Carbon Containment Lab

Technical Note: What Are the Environmental Benefits of Refrigerant Reclamation?

June 2024

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Introduction

Refrigerant reclamation – the process of restoring used refrigerant to virgin purity standards – underpins the circular economy for cooling. Reclamation creates end markets for recovered refrigerant, stimulating refrigerant recovery from end-of-life equipment. In large enough volumes, selling reclaimed refrigerant also facilitates phasedown policies by stabilizing prices for scarce gases and ensuring that existing equipment can be cost-effectively repaired. These benefits are especially important as the world begins phasing down hydrofluorocarbons (HFCs) pursuant to the Kigali Amendment.[2] But today, reclamation is not happening at large scale because of low demand for reclaimed gases and high costs associated with recovering and reclaiming HFCs.

These potential benefits of reclamation have left policymakers and industry in a tricky scenario. Today, reclaimed refrigerant must compete on equal price grounds with virgin refrigerant, the latter which is often cheaper to produce. How, then, do you favorably change the incentives for refrigerant reclamation?

A prerequisite for incentivizing reclamation – either via regulation or carbon markets – is articulating its practical and environmental benefits. For regulations, incentives for reclamation must pass a cost-benefit analysis, which might consider compliance costs, avoided social cost of HFC emissions,[3] and avoided costs from premature equipment retirement. For carbon markets, crediting for reclamation requires measurable emissions reductions that would not have occurred in the absence of the carbon credit ("additionality"). Carbon markets rely on the ability to quantify emissions reductions more rigorously and explicitly than regulations, especially in cases where credits are used to offset emissions elsewhere. Without the ability to claim emissions reductions, carbon credits for reclamation cannot exist.

To date, both policy and carbon market incentives have helped support the growth of reclaimed refrigerant in the United States and abroad. California, for example, has led the U.S. in requiring a

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[2] Christina Theodoridi et al., "The 90 Billion Ton Opportunity," 2022, https://us.eia.org/wp-content/uploads/2022/10/Refrigerant-Lifecycle-FullReport-6Spreads-PRINT.pdf.
[3] Tammy Tan, Lisa Rennels, and Bryan Parthum, "The Social Costs of Hydrofluorocarbons and the Large Climate Benefits from Their Expedited Phasedown" (Environmental Protection Agency, May 2023), https://www.epa.gov/environmental-economics/social-costs-hydrofluorocarbons-and-large-climate-benefits-their-expedited.

percentage of refrigerant used for new and currently operating equipment to be reclaimed material.[4] In October 2023, the U.S. EPA proposed an even more ambitious regulation to mandate the use of reclaimed refrigerant in major cooling sectors, starting in 2028.[5] And in the carbon market, the American Carbon Registry (ACR) has issued over 9 million carbon credits for emissions prevented by refrigerant reclamation.[6]

However, not all stakeholders agree about how to quantify emissions reductions from reclamation. Some have argued that reclaimed gases yield significant climate benefits by *displacing production* (and therefore emissions) of virgin refrigerant.[7] Others, however, have critiqued reclamation for prolonging use and emissions of environmentally harmful refrigerants and have cast doubt on whether displacement occurs in practice. This dispute about the relative benefits of reclamation is holding back progress in determining the appropriate incentive structure for reclamation and deserves both theoretical and empirical examination.

In this technical note, we investigate this issue in depth and apply economic theory to analyze assumptions around displacement. First, we examine the displacement benefits of reclamation and in conjunction, accuracy of carbon crediting for HFC reclamation on the voluntary carbon market. Second, we explore the potential for reclamation to create the technical capabilities to accelerate HFC phasedown schedules. Finally, we discuss past and future models for creating incentives for reclamation via regulations and procurement policy.

Examining Markets, in Theory and in Practice

The argument that the sale of reclaimed HFCs displaces the production of virgin HFCs is intuitive. For a given end user, using reclaimed HFCs instead of virgin HFCs displaces that end user's own demand for virgin gases. However, as we discuss next, displacement can occur on the micro basis (*i.e.*, for an individual end user) but not necessarily on a macro basis for the entire market when HFC phasedown is underway.

