# What Happened to My Corner Store? An Examination of the Potential for Low-Energy or Zero-Energy Buildings in the Retail Food Market

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**ABSTRACT**

This paper examines the retail food sales market and the potential for low energy and zero energy buildings in that market. The paper discusses patterns of ownership, operation, and decision-making and the importance of these for developing strategies to promote energy efficiency. The study describes the important segments and the value propositions that influence interest in energy efficiency and drive decision-making for these segments. Finally, the paper describes trends in store construction and design including the potential for zero or low energy buildings to be represented in the market.

## Introduction

The US Department of Energy and others are interested in the concepts of low energy and zero energy buildings and in developing effective and comprehensive strategies to rapidly move the technologies associated with these concepts into the market place. The purpose of this paper is to examine the retail food sales submarket from decision-making perspective, to assess the potential to incorporate low energy and zero energy technologies within the submarket, and to discuss strategies for diffusing the related technologies. In order to do this, we examine the structure and operation of the market, the characteristics of zero energy buildings, the physical characteristics of the buildings in the market, and the values that drive decision making within the market. This paper builds on earlier work that broadly described the commercial building market (Reed 2004).

According to our best estimates, there are approximately 50,000 grocery stores in the United States. These are divided among small independent stores/chains, intermediate independent stores/chains, large chains, and warehouse clubs. The differences among these segments are critical because there are differences in the way the stores/chains design, construct, furnish, and remodel their stores and because different strategies are needed to address energy efficiency in these segments. The paper also discusses the overarching trends that affect both independents and chains at the local, regional, and national levels. In recent years, attempts at market differentiation to meet the changing demands of the US customer have increased the complexity of the market.

## Methods

The data for this study are from three principal sources: CBECS data and the analysis of the 1999 CBECS public use sample, interviews for various projects conducted with commercial

building operators that have been completed over the last several years, and information gathered from the Internet. The information from the Internet is primarily surveys and studies compiled by trade associations and industry-specific publications.

## A Theory Guided Approach

Our analysis of this submarket is informed by Rogers' work on the Diffusion of Innovations (2003). The use of the theory is important for two reasons: it provides a meaningful framework for strategizing about how to change markets, and it provides a basis for the analysis guiding where and what to examine.

Diffusion of innovations was chosen because it is the most widely used, widely accepted, and systematic theory for describing and assessing the diffusion of technologies and practices. There are literally thousands of scientific studies documenting the basis for the theory. Readers of this document are likely aware of pieces of this theory although many may not be aware of the full scope of the theory.

There are five key aspects to the diffusion of innovations model:

1. The stages for the diffusion process including awareness, information, decision, implementation, and confirmation;
2. The characteristics of the socio-cultural and market environment that make it amenable to diffusion;
3. Adopter types including innovators, early adopters, early and late majorities, and laggards who vary in their willingness to adopt new technologies;
4. The characteristics of successful products including relative advantage, complexity, compatibility, observability, and trialability; and,
5. The communication processes of broadcast and contagion.

This analysis is based on key principles derived from diffusion of innovations theory.

1. The resources for promoting the diffusion of these technologies are limited, so the widespread diffusion of technologies and practices must result from firms replicating their own behaviors and firms observing and emulating the behaviors of others.
2. Contagion, that is the spread of ideas from one individual or firm to another individual or firm, will be the dominant communication mode by which potential adopters will learn about technologies and practices. Communication through broadcast methods, that is a message from a single source to multiple members of the target audience, will play a secondary and perhaps much lesser role in the widespread adoption of new technologies and practices. However, broadcast techniques may be important for recruiting innovators and early adopters.
3. The adoption of energy efficiency technologies and practices and the zero energy building concept will be driven by information that is spread through professional and social networks.
4. Innovators and early adopters can and will play an important role in refining new technologies and practices, but rapid and widespread diffusion of ideas will not occur until at least some firms within the early majority adopt the technologies and other members of the early majority reference their use of the technologies and practices.

Widespread diffusion will not necessarily result from the use of the technologies by innovators and early adopters.

