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EXECUTIVE COMMITTEE OF
THE MULTILATERAL FUND FOR THE
IMPLEMENTATION OF THE MONTREAL PROTOCOL
Eighty-second Meeting
Montreal, 3-7 December 2018

SYNTHESIS REPORT ON THE PILOT ODS DISPOSAL PROJECTS (DECISION 79/18(e))

Introduction

1. The Twentieth Meeting of the Parties acknowledged the importance of acquiring information on mitigating ODS emissions and on destroying ODS banks, and requested the Executive Committee to consider pilot projects that focused on assembled stocks of ODS with high net global-warming potential (GWP) in a representative sample of Article 5 countries and regions (decision XX/7[1]).

2. In response to decision XX/7, at its 58th meeting, the Executive Committee adopted interim guidelines for the funding of demonstration projects for the disposal of ODS (decision 58/19). Funding for the preparation of ODS destruction project proposals had been approved since the 54th meeting.

3. At its 75th meeting, the Executive Committee considered a Desk study on the evaluation of the pilot demonstration projects on ODS disposal and destruction,[2] prepared by the Senior Monitoring and Evaluation Officer, the conclusions of which are consistent with the lessons learned from the completed pilot projects.

4. At the 79th meeting, during the discussion of these projects under the document on projects with specific reporting requirements,[3] the Executive Committee *inter alia* requested that outstanding projects be

[1] To request the Executive Committee to consider as a matter of urgency commencing pilot projects that may cover the collection, transport, storage and destruction of ozone-depleting substances. As an initial priority, the Committee might consider projects with a focus on assembled stocks of ODS with high net GWP, in a representative sample of regionally diverse Article 5 countries. This initial priority would not preclude the initiation of other types of pilot projects, including on halons and CTC, should these have an important demonstration value. In addition to protecting the ozone layer, these projects will seek to generate practical data and experience on management and financing modalities, achieve climate benefits, and would explore opportunities to leverage co-financing; and to note that any project implemented pursuant to the present decision when applicable should be done in conformity with national, regional, and/or international requirements, such as those mandated by the Basel Convention and Rotterdam Convention.

[2] UNEP/OzL.Pro/ExCom/75/10

[3] UNEP/OzL.Pro/ExCom/79/14

completed and final reports to be submitted either to the 80th or 81st meeting, except for Brazil and Colombia, where extensions were allowed to 2022 and 2019, respectively; and to return to the 82nd meeting the remaining balances for projects for which reports had not been submitted to the 80th or 81st meeting (decision 79/18(d)).

5. At the 81st meeting, during the discussion on the progress of implementation of ODS disposal projects under the document on projects with specific reporting requirements,[4] it was noted that very small amounts of ODS waste were being destroyed by these projects. The Executive Committee requested that the reasons for the small size of the amounts destroyed be studied in detail for inclusion in the synthesis report, so that lessons could be drawn to prevent such a situation from recurring in future projects. The Executive Committee further requested the Secretariat, where possible, to gather information on leakages from the waste collected and to include similar analysis in the final synthesis report.[5]

6. Further, at the same meeting, during the discussion on the agenda item on the Development of the cost guidelines for HFC phase-down in Article 5 countries, the Executive Committee emphasized the importance and relevance of this synthesis report to future activities related to HFCs, and decided to consider, at its 82nd meeting, issues related to funding the cost-effective management of stockpiles of used or unwanted controlled substances, including through destruction, in light of the present document (decision 81/67(d)).

7. At the 82nd meeting, the Senior Monitoring and Evaluation Officer has included in the Draft monitoring and evaluation work programme for 2019,[6] the second phase of the evaluation of pilot demonstration projects on ODS disposal and destruction as a follow-up to the desk study presented at the 75th meeting.[7]

8. The Secretariat has prepared the present synthesis report in response to decision 79/18(e).

Scope of the document

9. The present synthesis report is based on nine pilot projects on ODS disposal, and two studies for the establishment of a private-public financing system for disposal of ODS, for which final reports were received by the Secretariat, as shown in Table 1.[8]

Table 1. Completed ODS disposal demonstration projects

Country	Project	Date final report
China	Pilot demonstration project on ODS waste management and disposal	April 2018
Colombia	Demonstration project on end of life ODS management and destruction	April 2018
Georgia	Pilot demonstration project on ODS waste management and disposal	May 2017
Ghana	Pilot demonstration project on ODS waste management and disposal	May 2017
Indonesia*	Project preparation for a pilot demonstration project for ODS waste management and disposal for Indonesia	March 2014
Mexico	Demonstration project for disposal of unwanted ODS	September 2017
Nepal	Demonstration project for disposal of unwanted ODS	May 2017
Nigeria	Demonstration project for disposal of unwanted ODS	April 2018

[4] UNEP/OzL.Pro/ExCom/81/10 and Corr.1
[5] Paragraph 84 of document UNEP/OzL.Pro/ExCom/81/58
[6] UNEP/OzL.Pro/ExCom/82/13
[7] UNEP/OzL.Pro/ExCom/75/10
[8] The report on the pilot ODS disposal project in Cuba was not submitted.

Country	Project	Date final report
Turkey	Demonstration project for disposal of unwanted ODS	April 2018
Philippines (the)*	Project preparation for a pilot demonstration project for ODS waste management and disposal for the Philippines	February 2014
Region: EUR	Demonstration of a regional strategy for ODS waste management and disposal in Europe and Central Asia	September 2017

*Report of a study only.

10. The document provides an overview and summary of the projects approved following decision 58/19. It summarizes the information presented in each report according to the different categories of activities associated with ODS disposal, the approaches used for ODS waste collection, the options used for transport, the destruction methods considered and applied in each project, related policies and regulations, synergies with other projects, and the business models for financial set up of the various approaches used. Further, it reviews and analyses the results from the final reports, and provides conclusions and a recommendation.

11. The document also contains the following two annexes:

Annex I Criteria and guidelines for the selection of ODS disposal projects and definition of activities

Annex II Overview of the pilot ODS disposal projects

Overview and summary of the ODS disposal demonstration projects

12. The report structure follows the elements in decision 79/18, where the Executive Committee requested for a synthesis report on the pilot ODS disposal projects collating lessons learned, and including issues related to project design, synergy with other projects, opportunities for resource mobilization, and the cost-effectiveness of the projects. The approaches for monitoring and verification of the destroyed ODS and the overall climate impact of the project are also presented.

Project design

13. The structure and contents of the project proposals were consistent with the draft guidelines approved by the Executive Committee. The following observations on the project design were relevant:

(a) The total amount of ODS waste included in the proposals was calculated based on assumptions; however, during project implementation, the amounts actually collected were different. These discrepancies were related to *inter alia* an assumption that there was a functioning ODS waste collection system in the country, and that the storage system of the collected ODS would maintain the quantity and quality of the waste, which led to discrepancies between the estimated amounts to those actually destroyed;

(b) In cases where the project design identified that the waste collection efforts were to be done in coordination with another project funded separately (e.g., equipment replacement programmes linked to promotion of energy efficiency schemes), during implementation it was shown that no formal links were established; therefore, collection efforts were done on an informal one-off basis which did not promote sustainability. In contrast, a few projects where synergies were institutionalized through agreements for joint implementation yielded very good results;

(c) Some of the pilot projects did not include elements that ensured the quality (including type, purity, location and ownership) of the ODS waste that was to be destroyed, which would be relevant when exploring options for carbon finance;

(d) Experience from recovery and recycling projects included in national phase-out plans, particularly as it contributed to a systematic collection of ODS waste, were not explored during project implementation;

(e) For LVC countries where no facilities exist for the disposal of ODS waste, the project design did not account for the fact that only small amounts of ODS waste were being generated; that no regulatory mechanism existed requiring the safe disposal and destruction of ODS waste; and that it was necessary to identify co-financing options for sustainable destruction of ODS given the high capital costs required to build domestic destruction facilities; and

(f) Projects that were designed to export ODS waste for destruction appeared to be one-off projects and did not identify the factors necessary to make the project sustainable.

Regulations and programmes supporting ODS disposal in the pilot countries

14. The projects envisaged some changes in the national policy and regulatory infrastructure to support or encourage collection, storage, analysis, tracking, certification of destruction and reporting requirements applicable to ODS waste. In some countries, revisions had to be made to allow the re-export of ODS for destruction. In others, challenges were faced with regard to lack of supporting regulations requiring the safe disposal of ODS waste, which inhibited a broader impact of the project.

15. The common policy and regulatory requirements and challenges as reported are described below:

(a) Existing strong national regulations that mandated ODS and other waste collection efforts and standards such as the extended producer responsibility (EPR) or the waste electrical and electronic equipment (WEEE) recycling management programme facilitated the implementation of the demonstration projects (China, Colombia, Ghana and Mexico);

(b) Some countries had existing regulations setting out monitoring and reporting requirements for sources of emissions, thereby ensuring that releases from domestic incineration facilities met standards (Colombia);

(c) In Mexico, while there are currently no legal impediments for the export of waste for destruction, the establishment of authorized domestic destruction capacity could change that, especially where there is the potential for using this domestic capacity to provide these services to surrounding countries in the region (i.e. Central America and the Caribbean);

(d) Some countries lacked regulatory mechanisms requiring safe disposal and destruction of ODS waste at project inception, and expected that results from the pilot projects would provide an opportunity to introduce requirements for decommissioning ODS-containing refrigeration equipment, including obligations to dispose of such waste, and to put in place mandatory requirements for destroying ODS (Georgia, Nigeria); and

(e) Ensuring consistency of national policies on waste handling, collection, recycling, and destruction with existing regional regulations (e.g., European Union) facilitated the work required to revise existing legislation to support ODS waste disposal (Turkey, Europe and Central Asia (ECA) countries).

