China's enforcement of international environmental agreements: The case of the Montreal Protocol

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Introduction

China is one of the largest stakeholders in global environmental governance. With its ascent as an economic superpower, China's ecological and climate footprint has grown exponentially, making it a major contributor to global environmental challenges and key player in providing solutions. Since entering the stage of global environmental governance in 1972, China has joined multilateral environmental agreements (MEA) in almost all environmental areas, and it has maintained a good record of compliance.[1] Yet, as this article shows, enforcing international environmental regulation in an increasingly complex and globalized economy demands robust implementation capability. Recent incidents at the international environmental regime on ozone

1. [Lianheguo Zai Hua Sishi Zhounian Xilie Zhuanti Baodao] Gong Zhu Zhongguo Lu Shui QingShan—Zhuanfang Huanjing Shu Zhu Hua Daibiao Tu Rui He ([联合国在华四十周年系列专题报道] 共筑中国绿水青山——专访环境署驻华代表涂瑞和) [Special Report on the 40th Anniversary of the United Nations in China] Building China's Green Water and Green Mountains Together - Interview with Tu Ruihe, Representative of the Environment Agency in China] (China) https://news.un.org/zh/story/2019/09/1040602 [https://perma.cc/9C2E-MLHF].

layer protection have put China's capability in chemical management to the test.

China's enforcement capacity varies across environmental issues. This article focuses on its regulation of ozone-depleting substances (ODS) under the Vienna Convention on the Protection of the Stratospheric Ozone Layer and its implementation mechanism, the Montreal Protocol on Substances That Deplete the Ozone Layer (thereafter the Montreal Protocol). Since joining the Montreal Protocol in 1991, China has been in full compliance with financial support from the Multilateral Fund of the Montreal Protocol. Starting in 2013, however, international monitoring stations have detected increasing concentration of CFC-11, over half of which later traced back to China. Although China swiftly cracked down on illegal CFC-11 production and filled domestic enforcement gaps, the incident damaged China's compliance record at the Montreal Protocol with ongoing repercussions. Recent detections of increasing HFC-23 and methyl bromide in 2023 and 2024 have again put China under the spotlight for potential illegal emissions.

This article starts by overviewing China's implementation and enforcement framework for the Montreal Protocol. It then examines the incident of the unexpected CFC-11 emissions, including the discovery of illegal production, the ensuing debate at the Montreal Protocol, and China's domestic and international responses. The next section traces subsequent reforms at the Montreal Protocol and China's involvement in emerging unexpected emissions. The concluding section evaluates China's efforts in enforcement capacity building and ongoing challenges it faces.

I. Chinese Institutions for Ozone Layer Protection

The Montreal Protocol was created to phase-out chlorofluorocarbons (CFCs, commonly known as "freon") – the primary ODS – as well as its substitutes, hydrochlorofluorocarbons (HCFCs) and hydrofluorocarbons (HFCs), through successive amendments.[2] Universally ratified, the Montreal Protocol is widely regarded as the most successful MEA.[3] Embodying the Common-but-differentiated responsibility principle, the Montreal Protocol grants developing countries (i.e. Article-5 countries) a 10- to 15-year grace period and access to the Multilateral Fund (MLF), financed by industrialized countries (i.e. non-Article 5 countries), to support their transitions. In line with their obligations, industrialized and developing countries phased out CFCs by 1995 and 2010, respectively,

2. *The Montreal Protocol on Substances that Deplete the Ozone Layer*, UN Environment Programme, https://ozone.unep.org/treaties/montreal-protocol-substances-deplete-ozone-layer/the-evolution-of-the-montreal-protocol [https://perma.cc/9PYQ-N5QU].

3. *Montreal Protocol on Substances that Deplete the Ozone Layer*, Department of Climate Change, Energy, the Environment and Water, https://www.dcceew.gov.au/environment/protection/ozone/montreal-protocol [https://perma.cc/28CF-B4RB].

and they are on track to phase out HCFCs by 2020 and 2030. China, the world's largest ODS producer and beneficiary of the MLF, has maintained a strong compliance record. It phased-out CFCs by 2010 and halved HCFC by 2023, in fulfillment with the Montreal Protocol.[4]

China's implementation of the Montreal Protocol consists of legal, regulatory, and economic measures, with regulatory policies guiding industries' compliance. China joined the Montreal Protocol in 1991 with the London Amendment and established the National Leading Group for the Protection of the Ozone Layer, headed by State Environmental Protection Administration with liaisons from seventeen ministries and national agencies. This taskforce oversees implementation of the phase-out management plan (PMP) for controlled substances.[5] China submitted its PMP to the Ozone Secretariat, and domestic companies work with the government and implementing agencies to apply for MLF support for their transitions.[6]

