A COOL CLIMATE STRATEGY: PAIRING HFC REDUCTION AND ENERGY EFFICIENCY

by Rachael Bruketta

Rachael Bruketta is a 2022 J.D. and Master of Energy Regulation and Law candidate at Vermont Law School.

Along with adopting the Paris Agreement to address global climate change and limit greenhouse gases (GHGs), several nations have taken climate action to phase down worldwide hydrofluorocarbon (HFC) production and consumption.[1] HFCs are commonly used for cooling and refrigeration and are very potent GHGs that get trapped in the stratosphere, rapidly heating the planet 150 to 5,000 times faster than carbon dioxide (CO_2).[2] By July 2021, 122 nations had ratified the Kigali Amendment to the Montreal Protocol, a legally binding agreement to reduce signatory nations' HFC production and consumption and reduce climate change.[3] Though the World Bank determined that the United States and China are the two greatest HFC emitters in the world, both countries have yet to ratify the Kigali Amendment.[4]

However, the Joseph Biden Administration has signaled its interest in ratifying the Kigali Amendment and aligning with other nations phasing down HFCs.[5] In January 2021, Executive Order No. 14008 instructed the Secretary of State to submit, within 60 days, a transmittal package seeking the U.S. Senate's advice and consent to ratify the Kigali Amendment to phase down U.S. production and consumption of HFCs.[6] By ratifying the Amendment, the United States could demonstrate climate leadership and participate in international HFC emissions trading to achieve further environmental and economic benefits.[7]

Further, under the American Innovation and Manufacturing (AIM) Act section of the 2021 Consolidated Appropriations Act, the United States is promulgating HFC-reducing regulations.[8] When passing the bipartisan AIM Act, the U.S. Congress authorized the U.S. Environmental Protection Agency (EPA) to establish an allowance-and-trading program to reduce U.S. HFC production and consumption by 85% by the end of 2035.[9] Allowance and trading, or cap and trade, is an effective market-based approach that could help the United States phase down HFCs.[10] Accordingly, the United States could target industries that largely use refrigeration and cooling systems, and pair HFC reduction and energy-efficiency improvements in new, climate-friendly technologies for compounded environmental benefits. These environmental benefits could also economically benefit producers and consumers.[11]

When establishing regulations under the Kigali Amendment and the AIM Act, and to achieve environmentally and economically effective HFC phasedown strategies, the United States must consider what climate strategies have worked well in the past. This Comment looks at the history of U.S. climate action, including regulating GHGs and HFCs, and presents market-based opportunities to phase down HFCs by providing examples of allowance-and-trading program successes. Further, it examines how HFC-free and energy-efficient technologies will be economically advantageous for consumers, will be supported by HFC-using industries, and will create employment opportunities. Finally, it explores how HFC reduction policies can provide compounded environmental benefits when pairing HFC reduction and energy-efficiency improvements in new, climate-friendly technologies.

1. *See* National Institute for Public Health and the Environment, *Contribution of HFCs to the Greenhouse Effect* (Neth.), https://www.rivm.nl/en/hydrofluorocarbons/contribution-of-hfcs-to-greenhouse-effect (last modified Nov. 2, 2018); U.S. Department of State, *The Montreal Protocol on Substances That Deplete the Ozone Layer*, https://www.state.gov/key-topics-office-of-environmental-quality-and-transboundary-issues/the-montreal-protocol-on-substances-that-deplete-the-ozone-layer/ (last visited July 11, 2021).
2. National Institute for Public Health and the Environment, *supra* note 1; Climate & Clean Air Coalition, *Hydrofluorocarbons (HFCs)*, https://www.ccacoalition.org/fr/slcps/hydrofluorocarbons-hfc (last visited July 11, 2021).
3. United Nations Treaty Collection, ch. XXVII, 2.f, Amendment to the Montreal Protocol on Substances That Deplete the Ozone Layer (2016), https://treaties.un.org/doc/Publication/MTDSG/Volume%20II/Chapter%20XXVII/XXVII-2-f.en.pdf XVII-2-f.en.pdf.
4. *See* World Bank, *HFC Gas Emissions (Thousand Metric Tons of CO_2 Equivalent)*, https://data.worldbank.org/indicator/EN.ATM.HFCG.KT.CE last visited July 11, 2021); *U.S. Joins China in Kigali Pledge*, Cooling Post, Apr. 18, 2021, https://www.coolingpost.com/world-news/us-joins-china-in-kigali-pledge/.
5. Congressional Research Service, Hydrofluorocarbon Phasedown: Issues for Congress (2021), https://crsreports.congress.gov/product/pdf/IF/IF11779.
6. Tackling the Climate Crisis at Home and Abroad, 86 Fed. Reg. 7619, 7619-33 (Feb. 1, 2021).
7. U.S. Environmental Protection Agency (EPA), Benefits of Addressing HFCs Under the Montreal Protocol (2016) (EPA 430-R-16-006), https://www.epa.gov/sites/production/files/2016-07/documents/benefits_of_addressing_hfcs_under_the_montreal_protocol_2016.pdf.
8. *See The AIM Act: Your Questions on U.S. HFC Legislation—Answered*, Env't Investigation Agency, Jan. 7, 2021, https://eia-global.org/blog-posts/20210107-aim-act-questions-answered.
9. *Id.*
10. *Id.*
11. *See* Kristin Igusky, *Reducing HFCs in the U.S. Would Benefit Consumers and the Climate*, World Resources Inst., Mar. 3, 2015, https://www.wri.org/insights/reducing-hfcs-us-would-benefit-consumers-and-climate.

