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Cooling Without Warming: India's Journey from the Montreal Protocol to ICAP

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Abstract—**The global effort to safeguard the stratospheric ozone layer stands as a landmark achievement in international environmental governance, anchored by the 1985 Vienna Convention and the 1987 Montreal Protocol. While these instruments successfully mandated the phased elimination of ozone-depleting substances (ODS) such as chlorofluorocarbons (CFCs), the transition away from such chemicals inevitably intersecting with rising cooling demands posed complex socio-economic challenges for developing nations. This article examines India's regulatory and policy trajectory from its accession to the Montreal Protocol in June 1992 to the formulation of the India Cooling Action Plan (ICAP). Grounded in the principle of Common But Differentiated Responsibilities (CBDR) and Operationalized through Article 5(1) of the Protocol, India leveraged its ten-year compliance grace period to align environmental stewardship with its pressing developmental imperatives. The study traces the evolution of India's domestic legal framework, financial mechanisms, and sustainable cooling strategies and illustrates how equitable international regimes empower developing economies to achieve ecological protection without compromising human welfare or economic growth.**

Index Terms—**Montreal Protocol, Ozone-Depleting Substances (ODS), Common But Differentiated Responsibilities (CBDR), Article 5(1), India Cooling Action Plan (ICAP), International Environmental Law, Sustainable Cooling.**

I. INTRODUCTION

Protection of the ozone layer has been a notable success story in international environmental cooperation. It was established that ozone depletion was caused by chemicals such as the chlorofluorocarbons (CFCs). In order to tackle the issue, there have been two treaties; the Vienna convention in 1985 and the Montreal protocol in 1987. The goal of the Montreal protocol was to regulate and phase out ozone depleting substances (ODS). This was achieved through international cooperation with information exchange and financial support on top of other legally binding control mechanisms. In order to fulfill this obligation, it was necessary for countries to have

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national laws and policies to regulate such harmful substances.[1] The Common But Differentiated Responsibility (CBDR) principle implies that all nations have an equal obligation towards environmental protection, but the level of obligations might be different depending on historical contributions, economic capability and development requirement of the particular nation. As provided in Article 5(1) of the Montreal Protocol, eligible developing countries were accorded a grace period of an extra decade for complying with the phase-out obligations. India, which became a signatory to the Protocol on 19 June 1992, was able to make use of the provision. Thus, India could conserve the ozone layer by considering its developmental obligations.[2]

In addition, the Montreal Protocol led to the replacement of ozone depleting compounds, such as CFCs, with other compounds by the industry. HCFCs and HFCs became replacements for CFCs since they had some benefits over CFCs. Unfortunately, even though HCFCs have the ability to destroy the ozone layer, many HFCs have a high global warming potential despite not having the capability of destroying the ozone layer. It means that the substitution of one compound with another could solve one environmental issue and introduce a new one at the same time.[3]

Whereas the Montreal Protocol was concerned with ozone depletion, the Kyoto Protocol and the Paris Agreement have been concerned about climate change and global warming. Even though HFCs were mentioned as greenhouse gases to which climate obligations would be attached under the Kyoto Protocol, no specific mechanism under the ozone treaty was created for the production and consumption of these gases. The consequence has been that regulations regarding ozone-depleting substances and climate-warming substances took place within two different international regimes.[4]

To tackle the problem of substitution-environment conflict, the Kigali Amendment was signed on 15 October 2016. Through this amendment, the Montreal Protocol was extended to deal with HFCs that do not deplete the ozone layer but could cause warming of the earth's atmosphere. The Kigali Amendment calls for reduction of production and use of HFCs in developed and developing nations using different timelines. It came into force on 1 January 2019, and is projected to cut down projected HFCs use by more than 80% within decades.[5]

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1 United Nations Environment Programme, "About Montreal Protocol", available at: https://www.unep.org/ozonaction/who-we-are/about-montreal-protocol (last visited on Oct. 23, 2026).

2 The Montreal Protocol on Substances that Deplete the Ozone Layer, 1987, art. 5(1), read with Government of India, Press Information Bureau, "Cabinet approves Ratification of Kigali Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer for phase down of Hydrofluorocarbons" (Aug. 18, 2021), available at: https://www.pib.gov.in/PressReleasePage.aspx?PRID=1746946 (last visited on Oct. 23, 2026).

