Understanding the Energy Use Needs of Small Grocery Stores in the United States

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ABSTRACT

Small grocery stores serve as vital anchors in neighborhoods across the United States, particularly in rural communities where they function as essential food access points. However, unlike large corporate chains, small grocers typically lack dedicated personnel and systematic processes to monitor, manage, and optimize their energy use or upgrade inefficient equipment. Store owners may remain unaware of significant building and equipment inefficiencies that impact their operational costs. To address this knowledge gap, we are conducting a study to characterize the energy use patterns of small grocery stores that will identify research opportunities to advance affordability for small businesses and the American consumers reliant on their services. Our multifaceted approach includes in-depth site visits with small grocery owners, a nationwide survey of store operators, and a yearlong energy monitoring project at a rural store located in a cool, dry region. We present findings from the first year of our study, revealing grocery owners' primary operational concerns and challenges while identifying opportunities for the buildings research community to provide meaningful support to this essential sector.

Introduction

Small grocery stores play a vital role in community health, providing food access, supporting local economies, and consuming significant amounts of energy in the process. Food purchases represent the third largest U.S. consumer spending category, accounting for 13% of household expenditures, behind only housing and transportation (Zeballos, Dong, and Islamaj 2023). The sector also serves as a meaningful source of employment, with over 2.6 million workers across the industry in 2023 (U.S. Bureau of Labor Statistics [BLS] 2024). Changes in this industry therefore carry broad implications for local economic stability and community access to nutrition.

These changes may have the most significant effects on rural shoppers. Over the past 30 years, the food retailing market has become increasingly consolidated, with large national retailers and supercenters steadily dominating the landscape. This concentration has hit rural and small nonmetro counties hardest (Zeballos, Dong, and Islamaj 2023), reducing the number of small grocery stores and weakening market competition that might otherwise keep prices affordable. For rural communities without reliable transportation infrastructure, small groceries are often the only viable option for local access to food (Ver Ploeg et al. 2009; Dutko, Ver Ploeg, and Farrigan 2012).

Grocery stores are inherently energy-intensive operations, regardless of size. They represent approximately 3% of major fuel consumption across U.S. commercial buildings. Small food sales buildings (1,001–10,000 ft^2) are no exception, consuming 98 trillion BTU with the third highest energy use intensity (EUI) at 216,000 BTU/ft^2, behind only small food service (272,100 BTU/ft^2) and large food sales (257,600 BTU/ft^2) (U.S. Energy Information Administration [EIA] 2018).[1] Refrigeration and heating, ventilation, and air-conditioning (HVAC) systems are responsible for the largest share of this consumption, with refrigeration systems accounting for 40%–60% of a supermarket's electricity use (Klemick, Kopits, and Wolverton 2015). Space heating and cooling add another 19% of major fuel energy consumption (EIA 2018).

Given this energy profile, energy costs for grocery stores can be up to 15% of the total operating budget (OUC 2020). For small grocery stores operating in a highly competitive industry with thin profit margins, reducing costs through efficiency measures can have an outsized impact on profitability (Trejo-Pech and White 2024). At the same time, store operations depend heavily on the very equipment driving these costs. Refrigeration is especially critical because perishable products must be kept at regulated temperatures at all times. Equipment failures can mean spoiled inventory, lost revenue, and added labor costs for salvage.[2] Yet the high cost of replacing refrigerated cases and other essential equipment leads many stores to defer replacement as long as possible. This burden falls hardest on small groceries, which lack the resources of larger chains and supercenters to maintain equipment consistently over time.

To help identify research opportunities to improve affordability among small grocery stores and the communities they serve, we are conducting a study of the energy use characteristics of this sector across the U.S. This paper presents preliminary results from our multifaceted investigation encompassing in-depth site visits with store owners, a nationwide survey of operators, and a yearlong energy monitoring project at a rural store located in a cool, dry region. For this study, we define small grocery stores as independently owned food retailers of approximately 25,000 ft^2 or smaller.

A Regional View: Colorado Case Studies

To characterize the energy use landscape of small, independent grocery stores, we first conducted a series of site visits at locally accessible stores throughout the Denver metro area. With local partners, we identified and visited stores operating in both rural and urban areas. A summary of the stores visited is provided in Table 1; researchers anonymized store names to encourage participants to speak freely about their energy concerns.

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[1] The EIA data cited here are from Commercial Buildings Energy Consumption Survey (CBECS). The "food sales" building type is defined as "buildings used for retail or wholesale of food" and includes the subcategories of grocery store or food market; convenience store (with or without a gas station); and bakery. The "food service" building type is defined as "buildings used for selling prepared foods and beverages" and includes the subcategories fast food; restaurant or cafeteria; bar, pub, or lounge; catering service; coffee, bagel, or doughnut shop; and ice cream or frozen yogurt shop.

[2] Interview with C. Hawthorne, National Co+op Grocers, 2024.