16. The countries that had opted to export their ODS waste for destruction are all signatories to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal[9]

[9] Article 6 of the Convention governs the transboundary movement of waste between parties, and requires the exporting country to notify the importing country through officially designated channels in writing of such export,

(Basel Convention), therefore they could export their ODS waste to other Parties when approval was obtained from the destination country. All transboundary movements of this waste followed the requirements of this Convention. Consequently, national policies consistent with the requirements of the relevant conventions particularly as it related to transboundary movement of these wastes needed to be in place.

Approaches used in ODS waste collection activities

17. The guidelines for ODS disposal projects defined collection as all efforts to extract ODS from an application (e.g., foam) or a product (e.g., refrigerator or other equipment), and aggregating the extracted ODS until the necessary quantity reasonable for further processing is reached. While the projects included the consideration of collection as an activity essential to the destruction process, it was agreed that the projects would focus on existing collected ODS waste stocks. Where there was already collected ODS waste but not supported by an existing institutionalised collection process, the parameters and requirements for establishing this collection system had to be defined; however, setting up this system would not be part of the funding provided for these projects.

18. The pilot projects reported that they had collected and aggregated ODS waste through several approaches, as follows:

(a) Using existing systems for collecting and dismantling end-of-life (EOL) electrical appliances including domestic and commercial refrigeration equipment, home appliance replacement and EPR programmes (Colombia, Mexico, ECA region);

(b) Domestic equipment replacement programmes linked to the promotion of energy efficiency schemes (Ghana);

(c) Established recovery and recycling centres, and private collection companies (China, Georgia, Nigeria, and Turkey);

(d) Confiscated ODS traded illegally (Nepal); and

(e) Manual extraction of CFC-11 in foams through national waste management service providers (China, Colombia, and Mexico).

19. Difficulties were identified in quantifying the amount and type of ODS waste, particularly its location, both during the project preparation process and implementation. Most of the ODS waste identified was CFC-11 (both as a substance and contained in foams), CFC-12, small quantities of R-500, R502, CFC-113, HCFC-HFC mixtures, CTC and halon-1301. In addition, refrigerators replaced under energy efficiency schemes did not produce as much ODS waste as expected, as the gas had already been vented from the equipment.

20. In a few of the pilot projects, there were discrepancies in the amounts and quality of ODS waste that had been identified in their proposals as already collected, and what was reported in the final reports. The reasons for this included difficulties in aggregating the waste from various sources due to lack of technical capacity and equipment, the poor condition of cylinders containing the ODS waste coupled with mishandling that might have caused venting of the gas, the need to improve the capacity and efficiency of the collection centres, and poor estimation of initial waste that was available for destruction.

clearly stating the purpose. The export can only happen after receipt of confirmation from the receiving country that such a transaction is allowed.

21. Based on the initial experience of identifying and collecting ODS wastes, during project implementation countries adopted various solutions to *inter alia* create or enhance the collection capacity. For example:

(a) Colombia and Mexico strengthened their existing systems for collecting waste from EOL equipment and paired these with their appliance replacement programmes;

(b) China is adjusting its existing hazardous and industrial waste management capacity to specifically include ODS waste, especially in provinces with high urbanization and population;

(c) Georgia showed the success of the synchronized collection of unwanted ODS waste and persistent organic pollutants (POP) waste, which are being used to develop a co-disposal system for these types of waste in the country; and

(d) Turkey is establishing a system to link their government-authorized recovery and reclamation centres with smaller centres and design a waste aggregation approach. Participating countries in the ECA region are assessing ways to aggregate waste with neighbouring countries, among other initiatives.

Transportation and storage of ODS waste

22. The available ODS waste was located in several recovery/collection centres across the country. The ODS waste therefore had to be transported to central facilities for aggregation, and further sent to the destruction facility, either locally or out of the country. Collection and aggregation was not funded, while transportation was.

23. The final reports provided limited information on the ways of transporting and storing ODS waste. The common activities that were implemented included the following:

(a) Local commercial hazardous waste handlers or specialized retrofitted transport to transfer aggregated ODS waste from different recovery and recycling centres to a central storage facility;

(b) A few countries (i.e., Colombia and Mexico) identified specific central sites situated around the larger recovery and recycling/reclaiming centres and storage facilities for CFC waste, where such facilities were part of earlier funded CFC phase-out projects, and consolidated the waste in these facilities for transport to domestic incineration sites; and

(c) In most countries, transfer of waste within the country followed the domestic policy requirements for the movement of hazardous waste.

24. With regard to transportation of the ODS waste from the country/region of origin to the destruction facility abroad, the following actions were reported:

(a) Contracts with developers/brokers included transportation costs to move ODS waste to the destruction facility;

(b) Some countries procured containers (iso-tanks) to transport the collected ODS waste to the destruction facility; and

(c) The requirements of the Basel Convention were applied during the transboundary movement of the waste, and coordinated by a waste handling sub-contractor.

Approaches used in destruction

25. The two most common approaches to destroy ODS waste implemented through the pilot projects were domestic destruction through a cement or rotary kiln, or use of plasma arc technology (China, Colombia, Mexico and Nigeria); and exporting the ODS waste to a destruction facility that met international standards (ECA region, Georgia, Ghana, Nepal and Turkey).

Domestic destruction (cement kiln, rotary kiln, and plasma arc)

26. Those countries that examined the approach of domestic destruction linked these to national regulations that mandated ODS and other waste collection efforts and standards. In some cases, these regulations or initiatives already existed, in others they needed to be linked through this project.

27. In the case of modifications that needed to be made to the cement kiln to enable destruction of ODS, particularly CFC-12 at the standards set by the TEAP,[10] this included the installation of a new feed port in the front end of the kiln and setting up the feeding cylinder system with appropriate metering and automated record tabulation, as well as a switching and purging capability for cylinders. For liquid CFC-11, a dedicated feed tank, pump, metering system and flow controls, as well as a connection into the existing liquid feed system and burner nozzle, was needed.

28. The demonstration project in China considered facilities located in each of the three provinces and municipalities, using plasma technology in one case and rotary kilns in the other locations, for CFC-12 destruction. CFC-11 was extracted from foam, which in most cases was disposed of as solid waste all over China, and destroyed through a rotary kiln through a solid waste facility, and a local hazardous waste facility. No modifications were required to the mainstream process, although more stringent monitoring measures were adopted for the disposal to take place in line with the project requirements. The pilot project has validated that the rotary kiln technology is efficient for the destruction of CFC-11, CFC-11-based foams and CFC-12. It also showed how the process could be replicated in other provinces in the future.

29. For Colombia, an important aspect of the selected destruction approach was the establishment of protocols to strengthen domestic destruction facilities (rotary kiln incineration) to meet international standards, through test-burn programmes, and the integration of these facilities into broader hazardous waste and energy-efficiency initiatives. The demonstration test-burn work showed that the domestic capability is qualified in principle for the destruction of ODS, specifically CFC-11 and HCFC-141b-based foam, and CFC-11 and CFC-12 chemicals up to established limits of chlorine feed content.

30. In Mexico, the initial approach considered was to export the ODS waste to be destroyed at a registered incineration facility in the United States of America, since there was no domestic capacity in the country at the time the project was submitted. During project implementation, two local incineration companies, one using plasma arc technology, and another a cement kiln, were granted authorization to destroy ODS waste using two different technologies. As a result, the collected waste was destroyed in these facilities.

Export for destruction

31. Four projects and one regional project chose to export their ODS waste for destruction. In most cases, the selection of the destruction facility was through a bidding process limited to facilities in the United States of America and Europe. For Georgia, the selection criteria required the facility was able to destroy ODS and POP wastes.

[10] 99.99 per cent destruction removal efficiency (DRE).

32. The common activities undertaken by each country included identifying a local institution or organization to manage the project; developing terms of reference for disposal operations including verification of the destruction removal efficiency (DRE) of the facility and the amounts of waste destroyed; and sending requests for tenders to selected facilities (the European Union has a list of registered facilities for ODS destruction). After identification of the facility, the ODS waste was transported for destruction.

33. The following summarizes the approaches implemented for the countries that exported ODS waste for destruction:

(a) Ghana exported its ODS waste to a destruction facility in Poland that used high-temperature incineration (HTI); the waste included CFC and methyl bromide. Some quantity of CFC-12 (i.e., 1 mt) is planned to be sent to a facility in the United States of America which offers potential sustainability for future disposal needs, which may include HFCs as these could be linked to carbon finance in future;

(b) Georgia selected an incineration facility in France for the co-disposal of collected ODS and POP wastes (around 500 kg of waste generated annually). The facility used the D10[11] type of HTI approved by the Basel Convention, and referenced in the Stockholm Convention on Persistent Organic Pollutants for highly chlorinated hazardous waste;

(c) The project in Nepal was a one-time to dispose of confiscated 10 mt of CFC-12. (107,000 CO_2-equivalent tonnes). The ODS was exported and destroyed at a United States of America facility through a broker;

(d) Turkey selected a HTI destruction facility in Poland to destroy their ODS waste, where this was combined with the waste from Montenegro (part of the ECA regional project); and

(e) The ODS wastes of the three countries of the ECA regional project, namely Bosnia Herzegovina, Croatia, and Montenegro, was aggregated nationally; two shipments were made to separate rotary kiln facilities, the first one in Germany and the second one in Poland.

