THE ALLIANCE
for Responsible Atmospheric Policy

CONSUMER COST OF KIGALI AMENDMENT RATIFICATION

Overview

The Kigali Amendment to the Montreal Protocol is supported by both users and producers of hydrofluorocarbons (HFCs), because the amendment provides a clear and predictable transition to new technologies. The timeline outlined established by the Kigali Amendment allows for a realistic, practical, and cost effective transition to new technologies that will benefit American industries, their employees, and consumers. The U.S. government's ratification of the Kigali Amendment would also ensure the United States remains competitive globally. If our government fails to ratify the amendment, the rest of the world will move forward with the transition, leaving the U.S. heating, ventilation, and air conditioning and refrigeration (HVACR) behind.

Market transitions are best managed when a predictable is in place. Predictability provides business certainty for industries to research, plan, test, design and introduce new products. For American consumers, a predictable transition timeline fosters market stability, which reduces or eliminates incremental costs to the consumer. Previous refrigerant transitions such as the transitions from CFCs to HCFCs and then from HCFCs to HFCs have proven this to be true in the HVACR industry.

Ratification of the Kigali Amendment will provide certainty to American businesses and is the lowest cost path to the adoption of new refrigeration technologies. In addition to a predictable transition timeline, consumer costs are mitigated by the following factors:

- **Refrigerants are and will remain a small portion of the cost of new air conditioning or refrigeration systems.**
- **Energy conservation standards will improve the energy efficiency of new systems reducing consumer operating cost over the life of the equipment.**

WHAT FOLLOWS IS A MORE DETAILED REVIEW OF THE IMPACT OF PREVIOUS TRANSITIONS IN THIS INDUSTRY, WHICH DEMONSTRATE THE CONSUMER BENEFITS FAR OUTWEIGHED THE INITIAL COSTS.

Minimizing the Consumer Cost Impact of New Refrigerant Transitions

Managing the costs to consumers is a primary challenge during market transitions and the transition from HFCs to new solutions is no exception. Today, refrigerants account for less than one percent of the cost of refrigerators, home air conditioners and residential air conditioning systems. The cost of replacement refrigerants is a small portion of the cost of new equipment today and will remain so in the future. In past refrigerant transitions, HVACR equipment manufacturers innovated to commercialize equipment through the use of smaller refrigerant charges, reduced leak rates, improved product reliability, increased energy efficiency and incorporated other design improvements that benefited the consumer. These changes has the added benefit of resulting in better reliability, comfort and safety. In many cases, these improvements **actually drove down both the initial purchase price as well as the operating cost, significantly improving the total cost of ownership.**

In the United States, regulations related to the phasedown or phase-out of refrigerants have always allowed existing equipment to be used throughout its lifetime. Decades-old equipment is in use today. Ratification of the Kigali Amendment would not require consumers to replace their existing HVAC equipment. In the United States, regulations have always allowed the continued use of existing equipment, avoiding both waste and consumers incurring untimely replacement costs.

Are consumers forced to buy a new air condition system?

No. In all previous refrigerant transitions, consumers chose when to replace old equipment and were not forced to buy new equipment due to a refrigerant transition For example:

- As an example, recycled CFCs remain readily available today, 22 years after the production of “virgin” CFCs ceased.
- CFCs (R-11,R-12) are still readily available today at a reasonable cost to the consumer.
- Replacement or alternate refrigerants are also available in the market, providing consumers with additional refrigerant choices.

Home Air Conditioning Systems[1]