Table 1. Small Grocery Store Site Visits in Colorado

Store ID	Population Density			Approx. Size (ft^2)	Own/Lease		Other services?
	Urban	Suburban	Rural		Own	Lease	
A		X		6500		X	
B		X		2100	X		
C		X		3200		X	Check-cashing
D	X			1400		X	
E		X		9000		X	Sublease to bakery, restaurant, catering
F	X			2200	X		Bakery, butcher, money transfers
G			X	2000	X		Deli, bakery
H			X	1000			Bakery, pub, internet café

One of the first observations from these site visits was the remarkable differences across small grocery stores, making it difficult to define a "representative" store. Across eight stores, the sample revealed wide variation in basic characteristics such as store size, number of employees, and refrigeration and HVAC equipment vintage (and their operational efficacy), as well as in the range of services offered. For example, several stores provide services beyond food retail, including check-cashing, money transfers, and informal internet café spaces. Also, store owners varied considerably in their awareness of energy use and familiarity with their mechanical equipment. While some owners seemed very knowledgeable about their systems and could identify problem equipment, others were equally concerned about their energy bills but lacked the background or resources to diagnose issues and pursue solutions. Given this range, defining a prototypical small grocery store would be a futile exercise. Instead, we chose to approach the site visits as opportunities for case studies, with the goal of highlighting specific operational challenges and concerns that can help us construct a more comprehensive picture of this complex landscape.

Many small grocery stores rely on residential HVAC equipment to heat and cool their buildings. Without a building automation system, owners must manage indoor temperature using standard single-zone thermostats, the same technology found in homes, despite the very different demands of a retail facility with constant foot traffic and frequently opening doors. This mismatch creates real challenges in practice. In one store we visited, the two thermostats serving the retail floor were poorly positioned, located in a stairwell leading to a second floor not used by the store. Compounding this, the constant opening and closing of the entrance door made it difficult to maintain a consistent temperature at the front of the store during winter. The store's furnace and air-conditioning system also relied heavily on flex ducts, which likely generate high pressure drop for the fans (Zmrhal and Boháč 2021), resulting in reduced airflow, difficulty maintaining uniform temperatures, increased energy consumption, and added wear on the blower motor. In addition, we noticed that several stores used evaporative (swamp) coolers, a common residential cooling solution in dry regions, but potentially problematic for humidity control in a grocery store.

Refrigeration equipment is a key energy user across all the stores we visited, and we observed a wide range in both equipment age and operational condition. Some stores recently upgraded their systems, whereas others had equipment in serious need of repair or replacement. Common issues included walk-in refrigerator doors that failed to latch correctly, allowing conditioned air to escape and driving up energy consumption. Simple fixes, such as door sensors or improved door seals, could reduce these losses at relatively low cost.

Stores in more remote areas face a distinct set of challenges. One rural store owner described frequent power outages lasting four to five hours or more, necessitating the use of a diesel generator to maintain food safety. The stakes extend beyond the store itself because many in the surrounding community rely on the store for internet access. The owner expressed interest in installing additional reliability measures for his building but cited lack of capital as the primary barrier. Water costs present a separate but equally pressing burden: supply is trucked in and can cost $1 per gallon during the peak season from June through September, making it this store’s single largest operational expense.

Energy cost intensity (ECI), measured as monthly energy cost per square foot, captures the relationship between store size and energy expenditures while accounting for operational variations that may indicate efficiency opportunities or challenges. Approximate ECI values for seven of the eight stores we visited are presented in Figure 1. Except for Store G, for which ten months of historical electricity and gas bills were obtained, all utility costs are owner-provided estimates. Smaller stores tend to have higher ECI, likely due to fixed energy loads such as lighting and refrigeration base loads being distributed over smaller floor areas, while larger stores demonstrate economies of scale in energy consumption. The notable outlier in our sample is a 9,000 ft^2 store with a disproportionately high concentration of large freezer cases and reach-in freezers. A walk through the back corridor behind the perimeter freezers revealed that many of the freezer doors were not closing properly and in some cases were left open entirely, which likely explains the store's unusually high electricity costs.

