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Energy savings opportunities in food retail

by Jean-Paul Genet

Executive summary

Retail buildings consume $60 billion in energy each year. With today's IoT-capable technology, this consumption could be reduced by $9 billion annually. This paper reviews retail building energy management opportunities, examines the applicability of best practices to multiple retail environments, and shares brief examples of retailers who achieved their energy management goals.

Introduction

Facing the new wave of online retailers, rising costs, shrinking net profit margins, and volatile energy costs, many of today's conventional brick-and-mortar retailers are struggling to stay in business. In some countries, retail energy bills have quadrupled and now account for over 40% of EBITDA.[1]

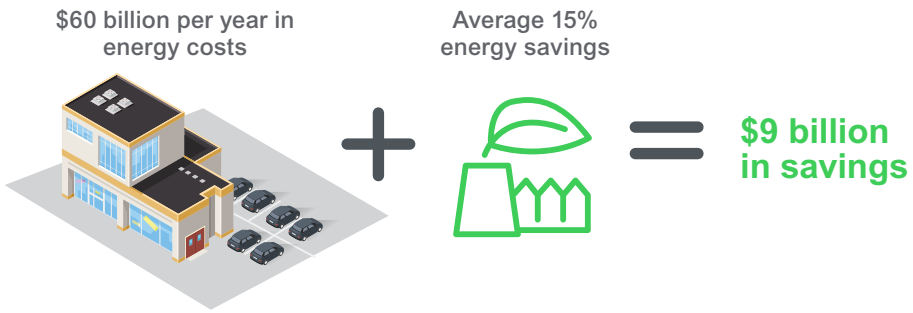
Taking into account the top 9,000 global retailers (more than five stores and total operations > 3M€), these retailers account for 2 million stores.[2] Food retail represents 40% or approximately 750,000 buildings. With an average U.S. energy cost of $5.65 per square foot, their combined annual energy consumption adds up to more than $60 billion.[3]

The size of this energy footprint highlights a huge opportunity to drive savings and protect profit margins by reducing energy consumption and saving on operational expenses (OpEx). With an intelligent building and energy management system, retailers can improve operational and energy efficiency, increase renewable energy use, reduce energy costs, and create new business value.

While savings vary by site, building characteristics, and operational control already deployed, savings from energy management initiatives can be as low as 1% for occupant sensors and as high as 30% or more for comprehensive lighting upgrades.

Figure 1

Global food retail industry savings opportunity



A study by the U.S. Department of Energy's Pacific Northwest National Laboratory estimates a reasonable range of energy savings potential in existing commercial buildings is between 10 and 20%.[4] In addition, the U.S. Environmental Protection Agency report "Sector Collaborative on Energy Efficiency Accomplishments and Next Steps" identified energy savings potential of up to 21% for supermarkets and up to 41% for retail stores.[5] Based on the food retail industry's $60 billion spent on energy a year, a 15% potential energy reduction represents a $9 billion opportunity to reduce costs.

These investments in energy efficiency are highly cost-effective, representing a tangible return on investment (ROI). For example, investing in intelligent, digitized refrigeration and HVAC upgrades that combine software and connected hardware can result in up to 60% energy savings in some cases.[6] This OpEx reduction has a significant impact on retailer profits. A food retailer's typical energy costs are 9% of OpEx.[7] Due to inflation and rising energy costs, most food retailers currently operate at a 3% profit margin, depending on the items.[8] A 15% reduction in energy cost can increase the profit margin from 3 to 4.3%, representing a 43% increase. Any delay in improving efficiency means lost potential savings.

1 "Energy crisis – alarm bells ringing for European retail and wholesale," EuroCommerce, September 2022
2 "The complete database contains more than 9000 retail chains with 1.9 million individual stores," Retail-index.com
3 "Energy management in Retail Operations," Schneider Electric, 2017
4 "Energy Efficiency Potential in Existing Commercial Buildings: Review of Selected Recent Studies," PNNL
5 "Sector Collaborative on Energy Efficiency Accomplishments and Next Steps," EPA
6 "Intelligent HVAC in a Warming World," Cleantech, September 2022
7 "Turning down the cost of utilities in retail," McKinsey & Company, June 2015
8 "What Is the Profit Margin for a Supermarket?" CHRON, November 2018

The transformative energy opportunity for food retail

Food retail is one of the most energy-intensive sectors within commercial building activities.[9]

