

India's management and governance in protecting the stratospheric ozone layer

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India has actively participated in the Montreal Protocol on Substances that Deplete the Stratospheric Ozone Layer through its noteworthy management and governance. This Protocol is an international treaty with most nations as signatories to safeguard the ozone layer. For the success of the Montreal Protocol, developing (Article-5) and developed (non-Article 5) countries, as well as those with economies in transition, need to adhere to its conditions and provisions fully. Ozone-depleting substances have been phased out from all countries. Since 1 August 2008, India has completely phased out the production and consumption of chlorofluorocarbons, almost 17 months ahead of the agreed phase-out schedule. The country has also contributed to the 'save ozone' efforts by all the world nations.

Keywords: Chlorofluorocarbons, international treaty, management and governance, ozone, stratosphere.

THE ozone layer in the stratosphere is a shield that protects all life on Earth from the harmful ultraviolet (UV) radiation from the Sun. It prevents UV radiation from reaching the Earth's surface. UV radiation is the leading cause of sunburn, skin damage, skin cancer, immune system suppression, cataract, etc.

The Vienna Convention was signed on 22 March 1985, resulting in an international treaty, the Montreal Protocol on Substances that Deplete the Stratospheric Ozone Layer. This treaty was signed initially by 46 signatories on 16 September 1987 to completely phase out the production and consumption of chlorofluorocarbons (CFCs), carbon tetrachloride (CTC), halons (brominated fluorochemicals), methyl chloroform and a few other ozone-depleting substances (ODS). This treaty has now been ratified by 198 countries.

CFCs were developed in the early 20th century as non-toxic, non-flammable refrigerants and were considered 'miracle products'. They have a wide range of applications as aerosol propellants, refrigerants, solvents and foam-blowing agents. These chemicals are stable, inert, non-toxic, non-flammable and inexpensive to produce. India has notably phased out ODS and, in turn, is contributing to protecting the ozone layer by implementing the Montreal Protocol.

Evolution of the Montreal Protocol

The Governing Council of the United Nations Environment Programme (UNEP) authorized UNEP to draft a glo-

bal framework convention for ozone layer protection, resulting in the adoption of the Vienna Convention for the Protection of the Ozone Layer. The Vienna Convention was concluded with 'a framework agreement in which States agree to cooperate in relevant research and scientific assessments of the ozone problem, to exchange information, and to adopt "appropriate measures" to prevent activities that harm the ozone layer.'¹

A diplomatic conference was convened in Montreal, Canada, resulting in the adoption of the Montreal Protocol on Substances that Deplete the Ozone Layer on 16 September 1987, which entered into force on 1 January 1989.

In 1990, at the second Meeting of the Parties (MOP) to the Montreal Protocol, in London, UK, 54 parties with 42 non-Party countries agreed on measures to be taken to protect the ozone layer. The objective of the London Amendment was to phase out widely used CFCs and halons, which have high ozone depleting potential (ODP) by 2000, and other minor CFCs and CTC to be controlled and eventually phased out. A special provision was made to phase out these chemicals by providing an Interim Multilateral Fund to assist developing countries consuming less than 0.3 kg per capita of CFCs and halons per year. These countries were also given a grace period of 10 years to phase out ODS.

In 1992, the Interim Multilateral Fund was made permanent and additional chemicals, including hydrochlorofluorocarbons (HCFCs) and methyl bromide, were brought under the ambit of the Montreal Protocol through the Copenhagen Amendment. In 1997, the Montreal Amendment established and implemented a licensing system for the export and import of new, recycled, reclaimed and used controlled chemicals. It also controlled the trade of chemicals that were in non-compliance with the Protocol. In 1999, the Beijing Amendment added bromochloromethane

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(halon) to the list of controlled substances. This Amendment defined the schedule of the phase-out of HCFCs, and subsequently, the phase-out of production and consumption of HCFCs was accelerated in 2007 through an adjustment. The latest extension of the Montreal Protocol is the Kigali Amendment in 2016 to regulate hydrofluorocarbons, which do not deplete the ozone layer but some of which are potent greenhouse gases.

Recovery of the ozone layer

‘The world solved the ozone problem. It can solve climate change’² was the headline of an opinion piece in *The New York Times* in 2019. It referred to the fact that human actions have enabled the slow recovery of the ozone layer from destruction due to anthropogenic activities, and this was the spark of optimism in the newspaper.

