

DAILY NEWS ANALYSIS

# Kigali Amendment 2026: HFC Phase-Down, India’s Commitments and Climate Impact – UPSC Guide

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The Kigali Amendment to the Montreal Protocol aims to reduce hydrofluorocarbons (HFCs) powerful greenhouse gases used in cooling systems. Learn about its objectives, India's phase-down schedule, climate benefits, and significance for sustainable cooling and UPSC preparation.

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## Kigali Amendment 2026: HFC Phase-Down, India’s Commitments and Climate Impact

The Kigali Amendment to the Montreal Protocol is an important international climate measure that seeks to reduce the production and consumption of hydrofluorocarbons (HFCs). These chemicals are widely used in refrigeration, air conditioning and other cooling applications. Although HFCs do not deplete the ozone layer, many have a high global warming potential.

Adopted in Kigali, Rwanda, on 15 October 2016, the amendment links environmental protection with technological change, energy efficiency and international cooperation. Its tenth anniversary in October 2026 provides an opportunity to examine India's commitments and the future of climate-friendly cooling.

International agreement

An amendment to the Montreal Protocol, adopted in Kigali in 2016.

Primary objective

Gradually reduce HFC production and consumption to limit climate warming.

UPSC relevance

International environmental agreements, climate change and India's commitments.

## 1. What Is the Kigali Amendment?

The Kigali Amendment is an amendment to the **Montreal Protocol on Substances that Deplete the Ozone Layer**. It was adopted on 15 October 2016 in Kigali, Rwanda, and entered into force on 1 January 2019.

The Montreal Protocol originally focused on phasing out substances responsible for ozone depletion, including chlorofluorocarbons (CFCs). As these substances were restricted, HFCs were adopted in many applications as alternatives because they do not significantly deplete stratospheric ozone.

However, many HFCs are potent greenhouse gases. The Kigali Amendment therefore introduced a global framework to phase down their production and consumption over time.

**Key concept:** The Kigali Amendment addresses the climate impact of HFCs. It does not replace the Montreal Protocol, it strengthens the existing treaty by adding HFC phase-down commitments.

## 2. What Are Hydrofluorocarbons (HFCs)?

Hydrofluorocarbons are synthetic chemicals used primarily in cooling and related industrial applications. They became widely used as substitutes for certain ozone-depleting substances.

### Common applications

- Domestic and commercial air-conditioning systems.
- Refrigerators and commercial refrigeration equipment.
- Cold-storage facilities and transport refrigeration.
- Some foam-blowing, fire-protection and industrial applications.

### Why are HFCs a climate concern?

Many HFCs trap heat in the atmosphere far more effectively per unit of mass than carbon dioxide over a specified assessment period. Their global warming potential varies by chemical and by the time horizon used.

Reducing HFC emissions can therefore help slow global warming, particularly as demand for air conditioning and refrigeration grows. The overall climate benefit depends on the refrigerants used, equipment efficiency, leakage prevention and responsible recovery and disposal at the end of equipment life.

### 3. Ozone Depletion and Global Warming: The Difference

| Aspect                        | Ozone-depleting substances                                  | Hydrofluorocarbons                                        |
|-------------------------------|-------------------------------------------------------------|-----------------------------------------------------------|
| Primary environmental concern | Damage to the stratospheric ozone layer.                    | Contribution to global warming.                           |
| Examples                      | CFCs and HCFCs.                                             | HFCs such as HFC-134a and HFC-23.                         |
| Ozone-depletion potential     | Some substances have significant ozone-depleting potential. | HFCs generally have negligible ozone-depletion potential. |
| Climate impact                | Many are also potent greenhouse gases.                      | Many have high global warming potential.                  |
| Relevant global framework     | Montreal Protocol and its amendments.                       | Kigali Amendment to the Montreal Protocol.                |

An important lesson is that replacing an ozone-depleting chemical with an alternative does not automatically eliminate its climate impact. Environmental policy must consider both ozone protection and greenhouse gas emissions.

### 4. Key Features of the Kigali Amendment

#### Gradual phase-down

The amendment establishes schedules to reduce HFC production and consumption rather than requiring an immediate, universal ban. Different groups of countries follow different timelines, recognising their varying circumstances and development needs.

#### Differentiated responsibilities

Countries are assigned to implementation groups with different baseline calculations, freeze dates and reduction schedules. Developing countries receive longer transition periods than developed countries, allowing time for technological and industrial adaptation.