The primary ODS regulator is the Ministry of Ecology and Environment (MEE).[7] Authorized by the Air Pollution Prevention and Control Law, it regulates ODS based on the *Regulation on the Administration of Ozone Depleting Substances* [8] with three sets of tools. First, it implements the PMP with sectoral policies guiding the phase-out of chemicals in the List of controlled Ozone Depleting Substances.[9] It typically bans the expansion of production capacity for controlled substances a couple of years prior to the freeze year stipulated by the Montreal Protocol.[10] It also coordinates regulatory timelines of different sectors and prioritizes industries with feasible alternatives. Second, the MEE establishes the Office for the Management of ODS Importation and Exportation

4. *Country Data (China)*, UN Environment Programme, https://ozone.unep.org/countries/profile/chn [https://perma.cc/5AS4-BQUA].

5. Guojia Baohu Chouyangceng Lingdao Xiaozu (国家保护臭氧层领导小组) [National Leading Group for the Protection of the Ozone Layer] (China).

6. *Project Guidelines and Tools*, Multilateral Fund For The Implementation of The Montreal Protocol, https://www.multilateralfund.org/resources/project-guides-tools [https://perma.cc/CQ5T-MW7X].

7. Ministry of Ecology and Environment of the People's Republic of China (MEE) (中华人民共和国生态环境部), Xiaohao Chouyangceng Wuzhi Guanli Tiaoli (消耗臭氧层物质管理条例) [Regulations on the Administration of Ozone-depleting Substances] (China). The MEE was preceded by SEPA (up to 2008) and MEP (2008–2018).

8. *Id.*

9. MEE, Zhongguo Shou Kong Xiaohao Chouyangceng Wuzhi Qingdan (中国受控消耗臭氧层物质清单) [List of controlled Ozone Depleting Substances in China] (China).

10. MEE, Shengtai Huanjingbu Daqi Huanjingsi Youguan Fuzeren Jiu <Guanyu Yange Kongzhi Diyipi Qingfutanhuawu Huagong Shengchan Jianshe Xiangmu de Tongzhi>(生态环境部大气环境司有关负责人就<关于严格控制第一批氢氟碳化物化工生产建设项目的通知>答记者问 [MEE's Q&A on<Notice on strictly controlling first batch of HFC chemical production projects>] (China). https://www.mee.gov.cn/ywdt/zbft/202201/t20220106_966269.shtml [https://perma.cc/3C7B-GM3B].

with Ministry of Commerce and National Customs.[11] All companies are required to obtain a quota license from the MEE to produce, export, or import ODS.[12] Third, it establishes the Office for the Implementation of Multilateral Fund Project to manage MLF-funded projects.[13] Given that the ODS sector is a export-oriented sector consisting of diverse products, the MEE works closely with industry stakeholders and coordinates regularly with economic authorities, including National Development and Reform Commission, Ministry of Industry and Information Technology, and Ministry of Commerce.

The MEE regulates ODS with a "capacity control and quota man-agement" approach.[14] It sets total allowable production capacity of controlled substances and allocates quotas to eligible companies that apply for them. Companies must register activities related to ODS pro-duction, sale, use, recycling and disposal to prefectural, provincial, and national MEE authorities. Local environmental and industrial agencies conduct regular inspections and unannounced spot checks on companies. Transboundary movements are regulated by National Customs.

To summarize, China's ODS institutions, such as the PMP and ODS export-import management office, are structured to implement Montreal Protocol decisions, but this regulatory approach reflects its own devel-opmental strategy and political institutions. As a developmental state, Chinese government works closely with industry to facilitate compliance, navigate technology transitions, and maintain export competitiveness while keeping abatement cost down.[15] In other words, ODS enforcement in China relies more on administrative measures than on public/indepen-dent monitoring capacity.

II. The Unexpected Emissions of CFC-11

China's compliance of the Montreal Protocol came under scrutiny in 2018. In May, *Nature* published a study by scientists from National Oceanic and Atmospheric Administration (NOAA) and European universities revealing unexpected emissions of CFC-11.[16] As the first-generation ODS, CFC-11 was supposed to be phased out globally by 2010 according to the Montreal Protocol. The study found that since 2013,

11. Guojia Xiaohao Chouyangceng Wuzhi Jin Chukou Guanli Bangongshi (国家消耗臭氧层物质进出口管理办公室) [National Ozone Depleting Substances Import and Export Management Office] (China).

12. MEE, *supra* note 7, at 2.

13. Baohu Chouyangceng Duobian Jijin Xiangmu Guanli Bangongshi (保护臭氧层多边基金项目管理办公室) [Multilateral Fund for Protection of the Ozone Layer Project Management Office] (China).

