

COMMENT TO CARB ON NON- RESIDENTIAL REFRIGERANTS, PURSUANT TO:

“Prohibitions on Use of Certain Hydrofluorocarbons in Stationary Refrigeration, Chillers, Aerosols-Propellants, and Foam End-Uses Regulation”

Response to:

https://ww3.arb.ca.gov/regact/2020/hfc2020/notice.pdf?_ga=2.16614582.180010128.1605894254-1879632539.1592679157

NOTE: These comments pertain only to non-residential refrigerants, not air conditioning.

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“Winning slowly is the same as losing.” Bill McKibben

“The writing is on the wall.” Old Testament: Daniel 5:5-31

INTRODUCTION

CARB, and the California Legislature, must be praised for California’s strong regulation of “F-gases” used in refrigeration. Taking over the EPA’s SNAP standards that were partially vacated by a court and passing SB 1383 and SB 1013 are strong statements of a commitment to reduce high GWP emissions from HFCs. The new CARB rule-making on refrigerants continues this thrust, but should be modified to reduce even further the impact of refrigerants on global warming. California is clearly perceived as leading other states in this realm in the US, so it should set a high bar.

I: SUMMARY OF PROPOSED CHANGES

A. *Alternative 1, as described in the Staff Report (page 130) and the Standardized Regulatory Impact Assessment (page 101), is far better than the Preferred Alternative which is up for final decision.*

1. Salient characteristics of Alternative 1 are:

- a. Like the Preferred Alternative, Alternative 1 applies to refrigeration systems with more than 50 pounds of refrigerant.

- b. Only natural refrigerants¹ could meet the new standard of a GWP of 10 or less.
 - c. The new standard would be implemented for new and remodeled equipment starting in 2022.
- B. *Modifications to Alternative 1 would make it more feasible and acceptable*
- 1. Phase-in the requirement so as to achieve 100% compliance by 2030 but spacing out the changes.
 - 2. Establish a performance standard for GWP emissions for each year, similar to a renewable portfolio standard for electricity generation or cap and trade. Facilities exceeding the standard (by switching to natural refrigerants) earn credits which they can trade to facilities who want to defer switching until their current equipment needs replacing. The performance standards increase gradually to near-zero GWP emissions from refrigerants by 2030.
 - 3. Offer extensive additional incentive programs to help with the change, including training of technicians and technical assistance from CARB as well as legislation to provide tax breaks for early conversion to natural refrigerants. The existing incentive fund is useful but far too small. Stores with low profit margins, particularly those in disadvantaged or “food desert” neighborhoods, in particular, will need assistance. And a tax break is the simplest way to influence the calculations of all facilities contemplating conversion to natural refrigerants.
 - 4. As many European countries do, tax high global warming potential HFCs during the transition at a level that will serve as an incentive to change as well as recognize the social costs of the emissions.
- C. Although Alternative 1 addresses many problems, it should be expanded in the near future to convenience stores and other facilities with less than 50 pounds charge.

II: REASONS TO FAVOR ALTERNATIVE 1 (WITH SUGGESTED MODIFICATIONS) OVER THE CARB PREFERRED ALTERNATIVE

- A. *The cost-benefit ratio which seems to favor the Preferred Alternative is thrown off dramatically by three questionable methodological decisions made in the staff report.*
- 1. The staff report notes that 100 year GWP values are used although 20 year GWP values are actually more appropriate given the nature of HFCs. The consequence is to minimize the effects of HFC emissions on global warming in the crucial next

¹ “Natural refrigerants occur in nature's biological and chemical cycles without human intervention. These materials include ammonia, carbon dioxide, natural hydrocarbons, water and air.”

https://www.epa.gov/sites/production/files/documents/ASHRAE_PD_Natural_Refrigerants_2011.pdf Natural refrigerants ruled during the start of refrigeration in the 1930s but were soon replaced by CFCs.

