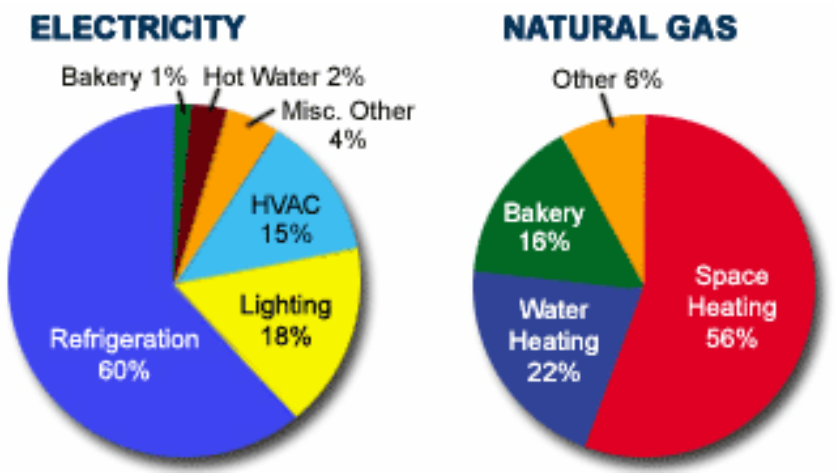
Background on Conventional Grocery Store Design/Systems

Recommendations in this report are built upon research and operator input regarding what is conventionally being designed for grocery stores of all sizes in Mid-Atlantic locations today. An understanding of these conventions and typical constraints helped to focus the recommendations. Below is a description of some of those conventions.

The charts below show national energy consumption averages for supermarkets:



Electric Energy Intensity National Supermarket Average 52.5 kWh/sf/year

Source: http://coastepa.apogee.net/ces/library/business_5.asp

Refrigeration and HVAC Current Conventions

There is often a split between who is responsible for the HVAC systems (the building owner) and who is responsible for the refrigeration systems (the operator). Similarly, refrigeration is often designed in-house or by a specialty contractor. As a result, energy modeling and system designs between the two systems is not well-integrated. Typically, energy modeling is more likely completed only as part of the refrigeration package.

To meet refrigeration demands, small stores most often use stand alone refrigerated display cases while mid and large size stores typically use conventional multi-plex and low-charged multi-plex DX air cooled refrigeration systems rather than water cooled condensers and secondary water loops. (See refrigeration terms next page). In addition, most stores will have some add-on package refrigerator units - either as a manufacturer requirement for spot merchandizing or to accommodate expansion. This can account for up to 30% of the refrigeration usage. These stand alone units tend to be far less efficient than even multiplex refrigeration. Anti-condensate is typically used in enclosed refrigerator cases over Low-E doors which tend to fog up.

Refrigeration Terms

Self Contained Cases: *Each display case contains its own refrigeration unit.*

Multiplex DX: *System consisting of a compressor located in a central room; out-side air-cooled condenser for condensing the refrigerant; and liquid lines containing the refrigerant that run to the various cooled display cases throughout the store.*

Low-charge Multiplex: *Similar to multiplex systems but with improved controls to limit refrigerant charge.*

Distributed Refrigeration: *System consisting of several compressor racks that are installed in close proximity to display cases/storage rooms. The refrigeration sides contain direct-expansion evaporators, and heat rejection occurs with common secondary fluid loops containing an antifreeze mixture and an air-cooled or evaporative fluid cooler normally located on the roof.*

Secondary Loop: *System where a central chiller is used to refrigerate a secondary coolant that is pumped to the food display cases through fluid loops on both condensing and refrigerating sides. Typically, warm secondary loops reject the condensing excess heat to the outdoor air by means of remote air-cooled or evaporative fluid cooler normally located on the roof.*

Each is capable of being paired with air-cooled, water-cooled and evaporative condensers except the self contained cases. In general systems using water for cooling are more efficient as water involves moving significantly less volume for the same amount of heat generation/dissipation.

Evaporative Condensers: *In an evaporative condenser the heated refrigerant is run into the top end of the unit where water is sprayed over the coils and a fan blows air through the mist to cool the refrigerant by evaporating some of the water. The fact that the cooling water comes into direct contact with the condenser coil is the most important difference between an evaporative condenser and a cooling tower / water cooled condenser.*

In conventional multiplex systems, long lengths of piping between the compressors located in a central mechanical room and the display cases along with numerous fittings result in significant refrigerant losses; between 15% and 30% of the total annual charge. Refrigerant leakages have a negative impact on global warming and ozone depletion.

