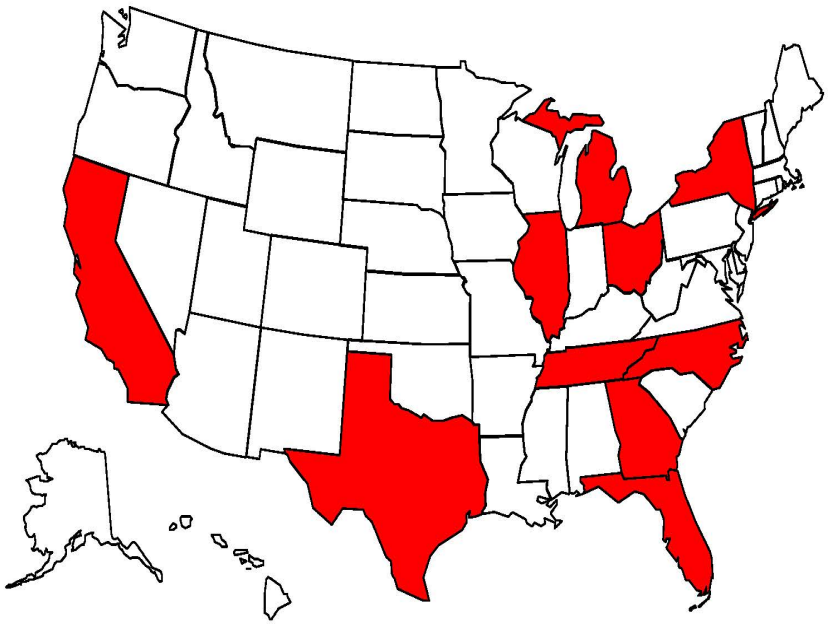

Figure 1-3
Top Ten States for Gas Stations (with Convenience Store)[5]

Market Trends

The number of grocery and convenience stores in the U.S. has declined dramatically over the past twenty years. In 1993, there were approximately 114,300 grocery stores and 49,500 convenience stores in the country.[6] By 2002, the number of establishments had dropped by nearly half to approximately 66,000 grocery stores and 29,000 convenience stores (see Table 1-1).[7] The number of grocery and traditional convenience store establishments in 2007 was lower than 2002 and, though partially offset by an increase in gas station convenience stores, the declining trend continued. The number of convenience stores increased slightly in 2009 relative to the 2007 level, but the number of grocery stores still continued to decrease.

[5] *Ibid*.

[6] U.S. Department of Agriculture, Economic Research Service, *Food Marketing Review*, 1994-1995.

[7] The reader is advised that the source for the information contained in Table 1-1 is the U.S. Department of Commerce, U.S. Census Bureau, 2002-2009 Economic Census data. The source for the information contained in section 2 is the U.S. Department of Energy, Energy Information Administration, 2003 CBECS.

Table 1-1
Profile of Grocery and Convenience Store Establishments

	Number of Establishments			Sales ($ billion)			Employees (thousand)		
	2002	**2007**	**2009**	**2002**	**2007**	**2009**	**2002**	**2007**	**2009**
Grocery Stores	66,150	64,881	63,634	$395.2	$466.2	N/A	2,438	2,432	2,440
Convenience Stores	29,212	25,510	26,625	$20.4	$20.9	N/A	138	119	121
Gas Stations	93,691	97,508	93,964	$186.7	$336.3	N/A	722	719	693
Total	**189,053**	**187,899**	**184,223**	**$602.3**	**$823.4**	**N/A**	**3,298**	**3,270**	**3,254**

Source: U.S. Department of Commerce, United States Census Bureau, 2002 - 2009 Economic Census data available online at: http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml

Several factors have contributed to the general decline in the number of grocery and convenience store establishments. One factor is the general rise in the popularity of "one-stop shopping" which arose in the early 1970s in response to changes in the American culture, such as women in the workforce and diminishing "leisure" time. A more recent factor is the loss of market share to nontraditional food retailers such as supercenters, warehouse clubs, department stores, drugstores, and "dollar" stores. Supercenters such as Super Wal-Mart and Super Kmart and Fred Meyer follow a cost-leadership strategy, offering a wide variety of food and nonfood merchandise at lower prices than traditional grocery and convenience stores. Warehouse clubs such as Costco and Sam's Club have lower prices for merchandise and lower operating expenses. Many mass-merchandise and department stores such as regular Target and Wal-Mart stores now offer grocery items to provide customers with a one-stop shop. By competing in both the food and drug industries, drugstores such as Walgreens and CVS follow a differentiation strategy to attract customers. Dollar stores such as Dollar Tree and 99-Cent stores have also emerged as formidable competitors to traditional food retailers by appealing to bargain and low-income shoppers with a cost-focus strategy.

Table 1-2 shows a breakdown of consumers' expenditures by type of outlet when making grocery purchases. The data in this table shows that the market share of traditional outlets such as grocery and convenience stores has decreased from 81.7% in 1994 to 67.4% in 2005. During the same timeframe, the share of nontraditional outlets has increased from 17.1% to 31.6% (most of this increase is accounted for by the large increase in market share of supercenters and warehouse club stores).

