

Further Changes to Kigali Requirements for Planning and New Refrigerants

Angarag Nemekh^{1*}, Urantsetseg Tsogtbayar^{2*}

¹Dept. Plumbing Engineering, Institute of Engineering, School of Ulaanbaatar, Mongolia

² Department of Environmental Engineering, School of Civil Engineering and Architecture, Mongolian University of Science and Technology, Ulaanbaatar, Mongolia.

ABSTRACT: Since the 1970s, scientists have observed significant depletion of the ozone layer, including the development of "holes" or areas of thinning. Refrigerants have been identified as key contributors to this depletion. In response, international agreements such as the Vienna Convention for the Protection of the Ozone Layer (1985) and the Montreal Protocol on Substances that Deplete the Ozone Layer (1987) were ratified by 197 countries. With the growing use of heating, ventilation, air conditioning (HVAC) systems and heat pumps, the selection and management of refrigerants have become increasingly important during both the design and maintenance phases. The environmental impact of refrigerants is commonly assessed using two main indicators: Ozone Depletion Potential (ODP) and Global Warming Potential (GWP). In addition to environmental factors, refrigerants must meet thermodynamic, operational, and economic performance criteria. In Mongolia, heat pumps are widely used to enhance energy efficiency through the integration of renewable energy. However, insufficient attention to the environmental characteristics of the refrigerants used in these systems can result in adverse effects on both human health and the ecosystem. This study compares five commonly used refrigerants—R410A, R454C, R32, R134a, and R290—based on their performance and environmental impact. The findings indicate that R454C is the most effective and sustainable option among the refrigerants examined.

Key words: alternative refrigerants, heat pumps, hybrid heating and cooling systems,

1. INTRODUCTION

The Kigali Amendment to the Montreal Protocol, ratified in 2016, is a key international agreement aimed at reducing hydrofluorocarbons (HFCs), potent greenhouse gases used as refrigerants. Although HFCs are not significant ozone-depleting substances, they have high global warming potentials and greatly contribute to climate change. The amendment enforces a phased reduction in HFC production and consumption, with different timelines for developed and developing countries. This change impacts the building sector, where HFCs are commonly used in cooling and refrigeration systems. Consequently, adjustments in system design, refrigerant selection, and long-term planning are necessary. This section examines how the Kigali Amendment influences regulatory frameworks and technical criteria for planning and designing cooling systems, with a focus on the adoption of sustainable refrigerant alternatives.

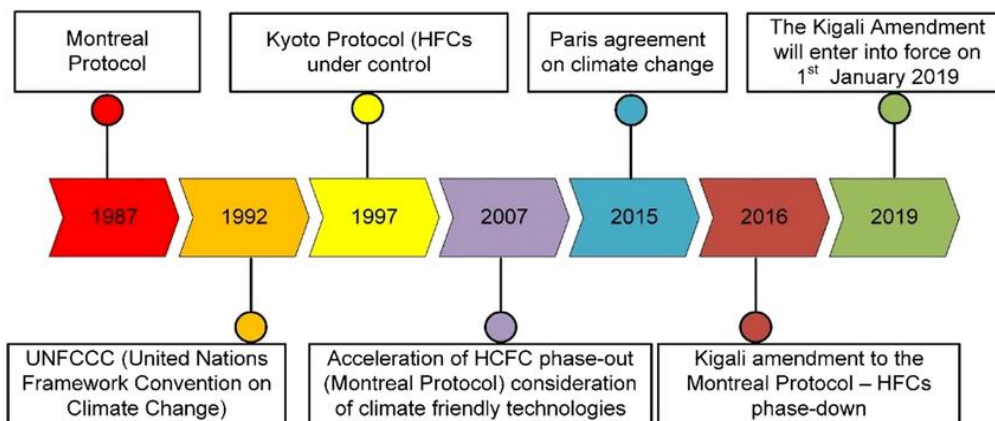
(1) Regulatory Shifts Introduced by the Kigali Amendment

