HFC Transition in the Grocery Industry

A REVIEW OF THE ANTICIPATED IMPACT OF THE EPA RULE

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In December 2022, the US Environmental Protection Agency ("EPA") published a proposed rule titled "Technology Transitions Restrictions on the Use of Certain Hydrofluorocarbons under Subsection (i) of the American Innovation and Manufacturing Act" ("Proposed Rule"), which proposes to restrict the use of certain higher-global warming potential ("GWP") hydrofluorocarbons ("HFCs") in refrigeration by various sectors and subsectors, including the retail grocery industry.

As drafted, the Proposed Rule would generally prohibit the use of the restricted HFCs in the grocery industry for new applications such as new stores and remodels by January 1, 2025 and, in some cases, by January 1, 2026. For the retail food refrigeration sector specifically, the Proposed Rule establishes a GWP limit of 300 for refrigeration systems with charge capacities less than 200 pounds and a GWP limit of 150 for systems with refrigerant charge capacities of 200 pounds or greater, along with a compliance deadline of January 1, 2025. These GWP limits are purportedly supported by the EPA's evaluation of costs as presented in the Regulatory Impact Analysis accompanying the Proposed Rule.

The Proposed Rule is itself layered on top of another regulation published by the EPA first enacted on December 27, 2020 and most recently updated as the "Phasedown of Hydrofluorocarbons: Allowance Allocation Methodology for 2024 and Later Years." This rule implements a requirement in the American Innovation and Manufacturing Act to phase down HFC use, culminating in an 85% reduction by 2036. The Act directs the EPA to implement this phasedown by determining the annual allowable total HFC consumption and issuing that quantity of transferrable production and consumption allowances each year. Put differently, the EPA is tasked with setting quantities in a market for HFC production and use over time.

In its regulatory analysis of the Proposed Rule, the EPA claims that the proposal will *reduce costs* in the grocery industry. The Agency reaches this conclusion for two reasons. First, it assumes that compliant systems are more energy efficient, leading to annual operating savings of over $11,000 per store each year.[1] Second, it assumes that the cost of CO2 or ammonia for use in compliant systems is "negligible" in comparison to the $9 per kilogram cost assumed for R-404A systems.[2] Put differently, the EPA assumes that no matter how "leaky" the compliant systems are, they can be refilled costlessly; this assumption leads to a savings estimate of approximately $2,000 per store per year.[3] These assumed reductions in ongoing operating costs outweigh EPA's assumed capital costs of installation; in fact, the EPA assumes that these systems would pay for themselves within 3 years.[4] As a result, the Proposed Rule is found to benefit the grocery industry.

To assess the reliability of the EPA's assumptions and conclusions, we have reviewed publicly available documents and interviewed industry representatives. Specifically, we have spoken with representatives of 8 grocery companies, comprising nearly 2,500 stores across 44 states; four of these companies are part of the EPA's GreenChill program that aims to reduce the environmental impact of refrigeration systems in grocery stores.[5] We also reviewed *The Food Retailing Industry Speaks* report produced by FMI.[6] This report has been compiled for 75 years and provides a snapshot of the state of the grocery industry. The 2023 report is based on a survey sent to US and Canadian food retailers in February 2023 and the 100 respondents represent over 39,000 stores.[7]

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1 "Draft Regulatory Impact Analysis Addendum: Impact of the Technology Transitions Proposed Rule," EPA, December 2022, Table 4-2, https://www.epa.gov/system/files/documents/2022-12/Regulatory%20Impact%20Analysis%20Addendum.pdf ("EPA RIA Addendum"); "Economic Impact Screening analysis for Restrictions on the Use of Hydrofluorocarbons under Subsection (i) of the American Innovation and Manufacturing Act," EPA, November 2022, Table 4 ("EPA Small Entity Assessment").

2 EPA Small Entity Assessment, Table 5.

3 "Regulatory Impact Analysis for Phasing Down Production and Consumption of Hydrofluorocarbons (HFCs)," EPA, September 2021, p. 47, https://www.epa.gov/system/files/documents/2022-07/RIA%20for%20Phasing%20Down%20Production%20and%20Consumption%20of%20Hydrofluorocarbons%20%28HFCs%29.pdf ("EPA RIA").

4 EPA RIA Addendum, Table A-5; EPA Small Entity, Table 5.

5 "GreenChill Keeping Cool for Fifteen Years, 2007-2022," EPA, https://www.epa.gov/system/files/documents/2022-09/GreenChill-Keeping-Cool-for-15-Years-2022_1.pdf.

6 "The Food Retailing Industry Speaks," FMI, 2023, p. 80, https://www.fmi.org/our-research/research-reports/food-retailing-industry-speaks ("The Food Retailing Industry Speaks").

7 The Food Retailing Industry Speaks, p. 67.

Overall, we conclude that the EPA's assumed capital costs dramatically understate those anticipated by industry and the energy and refrigerant cost savings are overly optimistic, especially for warmer parts of the country (areas that the EPA describes as "less viable" for its only modeled compliant system).[8] Instead, we find that the Proposed Rule will impose substantial costs on the industry—costs which could be reduced by relaxing the implementation timeline and focusing on the installation of these systems in new stores, rather than on converting systems in existing stores.

I. Energy Usage and Refrigerant Costs Will Increase, Leading to Higher Prices to Consumers and Higher Emissions

Contrary to the EPA's assumptions, many stores will experience higher energy and refrigerant costs under the Proposed Rule, especially across the southern US. A large share of operating costs like these are typically passed on to consumers, which would lead to higher grocery prices. Independent of the EPA's proposal, it has been widely reported that grocery prices have experienced high levels of inflation over the past few years; the Proposed Rule may therefore exacerbate these price increases. Aside from increasing costs, increased energy use and higher system leakage undercut the environmental benefits claimed by the EPA.

A. Groceries Have Experienced High Levels of Inflation

Food prices have increased substantially over the past several years. Table 1 below shows inflation overall and for food at home specifically from 2019 to 2023. While the overall price level increased approximately 19%, the price level of food increased by nearly 25%.[9] Figure 1 shows the year-over-year inflation rate for various categories of at-home food in 2022, all of which are above their historical averages. When considering a typical household, expenditures on food at home increased from about $6,400 in 2019 to $7,970 in 2022, a nearly $1,600 increase for each household.[10]

[8] The EPA only models the use of a CO2-based system for the grocery industry (EPA RIA, p. 29).

[9] See Table 1.

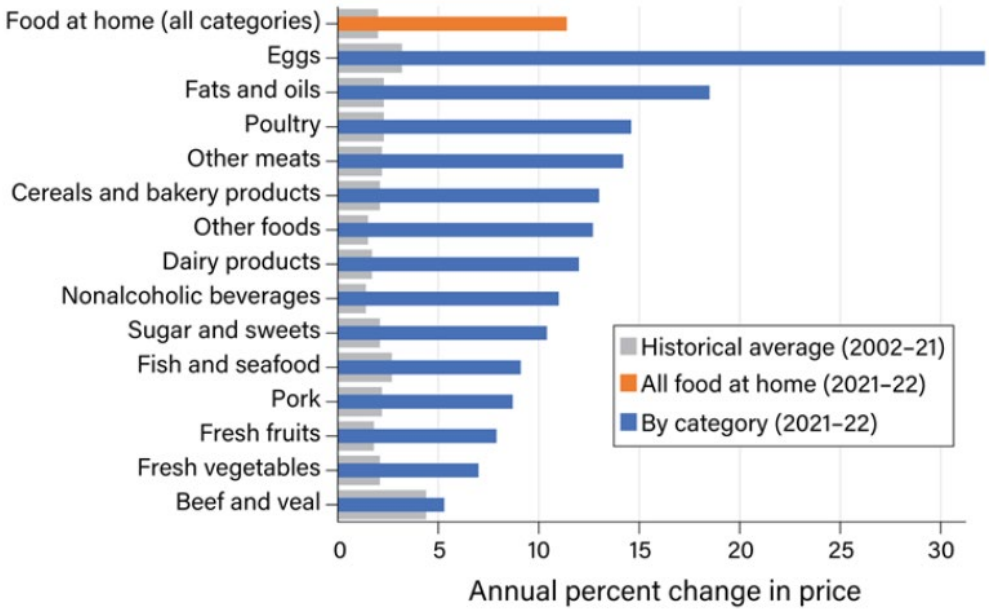
[10] "Food Expenditure Series," USDA, https://www.ers.usda.gov/data-products/food-expenditure-series/.