Related to HVAC, most markets use air based space conditioning units. Evaporative cooling is less typical for the mid-Atlantic region due to the climate which doesn't allow for maximum efficiency while requiring additional maintenance; however, water based systems are still more efficient than air based in this region and are particularly viable in urban stores in mixed use conditions where equipment location has limited access to outside air. While heat recovery is not traditionally used, it is becoming more common, especially with the comfort conditioning systems being installed. Packaged rooftop units for space conditioning are being provided with energy recovery wheels. Stocking and store rooms are typically heated in the winter for the comfort of the workers and improved productivity.

Lighting Current Conventions

Lighting demands for food retail fall into several different categories: ambient or general store lighting, display, refrigeration cases and exterior lighting (building and parking/security). There is a current trend towards providing more day lighting to the interior of stores. Studies have shown that increasing natural daylight in retail operations leads to increased sales. One important consideration is that the natural light needs to be controlled around produce as to not shorten its shelf life. While there does not seem to be a strong resistance to daylighting, some operators believe that artificial store lighting is easier to control overall.

The general approach to store lighting is to provide ambient lighting and to include additional display lighting on product to enhance the product's appeal. Most stores currently use fluorescent fixtures with T12 lamps which have better color rendition than metal halides. Lighting efficiencies have been improving as the controls and lamps (T8s and T5s) have improved. LED fixtures are not yet commonly used due to perceived issues with price point and color rendition. Today, they are most often found in refrigerator units.

Lamp Types (Listed from least efficient to most efficient):

Incandescent: A term for heat-driven light emissions produced by passing an electric current through a thin filament, heating it until it produces light. This is very inefficient form of lighting as the majority of the energy is given off in the form of heat rather than visible light. Lamp types: 40w, 60w, 75w, etc.

Low Voltage Incandescent (halogen): These lamps operate at higher efficiency than a conventional incandescent. A 60 W bulb will provide nearly as much light as a non-halogen 100 W and with much longer life. These lamps, which have a warm appearance, are frequently used for display lighting; however there are more efficient options that are not heat driven. Halogen lamps come in glass (Par lamps) or quartz (MR lamps) with the latter being slightly more efficient.

Fluorescent: A gas-discharge lamp that uses electricity to excite mercury vapor. The excited mercury atoms produce short-wave ultraviolet light that then causes a phosphor to fluoresce, producing visible light. These lamps are most effectively used for general ambient light and are available in warm light ranges, providing a more pleasing environment. Lamp types: T12, T8, T5 (the smaller the T lamp size the more efficient).

Metal Halide: A type of high-intensity discharge (HID) lamp which produces light by means of an electric arc between tungsten electrodes housed inside a translucent or transparent fused quartz or fused alumina tube. Originally created for industrial use, metal halide lamps are now available in numerous sizes and configurations for commercial applications and are a good alternative for display lighting and parking lot lighting. Lamps come in watts and vary depending on use (very high for exterior and lower for display).

Solid State Lighting/LED: A lamp that utilizes light-emitting diodes (LEDs) as a source of illumination rather than electrical filaments or gas. While LEDs are by far the most efficient lamp option they still pose some challenges with color rendition as they tend to be blue-ish, amount of light throw and cost. They are currently most effectively used in refrigerator cases and for exterior building lighting.

Operations and Maintenance Current Conventions

Most medium and large size stores have a Store Operations and Maintenance Plan as do a good number of the small stores. The challenge is consistently following through with the Plan and maintenance and with educating staff. When a store consists of 3 or more separate locations, the O&M for the systems and equipment is typically out-sourced which provides better efficiencies as compared to in-house operations and management systems.

Automated control systems are more common with operators with multiple stores as these systems can be operated remotely. Similarly, operators with multiple stores are more likely to out-source maintenance.

Commissioning and re-commissioning is typical for most large and chain stores. Per ASHRAE's definition commissioning is "a quality-focused process for enhancing the delivery of a project. The process focuses on verifying and documenting that the facility and all of its systems and assemblies are planned, designed, installed, tested, operated and maintained to meet the Owner's Project Requirements." Commissioning rarely occurs with smaller stores.

Most large stores can operate with as little as three to four loading docks while midsize stores can function with as little as one. This requirement depends in large part on the volume of perishables delivered and their coordination. As noted in the previous section, smaller, urban stores tend to have a greater floor area ratio of perishables compared to other products. As these are the higher profit margin items, the other products are those that lose floor area when a store has a smaller footprint. This is a particular challenge in urban areas with not a lot of space for additional loading docks.

Stores currently recycle cardboard. As not much glass and metal waste is generated on site, practices for this waste vary. There are also no typical standards for organic waste, practices depend on the operator.