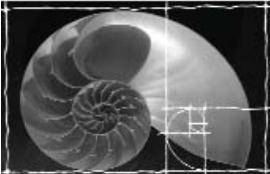


# GREENING GROCERY: STRATEGIES FOR SUSTAINABLE FOOD RETAILING

a project of The Food Trust: Spring 2008

Prepared by:

*Re: Vision*  
ARCHITECTURE



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## Introduction from The Food Trust

Providing access to nutritious and affordable food is the guiding principle for all of our work at The Food Trust. With our public and private partners, the Trust has already brought new fresh food markets to underserved areas. The advocacy of The Food Trust and other community leaders, notably Representative Dwight Evans, resulted in the creation of the Fresh Food Financing Initiative (FFFI) in 2004, the nation's first state-level program targeted specifically at increasing the number of supermarkets to meet the public health needs of underserved communities. The Food Trust, together with The Reinvestment Fund and The Greater Philadelphia Urban Affairs Coalition, has formed a public-private partnership with the Pennsylvania Department of Community and Economic Development to implement this initiative.

While FFFI provides financing for infrastructure and build-out costs associated with grocery store development, many store projects face challenges that extend beyond development financing. Supermarket operating models and merchandising programs require more space than ever before (median supermarket size in 2007 was 47,500 square feet<sup>i</sup>). With considerations for parking, loading docks, and ingress/egress, typical supermarkets require four to five times the amount of land space as selling space to operate. Unfortunately, most underserved communities do not contain the 5 or more acres of contiguous parcels of land necessary to accommodate the spatial needs of a full service supermarket.

Another obstacle lies in the increased cost of operations. The cost of energy for supermarkets is second only to labor. Energy prices have spiked over the course of the decade; for the Philadelphia MSA, kilowatt electricity costs increased by 26.9% since 1998 while utility gas prices increased by 78.3%<sup>ii</sup>. With the elimination of rate caps as the result of deregulation of electric utilities, energy costs are projected to continue this upward trend in the future. For older supermarkets and smaller grocery stores that are prevalent in underserved urban communities, the cost of operating with inefficient, antiquated mechanical systems and infrastructure place additional pressure on the balance sheet, eroding an already razor-thin profit margin.

The Green Supermarket Initiative, a project of The Food Trust, examines and promotes building and operating strategies that focus on energy-efficiency, high performance, and sustainability strategies that lower grocery store development and operating costs.

The first phase of the initiative includes three components – the prototype, the policy, and the pilot. ReVision Architecture, the author of this report, conceptualizes a prototype sustainable grocery store, complete with a comprehensive list of technologies and strategies designed to enhance building and systems performance while lowering costs over time. In addition, The Food Trust will recommend public policy action steps that help foster a development environment conducive to the proliferation of sustainable grocery stores in underserved communities. As a first step, Romano's Grocery, a small scale neighborhood grocery in North Philadelphia, was redesigned and retrofitted to demonstrate the efficacy of sustainable development and operation of grocery stores in underserved communities here in Philadelphia. Romano's will hopefully serve as a model for other underserved communities.

With funding available for store development in underserved areas, these strategies will enable grocery store operators to lock in energy savings today that will improve their bottom line and provide sustainable access to healthy food for communities for years to come.

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<sup>i</sup> Food Marketing Institute - [http://www.fmi.org/facts\\_figs/?fuseaction=superfact](http://www.fmi.org/facts_figs/?fuseaction=superfact)

<sup>ii</sup> United States Department of Labor, Bureau of Labor Statistics - <http://www.bls.gov/ro3/apphl.pdf>

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## Report Background

The goal of this report is to provide easily accessible sustainable design approaches, with an emphasis on energy savings, for grocery stores of all different sizes in the Mid-Atlantic region. The fact that the recommendations are for the Mid-Atlantic is important to note as the energy strategies are geared for this particular climate: mixed-humid with both a cooling and heating season. Additionally, the report was assembled with a slant towards urban development with many examples from the Philadelphia area, as this is both more sustainable and where there is the most need for markets, particularly in lower income neighborhoods. However, it should be noted that the recommendations typically apply to all store developments; urban or not. Considerations have been provided for existing buildings, adaptive re-use, and new construction. As the primary audience for this report are store operators who deal with tight profit margins, particular attention was paid the bottom line impact and cost benefit of various strategies. Others expected to be reviewing and using this report are real estate developers, policy makers and the design community.

*The key components of this report include:*

- *Factors that impact design decisions for food store operators*
- *Conventional food store design practices in this region*
- *Recommended prototype, energy efficient systems for stores of differing sizes*
- *Illustrations of sustainable recommendations in a prototypical store layout*
- *Matrix of green strategies along with select detailed take-away sheets*
- *Links to additional resources and case studies*

The crux of the report is the matrix of recommendations which is a menu which various strategies can be selected depending on the users needs. While the matrix emphasizes energy and bottom line savings, it also covers strategies that have beneficial environmental and social impacts. Items that required more description are marked with an asterisk denoting an additional page of information.

In developing the report, Re:Vision Architecture worked closely with Roy Rosenbaum and his team of grocery store experts at Rosenbaum Design Group Architecture and Engineering (RDG) in Lake Success, New York and Jeff Harris, Principal Engineer with Integrated Holistic Design in Lancaster, Pennsylvania. The Food Trust's Green Supermarket Initiative Advisory Group also provided valuable input and feedback that shaped this report.

## Grocery Store Design Factors

This section outlines some of the key factors that tend to drive how grocery stores are designed. For the purposes of this report the term "grocery store" is used to apply to small, medium, and large store types; where it is relevant, the report will differentiate for these types.

- *Corner Stores are small neighborhood food stores of 5,000 sf or smaller;*
- *Grocery Stores are midsized stores averaging +/- 25,000 sf;*
- *Supermarkets are large stores greater than 45,000 sf.*

In the grocery business, profit margins are extremely low, on average a 1% profit margin is the norm. Therefore, design decisions tend to support top line sales, margins, and productivity. Practically speaking, design strategies should not be perceived to hinder these key considerations.

Consumers typically choose where to shop based on location, convenience, and merchandising. Most shoppers are looking for "Trip Assurance" and to some extent in higher end stores, social activity and "grab and go" prepared services. Carry-out and home delivery is increasingly becoming a larger part of the equation. Urban stores can provide less choice in a smaller space, but they still need to operate as a full service store. The smaller footprint strategy tends to be more successful for independent operators as they have more merchandise flexibility than chain stores.

*Trip Assurance =  
One Stop Shopping  
= Convenience*

*"If you can't see it,  
you won't buy it"*

Store location, layout, and merchandising decisions are driven by the need for products to be easily visible and accessible; however, considerations will differ on a store-by-store basis depending upon the operator type (co-op, independent, chain) and whether the store operator owns or leases the store.

Co-ops, independents, and operators who own their buildings typically have more flexibility to push beyond the typical design mold.

On average, stores make physical changes every seven years. Urban stores with more traffic get more wear and tear than suburban stores. Stores change along with shifts in area demographics and, as appropriate, with trends in system improvements.

Refrigeration, significantly drives the design of the store. It also accounts for 50%-60% of power loads. Water, which is needed primarily for wash down of support areas, is another prime requirement. Supermarkets use upward of 1500 gallons of water per day.

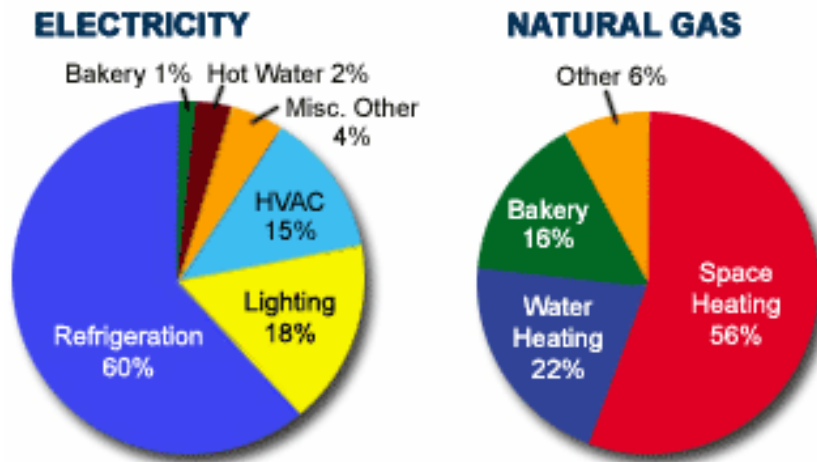
As with most commercial facilities, the availability and layout of parking are important considerations, as are loading and deliveries. If a store is expecting a regional draw, some parking must be provided; independent operators or neighborhood stores can more likely survive with little to no parking in urban locations. In general, urban stores have a greater floor area ratio of the higher margin perishable goods (produce, dairy, prepared foods, meat, fish) as compared to larger, non-urban stores. As a result, they tend to have more deliveries of these items. Store operators prefer delivery areas to be separate from shopper parking and access; however, this is not always possible in urban locations.

The above information is meant to provide some overarching guidelines, not necessarily unbreakable rules, when designing grocery stores; every operator will have different needs and customization in their operations. The recommendations in this report provide both innovative opportunities for early adopters in the field as well as common-sense strategies that are rapidly becoming more common as energy and building costs escalate and alternative technologies become more cost accessible.

## 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](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.

## **Prototype Mechanical/Electrical System Recommendations for Grocery Stores**

(See Background on Conventional Grocery Store Design and Systems for explanation of refrigeration terms)

### **SMALL SIZE STORE IN NEW OR EXISTING BUILDING**

**Refrigeration system:** Low charge multiplex or distributed system with ultra high efficiency air-cooled condensers. An alternative could be ultra high efficiency self-contained refrigeration units.

**Space Comfort system:** Small packaged, DX electric cooling with gas or electric heat. These units should be provided with energy recovery wheels. These units should be the premium efficiency selections from whichever manufacturer is selected. These units should be field or factory retrofitted with a capacity control device such as that manufactured by RAWAL. These units should also be provided with hot gas bypass and reheat to control humidity levels. These units could also include demand-based (CO<sub>2</sub>-Controlled) ventilation. For stores that utilize self-contained refrigeration units for their merchandise, an alternative space comfort system could be a variable refrigerant system such as the system manufactured by Daikin. This system is highly energy efficient and utilizes a refrigerant energy recovery system.

**Electrical Appliances:** All electric power using appliances must be Energy Star compliant.

**Artificial Lighting:** All general lighting needs to be high efficiency, color-balanced T8 or T5 fixtures, dimmed in response to available natural light and timer controlled off during unoccupied periods. Lighting for storage spaces, toilet rooms, and similar spaces often unoccupied for large periods during normal operations must have occupancy control sensors for the lighting. Place display lighting close to displayed items.

**Space Temperature Control System:** Stand alone digital, programmable controller provided by the HVAC unit manufacturer.

**Domestic hot water/wash down system:** Domestic water heating system should consist of a solar heating component with an ultra-efficient condensing gas boiler or electric boiler as 2<sup>nd</sup> or backup stage and a storage tank(s).

### **MID TO LARGE SIZE STORE IN A NEW OR ADAPTED BUILDING**

\* It is strongly recommended for best efficiency that the refrigeration system be integrated with the HVAC systems, particularly in considering use of waste heat. At a minimum the separate trades should be well coordinated and communicating with each other during design and the building should be modeled as a whole.

**Refrigeration System:** Low charge multiplex or distributed system with evaporative condensers and a glycol/water based heat rejection circuit that includes a closed circuit fluid cooler. Alternate would be a decentralized Secondary Loop System with an evaporative condenser and with a heat rejection circuit connected to the HVAC system. While the Secondary Loop System achieves approximately the same energy savings as water cooled distributed systems, it additionally has the potential to reduce the refrigerant recharge by up to 75% to 80% over a conventional multiplex system. In addition to refrigerant liquid and piping savings, this option has the highest capacity to lower total equivalent warming impact (TEWI) on the environment.

**Space Comfort System:** Water-source heat pumps connected to the glycol/water heat rejection circuit. These units would also include a desiccant energy recovery wheel in the outside air and exhaust air to recover energy and temper humidity levels. These units would include demand-based (CO<sub>2</sub>-Controlled) ventilation.

**Electrical Appliances:** Electric appliances should be Energy Star compliant.

**Artificial Lighting:** General lighting should be high efficiency, color-balanced T8 or T5 fixtures, dimmed in response to available natural light and timer controlled off during unoccupied periods. Lighting for storage spaces, toilet rooms, and similar spaces often unoccupied for large periods during normal operations should have occupancy control sensors for the lighting. Place display lighting close to displayed items.

**Environmental Control (building automation) System:** Install separate metering on refrigeration, lighting, and appliance (plug) loads. Control system will monitor and control all energy using systems to maintain consumption and energy use performance at or below as commissioned performance benchmark.

**Domestic Hot Water/Wash Down System:** Provide a heat exchanger in the glycol/water heat rejection circuit to preheat domestic cold water make up to the domestic water heating system. Domestic water heating system should consist of a solar heating component with an ultra-efficient condensing gas boiler or electric boiler as 2<sup>nd</sup> or backup stage and a storage tank(s).

## MID TO LARGE SIZE STORE IN AN EXISTING BUILDING

\* It is strongly recommended for best efficiency that the refrigeration system be integrated with the HVAC systems, particularly in considering use of waste heat. At a minimum the separate trades should be well coordinated and communicating with each other during design and the building should be modeled as a whole.

**Refrigeration System:** Low charge multiplex system with advanced display case sensing and variable speed feedback control for air-cooled condensers. Two (2) refrigerants to water heat exchangers should be installed in the condenser loop to extract condenser loop heat upstream of the air-cooled condensers.