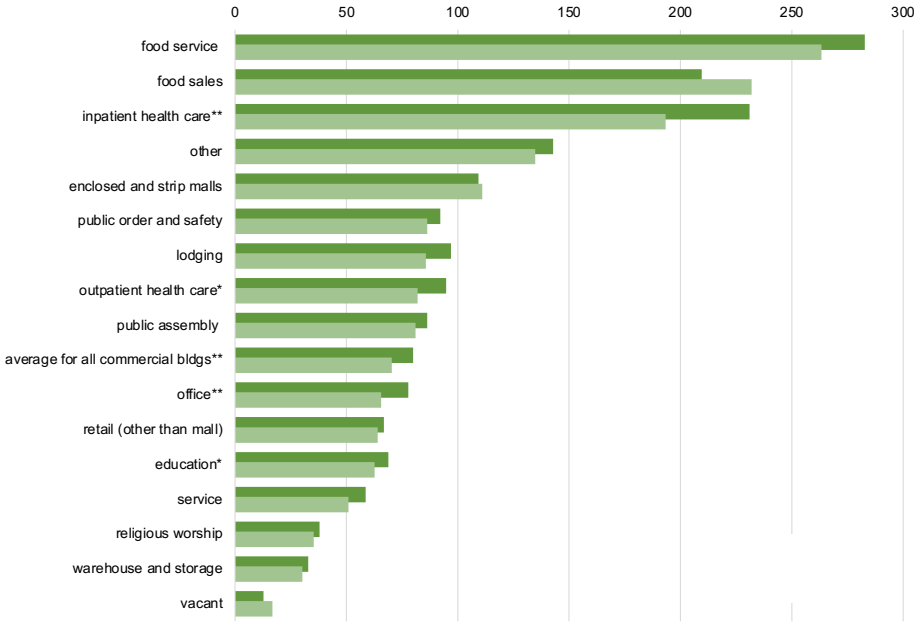


Figure 2

Energy intensity by principle building activity (2012 CBECS vs. 2018 CBECS) in thousand British thermal units per square foot.

Source: U.S. Energy Information Administration

Smaller stores, such as supermarkets or convenience stores, show higher energy intensity than larger superstores, which account for 95% of food retail chains. Therefore, when they consider energy savings, retailers should endeavor to focus on these store formats, especially considering the retail trend is to build small/medium stores to be close to the consumers and ensure the last mile delivery in an omnichannel world (home delivery, click & collect, curbside pick-up, returns, etc.).[10]

Table 1

Smaller supermarkets or convenience stores account for 95% of retail food chains. They have a much higher energy use intensity (EUI) than their larger counterparts.

Source: ENERGY STAR

Market Sector	Property Type	EUI kBTU/ft²
Food Sales	Convenience Store 4,000 square feet	231.4
Food Sales	Supermarket/Grocery Store 20,000 square feet	196
Food Sales	Wholesale Club/Supercenter > 80,000 square feet	51.4

Energy efficiency savings potential varies depending on the retailer's control over building infrastructure. Small-format and large-format, or supercenter, stores have differing levels of control over their energy efficiency.

9 "Eco-friendly supermarkets – an overview," ResearchGate, October 2016
10 "Global Power of Retailing," Deloitte, 2022

Small-format stores[11] – Controlling energy consumption can be more challenging. While these stores control their lighting, landlords often oversee the main HVAC system. Due to limited control, small-format stores' current potential energy reduction was 3-10%.[12] But we will see that new internet of things (IoT) technologies are now available to reach 20% savings with cost-effective solutions.[13]

Large-format stores – These sites can independently control most of their energy consumption (though sometimes chillers and transformer rooms are controlled by a landlord). Because of this high level of control, the large-format stores have an energy reduction potential of 20-30%,[14] depending on what initiatives/equipment are already in place and the age of the building.