3 Ibid.

4 Shiming Yang, "Regime shift in climate governance: HFCs, the UNFCCC, and the Montreal Protocol" *International Environmental Agreements: Politics, Law and Economics* (2026), available at: https://link.springer.com/article/10.1007/s10784-026-09736-x (last visited on Oct. 23, 2026).

5 Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer, Kigali, 15 October 2016, art. 1, available at: https://treaties.un.org/pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XXVII-2-f&chapter=27&clang=_en (last visited on Oct. 23, 2026).

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The Kigali Amendment is an example of how international agreements concerning the environment can be adjusted based on newly discovered scientific knowledge and changes in environmental conditions. The amendment helps to mitigate climate change while maintaining the ozone-protective framework that was created in the Montreal Protocol. The successful functioning of the agreement relies on its correct execution, monitoring, technological progress and substitution of hazardous substances. However, developing countries should also be provided with assistance in covering their growing needs for cooling while not being burdened financially and technologically.[6]

International environmental law has changed from solving problems one by one to seeing them all. The change from the 1985 Vienna Convention to the 2016 Kigali Amendment shows that when we fix one problem we must not create new ones. By putting HFC phase-downs into the Montreal Protocol the world joined ozone protection and climate help into one rule set. Guided by the idea of Common But Differentiated Responsibilities the main focus now moves from making treaties to putting good rules into practice inside each country especially in developing nations such, as India.

II. INDIA'S DOMESTIC EXECUTION: THE 2000 ODS RULES AND THE HCFC PHASE-OUT MANAGEMENT PLAN

India's compliance with its international obligations relating to ozone layer protection is mainly done through the provisions of the Environment (Protection) Act, 1986. The sections 3, 6 and 25 of the said Act serve as the legal backing for environmental protection measures and formulation of rules. Under these provisions, the Government made the Ozone Depleting Substances (Regulation and Control) Rules, 2000. These Rules regulate the manufacture, import, export, sale, use and handling of ozone depleting substances.[7]

The Ozone Cell, which operates within the MoEFCC, is an essential part of the implementation of the Montreal Protocol in India. It works in collaboration with industries, governmental organizations and international organizations like UNDP and UNEP to reduce the use of hazardous chemicals. Some of its activities include providing technological assistance, financial assistance, training and raising awareness programs for industries to adapt to safer chemical substances. The success of the Ozone Cell requires efficient data gathering, monitoring and coordination along with practical adoption of environmentally friendly technology.

The HCFC Phase-out Management Plan (HPMP) in India seeks to gradually reduce and finally stop the use of HCFCs, which are harmful to the ozone layer. This process is done in phases to

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[6] UNEP Ozone Secretariat, "Kigali Amendment Overview", available at: https://ozone.unep.org/kigali-amendment-overview (last visited on Oct. 23, 2026).

[7] The Environment (Protection) Act, 1986 (Act 29 of 1986), ss. 3, 6, 25; The Ozone Depleting Substances (Regulation and Control) Rules, 2000, Notification S.O. 670(E), dated July 19, 2000, available at: https://ozonecell.nic.in/home-page/montreal-protocol-implementation-in-india/regulatory-framework/the-gazette-of-india-notification-ods-rules-2000-its-amendments/ (last visited on Oct. 23, 2026).

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facilitate the move towards alternative technology adoption by industries and training for technicians and other workers. Phase III, which will be carried out between 2023 and 2030, seeks to accomplish the phase-out transition by the year 2030. India has also put in place a ban on the use of HCFCs for the manufacture of new equipment as from 1 January 2025.[8]

In addition to the Kigali Amendment and HPMP, the government of India introduced another plan named India Cooling Action Plan in 2019 to meet the demands of cooling as well as to minimize its impacts on the environment. The main aim of this initiative is to develop cooling technologies and energy-efficient cooling system by using sustainable refrigerants and proper management of cooling requirements in various sectors. It shows the need for achieving balance between economic development and provision of cooling facilities with environmental sustainability.[9]

The Indian case clearly shows that implementing international environmental law goes beyond just accepting the provisions of treaties and passing laws. Even though the ODS Rules, 2000, the Ozone Cell, and the HPMP offer the legal, institutional, and practical framework for phasing out ozone-depleting substances, implementation is crucial. Some of the hurdles faced include enforcement of licensing and reporting, monitoring and enforcement of these activities, prevention of illegal trade, coordination of regulatory agencies and adoption of proper technology. Assistance in finance and technology is particularly critical so as not to disrupt industrial production and development.