Supply and demand curves are a useful way of showing how displacement is contingent on market conditions under phasedown. Phasedowns operate by granting quota to refrigerant suppliers and consumers over a fixed (typically annual) period. When allowable virgin refrigerant supply is low

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[4] California Air Resources Board, "R4 Program," California Significant New Alternatives Policy (SNAP), accessed April 17, 2022, https://ww2.arb.ca.gov/our-work/programs/california-significant-new-alternatives-policy-snap/r4-program.
[5] Environmental Protection Agency and Office of Air and Radiation, "Management of Certain Hydrofluorocarbons and Substitutes under Subsection (h) of the American Innovation and Manufacturing Act," Overviews and Factsheets, September 25, 2023, https://www.epa.gov/climate-hfcs-reduction/management-certain-hydrofluorocarbons-and-substitutes-under-subsection-h.
[6] American Carbon Registry, "Certified Reclaimed HFC Refrigerants, Propellants, and Fire Suppressants," *ACR* (blog), April 14, 2022, https://acrcarbon.org/methodology/certified-reclaimed-hfc-refrigerants-propellants-and-fire-suppressants/.
[7] To those familiar with the refrigerants space, this dispute is nothing new. Refrigerant reclaimers and NGOs such as the American Carbon Registry are the strongest proponents of displacement, while companies such as TrakRef have openly critiqued reclamation. Much of the recent discussion around reclamation and displacement has occurred off the written record at Montreal Protocol meetings and stakeholder conversations around state and federal HFC policies in the United States.

relative to HFC demand, virgin suppliers may consume all their quota. In this case, reclaimers may play a role in meeting excess HFC demand, resulting in expanded refrigerant supply but not displaced virgin production.

To illustrate this dynamic, we first consider a hypothetical country that has not yet entered HFC phasedown. As shown in Figure 1, fluorocarbon producers and importers will supply as much HFC as end users demand. Here, the market settles in the equilibrium (P*, Q*).

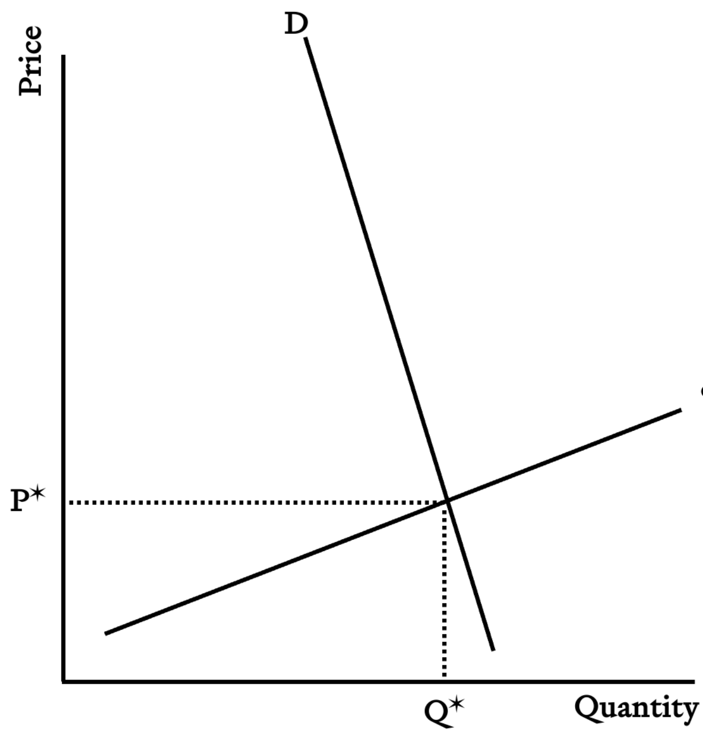

Figure 1 – Market Without Phasedown

When the country does begin phasedown, the government imposes a ceiling on the amount of virgin refrigerant that can be produced or imported. As shown next in Figure 2, we assume that there are only virgin suppliers and importers in the market. Since there is a cap on supply, the shape of the supply curve changes: suppliers can produce no more than their allocated quota, Q'. This restriction in supply causes a spike in fluorocarbon prices from P* to P'. As long as demand remains higher than allowable virgin refrigerant supply, producers and importers will fully expend their allocated allowances.[8]