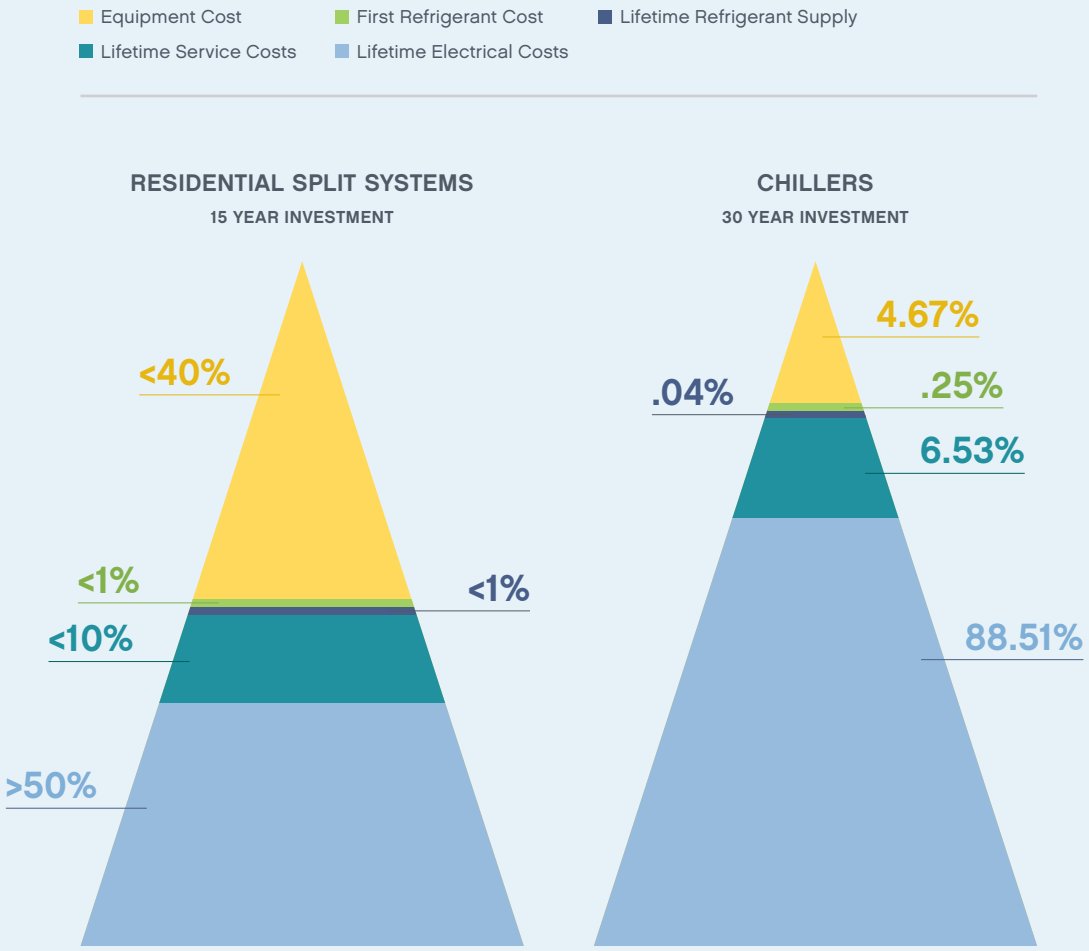
Next generation refrigerants are not currently used in home air conditioning systems. According to All Systems Mechanical, the cost to replace a current home air conditioning system costs between $6,000 and $12,000 depending on system features and potential ductwork modifications.

The Replacement Cost of Home Air Conditioning

Existing refrigerants currently used in non-residential applications can be used in residential applications by making modifications to existing HVAC equipment and these refrigerants cost less than the incumbent refrigerant (R-410A). In addition, future charge sizes will be reduced by up to 20% due to differences in refrigerant properties. The reduction in charge sizes, leak rates and refrigerant costs will more than offset the incremental cost of newly designed systems.[2] Separately, energy conservation standards enacted in 2015 and again in 2023 have reduced or will further reduce energy consumption by approximately 10% to 20%, providing additional savings to consumers.

Packaged Terminal Air Conditioner (PTAC)[3] units, commonly found in apartments and hotels, and Residential Window Air Conditioners[4] also use the incumbent refrigerant R-410A. PTACs and window units with next generation refrigerants are available commercially today and their prices are within the same range of units containing R-410A. Again, smaller refrigerant charges are used and refrigerant cost savings offset equipment modification costs. These systems consume 5-10% less energy providing an additional cost benefit to users.

The Cost of Ownership



Commercial - Air Conditioning and Refrigeration

Commercial air conditioning provides comfort in office buildings, factories, schools, hospitals, offices, hotels, multi-family buildings and in many other applications. Refrigeration preserves food in restaurants / grocery stores and preserves medical supplies and other products requiring preservation. These cooling and refrigeration applications indirectly impact consumer costs. As such, commercial equipment has also experienced price stability over decades, similar to that of home air conditioning, as equipment manufacturers innovated to reduce costs through new designs, lowered leak rates and improved efficiency and factory productivity.