30 years.² For example, in 2010 F-gases accounted for 3% of global warming emissions in CA using the 100 year standard but 5% using the 20 year standard.³

2. Calculation in the staff report as to the effect of the new regulations by 2040 are mis-stated because new evidence shows that the social costs of carbon should start at approximately \$100 per metric tonne.⁴ In practice, this means much more rapid change is justified since the costs of not changing are so high. In addition, the social costs of carbon are calculated using CO₂ rates, but HFCs have a GWP thousands of times greater. The staff report says:

It is also worth noting that the SC-CO₂ estimates discussed above were calculated using the social cost of atmospheric release of CO₂ and likely represent a lower bound for the damages caused by releasing HFCs. This is because HFCs are hundreds to thousands of times more potent at trapping heat in the near term than the longer-lived climate pollutants like CO₂. Unlike CO₂, methane and nitrous oxide, there are no official government estimates for HFCs, though one study estimates the social cost of atmospheric release of HFC-134a to be at least thousand-fold higher than CO₂.

3. The staff report and the Standardized Regulatory Impact Assessment also use discount rates that are far too high, indicating we are favoring our present interests over future interests in a way that does not make sense for climate change calculations. The rates used by staff are appropriate for individuals but not appropriate for assessing societal value. Or to put it another way, the rates shown would be appropriate for individual retailers but not CARB. A discount rate of zero or well below 2% would be more appropriate than the 5% to 2.5% used in the staff report.⁵

² From the staff report: "A 100-year GWP value is reflective of the warming impact of an HFC relative to CO₂ over that time period. In reality, most HFCs used as refrigerants or as part of refrigerant blends have atmospheric lifetimes shorter than 100 years and thus, their warming impact is even worse in the shorter term."

³ shecco comments to CARB on the 2015 rule-making regarding HFCs: <https://www.arb.ca.gov/lists/com-attach/44-proposed-sp-ws-AnEAblA0VGQHYIU6.pdf>

⁴ <https://yaleclimateconnections.org/2020/07/trump-epa-vastly-underestimating-the-cost-of-carbon-dioxide-pollution-to-society-new-research-finds/#:~:text=The%20latest%20research%20by%20an,to%20nearly%20%24600%20by%202100>

⁵ A discount rate of around 4.3 in 2010 would imply emissions reductions of 25% by 2050; one of 1.4 would imply emissions reductions of 53% by 2015 ("The Choice of Discount Rate for Climate Change Policy Evaluation", Goulder, LH and Williams, RC, III", National Bureau of Economic Research, 2012, page 8. Retrieved November 22, 2010 from <http://www.nber.org/papers/w18301>) For climate change a discount rate of no more than 2.0 is a consensus finding from over 200 experts in 2018. ("Discounting Disentangled," Moritz A. Drupp, Mark C. Freeman, Ben Groom, and Frikk Nesje, American Economic Journal: Economic Policy. Nov 2018, Vol. 10, No. 4: Pages 109-134) but much lower rates (e.g. 0.22%) are supported by recent empirical work, e.g. Bestard AB, Font AR, Estimation of implicit discount rates for climate change adaptation policies, Journal of Environmental Management, Volume 252, 2019, Retrieved November 22, 2020 from <https://doi.org/10.1016/j.jenvman.2019.109671>; and Courard-Hauri D, Klimas CA, Parrish C, An analysis of the long-term social discount rate and the valuation of large environmental losses using non-monetary tradeoffs, Journal of Behavioral and Experimental Economics, Volume 87, 2020, Retrieved November 22, 2020 from: <https://doi.org/10.1016/j.socec.2020.101549>; recent theoretical work points to lower discount rates as well, e.g.,

The effect of these three misleading methodological assumptions is to enormously undervalue the benefits of getting to zero HFC emissions quickly. The potential costs to food retailers of switching to natural refrigerants must be evaluated against a *much* higher future cost of not switching.