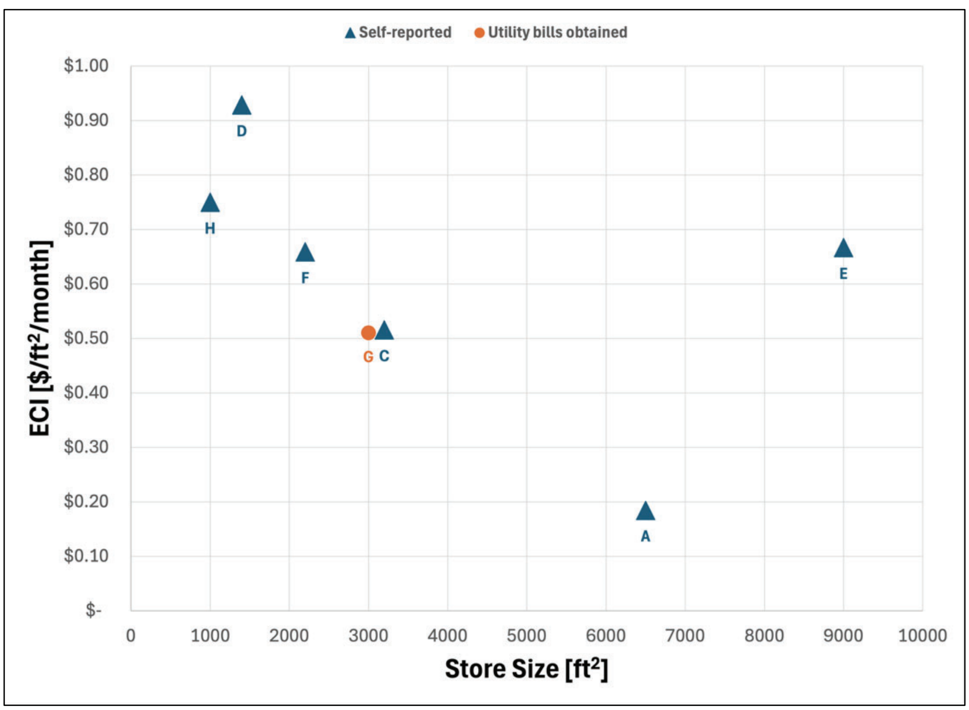

Figure 1. Energy cost intensity vs. store size for Colorado sites visited

A National View: National Co+op Grocers

To obtain a broader national perspective, we engaged with National Co+op Grocers (NCG), a business services cooperative representing 166 independent food cooperatives operating 240 stores across 39 states. Each member store is independently owned and governed by its own members, while NCG functions as a coordinating body that provides shared resources such as financing and bulk purchasing power across the network. While NCG member stores share certain characteristics that may limit their representativeness of the broader grocery landscape, this partnership offered valuable insight into how operational concerns and energy use challenges vary across different regions of the country.

We distributed a brief energy survey via Google Forms to NCG member stores across the United States with 25,000 ft^2 or less of retail space. The survey questions focused on energy usage patterns and efficiency practices, designed to shed light on current energy management approaches and persistent challenges facing small grocery store operations. We received 52 responses representing 56 stores.

Our sample captured a wide range of store sizes, from the smallest at 1,300 ft^2 to the largest at 26,600 ft^2. (One store reported a total area of just over 30,000 ft^2, but that includes unused spaces in the basement and adjacent building areas.) Across the 56-store sample, the mean and median store size are 11,359 ft^2 and 10,000 ft^2, respectively.

The distribution of self-reported monthly energy costs reveals significant variability among small grocery operations, with most stores (64%) reporting bills between $2,500 and $9,999 per month (see Figure 2). The mean and median monthly bill are $8,470 and $6,640, respectively. The presence of high-cost operations (21% spending greater than $10,000 monthly) indicates that even within the small grocery segment, some operations face substantial energy expenses that could drive efficiency investments focused on cost savings.

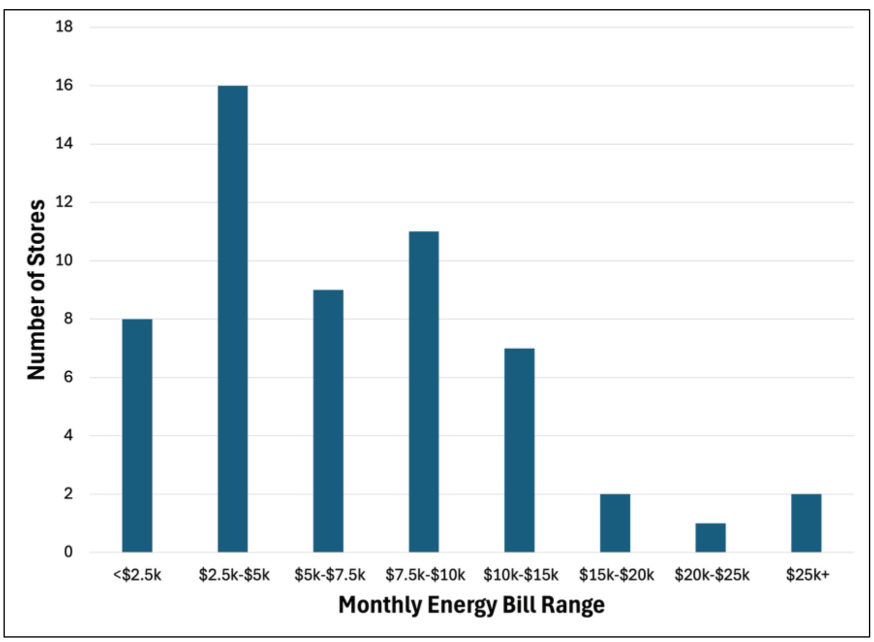

Figure 2. Average monthly energy bill distribution

The median and mean ECI for these respondents are \$0.56/ft^2/month and \$0.77/ft^2/month, respectively. Although there is much scatter in the data shown in Figure 3, smaller stores trend toward higher ECI values, similar to what we saw with the Colorado sites. Two outliers with ECI values of \$3.39/ft^2/month and \$3.42/ft^2/month were omitted from the figure because their inclusion would compress the *y*-axis scale and obscure remaining data points. The wide ECI variation (~34x difference between the highest and lowest ECI) suggests potential for specific bill reduction opportunities across the sector.