An article by Liverpool³ and a UN report⁴ also highlighted the recovery of the ozone layer.

As a result of phasing out of ODS, the Antarctic ozone hole is expected to return to the 1980 level around 2070 and the pre-1980 levels around 2050 (refs 5, 6).

The Montreal Protocol: India’s initiatives, management and governance

In 1990, Chinese and Indian delegations drafted an agreement for developing countries to take the required actions for phasing out ODS in exchange for⁷:

- Funding the agreed incremental cost of transition.
- A ‘grace period’ of approximately ten years after the phase-out ODSs by the developed countries.
- Commitment to make technology available to all countries to protect the ozone layer.

India became a Party to the Vienna Convention for the Protection of the Ozone Layer on 18 March 1991 and the Montreal Protocol on 19 June 1992. It is also a party to the London, Copenhagen, Montreal, and Beijing Amendments. India also played an important role in establishing the Multilateral Fund, a financial mechanism in Montreal Protocol.

India’s policies and regulations

Country programme: India prepared a detailed Country Programme (CP) in 1993 to phase out ODS in agreement with its National Industrial Development Strategy. The objectives of CP were:

- Phase-out ODS by accessing the financial mechanism of the Montreal Protocol without unnecessary and excessive economic burden on consumers, producers and manufacturers using ODS.

- Minimizing the drastic economic shift due to the adaptation of non-ODS technologies.
- Minimizing the use of and preferring one-time replacement.
- Maximizing indigenous production and emphasizing decentralized management.

The CP was updated in 2006 to include the amendments and adjustments of the Montreal Protocol. Moreover, the Government of India (GoI) has taken the initiative by assigning the ozone layer protection-related research and work to the Ministry of Environment, Forest and Climate Change (MoEF&CC). The Ozone Cell has been set up as a National Ozone Unit (NOU) to administer and implement the obligatory services for effective and timely execution of the Montreal Protocol and the phase-out activities of ODS in India⁸.

Ozone Depleting Substances (Regulation and Control) Rules: MoEF&CC, GoI, has notified Ozone Depleting Substances (Regulation & Control) Rules, 2000 in the *Gazette of India* on 19 July 2000, including the production, consumption, export and import of ODS. These Rules have been amended seven times (2001, 2003, 2004, 2005, 2006, 2007 and 2014). Under these Rules, according to the Montreal Protocol accelerated phase-out schedule:

- Use of CFCs in manufacturing various products was prohibited beyond 1 January 2003, except in metered dose inhalers (MDIs) and other medical purposes.
- Use of halons was prohibited after 1 January 2001, except for services.
- Use of CTC, methyl chloroform and CFC for MDIs was allowed until 1 January 2010.
- Use of methyl bromide was allowed until 1 January 2015.
- Use of HCFCs was permitted until 1 January 2030.

The MoEF&CC, GoI recommendation is mandatory before issuing a license by the Directorate General of Foreign Trade (DGFT), Ministry of Commerce and Industry, GoI, for the import and export of ODS. These Rules further prohibit the trade of ODS with non-Parties to the Protocol⁸.

Fiscal measures: In 1995, GoI has granted exemption on customs and excise duties on capital goods for phasing out ODS. In 1996, this was further extended. Since 1997, the benefit of duty exemption has been extended for new capacity or expanded capacity with non-ODS technologies. The Tariff Advisory Committee grants discounts on fire insurance premiums for halon-free fire extinguishers. The Indian financial institutions have not been financing/re-financing new ODS enterprises⁸.

Monitoring mechanism: The Ozone Cell monitors the productive, profitable and successful use of funding support