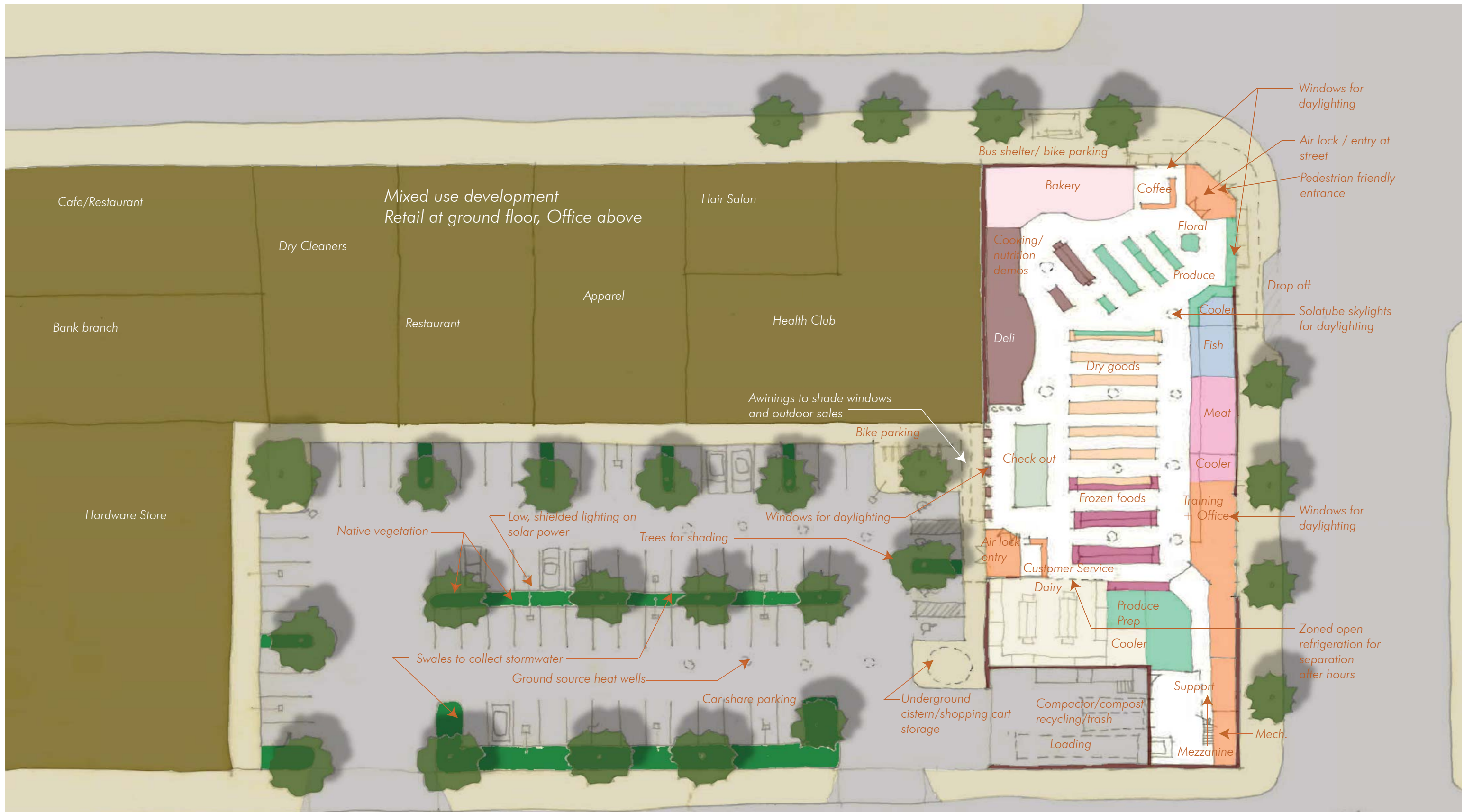
**Space Comfort System:** A packaged rooftop unit system that includes a desiccant energy recovery wheel in the outside air and exhaust air to recover energy and temper humidity levels. These units would include demand-based (CO<sub>2</sub>-Controlled) ventilation. These units should utilize a duct mounted hot water heating coil fed from the one of the heat exchangers in the refrigeration system condenser loop.

**Electrical Appliances:** Electric appliances should be Energy Star compliant.

**Artificial Lighting:** General lighting should be high efficiency, color-balanced T8 or T5 fixtures, dimmed in response to available natural light and timer controlled off during unoccupied periods. Lighting for storage spaces, toilet rooms, and similar spaces often unoccupied for large periods during normal operations should have occupancy control sensors for the lighting. Place display lighting close to displayed items.

**Environmental Control (building automation) System:** Install separate metering on refrigeration system, lighting, and appliance (plug) loads. Control system will monitor and control all energy using systems to maintain consumption and energy use performance at or below as commissioned performance benchmark.

**Domestic Hot Water/Wash Down System:** Preheat domestic cold water make up to the domestic water heating system by passing it through one of the heat exchangers in the refrigeration system condenser loop. Domestic water heating system should consist of a solar heating component with an ultra-efficient condensing gas boiler or electric boiler as 2<sup>nd</sup> or backup stage.



Prototype Store Site and 20,000 sf Floor Plan for New and Adapted Re-Use

A Project of The Food Trust



Site Selection: Prototype Site

Urban Site Selection

Choose an urban building site and smaller building site to serve dense local population and minimize material costs.

Alternative Transportation

Select a site near public transportation and develop project site to encourage additional access beyond a single passenger car to attract a larger customer base.

On-site Storm Water Management

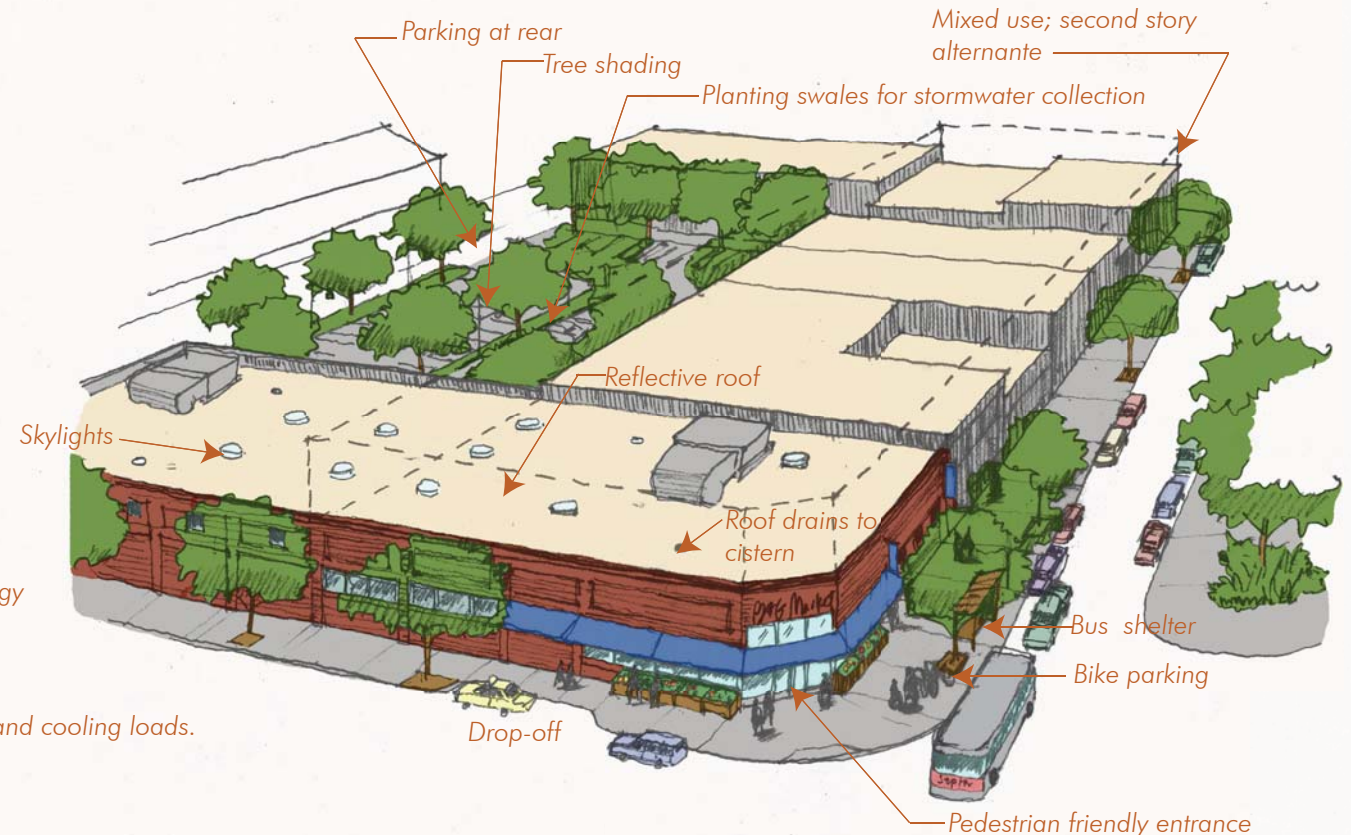
Infiltrate water on-site through vegetation, pervious surfaces, and rainwater harvesting to minimize the cost of structural storm water approaches, to minimize potential flooding, meet code and replenish the aquifer.

Mixed Use/Adapted Re-Use

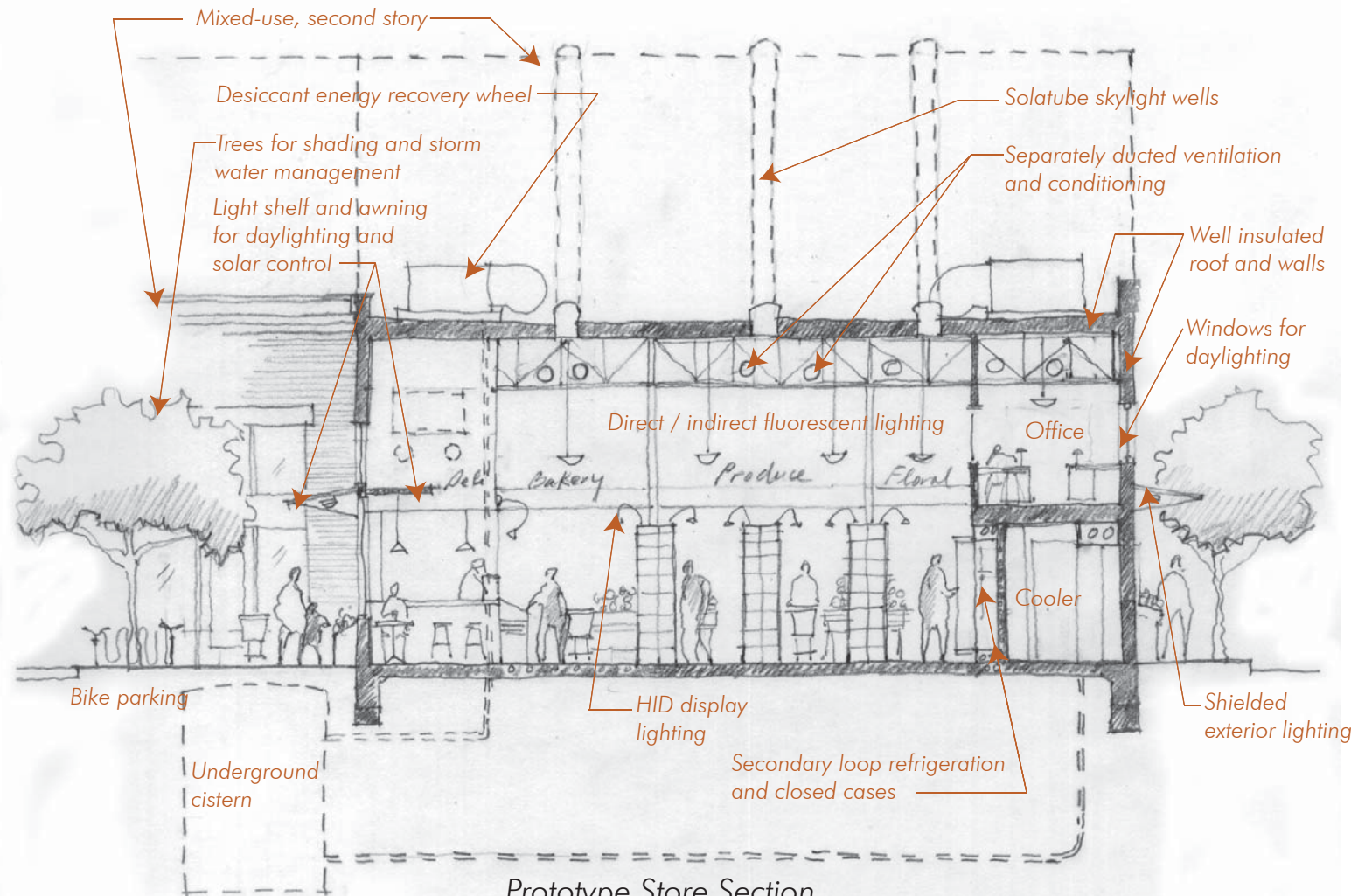
Locate stores in mixed-use projects; either sharing walls with adjacent retail or offices/residential above, in order to minimize energy loads, attract local customers and minimize exterior material costs.

Building Envelope

Design and build a tight, well insulated shell to help reduce heating and cooling loads.



Prototype Street Corner Perspective



Prototype Store Section

Comprehensive Daylighting Strategy

Strategically locate windows and skylights and use daylight sensors to reduce the amount of artificial lighting needed during the day.

Secondary Loop Refrigeration

Design for water chilled lines to refrigerator cases with refrigeration contained within the central cooling unit to reduce energy loads and refrigeration leakage.