The Kigali Amendment to the Montreal Protocol represents a crucial step in international regulatory reform aimed at reducing the climate impact of hydrofluorocarbons (HFCs), which have high global warming potential (GWP). Established to combat human-induced climate change, the amendment sets legally binding targets to gradually decrease HFC production and consumption, potentially preventing a global temperature rise of 0.4 to 0.5 degrees Celsius by century's end. Countries are classified based on their economic status. Developed nations, or Article 2 parties, began their 85% reduction in HFC consumption in 2019, while developing countries are divided into Group 1 (starting reductions in 2024) and Group 2 (beginning in 2028). This differentiated approach reflects the principle of common but differentiated responsibilities, allowing tailored implementations for each country.

Domestically, the Kigali amendment has prompted significant regulatory changes as governments align refrigerant policies with global commitments. Reforms include updating building codes, adopting minimum energy

performance standards (MEPS), and enforcing labeling and certification. The amendment also highlights the importance of complying with international safety standards, driving innovation in the HVACR industry, and promoting sustainable cooling technologies. Ratified in 2016, the Kigali Amendment targets HFCs, potent greenhouse gases that, while not ozone-depleting, significantly contribute to climate change. Its phased reduction plan for HFCs necessitates adjustments in cooling systems and refrigerant selection within the building sector, emphasizing the need for implementation of the Kigali Amendment in Mongolia.

Fig. 1 Steps for the Kigali Amendment.



As the phase-down of ozone-depleting substances progresses, the need to regulate the use of refrigeration and air conditioning equipment that relies on these substances has become increasingly important. This regulatory action is creating new challenges in balancing supply and demand across the sector. In particular, ensuring market equilibrium requires coordinated policies and oversight mechanisms, prompting both policymakers and manufacturers to adopt integrated and adaptive strategies.

Table 1. Period of Implementation in Mongolia

Year	Event
2016	Kigali Amendment adopted (in Kigali, Rwanda)
2019	Mongolia ratified the Kigali Amendment
2020	Implementation initiated by the Ministry of Environment through the National Ozone Unit
2021	Digital tracking system for HFC imports launched in cooperation with Customs
2022	Training programs began for refrigeration technicians on new refrigerants such as R-290, CO ₂ , and R-600a
2023	Draft of Minimum Energy Performance Standards (MEPS) developed
2024	Policy launched to support hybrid heating-cooling systems adapted to the climate
2025	Evaluation of implementation outcomes and planning for the next phase

Table 2. Kigali Amendment

	A5 Parties Group 1	A5 Parties Group 2*	Most Non-A5 Parties	Some Non-A5 Parties**
Baseline	2020-2022	2024-2026	2011-2013	2011-2013
HFC Formula	Average	Average	Average HFC	Average HFC
HCFC Formula	65% of the baseline	65% of the baseline	15% of the baseline	25%
Freeze	2024	2028		
1 st Step	2029-10%	2032-10%	2019-10%	2020-5%

2 nd Step	2035-30%	2037-20%	2024-40%	2025-35%
3 rd Step	2040-50%	2042-30%	2029-70%	2029-70%
4 th Step			2034-80%	2034-80%
Last Scheduled Step	2045-80%	2047-85%	2036-85%	2036-85%

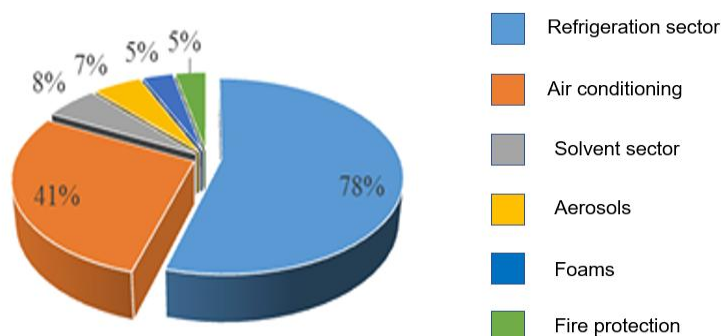
*Bahrain, India, Iran, Iraq, Kuwait, Oman, Pakistan, Qatar, Saudi Arabia, and the United Arab Emirates