5. Analysis of the market to identify groups of decision-makers who are highly likely to communicate with and observe each other is essential to accelerating the diffusion of innovations.
6. Innovations that have high compatibility with existing public policy, current legal and administrative frameworks, manufacturing systems, and market channels will move more rapidly into the market than innovations that do not.
7. Innovations that have high compatibility with existing technical systems will diffuse more rapidly than those that do not.
8. Innovations that exploit multiple and important types of relative advantage, such as status, environmental friendliness, increased sales, productivity, and comfort, will diffuse much more rapidly than innovations that are sold mostly on the basis of life cycle cost or price.
9. The ability to "observe" and "try" new technologies and practices is vital to their adoption.
10. Innovations that are simple to understand, use, and install will diffuse more rapidly than those that are more complex.

The basic thrust of these principles is that diffusion will take place most rapidly when the targets are:

- Relatively compact and homogeneous networks of firms and individuals,
- Who are likely to have numerous facilities and extensive linkages within their own firms and/or with other firms,
- Who are likely to reference each other, and
- That can be easily addressed through one-to-one contact.

In practice, these principles dictate that high priority targets are organizations that centrally manage many facilities, that are emulated by others in their market, and that are willing to try and test new ideas and technologies.

## Structure of the US Food Sales Market

In order to fully understand the energy efficiency possibilities within the food sales industry, it is important to first know the industry characteristics. Unfortunately data for this sector is very inconsistent. Different organizations define food sales firms in different ways, making comparisons of stores and sales across different sources extremely challenging. At least some of the variation results from the inclusion or exclusion of various types of food sales organizations such as convenience stores. The most consistent data show that more than $450 billion dollars are spent on food sales in about 50,000 stores in the US (Progressive 2005). The approximate square footage of all food stores is 2.2 billion square feet, which is about three percent of the total US commercial building space (EIA 1999). In 2005, the capital expenditures on construction of retail food stores in the US were slightly more than $5.4 billion. This was the third largest amount within the retail submarket following discount stores at $19.8 billion and home stores at $7.4 billion (Big Builders 2005). This construction added approximately 16

million square feet or about one percent to the total gross square footage for food sales establishments.[1]

Figure 1 lays out a simplified view of the retail food sales market. At the bottom of the structure are four groups of players: warehouse clubs, large chains, intermediate independent stores and chains, and small stores and chains. There are about 1,000 warehouse clubs such as Costco, BJ's, and Sam's that are combination stores that sell groceries and other merchandise. If Wal-Mart's Superstores are included in this group then the total is closer to 4,500. We have excluded Wal-Mart from the latter group. We are treating these warehouse stores separately, and we will not discuss them in detail in the remainder of this paper although they are included with the large chains in Figure 2.

The rest of the retail food sales submarket is divided into three segments: large chains with more than 10 stores with an average of more than two million in sales annually per store, intermediate independents with as many as ten stores that typically have between two and four million dollars in sales annually, and small independents with ten and fewer stores with sales averaging two million or less per store.