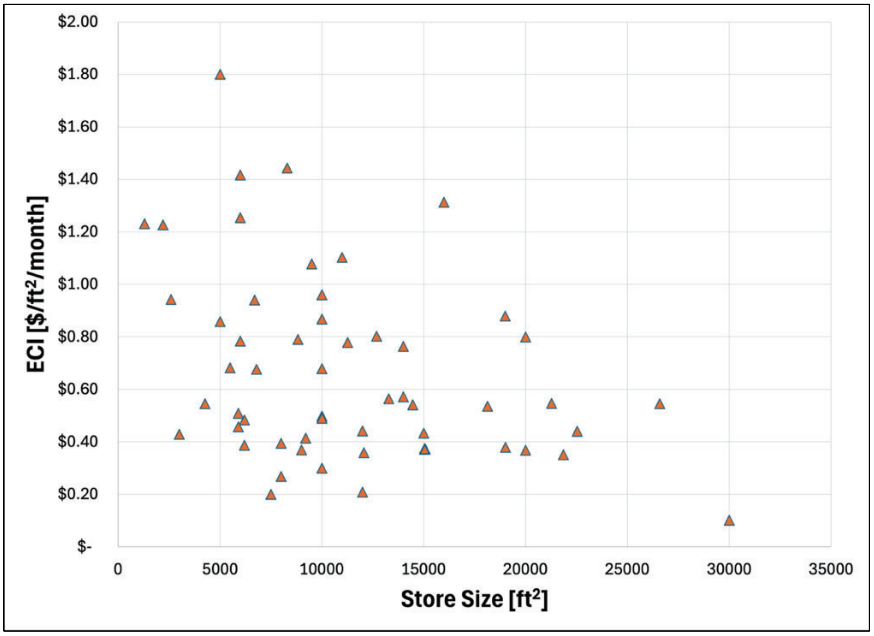

Figure 3. Energy cost intensity vs. store size for National Co+op Grocers survey respondents

When asked about their most pressing energy concerns, store operators consistently reported increasing utility rates, unpredictable seasonal bills, and challenges in budgeting for energy expenses (see Figure 4). Comments frequently mentioned winter heating costs and summer cooling demands that strain operational budgets despite efficiency investments. These concerns persist even among stores that have implemented efficiency measures (see Figure 5 and related discussion), suggesting that while technology deployments may be reducing energy consumption, external factors such as utility rate increases, demand charges, and seasonal variations continue to significantly impact operational expenses for small grocery operators. Aging refrigeration systems are another major concern among respondents, with multiple stores citing inefficient freezers and refrigerators that consume disproportionate energy. Issues with heating and cooling equipment systems range from aging equipment and poor performance to inadequate temperature control. Several responses specifically mention furnaces that "don't function properly" and HVAC systems that struggle with building heating and cooling demands.

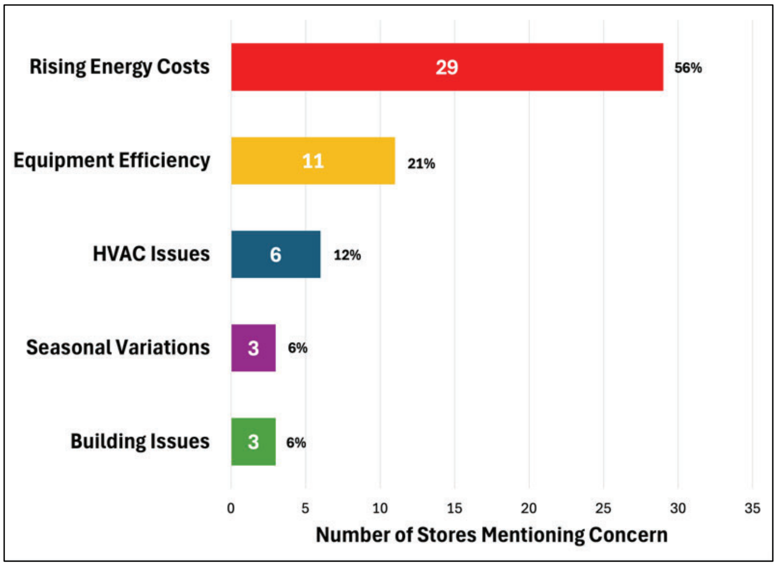

Figure 4. Primary energy concerns

Beyond primary categories, multiple responses highlight the challenge of seasonal energy cost fluctuations, particularly winter heating demands that create budget uncertainty during peak usage. Respondents frequently mentioned building-related challenges including poor insulation, older building construction, and structural limitations that complicate efficiency improvements. Several store operators noted that they do not own their buildings, creating additional complexity for efficiency improvements.

We also included a question asking whether stores had implemented any energy efficiency or cost reduction measures in the past 5 years or planned to do so in the next 5 years. Responses are summarized in Figure 5.