B. The Preferred Alternative will not get us on a track to meeting the 2045 goal of net-zero emissions.

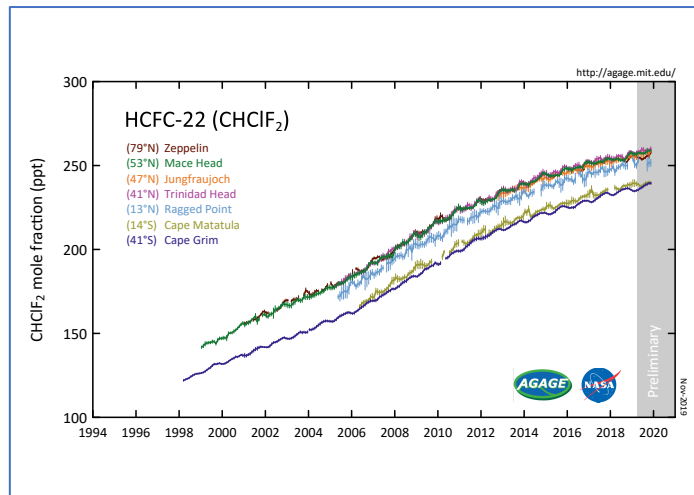
1. California’s goal of achieving carbon neutrality by 2045 compels more aggressive measures. It would be better to leapfrog the “low HFC” stage as it would simply require taking “another cut” in a few years and disrupting the stability of the economic environment twice.⁶ In 2014 the European Union adopted a “phasedown” of HFCs of 79% by 2030. CARB’s goals are much less ambitious, but note that Europe will still be left in 2030 with a need to replace large parts of the system with natural refrigerants since much of the phasedown can be accomplished by using lower GWP HFCs.
 - a. The goals in the proposed amendments state: “[T]he Proposed Amendments will reduce HFC emissions from the refrigeration and AC sectors by nearly 40 and 50 percent below baseline by 2040, respectively.” However, a 40% reduction from baseline for refrigerants by 2040 will be far short of the 2045 net-zero goal. The requirement that chains of 20 or more reduce GWP by at least 25% in the next six years is woefully inadequate as these are exactly the firms with resources to completely adopt natural refrigerants by 2026.
 - b. It is inexplicable that for existing retailers, the maximum reduction required would be to 1,400 GWP HFCs. True, this is less than R22 or other current HFCs but it is approximately 1,400 GWP higher than natural refrigerants. In short, these regulations are not actually intended to replace HFCs with very low or zero emission alternatives.⁷ And the emissions will continue to do harm. The graph below shows the consequences of our *prolonged* introduction of a ban on the HCFC R-22. Because effects are cumulative, the percent increase in the atmosphere hardly declines during the entire phase out period.⁸

Bauer, Michael D., Glenn D. Rudebusch. 2020. “The Rising Cost of Climate Change: Evidence from the Bond Market,” Federal Reserve Bank of San Francisco Working Paper 2020-25. <https://doi.org/10.24148/wp2020-25>

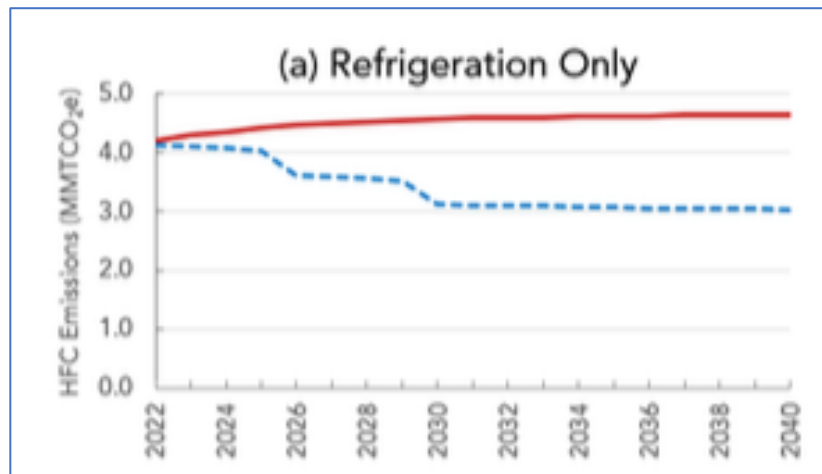
⁶ Now is also a good time to set the path to where we need to go because R-22 and other HCFCs are being phased out affecting a large part of the retail food market. We can piggy-back on that change to get to natural refrigerants without an intermediate HFC stage.

⁷ The staff report says: “Retail food companies will be required to reduce their average emissions by approximately 55 percent by 2030, across their facilities (via either the weighted-average GWP reduction or GHG reduction pathways). The most economical option will be to retrofit the current systems with refrigerants having a GWP value just under 1,400 e.g., R-448A or R-449A.”