14. Zhonghua Renmin Gongheguo Guowuyuan Ling (中华人民共和国国务院令) [Order of the State Council of the People's Republic of China] (China).

15. Shiming Yang, *Growing Apart: China and India at the Kigali Amendment to the Montreal Protocol*, 73 Global Environmental Politics 74 (2023).

16. Stephen A. Montzka et al., *An Unexpected and Persistent Increase in Global Emissions of Ozone-depleting CFC-11*, 557 Nature 413 (2018).

the rate of decline in atmospheric CFC-11 concentration had slowed by about 50 percent from 2002–2012 levels.[17] It estimated an annual increase in CFC-11 emissions of 13 ± 5 gigagrams since 2013, despite nearly no reported production after 2006.[18] With margins of error, the article suggested that the unexpected emissions of CFC-11 likely came from new production in the Northern hemisphere, especially in East Asia.[19] Because CFC still contributes to a quarter of all chlorines reaching the stratosphere, the resurgence in emissions raised serious concerns about a timely recovery of the stratospheric ozone layer. This study, published less than two months before the Open-End Working Group (OEWG) of the Montreal Protocol, alarmed parties and cast doubt on the regime's effectiveness.[20] The Montreal Protocol had until then nearly full compliance, as countries had conducted multiple ODS transitions, often ahead of schedule. Moreover, it was puzzling why any actors would switch back to CFC-11 after it had been replaced by HCFCs and HFCs.

The Environmental Investigation Agency (EIA), a prominent NGO active in ozone and climate governance at international and national levels, pointed the finger at China. Following the *Nature* article's indication that the emissions likely originated in East Asia, EIA conducted a covert investigation in China by buying and testing chemical samples through online channels. The investigation revealed that CFC-11 was being used as the blowing agent in the pre-blended "white agent" in rigid PU foams.[21] EIA hypothesized that regulatory changes contributed to this illegal use. China's tightening of fire retardant and energy efficiency standards for buildings in 2012, combined with the phase-out of HCFC-141b starting 2013, drove up HCFC prices,[22] incentivizing PU foam manufacturers to secretly switch back from HCFC to CFC-11.[23] Discovery of this violation was complicated by the industry's fragmentation, as it is dominated by small and medium sized enterprises.[24] EIA estimated that China's CFC-11 emissions between 2012 and 2017 averaged 10,307

17. *Id*.
18. *Id*.
19. *Id*.
20. Beate Antonich, Ph.D., Jennifer Allan, Ph.D & Nadia Sohier Zaman, *Summary of the 40th Meeting of the Open-ended Working Group of the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer*, 19 Earth Negotiations Bulletin 5 (2018).
21. Environmental Investigation Agency, Blowing It: Illegal Production and Use of Banned CFC-11 in China's Foam Blowing Industry 3 (2018).
22. *Id*.
23. *Id* at 11.
24. Guowai Fei Zhengfu Zuzhi Baogao Zhongguo Qiye Weigui Shengchan Shiyong Lu Fu Ting Wuzhi Buzhou Chouyang "Shashou": Zhibiao Geng Yao Zhiben (国外非政府组织报告中国企业违规生产使用氯氟烃物质 捕捉臭氧"杀手"：治标更要治本) [Foreign NGOs Report That Chinese Companies Violate Regulations in the Production and Use of CFCs Capturing Ozone "Killers": Treating the Root Cause is More Important Than Treating the Symptoms] (2018), https://news.sciencenet.cn/dz/upload/20188112722649.pdf [https://perma.cc/2RZE-UL6F].

to 12,165 tonnes annually, which fell within the range suggested in the *Nature* article (8,000–18,000 tonnes).[25]

EIA released its report right before the OEWG-40 and distributed it to parties and observers at the venue. NOAA also held a side event on the unexpected CFC-11 emissions to present its latest findings.[26] The revelations prompted strong reactions from parties. At the request of the European Union, the issue was added as a sub-item on the agenda, leading to a joint presentation by the Scientific Assessment Panel (SAP) and NOAA, followed by an extensive question-and-answer session and a contact group that continued discussion until the end of the OEWG-40.[27] Many parties expressed concerns over the violation and called for more information:

"Samoa pointed out that if high-volume producing countries are not complying, 'all of the efforts of the small island developing states will be wasted.' She asked the Montreal Protocol to address this complex issue as it has addressed other challenging issues in the past… Japan observed it may be difficult to continue to support the MLF at its current level if there is ongoing production in Article 5 parties as a matter of accountability . . . The Federated States of Micronesia stressed the need for urgent action, calling for investigation on the ground and remedial action. Saudi Arabia rejected the suggestion that the Middle East is producing or using CFC-11 and underlined the challenges of controlling online sales."[28]