[8] In the U.S., producers and consumers are allocated a pre-determined number of tradable allowances, each representing 1 $MTCO_2e$ of HFCs, each year. These allowances cannot be banked for future years. Phasedowns artificially restrict supply (domestic production or import) of virgin refrigerants, even if demand for HFCs remains high. These market dynamics explain why prices for HFCs typically rise – sometimes drastically – when phasedowns kick in.

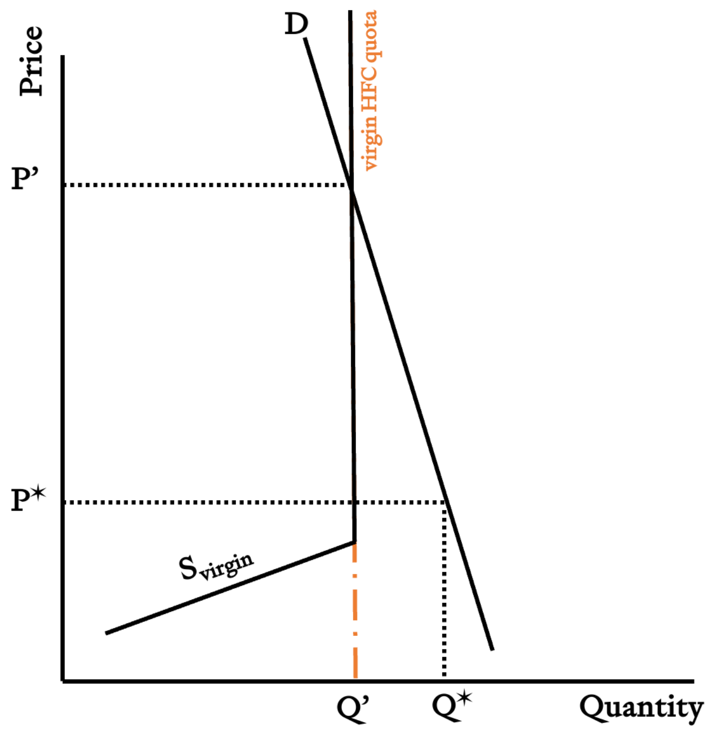

Figure 2 – Phasedown (No Reclaimers)

In practice, virgin refrigerant suppliers are not alone in the market. Refrigerant reclaimers can contribute additional supply of virgin-quality refrigerant. In Figure 3, we assume that reclaimers have two distinctive features: 1) marginal costs of producing reclaimed gas tend to be higher compared with producing or importing virgin gas; and 2) supply of reclaimed gas is *not* restricted under the phasedown.[9] As seen in Figure 3, the entry of reclaimers changes the market's supply curve. When demand is less than Q', virgin suppliers supply refrigerant to the entire market. But when demand exceeds Q', reclaimers enter the market to meet excess demand.

In this model, it is important to understand that reclaimers have played an important role in stabilizing prices for HFCs and in meeting surplus demand created by the phasedown. As we discuss later in this paper, this is the scenario that U.S. EPA assumes is occurring in their regulatory impact analysis for the HFC phasedown.[10] However, in this scenario, reclaimers do *not* displace any virgin refrigerant supply, since virgin refrigerant suppliers are already expending all their quota.

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[9] These assumptions are convenient for our economic theory but also generally true in practice. If it were cheaper on a marginal basis to reclaim HFCs, companies would recover and reclaim gases instead of producing virgin ones. Historically, virgin production and import has dominated in all countries across the globe, and reclaimed gases are only a small percentage of market share. Reclaimed gases are also not commonly regulated in national phasedown schedules such as in the U.S.