Table 1-2
Share of Grocery Expenditures by Type of Outlet

	1994	2001	2005
Traditional grocery retailers			
Supermarkets	59.2%	62.7%	58.2%
Convenience stores	3.1%	2.9%	2.9%
Other grocery	16.6%	3.5%	3.6%
Specialty food stores	2.8%	2.3%	2.7%
Total Traditional	**81.7%**	**71.4%**	**67.4%**
Nontraditional grocery retailers			
Supercenters (e.g. Super Wal-Mart) and warehouse clubs (e.g. Costco)	3.9%	11.7%	17.1%
Mass merchandisers (e.g. Target)	1.8%	2.2%	1.8%
Other stores (e.g. Walgreens, 99-Cent)	9.0%	9.6%	8.7%
Home delivered and mail order	2.4%	4.1%	4.0%
Total Nontraditional	**17.1%**	**27.6%**	**31.6%**

Source: U.S. Department of Agriculture, Economic Research Service, *The U.S. Food Marketing System: Recent Developments, 1997-2006*, May 2007.

Business Challenges

Grocery and convenience stores face the dual challenges of a competitive market and changes in consumer buying habits. As a result, their primary concerns center around reducing operating costs, and gaining and sustaining the interest of customers.

Competition

As discussed in the previous section, grocery and convenience stores exist in an environment of stiff competition. The grocery store segment is most affected by the increased competition from supercenters and warehouse club stores. These nontraditional food outlets have one key advantage: economy of scale. They purchase large volumes of products packaged in multipack or larger sizes, such that the cost per product unit is minimized. Coupled with a "no frills" shopping environment, this allows supercenters and warehouse clubs to offer low retail prices. On the downside, these large outlets stack a limited variety of products and brands and force customers to purchase goods in large quantities that must then be stored at home. However, the growth in the popularity of supercenters and warehouse clubs indicates that many shoppers are willing to forgo convenience to obtain lower prices. In this increasingly price-sensitive and cost-conscious environment, grocery stores owners and operators are focused more than ever on reducing operating costs, so they can have the flexibility to reduce retail prices to attract customers.

Labor represents the largest component of operating expenses in grocery stores. As a result, many grocery stores have moved toward the use of more sophisticated information technologies

that can improve checkout, accounting, stocking, and scheduling efficiencies while also reducing labor costs. Energy costs, which can account for 3% to 10% of total operating cost, can also be significant. A reduction in energy costs can significantly affect a grocery store's bottom line.

The convenience store segment has not been affected as much as grocery stores by the competition from superstores and warehouse clubs, but this segment appears to have reached saturation (as seen in the lack of change in market share between 2001 and 2005 in Table 1-2). In an effort to reduce operating costs, traditional convenience store operators are downsizing and some chains are consolidating. Convenience stores are also concentrating on improving existing stores by changing their product mix and enhancing customer service.

Attracting Customers

One of the most significant demographic changes in the U.S. over the past decades is the decline in the number of married-couple households. Because increasing numbers of people are living and eating alone, retailers must market more prepared foods and "single-serving" products. In addition, there are now a large number of dual-income families due to the large number of women in the workforce. Dual-income families compose a consumer group that values convenience and a swift checkout process.

In order to cater to the changing demographics and consumer buying habits, grocery and convenience stores have implemented the following strategies:

- Offer a greater variety of products and services: Many convenience stores now offer access to fast food, ATMs, copy and fax services, and postal services. Grocery stores are adding many of the same services as well as pharmacy, bakery, and deli/café departments. This enhanced variety of products and services increases foot traffic in the stores and expands revenues from nonfood sales.
- Increase convenience: Self-checkout lanes are now common in grocery stores. Improving the speed of the checkout process can make a critical difference for customers who put a premium on getting in and out of a store quickly.
- Improve appearance and atmosphere of store: New store designs offer consumers an upscale shopping experience. For example, the Stop & Shop Supermarket chain rents space to Dunkin' Donuts and Boston Market and has redesigned its health and beauty section to emphasize "health and relaxation." Safeway has opened "lifestyle" stores, which are sophisticated shopping venues with high-quality produce, soft lighting, and classes on topics such as flower arranging. These improvements help to attract customers and increase the amount of time shoppers spend in a store.

2
ENERGY USE

The results of the most recent Commercial Building Energy Consumption Survey (CBECS) conducted by the U.S. Department of Energy's Energy Information Administration (EIA) indicate that grocery and convenience stores across the nation consumed approximately 153 trillion BTU and 36 trillion BTU of energy in 2003, respectively.[8] These figures include electricity, natural gas, and fuel oil.

Table 2-1, Table 2-2, and Table 2-3 show the breakdown of the total annual energy consumption of grocery stores, convenience stores, and gas stations into the different fuel types, respectively. The tables show that electricity accounts for 80% of the total energy consumption in grocery stores, 89% in convenience stores, and 92% in gas stations. In terms of electricity consumption, grocery stores consumed 36 billion kWh (122,944 billion BTU), convenience stores consumed 9.5 billion kWh (32,344 billion BTU), and gas stations consumed 14 billion kWh (47,288 billion BTU) in 2003.

Table 2-1
Breakdown of Energy Consumption in Grocery Stores in the U.S.