Integrated Water-based HVAC-Refrigeration

Design for water source heat pumps (WSHP) in conjunction with water-loop heat rejection for the refrigeration to significantly lower energy operating costs.

Humidity Control

Install rooftop units using desiccant energy recovery wheels which moderate indoor humidity levels and help to reduce energy demands by recovering some of the energy to heat or cool outdoor makeup air to reduce energy loads and prolong refrigeration equipment life.

High Performance Lighting Strategy

Use or T-8 or T-5 preferred fluorescent fixtures, dimming controls, occupancy/daylight controls, LED lighting in cases and HID for display.

Rainwater Collection and Reuse

Collect rainwater on site to be used for toilet flushing, in water based cooling and heating equipment and for irrigation if needed.

Compost

Use immediately ripe produce in salad bars and other kitchen food prep; compost organic waste for use on site or by other local organizations/community gardens.



Key Plan: See Plan Sheet

Greening Grocery: Strategies for Sustainable Food Retailing - A Project of The Food Trust

Site Design: Strategies focus on methods for increasing user access and decreasing a store's environmental footprint. Additional consideration is paid to reducing initial land and construction costs and lowering long-term operating costs.									
	Category	Strategy	Relevant Store Size/Type	Initial Cost	** Return on Investment	Operator Benefits	Technical Considerations	Product + Manufacturer Suggestions/Resources/Examples	
*	1	Site Selection	Choose an urban building site and/or smaller building sites.	S,M,L/New & Adapted	0 - \$\$	Immediate	Ability to work with existing infrastructure (utilities); lease, construction, and utility costs are less for smaller sizes; denser location brings people in from surrounding neighborhoods.	This may involve multi-level structures including parking above or below grade, both of which have significant cost implications. Consider the following strategies: retail frontage with parking at rear; designs that minimize loading dock area and back of house storage (note: this requires additional coordination for loading demands); design compactly with narrower aisles.	Shop Rite, Acme, Romano's Grocery, Weaver's Way, Fresh Grocer, Trader Joe's, Whole Foods, Mariposa Coop
*	2	Alternative Transportation	Select a site near public transportation and develop project site to encourage additional access beyond a single passenger car.	S,M,L/New & Adapted	0-\$	Immediate	Brings in more customers; reduces the first-cost and on-going cost of parking areas.	Consider the following strategies: locate store in Transit Oriented Development; site selection near public transportation; provide bike parking; covered bus shelter integrated with site design for buses and shuttles; parking spaces for car share programs.	Bike Share / Philly Car Share / FlexCar / ZipCar
*	3	Stormwater Management	Infiltrate water on-site through vegetation, pervious surfaces, and rainwater harvesting.	S,M,L/New & Adapted	0-\$\$	Immediate	Can minimize the cost of storm water management; collection of rainwater can have added benefit of being used on site, thereby replacing municipal water demands; adding vegetation which includes appropriately located trees and green roofs also contributes to reducing cooling loads.	New development must meet storm water requirements which may be highly regulated. Provide additional vegetated spaces around the site and parking to absorb rain water. Although costly, porous asphalt/pavers and vegetated roofs are options. Investigate "hold and release" and buried cisterns. Soils testing generally required to determine allowable absorption rates.	See attached sheet.
	4	Adaptive Re-use / Renovation	Locate the market in existing buildings.	S,M,L/ Adapted	0 - \$\$	Immediate	Potential time and cost savings to work with existing infrastructure (utilities and structure).	This may involve unusual shaped footprints and multi-level structures; more limitations on type of mechanical systems that may be applicable.	Romano's Grocery, Weaver's Way, Trader Joe's, Mariposa Coop, Fresh Grocer, Supremo (Philadelphia stores)
	5	Parking	Reduce number of parking spaces; parking at rear to maintain urban street fabric.	S,M,L/New & Adapted	0 - \$	Immediate	Savings in land cost, construction cost, taxes, and maintenance costs.	Urban locations can support less parking and narrower spaces - 5/1000 occupants and 8w spaces. Upper and lower deck parking is not yet generally financially viable in the Philadelphia area due to relatively low land costs. Consider validated parking with nearby lots and provide drop off spaces for taxis, etc.	Philadelphia Parking Policies (see Appendix: Additional Resources)
	6	Loading Area Design	Minimize area of loading docks; Successful mid-size stores developed with only one dock.	M-L/New & Adapted	0	Immediate	Reduces construction costs and building size, allows more area for floor sales.	Seal loading docks from other areas to minimize infiltration; look at strategies around delivery and storage to minimize loading (for example, stacked storage and staggered deliveries).	Wild by Nature (Long Island, NY)

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**Energy Efficiency:** Strategies for system design, upgrades and operations focus on reducing energy consumption as related to mechanical and electrical usage. Typical supermarkets use an average of 52.5 kWh/sf/yr which accounts for 80% - 90% of its energy load. The benefits of this are realized in cost savings on utility bills to the store operator as well as reducing global environmental impacts from the use of non-renewable fossil fuels.

**Building Design Strategies**

	Category	Strategy	Relevant Store Size/Type	Initial Cost	** Return on Investment	Operator Benefits	Technical Considerations	Product + Manufacturer Suggestions/Resources/Examples
	1	Building Orientation	S,M,L/ New	0	Immediate	Can provide high quality daylighting; reduces cooling loads.	Limit east and west facing window exposure.	
*	2	Building Envelope Design	S,M,L/New, Adapted & Exist	\$-\$	1-3 years	Reduces cooling and heating loads for interior of building.	Reduce exterior envelope (for example, utilize party walls or multiple stories). Consider high performance glazing, reflective roof coverings, high R-value insulation with low infiltration rates, products with high SRI (solar reflectance index >29 for sloped roofs), spray foam insulation over batts.	Carlisle's white TPO roofing; Solarban Glazing; Kingspan Metal SIPs, BioBased Spray Foam Insulation
*	3	Energy Modeling	S,M,L/ New & Adapted	\$	Immediate	Modeling will inform decisions about which selection or combination of selections perform the best. General energy analysis data can be applied to multiple stores in a chain, increasing the return on investment.	Energy modeling is the best way to project energy use and savings while designing the building. Modeling is typically necessary for energy rebates. While uncommon for grocery stores, it is ideal to integrate refrigeration modeling together with space conditioning to realize full efficiencies, like heat recovery.	See attached sheet
*	4	Comprehensive Daylighting Strategy	S,M,L/New & Adapted	0-\$	Immediate	30%-50% light energy savings. Enhances the stores appearance and attracts customers. Numerous studies have shown that daylight increases sales. Enhances staff satisfaction and productivity.	Produce areas should not receive any direct day light; special care should be given to designing skylights and windows so as not to increase cooling loads. Preferred natural light is from the south and north. Use high performance and diffuse glazing for skylights.	Solatube Skylights; See attached sheets for more information.
	5	Zoned Design	M,L/New, Adapted	0	Immediate	Energy savings by reducing loads and controlling humidity; reduces electric loads to minimum requirements	Design areas that can be closed off and conditioned separately from each other particularly separating open refrigerated cases from rest of area	
	6	Mixed Use Configurations	S-M/ New & Adapted	0	Immediate	When walls or ceilings are shared it helps reduce heating and cooling loads, as well as saves in first-cost. Locating store near adjacent retail brings in more customers.	In general, multi-level grocery stores are less desirable as they impact worker productivity and tend to cost more to develop.	See Appendix for Transit Oriented Development
	7	Tree Planting	S,M,L/New, Adapted & Exist	\$	1-3 years	Reduces cooling loads for interior of building. Keeps site cooler around the building for users and provides visual amenity. Inexpensive way to deal with stormwater.	Locate trees in parking to cast shade over site paving and glazing. Consider intermediate planting strips to get more tree coverage in parking. Native and adapted trees preferred. Locate deciduous trees to shade south, east and west of building.	TreeVitalize - a partnership to restore tree cover in Philadelphia www.treevitalize.net

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General Mechanical/Electrical System Design Strategies								
	Category	Strategy	Relevant Store Size/Type	Initial Cost	** Return on Investment	Operator Benefits	Technical Considerations	Product + Manufacturer Suggestions/Resources/Examples
1	Digital Building-wide Automatic System Controls	Use micro-processor based controls integrated with a well-defined energy management program to monitor mechanical, electrical and refrigeration systems.	M-L/New, Adapted & Exist	\$\$-\$\$\$	4-7 years	Reduces building energy and maintenance costs; Savings in the range 10%-50%.	While savings can be high, initial costs for controls is also high; therefore it is best implemented in large grocery stores and supermarkets; most supermarkets typically use refrigeration controls, however even more efficiencies recognized if used building/system wide.	Emerson E2 Controller
2	Zone Control	Design controls to allow systems within the store to operate independently from each other, particularly in off hours, and to shut off when not in use.	S,M,L/New, Adapted & Exist	\$	1-3 years	Energy savings by reducing loads and controlling humidity.	For stores that are not 24/7: use night set-backs and on-demand settings; provide case covers on open cases; locate units in areas that can be separated from other areas for varying setbacks/shut-off.	
3	Integrated Approach	Design and maintain mechanical systems integrally.	S,M,L/New & Adapted	0 - \$	Immediate	Energy savings realized through higher efficiencies.	Requires more upfront coordination. Systems are most frequently handled separately, not taking advantage of efficiencies that can be realized. Facilitate communication between refrigeration and HVAC operators and designers.	
4	Rebates	Before purchasing equipment, research utility company and government rebates; select high efficiency equipment based on rebates.	S,M,L/New, Adapted & Exist	0	Immediate	Reduces initial outlay for fixtures and equipment that can have long term savings benefits.	Applicable to new facilities and upgrades.	PECO / PGW

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Refrigeration									
	Category	Strategy	Relevant Store Size/Type	Initial Cost	** Return on Investment	Operator Benefits	Technical Considerations	Product + Manufacturer Suggestions/Resources/Examples	
*	1	Low Charge Multiplex with Evaporative Condenser	Design for condensers with control systems that limit the amount of refrigerant recharge for the multiplex operation.	S, M, L / New, Adapted, Existing	\$	1-3 years	Lowest first cost premium giving the best payback; Energy savings in the range of 4-6%/year; Reduction in the amount of refrigerant by 1/3.	Liquid controls save additional energy by lowering condensing temperatures.	See attached sheet
*	2	Distributed Refrigeration	Design for small condensers located closer to the refrigerated cases, typically on the roof, reducing the amount of refrigerant and refrigerant lines.	M-L/New & Adapted	\$	4-7 years	Reduces piping length which reduces refrigerant leakage. Energy savings in the range of 11%/year.	Requires additional condensing units, although smaller. Water cooled systems require glycol and pumps which have implications maintenance and energy; energy use can be offset if an evaporative fluid cooler is employed.	Hussman Corp
*	3	Secondary Loop, Water/Glycol Cooled Refrigeration Cases	Design for water chilled lines to refrigerator cases with refrigeration contained within the central cooling unit.	M-L/New & Adapted	\$\$	4-7 years	Energy savings in the range of 10%/year; refrigerant savings in the range of 80%; even better benefits if tied to HVAC system, see Integrated HVAC below.	Not meant for packaged refrigeration units; requires additional maintenance of glycol; use a good installer and have a good maintenance contract.	See attached sheet
	4	High Efficiency Self Contained Refrigeration	Install/upgrade to high efficiency refrigerators. Select equipment with Energy Star ratings where applicable. Consider units with water cooled condensers and glycol loops to the exterior of the building for heat rejection.	S/New, Adapted & Exist	\$	1-3 years	Energy Savings; depends on unit selection.	Best for smaller stores where more efficient distributed systems are not a viable option. Glass door reach ins not necessarily best first approach for energy savings. Consider distribution systems.	See Energy Star Recommendations for Commercial Refrigeration <a href="http://www.energystar.gov">www.energystar.gov</a>
	5	Evaporative Condensers	Alternative to air-cooled condenser using wetted filter media to cool ambient air as it enters the condenser increasing its ability to reject heat.	M & L/New	\$	4-7 years	Savings in the range 2%-10% as water is a more efficient heating and cooling medium than air.	Water based systems in general are more efficient than air based systems, although they tend to require additional maintenance. They are most efficient in dry climates but are still effective in mixed climates like the Mid-Atlantic.	<a href="http://www.aps.com/main/services/business/WaysToSave/BusWaysToSave_59.html">www.aps.com/main/services/business/WaysToSave/BusWaysToSave_59.html</a>
	6	Refrigeration Night Covers	Install energy saving thermal curtains that reflect warm temperatures away from refrigerated display cases and keep cold air in.	S, M, L/New, Adapted & Exist	\$	1-3 years	Energy savings	Not applicable for stores open 24/7.	Econo-Frost <a href="http://www.econofrost.com">www.econofrost.com</a>
	7	Refrigerator Display Cases with Doors	Use refrigerators with doors over open cases as much as possible.	S, M, L/New, Adapted & Exist	0	Immediate	Doors reduce compressor energy and cold air leakage; savings as high as 50% over open cases; keeps customers more comfortable.	Existing cases can be retrofitted, but be sure to get input from a professional as to size the condenser properly.	<a href="http://www.aps.com/main/services/business/WaysToSave/BusWaysToSave_59.html">www.aps.com/main/services/business/WaysToSave/BusWaysToSave_59.html</a>
	8	Floating Head Pressure Controls	Use pressure controls which vary head pressure based on outdoor conditions (load matching).	S, M, L/New, Adp & Exist	0-\$	1-3 years	Energy savings in the range 3%-10%; helps refrigeration equipment last longer.	Floating head pressure controls are often standard on new systems but existing systems can be retrofitted.	<a href="http://www.aps.com/main/services/business/WaysToSave/BusWaysToSave_59.html">www.aps.com/main/services/business/WaysToSave/BusWaysToSave_59.html</a>
	9	Liquid Pressure Amplifiers	Use small refrigerant pumps that increase refrigerant liquid line pressure and system efficiency.	S, M, L/New, Adp & Exist	\$	1-3 years	Energy savings as high as 20%.	For systems with air-cooled condensers, the lower the outdoor air temperature, the greater the efficiency gain.	<a href="http://www.aps.com/main/services/business/WaysToSave/BusWaysToSave_59.html">www.aps.com/main/services/business/WaysToSave/BusWaysToSave_59.html</a>
	10	Anti-Sweat Heater Controls	Use electric heater controls to sense store humidity conditions and turn the heaters off when they are not needed.	S, M, L/New, Adapted & Exist	\$	1-3 years	Savings in the range 6%-20% depending on the type of case. Most effective with reach-in refrigerators.	Anti-sweat heaters are electric heaters installed in virtually all low temperature and many medium temperature display cases to keep their external surfaces free of condensation during high humidity conditions. Typically they are on all the time.	<a href="http://www.aps.com/main/services/business/WaysToSave/BusWaysToSave_59.html">www.aps.com/main/services/business/WaysToSave/BusWaysToSave_59.html</a>
	11	Defrost Controls	Use demand controls which initiate defrosting in a variety of ways such as measuring the temperature or pressure drop across the evaporator, measuring frost accumulation and sensing humidity.	S, M, L/New, Adapted & Exist	\$	1-3 years	Improves the defrost cycle providing energy savings in the range 1%-8%.	These methods are more effective than using a simple timer clock to initiate defrosting.	<a href="http://www.aps.com/main/services/business/WaysToSave/BusWaysToSave_59.html">www.aps.com/main/services/business/WaysToSave/BusWaysToSave_59.html</a>
	12	Ambient Subcooling	Use an oversized condenser or additional heat exchanger to sub-cool liquid refrigerant.	M-L/New, Adp & Exist	\$	4-7 years	Savings in the range 1%-10% on the higher end for walk-in coolers.		<a href="http://www.aps.com/main/services/business/WaysToSave/BusWaysToSave_59.html">www.aps.com/main/services/business/WaysToSave/BusWaysToSave_59.html</a>
	13	Mechanical Subcooling	Cool liquid refrigerant below its saturation pressure to increase system capacity and improve efficiency.	M-L/New, Adp & Exist	\$	1-7 years	Savings as high as 30% for refrigeration systems.		<a href="http://www.aps.com/main/services/business/WaysToSave/BusWaysToSave_59.html">www.aps.com/main/services/business/WaysToSave/BusWaysToSave_59.html</a>