**Belarus, Kazakhstan, Russian Federation, Tajikistan, and Uzbekistan Technology review in 2022 and every 5 years; Technology review 4-5 years before 2028 to consider the compliance deferral of 2 years from the freeze of 2028 of Article 5 Group 2 to address growth in relevant sectors above a certain threshold.

Mongolia ratified the Kigali Amendment in 2019, marking a significant step in the country’s commitment to addressing climate change and phasing down hydrofluorocarbons (HFCs). Under this international obligation, Mongolia has pledged to gradually reduce the consumption of HFCs and promote the adoption of environmentally friendly refrigerants. This commitment has led to national policy development, capacity-building efforts, and the introduction of monitoring mechanisms for refrigerant use and imports.

Since 2020, the Government of Mongolia, through the National Ozone Unit under the Ministry of Environment and Tourism, has been actively working to ensure the proper implementation of the Kigali Amendment. In cooperation with the General Customs Office, a digital tracking and registration system has been established to monitor imports of HFCs and HFC-based equipment, contributing to more effective enforcement of national import controls.

Fig. 2. As of Mongolia’s specific refrigerant consumption by type



In addition, Mongolia has partnered with international organizations such as the United Nations Environment Program (UNEP), the International Institute of Refrigeration (IIR), and the German development agency GIZ. These collaborations have resulted in training programs for refrigeration technicians, the drafting of Minimum Energy Performance Standards (MEPS), and technical capacity-building initiatives. Training sessions have focused on alternative refrigerants such as R-290 (propane), R-600a (isobutane), and CO₂, while promoting safety awareness and proper handling procedures.

Despite the progress, several challenges remain. These include the lack of sufficient technical knowledge among local technicians regarding new refrigerants and the high cost of energy-efficient, low-GWP (global warming potential) equipment, which limits market penetration. Addressing these challenges will require continued investment in professional training, financial incentives for technology adoption, and stronger regulatory enforcement.

Furthermore, considering Mongolia’s cold climate, it is crucial to promote the deployment of energy-efficient and climate-adapted technologies, such as high-performance heat pumps and hybrid heating and cooling systems. The

integration of these systems into national energy and infrastructure planning will not only enhance climate resilience but also support Mongolia's compliance with the Kigali Amendment by advancing the transition to sustainable refrigerant alternatives.

(2) Implications for Planning in Building Cooling Systems

The implementation of the Kigali Amendment has led to significant changes in how building cooling systems are planned and designed. This change requires that refrigerant considerations be taken into account in the overall development of HVAC systems. Traditionally seen as a secondary concern, selecting the right refrigerant has now become a primary design criterion due to evolving environmental regulations, safety standards, and performance expectations. Designers must evaluate not only the thermophysical properties and energy efficiency of refrigerants but also their global warming potential (GWP), flammability, toxicity, and long-term regulatory sustainability from the beginning of the planning process.

At the same time, the role of environmental impact assessments (EIAs) in HVAC system planning. In addition to traditional evaluations of energy use and thermal performance, EIAs now focus on refrigerant-related emissions, including direct emissions from leaks and indirect emissions from energy consumption. The use of metrics like Total Equivalent Warming Impact (TEWI) and Life Cycle Climate Performance (LCCP) allows for a more comprehensive evaluation of the environmental impact of cooling systems. Consequently, choosing sustainable refrigerants is now crucial for the ecological integrity and regulatory compliance of building projects. Moreover, the Kigali Amendment has significantly influenced the development and revision of national building codes and energy efficiency standards.