Monitoring and verification of destroyed ODS

34. Different approaches were reported on the monitoring and verification of the destruction process, to ensure that only recovered and waste ODS was destroyed. For countries that exported their waste for destruction, verification of the amounts destroyed was provided by the destruction facilities, which gave a signed and stamped certificate of proof of destruction, according to their procedures. Any hazardous waste disposal operation covered by the Basel Convention (including ODS) is supported by special disposal certification issued by the selected disposal facilities to the waste management company assisting with the waste transfer process, and then back to the originator of the waste. For those countries that outsourced the waste disposal process to qualified hazardous waste management firms, oversight of the operations was provided by the contracted institution.

[11] Covers the incineration of waste where the main purpose of the incineration is the thermal treatment of waste in order to reduce the volume and the hazardousness of the waste, and to obtain an inert product that can be disposed of. The most common examples are municipal solid waste incineration plants, hazardous waste incineration plants, sewage sludge incineration plants, incineration plants for clinical waste or animal carcasses. D10 also covers the incineration of waste in co-incineration plants where the waste undergoes thermal treatment rather than being used as a fuel (http://ec.europa.eu/eurostat/web/waste/methodology).

35. In addition to verifying the amounts of ODS waste destroyed, reported monitoring activities also included emissions of the destruction facilities to ensure they met national standards. Some of the reported approaches for monitoring and verification where waste was destroyed domestically included:

(a) The establishment of an electronic in-country database and monitoring of waste source, collection and aggregation (China);

(b) Establishing incineration test protocols and validation (China, Colombia, Mexico);

(c) Emissions and sample analyses from the incineration facilities to ensure they met standards (Colombia and Mexico); and

(d) Monitoring and verification system built into the ODS information and tracking system to verify the amounts of unwanted ODS recovered and destroyed at all stages, including information on safety and environmental provisions (Mexico)

36. It was also reported that verification by independent auditors was carried out to ensure that the destruction rate met the TEAP DRE, and that the overall destruction operations were consistent with what had been set out in the original proposals.

Business model and co-financing opportunities for sustainable management of ODS wastes

37. Most of the reports provided information on the planned management and financial set-up for ODS disposal, and how these could be managed in the future. Some parameters that were key to the sustainable management of ODS waste and its eventual destruction were also identified. These include the following:

(a) Developing a financing scheme through the refrigerant association and exploring options such as a fee for importers/users of refrigerants, tax incentives to encourage better maintenance practices, and cover the costs of disposal of unwanted refrigerants (ECA region (which includes Bosnia Herzegovina, Croatia,[12] and Montenegro), Georgia, Turkey);

(b) Strengthening and enhancing the participation of local stakeholders to encourage the collection of ODS-containing equipment and the destruction of ODS waste (Mexico);

(c) Establishing special subsidies to boost the collection and turning in of refrigeration equipment and facilitate proper destruction (China); and

(d) Encouraging the participation of the private sector (i.e., cement kiln owners or waste aggregators) in determining the overall collection and destruction process, noting that some investment may be required and that issues of long-term sustainability have to be addressed.

38. In Colombia, a sustainable EPR scheme following an industry-administered model is now established and operational in five major cities. It is supported by legislative and regulatory measures now in place, and by financial incentives related to tax (VAT) reductions and energy efficiency incentives applicable to equipment replacement. Substantial bilateral funding is in place through a National Appropriate Mitigation Action (NAMA) Support Project that will support accelerated introduction of climate-friendly refrigeration equipment along with technical assistance for their design and production as well as expanded processing of EOL domestic refrigerators. After the incineration facilities were tested and met the required protocols, the national EPR system for refrigeration and air-conditioning equipment, was developed within the regulatory and policy framework of the national initiative on integrated waste

[12] At the time of the approval of the pilot demonstration project, Croatia was classified as an Article 5 country.

electrical and electronic equipment (WEEE) management. This set up an institutionalised waste collection system, in addition to existing recovery and recycling efforts done through national phase-out plans. With an assured ODS waste stream through these means, the long-term sustainable business model for the EPR system includes a cost structure that would be sustained by EPR funding for the capture of ODS waste and the processing of EOL equipment, including destruction of EOL ODS waste.

Carbon markets

39. Voluntary carbon markets were initially thought to be an option to increase sustainability of the destruction process in Article 5 countries. The carbon credits that were expected to be generated from the destruction of ODS would provide the financing required to establish incentives that would encourage management of ODS waste and its eventual destruction.

40. The experience of Nepal was the only example of successful implementation of potential funds coming from carbon market, where 22,000 of the 89,000 credits, have been sold by the company on the voluntary carbon market through the Climate Action Reserve (CAR), noting that this was a one-time project that dealt with excess ODS from illegal imports.

41. However, the downturn in the carbon markets, including the uncertainty in generating carbon credits from ODS destruction, has made this option a lower priority. In addition, the complex operating mechanisms of carbon markets meant that in order to access funds from these markets, the projects had to be designed and operationalized to suit the procedures for measuring and recording carbon credits generated in those markets.

42. Those Article 5 countries that had not included this in the design of their pilot project had to reconsider their approach.

(a) For Ghana, the pilot project was to be closely linked to the GEF energy efficiency (EE) programme that had envisaged the recovery of ODS waste from around 100,000 refrigerators annually for 10 years, thereby assuring an ODS waste stream of around 2.4 mt per year, which would have made the facility sustainable. The GEF project provided co-financing for the collection system, where the cost of ODS waste collection was covered through an appliance replacement programme. However, it was found that there was not sufficient ODS waste collected from this old equipment to gather enough carbon credits (if these were viable) to sustain this approach. The pilot project had generated some interest from the private sector to get involved in these operations and continue exploring the carbon finance option, which the Government will pursue after the lessons learned from this project; in turn the experience with the GEF could potentially encourage and stimulate further collaboration with other financial institutions that may be sources of co-financing for one aspect of the disposal process; and

(b) For Mexico, the institutionalised system of collecting ODS waste through its recovery and recycling centres, home appliance replacement programme, potential confiscated illegal trade, and waste from other users, has assured it of a steady ODS waste stream. While Mexico had initially thought of sending a batch of ODS waste for destruction to a facility in the United States of America, this did not materialise because of the high costs associated with handling, transport, and disposal. This encouraged the authorization/licensing of domestic incineration facilities. Because of this, Mexico sees that the operation of these privately run facilities will continue, and one facility (cement kiln) may even be used to destroy waste from other countries in the region. There are also 34 cement kilns in Mexico, and while only one facility is licensed to co-process unwanted ODS, a detailed assessment of the other kilns might also eventually result in their ability to destroy ODS waste.

Cost considerations

43. The guidelines for the preparation of ODS disposal projects limited the funding to be provided to US $13.2/kg of ODS to be destroyed, for non-LVC countries. Out of the nine pilot projects, the average cost-effectiveness (CE) for the five non-LVC countries was US $10.27/kg, and US $24.22 for two LVC countries (Georgia and Ghana), as approved. The projects for Nepal and the ECA region were approved as technical assistance, and therefore not covered by the funding limit in decision 58/19.

44. The cost effectiveness after project implementation was calculated at an average of US $145.08/kg for the five non-LVC countries, calculated on the total funds approved and not on reported disbursement; in the case of Colombia, the reported amount destroyed is based only on the test burns completed. The country expects to continue destruction of the remaining amount of ODS waste committed based on the business model developed in the country. The average CE of the two LVC countries after project implementation was calculated at US $32.09/kg, 32 per cent higher than the original approval.

45. The average CE value after project completion for non-LVC countries is very high because except for one country, all other countries destroyed a much smaller amount than what had been estimated in the original proposals. Table 2 presents a comparison of the CE during approval and after project completion for the projects that submitted final reports.

Table 2. Comparison of cost effectiveness for the completed projects with final reports

Country	Funds approved (US $)	During project approval		After project implementation	
		Amount to be destroyed (mt)	CE (US $/kg)	Actual ODS destroyed (mt)	CE (US $/kg)
LVC countries					
Georgia	55,264	2.13	25.94	1.467	37.67
Ghana	198,000	8.8	22.5	7.47	26.50
Sub-total	253,264	10.93	24.22*	8.937	32.09*
Non-LVC countries					
China	2,127,885	192.00	11.08	194.793	10.92
Colombia	1,195,000	114.00	10.48	34**	35.15**
Mexico	1,427,915	166.70	8.57	113.2	12.61
Nigeria	911,724	84.00	10.85	1.66	549.23
Turkey	1,076,250	103.72	10.37	9.162	117.47
Sub-total	6,738,774	660.42	10.27*	352.815	145.08*
Technical assistance					
Nepal***	157,200	12.00	-	10	-
Region: ECA***	349,480	29.07	12.02	41.37	8.45
Sub-total	506,680	41.07	-	51.37	-

*Average CE
**Amount destroyed after test burns only
***Technical assistance

46. The Secretariat also compiled information on the cost of destruction reported by each country, summarized in Table 3. The information shows that the cost of destruction in facilities located in Europe was cheaper than some costs reported for domestic destruction in other countries, noting that the selection of facilities for destruction outside a country was made based on a bidding process. Also, the cost for domestic destruction varied greatly depending on the country, and it was not clearly explained why the cost of using the same technology in Article 5 countries would be substantially more expensive.