The Chinese delegation supported the agenda item and expressed its willingness to engage in discussions.[29] On the final day of OEWG-40, China gave a statement addressing the issue of unexpected CFC-11 emissions and the related publications:

> "[T]he representative of China made a statement denouncing the distribution at the meeting of a report by the Environmental Investigation Agency in which 18 companies in China's foam-blowing industry were accused of involvement in the large-scale illegal sale and use of CFC-11. His Government had launched an investigation the previous month, immediately after receiving a copy of the report from the Agency, and had found that the result of the investigation to date was not consistent with the findings of the Agency's report. The report, in sharp contrast to the *Nature* article that had sparked the current discussion, was based on uncorroborated data obtained

25. Environmental Investigation Agency, Blowing It: Illegal Production and Use of Banned CFC-11 in China's Foam Blowing Industry 8 (2018).

26. U.N. Environment Programme [UNEP], *Rep. of the Fortieth Meeting of the Open-ended Working Group of the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer*, U.N. Doc. UNEP/OzL.Pro.WG.1/40/7 at 21 (July 2018).

27. *Id.*

28. Beate Antonich, Ph.D., Jennifer Allan, Ph.D & Nadia Sohier Zaman, *Summary of the Fortieth Meeting of the Open-ended Working Group of the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer*, 19 Earth Negotiations Bulletin 11 (2018).

29. Author's notes from personal witnessing of the events.

> from unreliable sources, through social media; it impugned the reputation of his country's foam-blowing industry and undermined the prospects for goodwill and the involvement of non-governmental organizations in the dialogue needed to address the issue. Endorsing the conference room paper as a sound basis for further discussion at the Thirtieth Meeting of the Parties, in which his country was ready to actively participate, he called on all parties to work together in a calm, scientific and mutually respectful manner, urging them to condemn the unprecedented publication of baseless accusations against a fellow party."[30]

To dispel speculations among parties, the Chinese delegation detailed its response to the reported potential illegal emissions. Acting on leads from the EIA in June and July, Chinese authorities followed up on all nineteen enterprises that EIA mentioned. Of these, nine enterprises showed no evidence for CFC-11 involvement, one was awaiting test results, and nine remained under investigation at the time of OEWG-40.[31] From China's perspective, the claims made in the EIA report had yet to be substantiated. The Chinese delegation condemned the EIA for widely distributing its "fact-distorting" report based on "illegal evidence-collecting methods" and "baseless accusations" against a state party at an international treaty. The Chinese delegation expressed appreciation for the scientific vigor of the *Nature* article, while suggesting that scientists could notify relevant parties informally prior to publication to expediate correctional enforcement. The statement reaffirmed China's commitment to full compliance with the Montreal Protocol, highlighted the remaining uncertainty regarding the emissions, and reiterated its willingness to cooperate to address the issue.

The OEWG-40 convened a contact group on the issue and requested the SAP and Technology and Economic Assessment Panel (TEAP) to collect information for the MOP-30.[32] In the four months leading up to MOP-30, China took swift action to investigate domestic CFC-11 production and use and to strengthen enforcement with inspections and prosecution. Between August and October 2018, the MEE launched a nationwide ODS enforcement campaign, inspecting 1,172 companies across the country and uncovered CFC-11 containing products from 10 enterprises. It also identified two CFC-11 production sites totaling 29.9 tonnes.[33] In August 2018, Chinese ambassador to the UK

30. UNEP, *supra* note 26, at 25.

31. EIA contacted Chinese authorities on June 19th and 22nd (10 enterprises) and July 6th (9 enterprieses). Investigation of the latter 9 enterprieses were ongoing during the OEWG-40 (July 11-14th), according to the Chinese delegation. Author's notes from personal witnessing of the events.

32. UNEP, *supra* note 26, at 25.

33. UNEP, *Rep. of the Thirtieth Meeting of the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer*, U.N. Doc. UNEP/OzL.Pro.30/11 at 20 (Nov. 2018).

wrote a letter to the *Guardian* to reaffirm China's full enforcement of the Montreal Protocol.[34]

The MOP-30 in November 2018 brought greater clarity to the issue of unexpected CFC-11 emissions. While new scientific research remained inconclusive, it supported suspicions that the emissions originated in eastern China.[35] China did not deflect responsibility by citing the remaining untraced emissions or scientific uncertainty. Instead, it reported the extensive enforcement it had taken since OEWG-40. It acknowledged its "extremely weak ODS monitoring system,"[36] reiterated its determination to fully comply with the Montreal Protocol, and expressed openness to cooperation, including inviting parties and stakeholders to a seminar it planned on enforcement capacity building.[37] Continuing on the work at OEWG-40, the parties adopted a decision requesting the SAP and TEAP to continue their investigations and urging all parties to ensure sustained phase-out of CFC-11 under the Montreal Protocol.[38]