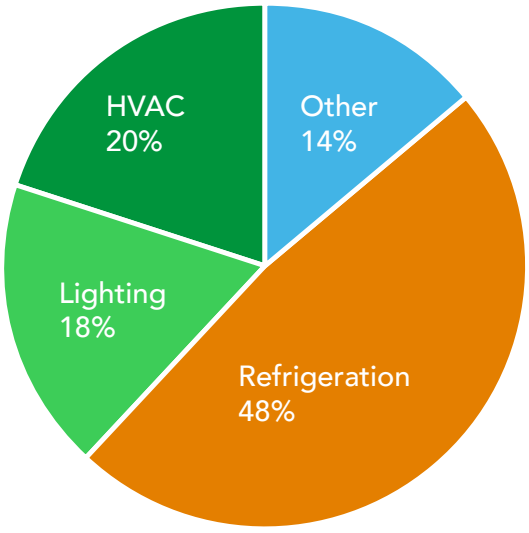
While large-format stores can apply more capital investment in energy projects to reduce energy consumption, many low-cost initiatives and behavioral changes can be implemented in small-format stores. In addition, retailers operating both small- and large-format stores can cluster stores to develop a more comprehensive portfolio of energy reduction targets.

Average food retailer load profile

Energy is the second-highest operating expense in the retail segment.[15] Within the segment, food retailers have a much higher energy consumption profile primarily due to their need for refrigeration. Of their total energy consumption, food retailers consume 82% electricity and 18% natural gas/other fuels; their average consumption per square foot is 51.3 kWh ft².[16] Due to refrigeration and HVAC system requirements, food retailers use three times as much energy per square foot as non-food retailers. Therefore, those two systems should be the focus of energy efficiency initiatives.

Figure 3

Average food retailer load profile based on Schneider Electric audits



11 "Marketplace Perspectives," ICSC
12 Based on limited capita investment and behavior changes, Schneider Electric case studies
13 "Top 3 technologies that improve energy and asset performance for buildings with limited resources," Schneider Electric
14 Based on Schneider Electric case studies
15 "Managing energy costs in grocery stores." National Grid, 2020
16 "Sector Collaborative on Energy Efficiency Accomplishments and Next Steps," EPA

The basics of energy-saving actions

While there is no one-size-fits-all solution for energy savings, there are basic frameworks. For example, powering off unnecessary equipment, reducing heating temperatures, and ensuring equipment is properly maintained all contribute to energy savings.

Four most effective basic strategies:[17]

1. **Low- or no-cost actions**
   - Turn it off: while it's the simplest of ideas, every 1,000 kWh saved equals a $200 utility bill reduction
     - Cash registers, computers, scales, and cooking equipment should be turned off when not in use
     - Turn off lights when not in use
   - Turn to minimum levels:
     - During closed hours, reduce temperature settings in warm seasons and increase during cooler seasons
     - Ensure HVAC settings in warehouses, stockrooms, offices, and other special-use rooms are at minimum settings
     - Ensure refrigeration temperature ranges are appropriate for food conservation and are not overcooling (which leads to high energy waste)
2. **Install an energy monitoring system to track energy waste**
3. **Ensure proper cleaning/maintenance, especially on refrigeration systems and HVAC systems**
4. **New or retrofit stores with high ROI**
   - Switch to efficient lighting systems such as high-performance fluorescent lamps or LEDs
   - Optimize refrigeration defrost with smart controllers
     - Add refrigeration cabinet doors/curtains
     - Use floating head pressure
   - Optimize HVAC systems

For more reading:

- Supermarkets: An Overview of Energy Use and Energy Efficiency Opportunities
- Energy Savings Tips for Small Businesses: Grocery and Convenience Stores
- Saving Energy Dollars in Stores, Supermarkets and Malls

"A 20% cut in energy costs represents the same bottom-line benefit as a 5% increase in sales."

-Carbon Trust

Deployment example: Food retailer

A large regional food retailer strategically targeted refrigeration costs as it represented 42% of their total energy consumption. To increase efficiency, they implemented a floating head and low-pressure system, saving energy by reducing the average amperage draw and compressor run time, resulting in 14-16% energy cost savings.[18]

Given current costs, energy efficiency improvements are essential to continued success. By beginning with lower-cost efficiency upgrades, these savings can later be leveraged into more extensive energy performance upgrades, helping to increase sales, worker productivity, and enhanced reputation as customers increasingly look to sustainability or net-zero responsibility in their purchase choices.

17 "Checklists of energy-saving measures: operations and maintenance." ENERGY STAR
18 Schneider Electric internal data

Control and automate building systems

In addition to traditional energy savings measures, new sustainability measures are increasingly integrated into modern facilities. For example, new loads, such as electric vehicle (EV) charging stations, are being introduced. These loads require sophisticated software to ensure they are properly integrated and managed into the facility's electrical distribution system. For example, EV charging stations can require an electrical consumption increase of up to 45% during peak periods in the day.[19]

It is worth noting that today only 13% of small- and medium-sized buildings have a building automation system (BAS). Yet, such systems in smaller buildings can cut energy use from 27 to 59%.[20]

Managing multiple systems

"There's a good way to go on improving efficiency – in terms of investment – before supermarkets really start going at self-generation in earnest."