As with residential systems, lower-cost commercial refrigerants are currently an option for use in next generation commercial air conditioning and refrigeration equipment. Again, refrigerant costs will decline as a result of lower charge sizes, which in many cases; more than offset the cost of equipment modifications. Like residential systems, energy conservation standards and innovation will reduce energy consumption by approximately 10%, providing an additional benefit to users.

Commercial Refrigeration Transition Case Studies

- **A grocery store chain installed several commercial refrigeration systems that cost approximately 10% more than older generation systems, but they are more efficient resulting in a payback period of two to five years[5] and a lower net cost to building owners and ultimately to consumers.**
- **Unilever installed freezers using low-cost hydrocarbons in self-contained systems known to reduce energy consumption by up to 9%[6] reducing operating costs noticeably.[7]**
- **Target's beverage coolers using low-cost carbon dioxide demonstrated a 25% reduction in energy consumption and their propane systems demonstrated a 53% reduction in energy consumption as reported in "Target's Transition to Sustainable Refrigerants" in 2017[8].**
- **Pepsico[9] and the Coca-Cola Company[10] are also using hydrocarbons and carbon dioxide in thousands of vending machines with building owners benefiting from reduced energy consumption.**

How can we apply lessons from the prior CFC transition to a future HFC transition?

Commercial Chiller Manufacturers view the CFC transition as a positive experience that led to better efficiency and reliability.

- Chiller manufacturers have already commercialized new chiller products with next generation refrigerants.
- The next generation HFOs will either be neutral on energy efficiency compared to HFCs (R-513A) or be 10-12% more efficient than the HFC refrigerants they replace (R-514A, R-1233zd).
- Next generation refrigerants are currently 2-7% more expensive than HFCs, but are expected to be at cost parity to HFC products by 2022 or earlier.
- Existing chiller products will have conversion options, but the availability of service stock of HFCs will render conversions unnecessary.
- Many customers will voluntarily choose to replace existing CFC, HCFC, and HFC chillers due to the improvement in energy efficiency, leading to both an economic benefit to the HVACR industry and an environmental benefit from reduction in energy consumption.

Automotive Air Conditioners

When R-134a was first introduced in the early 1990s, some predicted that its long-term pricing would be between $10 and $26/kg (bulk), which is the equivalent of $17 to $44/kg[11] today R-134a is currently priced at $6.6/kg[12] by distributors. Economies of scale and competition significantly reduced costs and prices throughout the R-134a value chain as they will for R-1234yf, which is currently the leading commercial alternative. In addition, other technologies are still being developed using low-cost refrigerants (e.g., carbon dioxide) which provide auto manufacturers with additional options.

At the average purchase price of a vehicle, the additional cost of new refrigerant to a consumer is approximately 0.1% of the total cost including any air conditioner equipment modifications required to adapt to the new refrigerant. The redesign of automobile air conditioners incorporates a smaller refrigerant charge and a reduced refrigerant leak rate that helps offset any increase in the cost of the refrigerant.

Air Conditioning Service Costs

Automotive Air Conditioning Service

In 1994, "The High Cost of Cool: The Economic Impact of the CFC Phase-out in the United States," predicted the cost to recharge an automobile's refrigerant would increase to as much as $200 by 1996. With inflation, $200 in 1996 would be $318[13] today. Automotive repair shops actually charge between $123 and $156 on average to recharge a car's air conditioning system[14]. The analysis also predicted consumers would be unable to service their own vehicles, and yet consumers can still purchase "do-it-yourself" refrigerant at a local auto parts store or online for less than $8/lb[15], and typically uses only a little over half that amount to service a vehicle's AC system. In both cases, the predicted cost to consumers did not occur.

Service Costs for Air Conditioning and Refrigeration Systems

The cost of the refrigerant is a small portion of the overall installed cost of a residential central air conditioning system. For example, if the refrigerant cost were to double, the refrigerant cost would still be less than one percent of the cost of the air conditioning system[16]. New refrigerants used in various air conditioning systems actually cost less than current solutions in many cases. In addition to lower cost refrigerants, charge sizes are lower and leak rates have been reduced which all reduce the cost and frequency of service. In cases where higher cost refrigerants are used, the energy savings of the refrigerant combined with the 2023 federally mandated increase in energy conservation standards will more than offset any incremental cost related to new refrigerants.

According to Home Advisor, the cost to recharge an air conditioning system ranges from $160 to $400[17] depending on the size of the system and geography[18]. This is similar to the comparative cost of servicing an automobile today versus the 1991 prediction[19].