Over the following year, China undertook comprehensive measures to eliminate illegal production and use of CFC-11. As it reported to the Executive Committee of the MLF after the MOP-31, China implemented four sets of actions since it was alerted to the unexpected CFC-11 emissions 18 months ago.[39] First, it launched two nationwide enforcement campaigns (August-October 2018, June-August 2019) covering all provinces, in which enforcement officers were equipped with portable instant detectors and they tested products from over 1,000 system houses and foam manufacturers. These enforcement actions effectively cracked down illegal production and use of CFC-11 in China, leading to a sharp decline of unexpected CFC-11 emissions and avoiding any substantial delay in ozone layer recovery.[40]

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34. Zeng Rong, *Embassy Spokesperson's letter to The Guardian on its report on Chinese enterprises' production and use of CFC-11*, Embassy of the People's Republic of China in the United Kingdom of Great Britain and Northen Ireland (2018).

35. M.F. Lunt et al., *Continued Emissions of the Ozone-Depleting Substance Carbon Tetrachloride from Eastern Asia*, 45 Geophysical Research Letters 11, 423 (2018); Sunyoung Park et al., *Toward Resolving the Budget Discrepancy of Ozone-Depleting Carbon Tetrachloride (CCl4): An Analysis of Top-Down Emissions from China*, 18 Atmospheric Chemistry and Physics 11, 729 (2018).

36. China's statement at the high-level Segment, the 30th Meeting of the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer, 2018.

37. *Id.*; Keith Ripley et al., *Summary of the Thirtieth Meeting of the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer*, 19 Earth Negotiations Bulletin 9 (2018).; UNEP, *supra* note 33, at 20.

38. UNEP, *supra* note 33, at 40.

39. Government of China, "Progress report pursuant to Decision 83/41 of the 83rd Meeting of the Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol", *in* UNEP, *Reports on Projects with Specific Reporting Requirements Addendum*. UNEP/OzL.Pro/ExCom/84/22/Add.1 at 24-32 (Nov. 2019).

40. UNEP, *Rep. of the Thirty-First Meeting of the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer*, U.N. Doc. UNEP/OzL.Pro.31/9

Second, China strengthened its implementation and enforcement capacity by upgrading enforcement equipment, introducing a whistleblower hotline with report-for-reward, and addressing regulatory and technical gaps. In January 2019, the MEE mandated six agencies, including the National Environmental Monitoring Center, to build capacity to detect ODS in industrial products, leading to a series of new national standards for ODS detection methods.[41] In September 2019, the MEE issued a legal opinion of Article 3 of the *Regulation on the Administration of Ozone Depleting Substances*, clarifying that "production without a permit" includes permits for controlled as well as phased-out substances.[42] To further standardize inspection practice and ODS detection, the MEE released *the ODS Inspection Guidelines (2020)* and *Technical Specification for Monitoring Ozone-depleting Substances in Chemical Products for Industrial Use (2021)*.[43] The overarching regulation for ODS management, the *Regulation on the Administration of Ozone Depleting Substances,* was also amended in 2024 to substantially increase penalties and introduce new categories of noncompliance.[44]

Third, China enhanced its domestic monitoring, reporting, and verification capacity. It tightened registration requirements for industrial activities concerning ODS and requires all companies to register

(Nov. 2019); World Meterological Organization, Report on the Unexpected Emissions of CFC-11: A Report of the Scientific Assessment Panel of the Montreal Protocol on Substances that Deplete the Ozone Layer, WMO-No: 1268 at 3 (2021).

41. Gongyeyong Huaxue Chanpin Xiaohao Chouyangceng Wuzhi Jiance Jishu Zhinan （ Zhengqiuyijian Gao ） Bianzhi Shuoming (工业用化学产品消耗臭氧层物质检测技术指南（征求意见稿）编制说明) [Technical Guidelines for the Detection of Ozone Depleting Substances in Industrial Chemical Products (Draft for Comments)] (2020), https://www.mee.gov.cn/xxgk2018/xxgk/xxgk06/202102/W020210203331720703735.pdf [https://perma.cc/W5FT-A6XQ].