#### Financial and technical support

The Multilateral Fund supports eligible developing countries in meeting Montreal Protocol obligations. Support can include assistance for technology transitions, equipment changes, capacity

building and training.

### Encouraging alternatives

The phase-down encourages the development and adoption of refrigerants with lower global warming potential. Alternatives can include hydrocarbons, ammonia, carbon dioxide and selected hydrofluoroolefins, depending on the application and safety requirements.

No refrigerant is universally suitable for every use. Flammability, toxicity, pressure, equipment design, energy performance and local operating conditions must all be considered.

## 5. India's Commitments Under the Kigali Amendment

India ratified the Kigali Amendment in 2021. As a developing country under the Montreal Protocol framework, India follows the applicable phase-down schedule for its country group.

| Milestone | Indicative Indian commitment                                     | Importance                                                         |
|-----------|------------------------------------------------------------------|--------------------------------------------------------------------|
| 2021      | India ratified the Kigali Amendment.                             | Formal commitment to the HFC phase-down framework.                 |
| 2028      | Scheduled baseline freeze for India's applicable group.          | Constrains further growth against the agreed baseline.             |
| 2032      | Initial reduction milestone under the applicable schedule.       | Begins a measurable reduction in HFC consumption.                  |
| 2047      | Long-term reduction milestone under India's phase-down schedule. | Supports the transition towards lower-impact cooling technologies. |

The exact baseline calculation, percentage reduction and compliance requirements depend on the treaty schedule and official implementation rules. Aspirants should check the latest government and Montreal Protocol documentation before memorising detailed numerical targets.

### Why is the transition significant for India?

- **Rising cooling demand:** Higher temperatures, urbanisation and economic growth increase the need for air conditioning and refrigeration.
- **Industrial transformation:** Manufacturers may need to redesign products, adopt alternative refrigerants and train technicians.
- **Energy efficiency:** Efficient cooling equipment can reduce electricity demand as well as indirect emissions from power generation.

- **Public health:** Reliable cooling supports food preservation, cold chains and temperature-sensitive healthcare applications.
- **International cooperation:** Financial and technical assistance can help developing economies meet environmental obligations without compromising development goals.

## 6. Kigali Amendment and the India Cooling Action Plan

India's Cooling Action Plan provides a broader framework for addressing cooling demand across sectors. It considers refrigerants, equipment efficiency, cooling needs, technology and the skills required to maintain cooling systems.

The Kigali Amendment and the India Cooling Action Plan are complementary, but they are not the same instrument. The amendment creates international obligations concerning HFC production and consumption, while the national plan provides a wider policy framework for sustainable cooling in India.

### Policy priorities for India

- Encourage energy-efficient air conditioners and refrigeration systems.
- Promote lower-global-warming-potential refrigerants where technically suitable and safe.
- Improve servicing practices to reduce refrigerant leakage.
- Strengthen refrigerant recovery, recycling and responsible disposal.
- Train technicians in safe installation, maintenance and handling.
- Support research, innovation and domestic manufacturing capabilities.

**UPSC insight:** Climate-friendly cooling requires more than changing refrigerants. Equipment efficiency, electricity sources, leakage management and end-of-life disposal also influence the total environmental impact.

## 7. Global Significance of the Kigali Amendment

### Climate change mitigation

Phasing down HFCs can avoid a meaningful amount of future warming. Estimates often cited for the amendment indicate that full implementation could avoid up to around 0.5°C of warming by 2100, depending on assumptions and the scenario assessed.

### Protection of the ozone layer

The Kigali Amendment builds on the institutional framework and cooperation established by the Montreal Protocol. The amendment specifically addresses HFCs, while the wider protocol continues to govern controlled ozone-depleting substances.

### Technology and investment

The transition can encourage research and investment in alternative refrigerants, efficient appliances, new manufacturing processes and improved servicing practices.

### Equity and international cooperation

Different compliance schedules and financial support recognise that countries have different technological capabilities and development priorities. This is important for building broad participation in international environmental agreements.

## 8. Challenges in Implementing the Phase-Down

### Cost of technological transition

Manufacturers may need to redesign products, modify production facilities and develop new supply chains. These costs can be significant, particularly for smaller firms.