I. HFC Regulatory History

The 1987 Montreal Protocol aimed to phase out ozone-depleting substances (ODS), and every country in the world ratified it.[12] However, ODS phaseout required ODS substitutes, resulting in human-made HFCs to replace ODS in several applications, such as refrigeration, cooling products, foams, and aerosols.[13] In 1990, under §612 of the Clean Air Act (CAA),[14] EPA approved certain HFCs as ODS substitutes and established the Significant New Alternatives Program (SNAP).[15]

In 2015, due to climate impacts from HFCs, EPA made changes to its HFC regulatory requirements.[16] EPA issued SNAP Rule 20, prohibiting high-global warming potential (GWP) HFCs used as alternatives to hydrochlorofluorocarbons (HCFCs) and chlorofluorocarbons (CFCs) phased out under the Montreal Protocol and banned by the CAA.[17] Under SNAP Rule 20, HFCs that were previously listed as acceptable ODS substitutes were restricted for specific uses in aerosols, foams, refrigeration, and air-conditioning.[18]

Additionally, in 2016, EPA issued SNAP Rule 21 to include low-GWP substances as ODS substitutes.[19] SNAP Rule 21 restricted the use of certain high-GWP HFC refrigerants, such as R-134a and R-443a in refrigeration and cooling systems.[20] SNAP Rules 20 and 21 listed restricted refrigerants and indicated which substitutes have lower GWP and are less harmful to human health and the environment.[21] In response to the new rules, HFC chemical manufacturers challenged EPA's authority to regulate HFCs under the CAA, claiming HFCs are not ozone-depleting and EPA cannot require manufacturers to replace HFCs in use.[22]

In 2017, Mexichem Fluor, Inc. (rebranded as Koura), a fluoroproduct and refrigerant manufacturer, sued EPA.[23] In *Mexichem Fluor, Inc. v. Environmental Protection Agency*, the U.S. Court of Appeals for the District of Columbia (D.C.) Circuit addressed SNAP Rule 20 and EPA's authority to regulate HFCs and require manufacturers to replace HFCs in use.[24] Then-Circuit Judge Brett Kavanaugh reviewed §612 of the CAA and concluded that EPA lacked authority to retroactively regulate HFCs.[25] The court said EPA may regulate ODS and forbid ODS users from switching to HFCs, but the Agency cannot require HFC replacements for products in use.[26] The court vacated a portion of the rule, reasoning that manufacturers are prohibited from using ODS, not HFCs, in future uses and the Agency did not articulate a retroactive HFC disapproval rationale in the SNAP rules.[27]

Then in 2019, Mexichem Fluor challenged SNAP Rule 21, and the D.C. Circuit vacated the rule that required manufacturer replacement of HFCs that were previously and lawfully used as ODS substitutes.[28] Though the D.C. Circuit vacated the rule, forbidding ODS users from switching to HFCs in new products, EPA gratuitously suspended its HFC regulations without going through notice-and-comment procedures and failed to issue new HFC regulations.[29] Consequently, HFCs were no longer listed as unsafe ODS substitutes and ODS users could shift to unregulated HFC use.[30]

II. Atmospheric Impacts of HFCs

A. *The Flawed* Mexichem *Court Reasoning*

SNAP Rules 20 and 21 regulated HFCs because many HFCs are more potent than CO_2 and rapidly heat the planet.[31] SNAP Rules 20 and 21 were based on EPA's projection that if left unregulated, HFC emissions would increase more quickly than any other GHG emission, doubling in 2020 and tripling by 2030.[32] The decision suspending SNAP Rules 20 and 21 was flawed for many reasons. First, the *Mexichem* court restricted only retroactive HFC prohibition and did not prohibit lower-GWP HFC alternatives in new products. Second, the *Mexichem* court's reasoning that HFCs are not ODS is erroneous and is based on outdated science. Lastly, because the court used outdated science in its reasoning, it failed to holistically address EPA's authority under the CAA to regulate HFCs and their ozone-depleting potential (ODP).