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HVAC								
	Category	Strategy	Relevant Store Size/Type	Initial Cost	** Return on Investment	Operator Benefits	Technical Considerations	Product + Manufacturer Suggestions/Resources/Examples
1	Integrated Air Based HVAC with Refrigeration System	Use units with premium efficiency motors. Use waste heat from refrigeration to temper ventilation and heating air.	S,M,L/New, Adapted & Exist	\$	4-7 years	Energy savings are yielded from higher efficiency unit and the use of waste heat and from not using energy to remove the waste heat.	Involves direct integration of the heat pump evaporator and the refrigeration condenser; Typically roof top units.	Hussman Corp; Energy efficient motors <a href="http://www.aceee.org/ogeece/ch4_index.htm">www.aceee.org/ogeece/ch4_index.htm</a>
* 2	Integrated Water Based HVAC with Refrigeration System	Design for water source heat pumps (WSHP) in conjunction with water-loop heat rejection for the refrigeration.	M-L/New, Adapted & Exist	\$\$	4-7 years	Produces the highest reduction in operating costs; Savings in the range 10-20% on HVAC and refrigeration loads; uses less refrigerant and reduces environmental impacts.	Refrigeration and HVAC units need to interface.; employ glycol loops for heat rejection; requires additional maintenance over air based system.	Loblaws Supermarket, Canada
3	Variable Speed Economizer Fans	The economizer allows for outdoor air usage rather than mechanical; Variable flow provides the ability to vary the speed of pump and fan motors as well as match load conditions.	S,M,L/New, Adapted & Exist	\$	1-3 years	Savings in the range 10%-30%.	Allows system to use outdoor air, when temperature and humidity allow, particularly relevant to supermarkets where interior loads create the need for cooling; typically an option for all package AC units.	
* 4	Humidity Control	Install rooftop units using desiccant energy recovery wheels which moderate indoor humidity levels and help to reduce energy demands by recovering some of the energy to heat or cool outdoor makeup air.	S,M,L/New, Adapted & Exist	\$	1-3 years	Reduces the cost to condition outside air by up to 80%; Improves indoor air quality; immediate payback when conditioning units are downsized to take advantage of work by ERW, extends shelf life of food by preventing sweating, creates a more comfortable environment for shoppers.	Humidity becomes present through infiltration, open doors, and ventilation. It is important to have good humidity control and a tight building. Where high outdoor air quantities are being introduced, consider liquid desiccant humidity control systems.	McQuay; See attached sheet
5	Demand Ventilation	Decouple ventilation from space conditioning.	M-L/New & Adapted	\$ - \$\$	4-7 years	Less energy used for space conditioning in off-hours and temperate times. Helps control humidity which contributes to energy savings.	Requires additional duct work. CO2 monitoring recommended. Not a good application in areas of cooking.	

Hot Water								
	Category	Strategy	Relevant Store Size/Type	Initial Cost	** Return on Investment	Operator Benefits	Technical Considerations	Product + Manufacturer Suggestions/Resources/Examples
1	Heat Recovery	Waste heat from refrigeration, AC units, and drain water can be used to heat water; options include a hot-gas-to-water heat exchanger, double-bundled condensers, and pipe wrapped drain lines.	S,M,L/New, Adapted & Exist	\$	4-7 years	Energy savings are yielded both from the use of waste heat and from not using energy to remove the waste heat.	Heated water can be used for tempering ventilation/heated air, domestic hot water, and water for food heating tables. Kitchens offer great opportunities for captured drain heat as quantities and temperatures are typically high.	Therma-Stor; Turbotec; Heat recovery water heating <a href="http://gfxtechnology.com/HR3-7-1.PDF">http://gfxtechnology.com/HR3-7-1.PDF</a>
2	Tankless Hot Water Heaters	Install instant hot water heaters that don't require water storage of heated water.	S/New, Adp & Exist	\$	1-3 years	Space savings by eliminating space for water heater. Energy savings from not heating stored hot water.	Best used for small stores not able to use heat recovery.	Takagi, Rinnai
3	Radiant Heating in Exterior Paving Areas	For projects heating water with recovered heat, install radiant piping in sidewalks for snow and ice removal.	M-L/New	\$	4-7 years	Helps reduce cost for snow and ice clearing by using on-site generated energy.	Can use recovered heat already heating water for other purposes; only costs are those to lay flexible tubing; best for projects providing new or replacement sidewalks.	

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Equipment								
	Category	Strategy	Relevant Store Size/Type	Initial Cost	** Return on Investment	Operator Benefits	Technical Considerations	Product + Manufacturer Suggestions/Resources/Examples
1	High Efficiency Equipment	Install/upgrade to high efficiency equipment; select equipment with Energy Star ratings where applicable.	S,M,L/New, Adapted & Exist	\$	1-3 years	Savings in the range 15%-35%.	Applies to packaged refrigeration units, all kitchen equipment, lighting/lamps, and water heaters. Use gas ovens, instead of electric. Install compensating hoods to reduce demand on HVAC and hood controllers that shut down the hood when not in use.	Select Energy Star rated equipment <a href="http://www.energystar.gov">www.energystar.gov</a> , follow CEE commercial recommendations <a href="http://www.cee1.org/com/com-main.php3">www.cee1.org/com/com-main.php3</a> (Consortium for Energy Efficiency)
2	High Efficiency Condenser Fan Motors	Select condensers using premium efficiency motors.	S,M,L/New, Adapted & Exist	\$	1-3 years	Savings range 3%-5%.		
3	High Efficiency Compressor Motors	Select compressors using premium efficiency motors.	S,M,L/New, Adapted & Exist	\$	1-3 years	Savings in the range 8%-18% depending on item (reach-ins, ice machines, vending machines, beverage merchandisers, etc).		
4	High Efficiency Evaporator Fan Motors	Select evaporator fans using premium efficiency motors.	S,M,L/New, Adapted & Exist	\$	1-3 years	Savings in the range 2%-30% depending on item (reach-ins, display cases, ice machines, vending machines, beverage merchandisers, etc).		

Lighting								
* 1	High Performance Lighting Strategies - Ambient Lighting	Use high performance fluorescent fixtures on occupancy and daylight controls.	S,M,L/New, Adapted & Exist	\$	1-3 years	High performance lighting systems have potential saving in the range of 8%-15%. Lighting improvements can be done incrementally with immediate payback.	Consider a lower level of overall general lighting to allow the display lit areas to better stand out; use fixtures with T8 or ideally T5 lamps; install occupancy sensors in storage rooms, back-of-house offices and other vacant and low traffic areas; install and adjust automatic dimming controls to take advantage of daylighting and enable lowering light levels for restocking and cleaning while the store is closed.	See attached sheet
* 2	High Performance Lighting Strategies - Display Lighting	Use LED lighting in cases, and fluorescent or metal halide lighting placed closer to product for display.	S,M,L/New, Adapted & Exist	\$	1-3 years	High performance lighting systems have potential saving in the range of 8%-15%. Lighting improvements can be done incrementally with immediate payback.	Use 39w HID display lighting hung lower in place of 70w. LEDs are 40x more efficient than incandescent however color rendition and throw need to be checked for display use, best for refrigerated cases.	See attached sheet
* 3	High Performance Lighting Strategies - Exterior	Use Metal Halide LED exterior fixtures for exterior applications, zoned for after hours usage.	S,M,L/New, Adapted & Exist	\$	1-3 years	High performance lighting systems have potential saving in the range of 8%-15%. Lighting improvements can be done incrementally with immediate payback.	Use 3fc average in parking lots. Consider solar pv in parking lots which offsets cost of conduit runs. Zone exterior site lighting - turn off certain areas of parking lot after hours.	See attached sheet

Operations and Maintenance								
* 1	Measurement and Verification/ Submetering	Tracking energy cost and usage involves the use of submetering to measure individual loads, such as lighting, refrigerators, main meter, and HVAC. "If you don't measure it, you can't control it."	M-L/New	\$	4-7 years	Very helpful in testing new strategies. Data can be used to help determine problem areas or areas not performing as expected. General energy analysis data can be applied to all stores in chain.	Special consideration needs to be given to electrical design in order to more effectively allow for submeters. Need to have a facilities person that is collecting and analyzing data; often works well with building automated systems and controls.	See attached sheet
2	Comprehensive Building Commissioning	Engage a commissioning agency to test all equipment for performance.	M-L/New, Adapted & Exist	\$ - \$\$	4-7 years/7+	Tested systems will perform at their peak efficiencies; Typically done for new facilities on the onset, but can provide benefit existing stores.	Commissioning agents typically will test HVAC, domestic hot water, and building controls. Refrigeration unit and controls testing are usually commissioned separately. Ideally the two would overlap and be cross-coordinated to maximize efficiency.	
3	Operating and Maintenance Procedures	Create and implement a well defined and consistently executed O&M plan.	S,M,L/New, Adapted & Exist	\$	Immediate	Regular coil cleaning, door seals, refrigerant leakage detection and repair, not overloading cases, etc. will yield long term consistent energy savings.	Use contract maintenance over in-house as it increases the chances of it happening regularly. Ideal to have all systems under the same contract. Requires some employee training.	
4	Energy and Waste Education Program for Employees	Train and educate employees on importance of energy efficiency and provide incentives for them to report leaks and under- functioning equipment.	S,M,L/New, Adapted & Exist	\$	Immediate	Helps systems run at their most efficient levels and yield operational savings in the 2% - 10% range.	Provide incentives for staff to report leaks and malfunctions in addition to training.	

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- \$\$\$ 50%-75% additional cost to equivalent conventional building method/technology

**Store Size Notes**

- S - Small store; Bodega style; 1000-5000sf
- M - Medium sized store; Grocery store; 5000 -25,0000 sf
- L - Large store; Supermarket; > 25,000sf, typ. 45,000sf - 60,000sf

**Store Type Notes**

- New - Ground-up new buildings
- Adapted - New stores in existing buildings
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Greening Grocery: Strategies for Sustainable Food Retailing - A Project of The Food Trust

**Water Efficiency:** Strategies focus on reducing use of municipally treated domestic water. Conventional supermarkets use 3500 - 4000 gallons/day of water. Most of this water is consumed for water based mechanical equipment or wash-down requirements at food prep areas. The benefits are realized in cost savings on water and energy bills from reduced use and in reducing the environmental impacts from treating municipal water.