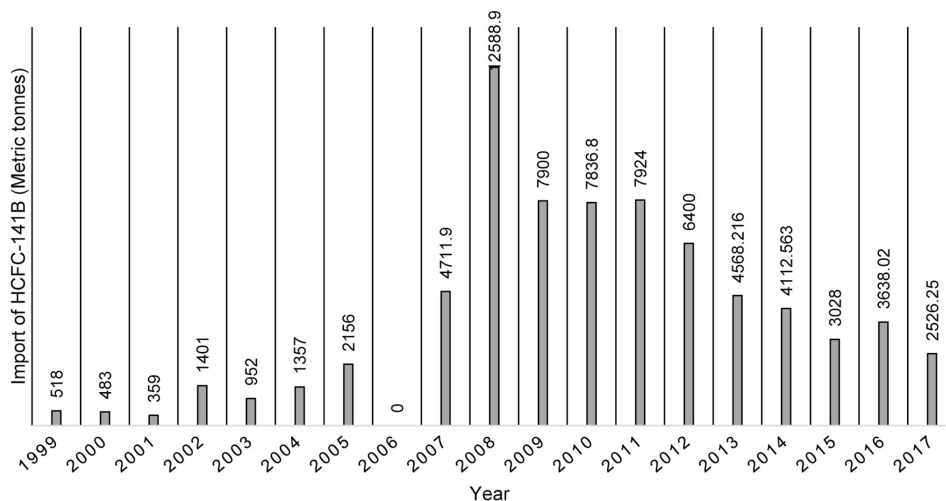


Figure 1. Import of HCFC-141b during the period 1999–2017.

provided by the Multi-Lateral Fund (MLF) through implementing agencies by the enterprises. MoEF&CC, GoI has constituted a Standing Committee on Monitoring under the chairmanship of the Chairman, Central Pollution Control Board, with Members from the concerned Departments, Industry Associations and the Ozone Cell. The Committee reviews the data collected and analysed by the Ozone Cell from ODS producers, DGFT, Directorate General of Commercial Intelligence and Statistics, etc. on production, imports, exports and industrial users in the country. The production, importation and export data are organized in the Article 7 format of the Montreal Protocol for submission to the Ozone Secretariat. The Standing Committee on Monitoring is an advisory body to the Empowered Steering Committee (ESC). The Article 7 data, thus vetted by the Standing Committee on Monitoring, is submitted to ESC for approval and then to the Ozone Secretariat.

The Ozone Cell has been convening regular meetings with representatives of the World Bank, UNDP, UNEP, UNIDO, and bilateral agencies. The Director of the Ozone Cell holds periodic meetings with industries to monitor their implementation progress for the ODS phase-out⁸.

India's success in phasing out ODSs in various sectors

From 1 August 2008, India has completely phased out production and consumption of CFCs, almost 17 months ahead of the agreed phase-out schedule, except for pharmaceutical-grade CFCs in the manufacture of MDIs; these are exempted uses.

The Ozone Cell received 'The Montreal Protocol Implementers Award, 2007' on the occasion of the 20th Anniversary of the Montreal Protocol for its extraordinary contributions to the effective implementation of the Proto-

col and the global effort to protect the ozone layer. 'The Stratospheric Ozone Protection Award, 2008' was also conferred upon the Ozone Cell by the United States Environmental Protection Agency, Washington, DC⁸ in recognition of its exceptional contribution to global environmental protection and leadership in ozone layer protection.

CFC phase-out in the foam manufacturing sector

One hundred and twenty-two foam manufacturing enterprises have phased out 702 metric tonnes of CFCs. CFC phase-out in the foam manufacturing sector has been successfully implemented, and the use of CFCs has been eliminated in this sector. The conversion of manufacturing facilities of the polyol systems house(s) on a priority basis has been considered strategically crucial to enable the customization of non-CFC formulations and facilitate CFC phase-out more economically.

Phase out of HCFC-141b, predominantly used as a foaming agent, has been considered under HCFC Phase-out Management Plan (HPMP) Stage-II (Figure 1). The importation of HCFC-141b in India has witnessed a decreasing trend after 2008. Table 1 shows the various technology options for the successful phase out of ODSs.

CFC phase-out in the refrigeration and air-conditioning sector

The phase out of CFCs in the refrigeration and air-conditioning (RAC) sector in India was initiated in 1993. Enterprises were recognized for the commercial refrigeration (157) and transport refrigeration (39) sectors. Thus, after implementing the phase-out plan, the use of CFCs in this sector has been eliminated⁸. Methyl chloroform has been completely phased out after 2000 (Figure 2).