	Billion BTU	Percent of Total	Thousand BTU per ft^2
Electricity	122,944	80%	172.0
Natural Gas	29,345	19%	41.1
Fuel Oil	1,001	1%	1.4
Total	**153,290**	**100%**	**214.4**

Source: U.S. Department of Energy, Energy Information Administration, 2003 CBECS, data available online at: http://buildingsdatabook.eren.doe.gov/CBECS.aspx

Table 2-2
Breakdown of Energy Consumption in Convenience Stores in the U.S.

	Billion BTU	Percent of Total	Thousand BTU per ft^2
Electricity	32,344	89%	202.1
Natural Gas	2,469	7%	15.4
Fuel Oil	1,422	4%	8.9
Total	**36,235**	**100%**	**226.4**

Source: U.S. Department of Energy, Energy Information Administration, 2003 CBECS, data available online at: http://buildingsdatabook.eren.doe.gov/CBECS.aspx

[8] The reader is advised that the source for the information contained in this section is the U.S. Department of Energy, Energy Information Administration, 2003 CBECS. The source for the information contained in Table 1-1 is the U.S. Department of Commerce, U.S. Census Bureau, 2002-2009 Economic Census data.

Table 2-3
Breakdown of Energy Consumption in Gas Stations in the U.S.

	Billion BTU	Percent of Total	Thousand BTU per ft^2
Electricity	47,288	92%	166.4
Natural Gas	3,103	6%	10.9
Fuel Oil	1,053	2%	3.7
Total	**51,443**	**100%**	**181.1**

Source: U.S. Department of Energy, Energy Information Administration, 2003 CBECS, data available online at: http://buildingsdatabook.eren.doe.gov/CBECS.aspx

The CBECS data provides a breakdown of the electricity consumption by end use, but only at the level of the general "Food Sales" classification which includes grocery stores, convenience stores, gas stations with a convenience store, and other food sales outlets such as delicatessens and bakeries. Table 2-4 and Figure 2-1 show the breakdown of electricity consumption in the Food Sales category of facilities in 2003. Overall, the Food Sales segment consumed a total of 61 billion kWh in 2003 (including 59.5 billion kWh from grocery and convenience stores), which is approximately 5.8% of the total electricity consumption of all commercial buildings in the country.

Table 2-4
Electricity Consumption by End Use for Food Sales and All Commercial Buildings in the U.S.

End Use	Food Sales		All Commercial Buildings	
	Billion kWh	kWh per ft^2	Billion kWh	kWh per ft^2
Space Heating	2	1.5	49	0.7
Space Cooling	4	2.9	141	2.0
Ventilation	2	1.8	128	1.8
Water Heating	Not Available	Not Available	26	0.4
Lighting	14	10.9	393	5.6
Cooking	1	0.6	7	0.1
Refrigeration	35	28.2	112	1.6
Office Equipment	2	0.9	66	0.3
Other	3	2.4	122	1.7
Total	**61**	**49.4**	**1,043**	**14.9**

Source: U.S. Department of Energy, Energy Information Administration, 2003 CBECS, data available online at: http://www.eia.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/detailed_tables_2003.html#enduse03

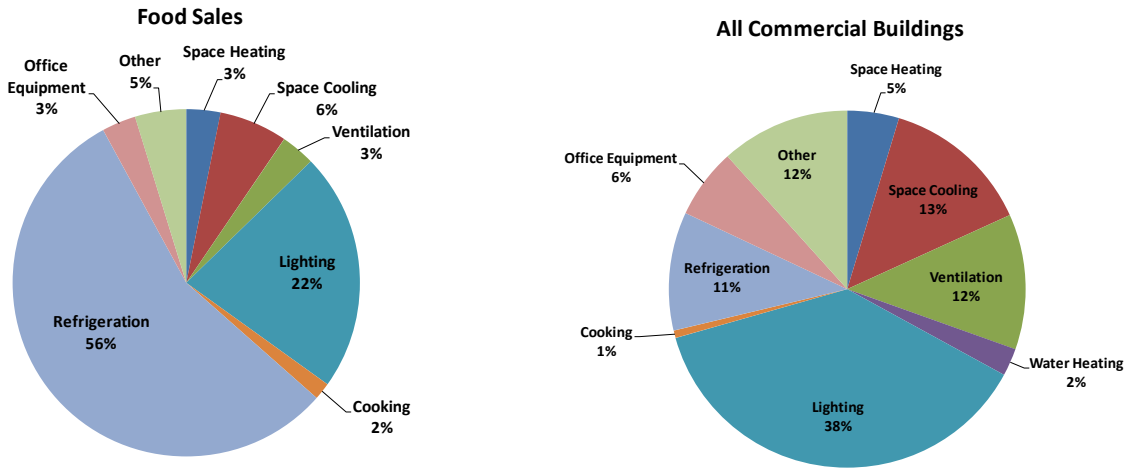

Figure 2-1
Breakdown of Electricity Consumption by End Use for Food Sales and All Commercial Buildings in the U.S.[9]

It can be seen in Table 2-4 and Figure 2-1 that the largest end uses of electricity in food sales facilities are refrigeration and lighting. Refrigeration equipment accounts for most of the electricity consumption (56%), and includes electricity used to produce the actual refrigeration effect as well as lighting and anti-sweat heater controls within the reach-in coolers. Lighting of the buildings' interior space is the next largest electricity end use at 22%, followed by the combination of space heating, ventilation and space cooling (HVAC) at 12%.