Window Air Conditioning Units

According to Mark Perry[26] ("The Good Old Days are Now: Home Appliances are Cheaper and More Energy Efficient than Ever Before"), in 1973, an 8,000 BTU room air conditioner retail price was $216.75. **At the average hourly wage in 1973 of $4.15[27]**, the average American needed to work 52.2 hours to earn enough pre-tax income to purchase this air conditioner.In 2015, **a Kenmore 8,000 BTU room air conditioner[28] is sold for $219.99**. The retail price at Sears has barely changed in over 40 years and adjusted for inflation, is significantly less expensive. The dire warnings and predictions of drastic equipment and refrigerant cost increases resulting from prior refrigerant transitions simply did not happen. At the current average hourly wage, the average work hours necessary to purchase an 8,000 BTU room air conditioner is reduced by 80% to only 10.4 hours. The cost of comfort did not increase, but rather decreased significantly through past transitions.

Like refrigerators, home air conditioning systems did not become more expensive as was predicted. They are not only less expensive on an inflation adjusted basis, but they are also much more efficient, saving consumers significant operating cost over the life of the equipment. As a result of improved affordability, the market for home air conditioning has grown substantially through the last two refrigerant transitions. In 1994, approximately 68% of American homes had an air conditioner and that penetration has increased to almost 90% in less than 25 years as a result of improved affordability.

Home Refrigerators

In 2016, the Association of Home Appliance Manufacturers (AHAM) announced their members will voluntarily transition appliances to next generation refrigerants by 2024,[20] additionally noting the industry is well on its way to transitioning foam insulation by 2020. This transition has gone unnoticed by consumers, just as other refrigerant transitions have due to the cost effective innovative designs incorporated by appliance manufacturers. Last year, the industry accelerated its commitment to transition out of both HFC refrigerants and foams starting in 2021 for compact products, 2022 for full-size products and 2023 for built-in products provided the new refrigerants are approved for use by EPA[21].

Today, refrigerants used in home appliances cost approximately $1.00 to $1.50 (R-134a) per refrigerator.[22] The isobutane used in future models will cost approximately $0.05/ refrigerator[23] creating a savings of $0.95 to $1.45 per unit due to the lower price of the refrigerant and the smaller charge size which more than offsets the capital investment required to transition. There are a variety of next generation foam agents available for this end use, and manufacturers have the ability to choose the most cost-effective solution to meet performance and energy efficiency requirements.

Timely implementation of the Kigali Amendment coupled with approval of new products would allow the appliance industry to coordinate transitions with other required design changes to minimize financial impact. AHAM estimated that failing to coordinate refrigerant and foam conversions with new energy conservation standards will cost the industry tens of millions of dollars requiring an additional re-design of appliances and manufacturing tooling, further increasing cost and negatively impacting consumers.[24]

The Appliance Standards Awareness Project[25] combined pricing from the U.S. Census Bureau, historic energy consumption and the size of home refrigerators as reported by AHAM. Over the past 40 years, during multiple refrigerant transitions, the average size and volume of refrigerators increased, average energy consumption decreased, the price adjusted for inflation decreased over $500 per refrigerator, resulting in significant savings for American consumers.

Foam Insulation

For most foam types and end uses, equipment manufacturers and their customers can choose from several solutions that are already commercialized that offer comparable ,or in some cases, more efficient insulation. Foam insulation provides savings to consumers that far outweigh the costs of the materials, which comprise a fraction of the total cost of insulating buildings and refrigerators. When given the appropriate time to transition to alternatives per the Kigali Amendment schedule, foam designs can be optimized to provide the highest performing insulation to consumers at the lowest cost while ensuring consumer safety.[29]

THE REAL THREAT TO AMERICAN CONSUMERS

Failure of the federal government to ratify the Kigali Amendment will substantially reduce American competitiveness, by punishing innovation and squandering the economies of scale facilitated by a predictable and rational transition. The confusion and inefficiency created by inaction will reduce American manufacturing jobs; negatively impact the balance of trade and ultimately increases consumer cost. Canada, the European Union, China and the rest of the Asia / Pacific region are already making the transition to new technologies and will gain a crucial advantage in the global HVACR industry.