Many jurisdictions have incorporated GWP thresholds for refrigerants, established minimum energy performance standards (MEPS), and introduced safety protocols for the handling and installation of next-generation refrigerants. These regulatory requirements impose new design constraints and necessitate increased technical coordination among various stakeholders. This complexity highlights the need for interdisciplinary collaboration among engineers, architects, environmental consultants, and policymakers to ensure that building cooling systems are compliant and aligned with broader climate mitigation goals.

(3) Adoption of New-Generation Refrigerants

The global transition toward climate-resilient cooling technologies, catalyzed by the Kigali Amendment, has intensified the pursuit of refrigerants with significantly lower global warming potentials (GWPs). In this context, the adoption of next-generation refrigerants—such as R-32, R-1234yf, carbon dioxide (CO₂/R-744), and ammonia (NH₃/R-717)—has emerged as a critical strategy for reducing the environmental impact of heating, ventilation, and air conditioning (HVAC) systems.

These substances are increasingly favored for their minimal contribution to climate change, while also presenting distinct thermodynamic properties that affect system design and performance.

R-32, a hydrofluorocarbon with a GWP of approximately 675, is widely used as a transitional alternative to R-410A due to its superior energy efficiency and relatively lower environmental impact. R-1234yf, an unsaturated hydrofluoroolefin (HFO), exhibits an ultra-low GWP (less than 1) and has gained prominence in both mobile and stationary applications.

Table 3. R-454C Refrigerant Overview

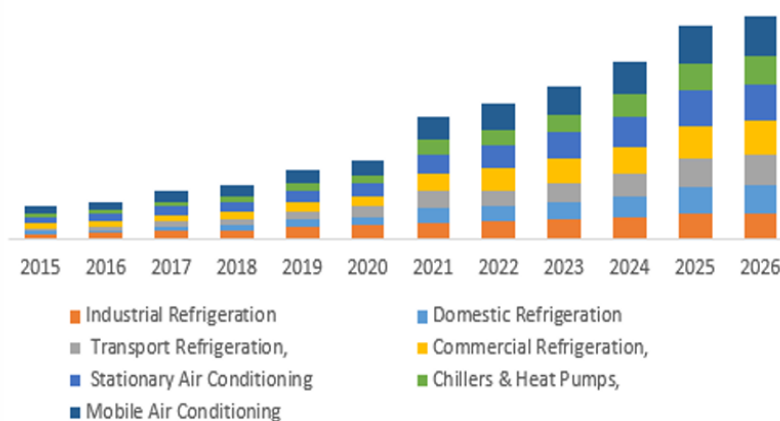
Property	Details
Chemical Composition	HFO-1234yf (78.5%) + HFC-32 (21.5%)
Refrigerant Type	A2L (low flammability) blend
GWP (Global Warming Potential, 100 years)	≈ 146 (compared to R-410A = 2088)
ODP (Ozone Depletion Potential)	0 (does not deplete the ozone layer)
Applications	Air conditioning, heat pumps, and commercial refrigeration

Natural refrigerants such as carbon dioxide and ammonia possess negligible GWP values and no ozone depletion potential, positioning them as long-term sustainable solutions. However, their deployment is constrained by specific operational and safety challenges. For instance, CO₂ systems operate under trans critical conditions with exceptionally high pressures, whereas ammonia is toxic and incompatible with certain materials, necessitating specialized handling and system components.

The integration of these low-GWP refrigerants into modern HVAC systems is accompanied by critical safety considerations. Many next-generation refrigerants, including R-32 and R-1234yf, are classified as mildly flammable (A2L) under ASHRAE Standard 34, while ammonia is categorized as both toxic (B2) and flammable. These classifications necessitate strict compliance with international safety standards and the incorporation of advanced engineering controls, such as leak detection systems, enhanced ventilation, and fire suppression mechanisms. Additionally, refrigerants like CO₂ require equipment capable of withstanding elevated pressures, which has implications for system durability, material selection, and operational reliability.