Grocery Stores

Energy consumption in grocery stores depends on geographic location (i.e., climate), building design, and operating hours. Figure 2-3 shows the breakdown of energy consumption (electricity and all other fuels combined) in grocery stores for five CBECS climate zones in the U.S. (see Figure 2-2). Space heating accounts for a larger portion of total energy consumption in colder climates, and the same is true for space cooling in warmer climates. Also, energy use for cooling is less in grocery stores than most other commercial buildings since a large amount of cooling effect is available from the display case and cooler refrigeration. The typical grocery store is open 105 hours a week (or 15 hours a day, for a store open seven days a week).

Convenience Stores and Gas Stations

Figure 2-3 also shows the breakdown of energy consumption (electricity and all fuels combined) in convenience stores and gas stations for the same five climate zones in the U.S. As expected, space heating accounts for a larger portion of total energy consumption in colder climates, and the same is true for space cooling in warmer climates.

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[9] Source: U.S. Department of Energy, Energy Information Administration, 2003 CBECS, data available online at:
http://www.eia.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/detailed_tables_2003.html#enduse03

Most convenience stores operate 18 to 24 hours per day; however, the number of convenience stores operating around the clock has been in decline. The factors contributing to this change include restrictive local legislation, security concerns, and the greater relative cost of doing business during the hours between midnight and 8AM when sales often do not meet overhead expenses. Gas stations with convenience stores tend to operate around the clock.

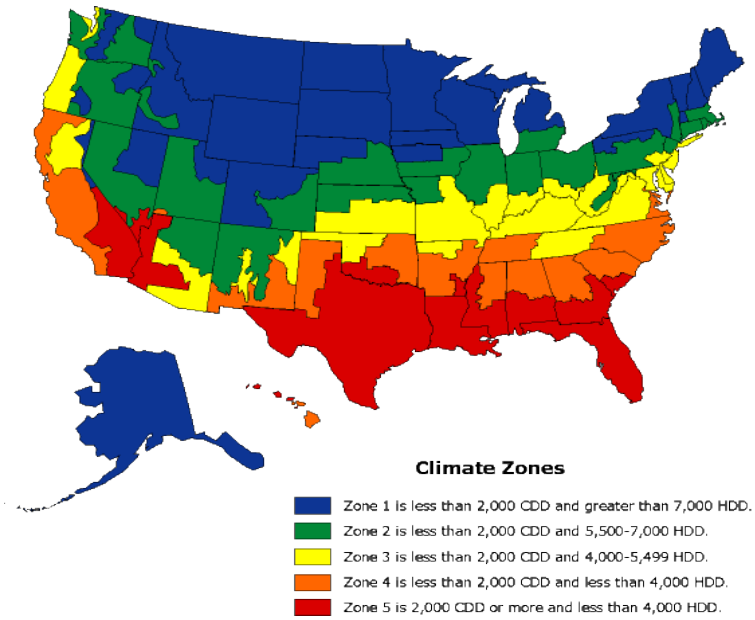

Figure 2-2
CBECS Climate Zones[10]

[10] Source: U.S. Department of Energy, Energy Information Administration, 2003 CBECS, available online at: http://buildingsdatabook.eren.doe.gov/Images/climzonenew.gif