The international initiatives undertaken to safeguard the ozone layer are a testament to the significance of cooperation between international organizations and national governments. Vienna Convention and Montreal Protocol formed the backbone of the control of ozone depleting substances, and the Kigali Amendment expanded the framework for tackling climate change caused by HFCs. The Environment (Protection) Act, 1986, ODS Rules, 2000, Ozone Cell, HPMP and India Cooling Action Plan are the various instruments which help in implementing these commitments in India. But their effectiveness in the long run depends upon stringent enforcement, constant monitoring, prevention of illegal trade, innovations in technology and international assistance. Hence, an all-encompassing approach which preserves both the ozone layer and climate is crucial for environmental governance.[10]

Treaty ratification is the first step; true environmental success depends on effective execution inside the country. I feel that India moved from legal compliance to a proactive framework. India

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[8] Ministry of Environment, Forest and Climate Change, Government of India, "Montreal Protocol: Fixing the Ozone Layer and Reducing Climate Change", Press Information Bureau, Sept. 16, 2023, available at: https://pib.gov.in/PressReleasePage.aspx?PRID=1957968 (last visited on Oct. 23, 2026).

[9] Ministry of Environment, Forest and Climate Change, Government of India, "India Cooling Action Plan", Press Information Bureau (Mar. 14, 2022), available at: https://www.pib.gov.in/PressReleaseIframePage.aspx?PRID=1805795 (last visited on Oct. 23, 2026).

[10] Ozone Cell, Ministry of Environment, Forest and Climate Change, Government of India, "ODS Phase-out in the Country: HCFC Phase-out Management Plan", available at: https://ozonecell.nic.in/home-page/montreal-protocol-implementation-in-india/ods-phaseout-in-the-country/page-hcfc-phaseout-management-plan/ (last visited on Oct. 23, 2026).

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uses the Environment (Protection) Act of 1986 the ODS Rules of 2000 the Ozone Cell and the HPMP. India finishes this with the India Cooling Action Plan or ICAP that mixes phase-outs with energy efficiency. Long-term impact needs a close link between policy design and ground level enforcement. India must curb trade enable technology transfer and support small and medium enterprises or MSMEs. In the end India's approach is a model, for developing nations. Developing nations can use it to turn mandates into sustainable industrial policy.

III. OVERCOMING THE PARADOX: THE HCFC-141B BAN & LEAPFROGGING

India faced critical hurdles which intersected with policy, legal and technical challenges while navigating and dealing with the issue of ozone layer depletion. While the main pact was the Montreal protocol, it replaced Chlorofluorocarbon (CFC) which has high Ozone depleting potential with Hydrofluorocarbon - 141b. While the HCFC - 141b has very low ozone depleting potential than CFC the problem is that it has 725 times more Global warming Potential (GWP) than carbon dioxide.[11] To solve this issue, India applied crucial strategy of targeting polyethylene industry and enabled micro small and medium enterprises to bypass the HFCs.

3.1. Foam Sector

One of the largest consumers of HCFC-141b in India is the Polyurethane (PU) Foam sector. The foam is used in insulation material in domestic and commercial refrigerators, cold chain infrastructure, spray foam application and pipe-in-pipe insulation. In the cold and storage logistical industry, PU foam is used as an insulation panel for agrarian chains. In refrigeration, it is used as an insulation in domestic refrigerators and water coolers. In construction as well for roofing panels and insulated doors the PU foam is used apart from spray foams.

During manufacturing these foams, the HCFC-141b is as a liquid blowing agent. Due to low gas phase thermal conductivity and its cost effectiveness, Indian industry heavily relied on HCFC 141b. It is also at liquid state at normal temperature which is simplified for pumping, mixing and storing without requiring high pressure gas. By 2010, India was using 50% of total HCFC in its manufacturing sector. The transition has to be on that particular targeted industry sector.