TABLE 1: INFLATION RATE FROM 2019 TO 2023

Index	Inflation Rate
Overall	18.9%
Food	24.5%

Sources and Notes:
Overall index includes all items in U.S city average. *See,* "CUSR0000SA0," BLS, https://data.bls.gov/timeseries/CUSR0000SA0.
Food index includes food in U.S city average. *See,* "CUUR0000SAF1," BLS, https://data.bls.gov/timeseries/CUUR0000SAF1.

FIGURE 1: PRICE CHANGES FOR CPI FOOD AT HOME CATEGORIES, 2021-2022

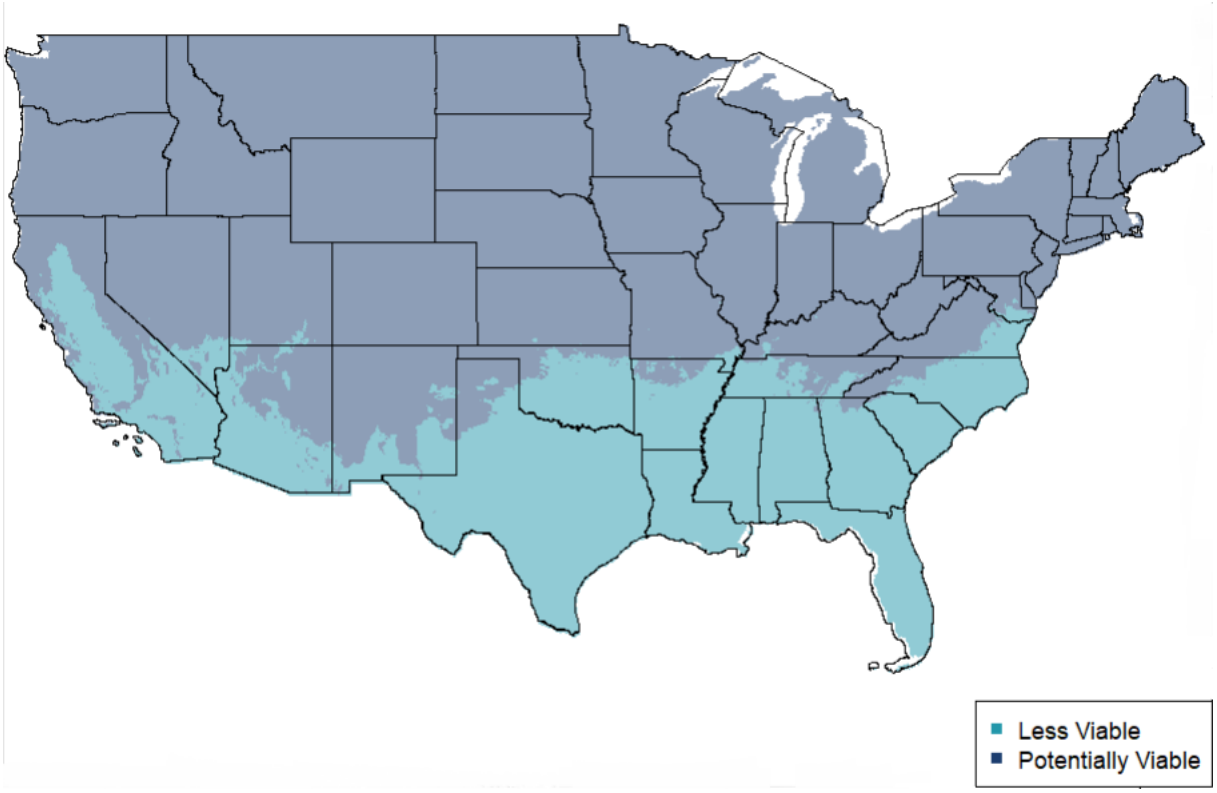


Sources and Notes:
"Food-at-home prices increased 11.4 percent in 2022 compared with 2021," USDA, https://www.ers.usda.gov/data-products/chart-gallery/gallery/chart-detail/?chartId=76961.

B. Contrary to EPA's Assumptions, Many Stores Will Experience Higher Energy Use and Refrigerant Costs in Switching to CO2-Based Systems

The EPA assumes that CO2 systems will be more energy efficient than traditional HFC systems. This is highly dependent on the climate at the installed location, as noted in the EPAs own RIA. Specifically, the EPA indicates that regions with average annual temperatures exceeding 59 degrees or average annual high temperatures exceeding 88 degrees are "less viable" for transcritical CO2 systems;[11] we identify these areas in the map below. Over 43% of the US population lives in these less viable areas.

FIGURE 2: POTENTIAL VIABILITY FOR CO2 SYSTEMS BASED ON AVERAGE ANNUAL TEMPERATURE



Sources and Notes:
Potentially viable climates have an annual average temperature less than 59°F.
2021 Annual Mean Temperature dataset, PRISM, accessed July 17, 2023, https://prism.oregonstate.edu/recent/.

[11] EPA RIA, p. 46.

In its potentially viable areas, the EPA assumes that energy use will fall by 5% to 10%.[12] A prime test of this hypothesis would be Hannaford's conversion of one store and opening of another using transcritical CO2 in Maine. Instead of energy savings, Hannaford's Director of Energy and Facilities Services reported that energy use was 5% higher in the store with transcritical CO2 than in similar stores using HFC refrigerants.[13] This example undermines the EPA's energy efficiency assumption in even its potentially viable areas.

Less amenable climates will generate even larger energy penalties for transcritical CO2 systems. Northern California is a moderate climate, in that it can become warm in the summer, but lacks humidity. Target compared two stores near one another in this region and found that its transcritical CO2 system used 20% more energy than the nearby HFC-based system.[14] In speaking with industry members, this increase is expected for all but the coolest northern climates.

Additionally, many transcritical CO2 systems use an adiabatic gas cooler. This device uses water to pre-cool the air to lower the energy usage of the system. While these systems may cut expected energy increases in half, they require a substantial amount of water to operate; an average-sized store may need over 500,000 gallons of water for cooling. Stores in the EPA's less viable areas would require mitigation of energy consumption increases, but many of these areas also have experienced prolonged droughts and water shortages. Hence, adiabatic gas systems may exacerbate one environmental problem in trying to solve another. In addition to creating additional environmental concerns, they also raise the cost of these systems by increasing water utility bills in an effort to curb electric bills. Accordingly, they are far from a clear solution.