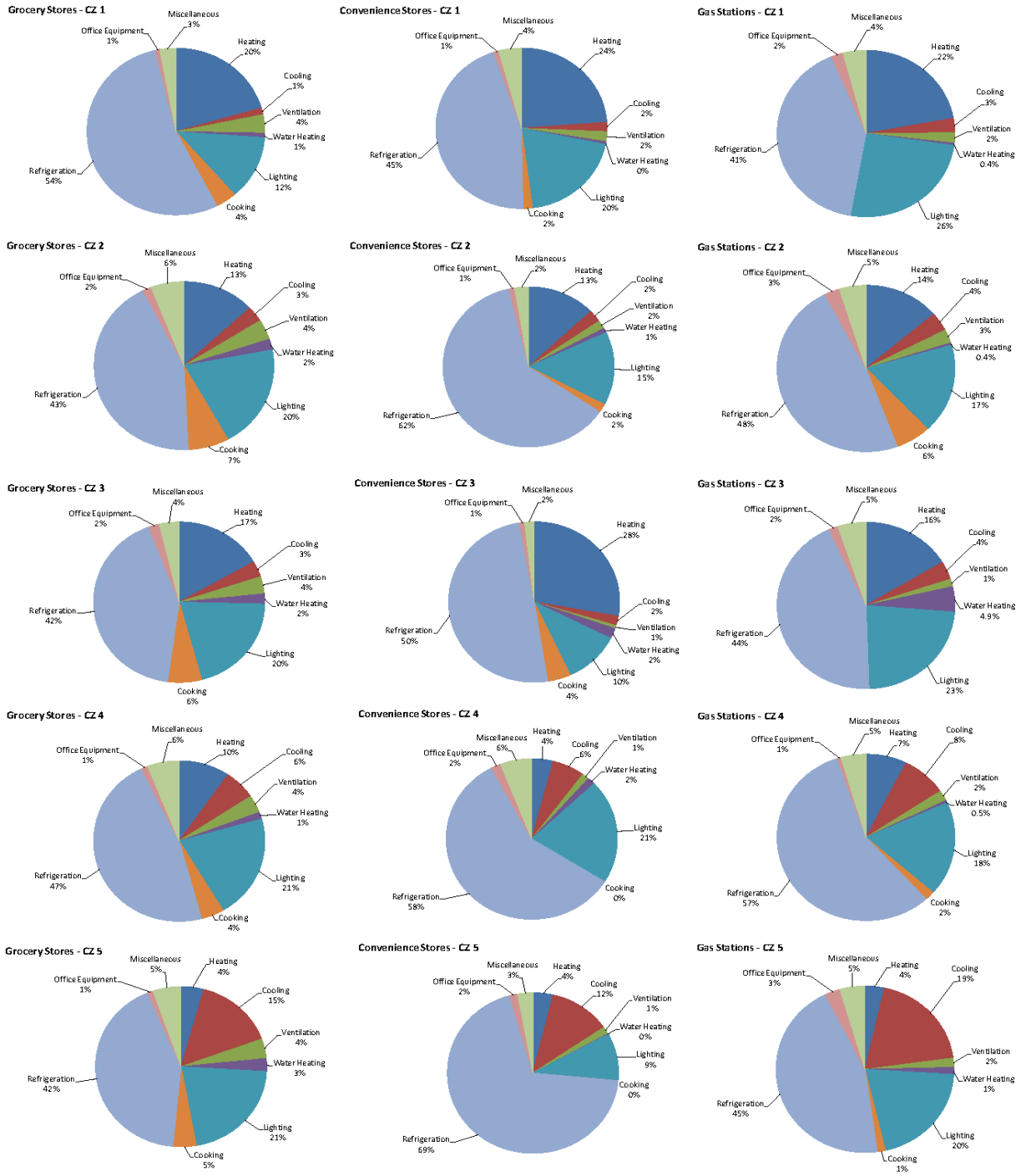

Figure 2-3
Energy Consumption by End Use in Grocery Stores, Convenience Stores, and Gas Stations by Climate Zone [11]

[11] Source: U.S. Department of Energy, Energy Information Administration, 2003 CBECS, data available online at: http://buildingsdatabook.eren.doe.gov/CBECS.aspx

3
DEMAND RESPONSE

Demand response refers to mechanisms that are used to manage the electricity demand in response to supply conditions, and it typically involves having electricity customers temporarily reduce their electric load at critical times or in response to market prices (a "demand response event"). Demand response aims to reduce the peak demand for electricity and is a different concept from energy efficiency, which involves using less energy to perform the same tasks on a continuous basis or whenever that task is performed. Some of the mechanisms used to facilitate demand response include special electricity rates and utility incentive programs to encourage electricity customers to reduce their demand during the critical times. This section focuses on the electric loads that can be curtailed in grocery and convenience stores, and not on the actual demand response mechanisms at the utility or programmatic levels.

Load Reduction Potential

A 2009 study published by the Federal Energy Regulatory Commission (FERC) indicated that the national potential for demand response to reduce peak demand could be as much as 150 GW by the year 2019 (relative to a "business as usual" scenario).[12] To provide some perspective, a typical peaking power plant is about 75 megawatts, so this reduction would be equivalent to the output of 2,000 such power plants. Of the 150 GW of achievable demand response potential, approximately 20 GW is attributable to small and medium facilities.[13] Assuming that grocery stores, convenience stores, and gas stations account for 5.8% of the 20 GW figure, an aggressive estimate of the achievable demand response potential for this segment is approximately 1 GW by the year 2019.[14]

In the previous section, the data in Table 2-4 indicates that the refrigeration and lighting end uses account for the majority of electric consumption in food sales facilities (which include grocery stores, convenience stores, and gas stations). Refrigeration accounts for 56% and lighting accounts for 22% of the total electricity consumption. The data in Figure 2-2 and Figure 2-3 also shows that the refrigeration and lighting end uses are the largest consumers of energy in grocery

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[12] Federal Energy Regulatory Commission, Staff Report, *A National Assessment of Demand Response Potential*, June 2009.

[13] The FERC study defined small facilities as commercial and industrial facilities that have summer peak demand less than 20 kW, and medium facilities as commercial and industrial facilities that have summer peak demand between 20 kW and 200 kW.

[14] As stated in Section 2, the entire Food Sales segment (which includes grocery stores, convenience stores, and gas stations) accounted for 5.8% of the total electricity consumption by commercial buildings in 2003. It is assumed that the portion of peak demand due to Food Sales would also be similar to its portion of the commercial building sector's total electricity consumption, and thus the figure of 5.8% is used to produce a rough estimate of the demand response potential for the entire segment. However, the 20 GW of demand response potential (from the FERC study) attributable to small and medium facilities includes commercial and industrial facilities (there was no way to isolate the data for commercial facilities only). As such, the 1 GW of demand response potential estimated for the combination of grocery stores, convenience stores, and gas stations is likely to be very aggressive.

stores, convenience stores, and gas stations regardless of the geographic location. As such, demand response activities that are focused on curtailing the refrigeration and lighting loads should produce the greatest load reduction within this segment.

Demand Response Measures

The following subsections discuss specific measures and opportunities that can be implemented to reduce the refrigeration and lighting loads during demand response events.