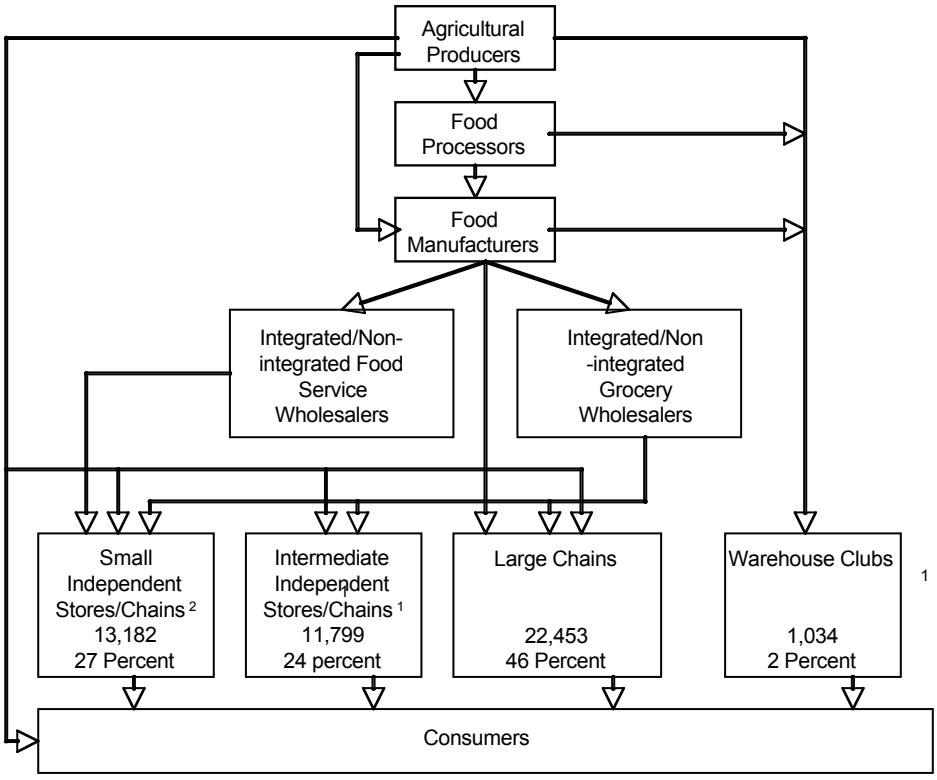
Figure 2 shows the cumulative number of stores and annual revenue per store for the large chain stores and intermediate independent stores. There are roughly 24,000 facilities in the large chain segment that account for about $410 billion in grocery sales. Fifty-six companies own these 24,000 facilities. These 56 companies control the design and operation of these facilities centrally. This concentration of ownership and control means that it takes less than 100 contacts to reach the ownership of roughly half of the grocery stores that sell 80 percent of the groceries in the US.

There are about 13,000 and 12,000 stores in small and intermediate independent retail food sales segments respectively. The intermediate independent chains/stores that have sales between $2 and $4 million per store sell approximately $50 billion in groceries annually. Revenue data are not available for the small independents which is why the information for them is not displayed in the figure.

While many of the grocery stores in the small and intermediate store/chains segments have the same physical characteristics as the stores owned by the large chains, they are likely to be harder-to-reach because of their diverse ownership. Table 1 shows that 58 percent of the independents own one or two stores. That means there are about 5,000 firms/owners that have one or two stores and roughly another 1,000 that have three to nine stores. This target audience is essentially 100 times the size of the audience for the large chains. The structure of the linkages within this target audience are less formal or non-existent. This part of the market is less well capitalized as well.

[1] The net increase may be smaller because we do not have data for buildings removed from service or destroyed.

**Figure 1. Structure of the US Food Sales Market**




Independents have 10 or fewer stores
1 $2,000,000 or more in annual sales
2 Less than $2,000,000 in annual sales

Source: Innovologie LLC 2005; Number of stores from 2005 Progressive Grocers Annual Report

## Design and Decision Drivers

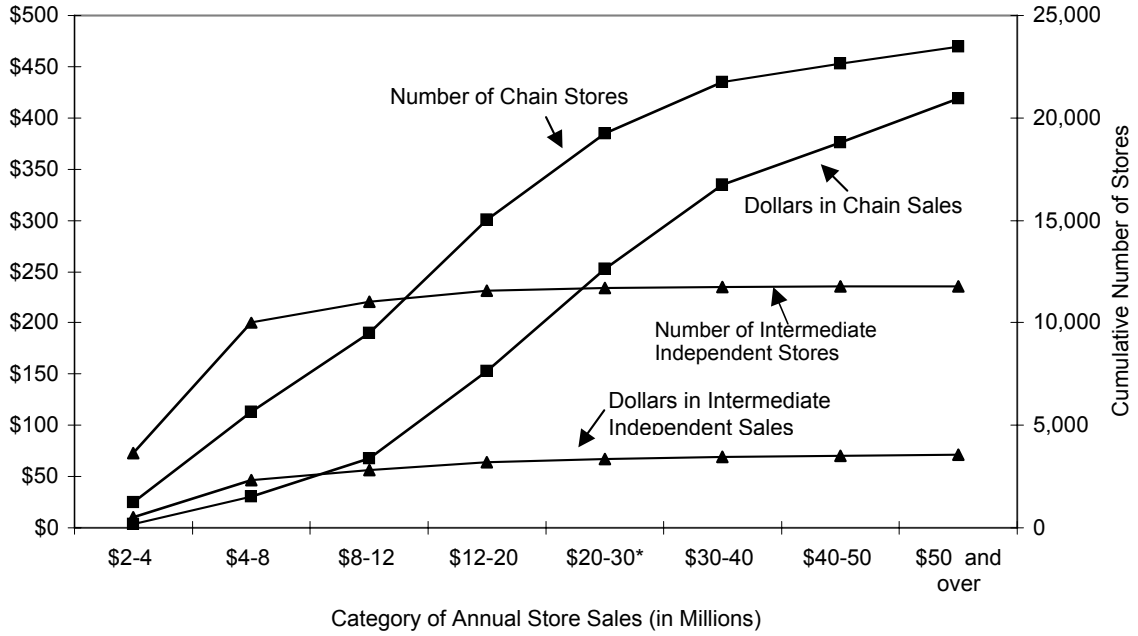
**Table 1. Market Breakdown of Intermediate Independent Grocers**