Lastly, the EPA incorrectly assumes that, in contrast to the price of HFC gas, the price of CO2 is "negligible." The price of high GWP HFC gases jumped in response to Europe's F-Gas regulations constraining the supply of these refrigerants, though these increases have moderated to some

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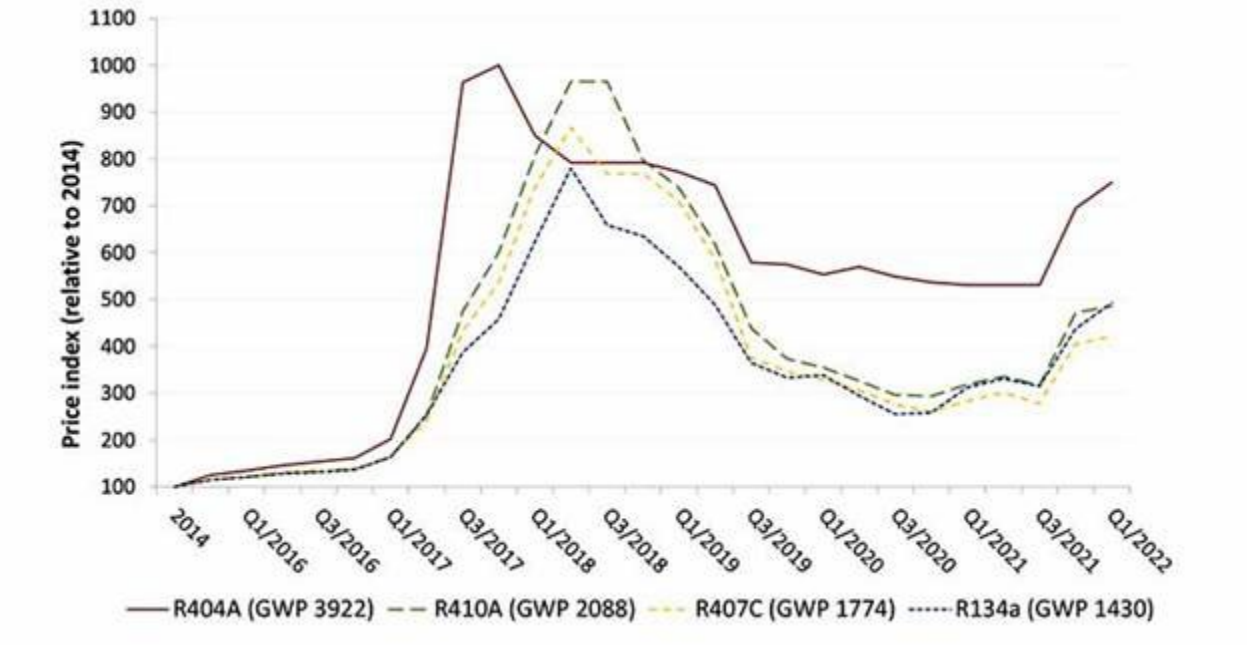
12 EPA RIA, p. 46.

13 "Transcritical Update: Hannaford Supermarkets," R744, November 1, 2017, accessed July 27, 2023, https://r744.com/transcritical-update-hannaford-supermarkets/ ("Transcritical Update: Hannaford Supermarkets").

14 Karim Amrane, "Reducing the Carbon Footprint of Commercial Refrigeration Equipment," globalFACT, December 2, 2019, p. 3, https://www.globalfact.org/wp-content/uploads/2019/12/globalFACT-MaintenanceEfficiency-White-Paper-2.pdf.pdf.

degree, as shown in Figure 3 below.[15] The price of CO2 gas has nearly doubled in less than a decade, with prices continuing to escalate, as witnessed in Figure 4 below.

FIGURE 3: PRICE INDEXES FOR HIGH GWP HFC GASSES IN EUROPE



Sources and Notes:
Prices of select GWP Gases in Europe from Cooling Post, "High GWP refrigerants show upward price trend," June 29, 2022, accessed July 27, 2023, https://www.coolingpost.com/world-news/high-gwp-refrigerants-show-upward-price-trend/.

[15] Cooling Post, "2017 ends with 60% price rise," November 26, 2017, accessed July 27, 2023, https://www.coolingpost.com/uk-news/2017-ends-60-price-rise/. See also, EIA, "EU F-Gas Regulation Handbook: Keeping Ahead of the Curve as Europe Phases Down HFCs," September 2015, https://eia-international.org/wp-content/uploads/eia_euf-gas_eng_medrez.pdf.

FIGURE 4: PRICE INDEX FOR CARBON DIOXIDE GAS

Sources and Notes:
FRED Economic Data, https://fred.stlouisfed.org/series/WPU06790302.

C. The Proposed Rule Will Increase the Relative Price of Refrigerated Foods, Pushing Consumers Toward Less Healthy Options

In the discussion above, we cited industry case studies demonstrating that transcritical CO2 systems will use at least 5% and in many parts of the country closer to 20% more energy than comparable HFC systems. In addition to generating unintended negative environmental outcomes, this additional energy use leads to higher costs. These costs are likely to be passed on to consumers.

Cost pass-through describes the degree to which a change in a firm's input costs lead to changes in the prices that the firm charges to consumers.[16] The extent of cost pass-through to

[16] Chris Walters et al., "Cost Pass-Through: Theory, Measurement, and Potential Policy Implications, A Report prepared for the Office of Fair Trading," *RBB Economics* (2014): 1-209, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/320912/Cost_Pass-Through_Report.pdf.

consumers in grocery stores can vary depending on several factors, including market competition, product differentiation, the price sensitivity of consumers, and the nature of the cost increase. Because the grocery industry is a highly competitive, low margin industry, we expect most increases in operating costs to be passed on to consumers.

Indeed, the academic literature confirms this expectation. Peltzman (2000) finds that 20% of cost increases are passed on to grocery consumers within the first month after the increase and over 50% of the increase is passed on after five months.[17] Besanko, Dubé, and Gupta (2005) study the pass-through behavior of a major supermarket chain for 78 products across 11 categories and find that, while pass-through rates vary substantially across products and categories, on average they exceed 60%.[18] Evidence from the impact of a soda tax in the city of Philadelphia indicated that the costs are passed through at an average rate of 97%.[19] These studies confirm that most of the increases in energy, refrigerant, and other operating costs are likely to be passed on to consumers.

Higher refrigeration costs are not likely to be spread equally across all the products in the grocery store, however; instead, products requiring refrigeration (that is, the products inducing the increased costs) are the ones most likely to be impacted by the price increases. The products in the store that require refrigeration include frozen foods, meats, seafood, dairy products, and some fresh produce. These categories are colloquially described to be the "perimeter" of the store, whereas non-refrigerated goods occupy the interior of the store. Hence, the refrigerated "perimeter" products will have larger price increases and become relatively more expensive than products in the interior.

Because of these larger price increases in the perimeter, consumers will be incentivized to consume more from the interior. This has important health implications, as food items from the perimeter tend to be healthier than those in the interior.[20] In particular, they are more likely to be "whole" foods, rather than processed foods. Non-refrigerated goods tend to contain

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17 Sam Peltzman, "Prices rise faster than they fall," *Journal of political economy* 108(3) (2000): 466-502, https://www.jstor.org/stable/10.1086/262126.

18 David Besanko, Jean-Pierre Dubé, and Sachin Gupta, "Own-brand and cross-brand retail pass-through," *Marketing Science* 24(1) (2005): 123-137, https://www.jstor.org/stable/40056943.

19 Stephan Seiler, Anna Tuchman, and Song Yao, "The impact of soda taxes: Pass-through, tax avoidance, and nutritional effects," *Journal of Marketing Research* 58(1) (2021): 22-49, https://doi.org/10.1177/0022243720969401.

20 "Grocery Store Tour: Shopping the Perimeter," Mayo Clinic Health system, March 23, 2018, accessed July 27, 2023, https://www.mayoclinichealthsystem.org/hometown-health/speaking-of-health/grocery-store-tour-shopping-the-perimeter ("Grocery Store Tour: Shopping the Perimeter").

additive or chemical preservatives that allow food to last longer and be shelf stable, but that may impact health.[21] Therefore, the Proposed Rule may have an unintended negative impact on the health of consumers.

D. Due to Higher Energy Use and Higher Leakage, GHG Emissions May Be Higher For CO2 Systems

As we have discussed, transcritical CO2 systems will likely use more energy than HFC systems, thereby offsetting some of the environmental benefits of relying on a lower GWP refrigerant. Based on discussions with industry participants, we understand that higher leak rates for transcritical CO2 systems relative to traditional HFC systems further reduce the environmental benefits.[22] This result runs counter to the EPA's assumption of lower leak rates for these systems.