B. *HFC Ozone-Depleting Potential*

Research in the 1990s erroneously promoted the idea that HFCs destroy a negligible amount of ozone. The research

12. Climate & Clean Air Coalition, *supra* note 2.
13. National Institute for Public Health and the Environment, *supra* note 1.
14. 42 U.S.C. §§7401-7671q, ELR Stat. CAA §§101-618.
15. *See generally* U.S. EPA, *Significant New Alternatives Policy (SNAP)—Reducing Hydrofluorocarbon (HFC) Use and Emissions in the Federal Sector Through SNAP*, https://www.epa.gov/snap/reducing-hydrofluorocarbon-hfc-use-and-emissions-federal-sector-through-snap (last updated May 19, 2021).
16. *See* Congressional Research Service, Hydrofluorocarbons (HFCs): EPA and State Actions (2020), https://fas.org/sgp/crs/misc/IF11541.pdf.
17. U.S. EPA, *supra* note 15.
18. *Id.*
19. *Id.*
20. *Id.*
21. *Id.*
22. Mexichem Fluor, Inc. v. Environmental Prot. Agency, 866 F.3d 451, 460, 47 ELR 20097 (D.C. Cir. 2017) (petitioning the court to review EPA's decision to remove HFCs from listed substitutes for ODS restricted by the CAA).
23. Koura, *Products*, http://www.kouraglobal.com/products/index.html (last visited July 11, 2021).
24. *Mexichem*, 866 F.3d at 460.
25. *Id.* at 461.
26. *Id.* at 460.
27. *Id.* at 461.
28. *Id.*
29. *See* 5 U.S.C. §553(b) (requiring agencies to publish notice of proposed rulemaking in the *Federal Register*); Congressional Research Service, *supra* note 16.
30. Natural Res. Def. Council v. Wheeler, 955 F.3d 68, 74 (D.C. Cir. 2020) (petitioning the court to review EPA's rule that suspended HFCs as unsafe substitutes for ODS restricted by the CAA).
31. *See generally* Protection of Stratospheric Ozone: Change of Listing Status for Certain Substitutes Under the Significant New Alternatives Policy Program, 80 Fed. Reg. 42870 (July 20, 2015) (codified at 40 C.F.R. pt. 82), *available at* https://www.govinfo.gov/content/pkg/FR-2015-07-20/pdf/2015-17066.pdf.
32. I*d.*

examined HFCs' ability to break down ozone molecules through chemical reactions only after molecules break down in the atmosphere.[33] However, in 2015 the National Aeronautics and Space Administration (NASA) used an atmospheric chemistry model to project HFC atmospheric impacts and discovered that HFCs contribute to ozone depletion.[34] NASA's study of HFC impacts on the atmosphere showed that HFC emissions increase stratospheric warming, speed up chemical reactions that destroy ozone molecules, and decrease ozone levels by accelerating the upward movement of ozone-poor air.[35]

Additionally, the American Geophysical Union confirmed that before the 2015 NASA study of HFC atmospheric impacts, no previous HFC assessment considered indirect radiative and dynamical impacts of HFCs on stratospheric ozone.[36] The Union predicted that HFCs will increasingly impact the global atmosphere because they increase tropospheric and stratospheric temperatures.[37] Accordingly, increased temperatures will enhance ozone-destroying cycles and modify atmospheric circulation, leading to stratospheric ozone depletion and global temperature increases.[38]

CFCs were regulated by the Montreal Protocol because the chemicals contributed to the growing hole in the ozone layer (see Figure 1 on the next page).[39] However, scientists' understanding of HFCs impacts on the ozone were less comprehensive.

C. How the CAA Regulates Air Pollutants

In 1990, the CAA was amended and expanded to protect the nonhuman environment.[40] The CAA bans substances, such as HCFCs and CFCs, and EPA's Administrator may add other substances that cause harmful effects on the stratospheric ozone layer if the substance has an ODP of 0.2 or greater.[41] Many harmful HFCs have an ODP under 0.2, but the ODP calculation for HFCs is more complex than many of the ODS they replace.[42] Though the raw ODP calculations of many HFCs appear small, radiative forcing increases HFC potency and planetary warming.[43] Because the CAA does not account for these complexities, some HFCs used as HCFC replacements have equal or larger ODP than HCFCs controlled under the Montreal Protocol and restricted by the CAA.[44]