| Number of supermarkets operated | Percent of total |
|---|---|
| 1-2 | 58 |
| 3-4 | 14 |
| 5-6 | 12 |
| 7 or more | 16 |

Source: Progressive Grocer, Executive Insight Series, Feb. 1, 2005, p. 3

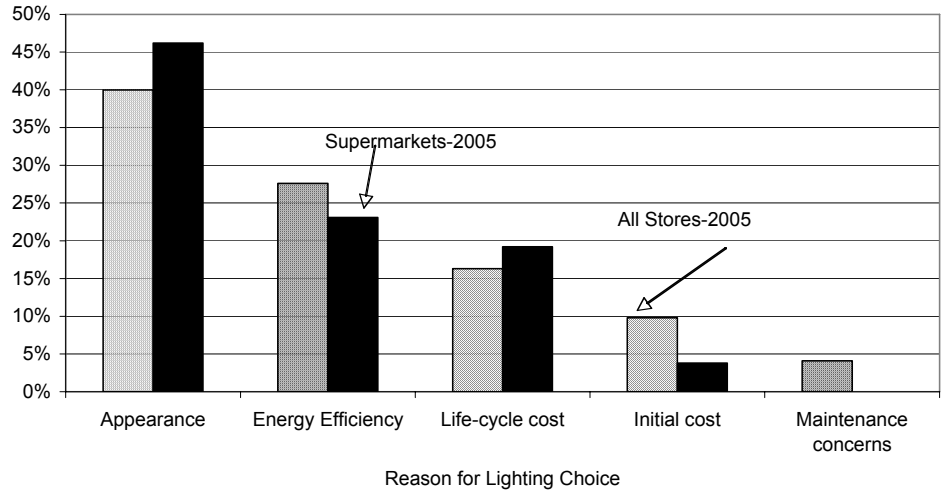
While retail food sales buildings are among buildings with the highest energy use intensities and retail food sales firms are under pressure to cut costs, energy efficiency is not necessarily the most important driver in store design. Figure 3 presents a comparison of reasons for lighting choices in foods sales stores and retail stores of all types. Forty percent of respondents from retail stores of all types identified appearance as the most important driver in lighting design. An even greater percentage of respondents from the food sales industry cited (46 percent) cited this as a reason for their lighting choices.

**Figure 2. Comparison of Annual Sales by Store Volume between Chains and Independents Supermarkets**




Innovologie added 1034 warehouse club stores, with $32.6 billion in total sales to the $20-30 million category, which were from Progressive Grocers report, but were not included in their analysis. Source: (Progressive Grocers 2005 )