Due to U.S. federal inaction on the Kigali Amendment, individual states are already in the process of developing a patchwork of regulations, creating uncertainty and costly inefficiencies for businesses, adding unnecessary costs for consumers. **In spite of industry's repeated warnings, the federal government is causing the very situation the federal government purports a desire to avoid.** This patchwork creates new challenges that will ultimately contribute to decreased U.S. industry competitiveness. California has already announced plans to develop its own HFC regulations separate from federal regulations and other states plan to follow.[30] If the U.S. is not a leader in the transition, other countries will push for their solutions. They will dominate the playing field as the U.S. lags behind their transition. The European Union strongly supports their technologies and will drive adoption of their alternatives, which are not necessarily optimal for applications in the United States. Federal government inaction has a significant negative impact on HVACR manufacturers, distributors, contractors and consumers.

With a coordinated global HFC transition, industry is better positioned to reduce cost and compete globally. Ratification of the Kigali Amendment facilitates a realistic, practical, and cost effective transition, reducing the costs associated with research and development through to commercialization. It allows the HVACR industry to reduce costly redundant design cycles by coordinating refrigerant transitions with federally mandated energy conservation standards. It allows manufacturers and distributors to carry a single product portfolio, rather than manufacturing, inventorying and selling regional or state-specific products. It allows manufacturers to realize economies of scale by reducing manufacturing complexity and cost. It allows manufacturers, distributors and contractors to reduce the costs associated with commercializing, merchandising and selling their products to the end customer or consumer. Failure to ratify the Kigali Amendment will negatively impact American jobs and exports to developing markets where air conditioning and refrigeration has not reached the penetration levels achieved in the United States and other developed countries. American industry will sit on the sideline, while the global market for HVAC products doubles over the next decade. Inaction is both harmful and shortsighted.

Innovation and Competition Wins

The dire predictions made in 1991 never happened and similar predictions today will not become a reality, **unless the federal government fails to act.** The timeline prescribed by the Kigali Amendment provides industry with a rational, predictable and cost effective pathway to transition to new alternatives. The same market dynamics will impact this transition as was the case with previous successful refrigerant transitions, where production capacity increased, product sales increased, penetration increased, competition increased and consumer cost decreased.

The Kigali Amendment adopts a systematic approach the industry used in prior successful transitions. The approach provided by t**he Kigali Amendment minimizes manufacturing inefficiencies, reduces consumer cost and levels the playing field to ensure the American HVACR industry can compete and win.**

Sources

1. "HVAC Installation Cost 2018 - What's a Fair Price for a New Heating and Air Conditioning Installation?" All Systems Mechanical Tim K https://asm-air.com/hvac/hvac-installation-cost/ Unitary Ducted System in US

2. OEM provided costs for this analysis and requested that this information be kept confidential due to competitive concerns.

3. PTAC unit pricing ranges from $650 to $1000. R32 units

4. 15,000 BTU AC window unit with new refrigerant is $100 less costly than older refrigerant unit https://www.homedepot.com/p/Comfort-Aire-15-000-BTU-Window-Air-Conditioner-with-Remote-RADS151P/30010518 ; http://www.lg.com/us/air-conditioners/lg-LW1516ER

5. "Lower-GWP Alternatives in Commercial and Transport Refrigeration: an expanded compilation of propane, CO2, ammonia and HFO case studies" Climate & Clean Air Coalition: Case Study 6

6. https://www.epa.gov/sites/production/files/documents/en-gtz-proklima-natural-refrigerants.pdf p. 337

7. https://www.benjerry.com/values/how-we-do-business/cleaner-greener-freezers

8. "Target's Transition to Sustainable Refrigerants" at the Energy and Store Development Conference in 2017

9. http://hydrocarbons21.com/articles/2379/pepsico__uses__hydrocarbons__in__5000__vending__machines

10. https://www.forbes.com/2010/03/11/greenhouse-gases-refrigerants-technology-ecotech-coca-cola.html#380ca0dd1f18

11. "Intellectual Property Rights and Possible Actions to Phase Down HFCs" Steve Seidel

12. According to Alec Johnson "How much does R-134a cost per pound in 2018", the cost for a distributor is $6.6/lb. https://refrigeranthq.com/2018-r-134a-refrigerant-pricing-predictions/ Mr. Johnson notes that $5/lb would be discounted by 20-30% for pallet purchases.

13. http://www.usinflationcalculator.com/ Inflation rates used for estimate.