Lighting Measures

Lighting loads account for the second largest portion of electricity consumption after refrigeration in grocery and convenience stores. Unlike refrigeration, lighting loads are more conducive to demand response since lighting does not have a direct impact on the food products in the store. Lighting can be curtailed in a variety of ways:

- Lower lighting levels in the sales floor area: Depending on how the lighting fixtures are circuited, it may be possible to turn off a portion of the lighting in the sales floor area. This strategy would require sets of lighting fixtures to be on separate circuits (luminaire switching), or the ability to turn off lamps separately within the same fixture (lamp switching). Another alternative is to use a lighting controller or energy management system to dim or turn off the lamps.
- Turn off lighting in areas that have low traffic or are near windows: Lighting can be completely turned off in unoccupied areas such as storage rooms, loading docks, and walk-in freezers. Lighting can also be turned off in areas that have natural lighting such as the front entrance.
- Turn off display case lighting: Reach-in refrigerated cases are used to display frozen or other food products that must be kept at a low temperature. These display cases typically have lights to illuminate the products, and although newer cases now utilize LED lamps, many older cases still use fluorescent lamps. These lamps can be turned off completely during a demand response event without impacting the food products within the cases.

Refrigeration Measures

Refrigeration accounts for the largest portion of electricity consumption in grocery and convenience stores, but it is also the most difficult load to curtail because it is important for the stores to maintain product temperature in order to meet government health codes and prolong shelf life. However, it is possible to implement the following demand response measures without creating an impact on the product temperature:

- Turn off anti-sweat heaters: Condensation occurs when warm, humid air from a store's interior meets the cold air of a refrigerated display case. This can lead to ice build-up on door gaskets and to the fogging and "sweating" of the doors, which can prevent customers from seeing the products inside the refrigerated case. To prevent this condensation and "sweating," the refrigerated display case doors and frames are heated (hence the name "anti-sweat heaters"). In essence, the heater dries up any warm, humid air that may have gotten trapped inside the display cases during customers' opening and closing of the doors. These anti-sweat heaters utilize electric resistance heating elements, and can be turned off during a

demand response event. However, the implementation of this measure will usually require the use of anti-sweat heater controls or an energy management system.

- Delay electric resistance defrost: The evaporator coils inside a refrigerated display case have an electric resistance heater to remove any frost or ice build-up on the coils, which can reduce the refrigeration efficiency and eventual equipment failure. An appropriate measure would be to delay the operation of the defrost heater until after the demand response event. This measure will require the installation of defrost controls or an energy management system.

HVAC Measures

Electricity consumption by the HVAC system is the third largest portion of the total electricity consumption in grocery and convenience stores, and in warmer climates it is possible to curtail the cooling load by implementing the following measures:

- Increase space temperatures: This demand response strategy involves increasing the store's space cooling setpoint by two to four degrees to decrease the operation and load of the cooling system. While increasing the store's indoor temperature has the potential to affect customers' comfort, the change in temperature will not usually be noticeable for a demand response period of one to two hours. Once the demand response event is over, the cooling setpoint should be gradually returned to normal levels in order to avoid any "spiking" of the cooling system demand.
- Cycle air conditioning units: Grocery and convenience stores are typically cooled by packaged air conditioning units. A possible demand response strategy is to cycle on and off groups of packaged units such that each group operates for 15 minutes at a time. When cycling the packaged units, it is possible to shut down only the compressor by itself, or the compressor and the fans. This measure also has the potential to cause discomfort for the store customers, but the change in space temperature will not usually be noticeable for a short demand response period.

Other Measures

Other demand response measures that can be implemented in grocery and convenience stores involve turning off or delaying the use of miscellaneous equipment within the store. The following are examples of strategies that may be implemented during a demand response event:

- Delay the use of electric cooking appliances in the bakery or deli departments of the store;
- Delay the use of trash compactors;
- Delay the use of forklift battery chargers.

Example of Demand Response Implementation

Customers participate in demand response programs and partnerships across the nation by shedding load in response to a signal, or request. If a utility or grid operator has a sudden increase in demand, it sends a demand response dispatch that notifies a participating customer or a company engaged to work with the customers to curtail loads to restore balance to the system and avoid blackouts or brownouts. If a customer reduces its load during these dispatch events, the utility company or grid operator pays the customer (and the enabling service company) for

this service. Customers are also paid for being on standby to reduce demand, thereby providing reliable capacity to the utility or grid operator.

According to data obtained from EnerNOC, a provider of demand response services, the 1,304 supermarkets in the company's demand response portfolio participated in a total of 68 demand response events during the period from January 2011 to May 2012, called by utilities and grid operators all across North America, with each entity calling between 1 and 14 events.[15] All of these events were dispatched on a "day-ahead" (notification issued on the day before the actual event) or "day-of" (notification issued on the same day as the actual event) basis.

The average load reduction achieved by the 1,304 supermarket sites during the demand response events was 39 kW per site (although many sites were able to shed loads in the range of 100 kW to 200 kW). This load reduction was accomplished by implementing a package of demand response measures, as depicted in Figure 3-1. The following describes the types of demand response measures implemented by the provider of demand response services' 1,304 supermarket customers during the 68 demand response events occurring between January 2011 and May 2012:

- 1,272 sites implemented lighting curtailment measures such as turning off or dimming lights within the store;
- 586 sites implemented HVAC-related measures such as increasing the space cooling setpoint within the store;
- 482 sites implemented refrigeration measures such as delaying or turning off the anti-sweat heaters within the reach-in merchandise coolers; and
- 279 sites implemented other miscellaneous measures such as delaying or turning off the use of trash compactors and fork-lift battery chargers.