Table 3. Cost of destruction reported for the pilot projects

Country	Destruction method	Cost of destruction (US $)
China	Domestic - rotary kiln incineration	8.00 – 12.50
Colombia	Domestic - high temperature incineration (HTI)	5.20 (for foam)[a]
		5.98 (for liquid CFC-11)[a]
		6.20 (for gas CFC-12)[a]
Georgia	Exported to France – HTI	5.99[b]
Ghana	Exported to Poland – HTI	No cost for destruction provided
Mexico*	Domestic – argon plasma arc	7.50
	Domestic – cement kiln incineration	6.00
Nigeria	Domestic – rotary kiln incineration	29.82[c]
Region: ECA	Exported to Germany and Poland – rotary kiln incineration	1.87 to 2.45[d]
Turkey	Exported to Poland – rotary kiln incineration	1.87 to 2.45[d]

[a] Indicative commercial pricing from TECNIAMSA based on test burn results, based on solid foam.
*Mexico identified the cost of US $1.4/kg for transport and consolidation of ODS waste within Mexico.
[b] Based on 1.5 mt ODS destroyed, includes transportation abroad and actual destruction including inland and maritime transportation.
[c] Based on 1.66 mt ODS destroyed, includes transportation costs.
[d] Destruction cost in Euros is 1.64-2.15/kg.

Synergy with projects funded by other institutions

47. Three of the nine projects (Colombia, Georgia and Ghana) proposed to implement the demonstration projects in close coordination with other similar projects funded from sources outside the Multilateral Fund, as described below.

48. In the case of Colombia, the objective was to implement the pilot project to enhance synergies with initiatives related to the country's obligations under the Stockholm Convention for the destruction of POP stockpiles. The idea was to identify facilities that would allow for co-disposal of these types of waste. During project implementation, it was realised that two different destruction approaches were being explored for these two waste streams, the use of a domestic cement kiln for PCB oil and contaminated soil for the GEF-funded POP project, and a rotary kiln incinerator for the ODS waste. The change in the approach for the POP destruction was driven by the country's interest in collecting the waste fuel from the cement kilns, as part of its overall integrated waste management strategy. The Government therefore decided to pursue destruction of ODS with high temperature incineration instead of cement kilns. The partnership with the national EPR programme was strengthened to ensure sustainability of future destruction.

49. In the case of Georgia, consolidated terms of reference was developed for waste co-disposal within the framework of the GEF/UNDP POP pesticides disposal project in parallel with the ODS waste project. One tender for the co-disposal of these wastes was launched; a sub-contractor was selected who was responsible for packing the POP waste and transporting it along with the ODS waste to the selected hazardous waste destruction facilities in the European Union. The requirements for export were synchronized between these two projects, resulting in cost and time savings, along with capacity building of the institutions responsible for both substances. In addition, staff responsible for the operation of the gas chromatograph at the Georgian Refrigerant Recovery and Recycling Centre were trained to build capacity for testing ODS waste that may be collected by the centre in future.

50. In the case of Ghana, the project was closely integrated with the GEF-funded UNDP energy efficiency project, which became the source of ODS waste to be destroyed, extracted from old refrigerators collected through a rebate system put in place by the GEF project. The Government had set up a fully equipped national ODS collection centre operated by two separate private contractors who were responsible for the collection and dismantling of the old refrigerators, and the recovery and collection of the refrigerant.

In order to achieve better economies of scale, the Government linked up with another GEF-funded project on PCB and POP disposal, allowing for a more cost-effective shipment of ODS waste.

51. The experience of the above-mentioned three projects have demonstrated the following:

(a) There may be potential problems in the long term related to the combination of POP and ODS destruction in the same facility; technical information shows that the change from POP to ODS for the same rotary kiln makes the equipment less efficient, and also results in higher emissions (i.e., fluorine and chlorine);

(b) Where countries exported ODS waste for destruction, these were done in line with the requirements of the Basel Convention, which would suggest that, for countries without their own destruction facilities, exporting waste for destruction is an option;

(c) Cooperation with other projects should be formally established to ensure a sustainable waste stream that will contribute to a successful destruction project.

Options for the establishment of private-public financing systems for the disposal of ODS

52. The project preparation funding for Indonesia and the Philippines resulted in desk studies that examined options for the establishment of private-public financing systems for the disposal of ODS, and provided a framework for the design of ODS disposal approaches, using carbon markets. The reports for both countries[13] suggested that a successful business model for the environmentally sound management of ODS waste requires a long-term approach that begins with the identification and understanding of ODS stockpiles that currently exist or may be collected in the future, in each country.

53. In Indonesia, although there were no stocks of ODS waste available, the Government was advised to put in place a plan for future management of unwanted ODS and other chemicals which may include HCFCs and HFCs, to prevent venting them into the atmosphere. Once an institutionalised collection system is defined, either through existing service shops or from EOL equipment, a central facility for waste aggregation and storage needs to be identified and consultations have to be held with stakeholders, followed by identification of sources of funding, identification of the developer, and implementation of the destruction process. An ODS destruction facility already exists in Indonesia through a cement kiln in Holcim Narogong facility.

54. For the Philippines, as an inventory of stockpiled ODS is available, the country can start exploring options for approaches to destroy the unwanted ODS, as well as financing options which could be available through the Verified Carbon Standard[14] (VCS) and Climate Action Reserve[15] (The Reserve).

55. While not considered as a major objective in the original proposals, some countries also reported potential synergies, particularly with POP destruction. In China, for example, two cement kilns and a hazardous waste treatment plant are involved in ongoing POP destruction.

[13] Both countries were provided with an Excel-based inventory tool that was designed to collect information on ODS stockpiles, and was used to collect data on the existing unwanted ODS inventory in the countries.

[14] Verified Carbon Standard (VCS) now called VERRA is a voluntary programme for generating offset credits known as verified carbon units (VCUs); VCS has methodologies for eligible ODS destruction projects (https://verra.org/?s=ODS+destruction)

[15] Climate Action Reserve is a non-profit organization that establishes standards for carbon offset principles, oversees independent third-party verification, issues carbon credits generated from these projects, and tracks transactions of credits over time. The Reserve has two offset protocols for ODS. (www.climateactyionreserve.org/how/protocols/ozone-depleting-substances/faqs/)

Climate benefits of the pilot ODS disposal demonstration projects

56. The net GWP of the potential assembled stocks of unwanted ODS, especially CFCs, was an important consideration for the Meeting of the Parties in decision XX/7. Many Parties expressed concerns about the perceived growing banks of ODS which remain in equipment, products and stockpiles held either by governments or private entities.

57. Based on the reports submitted, the completed projects resulted in the reduction of 2,229,777 CO_2-equivalent tonnes based on the actual amounts of ODS waste reported to have been destroyed, as shown in Table 4.

Table 4. Estimated environmental benefits of the demonstration projects

Country	Substance	GWP*	ODS destroyed (mt)	Greenhouse gas emission reduction (CO_2-eq.tonnes)
China	CFC-11	4,750	183.005	732,020
	CFC-12	10,900	11.788	100,198
		Subtotal	*194.793*	*997,763*
Colombia	CFC-11	4,750	8	38,000
	CFC-12	10,900	6	65,400
	CFC-foam	n/a	n/a	n/a
		Subtotal	*14*	*103,400*
Georgia	CFC-12	10,900	1.467	15,990
		Subtotal	*1.467*	*15,990*
Ghana	CFC-12	10,900	2.272	24,765
	Methyl Bromide	5	5.2	26
		Subtotal	*7.4*	*24,791*
Mexico	CFC-11	4,750	24.7	117,325
	CFC-12	10,900	25.3	275,770
	CFC-114	10,000	0.5	5,000
	HCFC-22	1,810	40.1	72,581
	HCFC-141b	725	0.2	145
	HFC-134a	1,430	21.5	30,745
	R-407	2,107	0.9	1,896
		Subtotal	*113.2*	*503,462*
Nepal	CFC-12	10,900	9.03	98,427
		Subtotal	*9.03*	*98,427*
Nigeria	CFC-12	10,900	1.66	18,094
		Subtotal	*1.66*	*18,094*
Region: ECA**	CFC-12	10,900	32.79	357,411
	HCFC/HFCs	***	8.58	***
		Subtotal	*41.37*	*357,411*
Turkey	CFC-12	10,900	9.162	99,866
		Subtotal	*9.162*	*99,866*
		Total	**392.154**	**2,229,777**

* Based on the IPCC 4th Assessment Report
** Bosnia Herzegovina, Croatia and Montenegro
*** Not specified

Lessons learned

58. The lessons learned from the implementation of the ODS disposal projects include the following:

(a) Systematic collection of ODS waste results from coordinated and synchronized efforts between appliance/equipment replacement and recovery-and-recycling programmes, including incentives to encourage collection, requires regulatory support to be successful;

(b) Long-term sustainability of ODS waste management remains a challenge without further involvement and cooperation from collection centres, and without institutional support, including policies for destruction;

(c) Awareness on the importance of developing concrete procedures for the management and disposal of ODS waste needs to be raised among waste management operators;

(d) While co-financing continues to be pursued, the currently low price of carbon credits and the downturn in the carbon markets had made it difficult to search for co-financing options that would support the sustainable disposal of ODS waste; and

(e) The establishment of a sustainable business model entails complex coordination arrangements with various stakeholders, and private sector commitment and involvement in these activities is necessary in order for these initiatives to be successful.