Beyond safety, technical adaptation poses a significant barrier to the widespread deployment of alternative refrigerants. The adoption of these substances often demands a fundamental redesign of key HVAC components—including compressors, heat exchangers, and expansion valves—to align with their unique pressure-temperature characteristics and thermodynamic behavior.

Fig. 2 The global refrigeration and air conditioning sector is expanding year by year.



Furthermore, successful implementation requires substantial investment in workforce training and capacity-building to ensure the safe handling, installation, and maintenance of these systems.

In sum, while next-generation refrigerants offer substantial environmental advantages, their adoption necessitates a coordinated response involving regulatory reform, technological innovation, and industry-wide upskilling. Only through such integrated approaches can the transition toward sustainable cooling solutions be effectively realized.

2. RESEARCH FIELD

(1) Standards and Compliance Requirements

The global shift toward environmentally sustainable refrigeration and air conditioning systems—driven in large part by the Kigali Amendment—has underscored the critical importance of adhering to internationally recognized safety and performance standards. As the industry transitions to low-GWP refrigerants, many of which exhibit novel physical and chemical properties, compliance with comprehensive regulatory frameworks has become essential to safeguard both human health and environmental integrity.

Three principal standards currently guide best practices in refrigerant application: ASHRAE Standard 15, EN 378, and ISO 5149. These technical standards provide the foundational criteria for the safe design, construction, operation, and maintenance of refrigeration systems across diverse applications. ASHRAE Standard 15, widely adopted in North America and increasingly influential globally, delineates the requirements for system pressure limitations, refrigerant concentration thresholds in occupied spaces, ventilation provisions, and emergency shutdown mechanisms. EN 378, the European standard, offers an integrated approach encompassing safety and environmental aspects throughout the life cycle of refrigeration and heat pump systems. ISO 5149, the international counterpart to EN 378, seeks to harmonize global safety practices while accommodating regional regulatory variations. A key component of these standards involves the classification of refrigerants according to their flammability and toxicity, as outlined in ASHRAE Standard 34.

Refrigerants are categorized from A1 (non-toxic, non-flammable) to B3 (toxic, highly flammable), with implications for system design, component selection, charge limits, and risk mitigation measures. The growing use of mildly flammable (A2L) and flammable (A3) refrigerants—such as R-32, R-1234yf, propane (R-290), and ammonia—necessitates the implementation of advanced leak detection systems, controlled ventilation, flame arrestors, and specialized containment strategies.

Moreover, high-pressure refrigerants such as CO₂ require reinforced materials and pressure-rated components to ensure structural integrity and safe operation under trans critical conditions. In addition to technical design requirements, the safe deployment of low-GWP refrigerants relies heavily on certification schemes and professional training.

The evolving refrigerant landscape demands that engineers, technicians, and installers possess up-to-date knowledge and practical competencies in handling alternative substances. Certification programs often encompass modules on refrigerant properties, safety protocols, environmental impact, applicable legislation, and the installation and servicing of systems using flammable or toxic media. In many jurisdictions, compliance with such certification is legally mandated, and ongoing professional development is increasingly recognized as vital to maintaining industry competence in a rapidly changing regulatory environment.

Ultimately, adherence to international standards and regulatory compliance mechanisms is not merely a legal obligation but a foundational element of sustainable HVAC system development. These standards ensure a consistent and science-based approach to managing safety risks, minimizing environmental harm, and promoting global harmonization in the deployment of next-generation refrigerants.

(2) Design and Operational Considerations

The integration of new-generation refrigerants within building cooling systems necessitates a rigorous and multifaceted analysis of design and operational parameters to ensure optimal system efficiency, economic viability, and long-term environmental sustainability throughout the equipment lifecycle. Achieving this balance requires a synthesis of thermodynamic performance, cost implications, and maintenance strategies, each critically influencing the overall effectiveness and resilience of HVAC installations.