[10] Environmental Protection Agency, "Draft Regulatory Impact Analysis Addendum: Analysis of the Economic Impact and Benefits of the Proposed Rule: American Innovation and Manufacturing (AIM) Act Subsection H Management of Regulated Substances," Regulatory Impact Analysis, AIM Act (Environmental Protection Agency, September 2023), https://www.epa.gov/system/files/documents/2023-10/subsection-h-proposed-rule-ria-addendum.pdf.

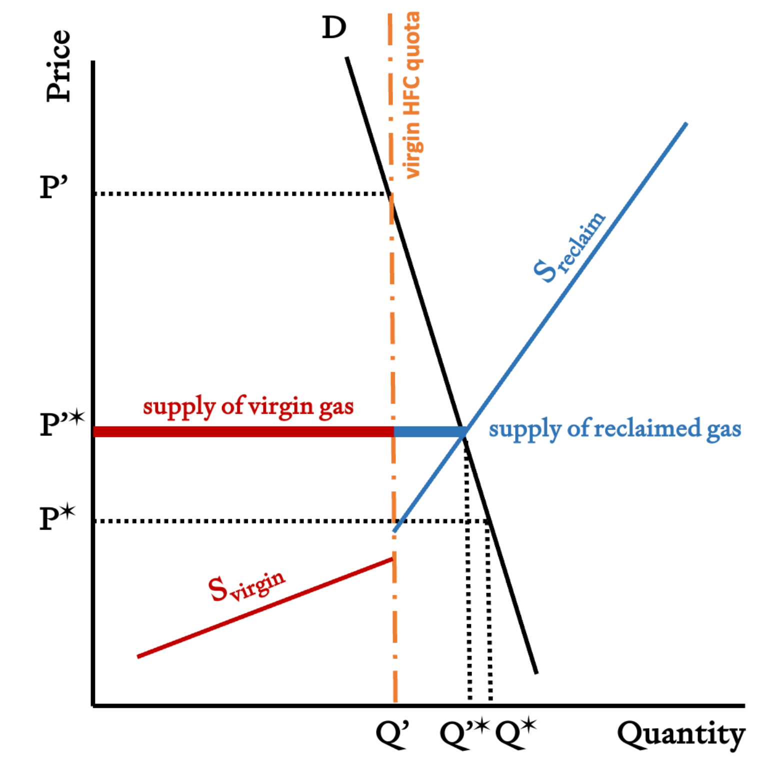

Figure 3 – Phasedown (With Reclaimers)

Our economic model necessarily leaves out important aspects of the market. First, we do not consider stockpiles of virgin HFCs, which, as of 2022, likely exceeded 380 million $MTCO_2e$ in the U.S.[11] Most of these stockpiled gases were imported to the U.S. prior to the commencement of the HFC phasedown in 2022, in anticipation of lower future supply. In theory, large stockpiles of virgin gas would reduce present and future demand for virgin gases, independent of reclamation volumes.

Second, we do not explicitly model the effect of technology transition to low-Global Warming Potential (GWP) refrigerants on HFC supply and demand. An aggressive transition to low-GWP refrigerants would reduce demand for HFCs (shifting the curve to the left) and potentially affect elasticity, depending on the cost of transitioning to low-GWP refrigerants. Since technology transition affects supply and demand, determining the effects of reclamation alone on displaced production becomes even more complicated.

Third, market conditions could change, with unit economics for HFC reclamation becoming more favorable, or demand for HFCs falling below the cap on virgin supply. In this case, reclamation could theoretically displace virgin production, but not necessarily on a measurable or attributable basis. Furthermore, reclamation could displace production of virgin HFCs, but with some indeterminate

[11] Environmental Protection Agency and Office of Air and Radiation, "HFC Data Hub," Other Policies and Guidance, September 28, 2023, https://www.epa.gov/climate-hfcs-reduction/hfc-data-hub.

time lag.[12] In our analysis, we assume that displacement occurs shortly after the sale of reclaimed gas, similar to arguments presented by the American Carbon Registry.