Conclusions

59. The projects offered a view of the activities necessary for environmentally sound management of ODS waste. The observations from the reports include factors that determine the sustainability of destruction, which are summarized below:

(a) For LVC countries:

(i) More efficient collection, dismantling and recovery of the ODS waste refrigerant lowers transaction and operational costs considerably;

(ii) Aggregating waste from nearby countries or regions may be an option to ensure that sufficient quantity is aggregated for cost-effective transportation and destruction, given due consideration to national/regional regulations on hazardous waste movement;

(iii) Close coordination among the different stakeholders responsible for all stages of the management of ODS waste, is essential to ensure that all activities are implemented efficiently; and

(iv) Public awareness is an important aspect, particularly in cases where it is important for the public to be made aware of the appliance replacement programme to encourage more owners to participate;

(b) Project design and sustainable business model:

(i) Due to the long implementation period of the demonstration projects and the focus on CFCs, additional qualification testing of incineration facilities with other wasted refrigerants (i.e., HCFCs and HFCs) may be necessary to ensure that these can be used for these relevant EOL substances;

(ii) Aligning the design of ODS destruction projects to procedures of the voluntary carbon markets could provide an opportunity for sustaining funding for such activities; and

(iii) Putting in place a cost-effective and sustainable EPR system based on an industry-administered partnership is necessary to ensure a waste stream that will make destruction efforts profitable and sustainable;

(c) With regard to synergies with other destruction activities for hazardous chemicals:

(i) Co-disposal of ODS waste and other hazardous waste (e.g., POP waste) provides opportunities for economies of scale leading to cost-effective disposal options, especially for those countries with very small ODS waste streams;

(ii) Exploring synergies with other multilateral environmental agreements, in particular with those that relate to climate change and chemical management, could be considered;

(iii) The requirements of the Basel Convention does not preclude countries from exporting ODS waste for destruction in line with the requirements of that Convention; and

(iv) Integrating ODS disposal issues within the national strategy of waste management linked with other aspects, such as energy efficiency, offers prospects for a sustainable ODS waste stream from replaced EOL equipment.

60. It was also noted the importance of including a strategy for the environmentally sound management of ODS wastes within a comprehensive phase-out plan from inception rather than considering it only at the end. This will ensure that the elements comprising the destruction process are integrated, an institutionalised collection process can be defined, and a waste stream will be assured. This would then allow countries to decide on options for destruction depending on the amount of waste collected.

61. For reasons that are not clear, the cost of destroying ODS waste in Article 5 countries appears to be substantially higher than the cost in non-Article 5 countries (as shown in Table 3). Based on the differences in destruction costs, and notwithstanding the additional transportation costs required for exporting ODS waste, it appears that in many instances a more cost-effective option for the destruction of ODS waste from Article 5 countries without their own destruction facilities would be to export such waste to non-Article 5 countries for destruction.

Recommendation

62. The Executive Committee may wish:

(a) To note the synthesis report on the pilot ODS disposal projects as contained in UNEP/OzL.Pro/ExCom/82/21;

(b) To request bilateral and implementing agencies to apply, where appropriate, the findings and recommendations of the synthesis report on the pilot ODS disposal projects;

(c) To urge bilateral and implementing agencies to return any remaining balances for ODS disposal projects, if not already returned, to the 82nd meeting, in line with decision 79/18(b); and

(d) To take into account the synthesis report on the pilot ODS disposal projects during its discussion on agenda item 11(d) of the 82nd meeting on the Development of the cost guidelines for the phase-down of HFCs in Article 5 countries.

Annex I

CRITERIA AND GUIDELINES FOR THE SELECTION OF ODS DISPOSAL PROJECTS AND DEFINITION OF ACTIVITIES

1. At its 58th meeting, the Executive Committee discussed a document on criteria and guidelines for the selection of ODS disposal projects, which was revised during the meeting.[1] Following the discussions, the Executive Committee decided (decision 58/19):

(a) To approve the following interim guidelines for the funding of demonstration projects for the disposal of ODS in accordance with paragraph 2 of decision XX/7 of the Meeting of the Parties:

(i) For each separate category of activities for ODS disposal, namely collection, transport, storage and destruction, the definitions are as set out in Annex VIII to the present report;

(ii) The Multilateral Fund will fund a limited number of demonstration projects under the following conditions:

a. No funding would be available for the collection of ODS, except as a contribution to the monitoring of the sources of the ODS for an already existing, separately funded, collection effort for CFCs;

b. A limited number of demonstration projects for ODS disposal related to paragraph 2 of decision XX/7, covering aspects not yet covered by other demonstration projects, will be considered only at the 59th meeting for project preparation funding;

c. The funding would be limited to a maximum level of up to US $13.2/kg of ODS to be destroyed for non-low-volume-consuming countries, on the understanding that this would be based on expectation of high start-up costs for these new activities, and would not constitute a precedent. Should the project not foresee activities related to all of the following areas (transport, storage and destruction), this threshold would be adjusted accordingly

d. For the disposal of halon and for the disposal of carbon tetrachloride (CTC), funding would be provided for a maximum of one demonstration project each, provided the respective projects have an important demonstration value;

(iii) Bilateral and implementing agencies are requested to report annually to the first meeting of the Executive Committee on progress and experiences gained in demonstration projects on disposal, commencing in the first year after project approval. These reports should cover the amounts of the different ODS collected or identified, transported, stored and destroyed, as well as financial, managerial and co-funding arrangements, and any other relevant issues;

[1] UNEP/OzL.Pro/ExCom/58/19/Rev.1

(iv) Bilateral and implementing agencies are requested, when submitting activities for funding that are related to the disposal of ODS, to provide:

a. In the case of requests for project preparation funding:

i. An indication of the category or categories of activities for the disposal of ODS (collection, transport, storage, destruction), which will be included in the project proposal;

ii. An indication whether disposal programmes for chemicals related to other multilateral environmental agreements are presently ongoing in the country or planned for the near future, and whether synergies would be possible;

iii. An estimate of the amount of each ODS that is meant to be handled within the project;

iv. The basis for the estimate of the amount of ODS; this estimate should be based on known existing stocks already collected, or collection efforts already at a very advanced and well-documented stage of being set up;

v. For collection activities, information regarding existing or near-future, credible collection efforts and programmes that are at an advanced stage of being set up and to which activities under this project would relate;

vi. For activities that focus at least partially on CTC or halon, an explanation of how this project might have an important demonstration value;

b. In the case of project submissions:

i. Updated and more detailed information for all issues mentioned under project preparation funding contained in all sub-paragraphs of (iv) a. mentioned above;

ii. A detailed description of the foreseen management and financial set-up; this should include details such as the total cost of the disposal activity including costs not covered by the Multilateral Fund, the sources of funding for covering these costs, description of the sustainability of the underlying business model, and an identification of time-critical elements of the implementation, which subsequently might be used to monitor progress;

iii. A clear indication how the project will secure other sources of funding; these other sources of funding should be available, at least partially, before the end of 2011. In case of activities of the collection type, any other sources of funding necessary in line with sub-paragraph (iv) a. iv. above related to collection would need to be secured before the project is submitted to the Executive Committee;

iv. A concept for monitoring the origin of recovered ODS for future destruction, with the objective of discouraging the declaration of virgin ODS as used ODS for destruction. This concept should include or at least allow for external verification of the amounts destroyed, and the costs for its operation should be covered sustainably;

v. The project proposal should include valid assurances that the amount of ODS mentioned in the proposal will actually be destroyed, and the agencies should submit proof of destruction with the financial closure of the project;

vi. An exploration of other disposal options for the used ODS such as recycling and reuse opportunities;

(b) To consider at its 60th Meeting any decision taken by the Parties at their Twenty-first Meeting that might relate to these interim guidelines and definitions;

(c) To request the Fund Secretariat to provide, to the second Meeting of the Executive Committee in 2011, a report on the experience gained in the implementation of the disposal projects, using reports from bilateral and implementing agencies and other relevant sources of information; and

(d) To consider whether to review the interim guidelines and related definitions at the 64th meeting in light of the experience gained and any additional information and guidance available at that time.