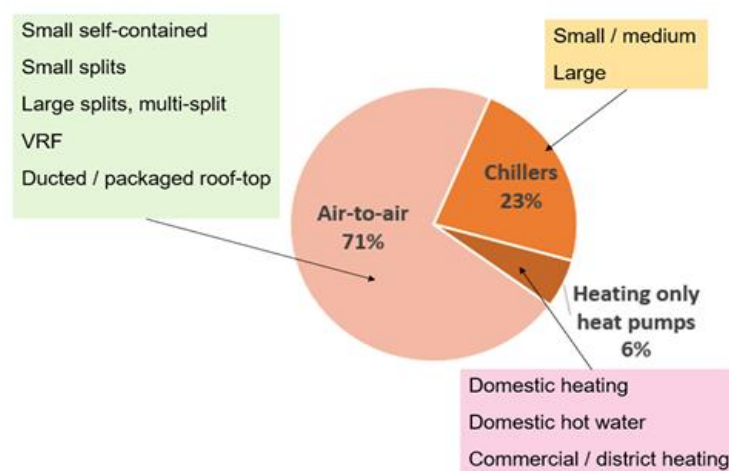
Foremost among these considerations is the imperative to enhance system efficiency. The physicochemical properties and thermodynamic behaviors of low-global warming potential (low-GWP) refrigerants diverge significantly from those of conventional hydrofluorocarbons, thereby compelling comprehensive redesign and recalibration of principal system components, such as compressors, condensers, evaporators, and expansion valves. Such adaptations seek to optimize the coefficient of performance (COP), cooling capacity, and part-load efficiencies, thereby mitigating

both direct refrigerant emissions and indirect emissions attributable to electricity consumption. The adoption of robust lifecycle assessment methodologies, including Life Cycle Climate Performance (LCCP) analysis, is indispensable for capturing the full spectrum of environmental impacts, encompassing refrigerant leakage, embodied energy in materials, and operational energy demand.

Economic considerations compound the technical complexities inherent in this transition. The capital expenditures associated with adopting novel refrigerants frequently entail premium costs attributable to specialized equipment design, enhanced safety features mandated by flammability and toxicity classifications, and requisite workforce training programs. However, these upfront investments are frequently offset by reductions in operational expenditures resulting from improved energy efficiencies and regulatory incentives. It is imperative to incorporate considerations of refrigerant availability, supply chain stability, and price volatility within comprehensive cost-benefit analyses to inform strategic decision-making and investment risk assessments.

Sustainability imperatives further necessitate the formulation of meticulous maintenance and operational protocols tailored to the specific properties of emergent refrigerants. Effective containment strategies, proactive leak detection technologies, and advanced diagnostic systems are essential to preclude inadvertent emissions and sustain system integrity. Furthermore, the operational durability of system components under variable ambient and load conditions requires anticipatory engineering to ensure reliability and minimize downtime. The responsible end-of-life management of refrigerants—including recovery, reclamation, and environmentally sound disposal—constitutes a critical component of the sustainability framework and regulatory compliance.

Fig. 3 Subsectors of air-conditioning and heat pumps



* VRF = variable refrigerant flow. VRF systems are sophisticated multi-split air-conditioning systems used to cool and heat medium-sized buildings.

There are many design options for building air conditioning, ranging from small systems that cool a single room to water chillers that can cool a large multi-storey building or an entire district. For water chillers, the refrigerant charge is high, but the equipment is usually in a limited-access location, e.g., a machinery room or a rooftop. This allows a wide choice of refrigerants, including flammable fluids, despite the large size. For split systems and VRF* systems, the refrigerant flows into the room being cooled, which makes the selection of a flammable refrigerant more difficult, especially for VRF systems because of their high refrigerant charge.