[15] Events were called by PJM, California utilities, Electric Reliability Council of Texas, Idaho Power, Independent System Operator (ISO) New England, New York ISO, Ontario Power Authority, Salt River Project, and TECO Energy. If multiple demand response events are dispatched on the same day by a utility or grid operator, then all the dispatches for that day are counted as one event.

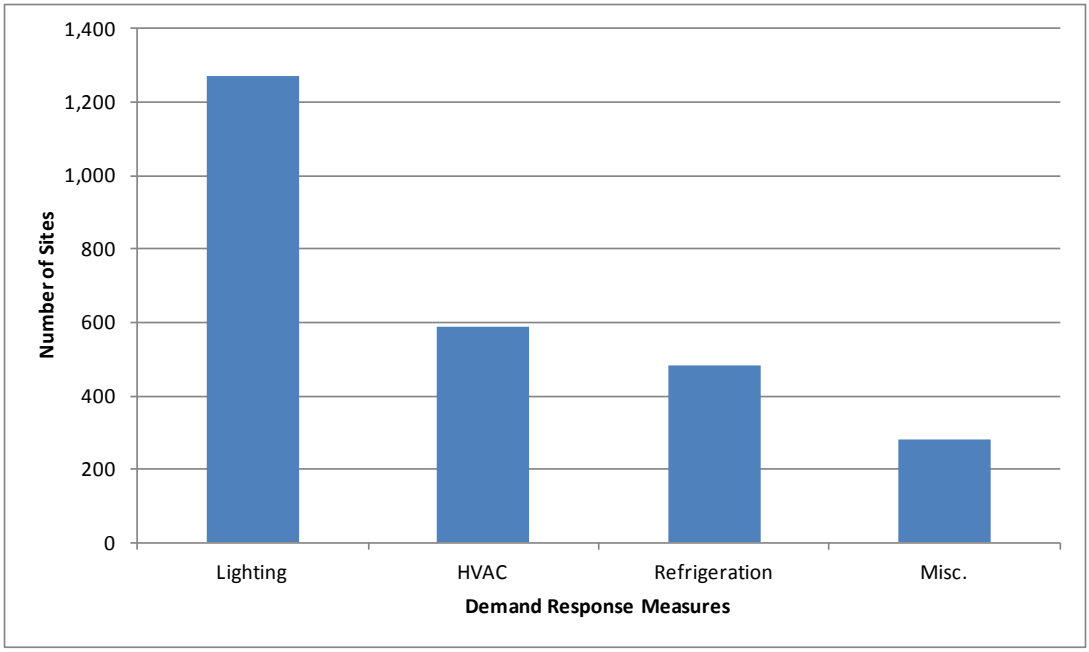

Figure 3-1
Demand Response Measures Implemented Supermarket Customers of a Provider of Demand Response Services[16]

Figure 3-2 shows the load profile of a supermarket customer located near San Luis Obispo, California (CBECS Climate Zone 4) that participated through a provider of demand response services. The load profile is for a day when an actual demand response event was dispatched by the local utility. This particular supermarket curtailed loads during the two hours between 3PM and 5PM, and it can be seen that the store's electricity demand during that two-hour period was lower than the baseline level. The following loads were curtailed during the demand response event: lighting, space cooling, and anti-sweat heaters in the reach-in refrigerated cases. Since the individual loads were not sub-metered, it is not possible to break down the curtailment by each type of equipment but the average load reduction achieved in aggregate during the two-hour period was 88 kW (approximately 8% of the baseline average of 1,076 kW).

Although the required curtailment period was for 3PM to 5PM, the load profile (Figure 3-2) shows that loads were reduced beginning at 2PM. The reason for this is that some of the loads such as those related to space cooling and anti-sweat heaters may require some time to ramp down, so the provider of demand response services executed the load reduction sequences well in advance of the curtailment period to ensure that loads were fully reduced by the time the demand response event began at 3PM.

[16] Source: EnerNOC, Inc.