Definitions of activities

Collection

2. "Collection" includes all efforts to extract ODS from an application or a product. In addition, for products that contain less ODS than specified as "significant", it would include aggregating the extracted ODS until the necessary quantity is reached. Collection would therefore cover, for example:

(a) The collection of refrigerators, their transport to a central disassembly or recycling site, and extracting the CFCs from the refrigerators, compressing and transferring them into a transport container;

(b) Similarly, it would cover the transport of foam, extraction of CFC-11 from it and transferring it into a suitable container; and

(c) It would also cover the collection of small halon cylinders and their refilling into transport containers, or the recovery of CFCs from a supermarket refrigeration system of 13.6 kg or more of CFC-12 content or a respective amount of other refrigerants with the same climate impact.

3. The effort necessary to collect ODS will depend on:

(a) The level of integration of ODS with the product, i.e. if the ODS can be recovered at the location of the product, or if the product needs to be transported to a central recovery

facility; in the latter case, volume and weight of the product vs. the amount of recoverable ODS are also important factors;

(b) The geographical distribution of equipment containing ODS, and the amount of ODS contained in the equipment; and

(c) Its environmental impact, measured in ozone depletion potential (ODP) and global warming potential (GWP).

4. Collection is the category of activity where the decisions are being made on whether the environmental impact of the ODS in the product surpasses the economical and/or ecological cost of its collection, and whether specific approaches for collection would fit into the economics of a planned project or activity. At the present point in time, ODS for some sub-sectors, e.g., building foams, are not collected systematically in any country because of economic and logistic considerations. In other cases, other considerations facilitate the collection of ODS, e.g. the need to collect and dispose of old refrigerators in the event of an energy-efficiency driven refrigerator replacement programme.

Transport

5. "Transport" includes the actual transportation of significant quantities, as defined above, in transport containers, both within a country as well as, where necessary, as transboundary transport. Furthermore, where applicable, necessary efforts to transfer ODS from containers for collection to potentially larger transport units, e.g. 13.6 kg cylinders of CFC-12 to 720 kg transport containers, and tests for substances contained for the purpose of labelling or to avoid undesired mixing will be needed. Transport would therefore cover, for example:

(a) The transportation of collected, contaminated refrigerant in cylinders from recovery/recycling centres in a country to a central location in the country for subsequent further transport;

(b) The transportation of halon 1301 in transport cylinders of 21.5 kg or above from building sites to destruction facilities; and

(c) Arranging of export/import and transit permits, where applicable consistent with the Basel convention, to prepare for transporting from a national storage site to a destruction facility in another country.

6. Paragraph 6 of decision XX/7 of the Meeting of the Parties specifically notes that "… any project implemented pursuant to the present decision when applicable should be done in conformity with national, regional, and/or international requirements, such as those mandated by the Basel Convention and Rotterdam Convention".

Destruction

7. "Destruction" covers preparation of ODS for destruction and the actual destruction itself, using destruction technologies approved by the Meeting of the Parties and operating them taking into account the Code of Good Housekeeping as per the Annex III of the report of the Fifteenth Meeting of the Parties. It would therefore cover, for example:

(a) The testing of ODS containers for composition, determining the exact content and the contaminants. This could serve to identify impurities in case of destruction facilities being sensitive to contamination, as well as necessary purification processes; at the same time,

this allows exact determination of the quantities of the different substances being destroyed, e.g. to serve the reporting needs under Article 7 of the Montreal Protocol, as well as other monitoring needs where exact quantification of substances may be of importance;

(b) Destruction of CTC from by-production of other chloromethane on-line with the chloromethane production process;

(c) Minor changes to existing facilities;

(d) Environmental assessments and application for permits, including, where applicable and required, continuous monitoring of the environmental impact; and

(e) Destruction of ODS and measurement of the effectiveness of destruction.

8. In the course of project review the Secretariat will need to pay particular attention to the assessment of the cost efficiency of destruction activities given that there appears to be a large amount of destruction capacity available at competitive prices. Agencies should therefore be encouraged to discuss related matters with the Secretariat early on during the project preparation phase to avoid a project design based on funding expectations which might not be seen as eligible once the project is assessed.

Storage

9. "Storage" includes all requirements for proper storage such as e.g. suitable containers and storage sites, as well as the necessary supervision, storage permits, and environmental assessments where applicable.

Annex II

OVERVIEW OF THE PILOT ODS DISPOSAL PROJECTS

1. Between the 54th and 65th meetings, the Executive Committee approved funding for the preparation of 16 pilot demonstration projects for ODS destruction. These included two regional ODS disposal demonstration projects, for Asia and the Pacific (ASP), and for Europe and Central Asia (ECA). These requests resulted in nine project proposals. The preparation funding provided for one country and one region did not result in complete projects and were cancelled.[1] In addition, the Executive Committee approved three technical assistance programmes (i.e., Nepal, regional strategy for Africa[2] and a global project[3]), resulting in a total of 12 projects approved, as shown in Table 1.

Table 1. Pilot ODS disposal projects approved

Country	Region	Agency	Meeting	Funds (US $)
Approvals for project preparation for ODS disposal demonstration projects				
Algeria	Africa	UNIDO	59	85,000
Region: ASP	Asia and the Pacific	Japan	54	30,000
Brazil	Latin America	UNDP	57	40,000
Colombia	Latin America	UNDP	59	40,000
China	South Asia	UNIDO	59	85,000
Cuba	Caribbean	UNDP	59	40,000
Region: EUR	Europe	Czech Republic	65	35,000
		UNIDO	65	35,000
Georgia	Europe	UNDP	65	30,000
Ghana	Africa	UNDP	65	30,000
Indonesia	South East Asia	IBRD	64	50,000
India	South Asia	UNDP	57	80,000
Lebanon	West Asia	UNIDO	57	85,000
Mexico	Latin America	UNIDO	61	50,000
		IBRD	61	50,000
Nigeria	Africa	UNIDO	57	60,000
Philippines (the)	South East Asia	IBRD	58	50,000
Turkey	Europe	UNIDO	60	60,000
Approvals for ODS disposal demonstration project implementation				
Region: AFR*	Africa	France	68	80,000
Algeria	Africa	France	72	250,000
		UNIDO	72	375,059
Brazil	Latin America	UNDP	72	1,490,600
Colombia	Latin America	UNDP	66	1,195,000
China	South Asia	UNIDO	67	1,227,885
		Japan	67	900,000
Cuba	Caribbean	UNDP	62	525,200
Region: EUR	Europe	UNEP	69	75,000
		UNIDO	69	274,480
Georgia	Europe	UNDP	69	55,264
Ghana	Africa	UNDP	63	198,000

[1] India, and the regional project for Asia and the Pacific submitted by Japan.

[2] The strategy for disposal and destruction of ODS for five countries (Central African countries (Burundi, Cameroon, Central African Republic, Congo and Guinea) was submitted without project preparation funding. It proposed to develop a regional strategy for LVC countries to address unwanted ODS stockpiles. However, due to difficulties in implementation, the project was cancelled.

[3] The global project for the World Bank was a study designed to explore opportunities for financing ODS destruction; it was approved outside the guidelines for ODS disposal projects and was not included in the synthesis report.

Country	Region	Agency	Meeting	Funds (US $)
Global*	Global	IBRD	55	250,000
Lebanon	West Asia	UNIDO	73	123,475
Mexico	Latin America	UNIDO	63	927,915
		France	63	500,000
Nepal*	South Asia	UNEP	59	157,200
Nigeria	Africa	UNIDO	67	911,724
Turkey	Europe	UNIDO	66	1,076,250
TOTAL				**11,528,052**

*Technical assistance

2. A final report was expected for each project that should cover the amounts of the different ODS collected, transported, stored and destroyed, as well as financial, managerial and co-funding arrangements, and any other issues relevant to the project implementation. Based on the draft guidelines, the Secretariat reviewed the projects, and reported to the Executive Committee at its 64th[4] and 70th[5] meetings.

3. The following challenges on project implementation were observed:

(a) For project preparation, on average, it took between nine to 40 months before the final projects were submitted for consideration of the Executive Committee, and between five to 72 months for the projects to be completed and final reports submitted;

(b) The information that needed to be included in the proposals was not easy to obtain; frequently, it was cited as the reason for the delays in submitting the project for funding. Specifically:

(i) Difficulties were encountered in examining the national policy and regulatory infrastructure in place, and to link the potential project with existing similar initiatives for chemical waste management to develop synergies for the projects;

(ii) Identifying sources of co-financing the project and developing the business model, and in some cases, the downturn in the carbon markets made this an unsustainable source of co-financing;

(c) Delays were experienced in getting agreement with the country with respect to the approach for ODS disposal;

(d) The survey and aggregation of already collected ODS took longer than expected; and

(e) Some countries gave priority to completing HCFC phase-out management plans (HPMPs) both during project preparation and implementation of the ODS disposal projects.

Summary of results from completed demonstration projects

4. A summary of the information presented in the 11 reports received are presented in detail below.

[4] UNEP/OzL.Pro/ExCom/64/49 Report on the experience gained in the implementation of the disposal projects (decision 58/10)
[5] UNEP/OzL.Pro/ExCom/70/54 Report on progress and experiences gained in demonstration projects for the disposal of ODS (decision 64/50)

China: Final report on the pilot demonstration project on ODS waste management and disposal (Government of Japan and UNIDO)

5. The objective of the pilot demonstration project is to explore treatment to the collected ODS wastes, set up a sustainable model for ODS wastes destruction, and the disposal of 192.0 metric tonnes (mt) of ODS wastes, particularly CFC banks.