In synthesis, the deployment of next-generation refrigerants demands an integrative approach encompassing advanced engineering design, rigorous economic analysis, and comprehensive sustainability planning. Such an approach is essential to actualize the climate mitigation objectives articulated by global environmental agreements while ensuring the technical and financial feasibility of building cooling systems over their operational lifespan.

(3) Multidisciplinary Collaboration

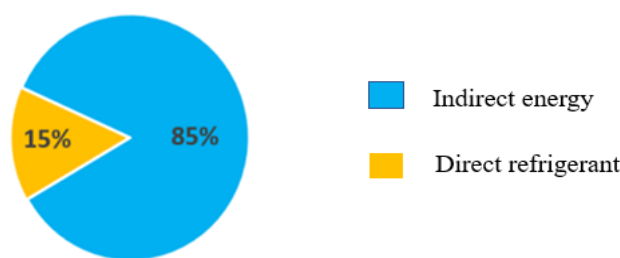
The transition toward environmentally sustainable cooling systems, especially those using low-GWP refrigerants following the Kigali Amendment, requires a comprehensive, multidisciplinary approach. The complexity of this transformation involves technical innovation, regulatory compliance, environmental stewardship, and socio-economic feasibility. Therefore, the coordinated engagement of various professional fields is essential. Engineers, architects, environmental consultants, and policymakers must work together synergistically to develop comprehensive, future-oriented solutions in the built environment.

Mechanical and HVAC engineers play a vital role in thermodynamic modeling, system specification, and technical validation of next-generation refrigerants, ensuring compliance with evolving safety and performance standards. Their expertise is crucial in dealing with design challenges linked to refrigerants that might be flammable, toxic, or operate under high pressure. Architects, through their design choices, significantly influence the spatial configuration and energy efficiency of buildings. They are essential for implementing passive cooling strategies, optimizing building orientation, and accommodating system infrastructure. Environmental consultants add rigor by evaluating the life-cycle environmental impacts of refrigerants and systems, making sure that these choices meet carbon reduction goals, environmental regulations, and sustainable development objectives.

The Importance of Energy Efficiency is crucial to consider the total global warming impact of products and equipment. This includes two separate elements:

- The direct impact of the fluid used (leakage of a refrigerant with a high GWP)
- The indirect impact of energy used to operate equipment (e.g., refrigeration or air-conditioning). In most RAC applications, it is the indirect energy-related emissions that are the dominant proportion of the total global warming impact, even if a high GWP fluid is used. It is crucial that new technologies using lower GWP fluids also have high energy efficiency. The pie chart shows a typical split of the total global warming impact for a room air-conditioner. The refrigerant has a high GWP (2,088), but it is the CO₂ from electricity use that represents most of the GHG emissions. High energy efficiency and low refrigerant leakage levels for this type of equipment are crucial.

Fig.4 Room air conditioner R410



Policymakers and regulatory bodies also play an indispensable role by creating the legislative frameworks that encourage innovation while protecting human health and the environment. They use policy tools such as building codes, equipment standards, and financial incentives to align local practices with international climate commitments. Bringing these diverse professional fields together under a unified strategic vision is critical for overcoming fragmented decision-making, which often leads to technical incompatibilities, regulatory non-compliance, or suboptimal environmental results.

Integrated planning methods—like the Integrated Design Process (IDP), Building Information Modeling (BIM), and collaborative project delivery systems—offer structured platforms for enhancing interdisciplinary coordination. These methods enable iterative feedback among stakeholders, allowing for early resolution of design conflicts, improvements

in system resilience, and the integration of emerging sustainability metrics. This coordination becomes particularly crucial when utilizing unconventional refrigerants such as CO₂, ammonia, or hydrocarbon blends, to ensure technical feasibility, regulatory approval, and user safety.

Empirical case studies highlight the effectiveness of multidisciplinary collaboration. In several advanced economies, collaborative efforts have allowed for the successful implementation of CO₂-based trans critical systems in retail and institutional buildings. Additionally, ammonia and hydrocarbon refrigerants have been effectively integrated into industrial applications through coordinated stakeholder engagement. These examples demonstrate that multidisciplinary collaboration not only mitigates risks but also promotes the sharing of best practices and accelerates the adoption of climate-resilient technologies.