14. According to Repair Pal "AC Recharge Cost – Know What Price You Should Pay to Get Your Vehicle Fixed" https://repairpal.com/estimator/air-conditioning-recharge-cost Estimate excludes taxes and fees.

15. https://www.amazon.com/DuPont-R134a-Automobile-Refrigerant-Freon/dp/B00WXQBUQ2/ref=nsa__da__sm__n__au__dka__US__pr__da__0__1?adId=B00WXQBUQ2&creativeASIN=B00WXQBUQ2&linkId=bc05b2bfe06ad7a3543db59425c399d0&tag=haubson-20&linkCode=w47&ref-refURL=https%3A%2F%2Frefrigeranthq.com%2F2018-r-134a-refrigerant-pricing-predictions%2F&slotNum=1&imprToken=pGiKN9gUhpbpDJFe2ZlD8w&adType=smart&adMode=auto&adFormat=grid&impressionTimestamp=1522841595544

16. According to Alec Johnson "How much does R-410A cost per pound in 2018", the cost for a distributor to purchase the refrigerant to charge a home unitary system would be approximately $72. https://refrigeranthq.com/much-r-410A-refrigerant-cost-per-pound-2017/

17. https://www.homeadvisor.com/cost/heating-and-cooling/repair-an-ac-unit/ "How much does it cost to repair an AC unit?"

18. https://fresh-air.net/archives/4615 "How much does a Freon™ charge cost?" Based on this article, re-charging 50% of the charge in a 3Ton unit would cost no more than $275

19. "HFO-1234yf:An Examination of Long-Term Costs of Production"

20. "Home Appliance Industry Sets Goal to Eliminate Use of HFC Refrigerants" Feb 9, 2016. https://www.aham.org/AHAM/News/Latest__News/Home__Appliance__Industry__Sets__Goals__to__Eliminate__Use__of__HFC__Refrigerants.aspx

21. EPA SNAP Rule 22, which is still in process, would allow the industry to increase charge sizes to allow the use of isobutane in larger units. The industry cannot complete its transition until this is finalized. Appliance manufacturers need time to finalize planning and re-design equipment and facilities after the rule is promulgated.

22. According to the "ICF International Report on the Assessment of Refrigerator/Freezer Foam End-of-Life Management Options", each appliance contains approximately .3 lbs of HFC-134a as a refrigerant. The cost of refrigerant is approximately $3.33/refrigerator "How much does R-134a cost per pound in 2017?" Alec Johnson https://refrigeranthq.com/much-r-134a-cost-per-pound-2017/ The author has discounted the price by a factor of 2 assuming that larger purchases by appliances companies will be significantly discounted.

23. http://folk.ntnu.no/skoge/book-cep/diagrams/additional__diagrams/more__on__refrigerants/isobutane(R600A)-Danfos.pdf and The cost of isobutane is $0.29/lb; <https://marketrealist.com/2014/07/natural-gas-liquids-prices-decline-from-propane-and-butane-price> ; Physical Properties http://www.aeropres.com/physical-properties/

24. Coordination would have negligible, if any, environmental impact.

25. https://appliance-standards.org/sites/default/files/refrigerator__graph__Nov__2016.pdf

26. http://www.aei.org/publication/the-good-old-days-are-now-home-appliances-today-are-cheaper-and-more-energy-efficient-than-ever-before/ Mark Perry "The Good Old Days are Now: Home Appliances are Cheaper and More Energy Efficient than Ever Before"

27. average hourly wage in 1973 of $4.15 http://research.stlouisfed.org/fred2/data/AHETPI.txt

28. Kenmore 8,000 BTU room air conditioner http://www.sears.com/kenmore-8-000-btu-room-air-conditioner/p-04279081000P?prdNo=2

29. Foams are also used in diverse applications (e.g., to reduce the weight of automobiles and trucks to reduce fuel consumption).

30. New York and Connecticut, members of the 15 state US Climate Alliance, have announced plans to promulgate new HFC regulations in 2019.

THE ALLIANCE
for Responsible Atmospheric Policy

2111 Wilson Blvd., 8th Floor
Arlington, VA 22201
USA

P +1 703.243.0344

www.arap.org

The Alliance is an industry coalition that was organized in 1980 to address the issue of stratospheric ozone depletion. It is presently composed of about 100 manufacturers and businesses which rely on HCFCs and HFCs.

Today, the Alliance is a leading industry voice that coordinates industry participation in the development of international and U.S. government policies regarding ozone protection.