6. The Regulation on ODS Management, which became effective in June 2010, is the basis for ODS recycling. It stipulates *inter alia* that enterprises specialized in the servicing and scrapping of refrigeration equipment, refrigeration and fire-extinguishing systems that contain ODS, shall be recorded under the local environmental protection bureaus (EPBs) and shall collect, recycle the ODS or transfer them to enterprises specialized in their collection, recycling and destruction to give proper treatment to ODS.

7. The project had provided for local EPBs to undertake verification activities such as on-site visits, and collect information on ODS recycling enterprises, destruction procedures applied and related cost; and record ODS recycling equipment and its operational status. The verification of some large refrigeration servicing facilities found that this sector only uses HCFCs (i.e., there are no CFCs for disposal).

8. The total amount of CFCs destroyed amounted to 194.793 mt, consisting of 11.788 mt of CFC refrigerants, 172.005 mt CFC in foam wastes and 11 mt of CFC-11 used as a blowing agent. All the collected wastes were incinerated using rotary kilns. The disposal cost for ODS-related foam wastes and refrigerants comprised direct and indirect costs. Direct costs included those related to energy including electricity and gas, water and other materials for flue gas treatment and testing. Indirect costs included shared investment of fixed asset, overheads, management and others (e.g., taxes). Although the costs vary among provinces, the average cost of destruction ranged from US $8.00/kg to US $12.50/kg.

9. The demonstration project has validated that the rotary kiln technology is efficient for the destruction of CFC-12, CFC-11 and CFC-11-based foams although the cost of operation is relatively high. Optimization of the destruction process is recommended in order to improve efficiency and reduce cost. While there are hazardous wastes disposal facilities available in some provinces, these are operating at full capacity dealing with other solid wastes. Considering the potential ODS waste coming from HCFCs and HFC-based products in the coming years, additional disposal facilities may need to be established in future.

Colombia: Final report on the demonstration project on end-of-life ODS management and destruction (UNDP)

10. The objective of the pilot project is to demonstrate a sustainable approach for ODS waste management from collection to destruction, by strengthening destruction capabilities of domestic facilities integrating them into broader hazardous waste, and energy efficiency initiatives. It proposed to address the disposal of 114 mt of ODS wastes for destruction; put in place measures to support the sustainability of the project taking into account ODS wastes that will be collected through the refrigeration servicing sector, and supported by policy initiatives now being implemented.

11. The ODS waste disposal project was implemented within a broader national policy framework of an integrated approach to hazardous waste management, energy efficiency, management of greenhouse gas emissions and the commitment to meeting the obligations under the Montreal Protocol. This included a priority attached to the environmentally sound management of end-of-life ODS as a result of national policy initiatives in the areas of refrigeration and air-conditioning. It was also supported by a sustainable Extended Producer Responsibility Programme that started in 2013, which progressed from a voluntary pilot phase to a mandatory system.

12. The demonstration test burn work showed that a domestic capability is qualified in principle, for the destruction of ODS, specifically CFC-11 and HCFC-141b-based foam and CFC-11 and CFC-12 chemicals up to established limits of chlorine feed content. While the destruction facility met the destruction efficiency requirements, there were limitations related to air emissions, particularly acid gases (hydrochloric acid (HCl) and hydrogen fluoride (HF)) that limit chlorine and fluorine content of the feed, impacting the productivity and cost-effectiveness of the destruction tests. The cost-effectiveness for destruction of CFC-11 and CFC-12 chemicals was estimated at half the cost-effectiveness specified by the Multilateral Fund (i.e., US $13.20/kg). However, for the destruction of foam, the cost-effectiveness was estimated at approximately four times the threshold and, therefore, not affordable. Based on this, the current option is either the use of an electric arc furnace steelmaking plant processing intact refrigerator cabinet and doors, or a commercial cement kiln to destroy foam and potentially ODS refrigerant. Depending on the option selected, overall cost estimates range from US $6.40 to US $12.30 per refrigerator.

Georgia: Pilot demonstration project for ODS waste management and disposal (UNDP)

13. The objective of the pilot project for Georgia was to demonstrate how barriers to destruction and management of unwanted ODS can be overcome through synergies between ODS waste and persistent organic pollutants (POPs) stockpiles, and the disposal of 2.13 tonnes of unwanted ODS wastes that had already been collected and were temporarily stored in facilities in the country.

14. The final report focused on the activities done jointly by the focal areas, where both waste streams were co-disposed in a cost-effective manner. Terms of reference and a tender document were prepared for the co-disposal process to identify a waste sub-contractor that could collect, aggregate, pack and transport the obsolete POPs and the ODS waste to a destruction facility in France. The policy framework on hazardous waste management was reviewed to consider both ODS and POPs wastes in a comprehensive manner.

15. One key factor to the project's success was the close coordination between two separately funded activities, with the support of the Government. Joint project management through one consolidated tender, one sub-contractor and one process followed for waste export permitting procedures resulted in overall savings. In addition, having smaller waste streams, ODS waste disposal will in future continue to benefit from joint export with POPs waste, where under the Stockholm Convention it is a national obligation to destroy such hazardous waste. Experience showed that implementation of such joint projects takes longer time for preparation and identification of companies with expertise of both wastes. This project allowed for such a system to be put in place.

16. The project resulted in the disposal of 1.2 mt of waste ODS, an amount lower than what had been originally targeted. This was due to deterioration of the tanks where CFCs were stored which may have resulted in gas leakage. The project identified all sources of ODS waste in the country; supported by legislation, such collection would continue in future.

17. With regard to the sustainability of the project, Georgia is currently in the process of establishing a National Environmental Fund to include funds collected from penalties associated with illegal ODS trade. This fund may thus be used for additional exports of ODS waste in the future.

Ghana: Pilot demonstration project for ODS waste management and disposal (UNDP)

18. The project for Ghana proposed to dispose 8.8 tonnes of CFC-12 that had already been collected and were ready for destruction, and to put in place measures to support the sustainability of the project by considering other potential ODS waste that could be collected nationally under a project on energy efficiency (EE) funded by the Global Environment Facility (GEF).

19. The final report provided details on project implementation, the set-up of the operations in particular the synergy between the pilot demonstration project and the GEF-funded project, procurement of equipment (e.g., portable recovery machines from Germany, laboratory equipment, refrigerant identifiers, refrigerant cylinders), and the results of the destruction process. It indicated that a total of 1.2 mt of CFCs and 5.2 mt of methyl bromide were destroyed through a facility in Poland (Veolia), and an additional 1 mt of CFC was exported for destruction at a facility in the United States of America (Tradewater). Thus, the total ODS waste destroyed amounted to 7.4 mt.

20. Some of the challenges faced during implementation included: difficulties in aggregating wastes in sufficient amount for a cost-effective destruction; instability of the carbon markets which was seen as a driver for the interest in export for destruction; internal process of getting clearances for exporting a mixture of waste to Poland and the United States of America (i.e., persistent organic pollutants (POPs), polychlorinated biphenyl (PCBs) and ODS); and addressing stocks of collected foam containing CFC-11 and its destruction.

21. One main lesson learned from the project was the importance of cooperation between projects of complementary nature, in this case the GEF-funded appliance replacement and rebate scheme and the pilot waste destruction project funded by the Multilateral Fund. While the approach was complex, combining these waste streams provided a cost-effective solution for destruction, saving on transport and destruction costs. This has also led to collaboration between Ghana's Energy Commission and Environmental Protection Agency, the two agencies responsible for the GEF and Multilateral Fund projects, respectively.

Mexico: Final report on the demonstration project for disposal of unwanted ODS (UNIDO)

22. The objective of the pilot demonstration project for Mexico was the disposal of the 166.7 metric tonnes (mt) of CFC-12 from old refrigerators and air-conditioners, and 7.0 mt from chillers. The demonstration project destroyed 113.0 mt of unwanted CFC-12.

23. In addition to ozone and climate benefits, the project encouraged the first Mexican facilities to obtain licenses to incinerate and co-process ODS waste, and proved the feasibility of ODS destruction using two different technologies: argon plasma arc and cement kiln. Mexico has two companies with the necessary authorizations from the Government, which were issued after satisfying relevant safety and environmental standards associated with ODS destruction.

24. The final report provides details on the phased implementation of the project. Preliminary activities consisted of training and recovery equipment endowment to home appliances replacement programme (HARP) centres, monitoring, reporting and verification (MRV) system design, awareness workshop, and implementation of ODS destruction pilot tests and licensing approval for two Mexican companies. Aggregation and consolidation of ODS banks were achieved and approximately 74.0 mt of unwanted CFC-12 banks were destroyed in the argon plasma; and an additional 39.0 mt were destroyed between 2016 and 2017. The cost-effectiveness based on implementation ranged from US $8.0/kg to US $9.20/kg.

25. The report states that the argon plasma arc is a cutting-edge destruction technology and is the cleanest; however, its limitation is the high cost. Cement kiln proved to be the most cost-effective ODS destruction technology, noting that the cement manufacturing industry in Mexico has a long experience in handling hazardous waste, other than ODS. Project lessons are provided in the final report.