⁸ Prinn, R.G.; Weiss, R.F.; Arduini, J.; Arnold, T.; Fraser, P.J.; Ganesan, A.L.; Gasore, J.; Harth, C.M.; Hermansen, O.; Kim, J.; Krummel, P. B.; Li, S.; Loh, Z.M.; Lunder, C.R.; Maione, M.; Manning, A.J.; Miller, B.R.; Mitrevski, B.; Mühle, J.; O’Doherty, S.; Park, S.; Reimann, S.; Rigby, M.; Salameh, P.K.; Schmidt, R.; Simmonds, P.G.; Steele, L.P.; Vollmer, M.K.; Wang, R.H.; and Young, D.: The ALE/GAGE/AGAGE Data



- c. The effect of the various provisions in the Preferred Alternative is summarized in Figure 13a from the staff report (below), which shows a reduction by 2030 from slightly more than four MMTCO₂ equivalents to three MMTCO₂ equivalents emissions per year. The graph is revealing: a) This is only a 25% reduction in annual emissions by 2030; b) HFC emissions are projected to remain at three MMTCO₂ equivalents until 2040 (and further), which is totally out of sync with the requirement of net-zero by 2045. Business as usual is the red line while the effect of the Preferred Alternative is blue. It is also worth noting that these regulations would not get us close to the Kigali Amendment goal of reducing HCFs to 15% of the 1990 baseline by 2036.



- d. The staff report says a goal is to swiftly: “transition[s] to technologies with the lowest GWP that is technologically and commercially feasible.” Unfortunately,

Base <http://agage.mit.edu/data>, or The ALE/GAGE/AGAGE Network (DB 1001), <http://cdiac.ess-dive.lbl.gov/ndps/alegagage.html> (<https://doi.org/10.3334/CDIAC/atg.db1001>)

the regulations are not explicit about the need to move to natural refrigerants in order to achieve net-zero emissions. This will result in years of delay before finally biting the bullet. It would be much better to make it clear that the industry has 10 years to move to natural refrigerants, as they are the only currently feasible way of reducing emissions sufficiently, and, as described above, provide incentives and assistance in making that change.

C. 2030 is a reasonable timeline by which to accomplish the switch to natural refrigerants

1. Changing the system to natural refrigerants was approved by the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. as long ago as 2009.⁹ Had we started then it would have been much easier.
2. CARB regulations should encourage research into extremely low GWP refrigerants. The new CARB regulation, by not explicitly moving aggressively toward natural refrigerants, encourages the industry to continue developing HFC/HFOs with high GWP (1,400) and discourages research into making natural refrigerants more efficient. In doing so it fails one of CARB's own goals: "support growth in technologies that lower HFC emissions."
3. In 2020, European industry leaders recognize the need for natural refrigerants to replace HFCs: "Natural refrigerant alternatives are available for every industry and application. It will be impossible for [the] EU to become climate neutral without strictly regulating HFCs."¹⁰
4. Recent studies show delay in acting on climate change comes with enormous costs.¹¹ The Preferred Option is temporizing at best.
5. Much of the lag in using natural refrigerants in California and the US is parochialism, as they are employed to a far greater extent in Europe and Japan. A 2019 article reports there are 20,000 supermarkets using CO2 refrigeration; including 14% of all stores in Europe. Table 1 from the article shows the recent growth (next page):¹²

⁹ *ibid.* "Through its Strategic Plan, ASHRAE has recognized that the advancement of sustainable building design and operations is critical to the protection of our global environment and to society. Expanding the safe and efficient application of natural refrigerants supports this move towards sustainability and continues ASHRAE's legacy as an international leader in the field of refrigeration and air conditioning."

¹⁰ shecco, *op.cit.* Vladyslav Tsyplakov, Development Director, Mirai Intex

¹¹ Sanderson BM, O'Neill BC, Assessing the costs of historical inaction on climate change , June 2020, Scientific Reports, 10(1) Retrieved on November 22, 2020 from: <https://doi.org/10.1038/s41598-020-66275-4>

¹² Skačánová KZ, Battesti M, Global market and policy trends for CO2 in refrigeration, International Journal of Refrigeration, Volume 107, 2019, Pages 98-104, <https://doi.org/10.1016/j.ijrefrig.2019.08.010>.