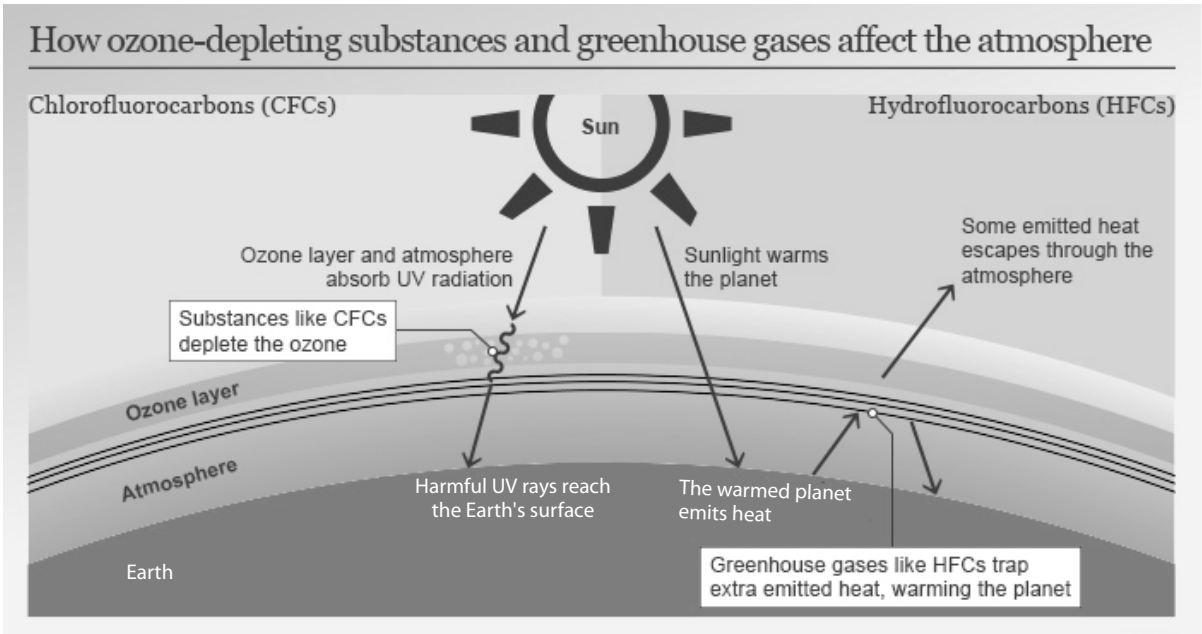
Though the CAA does not expressly grant EPA authority to regulate climate change, in *Massachusetts v. Environmental Protection Agency*, the U.S. Supreme Court held that Congress gave EPA authority to regulate GHGs that cause or contribute to air pollution and endanger public health or welfare.[45] Additionally, the CAA requires EPA's Administrator to study the effects of the pollutants, set national ambient air quality standards (NAAQS) for pollutants considered harmful to public health and the environment, and make appropriate revisions to NAAQS every five years.[46] The two categories of NAAQS are primary and secondary.[47] Primary standards provide public human health protection.[48] Secondary standards provide public welfare protection, including protection against damage to animals, crops, and vegetation.[49] Congress said stricter NAAQS will be set as needed to protect public health or to prevent adverse environmental effects, such as negative impacts on wildlife, aquatic life, or other natural resources.[50]

Under the NAAQS secondary standards, EPA regulates nitrogen oxides (NO_x) and sulfur oxides (SO_x) that react with other chemicals in the air and form pollutants, such as particulate matter, smog, acid rain, and sulfate aerosols.[51] These secondary pollutants create harmful human and environmental impacts when combined with other air pollutants.[52] Similarly, HFCs speed up chemical reactions, destroy ozone molecules, and accelerate climate change.[53] The accelerated climate change threatens society with costly health and environmental impacts and increasingly severe weather events, such as floods, droughts, and wildfires.[54]

Because the CAA grants EPA authority to regulate hazardous air pollutants and protect public health and welfare, EPA is arguably bound to ensure the United States complies with the CAA and the AIM Act to comprehensively regulate HFCs.[55] As the United States establishes HFC regulations, pairing the HFC phasedown strategies with energy-efficiency improvements will reduce overall GHGs, reduce air

33. Press Release, National Aeronautics and Space Administration, NASA Study Shows That Common Coolants Contribute to Ozone Depletion (Oct. 22, 2015), https://www.nasa.gov/press-release/goddard/nasa-study-shows-that-common-coolants-contribute-to-ozone-depletion.
34. *Id.*
35. *Id.*
36. Margaret M. Hurwitz et al., *Ozone Depletion by Hydrofluorocarbons*, 42 Geophysical Rsch. Letters 8686 (2015), *available at* https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/2015GL065856.
37. *Id.*
38. *Id.*
39. Melanie Hall, *Banning the "Super" Greenhouse Gas*, DEUTSCHE WELLE, Oct. 17, 2016, https://www.dw.com/en/banning-the-super-greenhouse-gas/a-36044849.
40. *See* David B. Firestone et al., Environmental Law for Non-Lawyers 107 (5th ed. 2014).
41. 42 U.S.C.S. §7671a (1990).
42. Durwood Zaelke et al., Primer on HFCs 6 (Institute for Governance & Sustainable Development, Working Paper No. 11, 2018), http://www.igsd.org/wp-content/uploads/2018/01/HFC-Primer-v11Jan18.pdf.
43. Hurwitz et al., *supra* note 36.
44. Zaelke et al., *supra* note 42, at 14.
45. Massachusetts v. Environmental Prot. Agency, 127 U.S. 1438, 1440, 37 ELR 20075 (2007) (petitioning by states, local governments, and environmental organizations to review an EPA order to regulate GHGs from motor vehicles under the CAA).
46. Firestone et al., *supra* note 40, at 109.
47. U.S. EPA, *NAAQS Table*, https://www.epa.gov/criteria-air-pollutants/naaqs-table (last updated Feb. 10, 2021).
48. *Id.*
49. *Id.*
50. Firestone et al., *supra* note 40, at 107.
51. Minnesota Pollution Control Agency, *Nitrogen Dioxide (NO_2)*, https://www.pca.state.mn.us/air/nitrogen-dioxide-no2 (last visited July 11, 2021); Minnesota Pollution Control Agency, *Sulfur Dioxide (SO_2)*, https://www.pca.state.mn.us/air/sulfur-dioxide-so2 (last visited July 11, 2021).
52. Minnesota Pollution Control Agency, *supra* note 51.
53. Press Release, National Aeronautics and Space Administration, *supra* note 33.
54. News Release, U.S. EPA, EPA Moves Forward With Phase Down of Climate-Damaging Hydrofluorocarbons (May 3, 2021), https://www.epa.gov/news-releases/epa-moves-forward-phase-down-climate-damaging-hydrofluorocarbons.
55. *See* U.S. EPA, *Summary of the Clean Air Act*, https://www.epa.gov/laws-regulations/summary-clean-air-act (last updated Aug. 6, 2020).