	Category	Strategy	Relevant Store Size/Type	Initial Cost	** Return on Investment	Operator Benefits	Technical Considerations	Product + Manufacturer Suggestions/Resources/Examples
1	No Irrigation / Native Vegetation	Install adapted/native vegetation that will require no irrigation after plant has taken hold.	S,M,L/New	0	Immediate	Water savings; eliminates cost of irrigation installation.	Plantings will probably need some initial irrigation until established; consider drip irrigation that can be easily removed or hand watering.	
2	High Efficiency Spray Nozzles for pre-rinse and wash-down / Aerators / Water Flow Restrictors on Hand Sinks and Spray Tables	Install equipment that restricts water flow over conventional flow rates.	S,M,L/New, Adapted & Exist	\$	1-3 years	Cost savings on water.	High pressure nozzles with lower water volume can perform wash-down as well as conventional nozzles.	Zurn, Encore, Fisher, Niagara Conservation
3	High Pressure Sprayers for Washing in Meat Department	Sprayers that use high pressure to achieve the same water force with less water.	S,M,L/New, Adapted & Exist	\$	1-3 years	Cost savings on water.	High pressure nozzles with lower water volume can perform wash-down as well as conventional nozzles.	
4	High Efficiency Toilets and Urinals	Install 1.1gpf or dual flush toilets; waterless or .5gpf or less urinals.	S,M,L/New, Adapted & Exist	\$	4-7 years	Cost savings on water.		Kohler, Zurn, Sloan
5	Aerators on lavatories and staff showers	Install .5 gpm aerators on lavatories and 1.5gpm heads on any staff showers provided.	S,M,L/New, Adapted & Exist	0-\$	Immediate	Cost savings on water.		Sloan, Bricor, Zurn
6	Condensate Re-Use from Refrigeration and AC Units	Recycle water back to water based heating and cooling systems.	M-L/New, Adapted & Exist	\$	4-7 years	Cost savings on water.	Applicable to water based systems; Much of water used in mechanical equipment is lost to evaporation.	
* 7	Rainwater Collection and Reuse	Collect rainwater on site to be used for toilet flushing, in water based cooling and heating equipment, and irrigation if required.	M-L/New, Adapted & Exist	\$\$	7+	Payback in 12 years or as little as 4 depending on tank sizing and demand.	Tank sizing is critical.	See attached sheet

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\* Additional information provided in cut sheets

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**Materials and Resources / Environmental Concerns:** Strategies focus on using less material, re-using materials, and using local materials in order to reduce material costs and impacts to the environment caused by material manufacturing and transportation costs. Additional strategies focus on using materials that minimize the impacts to air quality both internally and globally. Benefits are realized through lower material costs, increased durability, a healthier building for its occupants, and reduced global environmental impact.

	Category	Strategy	Relevant Store Size/Type	Initial Cost	** Return on Investment	Operator Benefits	Technical Considerations	Product + Manufacturer Suggestions/Resources/Examples
1	Refrigerant Selection	Pick refrigerants that are more environmentally friendly.	S,M,L/New, Adapted & Exist	0-\$	Immediate/1-3 years	These refrigerants tend to be more energy efficient; improves system design and maintenance.	Many older refrigeration systems are also energy inefficient, resulting in increased costs, as well as increased energy demand (further increasing GHG emissions).	<a href="http://www.epa.gov/ozone/partnerships/greenchill/">www.epa.gov/ozone/partnerships/greenchill/</a>
2	Reduce and Re-Use Materials	For existing facilities, use/renovate existing materials; design for less material need.	S,M,L/New, Adapted & Exist	0	Immediate	Savings on building materials.	Eliminate dropped ceilings, expose structure, use materials serving more than one purpose (structural and finish); consider exposed/stained concrete floor finishes.	
3	Local/Regional Materials	Use building materials that were extracted and manufactured locally (within 500 miles is the generally accepted target).	S,M,L/New & Adapted	0-\$		Savings on transportation costs.	When selecting materials, consider maintenance and life cycle of the options.	Armstrong; USG
4	Recycled Materials	Use building materials that have recycled content; gyp board can be specified with 95% recycled content.	S,M,L/New & Adapted	0-\$		Some recycled materials cost less; many don't cost more. Materials are a visible statement of environmental commitment.	When selecting materials, consider maintenance and life cycle of the options; compare recycled content percentages and specify the higher levels when cost competitive.	Armstrong ceiling tiles; USG and National Gypsum; Forbo marmoleum
5	Low VOC Adhesives and Finishes	Use adhesives and finishes that have low quantities of air contaminants (volatile organic compounds, VOCs).	S,M,L/New, Adapted & Exist	0-\$		Improves indoor air quality for employees and patrons. Reduces down-time due to fumes after renovations and repairs.	Including adhesives for plumbing and duct work.	Most paint manufactures have low VOC lines, some don't have a premium; Oatey for plumbing adhesives

**Waste Management / Recycling:** Strategies focus on reducing waste sent to the landfill. An average supermarket sends 1,000 tons of garbage to the landfill/year. The benefits of this are realized in cost savings in waste disposal fees, increased store traffic and in improving global environmental impacts by creating better soil and from minimized waste to a landfill.

* 1	Use/Compost Organic Waste	Use immediately ripe produce in salad bars and other kitchen food prep; compost organic waste for use on site or by other local organizations/ community gardens.	S,M,L/New, Adapted & Exist	\$	1-3 years	Reduces refuse fees. Re-using ripe produce increases profit.	Requires additional staff coordination. Needs to be designed not to attract vermin. Consider using industrial pulpers or water extractors with organic waste to minimize size and weight and then use/sell/give away for fertilizer.	
* 2	Comprehensive Recycling Strategy	Recycle cardboard and any metal, glass, and paper products used by store. Return/reuse any wood pallets. Provide area for customers to drop-off recycling - particularly cardboard and plastic bags which are not items picked up residentially by the City. Reduce use of packaging.	S,M,L/New, Adapted & Exist	0-\$	Immediate/1-3 years	Reduces refuse fees. Good PR. Attracts customers.	Requires additional coordination and staff education for garbage separation. Consider how items are packaged and ways to reduce packaging, such as sale of bulk items. Some packaging can be re-sold inexpensively as storage containers.	
3	Construction Waste Hauler During Construction	Recycle construction waste in lieu of sending it to the landfill.	S,M,L/New, Adapted & Exist	0-\$		Reduces landfill dump fees during construction.	Higher savings and recycling success if materials are separated on site rather than off.	

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Store Operations:								
	Category	Strategy	Relevant Store Size/Type	Initial Cost	** Return on Investment	Operator Benefits	Technical Considerations	Product + Manufacturer Suggestions/Resources/Examples
1	No Idling Policy for Trucks	Develop an operations policy requiring that all delivery trucks turn engines off when parked for delivery.	S,M,L/New, Adapted & Exist	0		Improves indoor air quality and acoustics for the store.	Involves education of drivers.	See Appendix: Philadelphia Transportation/Parking Policy for City Idling Policy
2	Cooking / Nutrition Classes and Demonstrations	Develop on-site programs to promote healthy eating including fresh produce.	M and L/New, Adapted & Exist	0-\$		Develops a loyal customer base, increases produce demand in underserved neighborhoods, brings in more shoppers, and creates a sense of the store serving the community.	Requires staff time and space allotment within store.	New Seasons Market (Portland OR); www.peoplesgrocery.org
3	Seasonal and Local Food Buying	Purchase and sell food raised and grown from nearby farms in-season; label location of food source.	S,M,L/New, Adapted & Exist	0-\$		Better quality food items, develops a loyal customer base, brings in more shoppers, and creates a sense of the store serving the community.	Requires more coordination for purchasing; tends to be more appropriate for independents and co-ops with more flexible buying policies.	Weaver's Way, Mariposa Co-op, Essene Market, Sue's Produce, Almanac (Philadelphia), Hen House Market (6238 N. Chatham Ave, Kansas City)

**Advanced Technologies:** These resource conserving strategies were studied for application in supermarkets and grocery stores. They are best for operators who have a sustainability agenda or a long-term hold on their properties, often coupled with a relatively good return on investment. Energy modeling is recommended to best understand the cost versus return as these will vary per particular store. While these strategies may not be commonplace today, they are likely strategies for the future.

* 1	CHP Systems / Cogen	Systems that provide simultaneous cooling, heating and power generation.	L/ New	\$\$\$	7+	Far more efficient than conventional refrigeration; uses waste heat; 50% savings on energy bills.	Due to high initial costs, most viable for supermarkets which have high operating costs	See attached sheet
2	On-Site Testing/Treatment of Rainwater for Wash-Down	Treating captured rainwater on site to meet Health Department requirements for wash down of food areas.	L/New, Adapted & Exist	\$\$\$	7+	Savings on water bills.	First step is to work with local jurisdictions to understand what is really required as using rainwater becomes more frequently utilized. If on-site treatment is required, consider reverse osmosis.	

**On-Site Renewable Energy:** Strategies focus on using renewable energy created on-site. The benefits of these will most likely be realized in the future when fossil fuel rates are de-regulated

1	Ground Source Heat Pumps	Where land is available, consider replacing or augmenting air-cooled condensers, cooling towers and evaporative condensers with ground-coupled condensers. Deep ground wells coupled with electric pumps used to pre-heat water for space conditioning and/or act as the condenser (including heat dissipation) for refrigeration system in either air or water based units.	M-L/New	\$\$\$	7+	Significant electrical energy savings.	Augments heat recovery and can be used for reverse heat exchange where unused waste heat, particularly in the cooling months; requires land for ground source wells. Locate wells in parking lots or sidewalks; viability of this system is high for new construction or renovation projects with ample land area (parking lots or green space) available for the well field.	
2	Solar Hot Water	Building mounted equipment to generate hot water heated by the sun. Typically first strategy for hot water is recovered energy; however, additional energy as needed for hot water can be achieved with this strategy.	S,M,L/New, Adapted & Exist	\$-\$	4-7 years	Grocery stores require high amounts of hot water and this strategy reduces monthly energy costs for heating hot water. Very low initial cost with quick return on investment.	Solar thermal hot water heating is a relatively inexpensive option for heating hot water but in the northeast it needs to be part of a 2-stage system with solar as the primary and heat recovery to augment.	
3	Photovoltaics	Building mounted, site mounted, or building integrated panels to provide electrical power from the sun.	M-L/New, Adapted & Exist	\$\$\$	7+	Significant electrical energy savings.	Future rebates are anticipated. Need area on roof or site for mounting panels which can require a significant amount of area depending on energy offset desired. Can be integrated with any solar shading, such as building mounted or over parking.	

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## Site Design: Site Selection

**Strategy:** Choose an urban building site, mixed use and/or smaller building sites.

**Relevant Store Scale/Type:** Works best for small and mid-size grocery stores or two story supermarkets, particularly for mixed use development.

### Initial Costs:

1. Elevators/escalators if necessary.
2. Cost of underground or above grade covered parking if required.
3. Construction mobilization costs can be higher in tight urban spaces.

### Return on Investment:

1. Depends on the site. May include reduced sales/lease costs, reduced parking construction, and reduced utility installation costs.
2. Ability to use existing infrastructure. Minimizes cost of utility runs.

### Operator Benefits:

1. Ability to work with existing infrastructure (utilities).
2. Lease, construction, and utility costs are less for smaller sizes.
3. Denser location brings people in from surrounding neighborhoods.
4. Mixed used development reduces amount of exterior roof/wall space which reduces conditioning loads.

### Technical Considerations/Strategies:

1. Tend to be tighter spaces that need more design and pre-planning coordination to effectively program.
2. This may involve multi-level structures including parking above or below grade, both of which have significant cost implications.
3. Construction requires more coordination in tight urban spaces.
4. Consider the following strategies: retail frontage with parking at rear; designs that minimize loading dock area and back of house storage (note: this requires additional coordination for loading demands); design compactly with narrower aisles.
5. If developing in mixed use environment, more attention is required for location of mechanical units.

### Product/Manufacturer Suggestions, Resources & Examples:

Loblaws Superstore, Canada

[http://www.canadianarchitect.com/issues/ISarticle.asp?id=70668&story\\_id=CA109520&issue=09012001&PC](http://www.canadianarchitect.com/issues/ISarticle.asp?id=70668&story_id=CA109520&issue=09012001&PC)

Neighborhood Store: (Philadelphia locations)

Romano's Grocery – 1219 E Luzerne St

Weaver's Way – 559 Carpenter Lane

Grocery Stores/Supermarkets: (Philadelphia)

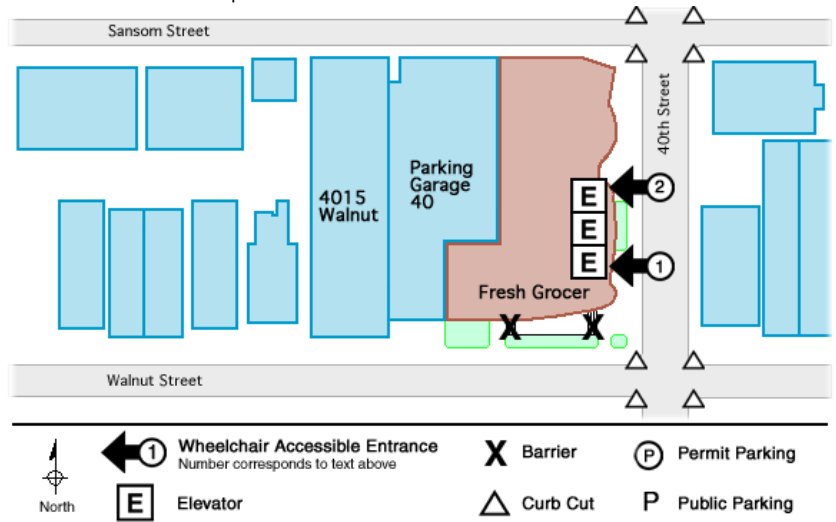
Acme – 1400 East Passyunk Avenue

Fresh Grocer – 4001 Walnut Street

ShopRite – 52<sup>nd</sup> and Jefferson

Supremo – 43<sup>rd</sup> and Walnut

Whole Foods – 929 South Street



## Site Design: Alternative Transportation

**Strategy:** Select a site near public transportation and develop project site to encourage additional access beyond a single passenger car.

**Relevant Store Scale/Type:** S,M,L/New & Adapted

### Initial Cost:

1. Site improvements for drop off and integrated site design for alternative transportation modes.
2. Bicycle Racks.

### Return on Investment:

1. Immediate savings if reduced parking provided.
2. 1-7 years for additional customer base to offset site improvements.

### Operator Benefits:

1. Brings in more customers.
2. Urban areas have reduced parking requirements which reduces the first-cost and on-going cost of parking areas.