Table 1Growth of CO₂ stores between 2015 and 2018 in selected regions.

Regions	2015	2018	Growth rate (%)
USA	52	370+	612
Canada	139	245+	76
Europe	5500	16,000+	190
New Zealand	9	40+	344
Australia	4	20+	400
Japan	1500	3530+	135

Source: Primary research among key CO₂ technology manufacturers in each region.

- In some European countries limits to HFCs are stronger than in the US. For example, “The European Union (EU) has adopted the world’s leading F-gas regulation that will phase down the production and import of HFCs by almost 80 percent from 2014 levels by 2030.”¹³
- Japan has pushed successfully for the introduction of natural refrigerants in convenience stores and in over a million vending machines.¹⁴ It has over 10,000 CO₂ installations.¹⁵ It currently has an incentive program worth \$69 million each year to help facilities convert to natural refrigerants.¹⁶ [Since Japan had a population of 125.5 million in 2018 and California’s population was 39.5 million, a comparable incentive program for California would be \$21.5 million, far above what we are spending.]

D. The Preferred Alternative offers far too much deference to industry preferences.

1. Replacement costs of refrigeration equipment is less than 1% of total supermarket costs.¹⁷ So the change is really at the margins.
2. Managers and owners investing in supermarket remodeling have highly complex calculations to conduct. They realize that the payback period for equipment that is replaced simply to reduce emissions will be much longer than payback for many other efficiency changes. This is because the social costs of HFCs are currently not borne by the stores and customers. It is up to regulatory bodies like CARB to require that stores include these costs.¹⁸ However, in a trade-off, rules such as

¹³ CARB: *Short Lived Climate Pollutant Reduction Strategy*, March 2017.

https://ww2.arb.ca.gov/sites/default/files/2020-07/final_SLCPP_strategy.pdf

¹⁴ https://issuu.com/shecco/docs/guide_japan-2016

¹⁵ Ibid.

¹⁶ Ibid.

¹⁷ The Energy Efficiency Paradox: A Case Study of Supermarket Refrigeration System Investment Decisions, National Center for Environmental Economics. 2015. <https://www.epa.gov/sites/production/files/2016-03/documents/2015-03.pdf>

¹⁸ *ibid.*

those proposed by CARB in Alternative 1 give investors a stable time frame to use in their calculations.

3. In our view too much deference is given in the new rules to the usual investment practices of supermarket chains in which energy efficiency and GWP of refrigerants are not high priorities but quick payback of investments (2-4 years) is.¹⁹ In addition, reluctance on the part of the supermarkets is in part irrational. It includes factors such as not wanting to be “out front” of the market in technology adoption; that is, delayed adoption is ordinarily preferred.²⁰ But these are not ordinary times. Without a regulatory priority, replacing refrigerant systems just competes on equal terms with all other opportunities to increase the return on investment. Regulation needs to restructure these priorities so that the social costs of investment decisions are prioritized.
4. While not fitting into the usual supermarket rapid return on investment paradigm, natural refrigerants have some advantages that are not taken into account sufficiently in the staff report assessing the costs of Alternative 1:²¹
 - i. Lowest life-cycle costs
 - ii. Major refrigerant conversions every 10 to 15 years are eliminated as is concern about regulatory phase out
 - iii. Energy efficiency advantages
 - iv. Total Equivalent Warming Impact improvements due to fewer direct emissions
 - v. There are also at least 10 technical ways in which CO₂ is superior to HFCs, for example, it is non-corrosive with most materials.²²
5. “Refrigerant leaks often increase energy expenditures, reduce equipment life, and increase material costs, all of which adversely affect operating budgets.”²³ However, these increased *operating* costs may be invisible to the organizational unit concerned with *capital* costs. In consequence, requirements for new natural refrigerant equipment are seen as an upfront cost unbalanced by the actual

¹⁹ *ibid.*

²⁰ *ibid.*

²¹ Supermarket Refrigeration System Design Process: A Consultant’s View Rob Arthur, P.E., P Eng, LEED AP CTA Architects Engineers. <https://www.fmi.org/docs/default-source/energy/supermarket-refrigeration-system-design-process---a-consultant's-view.pdf?sfvrsn=2> In addition the staff report on page 127 calculates a number of these savings for typical facilities and also notes regulatory savings of \$150 to \$3,100 annually.