Figure 1. ODS and GHG Effects on the Atmosphere



Source: Melanie Hall, *Banning the "Super" Greenhouse Gas,* DEUTSCHE WELLE, Oct. 17, 2016, https://www.dw.com/en/banning-the-super-greenhouse-gas/a-36044849.

pollution, and provide greater public health and environmental benefits.

III. Market-Based Opportunities to Reduce HFCs and Improve Efficiency

A. The AIM Act and HFC Cap and Trade

Regulatory rules take many forms, including command and control, cap and trade, tax credits for research and development, and direct consumer subsidies.[56] Each approach is not created equal, and cap and trade will phase down HFCs most effectively.[57] The AIM Act included in the annual congressional spending bill directs EPA to establish an HFC allowance allocation-and-trading program.[58]

The HFC allowance allocation and the trading program aim to reduce HFC production and consumption by 85%, from the 2011-2013 HFC production and consumption baseline, by the end of 2035.[59] Reducing HFC production and consumption by 85% has tremendous environmental impacts due to widespread HFC use and many HFCs' high potencies. However, lowering HFC production and consumption is difficult because of the increasing demand for cooling as the planet heats from climate change.

One of the ironic things about HFCs' impact on climate change is the Catch-22 that as climate change causes the planet to heat, demand for refrigeration and cooling increases, further increasing HFC emissions.[60] As a result, HFCs used in refrigeration, residential air-conditioning equipment, commercial buildings, and industrial operations made up approximately 75% of total HFCs used in 2018, while vehicle air-conditioning contributed to about 8% of total HFC used in 2018.[61]

To reduce HFCs and their environmental impact, the AIM Act lists 18 commonly used HFCs, many with high GWP.[62] GWP is an important factor for regulating HFCs because it is a relative indication of the amount of atmospheric heat trapped by HFC gas compounds, compared to the amount of heat trapped by a similar CO_2 mass.[63] For example, the refrigerant R-404a, with a GWP of 3,900, is 3,900 times more potent than CO_2.[64] Therefore, EPA will oversee phasing down these potent HFCs by assessing their GWP and setting HFC production and consumption allowances for each calendar year until the end of 2035.[65]

EPA's first step to setting an HFC production and consumption allowance was the May 2021 proposed rulemaking establishing calendar year 2022 HFC allowances by

56. *See* U.S. EPA, *Economic Incentives*, https://www.epa.gov/environmental-economics/economic-incentives (last updated Feb. 17, 2021).
57. *See* Center for Climate and Energy Solutions, *Cap and Trade Basics*, https://www.c2es.org/content/cap-and-trade-basics/ (last visited July 11, 2021).
58. *The AIM Act: Your Questions on U.S. HFC Legislation—Answered*, *supra* note 8.
59. *Id.*
60. *Id.*
61. Phasedown of Hydrofluorocarbons: Establishing the Allowance Allocation and Trading Program Under the American Innovation and Manufacturing Act, 86 Fed. Reg. 27150, 27155 (May 19, 2021) [hereinafter Phasedown of Hydrofluorocarbons] (to be codified at 40 C.F.R. pts. 9 and 84).
62. *Id.*
63. *Id.*
64. California Air Resources Board, *High-GWP Refrigerants*, https://ww2.arb.ca.gov/resources/documents/high-gwp-refrigerants (last visited July 11, 2021).
65. Phasedown of Hydrofluorocarbons, *supra* note 61, at 27210.

October 2021.[66] By October 2022, EPA will establish HFC allowances for calendar year 2023.[67]

As EPA establishes HFC phasedown strategies, the Agency should look to historic examples of cap and trade effectively curbing SO_x pollution leading to acid rain.[68] Congress established an SO_x allowance trading program with ambitious emissions reduction targets, and each SO_x-producing coal plant received allowances they could flexibly buy or sell to other plants.[69] The program incentivized SO_x emission-reduction strategies and incentivized innovation, resulting in less expensive SO_x emission reductions than anticipated.[70] HFC cap and trade could also help polluters more easily and inexpensively meet HFC reduction standards than otherwise required by an inflexible pollution reduction strategy, such as command-and-control regulation.[71]

Not only does the AIM Act authorize EPA to establish HFC allowances, but the Act also directs EPA to issue international HFC production allowance regulations by December 2021.[72] Through international HFC allowance, the United States could participate in HFC cap and trade to further reduce HFC emissions and increase energy-efficient technologies.