These higher leak rates are largely due to the relatively high-pressure nature of CO2-based systems, which cause any leaks to vent much more refrigerant than lower pressure HFC systems. Additionally, CO2 systems require safety relief valves that are much more likely to vent in the event of a system fault. Lastly, these relief vents often develop dry ice buildup, which prevents the valve from fully reseating; this can cause the relief vent to remain open until nearly all the CO2 refrigerant has been released.

The climate benefits of the Proposed Rule will be reduced by the unintended impacts of higher energy use and higher leak rates. Furthermore, as we mentioned above, transcritical CO2 systems with adiabatic gas coolers also consume substantial amounts of water, another unintended environmental cost. These impacts were not considered by the EPA in its assessment, leading to overstated benefits attributed to the Proposed Rule.

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[21] Grocery Store Tour: Shopping the Perimeter.

[22] If stores close in response to the Proposed Rule (or plans for new stores are scrapped), this can cause additional emissions increases. Not only would consumers have to travel further to shop (their transportation generating emissions), research by Dean (2020) finds that reductions in the number of grocery stores in an area can lead to additional food waste. Food waste contributes substantially to GHG emissions; the emissions arising from food waste is equivalent to that of all road miles driven. Hence, the Proposed Rule can have a secondary unintended impact of increasing food waste and its associated emissions. See, James Dean, "Better Access to Groceries Could Reduce Food Waste, Emissions," January 31, 2020, accessed May 16, 2023, https://news.cornell.edu/stories/2020/01/better-access-groceries-could-reduce-food-waste-emissions.

II. The Proposed Rule Will Require Substantial Capital Investments, Reducing the Profitability and Viability of Stores

In its analysis, the EPA assumed that the incremental costs of transcritical CO2 systems is low. Combined with the cost savings that the EPA assumes to arise from the transition (which we disputed in the section above), it finds that these systems pay for themselves within three years. Our discussions with industry representatives cast doubt on this conclusion, however.

In the previous section, we discussed how operating costs may be higher for transcritical CO2 systems. In this section, we discuss the additional capital costs associated with these systems. While some companies may find these increases to be modest for new stores, discussions with members of the industry indicate that retrofitting HFC systems to be compliant would be especially disruptive and costly. Because the grocery industry operates on low margins, these investments may not be justifiable, especially for low profitability stores, leading to store closure or averted openings. Notably, these low profitability stores are often in areas with limited access to fresh groceries, exacerbating the issue of "food deserts."

A. Compliant Systems Are Currently Substantially More Costly Than HFC Systems

From speaking with FMI members, we understand that transcritical CO2 systems cost substantially more than traditional HFC systems. This is due to both higher equipment costs and higher installation costs. Based on our discussions with FMI members, we find that the cost of a traditional HFC system is approximately $3.6 million for a typical store (with an average size of 50,000 square feet). Those discussions also indicated that a transcritical CO2 system has an approximately 30% cost premium, implying a $1.1 million cost difference for an average-sized store.

In its assessment, the EPA assumed that the additional cost of a compliant system would be $35,000 for a large (60,000 square foot) store, giving a cost of approximately $30,000 for an average-sized store.[23] This is far below the incremental capital cost projected by industry.

[23] EPA RIA, p. 47.

Furthermore, these costs do not include financing. Businesses typically do not pay for large capital expenses upfront; instead, they finance the project using debt (either by obtaining a loan or issuing bonds) or equity (selling shares in the company).[24] Considering the typical financing methods of publicly traded grocery companies, the average cost of this financing is 6.37%.[25] Given this rate, financing adds an additional $600,000 to the capital cost; hence, the total incremental cost of a transcritical system for an average-sized store is approximately $1.7 million.

Following our discussions with a number of industry participants, we conclude that the EPA dramatically understated the cost of a compliant system in its assessment of the Proposed Rule.

B. Low Industry Margins Reduce the Ability of Stores to Absorb These Costs

Unlike increases in operating expenses discussed in Section I, firms are less capable of passing capital costs on to consumers. Instead, these investments are paid using firm profits. As we demonstrate below, profit rates in the grocery industry are low, which limits the ability of stores to absorb capital cost increases that stem from the Proposed Rule.

In general, the grocery industry is highly competitive, with stores representing a range of price points, shopping experiences, and product variety. Conventional grocery stores, such as Safeway, compete against high-end stores like Whole Foods, big box stores like Walmart Supercenters, and against small local markets. Because of this wide competition, the grocery industry has notoriously low profitability.

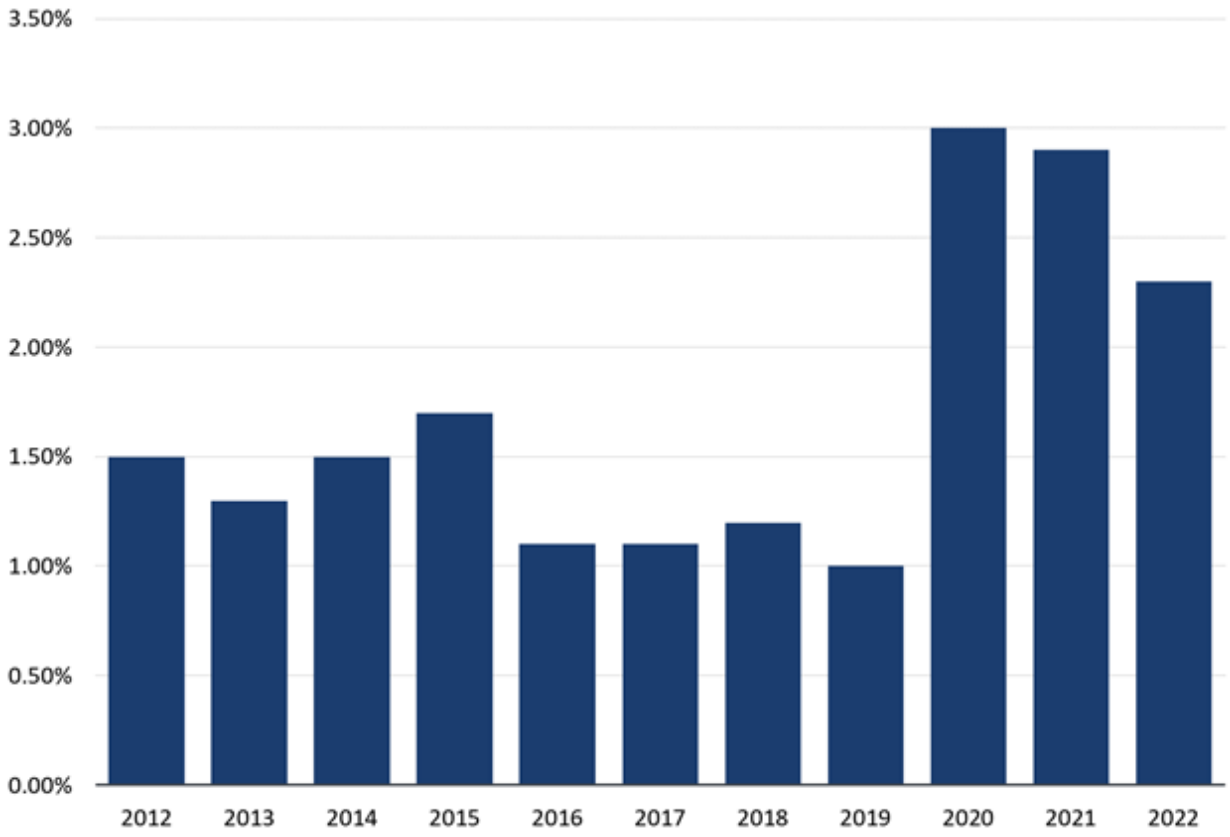
Figure 5 below shows typical net income rates over the past 11 years. Net income subtracts all expenses, including capital expenditures, operations and maintenance costs, and taxes from revenue. The net income rate divides net income by revenue. These rates have varied between 1% and 3%; the most recent data indicate a rate in the middle of this range (2.3%). Net income

[24] Some companies may finance projects directly. The financing costs, then, should be considered the opportunity cost of foregone investment income due to the added expense.