Table 1. Technology options in the foam manufacturing sector

Sub-sector	Obsolete technology	Identified technology options
Polyurethane rigid foam		
Domestic refrigerators – freezers	HCFC-141b	Hydrocarbons, HFC-245fa, HFC-134a, HFOs, FEA-1100, solstice-LBA (liquid blowing agent)
Other appliances	HCFC-141b	Hydrocarbons, HFC-245fa, HFC-365mfc/HFC-227ea blends, HFC-134a, methyl formate, CO ₂ (water), HFOs
Transport and reefers	HCFC-141b	Hydrocarbons, HFC-245fa, HFC-365mfc/HFC-227ea blends, HFC-134a, HFOs
Continuous panels	HCFC-141b	Hydrocarbons, HFC-245fa, HFC-365mfc/HFC-227ea blends
Discontinuous panels	HCFC-141b	Hydrocarbons, HFC-245fa, HFC-365mfc/HFC-227ea blends, HFC-134a, methyl formate, CO ₂ (water), formic acid
Spray	HCFC-141b	HFC-245fa, HFC-365mfc/HFC-227ea, supercritical CO ₂ , CO ₂ (water), HFOs
Pipe-in-pipe	HCFC-141b	Hydrocarbons, HFC-245fa, HFC-365mfc/HFC-227ea blends, methyl formate, CO ₂ (water)
Extruded polystyrene		
XPS sheet	HCFC-142b, HCFC-22	Hydrocarbons (butane, isobutane, pentane, isopentane), HFCs (HFC-134a, HFC-152a) and hydrocarbon/CO ₂ (LCD) blends
XPS board	HCFC-142b, HCFC-22	HFCs + blends, CO ₂ (or CO ₂ /alcohol), hydrocarbons
Polyurethane flexible foam		
Integral skin	HCFC-141b, blends of HCFC-142b and HCFC-22	HFC-134a, HFC-245fa, HFC-365mfc/HFC-227ea blends, <i>n</i> -pentane, methyl formate, CO ₂ (water)
Shoe sole	HCFC-141b, HCFC-142b	CO ₂ (water), HFC-134a
Flex moulded	HCFC-141b, HCFC-142b	CO ₂ (water), methyl formate
Flexible slab stock	HCFC-141b, HCFC-142b	CO ₂ (water), methylene chloride

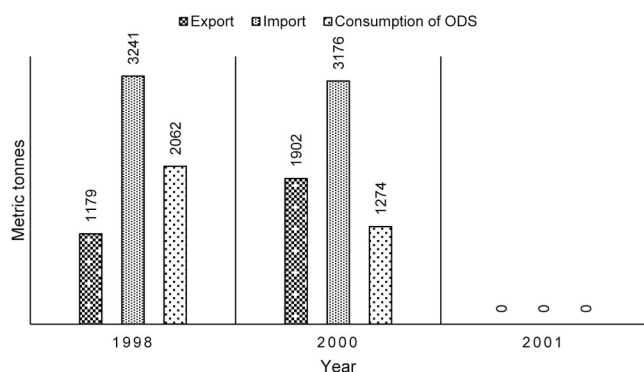


Figure 2. Phase-out data of methyl chloroform for the period 1998–2001.

National CFC consumption phase-out plan: In April 2004, at the 42nd Meeting, the Ex-Com of MLF approved the National CFC consumption phase-out plan (NCCoPP) for the RAC servicing sector to phase out 1502 ODP tonne of CFCs. NCCoPP established training cells in 15 states of India. The objective was to encourage good servicing practices among all RAC enterprises, especially those consuming more than 50 kg of CFCs per annum. A total of 955 recovery and recycling units were provided to the enterprises in four stages, with equipment support to 120 Industrial Training Institutes. Awareness-generation workshops were conducted for the servicing enterprises with training programmes to create a demand for recovered and reclaimed refrigerants. Approximately 20,000 technicians were trained. Many reclamation centres have been set up across

the country, viz. Bengaluru, Lucknow, Chandigarh, Kolkata, Hyderabad, Jaipur and Ahmedabad, and reclamation units have also been provided to the Indian Railways and the Indian Armed Forces. Hence, NCCoPP has been effectively executed and has achieved its aim to phase out CFCs completely⁸.

CFC phase-out in the aerosol sector

The consumption of CFCs was phased out in December 2003, except for using pharmaceutical-grade CFCs in manufacturing medical aerosols, MDIs for asthma and COPD patients. In 2002, 637 ODP tonnes of CFC were phased out in the industrial aerosol sector. Hydrocarbon-based propellants such as butane have substituted the previous CFC-containing aerosol propellants (chiefly, CFC-11 and CFC-12). Furthermore, safety measures for handling hydrocarbons were considered an important part of the investments needed for conversion. Figure 3 shows the phase-out of CFC-11 and CFC-12 from 1998 to 2011.