**Figure 3. Reason for Lighting Choice Differences among All Stores and Supermarkets**



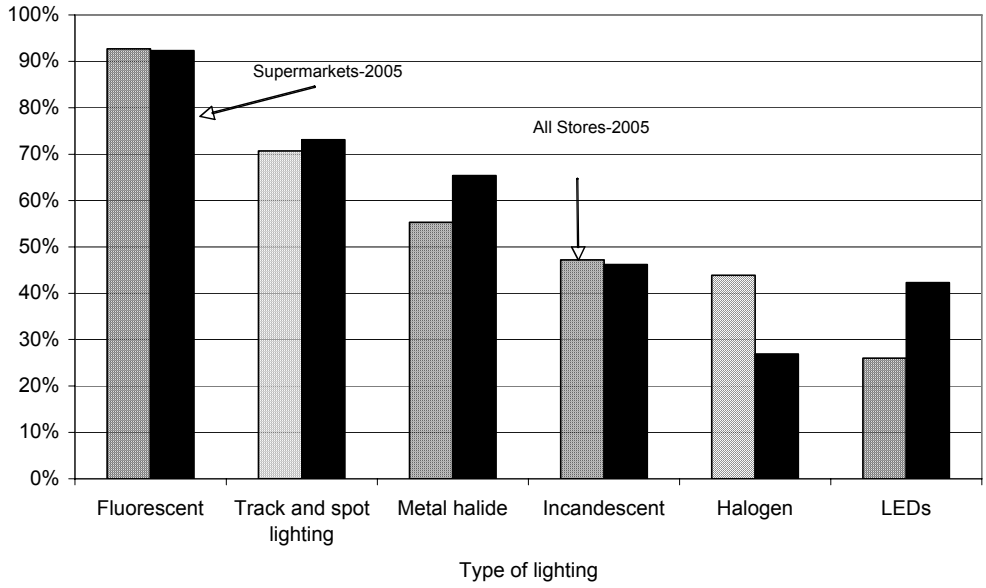

Source: Chain Store Age/Leo J. Shapiro & Associates

Respondents for all types of retail sales recognized energy efficiency as a driver of lighting choices more often (27 percent) than did respondents in retail food sales (23 percent). On the other hand, respondents (19 percent) in retail food sales cited life-cycle cost as an

important driver slightly more often that did all retail respondents (16 percent). To the extent that the motivations of energy efficiency and life-cycle cost overlap, the differences in the two sets of motivations may essentially cancel one another.

The concern for appearance is born out in a comparison of the types of lighting being used in all retail food sales stores and all retail stores. Figure 4 presents the types of lighting that respondents mentioned being installed in new stores. Respondents from retail food firms were more likely to mention track lighting, metal halide, and LEDs. In fact, substantially more respondents from the food sales segment (42 percent) mentioned the use of LEDs than did respondents from all retail. The evidence suggests that the current high interest in LEDs is driven by desire to highlight colors in displays and product packaging and the potential for energy savings is cold cases.

**Figure 4. Comparison of Types of Lighting Used between All Retail Stores and Supermarkets**




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

Energy consumption in retail food stores will be driven by larger forces that are playing out in the market. In order to meet the challenges of the future, Litwak (2002) argues that grocery stores will have some of the following characteristics as a way to meet the challenges of the future:

1. Stores will be constructed of prefabricated store pieces pre-assembled and quickly erected. There will expanded use of lightweight metals and manufactured shelving.
2. Cool fluorescents are on the way out and will be replaced by warm ambience and background music from far off lands and store employees dressed in ethnic garb while cooking irresistible delights from far off lands.
3. "Fresh" will remain the dominate concept (or at least well preserved) and food preparations will be timed to customer arrivals with automated customer recognition systems. There will be a shift back to "main street shopping." Consumer convenience in multi-purpose flexible formats will be paramount.

4. The big box will have two to three split service zones on each side of the building acting as anchors to the main entrance. These would include: meal zones (a.k.a. food courts), green zones (floral/gift shop) and spirit zones (one-stop party supply zone). The other side of the store may include a fresh zone (with café seating) and a health zone (health and organic foods in a pharmacy store setting).

It is unclear how these trends may influence energy consumption in retail food establishments. Prefabrication could increase the quality of construction with attendant benefits for thermal integrity. The move toward warm ambience may drive the adoption of LEDs and/or it may limit or enhance interest in daylighting. The use of zones in the store may increase the number of appliances being used in stores thereby increasing the load.