Crediting Reclamation in the Carbon Market

For carbon credits to be issued for HFC reclamation, emissions reductions must be robustly quantified. Each carbon credit represents 1 metric ton of CO_2 equivalent avoided, reduced, or removed. The voluntary carbon market consists of large corporate credit buyers who purchase and retire carbon credits toward their climate targets. Since the retirement of credits are often associated with a compensatory claim (*i.e.*, net zero or climate neutral), the integrity of carbon credits matters. If credits are not associated with real emissions reductions, they can justify *more* emissions, rather than fewer.

Currently, the only methodology crediting HFC reclamation on the voluntary market is from the American Carbon Registry (ACR).[13,14] This methodology is active in the U.S., Canada, and Mexico. As of early 2024, ACR has issued approximately 9 million credits from this methodology, about 6 percent of which have been retired.[15]

To quantify emissions reductions associated with reclamation, ACR assumes that selling reclaimed gas displaces virgin refrigerant on a nearly one-to-one basis. Historically, ACR has credited 98 percent of the HFCs reclaimed and sold using the methodology, but since mid-March 2024 has credited 97 percent of sales to account for a slight uptick in national baseline reclamation rates. The small discount on crediting accounts for the 2 to 3 percent historical baseline reclamation rate in the U.S.[16] It is important to understand that ACR credits project developers for displacing virgin production of HFCs, rather than crediting the initial recovery of refrigerant. In a justification for the methodology,[17] ACR writes:

> *Typically, virgin (newly produced, never previously used) HFC is used to "charge" refrigeration and A/C systems and various types of equipment when they are manufactured and installed, and when the systems leak during normal operations. Re-using previously used HFC that has been recovered from equipment, and reclaimed to virgin-grade purity, either to "recharge" existing systems that require servicing, or in newly manufactured equipment, <u>displaces new production of virgin HFC that would otherwise be manufactured to meet that demand</u>.*

[12] Theodoridi et al., "The 90 Billion Ton Opportunity."
[13] American Carbon Registry, "Certified Reclaimed HFC Refrigerants, Propellants, and Fire Suppressants."
[14] As noted by our peer reviewers, three refrigerant reclaimers – A-Gas, Hudson Technologies, and Diversified Pure Chem – financially supported the development of this methodology.
[15] Berkeley Carbon Trading Project, "Voluntary Registry Offsets Database," Voluntary Registry Offsets Database, December 2023, https://gspp.berkeley.edu/research-and-impact/centers/cepp/projects/berkeley-carbon-trading-project/offsets-database.
[16] Office of Air and Radiation Environmental Protection Agency, "Summary of Refrigerant Reclamation Trends," Data and Tools, November 28, 2023, https://www.epa.gov/section608/summary-refrigerant-reclamation-trends.
[17] American Carbon Registry, "Certified Reclaimed HFC Refrigerants, Propellants, and Fire Suppressants."

One way to quantify whether HFC reclamation is displacing virgin production is to look at U.S. HFC allocation expenditure data.[18] These data, published by the U.S. Environmental Protection Agency (EPA), show how many allowances are allocated to producers and consumers of HFCs, and how many of those allowances get used ("expended") each year. Each allowance is representative of 1 metric ton CO_2e and expires at the end of the year. Allowances can be traded among regulated companies. If reclamation is indeed displacing virgin production in the same year, the number of HFC reclamation carbon credits issued in that year should be *at most* the number of unused consumption allowances in that year.

Early data from the EPA show that HFC reclamation is not displacing as much virgin production as the methodology claims. In 2022, the earliest and only year for which allowance expenditure data are available, regulated entities expended 271.7 million of 273.5 million allocated allowances, leaving 1.8 million allowances unused (0.65 percent of the total allocation). This high level of expenditure suggests that demand for HFCs in 2022 was still very high relative to allowable supply. Meanwhile, EPA reported 7.5 million pounds (7.2 million $MTCO_2e$) of reclaimed HFCs in 2022.[19] ACR issued 3.9 million carbon credits during vintage year 2022,[20] roughly twice the number of consumption allowances that went unexpended. If one agrees that the number of credits issued should be at most the number of unused consumption allowances in the same year, these data suggest that ACR issued twice as many credits as they should have in 2022.