### Technical Considerations:

1. Consider the following strategies: site selection near public transportation; provide bike parking; covered bus shelter integrated with site design for buses and shuttles; parking spaces for car share programs and drop off/pick up areas for cabs; locate bike share as a hub on site.
2. Locate stores in Transit Oriented Developments.

### Suggested Providers:

Philly Car Share [www.phillycarshare.org](http://www.phillycarshare.org)

ZipCar/FlexCar [www.zipcar.com](http://www.zipcar.com)

Bike Share Philadelphia <http://bikesharephiladelphia.org/home/>

SEPTA <http://www.septa.com/>

### Product/Manufacturer Suggestions, Resources & Examples:

Transit Oriented Development (See Appendix for additional sources):

<http://www.philaplanning.org/plans/tod.html>

<http://www.thestar.com/article/216684>

Philadelphia Green Transportation Policy:

[http://www.phila.gov/green/LocalAction/PlanElements\\_Transportation.html](http://www.phila.gov/green/LocalAction/PlanElements_Transportation.html)



## Site Design: On-Site Storm Water Management

**Strategy:** Infiltrate water on-site through vegetation, pervious surfaces, and rainwater harvesting.

**Relevant Store Scale/Type:** S,M,L/New & Adapted

### Initial Cost:

1. Cistern and/or hold and release detentions.
2. Cost of porous pavement including additional sub-base requirements for porous asphalt.
3. Additional vegetated areas.
4. Additional structure if doing a green roof.

### Return on Investment:

1. Depends on strategies employed. Using vegetation can decrease first costs over other mandated strategies and piping storm water while cisterns using captured rainwater require longer term investment depending on the amount of rainwater re-use off-setting potable water use.
2. Depending on the costs pipe to storm water, porous pavement or retain and release strategies can be more cost effective on certain projects.

### Operator Benefits:

1. Certain strategies can minimize the cost of structural storm water management approaches.
2. Collection of rainwater can have added benefit of being used on site, thereby replacing municipal water demands.
3. Addition of vegetated areas which include appropriately located trees and green roofs also contributes to reducing cooling loads.

### Technical Considerations:

1. New development must meet storm water requirements in Philadelphia which is highly regulated.
2. Provide additional vegetated spaces between parking and around the site to absorb rain water.
3. Porous asphalt/pavers and vegetated roofs are options, although the cost is higher.
4. Investigate "hold and release" and buried cisterns.
5. Soils testing generally required to determine allowable soil absorption rates.

### Product/Manufacturer Suggestions, Resources & Examples:

EP Henry, Porous Pavers

[https://www.ephens.com/Design/Product.asp?Product\\_ID=79](https://www.ephens.com/Design/Product.asp?Product_ID=79)

Porous Asphalt:

[http://www.stormcon.com/sw\\_0305\\_porous.html](http://www.stormcon.com/sw_0305_porous.html)

[http://www.hotmix.org/view\\_article.php?ID=533](http://www.hotmix.org/view_article.php?ID=533)

[http://www.pavegreen.com/water\\_quality.asp](http://www.pavegreen.com/water_quality.asp)

Philadelphia Stormwater Management Policy:

<http://www.phillyriverinfo.org/programs/SubProgramMain.aspx?Id=StormwaterManual>

<http://postwritersgroup.com/archives/peir0813.html>

## Energy Efficiency - Building Design Strategies: Building Envelope Design

**Strategy:** Design and build a tight, well-insulated shell to help reduce heating and cooling loads.

**Relevant Store Scale/Type:** S,M,L/New, Adapted, Existing

### Initial Cost:

1. Higher performing products tend to have higher first costs, but not all. Some exceptions are TPO /EPDM roofing, metal SIPs, and ICFs.

### Return on Investment:

1. Savings as high as 25% can be realized on energy bills within the first year by simply creating a tight building envelope.
2. Recommendations include using energy modeling to study first cost trade-offs with energy saving benefits.

### Operator Benefits:

1. Reduces cooling and heating loads for interior of building.
2. Reduces air infiltration and helps with humidity control.
3. Better acoustic performance.

### Technical Considerations:

1. Reduce exterior envelope (for example, party walls or multiple stories, mixed use development).
2. Consider high performance glazing, roofing with high SRI (solar reflectance index >29 for sloped roofs), high R-value insulation with low infiltration rates such as spray foam insulation over batts, metal SIPs (Structurally Insulated Panels), ICFs (Insulated Concrete Forms)
3. Include air locks / vestibules at all primary entrances.

### Product/Manufacturer Suggestions, Resources & Examples:

Carlisle white TPO roofing <http://www.carlisle-syntec.com/>

Solarban Glazing by PPG Glass <http://corporateportal.ppg.com/NA/IdeaScapes/productInfo/glass/>

BioBased Spray Insulation <http://www.biobased.net/>

King Span Metal SIPs <http://www.kingspanpanels.ca/>

Kortek <http://www.koreteck.com/>

Insulated Concrete Forms:

<http://www.forms.org/>

Study on thermal performance in supermarkets as related to thermal insulation:

[http://www.sciencedirect.com/science?\\_ob=ArticleURL&\\_udi=B6V2V-4H7THGJ-1&\\_user=10&\\_rdoc=1&\\_fmt=&\\_orig=search&\\_sort=d&\\_view=c&\\_acct=C000050221&\\_version=1&\\_urlVersion=0&\\_userid=10&md5=ccd70c05df830fe866316ed643c85709](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V2V-4H7THGJ-1&_user=10&_rdoc=1&_fmt=&_orig=search&_sort=d&_view=c&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=ccd70c05df830fe866316ed643c85709)

## Energy Efficiency - Building Design Strategies: Energy Modeling

**Strategy:** Computer model building design and systems to test the potential energy use and performance of various energy efficiency alternatives.

**Relevant Store Scale/Type:** S,M,L/New & Adapted

### Initial Cost:

1. Design fees for an energy modeler. Typically, refrigeration systems include modeling as part of the purchase; however, it is recommended the store is modeled holistically.
2. It is all recommended that the services include several iterations for design study to best compare design options.
3. \$5,000 start for energy modeler fees; depends on size and complication of system.

### Return on Investment:

1. Savings depend on the design choices made for the energy efficient systems relevant to the cost of the energy model.

### Operator Benefits:

1. Modeling will inform decisions about which selection, or combination of selections, perform the best.
2. General energy analysis data can be extrapolated to multiple stores in a chain, increasing the ROI.

### Technical Considerations:

1. Energy modeling is the best way to project energy use and savings in order to make strategic design / system choices.
2. Modeling is typically necessary for energy rebates.
3. While uncommon for grocery stores, it is ideal to integrate refrigeration modeling together with space conditioning to realize full efficiencies, like heat recovery.
4. Because energy systems of a supermarket are relatively complex, it is recommended that the energy modeling consultant have experience with grocery store/supermarket modeling for a comprehensive understanding of integrating the systems and choices.

### Suggested Programs:

Basic modeling programs include:

DOE2 / eQUEST <http://www.doe2.com/>

More complex programs are recommended for extensive and integrated modeling of supermarkets; check with modeling experts for best programs based on store requirements.

### Product/Manufacturer Suggestions, Resources & Examples:

Supermarket Energy Modeling Conclusions from KTH using CyberMart program for integrated overview:

<http://www.diva-portal.org/kth/theses/abstract.xsql?dbid=217>

## Energy Efficiency - Building Design Strategies: Comprehensive Day Lighting Strategy

**Strategy:** Strategically locate windows and skylights to reduce the amount of artificial lighting needed during the day.

**Relevant Store Scale/ Type:** S,M,L/New

**Initial Cost:**

1. Cost of skylights and additional windows.

**Return on Investment:**

1. Use of daylight can save \$.30/year for each square foot of daylight floor area, not to mention increased sales.

**Operator Benefits:**

1. Having natural daylight reduces the need for artificial light and associated costs.
2. Enhances the stores appearance and attracts customers.
3. Numerous studies have shown that daylight increases length of customer visit and volume of sales.
4. Enhances staff satisfaction and productivity.
5. Reduced lighting reduces cooling loads.



**Technical Considerations:**

1. Preferred natural light is from the south and north.
2. Use high performance and diffuse glazing for skylights so space is not receiving direct beam light.
3. Evenly distribute lights from above; consider vertical glazing such as clerestories because the light and heat are easier to control.
4. Produce areas should not receive any direct day light.
5. Special care should be given to designing skylights and windows so as not to increase cooling loads.
6. Use of daylight sensors on artificial lighting to automatically reduce lighting loads.
7. Use light colored finishes for floors, ceilings and walls to help reflect and distribute light throughout the space.

**Product/Manufacturer Suggestions, Resources & Examples:**

Solatube Skylights <http://www.solatube.com/>

Sun-Dome <http://www.sun-dome.com/>

Bristolite [www.bristolite.com](http://www.bristolite.com)

Velux [www.veluxusa.com](http://www.veluxusa.com)

Article on daylighting in supermarkets:

<http://www.archlighting.com/industry-news.asp?articleID=670546&sectionID=1306>

Lighting Design Guidelines, including daylight, in Retail Stores:

[http://www.designlights.org/downloads/skylighting\\_Retail.pdf](http://www.designlights.org/downloads/skylighting_Retail.pdf)

<http://www.designlights.org/guides.html>

Daylight and Retail Report:

[http://www.h-m-g.com/downloads/Daylighting/A-5\\_Daylgt\\_Retail\\_2.3.7.pdf](http://www.h-m-g.com/downloads/Daylighting/A-5_Daylgt_Retail_2.3.7.pdf)

Giant Supermarket Example:

[http://www.solatube.com/commercial/cs\\_geg.php](http://www.solatube.com/commercial/cs_geg.php)

## Energy Efficiency System Design Strategies: Refrigeration Low Charge Multi-Plex with Evaporative Condenser

**Strategy:** Multiplex refrigeration with evaporative condensers and control systems that limit the amount of refrigerant recharge for the multiplex operation.

**Relevant Store Scale/Type:** S,M,L/New, Adapted and Existing. Can be done fairly easily as part of an existing store retrofit. Small stores are more likely to use air cooled systems.

### Initial Cost:

1. Cost of control systems.
2. Evaporative condensers have a higher first cost than air-cooled condensers.

### Return on Investment:

1. Lowest first-cost premium for refrigeration systems, yielding the fastest payback.
2. Energy savings in the 10-11% range annually as compared to conventional multiplex systems and 5-6% range when compared to air-cooled low charge multiplex systems.

### Operator Benefits:

1. Energy savings.
2. Reduction in the amount of refrigerant by 1/3.

### Technical Considerations:

1. Liquid controls save additional energy by lowering condensing temperatures.
2. Will require more maintenance than conventional air-cooled multi-plex systems.

### Product/Manufacturer Suggestions, Resources & Examples:

Refrigeration Technologies Studies:

[http://findarticles.com/p/articles/mi\\_m0BPE/is\\_12\\_9/ai\\_68706789](http://findarticles.com/p/articles/mi_m0BPE/is_12_9/ai_68706789)

[http://www.arb.ca.gov/cc/commref/adv\\_supmkt\\_ref\\_syst.pdf](http://www.arb.ca.gov/cc/commref/adv_supmkt_ref_syst.pdf)

## Energy Efficiency - System Design Strategies: Refrigeration Distributed Refrigeration

**Strategy:** Distributed Refrigeration consists of several compressor racks that are installed in close proximity to display cases/storage rooms. The refrigeration sides contain direct-expansion evaporators while 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. Multiple compressor racks are located in several independent cabinets distributed throughout the store, and all condensers are connected to a unique heat rejection closed loop containing an antifreeze mixture and an air-cooled or evaporative fluid cooler normally located on the roof.

**Relevant Store Scale/Type:** S,M,L/New, Adapted, Existing

### Initial Cost:

1. Additional condensing units, pumps, and glycol.
2. Additional maintenance.

### Return on Investment:

1. Energy Savings in the 11% range annually as compared to conventional multiplex systems.

### Operator Benefits:

1. Energy savings of 11 – 12%
2. Reduction in the amount of refrigerant by 30% - 35%.
3. Reduction in CO2 emissions

### Technical Considerations:

1. Water cooled systems will realize more savings than air cooled condensers and have a better ability at lowering environmental impacts or TEWI
2. Further savings can be recognized if evaporative heat rejection for the fluid loop is employed.
3. Water cooled systems use secondary coolants and pumps which require additional maintenance and energy; energy use can be offset if an evaporative fluid cooler is employed.
4. In order for distributed systems to perform as designed, condensing temperatures have to be lowered by rejecting a sufficient amount of heat from the water loop.

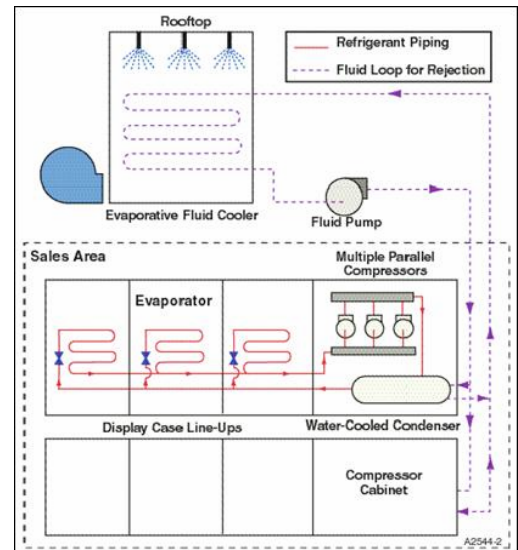
### Product/Manufacturer Suggestions, Resources & Examples:

Hussman Corp. [www.hussmann.com/](http://www.hussmann.com/)

Refrigeration Technologies Studies:

[http://findarticles.com/p/articles/mi\\_m0BPE/is\\_12\\_9/ai\\_68706789](http://findarticles.com/p/articles/mi_m0BPE/is_12_9/ai_68706789)

[http://www.arb.ca.gov/cc/commref/adv\\_supmkt\\_ref\\_syst.pdf](http://www.arb.ca.gov/cc/commref/adv_supmkt_ref_syst.pdf)



Source: International Energy Agency (IEA). 2003. "IEA Annex 26: Advanced Supermarket Refrigeration/Heat Recovery Systems, Final Report Volume 1-Executive Summary." See links below

## Energy Efficiency - System Design Strategies: Refrigeration Secondary Loop System

**Strategy:** Design for water chilled lines to refrigerator cases with refrigerant contained within the central cooling unit using evaporative condensers.