Ozone Cell, Ministry of Environment & Forests, Government of India, "Roadmap for Phase-out of HCFCs in India" 50 (New Delhi, 2009).

3.2. The January 1, 2020 Milestone

On the first January 2020, the Ministry of Environment, Forest and Climate Change (MoEFCC) through amendments to the Ozone Depleting Substances (Regulation and Control) Rules, completely eliminated the use of HCFC-141b and went ahead of Montreal Protocol.[12]

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[11] United States Environmental Protection Agency, "Ozone-Depleting Substances", available at: https://www.epa.gov/ozone-layer-protection/ozone-depleting-substances (last visited on Oct. 23, 2026).

[12] Lok Sabha, Unstarred Question No. 2546 on "Prohibition of Hydro-Chlorofluorocarbons" (Answered on Mar. 6, 2020), available at: https://sansad.in/getFile/loksabhaquestions/annex/173/AU2546.pdf?source=pqals (last visited on Oct. 23, 2026).

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The phaseout was executed in a multi-layered process keeping in mind the economic cruciality of these sectors. The supply line was cut by notification issued by Directorate General of Foreign Trade (DGFT) by prohibiting import of HCFC-141b across all sectors.
The chemical formulators which this material to manufacturers mandated to reformulate polyols without HCFC-141b. And finally Sectoral audits ensured that the compliance with Non-Use of Ozone depleting substances. This enforcement eliminated roughly 8400 metric tons of HCFC-141b consumption. But this was faced with the challenge that industries might move towards alternatives, such as HFC-245fa or HFC-365mfc/227ea blends which has high global warming potential. India chose technological leapfrogging. It bypassed the alternative HFC and moved directly to zero ODS and ultra low GWP alternatives.
Cyclopentane Hydrocarbons also known as pentane technology is hydrocarbon blowing agent with zero ODP and having a global warming index less than 5. It offers strong thermal performance and low raw material cost. It has become a preferred choice for panel lines and manufacturing appliances.[13] Hydrofluoroolefins (HFOs) is a next generation unsaturated fluorinated hydrocarbon which offers zero ODP and has GWP less than 1. It is combined with high thermal performance with non-inflammability,

3.3. Supporting MSMEs through the Transition

While large manufacturing units have sufficient capital capacity to effectuate the transition and they can use Cyclopentane by investing in infrastructure, gas detectors, flameproof equipment and ventilation systems. However, the MSME sector comprising hundreds of small foam producers may face technical and financial barriers. The Government of India partnered with UNDP, UNEP and Multilateral Fund (MLF) to help MSME in this transition without which it may have faced job loss and closures.
High volume MSME were guided and assisted to convert into Cyclopentane and smaller MSME were transitioned to Hydrofluoroolefin (HFO). In stage II of HPMP, financial assistance was provided to MSME to raise capital to move towards high pressure units capable of handling alternative raw material. This funding included safety equipment such as hydrocarbon leak detectors, emergency ventilation, grounding systems, and nitrogen purging systems. Therefore, the import ban coupled with institutional and financial assistance to vulnerable segment of industry made it possible for India to bypass the high GWP pollutants entirely and securing long term achievement in climate fight

IV. HOLISTIC THERMAL GOVERNANCE: THE INDIA COOLING ACTION PLAN (ICAP)

There exist two pacts at international level. Montreal Protocol governed strictly over stratospheric ozone depletion and climate treaties addressed greenhouse gas emission. Due to rapid urbanization

[13] Mariia P. Filina, Abdigali A. Bakibaev, et.al., "Cyclopentane as an Eco-Friendly Alternative: A Review of its Properties, Industrial Applications, and Production Methods" 30 *Eurasian Journal of Chemistry* 4 (2025).

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and increasing population, India faced urgent demand for cooling. Government of India launched the India Cooling Action Plan (ICAP) in 2019 under the aegis of the Ministry of Environment, Forest and Climate Change (MoEFCC). This plan was created in intersection and linked with public health, agricultural productivity and international climate commitments.