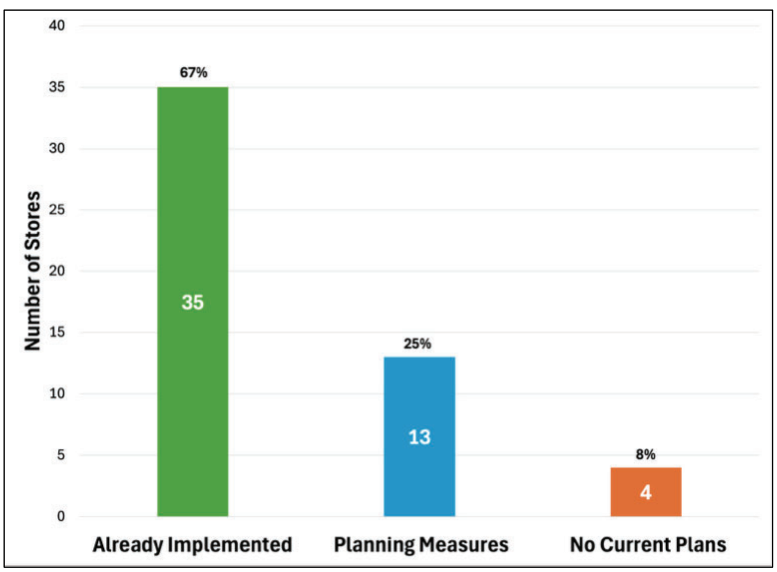

Figure 5. Implementation status of energy efficiency or cost reduction measures

LED lighting is the most widely implemented technology among participating stores, with 18 stores (35%) completing lighting upgrades. This preference may reflect the immediate visibility of results and relatively straightforward implementation requirements. Fourteen stores have invested in photovoltaic panels, indicating willingness within this retail segment to pursue larger capital investments.

Outside of these more common upgrades, responses were largely anecdotal, but a pattern emerged. Technology adoption appeared to follow a progression from low-cost, high-visibility improvements toward more substantial, if less visible, investments. One notable gap in this pattern was HVAC upgrades, which only two stores reported despite heating and cooling typically constituting a major portion of energy consumption in retail buildings. Several stores did mention building envelope improvements, programmable thermostats, and energy management systems, suggesting some awareness of comprehensive efficiency approaches that go beyond single-technology solutions.

In-Depth Energy Study: A Store in Rural Colorado

To take a closer look at energy use in practice, we selected one store from our initial site visits for a yearlong energy monitoring study: a small store in Colorado's Front Range with deep roots in its rural community. Founded in 1885 as a general store, the building, which retains its original footprint of 2000 ft^2 on the ground floor and 1000 ft^2 in the basement, has been a local institution for over 140 years. Historical records suggest it has always been family-operated, a tradition that continues today under new ownership. Through a local energy efficiency organization's existing relationship with the store, we were introduced to the owners who purchased the business in 2025, and they graciously agreed to participate in our study.

As the only grocery store in town, it serves as a true community anchor. Beyond a full selection of grocery staples such as fresh produce, meat, and seafood, the store features an in-house bakery and a deli with a variety of prepared foods. For local shoppers, it is their primary source for everyday groceries, and the store reinforces that bond by offering a 10% discount to community members.

The store also draws visitors from beyond the town limits. Situated along the route from Denver to surrounding mountains, the town hosts several music festivals each year, bringing a seasonal surge of tourists. To meet this demand, the store offers brown bag lunches for hikers and festivalgoers, a small but telling example of how the business has adapted to serve both its permanent residents and its passing guests.

Energy costs and equipment reliability are ongoing concerns, and the challenges of maintaining an aging building were evident in the owners' first months of ownership. Since taking over in March 2025, they spent $750 maintaining their deli case alone (Figure *6*) and have since installed independent case temperature monitors to ensure they are alerted if a case fails. When we first visited in August 2025, the produce cooler had broken down entirely, its empty shelves marked by a handwritten sign reading, "We have produce in the back, just ask." Beyond the inconvenience to shoppers, this kind of failure likely affects sales: customers are far less likely to purchase produce they cannot see and select themselves. Fortunately, a local energy efficiency organization was able to support the store in replacing the case, and by our next visit a few weeks later, the full produce selection was back on display.

The building's age brings character, but it also means aging infrastructure with the mechanical challenges that come with it. For example, the store's original walk-in cooler (Figure *7*) features a top-mounted ice box compartment from its early years of operation. The vintage meat display case tells a similar story. It remains mechanically sound, if not particularly energy efficient, but its original glass panels show their age, and older cases like this carry an elevated risk of failure and costly emergency repairs. Also notable, though not shown, is the store's gravity furnace. Originally coal-fired and later retrofitted for natural gas, this furnace is showing significant wear. Unlike larger retail stores with redundant heating systems, this store relies solely on this unit, meaning any failure would leave the building without heat until a replacement or repair is secured. Sourcing parts for vintage equipment can be difficult, and replacement is no small expense. Several small grocers we spoke with noted that their meat display case was among their highest-selling features while also being one of the most expensive pieces of equipment to replace, often costing around $50,000. Compounding this, the rated energy use for equipment models can be difficult to find, making it hard to quantify the savings that would come from upgrading. For programs that require documented energy savings to justify financial assistance, this becomes a significant barrier, leaving stores without access to the support they may need most.

Figure 6. The deli case, a recurring source of maintenance costs for the new owners

Figure 7. Original walk-in cooler with its historic ice box compartment above

Figure 8. Vintage meat display case with original glass, still fully functional despite its age

The store also faces the nuanced challenge of serving a variety of customers with competing needs. Some shoppers seek out local and organic produce and are willing to pay a premium for it, while others depend on keeping their grocery bills as low as possible. This tension extends beyond the produce aisle to shelf staples as well.