David Tobin, Associate Director at the Carbon Trust

Given the variety of systems in use within food retail – refrigeration, lighting, heating, cooling, and energy management – there is a great need to integrate these systems into a single, harmonized platform that can orchestrate, automate, and help streamline these systems. The benefits of combining these into a single platform, serviced by cloud analytics and software, are:

- Connects controllers like thermostats to supplement their intelligence with weather forecasts
- Alerts in case of energy waste or deviations from sustainability targets
- Increases equipment life with condition-based maintenance, detecting low efficiency on refrigeration compressor rack
- Supports food savings by ensuring refrigerated goods (produce) are stored at the correct temperatures – energy consumption can be reduced by 2-4% if 1ºC can safely increase the set temperature [21]

For example, consider a store that closes at 8 p.m. for customers. Once the store is closed to the public, security systems must remain operational, but certain areas of the store can be shut down to save energy. Lights can be turned off, and heating or air conditioning units can be turned down.

Integrating these disparate systems also crosses the data of different domains to optimize building efficiency further. For example, the occupancy rate is typically used for sales performance. Still, the same data can also be used to optimize HVAC consumption. There is a potential for retail stores to save electrical energy by using actual measured occupancy rates rather than the design occupancy required by the ASHRAE standard 62.1. These savings ranged from 17% to 38% annually.[22]

A customized and digitized automation scheme can be implemented using an integrated building management system (IMS) to facilitate this process. Once the store closes, the IMS can be programmed to automatically shut off the lights and certain appliances (like cooking equipment and machines). This can save energy and reduce OpEx.

19 "Summary Report on EVs at Scale and the US Electric Power System," US DRIVE Driving Research and Innovation for Vehicle Efficiency and Energy Sustainability, November 2019

20 "Realizing the energy efficiency potential of small buildings," Preservation Green Lab/New Buildings Institute, June 2021

21 "Refrigeration: A guide to energy and carbon saving opportunities." Carbon Trust, October 2019

22 "Retail store energy savings with modified ventilation rates based on real-time occupancy data." ASHRAE, 2015

Modern systems now include a complete network of smart, connected devices. These deliver timely, actionable information to facility teams through powerful software applications on the desktop, in the cloud, or on mobile devices. The newest tools simplify understanding all operational conditions and managing complex systems. The steps to implementing such a solution can be highly cost-effective, considering all the dimensions of ROI previously discussed in this paper that can be achieved in a very short payback period.

Once installed, retail businesses can benefit from:

1. Identification of energy efficiency and sustainability improvement measures
2. Sites benchmarking enabling them to focus first on poor performers
3. New time and cost-saving opportunities
4. Streamlined maintenance
5. Enhanced equipment performance and lifespan

Without a fully connected and intelligent system, retail businesses are effectively operating manually or, worse, unaware of any risks that might affect business continuity and efficiency. Moreover, these risks can increase as new loads are added.

These benefits can also improve net margins in the retail space. Integrating different systems and using an IMS is crucial for efficient control and automation in modern facilities. Whether for traditional energy management or integrating new sustainability measures, an IMS can help streamline the management of various systems, improve energy efficiency, and help ensure energy resilience.

Deployment example: BMS

An Italian retail chain with over 3,500 supermarkets has validated (so far for one of its stores) a 15% energy savings with a centralized monitoring and control system.[23] It integrates HVAC, refrigeration, lighting, and emergency lighting. They are currently deploying this solution to the other stores.

Net zero as a retail value opportunity

Sustainability is an increasingly important topic due to global challenges such as reducing carbon emissions. Regulations are now common in most countries, while most major retailers have set and committed to sustainability goals such as Science Based Target initiative.[24] Their customers are also asking now to prove their engagement, and retailers need to implement solutions to reduce their carbon footprint.

Another challenge is to achieve some energy independence as retailers cope with more unpredictable events like hurricanes, floods, fires, and incidents on the utility network leading to a risk of blackout. Add in the energy crisis with its price fluctuations, and it's become extremely difficult to run a profitable business in these conditions.