We believe that these data are generally consistent with the economic theory we present in this paper, which argues that displacement of virgin production does not occur when demand for HFCs exceeds (or is high relative to) allowable supply.

What Market Conditions Have Led to Past Phasedown Accelerations?

In recent years, some stakeholders have become interested in reclamation for its strategic role in accelerating phasedown schedules. The idea is compelling: if the market has enough reclamation capacity, policymakers can tighten phasedown schedules to allocate fewer allowances without fear of creating rippling adverse effects for refrigerant end users. An acceleration of many Kigali Amendment phasedown schedules at once could have climate benefits in the scale of gigatons of CO_2e by 2050.[21] These potential benefits from reclamation have largely motivated policy and lobbying efforts around reclaimed gases, including from large environmental NGOs.

This strategy isn't new. Subsection (f) of the American Innovation and Manufacturing (AIM) Act explicitly allows EPA to accelerate the phasedown schedule after 2025 at a level commensurate to

[18] Environmental Protection Agency and Office of Air and Radiation, "HFC Data Hub."
[19] Office of Air and Radiation, Environmental Protection Agency, "Summary of Refrigerant Reclamation Trends," Data and Tools, November 28, 2023, https://www.epa.gov/section608/summary-refrigerant-reclamation-trends.
[20] American Carbon Registry, "ACR Issuance Registry," Issued Credits, May 6, 2024, https://acr2.apx.com/myModule/rpt/myrpt.asp?r=112.
[21] Pallav Purohit et al., "Achieving Paris Climate Goals Calls for Increasing Ambition of the Kigali Amendment," *Research Square*, September 29, 2021, https://doi.org/10.21203/rs.3.rs-948327/v1.

the proportion of allowances that went unused the previous year.[22] Previously, the Montreal Protocol also accelerated the phaseout of CFCs in 1992 and accelerated the HCFC phasedown into a phaseout in 2007. The HCFC phaseout had a staggering climate impact: 16 billion $MTCO_2e$ in avoided emissions by 2040.[23] Reclamation, in large enough volumes, could certainly play a role in making acceleration technically and legally possible.

Viable low-GWP alternatives to HFCs, such as hydrocarbons and hydrofluoroolefins, will also be crucial in accelerating the phasedown schedule. In the case of the HCFC phaseout, for example, the ability to transition from HCFCs to HFCs was the major technical enabler of acceleration.[24] At the time of acceleration, reclamation volumes for HCFCs were still low, yet there was a glut of HCFC allowances in the market.[25] These conditions suggested that technology transition – rather than reclaimed refrigerant – was the primary driver of excess allowances. Other factors, such as the adoption of robust national regulations and support from the Multilateral Fund, was also instrumental in acceleration.

Today, reclamation might play a more important strategic role in accelerating the HFC phasedown than it did for the HCFC phaseout. Currently, low-GWP alternatives to HFCs face certain barriers to adoption that may require time to be resolved. Although adoption of climate-friendly hydrocarbon equipment is growing rapidly in Europe, other countries such as the United States have been slower to adoption. Hydrocarbons are flammable and currently prohibited in many state building codes. Hydrofluoroolefins, a synthetic gas, are commonly considered PFAS and often have higher GWPs than hydrocarbons.[26] If the menu of low-GWP technology is limited, reclaimed gases could become a more significant enabler for acceleration.

Alternative Strategies for Promoting Reclamation

Regulations and procurement policies can send both indirect and direct market signals to scale refrigerant reclamation. First, phasedown policies create scarcity for common HFCs needed to service equipment today and well into the future. Scarcity typically causes virgin HFCs to rise in price, creating markets for reclaimed products. Second, regulations can explicitly create demand for reclaimed gases by mandating the use of reclaimed gases in new and/or operating equipment.