In Figure 3, the decreasing trend in the production of CFC-11 and CFC-12 can be seen from 1998 to 2009 with a small production in 2010. The decreasing trend can be observed in the case of consumption of ODS for the manufacture of MDIs according to the approved EUN in Article-5 Party for manufacturing MDIs. Moreover, due to the accelerated phase-out of the CFC Production Agreement, there was quite a noticeable decrease in consumption of ODS from 2008 to 2009. CFC-11 was completely phased out thereafter, and the same can be seen in 2011.

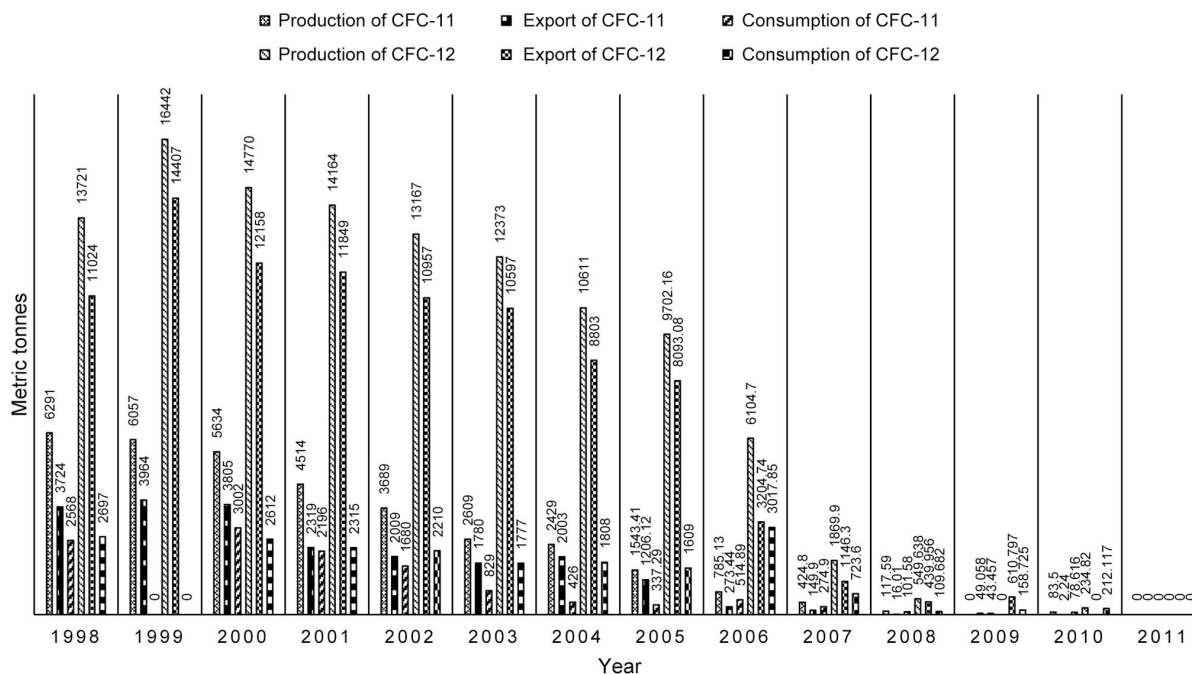


Figure 3. Phase-out data of CFC-11 and CFC-12 for the period 1998–2011.

The production of CFC-12 was due to the manufacture of pharma-grade (inclusion of 24.4 MT non-pharma-grade) MDIs under approved EUN. Also, the same trend can be observed in the case of ODS consumption from 2008 to 2010. This is due to the consumption of ODS in the manufacture of MDIs according to the approved EUN in an Article-5 party for the same. CFC-11 and CFC-12 were completely phased out thereafter and the same can be seen in 2011.

CFC phase-out in the manufacture of pharmaceutical MDIs

With the United Nations Development Programme (UNDP) as the lead implementing agency, UNEP and the Government of Italy as cooperating agencies with the MDI manufacturing industry under the guidance of the Ozone Cell, MoEF&CC, GoI have implemented the National Strategy for Transition to Non-CFC MDIs and plan for phasing out CFCs in the manufacture of pharmaceutical MDIs. Many national/regional workshops have been organized to spread awareness about phasing out CFCs. In November 2010, the 22nd MOP congratulated India for phasing out CFCs in this sector. Nevertheless, since 2011 all the MDI manufacturing industries in the country are CFC-free, which was confirmed by the independent verification by UNDP through an MDI International Expert in November 2012.