[25] This figure is known as the weighted average cost of capital ("WACC"). It considers the cost, here specific to the grocery industry, of issuing debt and the cost of issuing equity. It then takes a weighted average of those values based on the share of debt relative to equity used by publicly-traded companies. As a result, the WACC represents typical financing costs based on the corporate finance decisions made by firms in the industry. 6.37% is taken from data last updated in January 2023 from NYU Cost of Equity and Capital (US) for "Retail Grocery and Food", https://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/wacc.html.

was unusually high at the start of the pandemic, then fell as post-pandemic inflation accelerated. Consistent with these low rates, grocery stores tend to make their money on volume and less on the margin.[26]

FIGURE 5: AVERAGE NET INCOME OF FOOD RETAILERS, 2012 TO 2022



Sources and Notes:
Food Retailing Industry Speaks, p 66.

Below, we illustrate the impact of the Proposed Rule on the net income for a typical store. For these calculations, we rely on sales and business-as-usual expenses reported by FMI. Consistent with our discussions above, we make the following assumptions to calculate the impact of the Proposed Rule on net income:

- The incremental capital cost of a transcritical CO2 system is $1.1 million for an average-sized store.

[26] Barbara Bean-Mellinger, "What is the Profit Margin for a Supermarket?," CHRON, November 14, 2018, accessed July 27, 2023, https://smallbusiness.chron.com/profit-margin-supermarket-22467.html.

- We assume that this incremental capital cost is financed by a loan with a 6.37% annual financing rate, with monthly payments spread over 15 years.
- Based on discussions with industry participants, we assume that approximately one-third of a store's utility costs are associated with refrigeration and these costs increase by 20% for a transcritical CO2 system, especially in less viable areas.
- Stores are able to pass on 60% of the increase in energy costs to consumers.

Given these inputs, we calculate net income for the average store in 2022 and the net income that would have arisen had the store been in compliance with the Proposed Rule. Note that we do not consider any potential increases in maintenance or refrigerant costs.

In Table 2 below, we find that the average store has a net income of approximately $700,000 per year in 2022. That net income would be reduced by about $117,000 per year if compliance with the Proposed Rule is required—a decrease of 16%. Medium-sized chains are impacted the most on a percentage basis; their net incomes fall by 25%.

TABLE 2: IMPACT OF TRANSCRITICAL CO2 SYSTEM COSTS ON NET INCOME

Category		All Retailers	Number of stores operated 1-10	11-100	>100
Annual Sales per store	[1]	$ 30,991,324	$ 18,381,324	$ 25,854,400	$ 31,694,676
Expenses excluding utilities	[2]	$ (29,968,610)	$ (17,756,359)	$ (25,156,331)	$ (30,553,668)
Utilities	[3]	$ (309,913)	$ (202,195)	$ (284,398)	$ (316,947)
Increase in energy costs for compliant systems	[4]	$ (20,661)	$ (13,480)	$ (18,960)	$ (21,130)
Amortized Compliance Capital Cost for given year	[5]	$ (108,422)	$ (65,488)	$ (94,934)	$ (110,363)
Pass-through of energy costs to consumers	[6]	$ 12,397	$ 8,088	$ 11,376	$ 12,678
Annual profit per store	[7]	$ 712,800	$ 422,770	$ 413,670	$ 824,062
Impact of the Proposed Rule on Profits	[8]	$ (116,686)	$ (70,879)	$ (102,518)	$ (118,815)
Annual profit per store after proposed rule	[9]	$ 596,114	$ 351,891	$ 311,153	$ 705,246

Sources and Notes:
Figures in parentheses indicate negative values (*i.e.,* costs).
[1], [2], [3]: Figures from Food Retailing Industry Speaks 2023 report, pages 57, 98, and 85.
[4]: [3] x (1/3) x (1/5). Assumes that refrigeration is 1/3 of utilities expenses and that these costs increase by 20% for compliant systems based on interviews with FMI members.
[5]: Assumes a 30% increase in capital costs for a compliant system relative to a baseline cost of $3.6 million for a 50,000 sq. foot store financed with a 15 year amortized monthly payment at a 6.37% interest rate.
[6]: [4] x 0.6. This assumes that 60% of the increase in utility costs is passed on to the consumer.
[7]: From Food Retailing Industry Speaks 2023.
[8]: [6] + [5] + [4]
[9]: [7] + [8]

Industry members are not anticipating more favorable profitability in the near-term. According to FMI's annual report, 80% of retailers expect their operating costs to increase this year and

only 12% expect their profits to increase.[27] They are confronting the impacts of recent inflation on their businesses, with one retailer remarking that "inflation has been killing the price image of our business" and 86% of retailers expecting inflation to put pressure on their margins.[28] Given these headwinds, 32% of retailers expect more brick-and-mortar stores to close.[29] As it stands, 53% of retailers indicate that federal government regulations are negatively affecting their businesses, with 46% expecting regulatory costs to increase.[30]

Our analysis indicates that transcritical CO2 systems would require larger capital investments that reduce store profitability. The European example indicates that much of the implementation of CO2-based systems has been in Germany, where the government provides subsidies such that investment costs for HFC systems exceed those of CO2-based systems.[31] Such financial inducements would be unnecessary if, as the EPA claims, transitioning to CO2-based systems would reduce costs.

C. Because the Industry Experiences Low Margins, Higher Capital Costs May Reduce the Number of Grocery Stores

The analysis above indicates that, while the profit for the example store would fall notably, it would remain profitable. Though this finding may be true for the average grocery store, it likely would not be true for all stores. Some stores may no longer be profitable if compliance is required, pushing them out of business.[32] Others may not be sufficiently profitable to obtain a loan to finance upfront capital expenditures, leading them to limit or eliminate the selection of

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27 The Food Retailing Industry Speaks, p. 75.

28 The Food Retailing Industry Speaks, p. 37 and p. 75.

29 The Food Retailing Industry Speaks, p. 40.

30 The Food Retailing Industry Speaks, p. 16 and p. 75.

31 "Natural Refrigerants: State of the Industry," ATMO, 2022, p. 41, https://atmosphere.cool/marketreport-2022/.

32 This result is consistent with the academic literature. Millimet et al. find that an increase in environmental standards discourages new firms from entering the market, induces existing firms to exit the market, and increases market concentration. See, Millimet et al., "Environmental Regulation and Economic Activity: Influence on Market Structure," *Annual Review of Resource Economics* 1 (2009): 99-117, https://www.jstor.org/stable/43202487. Li and Wang find that this pattern holds for firms in China. They use corporate registration information for all firms in 35 industries from 1991 to 2010 and show that environmental regulations deter firm entry and increase firm exit. See, Shuo Li and Min Wang, "Environmental Regulation and Firms' Extensive Margin Decisions An Evaluation of Environmental Regulation in China," JSTOR (October 2022): 1-39, https://www.jstor.org/stable/resrep46950.

refrigerated food that they offer. Even companies that could finance the project may decide that the return on that investment is too low to justify the expense, leading to similar outcomes.