UBS Securities warns that in the future, the traditional supermarket model "could die a slow death" at the hands of Wal-Mart and other nontraditional formats. USB believes that to survive, supermarkets must:

- Scale back the total number of different brand items
- Focus on the strongest leading brands and the private label
- Sell a smaller assortment at lower prices to net greater sales per square foot
- Throw away the "crutch" of vendor dollars that has led to too many SKUs (Progressive 2005 Annual Report, 2005).

One last trend in this industry has been the consolidation of the industry through mergers and acquisitions. Since 1996, almost 4,700 supermarkets have been acquired, representing $75.5 billion in sales. Among firms that have consolidated, Kroger, the Nation's largest supermarket operator, acquired the sixth largest retailer, Fred Meyer, in 1998. Also in that year, the fourth largest retailer, Albertson's, acquired second-ranked American Stores, operator of 802 Lucky, Jewel, and Acme supermarkets. Albertson's is now being acquired. The share of the 20 largest retailers has increased significantly since 1997 (US Food 2002).

## Interest in Energy Efficiency

There is evidence of significant interest in energy efficiency on the part of the chains. The Food Management Institute has an Energy and Technical Services Subcommittee. Some chains, for example, Albertsons and Food Lion, are already extensively involved in increasing the energy efficiency of their stores. Albertson's has recently done energy efficiency upgrades in most of its stores in Utah. At a recent conference, a representative of Food Lion claimed that in the last four years Food Lion has displaced the equivalent energy for 234 of their more than 1200 stores (Holtheit 2004). Based on an analysis of public documents, there is evidence that at least half of the remaining chains are interested.

## Characteristics of Low Energy and Zero Energy Buildings

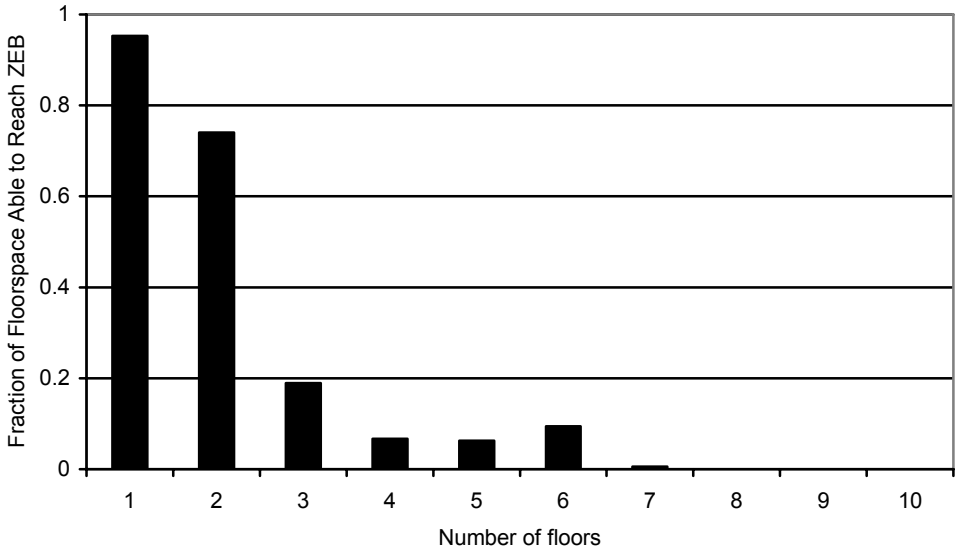
In a low energy building, energy use is minimized consistent with the building's functional design requirements and the activities and comfort needs of its occupants. A zero energy building generates or produces sufficient energy to offset the energy that it consumes. It is generally assumed that being a low energy building is a necessary pre-condition for being a

zero energy building, although theoretically a zero energy building could consume well more then the minimum possible energy depending on the amount of energy produced.

The National Renewable Energy Laboratory (NREL) is examining the potential to optimize commercial buildings to reduce their energy use while maximizing their potential to produce energy and thus reduce energy use of buildings from external sources. Based on the availability of current technology and simulations of retail buildings, there appear to be significant limitations on the types of commercial buildings that have the potential to be zero energy commercial buildings. Presently, it is projected that one could build a net zero energy 20,000 square foot single story commercial office building in Chicago. To reach this goal the building design requires a single rather than two-story building (Griffith, *et. al.* 2004).