²² Prajapat UR, CO₂ as a Refrigerant in Supermarket Refrigeration Systems: A Review, International Research Journal of Engineering and Technology. Vol 6(6) 2019.

²³ Vanderberg MP, Atwood T. Private Governance Response to Climate Change: The Case of Refrigerants. 2019. Retrieved on November 25, 2020 from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3337730&download=yes

negative operating impacts of refrigerant leaks.²⁴ The staff analysis of costs for Alternative I suffers from this same defect.

E. *The Preferred Alternative does not sufficiently recognize the years of failure of past refrigerant regulation and voluntary incentives, especially coming from large chains. As long as HFCs are in use, lax enforcement or lax maintenance could lead to a failure to decrease emissions to the (already inadequate) level anticipated.*

1. The Environmental Investigation Agency is an independent non-profit concerned with climate change and the role of refrigerants in causing it. In 2020 it rated 16 US retail chains on their approach to refrigeration and refrigerants.²⁵ The maximum score was 100%, minimum 0%. Highest scoring was the Aldi chain at 71%; a chain that has over 300 HFC-free stores. Whole Foods scored 46%, Target 34%, Walmart and Albertsons 15%, Costco 4%, and Trader Joe's 0%. These low scores indicate the need to put teeth in the regulations or – preferably – switch very rapidly to natural refrigerants.

F. *The argument that switching to natural refrigerants is not feasible takes a narrow view of feasibility, essentially adopting the spreadsheets of store managers.*

1. As suggested above, the social costs of not moving entirely to natural refrigerants are far higher than the staff report states. On balance, and given the current warnings of the IPCC that at least 50% of emissions need to be curtailed by 2030 to have a chance of limiting global temperature rise to 1.5 degree C, the higher costs of quick action seem necessary. Given the vastly greater number of retail food markets in Europe and Japan that have adopted natural refrigerants, the claim of infeasibility by owners must be exaggerated. And both cost and feasibility are going to have to be dealt with in the near future in any case if we are to meet our goal of net-zero by 2045. The multiple costs of a “double transition” from high to low HFCs and then to natural refrigerants should be avoided. In particular, there is an opening because the very popular R-22 cannot be manufactured or imported any more, so many retail stores will need to upgrade. They should only upgrade once – to natural refrigerants. Otherwise you are inflicting on them the costs of a future second upgrade. This was affirmed by CARB in its *Short Lived Climate Pollutant Reduction Strategy* of March 2017.

²⁴ Ibid.

²⁵ “Each company is scored on their actions in three categories of technology adoption, refrigerant management, and policy & commitments and awarded an overall score based on a weighted average of points. The technology adoption category is most heavily weighted in terms of overall points, since these actions reflect the greatest emissions reduction potential both during and after the life of equipment. This is followed by refrigerant management which prevents emissions during use, and finally followed by the company’s engagement with HFC policy and commitments. Overall scores also reflect some extra credit for companies making extra commitments to future actions and goals, such as purchasing only HFC-free standalone refrigeration equipment, committing to replace at least 5% of existing stores each year with HFC-free technologies, or setting a public goal to reduce refrigerant leaks. The overall percentage of a company is then a percentage of a perfect score, based on feasible actions and commitments in those three areas.”

A window of opportunity exists in the next five years to accelerate the transition of refrigeration and air-conditioning equipment to lower-GWP refrigerants, before another generation of equipment is locked into using higher-GWP refrigerants over their average lifetimes of 15 to 20 years.

2. The staff report states that in order to switch to a natural refrigerant a complete remodel must be done, which necessitates closing the store during the remodel. Actually, however, there are work-arounds. For example, there are propane “plug in” cases that can be used during the refit. For most chains the same set of temporary cases can be re-used as each store is remodeled.²⁶ Or conversion can be phased in.²⁷ Ultimately the transition to natural refrigerants will need to be made, so the Preferred Alternative only puts off the inevitable with no long-term advantage to the industry.