System involves secondary fluid loops on both condensing and refrigerating sides, with water-to-air heat recovery heat pumps. Low temperature (frozen foods) and a medium temperature (for chilled food) primary loops use noncorrosive and nontoxic brines with high heat capacities and low viscosities at low temperatures. They eliminate the use of refrigerants on both cold and freezing sides of the system and are separately pumped to the display cases and cold storage rooms. The display case heat exchangers are designed to use secondary fluids so the temperature differences between the brines and the air are minimized. Warm secondary loops reject the condensing excess heat to the outdoor air by means of remote air-cooled liquid coolers typically located on the roof. Loops use ethylene glycol as the warm secondary fluid.

**Relevant Store Scale/Type:** M,L/New & Adapted

### Initial Cost:

1. Coolants and high efficiency compressors and evaporative condensers; the rest is similar to multiplex systems.

### Return on Investment:

1. Savings in the 10-11% range annually as compared to multiplex systems.
2. Further operating savings if integrated with HVAC system to use waste heat. See Integrated HVAC with Refrigeration.

### Operator Benefits:

1. The more efficient and shorter defrosting cycles, higher average evaporating temperatures, proper insulation of the secondary fluid piping, and close coupling of the compressor racks to the condensers and fluid chillers (evaporators) contribute towards the energy-use savings.
2. Can reduce refrigerant demand up to 80%.
3. Highest capacity to lower total equivalent warming impact (TEWI) – water cooled units followed by evaporative cooled.

### Technical Considerations:

1. Use a good installer and have a good maintenance contract with them.
2. Requires additional maintenance of glycol and evaporative coolers.
3. The use of evaporative heat rejection for the fluid loop is recommended to reduce energy usage.

### Product/Manufacturer Suggestions, Resources & Examples:

See also section on Integrated HVAC and Refrigeration

Articles on Secondary Loop Refrigeration Systems in Supermarkets:

[http://findarticles.com/p/articles/mi\\_m5PRB/is\\_9\\_49/ai\\_n25012861](http://findarticles.com/p/articles/mi_m5PRB/is_9_49/ai_n25012861)

Investigation of Secondary Loop Supermarket Refrigeration Systems:

[www.energy.ca.gov/pier/final\\_project\\_reports/500-04-013.html](http://www.energy.ca.gov/pier/final_project_reports/500-04-013.html)

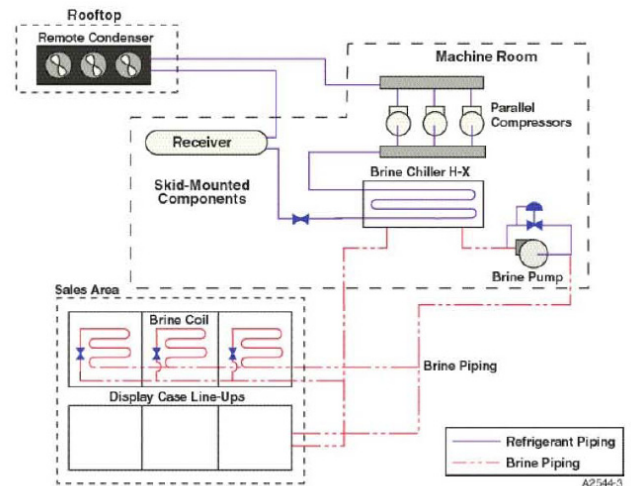


Figure 3. Flow Diagram for a Secondary Loop Refrigeration System

Source: Southern California Edison and Foster-Miller, Inc. 2004. "Investigation of Secondary Loop Supermarket Refrigeration Systems." Report prepared for California Energy Commission, Public Interest Energy Research Program.

## Energy Efficiency - System Design Strategies: HVAC Integrated Water Based HVAC with Refrigeration System

**Strategy:** Design HVAC in conjunction with water-loop heat rejection from the refrigeration; ideally using water source heat pumps and evaporative condensers. In this strategy, a warm temperature liquid is circulated through a low-temperature rooftop liquid cooler. The same warm secondary fluid flows through heat recovery heat pumps. These heat pumps then provide heat to the various parts of the store. The water-source heat pumps use the heat rejected by the low-temperature rack to provide space heating without requiring the condensing temperature and discharge pressure to be raised as in some conventional systems. There are, therefore, substantial energy savings because of the heat pumps' high coefficients of performance. Additionally a conventional heat reclaim coil, located in the central air handler, allows the recovery of between approximately 30 % and 50 % of total heat rejection.

**Relevant Store Scale/Type:** M-L/Best for new or existing buildings but can be integrated into existing buildings doing upgrades.

### Initial Cost:

1. Costs for systems are about 30% above conventional roof top units.

### Return on Investment:

1. Energy savings are in the 10% - 20% savings in operating costs over conventional air cooled roof top units with multiplex refrigeration.

### Operator Benefits:

1. The more efficient and shorter defrosting cycles, higher average evaporating temperatures, proper insulation of the secondary fluid piping, and close coupling of the compressor racks to the condensers and fluid chillers (evaporators) contribute towards the energy-use savings
2. When using water source heat pumps and evaporative condensers, this strategy produces the best overall savings in operating costs from the recommendations other than those in Advanced Technologies.
3. Minimizes electrical energy consumption for outdoor air preheating.
4. Reduces amount of refrigerant, both generating savings and reducing annual total equivalent warming impact (TEWI).

### Technical Considerations:

1. Use an experienced, reliable installer and have a good maintenance contract with them.
2. Heat pumps have high efficiency factors which have an even better performance when water based over air.
3. Employ glycol loops for heat rejection.

### Product/Manufacturer Suggestions, Resources & Examples:

IEA Annex 26: Advanced Supermarket Refrigeration/Heat Recovery Systems:

<http://www.ornl.gov/~webworks/cppr/y2003/rpt/117000.pdf>

Improved Supermarket Refrigeration and Heat Recovery System:

[http://findarticles.com/p/articles/mi\\_m5PRC/is\\_2\\_112/ai\\_n24998201](http://findarticles.com/p/articles/mi_m5PRC/is_2_112/ai_n24998201)

Case Study: Loblaws Supermarket, Canada:

<http://cetc-varenes.nrcan.gc.ca/fichier.php/codectec/En/2005-025/2005-025e.pdf>

<http://cetc-varenes.nrcan.gc.ca/fichier.php/codectec/En/2004-119/2004-119e.pdf>

## Energy Efficiency - System Design Strategies: HVAC Humidity Control

**Strategy:** Install rooftop units using desiccant energy recovery wheels which moderate indoor humidity levels and help to reduce energy demands by recovering some of the energy to heat or cool outdoor makeup air.

**Relevant Store Scale/Type:** S,M,L/New, Adapted, Existing

### Initial Cost:

1. There is a very large variance in type and size for commercial equipment, depending on store size.

### Return on Investment:

1. The payback on energy savings is very short when ASHRAE compliance ventilation rates are being maintained. The payback is immediate in new construction when air-conditioning equipment sizing and installations account for the added cooling and heating capacity provided by the ERVs.
2. Reduces the cost to condition outside air by up to 80%.

### Operator Benefits:

1. Energy savings accrue through avoiding dehumidification and reheat by conventional equipment which requires more expensive handling of latent loads and more frequent defrost cycles due to higher dew points than those using desiccants.
2. Desiccant systems can improve indoor air quality by removing air pollutants and odors.
3. Improves ventilation rates.
4. Low humidity allows food to avoid sweating and frosting, which extends shelf life.
5. Aisles are kept at warmer, more comfortable temperatures than conventionally dehumidified stores.

### Technical Considerations:

1. Humidity becomes present through infiltration, open doors, and ventilation. It is important to have good humidity control and a tight building.
2. Desiccants naturally attract moisture, efficiently removing latent (humidity-related) load from the air. Conventional air conditioners are then typically used to reduce the temperature (called the sensible load) of the dried air to desired occupant comfort levels. Latent and sensible loads are handled more efficiently because each component is optimized to independently remove these loads. When heated, the saturated desiccant is regenerated to be used again.
3. In supermarkets, desiccant dehumidification systems displace anti-sweat heaters and defrosters that consume considerable energy to control moisture levels in freezer display cases.
4. Where high outdoor air quantities are being introduced, consider liquid desiccant humidity control systems.
5. Special care should be exercised to assure that air quality levels meet the expected levels, including: using high quality filters; proper installation and maintenance of the desiccant with the ERV and designing the unit to meet its actual application.

### Product/Manufacturer Suggestions, Resources & Examples:

Moving Advanced Desiccant Materials into Mainstream Non-CFC Cooling Products:

<http://www.ornl.gov/~webworks/cpr/rpt/103923.pdf>

Energy Recovery Wheels and IAQ:

<http://www.michaelsengineering.com/Briefs/IAQ15.htm>

## **Energy Efficiency - System Design Strategies: High Performance Lighting Strategies – Ambient, Display and Exterior**

**Strategy:** Use high efficiency lamps/light fixtures tailored to specific task, dimming controls, and occupancy/daylight controls.

**Relevant Store Scale/Type:** S,M,L / New, Adapted, Existing

### **Initial Cost:**

1. Premium for high efficiency fixtures.
2. Sensors.

### **Return on Investment:**

1. High performance lighting systems have potential saving in the range of 8%-15%.

### **Operator Benefits:**

1. Energy savings yielded from lower cooling demands and lower electrical lighting demands.
2. Warm light and varying light levels creates a more attractive environment.
3. Lighting improvements for retrofits can be done incrementally with immediate payback.

### **Technical Considerations: Ambient**

1. Use combination of down and uplight fixtures to eliminate hot spots in the ceiling area, give shadow-free illumination of the products below, and enable good visual acuity at lower lighting levels. This contributes to making shopping less frenetic and lowers lighting and cooling costs.
2. Install occupancy sensors in storage rooms, back-of-house offices and other vacant and low traffic areas.
3. Install and adjust automatic dimming controls to take advantage of daylighting and enable lowering light levels for restocking and cleaning while the store is closed.
4. Install fluorescent fixtures using T-8 lamps or ideally T-5 lamps
5. Consider lower ambient lighting levels with display lighting placed close to product to provide more contrast, allowing the items to better stand out.
6. For ambient lighting select lamps with good color rendering. Lower color temperatures (3,000 K or below) give a warmer feel.

### **Technical Considerations: Display**

1. Install fluorescent fixtures using T-8 lamps or ideally T-5 lamps for display lighting.
2. Alternatively, use 39w metal halide display lighting hung lower in place of 70w.
3. For display lighting, consideration must be given to impact on life of food. Use lamps with full color rendition.
4. Use LED fixtures for signage and refrigerator cases. LEDs are 40 times more efficient than incandescent lamps.

### **Technical Considerations: Exterior**

1. Use metal halide or LED lighting in parking lots with a 3fc average.
2. Use LED for pedestrian and building lighting.
3. Consider solar power to parking lot lights which offsets costs of conduit runs.
4. Zone parking lot lighting to minimum level after hours as needed for employee parking or minimal customer use if open 24/7.
5. Shield all exterior lights to shine down so only lighting needed areas.

## **Product/Manufacturer Suggestions, Resources & Examples for Lighting:**

Case Study: A&P Food Market, Old Lyme, CT:

<http://www.lrc.rpi.edu/programs/DELTA/pdf/Vol-1-1-A&P.pdf>

Lighting Design Guidelines in Retail Stores:

<http://www.designlights.org/guides.html>

Lighting Supermarket Freezers with LEDs:

[http://www.lrc.rpi.edu/programs/solidstate/cr\\_freezers.asp](http://www.lrc.rpi.edu/programs/solidstate/cr_freezers.asp)

Lighting for Food Display

<http://www.promolux.com/>

## Energy Efficiency: System Design Strategies: Operations and Maintenance Measurement and Verification / Submetering

**Strategy:** Track energy cost and usage involving the use of submetering to measure individual loads, such as lighting, refrigerators, equipment, main meter, and HVAC.

**Relevant Store Scale/Type:** M-L/New

### Initial Cost:

1. Additional submeters.
2. M&V Plan and Data analysis

### Return on Investment:

1. Savings depends on what is being submetered. See case studies below for some ranges in savings.

### Operator Benefits:

1. Helps assure that all systems are running at best efficiency creating energy savings.
2. Very helpful in testing new strategies.
3. Data can be used to help determine problem areas or areas not performing as expected.
4. General energy analysis data can be applied to all stores in chain.

### Technical Considerations:

1. Special consideration needs to be given to electrical design in order to most effectively allow for submeters.
2. Important to create a Measurement and Verification plan to understand the scope to be analyzed.
3. Need to have a facilities person that is collecting and analyzing data; often works well in conjunction with building automated systems and controls.
4. "If you don't measure it, you can't control it."