To date, California has been the leader in mandating the use of reclaimed HFCs, via the Refrigerant Recovery, Reclaim, and Reuse (R4) Program. The R4 Program requires manufacturers of air

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[22] "42 USC 7675: American Innovation and Manufacturing Act," 42 U.S.C. § 7675(f) (2020), https://uscode.house.gov/view.xhtml?req=granuleid:USC-prelim-title42-section7675(a)&num=0&edition=prelim.
[23] Yale Carbon Containment Lab, "Maximizing the Climate Benefits of the HFC Transition" (Yale Carbon Containment Lab, March 14, 2023), https://carboncontainmentlab.org/documents/yale-workshop-report---maximizing-the-climate-benefits-of-the-hfc-transition_may-1.pdf.
[24] Guus J. M. Velders et al., "The Importance of the Montreal Protocol in Protecting Climate," *Proceedings of the National Academy of Sciences* 104, no. 12 (March 20, 2007): 4814–19, https://doi.org/10.1073/pnas.0610328104.
[25] Benjamin Longstreth, "NRDC Letter on HCFC Allocation," October 30, 2013, https://obamawhitehouse.archives.gov/sites/default/files/omb/assets/oira_2060/2060_10302013-1.pdf.
[26] ATMO Network and Thomas Trevisan, "Overview of PFAS Refrigerants Used in HVAC&R and Relevance of Refrigerants in the PFAS Restriction Intention" (45th Open-Ended Working Group for the Montreal Protocol, Bangkok, Thailand, July 3, 2023), https://ozone.unep.org/system/files/documents/OEWG45_ATMO_sidevent.pdf.

conditioning and variable refrigerant flow equipment to use reclaimed HFC-410A in new equipment or in servicing of existing equipment. Notably, in the R4 Program's regulatory impact analysis, California regulators did not cite emissions reductions from displaced production as their primary justification for the program.[27] Instead, they state:

> *Use of reclaimed refrigerants has direct (GHG) reduction benefits because it necessitates refrigerant recovery from equipment in use or at end of life, thereby preventing refrigerants from getting emitted or leaked.*
>
> *The emissions reductions expected from the R4 program are modest. However, the program establishes and jump-starts a reclaim program in California, which CARB can build upon in the future. In the long term, a robust recovery and reclamation program is expected to be an important tool in California's strategy towards achieving a low emissions, low-carbon future.*

Policies that mandate the use of reclaimed gases help create a deserved green premium for reclaimed gases, supporting prices for reclaimed HFCs that are even higher than the price of virgin HFCs. In California's regulatory impact analysis, for example, regulators estimate that the cost of reclaimed HFC-410A would increase from $3 to $9 per pound under the program – a significant increase in prices. Here, it is important to note that price increases associated with a regulation-induced green premium may exceed the value of a carbon credit. Carbon credits from HFC reclamation typically trade for only $2 to $3 per ton CO_2e.[28]

In October 2023, the U.S. EPA proposed a regulation that would mandate the use of reclaimed gases in major cooling sectors, starting in 2028. According to our estimates, the proposed rule would be a boon to the reclamation industry. If implemented as written, the regulation would require HFC reclamation volumes to grow by approximately 12 times by 2028.[29]

Notably, the EPA also does not assume that reclaimed gases displace virgin production in their base regulatory impact analysis for the proposed rule. Instead, EPA presents displacement as a component of a high net benefits scenario. In fact, EPA also acknowledges the opposite possibility – that reclaiming gas enables the expansion (or continued use) of HFCs in regulated sectors, due to nature of allowances being tradeable and representative of 1 $MTCO_2$e, rather than to a particular species of refrigerant. In their analysis,[30] EPA writes:

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[27] California Air Resources Board, "Attachment B: Updated Costs and Benefits Analysis - Proposed Amendments to the Prohibitions on Use of Certain Hydrofluorocarbons in Stationary Refrigeration, Chillers, Aerosols-Propellants, and Foam End-Uses Regulation" (California Air Resources Board, n.d.), https://ww2.arb.ca.gov/sites/default/files/barcu/board/15day/hfc/2nd15dayattb.pdf.