As a first step to better understand this store’s utility expenditures, we reviewed ten months of electric and natural gas utility bills to establish baseline trends in energy use. Monthly utility expenditures from May 2025 through February 2026 are shown in Figure 9. Electricity was the dominant utility expense throughout this period. Electric costs increased substantially during warmer months, indicating cooling and refrigeration sensitivity. Natural gas costs increased significantly during winter months due to space-heating demand.

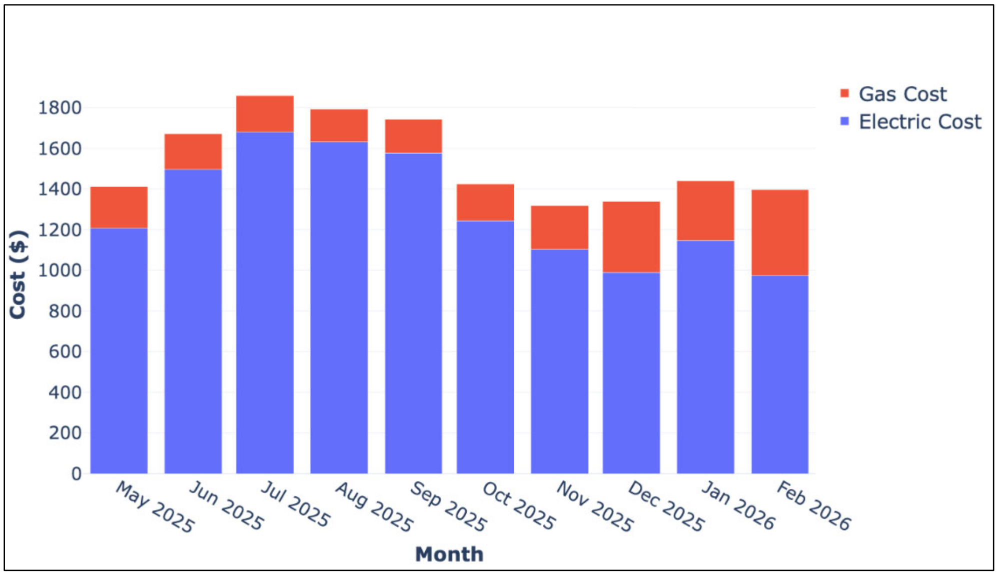

Figure 9. Monthly electricity and natural gas expenditures for store G

While electricity represents the primary cost driver, natural gas heating constitutes the dominant energy end-use during winter months. Figure 10 presents total site energy consumption, combining electricity and natural gas on a common basis using a kWh-equivalent conversion (1 therm ≈ 29.3 kWh-equivalent), and illustrates how seasonal heating demand substantially elevates overall building energy use. From these data, we estimate a relatively constant electric baseload of approximately 7,100 kWh/month, consistent with the continuous operation of refrigeration systems, walk-in coolers, freezers, lighting, and other process loads characteristic of grocery store operations.

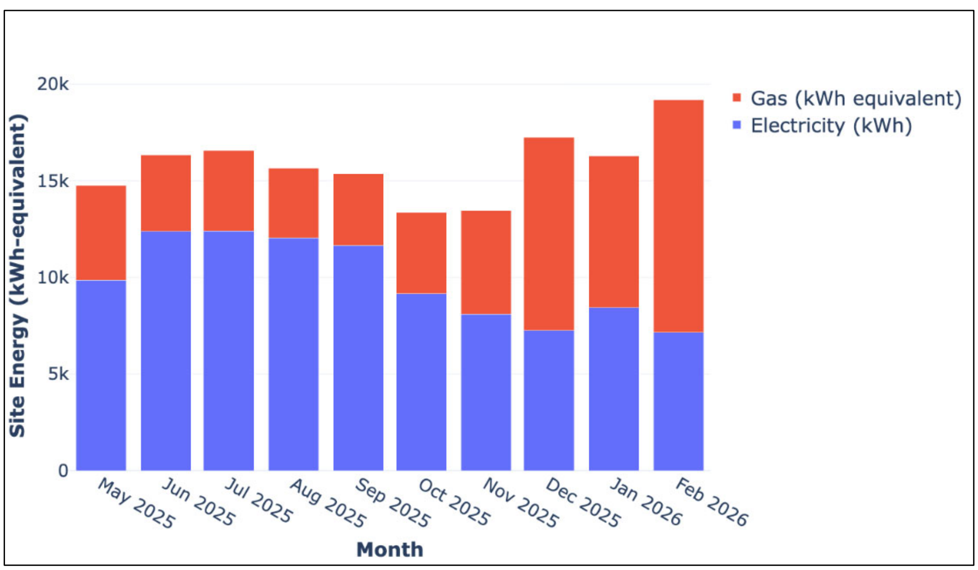

Figure 10. Monthly site energy including electricity and gas kWh-equivalent for store G

Figure *11* shows the Heating Degree Days (HDD65) and Cooling Degree Days (CDD65) computed from hourly outdoor temperature data over the 10-month billing period. As expected, this location in Colorado is strongly heating dominated, with HDD65 substantially exceeding

CDD65, such that the building's thermal load is primarily driven by heating demand. Electricity consumption follows a different pattern. Although dominated by a persistent refrigeration baseload, it shows a modest positive correlation (see Figure *12*) with CDD65, reflecting incremental cooling and refrigeration loads during warmer periods. This yields a dual energy profile in which natural gas use is regionally driven by heating demand, while electricity is anchored by a continuous process baseload but remains secondarily sensitive to warmer outdoor temperatures.