G. The Preferred Alternative lacks an incentive system that would get us to near zero emissions.

1. California has incentive programs to speed up the move to natural refrigerants (e.g. FRIP), but they are far from sufficient if Alternative 1 is to be implemented. CARB should offer a greater role for itself in brokering stimulus programs like that provided by SMUD in Sacramento. And special attention needs to be paid to helping low profit stores in “food desert” disadvantaged areas make the transition successfully. But perhaps the most feasible stimulus would simply be tax breaks, which CARB could work with the Legislature to craft.
2. Flexibility is needed in the regulatory system, even if we convert entirely to natural refrigerants by 2030. Consider that if all refrigerant systems that are 10 years old or more in 2020 (assuming a lifetime of 20 years) would need to be replaced because it would not pay to invest in an upgraded HFC system in the time until replacement would be required. If we assume equipment install dates are randomly distributed, then for half of the current systems a new installation with natural refrigerants is going to be a better investment than an update in any case. The question then becomes how to incentivize new systems in the remaining half and how to distribute these across a ten year period. This is a much different picture than the staff report statement that requiring new systems would not be feasible. Other considerations are the increasing costs of HFCs as their phase-out increases and the range of leakage in different stores – high leakage stores should be prioritized for conversion. A very recent economic model used existing stores in England in order to optimize investment strategies in deciding between upgrading and remodeling.²⁸

²⁶ NASRC presentation: <https://register.gotowebinar.com/recording/8337269425998822918>

²⁷ NASRC presentation: <https://register.gotowebinar.com/recording/8886854815385413633>

²⁸ Hart M, Austin W, Acha S et al., A roadmap investment strategy to reduce carbon intensive refrigerants in the food retail industry, Journal of Cleaner Production, Volume 275, 2020, <https://doi.org/10.1016/j.jclepro.2020.123039>.

3. A way of combining incentives and taxes would be to regulate the refrigerant system in an approach similar to cap and trade (or a renewable energy portfolio standard). Emissions would be measured and an emissions cap for the system would decrease every two years. Stores would have to buy allowances for their current emissions, so stores using very high GWP refrigerants would be paying more (a tax of a sort). Those stores that converted to natural refrigerants could offer the allowances for sale that they were no longer using in that time period and stores that wanted to defer conversion could purchase those allowances in an auction. The pace of conversion could be controlled by where the emissions cap was set and the price for allowances, ensuring that the system would reach approximately zero emissions by 2030. Revenues from the auction could be granted or loaned to stores in disadvantaged areas to help them with the remodeling costs.
6. One way to help the transition in this time frame would be to require training of certified technicians on the installation and use of natural refrigerants. The training should be paid for or offset by CARB. Lack of training on natural refrigerants among certified technicians causes two concrete problems:

“[Lack of mandatory training] is potentially dangerous as natural refrigerants require specific training to address associated risks with toxicity, flammability, or higher operating pressures. This puts the untrained certified personnel at risk. Secondly, it also disproportionately impacts small- and medium-sized enterprises (SMEs) that do not have the capacity to set up their own training schemes and places the onus to secure training on the certified personnel themselves.”²⁹

The overall effect is that the lack of trained natural refrigerant technicians creates a barrier to adoption of natural refrigerants – one the industry is unlikely to remedy on its own.³⁰

H. The scope of CARB’s rule-making is insufficient for either the Preferred Alternative or Alternative I. HFC restrictions should be extended to convenience stores, and refrigerant limitations should be part of an overall strategy for energy savings.

1. The rule is limited to facilities with more than 50 pounds of charge, which omits a huge number of convenience stores, coffee shops and the like that use HFC (or HCFC) refrigerants.³¹ It is likely that leaks or failures to reclaim are

²⁹ F-Gas Regulation Revision: Industry Wants More Ambition, October 2020, Shecco. Brussels, Belgium. https://issuu.com/shecco/docs/fgas_report_2020_201116. This study, a survey of 80 European Heating, Ventilation, Air Conditioning and Refrigeration companies, is input to a European review of refrigerant regulations

³⁰ Ibid. “During our market study, 44% of respondents indicated that the lack of mandatory training on natural-refrigerant technologies in the certification programmes established by Member States created barriers to the uptake of their product. Seventy-five percent of respondents said that their business would positively benefit from mandatory training on natural-refrigerant technologies.”