A recent analysis of the potential for commercial building floor space by NREL (Torcellini 2005) shows that the fraction of floor space that has the potential for being in a zero energy building declines rapidly from 95 to 74 to 19 percent as the number of floors increases (Figure 5). The major factors are the daylight space and the roof area available for photovoltaics.

**Figure 5. Estimate of the Available Fraction of Floorspace That Has the Potential to Reach Zero Energy Use**




Source: Paul Torcellini, personal communication, June 2005

If we assume that this same principal applies to retail food stores, then we can examine the existing stock of buildings to identify the characteristics of buildings that might be candidates for zero energy buildings. As can be seen in Table 2, nearly 60 percent of grocery stores under

**Table 2. Distribution of Percentage of Floors in Food Sales Establishments**

| Number of floors | Grocery Stores under 10k square feet | Grocery Stores from 10k-50k square feet | Grocery Stores greater than >50k square feet | All Grocery Stores |
|---|---|---|---|---|
| 1 | 42 | 80 | 39 | 55 |
| 2 | 10 | 15 | 57 | 29 |
| 3 | 49 | 5 | 4 | 17 |
| 4 | 0 | 0 | 0 | 0 |
| Total | 100 | 100 | 100 | 100 |

Source: (CBECS 1999)

10,000 square feet have two or more floors. Almost all of these are small independently owned stores. Eighty percent of grocery stores with floor areas between 10,000 and 50,000 square feet are single story stores. The preponderance of grocery stores with more than 50,000 square feet is two stories or less.

Table 3 displays the median average new store square footage for different food sales formats. Formats should not be confused with the segments identified earlier. For example, a large chain might have conventional, super/combination, and target market focused stores. The median size of newly built conventional supermarkets is about 46,000 square feet. Warehouse stores are about half again as large. Super combination stores are coming in at around 56,000 square feet. Target market focused stores, for example, a store built by a company like Whole Foods that targets the upscale market, are about 40,000 square feet.

**Table 3. Median of the Average Size (square feet) New Food Sales Stores by Store Format**

| Store Format | Median Square Footage |
|---|---|
| Conventional supermarket | 46,000 |
| Super/Combination store | 56,221 |
| Warehouse/Price impact store | 69,000 |
| Target market focused store | 40,000 |

Source: (Facts 2004)

Seventy percent of new food sales stores are being built in or in conjunction with community and regional shopping centers. Currently only 11 percent of grocery stores are being built as freestanding stores. The balance 19 percent are being located in neighborhood shopping centers (Facts 2004). All of these data point to the fact that a large proportion of the existing and new grocery stores for large chains are low rise, one or two stories, and of substantial square footage.

A key component of for a zero energy building is daylighting. Although the estimates will vary by location, Loveland (2003) suggests that the optimal ratio of skylights to floor area is about five percent. In a 30,000 square foot building the costs of 40 installed skylights with fluorescent lighting controls is estimated to be about $40,000. Skylights might add about three to four percent to the cost of a large building which is likely to be between 1.2 and $1.6 million.. Paybacks are estimated in the range of three to six years. Thus, the space requirements, cost, and paybacks for daylighting seem feasible.

Because equipment is such a substantial share of the total cost of supermarkets and refrigeration is both a costly item and a significant source of energy consumption, it is useful to characterize refrigeration in retail food stores. Refrigeration accounts for roughly half of the energy consumption in a grocery store. Ninety-five percent or more of the food sales establishments over 10,000 square feet have walk-in refrigerators (Table 4). Less than 40 percent of such stores under 10,000 square feet have walk-in refrigerators. Open-case refrigerators are found in 90 percent or more of establishments with more than 10,000 square feet. The average number of open cases is about 26 for stores that are between 10,000 to 50,000 square feet and about 52 for stores over 50,000 square feet. Thirty-seven percent of the stores with 10 to 50,000 square feet do not have closed refrigerator cases. Open-case refrigerators predominate with the ratio of open- to close-case refrigerators in the larger stores ranging between 1.3 and 1.4 (CBECS 1999). The potential for zero energy grocery sales will depend on the ability to reduce energy consumption for refrigeration and generate sufficient energy to accommodate refrigeration loads.