42. Guanyu Xiaohao Chouyangceng Wuzhi Guanlitiaoli Zhong " Shiyong " Gainian Ji " Wu Shengchan Peie Xukezheng Shengchan " De Falu Shiyong Yijian . Huan Fagui Han (关于《消耗臭氧层物质管理条例》中"使用"概念及"无生产配额许可证生产"的法律适用意见. 环法规函〔2019〕112号) [Opinions on the legal application of the concept of "use" and "production without a production quota license" in the "Regulations on the Management of Ozone Depleting Substances". Environmental Law Letter No. 112] (2019), https://www.mee.gov.cn/xxgk2018/xxgk/xxgk04/201909/t20190924_735336.html

[https://perma.cc/9B5M-JDS6]. This opinion was later incorporated in the amendment of the Regulation in 2024.

43. MEE, Xiaohao Chouyangceng Wuzhi Jianguan Zhinan (Shixing) (消耗臭氧层物质监管指南（试行）. 环办执法函〔2019〕949号) [Guidelines for the Regulation of Ozone Depleting Substances (Trial)] (2019); MEE, Gongyeyong Huaxue Chanping zhong Xiaohao Chouyangceng Wuzhi Jiance Jishu Guifan (工业用化学产品中消耗臭氧层物质检测技术规范, HJ1197–2021) [Technical Specification for Monitoring Ozone-depleting Substances in Chemical Products for Industrial Use] (2021).

44. Guowuyuan Guanyu Xiugai Xiaohao Chouyangceng Wuzhi Guanlitiaoli De Jueding Guo Ling Di 770 Hao (国务院关于修改(消耗臭氧层物质管理条例)的决定.国令第770号) [Decision of the State Council on Amending the Regulations on the Administration of Ozone Depleting Substances (Decree No. 770 of the State Council of the People's Republic of China)] (Jan. 5, 2024).

ODS-related information to local, provincial, and national authorities. New companies are forbidden from entering the ODS market without prior authorization.[45] In building a monitoring network, China began by installing a monitoring system for carbon tetrachloride, which is used to produce CFCs. The government has also been laying groundwork for air quality monitoring network capable of detecting ODS.[46]

Fourth, China implemented domestic and international policies to enhance communication with the international community. In March 2019, it hosted the International Seminar on the Montreal Protocol Enforcement Capacity was held in Beijing, where Chinese stakeholders presented its progress on enforcement capacity building and engaged in dialogue on ongoing challenges. In September 2019, Shandong province[47] held a widely publicized event to commemorate the International Ozone Day under the theme of "Cracking Down on Illegal ODS Activities and Strengthening Domestic Supervision and Management." The event drew participation from domestic and international stakeholders and received broad media coverage. National government attached importance to showing China as a responsible party in ozone layer protection by sending ministerial-level officials to Montreal Protocol meetings Ozone Day events. It also invited EIA, the whistle-blower of unexpected CFC-11 emission in China, in 2018 and 2019 to discuss improvement in enforcement and monitoring and for the International Ozone Day, respectively. The MEE established the Montreal Protocol Compliance Expert Group as well as the ODS Monitoring Expert Group in 2020 to inform domestic implementation policy-making.[48] China provided regular updates to the Montreal Protocol bodies and relevant international institutions. By 2021, the CFC-11 emissions as an incident had largely blown over, as it ceased being a hot topic at the Montreal Protocol meetings.

The illegal CFC-11 emission incident reveals weakness of China's ODS regulation system. The emissions went unnoticed for two reasons.

45. *Id.*

46. *See* Government of China, *supra* note 39, at 24.

47. UNEP, Meeting to Commemorate the 2019 International Ozone Day Held in Jinan (Sept. 16, 2019), https://wedocs.unep.org/bitstream/handle/20.500.11822/30721/8080WODChina_2019.pdf?sequence=1&isAllowed=y [https://perma.cc/L5Q4-QKNG].

48. Guanyu Chengli Guanyu Xiaohao Chouyangceng Wuzhi De Mengtelier Yidingshu Zhongguo Luyue Zhuanjiazu De Han, Daqi Han 1 Hao, 关于成立《关于消耗臭氧层物质的蒙特利尔议定书》中国履约专家组的函 大气函1号 [Letter on the establishment of the China Implementation Expert Group on the Montreal Protocol on Substances that Deplete the Ozone Layer, Atmospheric Letter No. 1] (2020) https://www.mee.gov.cn/xxgk2018/xxgk/sthjbsh/202001/t20200121_760767.html [https://perma.cc/GUS4-HQ5U]; Guanyu Chengli Zhongguo Luxing Mengtelier Yidingshu Xiaohao Chouyangceng Wuzhi Jiance Zhuanjia Weiyuanhui De Tongzhi , Jiance Han 5 Hao (关于成立中国履行《蒙特利尔议定书》消耗臭氧层物质监测专家委员会的通知, 监测5号) [Notice on the Establishment of the Expert Committee on Ozone Depleting Substances Monitoring for the Implementation of the Montreal Protocol in China, Monitoring Letter No. 5] (2020), https://www.mee.gov.cn/xxgk2018/xxgk/sthjbsh/202004/t20200429_776888.html [https://perma.cc/SX5J-LUFA].