These hardships are especially likely for small, local businesses as well as regional chains. Small businesses have lower annual profits, reducing their ability to finance capital investments, and are less sophisticated than larger businesses with dedicated planning and compliance teams. Smaller firms may have less access to capital, making financing more expensive and expansions more difficult. They likely have fewer stores and less opportunity to "learn by doing" and from prior experience as well as smaller technical staffs. A study of the European experience in phasing out HFCs reports that "many smaller retailers have little technical capacity and are only taking first steps."[33] For this reason, the report recommends that governments "[f]inancially support smaller retailers to transition away from HFCs, particularly with respect to costs for new equipment."[34]

Medium-sized, regional companies may have corporate teams that can assist individual store managers with planning and compliance. However, these companies have been most susceptible to cost pressures from large national big box chains, including superstores from Walmart and Target, as well as from cost-conscious options like Dollar General. Because of this competition, their margins have been particularly reduced, leading to reduced profits capable for funding capital investments.[35]

According to FMI's annual industry report, many grocery stores are currently planning to increase store area devoted to products that require refrigeration. Table 3 below indicates that 22% of stores intend to increase area for the fresh meat department and 17% for the fresh seafood department; 15% plan to increase area devoted to frozen foods. We understand that it is generally not sensible for a store to operate separate refrigeration systems for different parts of the store. To the extent that expansions of existing systems would trigger compliance with the Proposed Rule, these planned expansions may be cancelled.

The table also shows that some stores are already planning to reduce area devoted to refrigerated categories: 11% of all stores plan to cut area for fresh meat, 8% to reduce area for

[33] "Chilling Facts VII: Are Europe's Supermarkets Ready to Quit HFCs?," EIA, June 2017, p. 12, https://eia-international.org/wp-content/uploads/Chilling-Facts-VII-FINAL-1.pdf, ("Chilling Facts VII").

[34] Chilling Facts VII, p. 22.

[35] Richard Volpe & Michael A. Boland, "The Economic Impacts of Walmart Supercenters," Annual Review of Resource Economics, October 2022. Accessed at: https://www.annualreviews.org/doi/abs/10.1146/annurev-resource-111820-032827.

seafood, and 6% plan to cut back on frozen foods. These trends will be further accelerated if costs for these departments increase.

TABLE 3: EXPECTED CHANGES IN AREA DEVOTED TO DEPARTMENTS REQUIRING REFRIGERATION

Item	All Retailers n = 88		Number of Stores Operated					
			1-10 n = 52		11-100 n = 16		>100 n = 18	
	↑	↓	↑	↓	↑	↓	↑	↓
Fresh Meat	22%	11%	29%	8%	6%	19%	17%	17%
Fresh Seafood	17%	8%	22%	6%	13%	19%	11%	6%
Frozen	15%	6%	13%	4%	13%	6%	22%	11%
Dairy	14%	1%	15%	2%	6%	0%	17%	0%
Alcoholic Beverages	28%	2%	20%	2%	19%	6%	56%	0%
Fresh-prepared grab-and-go selection	74%	1%	63%	2%	88%	0%	94%	0%
Fresh Produce	40%	1%	46%	0%	19%	6%	39%	0%

Sources and Notes:
The Food Retailing Industry Speaks, Table 7.

Because of the capital investments required, the Proposed Rule will render some stores no longer profitable, leading to their closure. Stores may also reduce the number of linear feet devoted to products requiring refrigeration to control costs or avoid replacing outdated or failing equipment to avoid bringing other refrigerated areas into compliance.

D. Access to Grocery Stores Has Important Social Implications

The United States Department of Agriculture ("USDA") formalizes the concept of "food deserts" as areas where a significant number of residents have *both* low incomes and limited access to supermarkets or large grocery stores.[36] These areas often lack affordable, fresh, and healthy food options. According to the USDA's Food Access Research Atlas, approximately 39.4 million people, or 12.8% of the US population live in a Low Income and Low Access ("LILA") census tract

[36] "State-Level Estimates of Low Income and Low Access Populations," USDA, https://www.ers.usda.gov/data-products/food-access-research-atlas/state-level-estimates-of-low-income-and-low-access-populations/.

as of 2015. Approximately 30% more non-white residents face limited access to food retail than their white counterparts.[37]

Areas with higher levels of poverty are more likely to be food deserts, but the relevance of other factors, such as vehicle availability and the use of public transportation, differs between urban and rural areas. Multivariate analysis techniques conducted by the USDA show that measures of income inequality and racial segregation were important predictors of low access in urban core areas, while the most important factor in rural areas was lack of transportation infrastructure.[38] Overall, however, areas with higher poverty rates are more likely to be food deserts regardless of rural or urban designation.[39]

The map in Figure 6 below shows that food deserts (that is, LILA census tracts) are found in every state, with larger concentrations in the southern states. This concentration of LILA areas in the south has important implications for the Proposed Rule. As we discussed in Section I.B, the EPA recognizes that transcritical CO2 systems are less viable in hot and humid regions, which includes much of the southern US. This region also has the largest number of Americans living in food deserts. Texas was the state with the highest absolute count of population living in a LILA census tract, with 5 million people or 20% of its population. The two states with the highest shares of their populations living in food deserts are Mississippi (30%) and New Mexico (29%).[40] If grocery stores are required to comply with the Proposed Rule in these less viable areas, this policy may exacerbate the already high incidence of low access areas in this region.

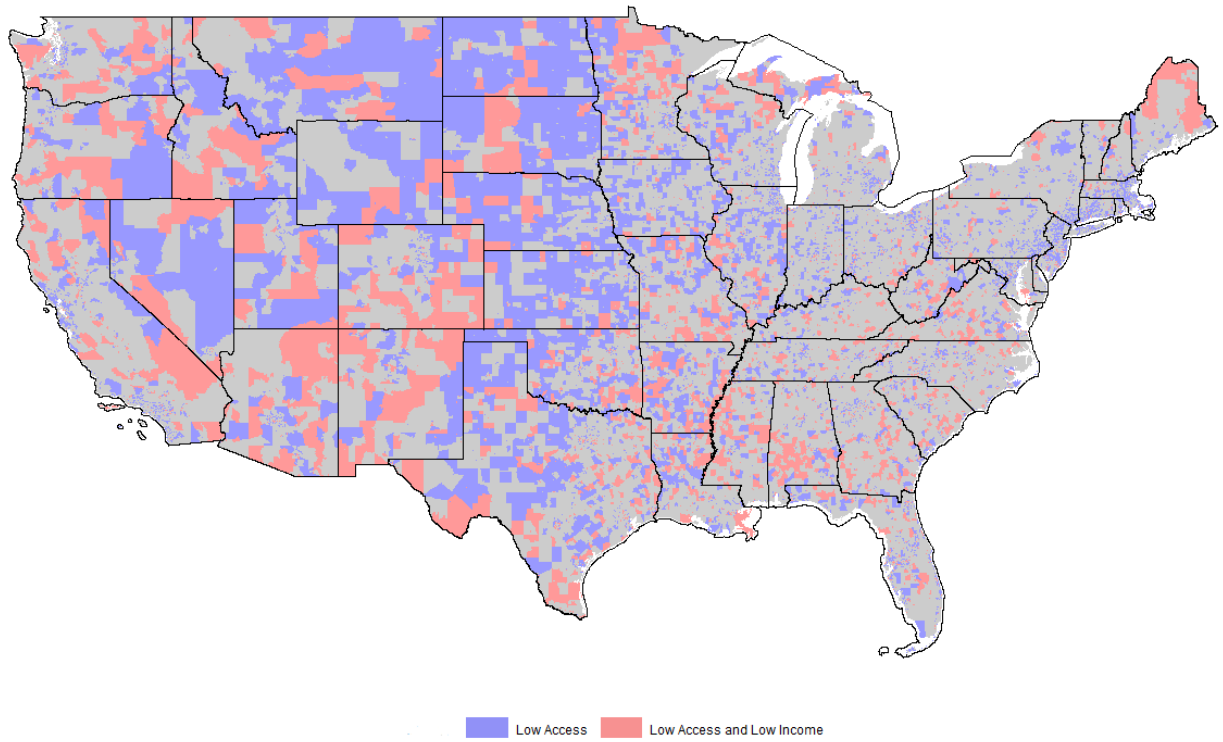
[37] Alana Rhone et al., "Low-Income and Low-Supermarket-Access Census Tracts, 2010–2015," USDA Economic Research Service, January 2017, https://www.ers.usda.gov/webdocs/publications/82101/eib-165.pdf?v=42752.