Halon phase out in various sectors

The phase-out in the consumption of halons in India started in 1994 and has now been accomplished. MoEF&CC, GoI,

with financial help from MLF, has set up a National Halon Banking Facility at the Centre for Fire, Explosive and Environment Safety, Defence Research and Development Organization, Ministry of Defence, GoI. Moreover, the three Defence Forces have their own Halon Banking Facilities for future requirements. Also, halon conservation programmes have been introduced to limit emissions. Figure 4 shows the decreasing trends of importation of halon-1301 and halon-1211 till 2007, after which the importation shows an irregular pattern as this includes recycled halon-1301 and halon-1211. The halons were completely phased out in 2003, except in the servicing sector.

CTC phase-out for the solvent sectors

CTC usage of 2080 ODP tonnes has been phased out after establishing the CTC phase-out projects. Since 1 January 2010, consumption of CTC has been entirely phased out. Due to the awareness programmes and the policy adopted by GoI, the CTC phase-out plan is counted as an achievement in industries involving garment and metal cleaning. Figure 5 shows the decreasing trend of feedstock till 2009, but its production increased in 2010 for restocking. The export and import also increased after 2013 due to feedstock applications.

Comparison of consumption and production of ODS

Globally, 98.6% of ODS or 1.75 million ODP tonnes has been phased out as a result of the implementation of the Montreal Protocol⁹ (Table 2).

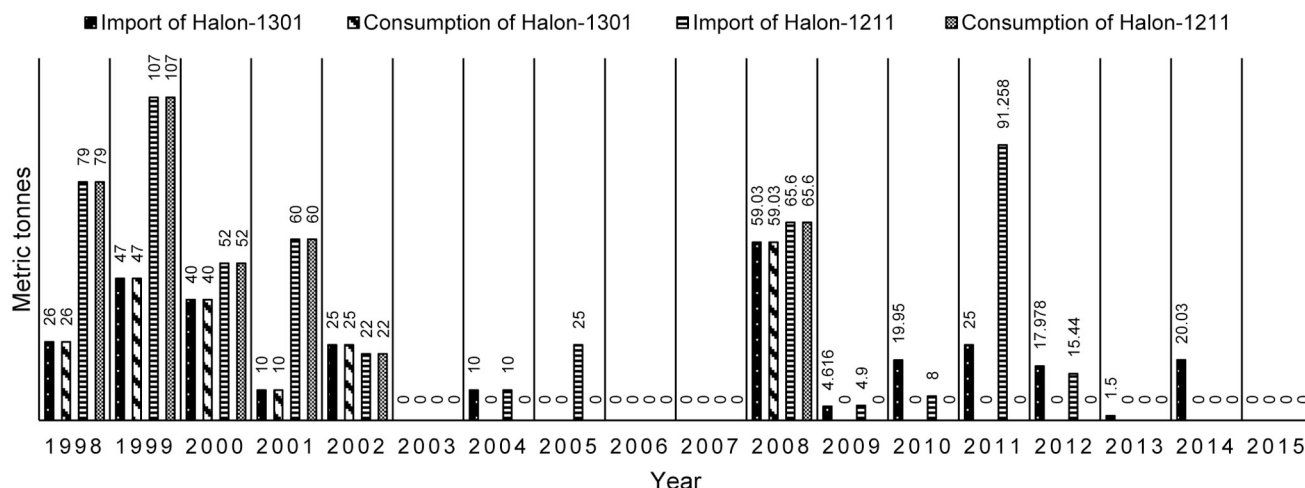


Figure 4. Phase-out data of halon-1301 and halon-1211 for the period 1998–2013.