Structurally, the foam sector -where the illegal use occurred - is more difficult to regulate than the ODS production and cooling sectors. Since China joined the Montreal Protocol in 1991, ODS production in China has been consolidated into around 50 companies, which are under strict quota management and frequent inspections.[49] However, the foam sector consists of numerous small and medium-sized enterprises.[50] It is not cost-effective to enforce ODS regulations on the foam industry with the same stringency as on the ODS production and cooling sectors. Indeed, all three CFC-11 production facilities uncovered during enforcement campaigns were small-scale and underground, indicating no widespread swing back to CFC production.[51] Technically, since illegally-produced CFC-11 was blended in the "white agent" to make PU foams, enforcement officers must test these blends to detect CFC-11, making it harder to detect the use of CFC-11 than production.[52] As regulators did not anticipate CFC-11 to be back in use, they lacked procedures, equipment, and appropriate penalties for its resurgence. This enforcement model, which relies on quotas and registration (that does not cover the full supply chain) without robust monitoring or third-party oversight, has proven to be vulnerable in the face of constantly changing industry practices and the current regulatory landscape.

III. Aftermath: institutional reforms at the Montreal Protocol

While the CFC-11 incident was addressed timely, the shock of the enforcement failure does not dissipate easily. Although the Chinese government took swift and comprehensive actions to eliminate illegal emissions and put ozone layer recovery back on track, this incident prompted parties to reflect on the Montreal Protocol's institutional capacity. As a party pointed out, it is alarming that this the illegal emissions were caught by entities outside of the Montreal Protocol.[53] Moreover, it

49. Zhongguo Futan Huaxuepin Fazhan Xianzhuangji Zhanwang (中国氟碳化学品发展现状及展望) [Current Status and Prospects of Fluorocarbon Chemicals Development in China], CAFSI (May 23, 2023), http://sif.org.cn/article/922 [https://perma.cc/UU8G-H7L9].

50. Guowai Fei Zhengfu Zuzhi Baogao Zhongguo Qiye Weigui Shengchan Shiyong Lu Fu Ting Wuzhi Buzhou Chouyang "Shashou": Zhibiao Geng Yao Zhiben (国外非政府组织报告中国企业违规生产使用氯氟烃物质 捕捉臭氧"杀手"：治标更要治本) [Foreign NGOs Report That Chinese Companies Violate Regulations in the Production and Use of CFCs Capturing Ozone "Killers": Treating the Root Cause is More Important Than Treating the Symptoms] (2018), (https://news.sciencenet.cn/dz/upload/20188112722649.pdf [https://perma.cc/2RZE-UL6F].

51. Government of China, *supra* note 39, at 24-25.

52. Environmental Investigation Agency, Blowing It: Illegal Production and Use of Banned CFC-11 in China's Foam Blowing Industry 4 (2018);Environmental Investigation Agency, Tip of the Iceberg: Implications of Illegal CFC Production and Use, EIA Briefing to the Thirtieth Meeting of the Parties to the Montreal Protocol 10 (2018).

53. UNEP, *supra* note 33, at 21.

remains unclear whether Eastern China was the only emission source, as there was limited monitoring stations covering other potential emission areas (the rest of Asia, Africa and South America).[54] Parties are reminded to stay vigilant regarding the variety of controlled substances,[55] and they have taken steps to enhance Montreal Protocol institutions.

The unexpected CFC-11 emissions in 2018 exposed weaknesses in the Montreal Protocol's implementation framework. The success of the Montreal Protocol largely stemmed from its ability to align the interests of industry in the global North and South towards ODS transition, including incentivizing the ODS sector in the North to invest in ozone-friendly technology and to finance ODS transition in the global South, meanwhile encouraging ODS producers in the South to switch to ozone- and climate-friendly alternatives as they integrate into the global supply chain. However, shifting economic and regulatory conditions can distort business incentives in ways that lead to non-compliance, particularly when monitoring systems are weak. A past example is the incineration of HFC-23 under the Clean Development Mechanism. Originally designed for ODS producers to incinerate high-GWP byproducts in ODS production, it incentivized them to intentionally produce HFC-23 so they can incinerate it later for carbon credits.[56] Similarly, CFC-11 re-emerged illegally as regulatory changes and market pressures made it appealing again for use in PU foam production.[57] Since the foam industry emits less ODS than the cooling sector and involve far more companies, it is costlier to regulate.