Though international HFC cap and trade is a new opportunity for the United States, interstate and regional cap-and-trade strategies have successfully reduced polluting air emissions in multiple circumstances. For example, cap and trade reduced power-sector GHG emissions in the New England and Mid-Atlantic U.S. Regional Greenhouse Gas Initiative (RGGI).[73] RGGI states implemented a 2014 cap of 91 million tons of CO_2 emissions, declining 2.5% each year from 2015 to 2020.[74] RGGI states sold nearly all emission allowances through auctions and invested proceeds in energy efficiency, renewable energy, and other consumer benefit programs.[75] The initiative sparked the clean energy economy, led to innovative technologies to reduce GHG emissions, and created green jobs in RGGI states.[76] Similarly, international HFC cap and trade could spark the economy, lead to more efficient HFC-alternative technologies, and reduce overall GHG and HFC emissions that contribute to catastrophic climate impacts.

Moreover, if the United States ratifies the Kigali Amendment, Congress may appropriate funds for international HFC reduction efforts, including U.S. investments in low-income countries to establish HFC trading programs and improve HFC-using technologies.[77] HFC cap and trade could provide incentives for industry and businesses to competitively innovate efficient technologies to not only reduce HFC emissions, but also to keep production costs down.[78]

B. Pairing HFC Phasedown With Energy Efficiency

In addition to authorizing EPA to establish HFC production and consumption allowances, the AIM Act also authorizes technology grants, including $5 million per fiscal year 2021 through 2023, to small businesses to purchase equipment to recycle, recover, or reclaim HFC substitutes.[79] These technology grants could not only provide opportunities to phase down HFCs in cooling technology, but also require technologically improved energy-efficiency improvements for compounded environmental improvements.[80]

Investing in energy efficiency and HFC reduction in cooling technology offers opportunities to redesign refrigerators, air-conditioners, freezers, and other HFC-using products.[81] Already, in all major sectors, the best available HFC alternatives demonstrate at least equal, and often greater, energy efficiency than the products they replace.[82] Many companies report significant energy-efficiency improvements when transitioning away from HFCs.[83] For example, the Coca-Cola Company and PepsiCo have reported up to 47% increased energy efficiency in new CO_2 and hydrocarbon-based refrigeration equipment compared to the high-GWP HFC refrigeration technologies they previously used.[84] Therefore, investing more in technical improvements in HFC-using sectors could lead to additional environmental benefits, technological learning, and increased consumer savings.

Further, if HFC phasedown strategies and energy-efficiency improvements are dually implemented, the resulting electricity savings could exceed one-fifth of projected future global electricity consumption, preventing between 390 and 640 gigatons of CO_2 equivalent of GHG emissions between 2018 and 2100, further mitigating adverse climate impacts.[85] Congressmembers also anticipate that phasing down HFCs and improving the efficiency of cooling technologies will save American consumers $3.7 billion over 15 years, increase U.S. manufacturing output by almost $39 billion over seven years, and create more than 150,000 American jobs.[86]

66. *Id.* at 27157.
67. *Id.*
68. Richard Conniff, *The Political History of Cap and Trade*, Smithsonian Mag., Aug. 2009, https://www.smithsonianmag.com/science-nature/the-political-history-of-cap-and-trade-34711212/.
69. *Id.*
70. Cole Martin, *Lessons From the Clean Air Act*, Resources Mag., June 15, 2020, https://www.resourcesmag.org/archives/lessons-clean-air-act/.
71. Kahn Academy, *Command-and-Control Regulation*, https://www.khanacademy.org/economics-finance-domain/microeconomics/market-failure-and-the-role-of-government/environmental-regulation/a/command-and-control-regulation-cnx (last visited July 11, 2021).
72. Phasedown of Hydrofluorocarbons, *supra* note 61, at 27154.
73. RGGI, *Home Page*, https://www.rggi.org/ (last visited July 11, 2021).
74. *Id.*
75. *Id.*
76. *Id.*
77. Congressional Research Service, *supra* note 16.
78. Environmental Defense Fund, *How Cap and Trade Works*, https://www.edf.org/climate/how-cap-and-trade-works (last visited July 11, 2021).
79. Phasedown of Hydrofluorocarbons, *supra* note 61, at 27153.
80. *See* Pallav Purohit et al., *Electricity Savings and Greenhouse Gas Emission Reductions From Global Phase-Down of Hydrofluorocarbons*, Atmospheric Chemistry & Physics 1 (2020), https://doi.org/10.5194/acp-2020-193.
81. *Id.* at 2.
82. Zaelke et al., *supra* note 42, at 14.
83. *Id.* at 11.
84. *Id.*
85. *Id.* at 1.
86. *See* Press Release, U.S. Senate Committee on Environment and Public Works, Carper Secures Biggest Climate Win in Congress in Over a De-