4.1. India Cooling Action Plan (ICAP) in 2019

Prior to ICAP, the ozone depletion issue in India was dealt with under Ozone Depleting Substances (Regulation and Control) Rules, 2000 which had banned Chlorofluorocarbons. By amendment, it also banned HCFC-141b effective January 1, 2020. This was putting negative constraints which prohibited specific substances. But there was something vulnerable in industries. They all transitioned away from ozone depleting substances but transitioned towards hydrofluorocarbons (HFCs) which has global warming potential thousands of times more than carbon dioxide. The ICAP was formulated to resolve this issue by focusing on phase out and multi sectoral planning. It has established a 20 year plan from 2017 to 2038. The main feature of ICAP is that the cooling requirements in all the sectors can not be managed in isolation. The cooling demands have been projected and studied across various sectors; it may be for residential or commercial purposes. The cooling demand is the result of Global temperature rise, urbanization and increasing income of the middle class. India's cooling demand cannot be fulfilled in the way that puts the nation into high carbon, energy inefficient and climate costly ways.

4.2. Linking HFC Phasedown with Aggressive Energy-Efficiency Targets

The peculiarity of ICAP lies in the integration of addressing direct emission from refrigerants and indirect emissions from fossil fuels. In a country like India, indirect emission from energy consumption is vast. ICAP's first task was to reduce cooling demand. The cooling demand is going to increase aggressively by 2038. This can be reduced by developing Energy Conservation Building Code (ECBC) for urban planning to mitigate urban heat effects and to lay down architectural design principles. Secondly, the plan provides for policies for refrigerants transition which adopted and encouraged the zero ODP and low GWP alternatives without compromising cost effectiveness. It also collaborated with India's Bureau of Energy Efficiency (BEE) which worked on star rating standards which ultimately pushed manufacturers to continuously upgrade their technologies. Apart from it, the crucial task of upskilling programs nationwide were conducted.

4.3. Aligning Domestic Growth with Global Climate Obligations

Considering emissions by India compared to developed nations, the reality is that India's emission rate is low, but due to high population, cooling demand is expanding, which is also essential for human comfort, cold chain and workplace productivity. If left unchecked, this demand threatens the national power grid. India has transformed international compliance into an industrial modernization opportunity.

This shows a change in how we manage the environment. It moves from bans on each chemical to a plan that looks at the whole system. The India Cooling Action Plan (ICAP), stops treating ozone

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and climate change as separate issues. ICAP tackles both the release of refrigerants and the indirect use of energy at the same time. By looking at cooling from angles—building design keeping cities cool making appliances use less power and teaching workers new skills—ICAP shows that we can meet the huge demand for home cooling without hurting the power grid or the planet. In the end ICAP changes the idea of rules from a cost to a smart move that helps industry grow and stay green, in developing countries.

V. CONCLUSION

This has been proved a successful experiment in international environmental law. This started as a response to the ozone layer depletion and evolved into a more capable and sophisticated mechanism addressing the linkage between ozone protection and climate change. India's attempt to resolve this issue proved that when international mandate met with domestic action, it produces outcomes beyond expectation. India showed progressive trajectory by introducing rules and then amending it in a steady way. The complete ban on HCFC-141b with effect from 1 January 2020 was a decisive step. When high GWP substances were bypassed, the main task was to offer smooth transition for industries. India successfully avoided locking itself into another problem and used this to turn into technological modernization. India's Cooling Action Plan remains the most important and significant domestic innovation. Effectiveness of this scheme remains conditional and challenges of monitoring and enforcing prevention of illegal trade and continuous capacity building still persist. The study looks at how international environmental law has changed over time. It started with treaties focused on protecting the ozone layer like the Vienna Convention and the Montreal Protocol. Now it has grown into a complete system for dealing with climate change, which is clearly shown in the Kigali Amendment. The study also looks at how India has handled these laws within its country. It talks about the Environment (Protection) Act, 1986 and the ODS Rules, 2000. It also mentions how India has made a move forward like the 2020 ban on HCFC-141b in the foam industry. This move was helped by money from countries and support for small businesses. In the end the study shows how the India Cooling Action Plan is an complete example. It brings together the reduction of cooling agents with goals for using energy more efficiently. It turns following laws into a plan, for making industries modern and green.