Institutional reforms at the Montreal Protocol have taken two directions. First, parties at the MOP-31 requested the SAP to identify gaps in global atmospheric monitoring of controlled substances and ways to improve it.[58] With the SAP report, parties discussed in contact groups and approved a budget of 400,000 USD at the MOP-36 to assess the suitability of potential sites.[59] A second reform aims to strengthen

54. M. Rigby et al., *Increase in CFC-11 Emissions From Eastern China Based on Atmospheric Observations*, 569 Nature 546, 549 (2019); Sunyoung Park et al., *A Decline in Emissions of CFC-11 and Related Chemicals From Eastern China*, 590 Nature 433, 436 (2021).

55. UNEP, *Rep. of the Thirty-First Meeting of the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer*, U.N. Doc. UNEP/OzL.Pro.31/9 at 2, 10, and 26 (Dec. 2019).

56. Lambert R. Schneider, *Perverse Incentives U*nder the CDM: An *E*valuation of HFC-23 *Destruction Projects*, 11 Climate Pol'y 851, 852 (2011).

57. Environmental Investigation Agency, Blowing It: Illegal Production and Use of Banned CFC-11 in China's Foam Blowing Industry 4 (2018); Environmental Investigation Agency, Tip of the Iceberg: Implications of Illegal CFC Production and Use, EIA Briefing to the Thirtieth Meeting of the Parties to the Montreal Protocol 5 (2018).

58. UNEP, *supra* note 55, at 22.

59. UNEP, *Decisions Adopted by the Conference of the Parties to the Vienna Convention for the Protection of the Ozone Layer at its Thirteenth Meeting and by the Thirty-Sixth Meeting of the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer*, at 15, U.N. Doc. UNEP/OzL.Conv.13/8/Add.1–UNEP/OzL.Pro.36/9/

implementation and combat illegal production and trade of controlled substances. The OEWG-45 organized a workshop on this topic and parties have since then been working towards building a licensing system for controlled substances. First raised in the OEWG-44, this issue was discussed in a contact group starting the MOP-34 and may lead toward a licensing system.[60]

Concluding Thoughts: Challenges for China

The unexpected CFC-11 emission incident damaged China's compliance record under the Montreal Protocol. As the world's largest ODS producer and recipient of the largest share of the MLF, China plays a central role in ozone governance and remains a key actor in future negotiations, which also makes it a primary suspect if irregular emissions are detected. This is evident again with the unexpected HFC-23 emissions discovered since 2022, prompting renewed investigation by parties and external stakeholders. The process of reaching the decision regarding emissions of HFC-23 illustrated how China was targeted on this issue.[61]

China's response to the unexpected CFC-11 emissions effectively addressed the immediate concerns of the international community. Its swift and comprehensive actions to eliminate illegal production and use of CFC-11 demonstrated its initiative and commitment to compliance. By holding press conferences, organizing seminars, hosting public events, and submitting detailed reports to the Ozone Secretariat, China reassured parties and diffused international tension, ultimately avoiding formal attribution and penalty. Notably, its expansive enforcement and policy response met all the suggestions made in the EIA's report.[62]

However, the long-term enforcement challenge remains unresolved. Given China's dominance in the global ODS sector, it is imperative to develop a robust monitoring network for domestic production and emission. Such a system would help detect violations internally while also providing transparency to counter potential international accusations. In the long run, these monitoring capabilities would support ongoing discussions on issues such as HFC-23 emissions, ODS leakage, and stockpile management. Building a domestic monitoring network will require technology and infrastructure, which brings its own challenges, but it could be achieved in time with research and investment. On the other hand, monitoring alone is insufficient. Controlled substances have complex chemical pathways and can transform into one another as products or byproducts, and illegal production can move to places with less monitoring.

Add.1 (2024).

60. *Id.* at 26.

61. The decision draft was proposed by USA. China then submitted its own draft decision. The contact group agreed on the final decision. UNEP, *Draft decision XXXVI/[--]: Emissions of HFC-23*, U.N. Doc. UNEP/OzL.Pro.36/CRP.7/Rev.1 (Oct. 29, 2024).

62. Environmental Investigation Agency, Blowing It: Illegal Production and Use of Banned CFC-11 in China's Foam Blowing Industry 8 (2018).

Addressing this requires innovative approaches to enforcement, including greater engagement with the public and NGOs. The EIA's reporting of the unexpected CFC-11 emissions, despite some inaccuracies, illustrated the value of third-party oversight. The MEE's decision to invite the EIA to the International Ozone Day events underscores the potential for constructive collaboration. Whether such cooperation will be sustained, however, remains to be seen.