³¹ There are roughly 40,000 supermarkets in the US, but 150,000 convenience stores.

even more prevalent and greater in this population of refrigerant users, in part because of the much laxer regulations. We know from efforts in Japan that it is possible to include these facilities in rules that apply to new/remodeled systems. If it is not possible to include these facilities in this rule-making, it should be a high priority to study the under-50 pounds charge facilities including measuring their leakage. Based on the results a rule-making specific to them should be instituted.

2. Since the GWP of refrigerants stems from both direct (leaks) and indirect (energy use) effects, CARB is missing an opportunity by not coordinating its standards with green building standards to reduce overall energy use in supermarkets and similar locations. “Cool” roofing is an obvious example.³² *The Cooling Imperative*³³ lists many instances in which type of refrigerant is only one among multiple ways in which GWP of buildings can be reduced. Since natural refrigerant equipment is somewhat more expensive upfront, it is important to integrate its installation with other energy-saving measures.
 - “Refrigerated display case manufacturers now must comply with the commercial refrigeration equipment standards published by the Department of Energy. The DOE energy standards have had a large impact in pushing end users to install doors on the medium temperature cases that historically have not included them...”³⁴ This reduces the amount of refrigerant needed as well as reducing energy demands.
 - ASHRAE is a non-profit organization focusing on design for sustainability. In 2015 they published *Advanced Energy Design Guide for Grocery Stores* which laid out ways in which supermarkets could save 50% of the energy they use.³⁵
 - “The India Cooling Action Plan (ICAP), finalized in 2019, is an early example. Bringing together multiple diverse stakeholders, ICAP is targeting reductions of 20–25% in overall cooling demand, 25–40% in cooling energy requirements, and 25–30% in refrigerant demand by 2037–38. It also aims to train and certify 100,000 technicians and boost cooling research.”³⁶

³² Although a local supermarket manager said it was not coordinated, putting doors on open refrigerators happened in 2019 at three Humboldt markets I shop at.

³³ The Cooling Imperative Forecasting the Size and Source of Future Cooling Demand. A report from the Economist Intelligence Unit. <https://www.eiu.com/graphics/marketing/pdf/TheCoolingImperative2019.pdf>

³⁴ Lilya D, Natural Refrigerant System Selection Comparisons in Commercial Systems, North American Sustainable Refrigeration Council, Retrieved on November 25, 2020 from https://static1.squarespace.com/static/55a672f1e4b06d4dd52f83de/t/5c8fd744fa0d6064d805b43d/1552930630774/T_P1_Natural+Refrigerant+System+Selection_Lilya.pdf

³⁵ Downloadable at: <https://www.ashrae.org/technical-resources/aedgs/50-percent-aedg-free-download>

³⁶ Op cit.

The Total Equivalent Warming Impact (TEWI) should be incorporated by CARB into its regulations so that the indirect effects of refrigeration (life cycle energy use) are regulated.

I. *There are broad economic consequences of choosing either the Preferred Alternative or Alternative 1; they weigh on the side of Alternative 1.*

1. Another factor, not considered by staff in assessing Alternative 1, is the competitive advantage provided to US manufacturers of natural refrigerant equipment. Initial difficulties are balanced by not only reduced emissions and greater efficiency of non-HFCs but also the head start California and the US will enjoy in a fast-growing sector that is going to have to change radically around the world.
2. As global temperatures rise, refrigerant use will too. It is very important to have exportable solutions. California banning HFCs and opting for natural refrigerants could have positive consequences far beyond the actual emissions reductions in California.
3. Natural refrigerants are going to have a very rapid growth around the world in the next ten years due to regulatory pressures. However, that growth can be slowed down substantially if HFCs are incentivized to compete with natural refrigerants as the Preferred Alternative would do.
4. One final, but quite significant, advantage to a swift conversion to natural refrigerants, is avoiding the smuggling and black market sales of HFCs or fake HFCs that bedeviled the US when ozone-depleting gases were banned here. Caught in the transition, Europe is currently fighting a flood of illegal and in some cases fake HFCs.

THE WRITING IS ON THE WALL. UNLIKE BELSHAZZAR, WE *DO* UNDERSTAND IT AND NEED TO RESPOND QUICKLY.