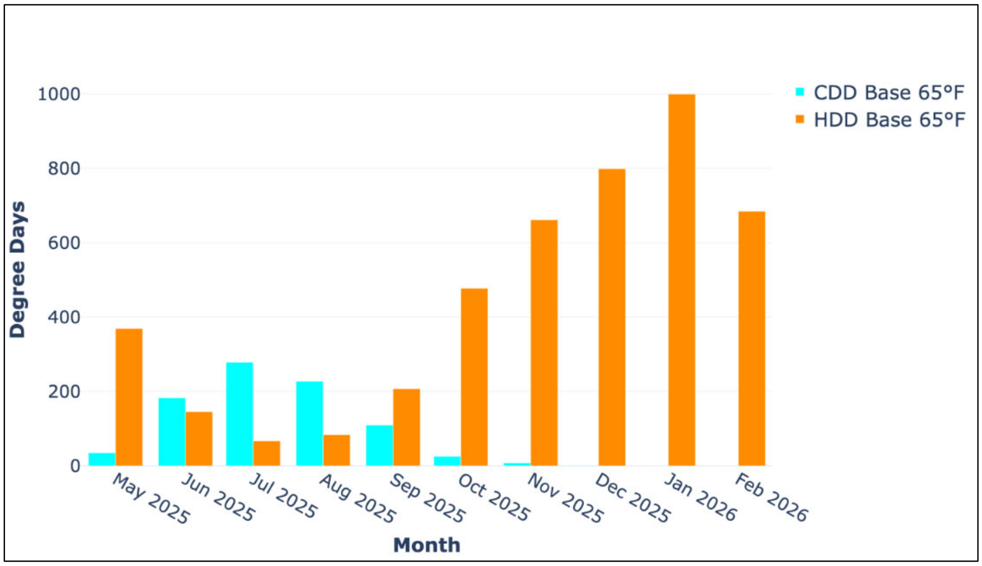

Figure 11. Monthly heating degree days and cooling degree days

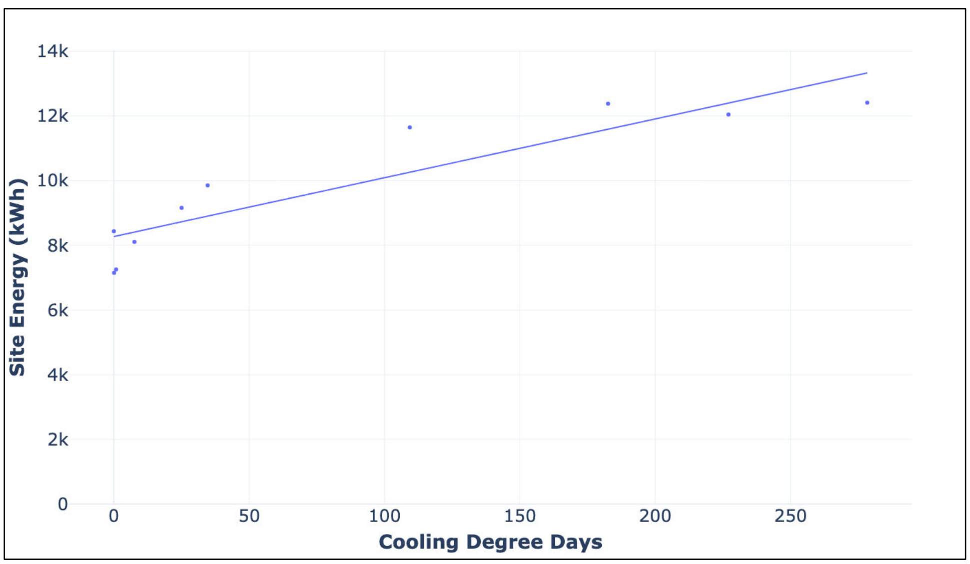

Figure 12. Electricity consumption versus monthly CDD65

Key energy metrics for this site are summarized in Table 2.

Table 2. Summary of Energy Metrics for Store G

Estimated Annual Site EUI	216 kBtu/ft²/year
Estimated Monthly Utility Cost per Floor Area	$0.50/ft²/month
Estimated Electric Baseload	~7,100 kWh/month
Dominant Electric Load	Refrigeration systems
Winter Dominant Load	Natural gas heating
Summer Sensitivity	Cooling and refrigeration

To obtain a more detailed picture, we recently instrumented the facility for 12 months of equipment-level energy monitoring, with the goal of identifying operational challenges relevant to rural grocery stores more broadly. The list of what is being monitored is provided in Table 3, although the data are not yet available.