**Table 4. Walk-In Refrigerators in Food Sales Building**

| Energy Types In Use | Stores under 10k square feet | Stores from 10k-50k square feet | Stores >50k square feet | 1999 All Stores |
|---|---|---|---|---|
| Percent buildings with walk-in refrigerators | 39 | 95.0 | 100.0 | 81.0 |
| Number of walk-in refrigerators per building | 1.5 | 5.5 | 7.2 | 5.7 |
| Percent buildings with open-case refrigerators | 69 | 91.0 | 94.0 | 86.0 |
| Number of open-case refrigerators per building | 1.4 | 25.8 | 52.1 | 30.5 |
| Percent buildings with closed-case refrigerators | 95 | 63.0 | 87.0 | 80.0 |
| Number of closed-case refrigerators per building | 4.5 | 20.0 | 37.8 | 21.8 |

Source: CBECS 1999 Public Use Sample.

## Summary and Conclusions

The purpose of this paper is to examine the retail food services market to assess the potential for the implementation of the zero energy building concept in the submarket from technical and market standpoints. From a technical standpoint, zero energy buildings might best be single story buildings with a sufficiently large footprint to support solar arrays and daylighting. Laree chain retail grocery stores meet these criteria. Internal loads, particularly refrigeration, need to be minimized so that solar generation is able to support the load.

From a market standpoint, it appears that there are segments within that retail food sales market where there is potential for promoting the adoption of zero energy buildings. Our assessment suggests that the 56 largest retail food sales chains may be a good target. These 56 firms own about half of the retail grocery outlets in the US. This is a compact target audience that can be addressed relatively easily through one-to-one communication methods. The design processes for these firms are centrally managed and controlled. These chains have large numbers of stores and thus substantial potential for replication.

This segment of the market is highly competitive. Social and professional networks exist among these players offering the potential for players to emulate one another. In recent years, these chains have been third in terms of the level of capital invested in new commercial retail buildings and the square footage of new buildings constructed. Because newly constructed stores are typically 40,000 square foot single story buildings, there is potential for daylighting and solar arrays making them candidates for zero energy buildings although the potential to reduce refrigeration loads to a level that can be served by on-site generation has yet to be demonstrated. There do appear to be major opportunities for more efficient lighting, refrigeration, and HVAC. The cost of generation will need to be competitive. There is also the issue of whether large chains will be willing to take on the role of managing on-site generation.

Other segments of the retail food sales market appear to be less promising. The smallest stores tend to be located in multistory buildings and have footprints that may be marginal for zero energy buildings. Relative to the number of large retail chains, the number of firms in the rest of the market is very large. There is relatively little new construction taking place in this part of the market. A majority of firms have one or two stores, minimizing the potential for replication

One possible strategy for reaching these smaller stores is through grocery wholesalers. Grocery wholesalers, who are under economic pressure from the larger chains, superstores, and warehouse chains and who supply many of these smaller stores, are interested in adding to the services that they provide to independent operators. Thus, a possible strategy might be to work with the wholesalers to provide added value energy efficiency services. However, providing

energy efficiency services requires expertise and capital and at present wholesalers would have to develop or buy the expertise and find the capital. Some observers have noted that wholesalers do not appear to have the required capital.

Finally, we should note that that the decisions of the large chains are not necessarily driven by energy efficiency. For example, appearance and convenience are key values that drive store design. Lighting is a key component of appearance, and there is evidence that retail food firms are leading the way in the use of LEDs. The issue is not efficient lighting but lighting designs that are both efficient and motivate the customer.

There is a similar issue with convenience. The high number of open refrigerator cases exist because marketing staff perceive that they are a customer convenience. The future designs of stores are likely to be organized around the concept of convenience for the shopper. Thus, the key becomes designs that are both convenient and efficient.

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