### Safety and technical capacity

Some lower-impact refrigerants have flammability or toxicity considerations or operate at different pressures. Safe adoption requires appropriate equipment design, standards and technician training.

### Leakage and end-of-life management

Refrigerant emissions can occur during servicing, equipment damage and disposal. Without effective recovery and handling systems, the climate benefits of the phase-down may be reduced.

### Balancing affordability and sustainability

Cooling is increasingly important for comfort, productivity, food preservation and healthcare. Policies must encourage efficient technology while ensuring that safer and more sustainable cooling remains accessible to households and businesses.

## 9. Way Forward

- **Accelerate efficient cooling:** Set and enforce suitable performance standards for appliances and cooling equipment.
- **Support innovation:** Encourage research into safe, affordable refrigerants and energy-efficient technologies.
- **Strengthen technician training:** Expand professional skills in refrigerant handling, maintenance and recovery.
- **Improve enforcement:** Monitor compliance, prevent illegal trade and strengthen implementation of refrigerant rules.
- **Build circular systems:** Develop refrigerant recovery, reclamation and recycling infrastructure.
- **Use finance effectively:** Direct available international support towards eligible conversion costs, training and technical capacity.
- **Promote sustainable cooling access:** Integrate cooling policy with energy planning, building design and urban heat management.

## 10. UPSC Civil Services Examination Relevance

### General Studies Paper III

- Environmental pollution and degradation.
- Climate change mitigation and international environmental agreements.
- Science and technology applications in cooling and refrigeration.
- Energy efficiency and sustainable industrial development.

### General Studies Paper II

- International treaties and institutions.
- India's participation in multilateral environmental cooperation.
- Implementation of international commitments through domestic policy.

### Prelims facts to revise

- The Montreal Protocol was adopted in 1987.
- The Kigali Amendment was adopted on 15 October 2016 in Rwanda.

- The amendment entered into force on 1 January 2019.
- HFCs generally do not deplete the ozone layer but can contribute significantly to global warming.
- The Kigali Amendment requires a phased reduction in HFC production and consumption.
- The Multilateral Fund supports implementation of the Montreal Protocol in eligible developing countries.

## 11. UPSC Practice Questions

### Prelims-style MCQ

Consider the following statements about the Kigali Amendment:

1. It is an amendment to the Montreal Protocol.
2. It seeks to phase down hydrocarbons.
3. HFCs are major ozone-depleting substances in the same way as CFCs.

Which of the statements given above are correct?

**Answer:** 1 and 2 only.

**Explanation:** HFCs were widely adopted as alternatives to ozone-depleting substances because they generally do not deplete the ozone layer. However, many HFCs are powerful greenhouse gases.

### Mains question — GS Paper III

“The Kigali Amendment demonstrates the need to integrate ozone protection with climate change mitigation.” Explain its significance and discuss the challenges India faces in transitioning to sustainable cooling.

**Suggested approach:** Explain the Montreal Protocol and HFCs, discuss the climate benefits of the phase-down, analyse technological and affordability challenges, and conclude with efficient cooling, technician training and responsible refrigerant management.

## Conclusion

The Kigali Amendment represents an important step in international efforts to limit the climate impact of HFCs. By building on the Montreal Protocol, it brings refrigerant management into the wider agenda of climate change mitigation and sustainable development.

For India, successful implementation requires a carefully managed transition towards safer, lower-impact refrigerants and energy-efficient cooling. Investment, technical training, innovation and responsible refrigerant recovery will be essential to achieve environmental objectives while meeting the country's growing cooling needs.

**Quick revision:** Montreal Protocol — ozone protection; Kigali Amendment — HFC phase-down; India Cooling Action Plan — broader national framework for sustainable cooling. Remember the distinction between ozone depletion and global warming for UPSC.

## Frequently Asked Questions

### What is the main objective of the Kigali Amendment?

Its primary objective is to phase down HFC production and consumption to reduce their contribution to global warming.

### Do HFCs deplete the ozone layer?

HFCs generally have negligible ozone-depletion potential, but many have high global warming potential.

### When was the Kigali Amendment adopted?

It was adopted on 15 October 2016 in Kigali, Rwanda, and entered into force on 1 January 2019.

### Why is the Kigali Amendment important for India?

It encourages a transition to lower-impact refrigerants and efficient cooling while requiring technological adaptation, skills development and compliance with international commitments.

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