[38] "Access to Affordable and Nutritious Food: Measuring and Understanding Food Deserts and Their Consequences—Report to Congress," USDA Economic Research Service, June 2009, https://www.ers.usda.gov/webdocs/publications/42711/12716_ap036_1_.pdf.

[39] Paula Dutko, Michele Ver Ploeg and Tracey Farrigan. "Characteristics and Influential Factors of Food Deserts," USDA Economic Research Service, August 2012, https://www.ers.usda.gov/webdocs/publications/45014/30940_err140.pdf.

[40] "State-Level Estimates of Low Income and Low Access Populations," USDA, https://www.ers.usda.gov/data-products/food-access-research-atlas/state-level-estimates-of-low-income-and-low-access-populations/.

FIGURE 6: LOW INCOME AND LOW ACCESS CENSUS TRACTS



Source: USDA Food Access Research Atlas, https://www.ers.usda.gov/data-products/food-access-research-atlas/go-to-the-atlas/. We use the variable LA1and10 which is measured at 1 mile for urban areas and 10 miles for rural areas.

In the current environment, retailers may choose not to establish or maintain stores in certain areas due to perceived low profitability or higher operational costs, contributing to limited food access.[41] Rural areas often have higher operations costs due to their distance from distribution centers and from corporate staff who travel from store to store. These areas are also less likely to have contractors who are trained to service more complex transcritical CO2 equipment. While some companies may have in-house refrigeration technicians, this is less likely for chains that are geographically dispersed across rural areas.

Low-performing stores also often tend to be in poorer areas. Residents of these areas tend to be more price sensitive and more open to shopping for groceries at big box retailers and discount chains. Not only is baseline profitability in these stores lower, the price sensitivity of customers is higher, limiting the ability of stores to pass on cost increases. Accordingly, stores in

[41] Chicago Tribune, "Grocery chains leave food deserts barren, AP analysis finds," December 7, 2015, accessed July 27, 2023, https://www.chicagotribune.com/business/ct-grocery-chains-ignore-food-deserts-20151207-story.html.

these regions may be particularly susceptible to falling below breakeven profitability and, ultimately, closure. This would further reduce food access for vulnerable populations.

Lastly, some studies indicate that white neighborhoods contain an average of four times as many supermarkets as predominantly black ones do and that grocery stores in black communities are often smaller with selection that is more limited.[42] Because the Proposed Rule will increase the fixed costs of building and expanding grocery stores, this could exacerbate the differential in the density of stores and in the selection available at stores in predominantly white versus predominantly black neighborhoods.

III. These Impacts Can Be Mitigated By Extending the Compliance Timeline

The transition to compliant systems can only occur if the necessary equipment is available in sufficient quantities and is approved for use in grocery stores. It also requires a sufficient number of trained technicians to install and maintain these systems. Based on the interviews we conducted, we found that increasing HFC prices are already encouraging the development of new stores using transcritical CO2 in parts of the country where the system is most viable. This early adoption can spur improvements in the manufacturing process as well as additional innovation, reducing the costs of these systems and leading to additional uptake in the future. These cost-effective projects should be encouraged as a means to maximize the net benefits of the transition away from HFCs.

More expansive requirements, particularly for new stores in less viable areas or relating to conversion of existing stores, will substantially increase the costs of the Proposed Rule. Not only are these projects per se inefficient, requirements to implement them simultaneously with otherwise cost-effective projects will put additional pressure on labor markets and on supply chains, raising costs for all projects.

[42] Kimberly Morland et al., "Neighborhood characteristics associated with the location of food stores and food service places," *American Journal of Preventive Medicine* 22(1) (January 2002): p. 23-29, http://www.ncbi.nlm.nih.gov/pubmed/11777675.

A. Ratcheting Caps on HFC Production Are Already Inducing New Stores to Shift Away From HFCs

As we discussed in Section I.B, HFC prices, notably for R-404A, have increased substantially. This is largely due to ratcheting restrictions on HFC production that have been instituted in both the US and in Europe.[43] These price increases are likely to persist in the face of restricted supply, leading the industry to incorporate higher HFC prices into their planning processes.

Accordingly, many companies are looking to identify alternatives to R-404A for use in new stores. Specifically, companies will consider whether the benefits of lower refrigerant prices outweigh the costs of installing HFC alternatives. Crucially, the price mechanism encourages stores with the lowest costs of transitioning to do so first, thereby maximizing the net benefits of the rule.

There are at least three factors that we expect—and observe—to influence the propensity of stores to transition to alternative refrigerants.

- First, companies will focus on developing new stores around alternative refrigerants rather than on retrofitting existing stores. We discuss the particularly high costs of retrofitting existing stores in Section III.D.
- Second, stores in more favorable climates are more likely to transition earlier. Hannaford, a chain based in northern New England, considers transcritical CO2 "the new standard" for its new stores.[44] Among the industry representatives who we spoke with, the ones most optimistic about transcritical CO2 were ones who have opened stores in states along the Canadian border.[45]
- Third, larger public companies with more ready access to capital and potentially higher margins are more capable of undertaking these investments. For example, Target

[43] For US, see a related rule from the EPA, "Phasedown of Hydrofluorocarbons: Allowance Allocation Methodology for 2024 and Later Years", Federal Register, https://www.federalregister.gov/documents/2023/07/20/2023-14312/phasedown-of-hydrofluorocarbons-allowance-allocation-methodology-for-2024-and-later-years; For Europe, see European Commission, "EU legislation to control F-gases," 2014, https://climate.ec.europa.eu/eu-action/fluorinated-greenhouse-gases/eu-legislation-control-f-gases_en.

[44] Transcritical Update: Hannaford Supermarkets.

[45] Even these industry representatives were concerned about the costs associated with retrofitting stores with transcritical CO2 systems, however.

announced plans to scale transcritical CO2 systems chain-wide by 2040.[46] Walmart has committed to using "ultra-low GWP" systems "in new construction where commercially available."[47]

The caps on HFC production already provide substantial incentives to transition to alternative refrigerants. Notably, the price mechanism encourages the most efficient transitions to happen first. These early adopters help fund the learning-by-doing process that lowers manufacturing costs as well as the development of more favorable technologies. These industrial improvements enable more projects to pass a cost-benefit calculation in the future. The ratcheting of the caps also encourages a staggered transition, further controlling costs. We discuss each of these advantages in more detail below.

B. Short Compliance Horizons Increase Costs

Compressed compliance timelines induce a burst of demand for machinery, parts, and labor; these bursts are accommodated through a combination of project delays and increases in costs.

For example, a key limitation to transitioning to compliant systems will be the number of technicians able to install and service these systems. Transcritical CO2 systems are more complex than traditional HFC systems and require new training for technicians. Workers may be able to undertake this training and service the new systems if there is a relative surplus of labor in this market; if supply and demand are balanced in current conditions, then absorbing these new requirements and projects will increase labor costs and slow project timelines.

We reviewed employment levels and wages for HVAC workers across the country.[48] Overall, this specialized labor market is in relative equilibrium in comparison to the full labor market. Specifically, the ratio of wages for HVAC workers to average wages has remained relatively stable and the growth in wages is similar for HVAC workers and the broader workforce, as shown in Table 4 below. These facts suggest that current demand for these workers is well-aligned with supply.

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[46] "Target Tests First Net Zero Energy Store," Target, March 17, 2022, accessed July 27, 2023, https://corporate.target.com/press/releases/2022/03/target-tests-first-net-zero-energy-store.

[47] "Climate Change," Walmart, May 19, 2023, accessed July 27, 2023, https://corporate.target.com/press/releases/2022/03/target-tests-first-net-zero-energy-store.

[48] "Metropolitan and nonmetropolitan area," May 2014 – May 2022, https://www.bls.gov/oes/tables.htm. Note: we consider HVAC workers under the occupational code "49-9021": "Heating, Air Conditioning, and Refrigeration Mechanics and Installers."