C. Funding Research and Development for HFC Alternatives and Energy Efficiency

U.S. investments in research and development of low-GWP HFCs and HFC-free products could provide technological learning, decreased HFC emissions, and increased energy efficiency. State and federal tax credits could also incentivize HFC reduction, and resulting tax savings could fund research and development for technologies that are HFC-free and energy efficient.[87] For example, since 2010, Congress has used the Plug-In Electric Drive Vehicle (EV) Credit for electric cars and light trucks.[88] The program stimulated EV demand, increased profits, improved EV technology, and got automakers closer to meeting global GHG emission requirements.[89]

Additionally, amending existing energy-efficiency programs to include HFC reduction strategies could increase programmatic benefits. For example, the California Public Utilities Commission (CPUC) ensures that low-GWP refrigerants in applicable technologies comply with energy-efficiency requirements for funding and incentives from the CPUC.[90] Additionally, California introduced Senate Bill 1013, the California Cooling Act, which directs the California Air Resources Board to establish the Fluorinated Gases Emission Reduction Incentive Program to increase low-GWP refrigerant technologies.[91] Pairing HFC alternatives with energy-efficient technologies dually incents product developers to introduce newer, more climate-friendly technologies and receive funding from the energy-efficiency program.[92]

D. Direct Subsidies for Consumers to Reduce HFC Emissions

Despite technological improvements, if new HFC-free products remain expensive, consumers may be slow to adopt the new technologies.[93] As a result, consumers will continue using older product models, many of which contain high-GWP HFCs and other GHGs, worsening climate threats. Direct subsidies or consumer rebates from governments, manufacturers, and public utilities could encourage consumers to adopt HFC-free energy-efficient products. Like the energy-efficient products on EPA's Energy Star website, EPA could endorse climate-friendly refrigeration products and list them on the Agency's website so consumers may search for and purchase HFC-free and energy-efficient products.[94] Product purchasers could then submit proof of purchase and receive a manufacturer rebate or partial product reimbursement for adopting the new, climate-friendly technology.

The federal government sponsored similar rebate programs, which effectively achieved energy efficiency and economic development. With funding from the American Recovery and Reinvestment Act of 2009, the U.S. Department of Energy developed the State Energy Efficient Appliance Rebate Program (SEEARP) to spur economic activity and invest in long-term energy savings by helping consumers replace older, inefficient appliances with newer, more energy-efficient models.[95] SEEARP provided nearly $300 million to support state-level consumer rebate programs for efficient appliances from December 1, 2009, to February 17, 2012.[96] Across all U.S. states and territories, SEEARP issued 1,783,425 consumer rebates totaling approximately $264 million.[97]

The rebates for major appliances, heating, ventilation, air-conditioning, and hot water heaters resulted in an estimated lifetime energy savings of 27 trillion British thermal units of heat, $550 million in consumer energy cost savings, 43 billion gallons of water, and $326 million in consumer water cost savings.[98] The program also ensured replaced appliances were properly recycled and kept out of landfills.[99] Similarly, HFC-free rebate programs could stipulate proper high-GWP HFC products disposal, to prevent harmful refrigerant leaks from improper disposal while helping consumers transition to HFC-free and energy-efficiency products.

E. States' and Tribal Nations' Climate Commitments and Economic Expansion

Manufacturers' support for HFC reduction and industry growth are not mutually exclusive, as evidenced by the U.S. Climate Alliance. While awaiting a federal commitment to regulate HFCs, many U.S. states took an HFC reduc-

cade (Dec. 22, 2020), https://www.epw.senate.gov/public/index.cfm/press-releases-democratic?ID=BB29511F-EE64-49F9-8CCC-DB4304610CAD.

87. *See generally* Deloitte, *Pollution Control Tax: State and Local Credits and Incentives*, https://www2.deloitte.com/us/en/pages/tax/articles/pollution-control-tax-state-and-local-credits-and-incentives.html (last visited July 11, 2021).
88. *See* Kristy Hartman & Laura Shields, *State Policies Promoting Hybrid and Electric Vehicles*, Nat'l Conf. St. Legislatures, Mar. 12, 2021, https://www.ncsl.org/research/energy/state-electric-vehicle-incentives-state-chart.aspx.
89. *Id.*
90. California Air Resources Board, *California Significant New Alternatives Policy (SNAP)—About*, https://ww2.arb.ca.gov/our-work/programs/california-significant-new-alternatives-policy-snap/about (last visited July 11, 2021).
91. *Id.*
92. *Id.*
93. *See* International Monetary Fund, The Economics of Climate 11 (2019), https://www.imf.org/external/pubs/ft/fandd/2019/12/pdf/fd1219.pdf.
94. *See* Energy Star, *Energy Efficient Products*, https://www.energystar.gov/products (last visited July 11, 2021).
95. *See* U.S. Department of Energy Office of Energy Efficiency and Renewable Energy, *State Energy-Efficient Appliance Rebate Program*, https://www.energy.gov/eere/buildings/state-energy-efficient-appliance-rebate-program (last visited July 11, 2021).
96. D+R International, *State Energy Efficient Appliance Rebate Program (SEEARP)*, https://drintl.com/case_study/state-energy-efficient-appliance-rebate-program-seearp (last visited July 11, 2021).
97. *Id.*
98. *See* Office of Energy Efficiency and Renewable Energy, U.S. Department of Energy, State Energy-Efficient Appliance Rebate Program: Volume 2—Program Results 2 (2015), https://www.energy.gov/sites/prod/files/2015/06/f23/SEEARP_volume_2_report_UPDATED%206-18-15.pdf.
99. *Id.*