Table 3. Small Grocery Energy Monitoring Points Summary

HOBO Plug-Load Monitoring Points (120 V outlets on sales floor)	Produce Case (Hussman)
	Dairy Case (Beverage-Air)
	Frozen Pizza (Beverage-Air)
	Ice Cream Display (Turbo)
	Blue Bunny Display
	Coke 1 (Amaram)
	Coke 3 (Imbera)
	Vitamin Water (Beverage-Air)
	Meat Walk-in Cooler
	Bread Freezer (Aramco)
	Walk-in Cooler (HeatCraft)
Pass-through Electrical Box (230 V outlets on sales floor)	Frozen Meals
Circuit-Breaker Panel Measurements (Equipment located in basement)	Compressor Meat Walk-in
	Compressor Meat Case
	Compressor Cheese Case
	Compressor Walk-in Freezer
	Compressor Walk-in Cooler (Produce)
Environmental Monitoring Points	Sales Floor (Central): Baseline indoor ambient temperature
	Refrigerated Aisle: Capture microclimate near high-density open cases
	Basement Mechanical: Monitor ambient temperature that affects the remote compressor's heat rejection
	Exterior (North Wall): Outdoor ambient baseline for total building load correction
High Temperature Metering (Equipment located in basement)	Water Heater (burn ON time as proxy for gas metering)
	Gas Furnace (burn ON time as proxy for gas metering)

Conclusions

While we are still waiting on results from our monitoring component, our research findings already provide important insights into energy management practices and challenges within small grocery operations. The identified patterns suggest several research opportunities that could address the persistent energy challenges facing this retail segment.

One opportunity is for longitudinal studies on the effectiveness of various efficiency technologies in small grocery stores, as most existing research focuses on larger retail operations. Another gap is lack of understanding of how energy-related first cost and operational cost impacts shape energy management decisions for small operators, who often lack the resources to fully understand their buildings' energy systems on their own. Additional information is still needed to examine demand management strategies and performance monitoring systems tailored specifically to grocery operations. Given the outsized role of refrigeration in driving energy consumption, removing barriers that prevent small grocers from adopting HVAC and refrigeration upgrades remains an important open question, especially given the first cost and financing challenges described above.

Finally, field visits and informal surveys revealed that while small grocery store operators are mindful of energy costs, equipment failure is what keeps them up at night. For many, a major failure could force significant operational changes or threaten viability entirely. Serving this sector effectively requires balancing energy efficiency with simplicity of installation, operation, and maintenance, while minimizing failure risk for equipment that is often already past its prime. Owners are generally engaged, capable, and extremely hard working, but proactive failure planning for critical systems (namely HVAC, refrigeration, and key process loads) competes with numerous other day-to-day priorities. As a result, overly complex installations, unproven technologies, and untested control strategies can be poorly suited to this market without additional resources and technical support. Energy efficiency measures intended for small grocery stores must above all be affordable, reliable, straightforward to deploy, and easy to maintain.

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Sources

Dutko, P., M. Ver Ploeg, T. Farrigan. 2012. Characteristics and Influential Factors of Food Deserts. ERR-140, U.S. Department of Agriculture, Economic Research Service.

Klemick, H., E. Kopits, and A. Wolverton. 2015. *The Energy Efficiency Paradox: A Case Study of Supermarket Refrigeration System Investment Decisions*. Working Paper Series, Working Paper # 15-03. U.S. Environmental Protection Agency, National Center for Environmental Economics. www.epa.gov/sites/default/files/2016-03/documents/2015-03.pdf.

OUC. 2020. “Grocery Stores.” https://ouc.bizenergyadvisor.com/article/grocery-stores.

Trejo-Pech, Carlos J.O., and Susan White. 2024. “Financial Ratios of the U.S. Grocery Sector in a Changing Industry Landscape.” *Applied Economics Teaching Resources* 6(2): 63–80. https://doi.org/10.22004/ag.econ.343483.

U.S. Bureau of Labor Statistics (BLS). 2024. “Spotlight on Statistics: Number of workers employed at grocery stores, 2000-2023.” https://www.bls.gov/spotlight/2024/scanning-grocery-store-productivity-statistics/home.htm?utm_source=chatgpt.com.

U.S. Energy Information Administration (EIA). 2018. “2018 CBECS Survey Data.” https://www.eia.gov/consumption/commercial/data/2018/.

Ver Ploeg, M., V. Breneman, T. Farrigan, K. Hamrick, D. Hopkins, B.-H. Lin, M. Nord, et al. 2009. *Access to Affordable and Nutritious Food: Measuring and Understanding Food Deserts and Their Consequences*.: *Report to Congress*. U.S. Department of Agriculture Economic Research Service. https://www.ers.usda.gov/publications/pub-details?pubid=42729.

Zeballos, E., X. Dong, X., and E. Islamaj, E. 2023. *A Disaggregated View of Market Concentration in the Food Retail Industry*. ERR-314, U.S. Department of Agriculture, Economic Research Service. ERR-314. https://doi.org/10.22004/ag.econ.333546.

Zmrhal, V. and Boháč, J. 2021. *Pressure loss of flexible ventilation ducts for residential ventilation: Absolute roughness and compression effect*, Journal of Building Engineering, Volume 44, 103320, ISSN 2352-7102. https://doi.org/10.1016/j.jobe.2021.103320.