Nepal: Pilot demonstration project for ODS waste management and disposal (UNEP)

26. The project for Nepal was approved by the Executive Committee at the 59th meeting to allow Nepal to explore two options for destroying a small amount of unwanted ODS that had been collected and stored through the national ozone unit. This ODS could not be sold in the market as it had been brought in above

the country's allowable CFC consumption and was considered unwanted. As Nepal had a restriction for ODS re-export, the country had no option but to explore destruction possibilities.

27. The selected approach that the destruction project used was to export the ODS for destruction to the United States of America. This was done through a broker, EOS Climate, who organised the transfer to a licensed facility for destruction. UNEP reported that the shipment reached the United States of America in November 2012, and subsequently has been reported as destroyed as of February 2013. The amount of ODS handled in this project was 10 ODP tonnes (107,000 CO_2-equivalent tonnes).

28. In March 2013, the Nepal project was submitted to the Climate Action Reserve (CAR). This has subsequently been listed in CAR with a reserve project identification number of CAR955. Upon further verification with the CAR website, the Secretariat noted the project has now changed status with CAR as registered, as of 24 May 2013. It has met final verification requirements of the CAR, and Climate Reserve Tonne (CRTs) may now be issued.[6]

29. In summarizing the demonstration value of the Nepal project, this provided an opportunity to link ODS destruction to the carbon market and explore the possibility of other financial mechanisms to support ODS destruction activities. The project's registration with the CAR is a good example for other countries who are pursuing this track for their ODS disposal projects. It also reported that one of the challenges that was faced during project implementation was the lengthy process to get approval for the export of the ODS to the United States of America, because of the legal impediments that required Parliamentary clearance.

Nigeria: Final report on the pilot demonstration project for disposal of unwanted ODS (UNIDO)

30. The objective of the pilot project is to demonstrate a sustainable business model for ODS waste management from collection to disposal using Multilateral Fund assistance as seed money to destroy current stock of unwanted ODS and generate carbon credits. These credits would be used to establish an Appliance Replacement Programme (for the replacement of existing domestic refrigerators and air-conditioners with more energy efficient ones), to sustain the current recovery and collection system for ODS, with the view to incorporate other refrigerants in the future. The project intended to destroy future ODS wastes through local incineration facilities whose capacity would be developed through the revenues generated from these carbon credits. The expected output from this project was the destruction of 84.0 mt of CFC-12 which had been reported as already collected during the project preparation from industrial sources, particularly from oil refineries.

31. An inception workshop took place in November 2013, with participation from Government agencies, servicing companies, waste management companies and end-users. A local contractor was hired to aggregate ODS wastes in the country; a training workshop was provided to technicians on safe collection, transportation and storage of ODS wastes including testing, correct labelling and documentation procedures; and a capacity building workshop for ODS collection and aggregation was held in June 2014. Companies and end-users that were identified during the preparatory phase were contacted to enquire about their stocks of ODS. However, stocks of ODS reported in most cases were not found. The total ODS

[6] Project developers submit a project by uploading the necessary forms and supporting documents to the Climate Action Reserve online software. The Reserve staff pre-screen projects for eligibility. Eligible projects are posted on the Reserve site with a status of "listed." The next step is verification by an independent, accredited verification body. Once completed, Reserve staff review the verification documentation, and if the project passes this final review process, it is labeled "registered" and CRTs are issued. Project developers submit a project by uploading the necessary forms and supporting documents to the Reserve online software. The Reserve staff pre-screen projects for eligibility. Eligible projects are posted on the Reserve site with a status of "listed." The next step is verification by an independent, accredited verification body. Once completed, Reserve staff review the verification documentation, and if the project passes this final review process, it is labeled "registered" and CRTs are issued.

collected amounted to only 1.66 mt of CFC-12. The collection activities were halted as no new stocks of CFC-12 were found and new inquiries repeatedly turned out to be halons (which are stored in Government agencies).

32. The revised ODS Regulations (2016) makes provisions for mandatory destruction of wastes, guidelines for destruction facilities including emission limits, and extends responsibility of end-of-life waste equipment to producers/suppliers. Extended Producer Responsibility regulations are now in place for the electronic/electrical sectors; thus, for new refrigerators, future recovery of refrigerants at their end-of-life should be the responsibility of the private sector. Training sessions on e-waste collection and management were carried out.

33. Officials from the Ministry of Environment and UNIDO inspected four disposal facilities and invited two of them to bid for the disposal of CFCs. The company selected has a proven track record of hazardous waste management for multinational companies and experience of managing CFC wastes specifically from collection to recycling. The collected stocks of CFC waste were tested for purity at the storage facility before loading, and transported to the destruction facility in Port Harcourt, Nigeria. The destruction process employed by the contracted facility is a rotary kiln incineration.

34. Of the total funds approved of US $911,724, only US $253,965 has been disbursed. Based on these disbursement, the actual cost of destruction for this project was US $153/kg of ODS waste. The financial report will be updated once destruction is complete and all outstanding payments are made. The balance of funds will be returned to the 82nd meeting.

Indonesia and the Philippines: Final reports of ODS disposal projects (World Bank)

35. At the 57th meeting, the Executive Committee approved funds for the preparation of pilot demonstration projects for ODS waste management and disposal for Indonesia and the Philippines. At that meeting, the World Bank had indicated that these funds would be used to generate data and experience on management and financing modalities, and would examine opportunities to leverage co-financing.

36. The World Bank submitted final reports containing material describing the current ODS waste inventories for Indonesia and the Philippines, information on how to do inventories and data collection, guidance on the management of unwanted ODS, financing options for destroying unwanted ODS including information about available markets, cost considerations and market prices. The reports also contain specific options for each country, an evaluation of these options, and the next steps that would be needed for implementation.

Turkey: Final report on the demonstration project for disposal of unwanted ODS (UNIDO)

37. The objective of the project was to establish a sustainable and integrated business model for an efficient waste management system of ODSs, through institutional measures that will organize the existing recovery and collection systems in the country into an integrated and efficient collection validation and valuation system.

38. Turkey had already collected some ODS wastes through Government-authorized recovery and reclamation centres established in three cities, Ankara (TUHAB), Istanbul (ISISO) and Izmir (ESSIAD); the expected amount of ODS wastes to be destroyed was 103.72 mt of CFC-12. However, during implementation, it was found that the ODS wastes available were in many cases mixtures of all types of refrigerants and the actual amount available for destruction was 9.162 mt of CFC-12.

39. The project had envisaged exporting the ODS waste to the United States of America for destruction; however, the absence of expected revenue from carbon markets, and the very small amounts of ODS wastes

to be destroyed led to a redesign of the disposal strategy. It was decided to destroy the collected waste in Europe through an international bidding process.

40. In order to be more cost-effective, the ODS wastes from Turkey was combined with that of ODS waste from Montenegro; the latter was part of the regional demonstration project for ODS waste disposal pilot project for the Europe and Central Asia (ECA) region also funded by the Multilateral Fund. Other activities such as sharing of lessons learned, awareness raising were also done in close cooperation with the ECA region.

41. The project resulted in the destruction of 9.162 mt of CFC-12, reported an expenditure of US $598,345 out of the approved US $1,076,250, plus agency support costs, resulting in a cost-effectiveness of US $65/kg of ODS wastes destroyed

ECA region: Demonstration of a regional strategy for ODS waste management and disposal (UNIDO)

42. The objective of the pilot demonstration project for three countries – Bosnia and Herzegovina, Croatia and Montenegro in the ECA – was to evaluate a regional approach for ODS waste disposal in terms of cost-effectiveness and sustainability, particularly in LVC countries that do not have their own ODS destruction facilities.

43. The project aimed at destroying 29.07 mt of ODS waste from the three countries. It collected mainly CFCs, HCFCs and small amounts of HFCs. A total of 41.37 mt of waste were destroyed, including 32.79 mt of ODS waste. It was not feasible to separate ODS waste from non-ODS waste, meaning that all collected quantities were destroyed under the project. The cost-effectiveness of the project was US $8.01/kg calculated based only on the portion of ODS waste destroyed, exceeding the expected cost-effectiveness of US $12.02/kg. Therefore, the overall cost estimate of the project is US $262,622, and any balances will be returned to the Multilateral Fund after financial completion of the project.

44. The final report highlights that both legislation and institutional arrangements of the beneficiary countries did not support the aggregation of ODS waste at the regional level, synchronization of the shipments from different countries, and synergies with persistent organic pollutants (POPs) destruction.

45. The project facilitated the establishment of the Regional Cooperation Forum (RCF) as a communication platform that provided, *inter alia*, a list of equipment and tools that are necessary for proper aggregation of waste; check list for laboratory analysis of ODS waste; list of eligible destruction facilities in the European Union (EU); and recommendations and lessons learned.

46. Some lessons include improved knowledge on legislation in the EU and project countries, which does not allow the aggregation of ODS waste at regional level because ODS waste is classified as hazardous waste; the need for national legislation of the country in which destruction is to take place to allow the import of waste mixtures containing ODS for destruction; a list of destruction facilities in EU countries that accept waste mixtures containing ODS for destruction would be useful to other countries in the ECA region; and environmental taxes on refrigerants contributing to ozone layer depletion and climate change might feed into environmental funds to finance the environmentally sound disposal of refrigerant waste in the long-term.