tion initiative.[100] In 2017, the U.S. Climate Alliance formed to reduce states' HFC and GHG emissions while growing states' economies.[101] The Alliance is a bipartisan coalition of governors committed to transitioning to a clean economy, slowing climate change, working alongside American industry, and creating innovative opportunities that support communities' climate resilience.[102] The Alliance acknowledges that short-lived climate pollutants (SLCPs), such as HFCs, are potent and that reducing SLCP emissions will achieve significant climate benefits within a few decades.[103] Accordingly, the Alliance aims to reduce SLCP emissions by 40%-50% below current levels by 2030 while making U.S. businesses and states more competitive globally.[104]

By early 2021, Alliance members included 24 U.S. states and Puerto Rico.[105] The Alliance represents 55% of the U.S. population and 60% of U.S. gross domestic product (GDP).[106] The Alliance has already reduced HFC emissions more rapidly than the rest of the country, while growing Alliance states' per capita GDP three times faster.[107] Hence, emission reduction and industry growth harmoniously increase economic and environmental benefits.

Additionally, each Alliance state's governor adopts goals and sets state climate actions, often with industry support.[108] By 2020, 15 states' Alliance goals implemented or proposed HFC regulation, including California, Colorado, Connecticut, Delaware, Hawaii, Maine, Maryland, Massachusetts, New Jersey, New York, Oregon, Pennsylvania, Rhode Island, Vermont, and Washington.[109] Many Alliance states' HFC phasedown strategies adopted EPA's SNAP Rules 20 and 21.[110]

Alliance states anticipate HFC reduction will lead to greater climate action, and several tribal nations throughout the United States are also adopting climate action plans.[111] With more than 570 native tribes in the United States, representatives from approximately 300 tribes have worked with the Institute for Tribal Environmental Professionals, implementing more than 50 tribal climate action plans.[112] Many tribes' climate action plans include energy independence, such as the Navajo Nation's reduced fossil fuel dependency and its $10 million solar power investment.[113] Through HFC reduction and increased energy efficiency, many states and tribal nations are proving they can grow their economies while reducing their environmental impacts. Federal strategies that dually prioritize HFC reduction and improved energy efficiency could also achieve greater economic and environmental benefits.

IV. Conclusion

Many HFCs commonly used for cooling and refrigeration stay in the stratosphere, deplete ozone, heat the planet, and worsen climate change threats, public health threats, and existential dangers to humans and many living species. As the United States establishes federal HFC phasedown strategies, pairing HFC phasedown and energy-efficiency improvements provides more economical and comprehensive climate benefits. Additionally, ratifying the Kigali Amendment to the Montreal Protocol could help the United States align with global HFC reduction goals, significantly reduce the nation's climate impact, and demonstrate climate leadership. These needed actions could significantly lessen the U.S. contribution to climate change and ease the bleak projections of climate impacts on human health and the environment.

100. *See* Congressional Research Service, *supra* note 16.
101. *See* U.S. Climate Alliance, *Alliance Principals*, http://www.usclimatealliance.org/alliance-principles (last visited July 11, 2021).
102. *See* U.S. Climate Alliance, 2019 Annual Report: Strength in Numbers (2019), https://static1.squarespace.com/static/5a4cfbfe18b27d4da21c9361/t/5df15fb788c20e5b82583498/1576099786843/USCA_2019+Annual+Report_Final.pdf.
103. *Id.*
104. *Id.*
105. *See* U.S. Climate Alliance, *About Us*, http://www.usclimatealliance.org/about-us (last visited July 11, 2021).
106. *Id.*
107. *Id.*
108. *Id.*
109. *See* David Doniger & Christina Theodoridi, *More States Announce HFC Action, Raising Tally to Fifteen*, Nat. Res. Def. Council, Feb. 18, 2020, https://www.nrdc.org/experts/david-doniger/more-states-announce-hfc-action-raising-tally-fifteen.
110. *Id.*
111. Nicola Jones, *How Native Tribes Are Taking the Lead on Planning for Climate Change*, Yale Env't 360, Feb. 11, 2020, https://e360.yale.edu/features/how-native-tribes-are-taking-the-lead-on-planning-for-climate-change.
112. *Id.*
113. *Id.*