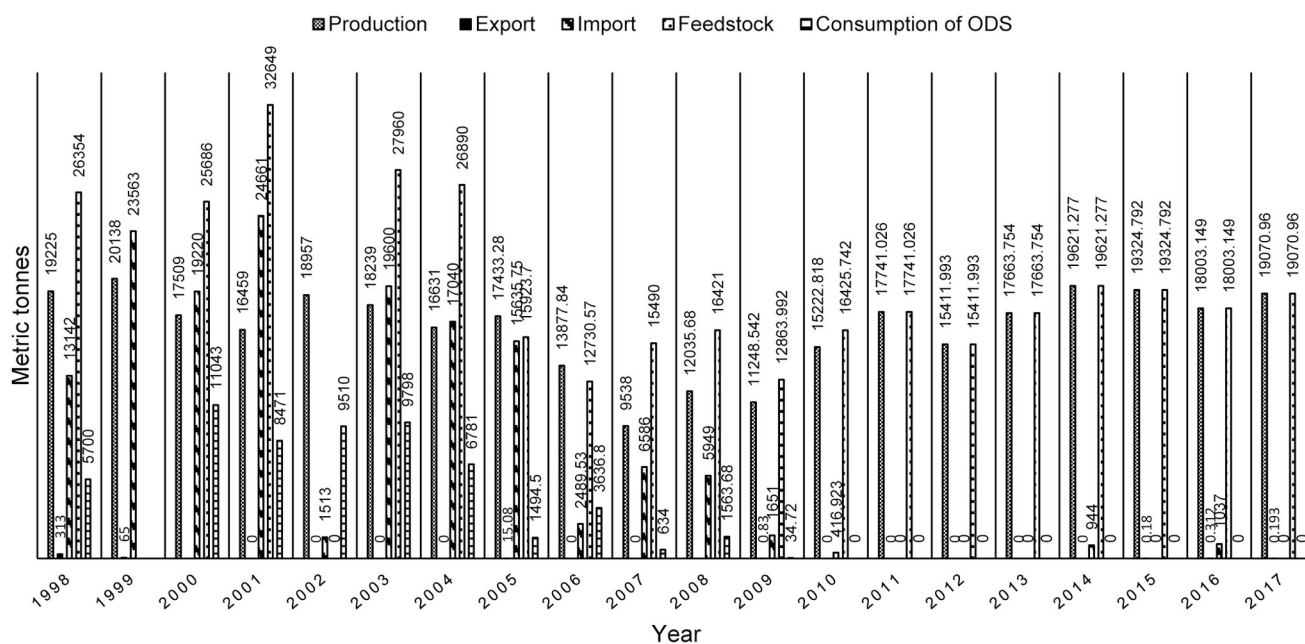


Figure 5. Phase-out data of CTC for the period 1998–2017.

Table 2. Consumption of ODS in ODP tonnes

Country	2015	2016	2017	2018	2019	2020
India	958.24	1,014.18	806.49	866.76	935.27	297.49
European Union	-3,248.88	-4,096.01	-3,907.9	-1,061.98	61.2	-2,043.05
United States of America	274.07	-7.75	-532.22	-2,310.5	-2,248.07	-1,801.2
China	13,758.01	14,496.89	14,680.06	14,658.32	14,346.51	10,803.95
Russian Federation	441.13	59.09	283.01	288.18	286.69	-4328.66

Source: Ozone Secretariat UNEP¹⁰.

India continues to phase out ODS and is striving towards meeting its commitment under the Montreal Protocol. In 2020, the consumption of ODS amounted to 297.49 ODP tonnes, down from 935.27 ODP tonnes in 2019.

Also, the production amounted to 1354.83 ODP tonnes in 2020, down from 1933.08 ODP tonnes in 2019 (Table 3). India's ODS consumption and production are more than those of developed nations such as the USA, the European

Table 3. Production of ODS in ODP tonnes

Country	2015	2016	2017	2018	2019	2020
India	1,693.32	1,665.19	1,789.48	1,907.97	1,933.08	1,354.83
United States of America	564.9	239.56	-305.03	-2,170.03	-1,987.09	-1,678.89
China	22,171.21	22,789.4	21,745.93	21,030.33	20,687.08	16,243.15
Russian Federation	404.67	-136.85	161.31	188.4	181.89	4.33

Source: Ozone Secretariat UNEP¹⁰.

Union and the Russian Federation but considerably lower than developing nations such as China. India's contribution to consumption and production of ODP, when compared to China, is significant but small compared to other countries. Yet India commendably signed the Montreal Protocol and reduced its emissions.

Conclusion

The Montreal Protocol to safeguard the ozone layer is the only international treaty with most nations as its Members. India was successful in phasing out ODS due to effective identification of priority sub-sectors, involving the right stakeholders at the right time in the planning and implementation levels, notifying regulations and policies to the stakeholders, organizing awareness workshops, monitoring the production and consumption of ODS, and increasing the capacity of the Ozone Cell at the regional level. India's control, management and governance thus provide an example to other developing countries to phase out ODS. The country has set an example for the world to follow with regard to the phasing out of ODS. Atmospheric measurements have not verified these reported values. Such measurements would be useful in validating the reported data.

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