### Product/Manufacturer Suggestions, Resources & Examples:

Case study: Shaw's Supermarkets

<http://www.cool-companies.org/ads/shaws.cfm>

Case study: Food Lion

[http://www.energystar.gov/index.cfm?fuseaction=partners\\_in\\_practice.showStory&step=AP&storyid=1000000](http://www.energystar.gov/index.cfm?fuseaction=partners_in_practice.showStory&step=AP&storyid=1000000)

## Water Efficiency: Rainwater Collection and Reuse

**Strategy:** Collect rainwater on-site and air conditioner/refrigeration condensate to be used in water based cooling and heating equipment, for toilet flushing, and for irrigation if needed.

**Relevant Store Scale/Type:** M-L/New, Adapted, Existing

**Initial Cost:**

1. Cisterns, filters, treatment chemicals, and piping.

**Return on Investment:**

1. Return is typically reached in twelve years with examples as little as four years.
2. Tank sizing is critical for determining payback.

**Operator Benefits:**

1. Reduces municipally treated water utility bills.
2. Helps meet and exceed local storm water regulations.

**Technical Considerations:**

1. Need to consider freezing conditions; ideally locate cistern below grade or on the interior.
2. Discuss use of minimally treated rainwater with local officials and health department to determine an appropriate level of treatment.

**Product/Manufacturer Suggestions, Resources & Examples:**

Environmental Building News Alternative Water Sources:

<http://www.buildinggreen.com/auth/article.cfm/2008/4/29/Alternative-Water-Sources-Supply-Side-Solutions-for-Green-Buildings/>

The Texas Manual on Rainwater Harvesting:

[www.twdb.state.tx.us/publications/reports/RainwaterHarvestingManual\\_3rdedition.pdf](http://www.twdb.state.tx.us/publications/reports/RainwaterHarvestingManual_3rdedition.pdf)

Case Study: Sam's Club, Fayetteville, AR:

<http://walmartstores.com/FactsNews/NewsRoom/6699.aspx>

## Materials and Resources / Environmental Concerns: Refrigerant Selection

**Strategy:** Use refrigerants that are more environmentally friendly; those that are non-ozone depleting and minimize global warming impacts.

**Relevant Store Scale/Type:** S,M,L/ Most applicable for New and Adapted but Existing store should consider refrigerant selection when upgrading Refrigeration and HVAC systems.

### Initial Cost:

1. Some of the more environmentally friendly refrigerants.

### Return on Investment:

1. Environmentally friendly refrigerants should pay for themselves in the first 1 to 3 years.

### Operator Benefits:

1. These refrigerants tend to be more energy efficient.
2. They typically improve system design and maintenance.

### Technical Considerations:

1. Just as CFC refrigerants have been taken out of production, HCFC refrigerants are also scheduled to be removed from production in the future.
2. Primary refrigerant recommendation: R507, a nonflammable fluid, featuring no ozone-depletion potential
3. As a two-phase secondary coolant for secondary loop systems, carbon dioxide would be a valuable option for a deep freeze coolant (frozen foods) which has no ozone degradation potential and negligible global warming impact. It is universally available, uses very little energy for pumping, has excellent transport properties and has low costs.
4. For the medium-temperature cold secondary loop, propylene glycol is recommended.
5. As a warm secondary fluid for heat rejection, ethylene glycol is recommended. This fluid presents certain environmental risks, but they are minimal compared to the risks associated with common refrigerant leakages.

### Product/Manufacturer Suggestions, Resources & Examples:

The GreenChill Advanced Refrigeration Partnership:

This is an EPA cooperative alliance with the supermarket industry and other stakeholders to promote the adoption of technologies, strategies, and practices that reduce emissions of **ozone-depleting substances** (ODS) and **greenhouse gases** (GHGs) and increase refrigeration system energy efficiency.

<http://www.epa.gov/ozone/partnerships/greenchill/>

Advanced Refrigeration Technology:

<http://www.epa.gov/ozone/partnerships/greenchill/alttechnology.html>

Refrigeration Technologies Studies:

[http://www.arb.ca.gov/cc/commref/adv\\_supmkt\\_ref\\_syst.pdf](http://www.arb.ca.gov/cc/commref/adv_supmkt_ref_syst.pdf)

## Waste Management/Recycling: Use and Compost Organic Waste

**Strategy:** Use immediately ripe produce in salad bars and other kitchen food prep; compost organic waste for use on site or by other local organizations/community gardens.

**Relevant Store Scale/Type:** S,M,L/New, Adapted, Existing

### Initial Cost:

1. Compactor/collector and workstation collection containers.
2. Biodegradable lining bags, which are suggested for compost compactors.
3. Staff and management training is needed on the use and compost of organic waste.

### Return on Investment:

1. Composting saves \$40/ton compared to the costs of trash disposal systems.
2. Disposal costs are now at \$80 to \$100/ton of waste and rising. Stores that use and compost organic waste can save dramatically. Supermarkets that compost even 5 to 10 tons of waste per week have been known to save \$10,000 to \$20,000/year.

### Operator Benefits:

1. Using and composting organic waste will reduce refuse fees.
2. Re-using ripe produce increases profit.
3. When using a compactor for compost, compactor units store more material in less space.
4. Compost enriches soils and does not end up in landfills, therefore playing a valuable role in preserving natural resources.

### Technical Considerations:

1. Composting systems require additional staff coordination.
2. Needs to be designed not to attract vermin.
3. Consider using industrial pulpers or water extractors with organic waste to minimize size and weight and then use/sell/give away for fertilizer.
4. Companies interested in composting have the choice of using a compacting system or a tote collection system.

### Product/Manufacturer Suggestions, Resources & Examples:

Save money by composting article:

[http://www.jgpress.com/archives/\\_free000544.html](http://www.jgpress.com/archives/_free000544.html)

Supermarket Composting handbook:

<http://www.mass.gov/dep/recycle/reduce/smhandbk.pdf>

Innovative Public – Private Recycling Partnership in Massachusetts

<http://www.astswmo.org/files/meetings/2005SWConference/Wolfe.pdf>

Solid & Hazardous Waste Education Center

<http://www4.uwm.edu/shwec/publications/newsletters/pdf/December2006.pdf>

## Waste Management: Comprehensive Recycling Strategy

**Strategy:** Recycle cardboard and any metal, glass and paper products used by store. Return/reuse any wood pallets. Provide area for consumers to drop-off recycling, particularly cardboard and plastic bags or items which are not typically picked up residentially by the City. Reduce use of packaging.

**Relevant Store Scale/Type:** S,M,L / New, Adapted, Existing

### Initial Cost:

1. Tipping costs.
2. Staff and management training.

### Return on Investment:

1. An average supermarket that recycles 8,900 tons of organic waste and 26,200 tons of cardboard/year has the potential to save \$45,000/year.
2. Recycling organic materials reduces disposal costs. The average cost for trash disposal is over \$80/ton, whereas recycling costs about \$60/ton.

### Operator Benefits:

1. Recycling reduces fees and provides instant savings.
2. Good PR
3. Attracts customers.
4. Reduces landfills and environmental impact.

### Technical Considerations:

1. Requires additional storage space for containers and staff coordination and education for garbage separation.
2. Consider how items are packaged and ways to reduce packaging, such as bulk sale of items.
3. Some packaging can be re-sold inexpensively as storage containers.

### Product/Manufacturer Suggestions, Resources & Examples:

Article on supermarket savings through recycling:

<http://www.epa.gov.epaoswer/osw/consERVE/2005news/02-food.htm>

A Guide to Waste Reduction at Shopping Centers:

[http://www.epa.gov.epaoswer/osw/consERVE/ontheGO/documents/\\_amrguide/amrguide.pdf](http://www.epa.gov.epaoswer/osw/consERVE/ontheGO/documents/_amrguide/amrguide.pdf)

WasteCap – Supermarket Recycling Organics Initiative:

<http://www.wastecap.org/wastecap/Programs/sroi/Overview%20of%20Startup%20Costs%20&%20Svngs.pdf>

Article on encouraging recyclable choices in supermarkets; Greening the Grocery Store:

<http://www.designobserver.com/archives/entry.html?id=37924>

## Advanced Technologies: CHP Systems or Cogen

**Strategy:** CHP (combined heat and power) Systems are those that provide simultaneous cooling, heating and power generation, also known as Cogeneration or Cogen. In supermarket applications, microturbines integrated with a double-effect absorption chiller convert waste heat to provide cooling in summer, heating in winter, sub-cooling for refrigeration, power for electrical needs, and desiccant regeneration.

**Relevant Store Scale/Type:** L/New

### Operator Benefits:

1. Provides high efficiency cooling, heating and power, providing energy savings.
2. Extremely efficient as compared to conventional refrigeration options.
3. Integrates HVAC with Refrigeration for greater efficiencies.
4. Uses waste heat.
5. Provides power continuously on site, reducing dependency on the power grid and helping minimize power interruption for higher productivity.
6. Uses no ozone depleting fluorocarbons and has ultra low CO<sub>2</sub> emissions.

### Initial Cost:

1. Initial costs are significantly higher than conventional systems

### Return on Investment:

1. Reduces utility bills up to 50%.

### Technical Considerations:

1. A Cogen system has the capacity to significantly lower operating costs. However, with its high first costs as compared to conventional systems, it is currently cost prohibitive for all but larger supermarkets with high operating costs.

### Product/Manufacturer Suggestions, Resources & Examples:

UTC Power Pure Comfort 240M

[www.utcpower.com](http://www.utcpower.com)

ElectraTherm

[www.electratherm.com](http://www.electratherm.com)

Applying a Microturbine/Desiccant CHP System to a Supermarket:

<http://www.cdhenergy.com/presentations/ASHRAE%20Anaheim%202004%20Supermarket%20Microturbine-Desiccant%20System.pdf>

Examples:

Waldbaum's Supermarket, Long Island, NY:

[http://www.chpcentermw.org/rac\\_profiles/Northeast/Waldbaums\\_CHPPProjectProfile.pdf](http://www.chpcentermw.org/rac_profiles/Northeast/Waldbaums_CHPPProjectProfile.pdf)

A&P Fresh Market, Mount Kisco, NY:

<http://files.harc.edu/Sites/GulfCoastCHP/CaseStudies/APFreshMarketMountKiscoNY.pdf>

## Appendix: Additional Resources, References & Case Studies

### General Green Grocery Store Guidelines and Resources

<http://www.betterbricks.com/SubHomePage.aspx?ID=2>

### Energy Efficiency Opportunities Supermarkets

Energy Efficiency Opportunities: Big Box Retail and Supermarkets:

<http://files.harc.edu/Sites/GulfCoastCHP/MarketAssessments/EnergyEfficiencyOpportunitiesBigBox.pdf>

American Council for an Energy Efficient Economy's Online Guide to Energy Efficient Commercial Equipment:

[http://www.aceee.org/ogeece/ch1\\_index.htm](http://www.aceee.org/ogeece/ch1_index.htm)

Refrigeration and Thermal Test Center – Research Projects – Supermarkets:

<http://www.sce.com/RebatesandSavings/DesignandEngineering/RTTC/ResearchProjects/SupermarketSummaries/>

IEA Annex 26: Advanced Supermarket Refrigeration/Heat Recovery Systems:

<http://www.ornl.gov/~webworks/cppr/y2003/rpt/117000.pdf>

Improved Supermarket Refrigeration and Heat Recovery System:

[http://findarticles.com/p/articles/mi\\_m5PRC/is\\_2\\_112/ai\\_n24998201](http://findarticles.com/p/articles/mi_m5PRC/is_2_112/ai_n24998201)

Advances in Supermarket Refrigeration Systems:

[http://www.arb.ca.gov/cc/commref/adv\\_supmkt\\_ref\\_syst.pdf](http://www.arb.ca.gov/cc/commref/adv_supmkt_ref_syst.pdf)

Green Chill Advanced Refrigeration Partnership:

<http://www.epa.gov/ozone/partnerships/greenchill/>

### Energy Efficient Retrofits for Supermarkets and Malls

<http://www.oee.nrcan.gc.ca/publications/commercial/m144-23-2003e5.cfm?text=N&printview=N>

### Water Conservation Opportunities in Supermarkets

[http://www.aquacraft.com/Download\\_Reports/Calfed\\_Report.pdf](http://www.aquacraft.com/Download_Reports/Calfed_Report.pdf)

### Philadelphia Parking/Transportation Policy

[http://www.amlegal.com/nxt/gateway.dll/Pennsylvania/philadelphia\\_pa/thephiladelphiacode?f=templates\\$fn=default.htm\\$3.0\\$vid=amlegal:philadelphia\\_pa](http://www.amlegal.com/nxt/gateway.dll/Pennsylvania/philadelphia_pa/thephiladelphiacode?f=templates$fn=default.htm$3.0$vid=amlegal:philadelphia_pa)

Local Action Plan for Climate Change:

[http://www.phila.gov/green/LocalAction/PlanElements\\_Transportation.html](http://www.phila.gov/green/LocalAction/PlanElements_Transportation.html)

### Transit Oriented Development

Neighborhoods Now Transit-Oriented Development:

<http://www.neighborhoodsnowphila.org/transit/>

Transit-Oriented Development Plans:

<http://www.philaplanning.org/plans/tod.html>

Plan Philly: Building for transit-based living:

<http://www.planphilly.com/node/2848>

See also Loblaw Superstores case study links below.

## Case Studies/Examples

Acme, Philadelphia, PA:

[http://www.progressivegrocer.com/progressivegrocer/content\\_display/supermarket-industry-news/e3i2ebcd68bdc5ad9af909e516137e0c50c](http://www.progressivegrocer.com/progressivegrocer/content_display/supermarket-industry-news/e3i2ebcd68bdc5ad9af909e516137e0c50c)

Loblaws Superstores, Canada:

<http://www.energymanagementcanada.com/index.php/Features/Loblaws-cool-moves.html>

<http://cetc-varenes.nrcan.gc.ca/fichier.php/codectec/En/2005-025/2005-025e.pdf>

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