[28] Conveniently, 1 pound of typical high-Global Warming Potential HFCs such as HFC-410A is roughly equivalent to 1 $MTCO_2$e (GWP-100). Spot price from early 2024.

[29] Tilden Chao, Charlie Mayhew, and Anastasia O'Rourke, "Public Comments on EPA's Proposed Refrigerant Management Rules" (Yale Carbon Containment Lab, December 18, 2023), https://carboncontainmentlab.org/publications/subsection-h.

[30] Environmental Protection Agency, "Draft Regulatory Impact Analysis Addendum: Analysis of the Economic Impact and Benefits of the Proposed Rule: American Innovation and Manufacturing (AIM) Act Subsection H Management of Regulated Substances."

> *To the extent that this additional use of recycled/reclaimed HFCs displaces consumption of virgin HFCs either a) the reduced consumption of virgin HFCs in one sector would free up allocation allowances that would then be used elsewhere for consumption of HFCs, or b) the reduction in the consumption of virgin HFCs would result in incremental climate benefits under this proposed rule.*

We appreciate EPA's approach in presenting both scenarios, with their base cost-benefit analysis excluding emissions reductions from displaced virgin production. One clear benefit of taking a regulatory, rather than carbon markets approach, is that EPA can present emissions reductions from displacement as a possibility rather than a guarantee, without creating problems for the program's viability.

The other potentially impactful strategy to incentivize reclamation is through procurement policy. Large refrigerant end users, such as original equipment manufacturers (OEMs) and the U.S. federal government, can create significant demand signals by committing to use reclaimed gases in their new and/or operating equipment. This topic is the subject of ongoing work by the Carbon Containment Lab in collaboration with groups such as the Sustainable Purchasing Leadership Council's Climate Collaborative.

Conclusion

To date, lifecycle refrigerant management stakeholders have occasionally disagreed about the specific environmental benefits of reclaiming refrigerants such as HFCs. One claimed benefit from reclamation is the displacement virgin refrigerant production, resulting in less refrigerant emitted to the atmosphere overall. However, as we discuss in this technical note, we are not convinced that displacement always occurs in practice, nor at the level previously assumed. Our analysis has particularly strong implications for current crediting for HFC reclamation on the voluntary carbon market, which assumes that displacement of virgin gases is occurring on a near one-to-one basis.

There are strong merits to increasing volumes of reclaimed gases, but stakeholders must use rigorous approaches to assess the true environmental benefits of reclamation. Mandating reclamation – which need not precisely quantify emissions reductions from displacement – appears to be a cleaner and more effective way of increasing reclamation volumes compared with the voluntary carbon market. We reiterate that reclamation will become an increasingly important tool in enabling the acceleration of HFC phasedown schedules and the national and global level.

In our next technical note, we will discuss how the destruction of ozone-depleting substances (ODS) and hydrofluorocarbons (HFCs) can, under certain conditions, be environmentally preferable to reclamation. We advocate for a paradigm shift toward a greater balance between reclamation and destruction, while maintaining caution about the perverse incentives that each strategy can create. We also argue that carbon credits for destruction – if accompanied with appropriate methodological safeguards – can be a promising way of incentivizing refrigerant recovery, particularly in developing countries with high HFC consumption.

Carbon Containment Lab

About the Carbon Containment Lab

The Carbon Containment Lab (CC Lab) is a 501(c)(3) nonprofit that supports the development, testing, and implementation of novel and neglected climate solutions. The CC Lab's work on lifecycle refrigerant management focuses on ways to scale financing for projects that recover and mitigate HFCs. The CC Lab was founded at the Yale School of the Environment in 2020 and spun out into an independent nonprofit in 2024. The CC Lab does not have a financial stake in the carbon market and is not a carbon market registry.

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