TABLE 4: RATIO OF NATIONAL AVERAGE WAGES FOR HVAC WORKERS TO WAGES FOR ALL WORKERS

OCC		2014	2017	2019	2022
All Occupations	[1]	$21.22	$22.74	$25.69	$29.63
HVAC	[2]	$21.40	$22.54	$24.73	$27.66
Ratio	[3]	1.01	0.99	0.96	0.93

Sources and Notes:
[1], [2]: From US Bureau of Labor Statistics.
[3]: [2] / [1]

This alignment would be disrupted if a large number of workers are required to perform system installations or if workers would need to up-skill to service the systems. In the former case, the existing labor pool needs to grow; in the latter, the *qualified* labor pool is smaller than it appears. In either case, wages for these workers would increase in the short-term to allocate the existing workforce efficiently. In the medium- to long-term, higher wages will lead to new workers acquiring HVAC skills and existing HVAC workers gaining the requisite skills to service the new equipment; this entry and retraining will reduce the upward pressure on wages. If the burst in labor demand falls after a short compliance horizon passes, then there may be excess workers in this industry, leading to layoffs. The spike in wages and relative shortage in labor availability can be dampened by spreading the transition over a longer period.

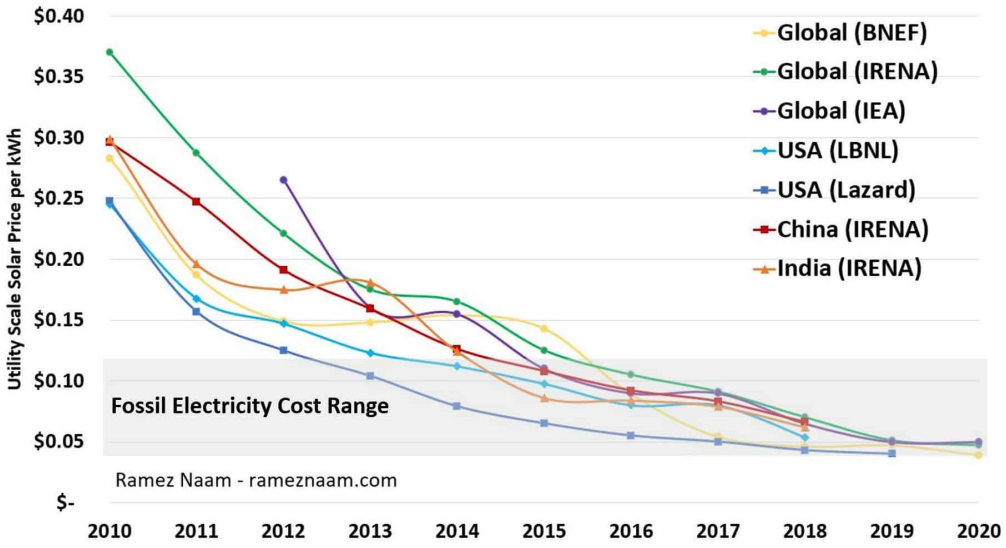
The experience of the solar energy industry provides some evidence that rising labor costs and permitting costs can impede the penetration of new technology. Several studies have found that, while the overall cost of solar has fallen as components become less expensive and the technology has become more efficient, the rate of the cost decline has been slowed by increasing "soft costs."[49] These costs include labor for installation and permitting costs. Programs to train more technicians and to reduce permitting requirements and time have been introduced to address these issues.

[49] Vignesh Ramasamy et al., "U.S. Solar Photovoltaic System and Energy Storage Cost Benchmarks, with Minimum Sustainable Price Analysis: Q1 2022," National Renewable Energy Laboratory, https://www.nrel.gov/docs/fy22osti/83586.pdf.

C. Manufacturing Costs Are Likely to Fall and Efficiency to Rise in the Future

One reason that the price incentive created by ratcheting HFC production limits is particularly cost-effective is that the associated technologies will become less expensive as they are developed over time. A particularly notable illustration of cost reductions that come from "learning-by-doing" in manufacturing is the solar industry. In the span of a decade, solar costs have fallen by a factor of 5, reaching prices that are competitive with fossil fuels as shown in Figure 7.[50] These improvements in the manufacturing process have made solar a competitive energy alternative in many more regions and applications.

FIGURE 7: SOLAR COSTS, 2010-2020



Sources and Notes:
"Solar's Future is Insanely Cheap," Ramez Naam, 2020, https://rameznaam.com/2020/05/14/solars-future-is-insanely-cheap-2020/.

Alternative refrigeration systems are also likely to become more efficient over time. A study of HFC transitions in Europe notes that particular progress has been made for smaller systems; new systems in development may be more energy efficient than HFC systems with a smaller size.[51] This progress is likely to continue for units of various sizes.

[50] "Solar's Future is Insanely Cheap," Ramez Naam, 2020, https://rameznaam.com/2020/05/14/solars-future-is-insanely-cheap-2020/.

[51] Chilling Facts VII, p. 20.

Furthermore, new technologies will be developed that both provide superior options for some stores and put competitive pressure on early versions of low GWP systems, improving the cost effectiveness of the transition. For example, a case study comparing the performance of transcritical CO2 and A2L systems in Britain found that the A2L system reduced energy use by 34%, reduced leakage, and reduced maintenance costs.[52] We understand that these systems are not available for widespread use in the US at this point, in part due to the need for changes to building codes and other regulations; however, in the future these systems will provide a much more viable alternative for many stores.

D. Converting Existing Stores Is Difficult to Justify At Current Cost Levels

Across all our interviews with industry participants, there was unanimous agreement that converting existing stores from HFCs to a transcritical CO2 system would be incredibly disruptive and expensive. Under normal business practices, remodels or replacements typically occur for only a portion of equipment at a given time. This is partly due to the lifespans of the components of the systems: cases last for roughly 10 to 15 years, while compressors and condensers can last from 20 to 30 years. Thus, while cases need to be replaced more frequently, the overall infrastructure of the system can remain intact. The smaller scale of these replacements also reduces the disruptions experienced by consumers.

An example project might be to remove and replace cases that have rusted. As of now, companies are experiencing uncertainty as to whether this kind of project would trigger requirements to transition to a low GWP system. If so, the company will likely determine that it is not cost effective to replace the entire refrigeration system and instead make do with the damaged cases or remove them and reduce the linear feet devoted to refrigerated goods.

Another example project would be to replace cases with more modern, more energy efficient versions. Here, too, the project is unlikely to generate a sufficient return to justify replacing the entire refrigeration system if required under the Proposed Rule. Instead, the store may enact half-measures, such as installing doors on cases. While these updates can improve the energy efficiency of the store, projects that would generate even larger energy savings would be forestalled due to the burdens of the Proposed Rule.

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[52] "ASDA and A2L: How HFOs are helping retailers get more, for less," Opteon, p. 2, https://www.opteon.com/en/-/media/files/opteon/case-studies/opteon-asda-casestudy.pdf?la=en&rev=3709edb1eee141c39f9dee2137fdbeba.

While transitioning to an "ultra low" GWP alternative may not be cost effective for existing stores, retrofitting systems to use lower GWP HFC blends may provide a cost effective middle ground. A study in Europe found that major grocers have reduced consumption of the highest GWP HFCs (HFC-404A and HFC-507/507A), but increased use of lower GWP HFCs (HFC-407A/407C/407F).[53] Several industry members who we spoke with indicated that they have retrofitted stores using HFC-448A/449 and that these conversions can reuse much of the existing system infrastructure. These substitutions indicate that cost-effective net reductions of GHG emissions for store conversions are possible by switching to intermediate HFCs rather than transitioning entirely away from HFCs. This is particularly the case if these alternative gases can be used in existing systems.

[53] Chilling Facts VII, p. 4.