23 Schneider Electric's internal data
24 "Climate sustainability in retail: Who will pay?," McKinsey & Company, May 2022

Reduce dependency on volatile tariffs and increase reliability

One way to address these challenges is to leverage energy production and storage technologies along with the internet of things (IoT) to help reduce energy costs and carbon emissions while improving resiliency.

The U.S. Department of Energy estimates that "with the application of new and existing technologies, buildings can be made up to 80 percent more efficient or even become 'net zero' energy buildings by incorporating on-site renewable generation."[25] This presents a massive opportunity for organizations to reduce energy consumption, carbon emissions, and operating costs.

For example, integrating microgrids and energy storage batteries can improve energy efficiency and reduce reliance on the traditional power grid. These systems store excess energy generated by renewable sources, such as solar panels, and sell it back into the grid when needed, to certain business operations when available, or when the energy price is high (peak hours). This is especially important when businesses must adapt to unforeseen changes or regulations. They can also use local production and storage when energy prices are high or when there is a risk of a blackout due to high peak demand or an incident on the utility network.

Hypermarkets, superstores, and supermarkets also have large roofs and parking garages that are ideal for solar installations. Moreover, solar installation costs have dropped, divided by five over the past ten years and credits and incentives from governments or utilities significantly lower the upfront cost.[26]

Refrigeration systems are usually designed for the hottest days and therefore have a big capacity to store energy (thermal battery storage) on average days. So, without compromising food safety requirements, stores can raise temperature settings and reduce compressors' run for a limited period, if the temperature stays within limits reducing energy consumption and providing flexibility for the grid.

Net-zero energy buildings (producing as much annual energy as it uses) are no longer just a concept. While only a few highly efficient buildings today can be called "Net-Zero," progress in IoT technologies, renewable energy systems, and distributed energy resources (DERs) means creating net-zero energy retail space is feasible and reinforcing the brand image of retailers showing tangible results and leading the path in the sustainability journey.

Deployment example: Retail logistics center

A regional retailer wanted to reduce the energy consumption of its logistics centers. The project analyzed energy usage over 725,000 square feet (including office space and 150,000 square feet of cold storage). The annual energy consumption for this space was 9 gigawatt hours (GWh), and 50% of this consumption was cooling for the cold storage areas. They were able to reduce their energy bill by 18% by:

- Optimizing HVAC system controls
- Installing variable speed drives
- Deploying floating high-pressure controls for refrigeration applications
- Measuring, monitoring, and benchmarking site energy consumption

25 "Operations & Maintenance Best Practices: A Guide to Achieving Operational Efficiency." Federal Energy Management Program, US Department of Energy

26 "Average installed cost for solar photovoltaics worldwide from 2010 to 2021," Statista, August 2022

This energy management project resulted in a 36% decrease in energy use for cold storage without sacrificing any level of service and generated a payback within 2.1 years.[27]

Deployment example: Food retail upgrades to microgrids

A major northeastern U.S. grocery store chain plans to upgrade its 40 stores with clean energy microgrids to reduce its carbon footprint. It intends to convert biogas into electricity without combustion using solid oxide fuel technology. This will make each store much more resilient to extreme weather as they receive fuel via an underground pipeline. As a result, the retailer expects to generate 10 MW and cut carbon emissions by more than 15,000 metric tons annually. Their energy servers also virtually eliminate smog-forming pollution and particulate emissions.

Conclusion

Energy efficiency programs and robust control and automation systems create significant opportunities to reduce costs and improve the profitability of retail operations. While retail store energy consumption varies widely, it is important to analyze the building portfolio and account for internal and external influences on energy prices and consumption. The paper's statistics can help retailers justify initiatives that will engage retail executive leadership and generate support for deploying enterprise-wide energy management programs.

27 Schneider Electric's internal data

About the author

Jean-Paul Genet is a marketing professional with experience in offer creation and management in the arenas of software, building digital systems, and cloud services. With a degree in Electrical Engineering, he joined Schneider Electric in 1998 as a power system engineer working specifically on electrical distribution installation design.

Jean-Paul took several positions in offer management dealing with communication systems, energy metering, cloud software, and services dedicated to the mid-size buildings segment to help facility teams improve buildings' performance regarding energy and uptime

He is currently the Retail segment marketing manager in charge of identifying global trends, needs and challenges faced by retailers and building with the Retail segment team appropriate solutions to help them boost their efficiency and achieve their sustainability goals.