In summary, achieving cooling strategies that align with the Kigali Amendment requires not just technological advancement but also the institutionalization of interdisciplinary collaboration throughout the entire lifecycle of planning, implementation, and policy development. Such collaborative frameworks are essential for creating robust, efficient, and sustainable cooling solutions that address both global environmental challenges and local operational realities.

3. CONCLUSIONS

In the case of Mongolia, the implementation of the Kigali Amendment represents both a strategic imperative and a significant opportunity for advancing sustainable cooling practices. As a Party categorized under Group 1 of the phasedown schedule, Mongolia commenced its formal commitment to reducing hydrofluorocarbon (HFC) consumption in 2024. This timeline presents a critical juncture for the country to reinforce its institutional frameworks, harmonize national policies with global environmental standards, and catalyze the transition toward low global warming potential (GWP) refrigerants.

Although constrained by limitations in infrastructure, technical expertise, and financial resources, Mongolia has made commendable progress in laying the groundwork for compliance. Notable efforts include the formulation of a national HFC phase-down strategy, enhancement of regulatory instruments governing refrigerant use, and engagement in international capacity-building initiatives. Moreover, there is a growing integration of energy efficiency and environmental sustainability principles into national building codes and construction practices.

To ensure long-term success, Mongolia must intensify its investment in workforce training, incentivize the adoption of natural and low-GWP refrigerants, and foster innovation through research and development in the heating, ventilation, and air conditioning (HVAC) sector. Interdisciplinary collaboration—engaging engineers, architects, environmental scientists, and policymakers—will be crucial in facilitating this transition. Furthermore, the incorporation of advanced planning and assessment tools, such as Building Information Modeling (BIM) and life-cycle analysis, will enhance the environmental performance and resilience of cooling systems.

In conclusion, the Kigali Amendment provides Mongolia with a unique opportunity not only to fulfill its international environmental commitments but also to modernize its building cooling infrastructure, reduce greenhouse gas emissions, and promote sustainable urban development. Achieving these objectives will require sustained policy support, international cooperation, and the institutionalization of best practices across all levels of governance.

ACKNOWLEDGMENT. The author gratefully acknowledges the National Ozone Authority of the Ministry of Environment and Tourism, Ulaanbaatar, Mongolia, for their invaluable support and collaboration.

REFERENCES

- [1] Bais, A.F., et al., (2015) Ozone depletion and climate change: impacts on UV radiation, p. 1-47 in Environmental effects of ozone depletion and its interactions with climate change: 2014 Assessment. United Nations Environment Programme, Nairobi.
- [2] Multilateral Fund Secretariat (2018). Project Proposal Ecuador - HCFC Phase Out Management Plan Stage-II. UNEP / OzL Pro/ExCom/81/32. Montreal: UNEP
- [3] UNEP. Ozone Action Series of Fact Sheets relevant to the Kigali Amendment. Retrieved from
 - a. https://wedocs.unep.org/bitstream/handle/20.500.11822/26770/7897FS_Kigali_series.pdf
- [4] Sustainable and Renewable Energy Development Authority (SREDA) (2015). Energy Efficiency and Conservation Master Plan up to 2030. Retrieved from <https://bit.ly/3cz9ezq>, last accessed on 11 June 2021.
- [5] www.unep.org/ozoneaction.Kigali Fact Sheet 9
- [6] www.refrigerants.danfoss.com
- [7] www.multilateralfund.org/63English%20Documents%20Lib/1/6352.pdf
- [8] www.multilateralfund.org/67/English/16727.pdf
- [9] www.ozone.mn
- [10] <https://ozone.unep.org/sites/default/files/Handbooks/MP-Handbook-2020-English.pdf>

a.