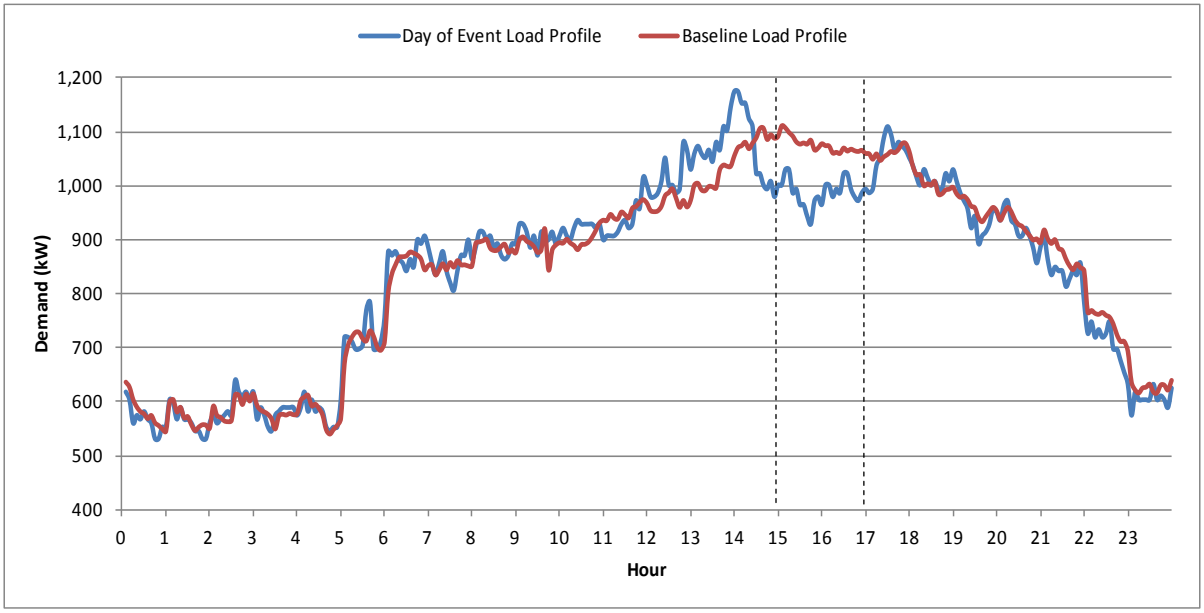

Figure 3-2
Load Profile of a Supermarket during a Demand Response Event[17]

The California Energy Commission (CEC) has also published a case study documenting grocery retailer Albertsons' experience in working to curtail lighting loads during demand response events.[18] In 2005, Albertsons signed up for the California Power Authority Demand Reserves Partnership and agreed to curtail load upon request. Albertsons installed a customized automated demand response system utilizing their existing energy management system. When demand response events are called by the Demand Reserves Partnership, Albertsons receives signals and communications directly to the stores' energy management systems to dim overhead lighting levels in the sales floor area by 35%. After initial tests were successful in demonstrating that reducing the lighting in one store can result in a 26.5 kW reduction, Albertsons proceeded to implement the curtailment system at a total of 300 stores in California (total summer peak demand of 110 MW) with a total curtailable load of 7.5 MW, a 6.8% reduction in peak demand.

Barriers to Demand Response

A number of barriers may prevent grocery and convenience stores from participating in demand response. Some of these barriers are economic in nature, while others have to do with technological limitations or perception. The following is a discussion of the barriers to demand response implementation in the grocery and convenience store segment.

[17] Source: EnerNOC, Inc.

[18] Albertsons worked with EnerNOC to enable and manage their load curtailment within the Demand Reserves Partnership. The case study is available online at: http://www.energy.ca.gov/enhancedautomation/case_studies/CS07_Albertsons_w2.pdf

Electricity Rates

Since demand response involves a temporary reduction in electricity demand, the energy savings resulting from demand response actions are usually small or negligible when compared to the total monthly or annual energy consumption. For grocery and convenience store operators that are looking to decrease operating costs, demand response will not result in a significant reduction in energy bills unless their electric tariff is structured to provide an incentive for reducing load during demand response events. However, most of today's retail electric tariffs are not structured to promote demand response participation. In these instances, the onus is on the electric utility to develop supportive tariffs or programs that will provide financial incentives for demand response participation, with the additional challenge of having to market the new tariffs to grocery and convenience store operators who may be unfamiliar with the demand response concept.

Metering Infrastructure

In order to receive the monetary benefits associated with participating in demand response events, the grocery or convenience store must have the appropriate electric meters (referred to as advanced meters). Advanced meters are capable of measuring, recording, and communicating electricity consumption in short time intervals (i.e. hourly or greater frequency). The ability to measure and record energy at short intervals and demand is necessary because demand response events generally last for only a few hours at a time. The penetration of advanced meters is still low in many parts of the country. Furthermore, in service territories where there is low penetration, utilities are more likely to give higher priority to large electricity consumers when installing advanced meters. This means that smaller facilities, such as convenience stores, may not have the required advanced meters for demand response participation.

Food Safety

Government health and food safety codes require that refrigerated or frozen food products be maintained at specific temperatures. For this reason, grocery and convenience store operators are reluctant to implement any demand response measures that are perceived to compromise their ability to maintain the food products at the required low temperatures. Although the refrigeration end use accounts for the largest portion of electricity consumption in grocery and convenience stores, the list of possible demand response measures for curtailing the refrigeration load is limited. The previously-discussed measures related to turning off anti-sweat heaters and delaying electric defrost in the reach-in coolers can be implemented without any impacts to the refrigerated or frozen food products.

Awareness and Education

The lack of awareness regarding demand response and its benefits can be a major barrier. Many grocery and convenience store operators are likely to have limited or no experience with demand response, and thus may be reluctant to participate. The electric utility will need to focus on raising customer awareness and education in these instances, which can be challenging if the utility also has limited experience with marketing demand response programs.

Fear of Customer Backlash

Grocery and convenience store operators may be concerned that the reduced load during a demand response event may cause customers to react negatively. For example, store operators

may be concerned that shoppers may complain about not having adequate light if interior lighting is curtailed, or that customers might not feel comfortable if the space cooling temperature is increased. While these concerns are legitimate, they can usually be alleviated by providing technical assistance and helping the store operators to find a level of load curtailment that they are willing to accept. Furthermore, shoppers can be informed about the store's participation in the demand response event by posting signs in the store (this can actually have a positive impact on the shoppers' perception of the store when they realize that the store is taking an active role in alleviating the power emergency).

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