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GUIDE FOR DEVELOPING GREENHOUSE GAS EMISSION REDUCTION PROJECTS BASED ON THE DESTRUCTION OF OZONE DEPLETING SUBSTANCES

1. The annex to the present document contains the project report for the Nordic Environment Finance Corporation (NEFCO) on the guide for developing greenhouse gas emission reduction projects based on the destruction of ozone depleting substances, submitted by Switzerland for the information of the Sixtieth Meeting of the Executive Committee.

2. The document is reproduced as submitted to the Secretariat and no editing has been made to it.

Project report for the Nordic Environment Finance Corporation

March 24, 2010

Guide for developing GHG emission reduction projects based on the destruction of Ozone Depleting Substances

Case: Collection and destruction of ODS in Russia

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REPORT PREPARED BY:

CLIMATE WEDGE LTD OY
FREDRIKINKATU 29A
00130 HELSINKI

CONTACT: Kristian Brüning
kristian.bruning@climatewedge.com

Key Observations for ODS destruction projects

This paper describes the procedural requirements for projects that aim to convert the climate benefit of destroying existing banks of Ozone Depleting Substances (ODS) into verified emission reductions and carbon credits. The basic financial requirement for undertaking an ODS destruction project is that the value of the carbon credits merit an investment into collection, transport, storage and destruction of ODS. The development of such a project requires, aside from regulatory and techno-economic feasibility, an understanding of the technical and procedural requirements in the carbon markets, and an ability to use this information to evaluate the feasibility of an ODS destruction project opportunity as a stand-alone emission reduction project or as part of a broader investment project.

In evaluating the prospect of using carbon financing in ODS destruction projects a project developer should in particular keep the following key observations in mind.

- **QUALITY- Know the source of and understand the alternate use of ODS!**
  - Prefer projects where ODS will clearly leak out in the near future without the destruction project – this will strengthen the business case for carbon financing
  - Always exceed the legal requirements for ODS management in the jurisdiction
  - Focus, to the extent possible, on high quality homogenous ODS to reduce monitoring costs

- **VOLUME – costs mostly fixed, volume has big impact on unit cost of destruction!**
  - Focus on high GWP ODS, such as e.g. CFC-12 and halon 1301
  - Focus on larger units of ODS (e.g. industrial refrigeration) to reduce cost of collection and transport

- **SHARE COSTS - Integrate ODS management and destruction with other business!**
  - Collect ODS/appliances with other products/services to reduce collection cost – and share operating costs with existing waste management practices
  - Combine destruction facility with a waste management site to minimize investment cost and maximize efficiency of ODS recovery
  - Reduce the number of transfers between collection and destruction to avoid leaks – enable collection, recovery, storage (and destruction) at one site

- **SCALE OPERATIONS – gradually grow from collection to destruction!**
  - Carbon financing is a new stream of financing – design ODS management/destruction operations to enable gradual growth of collection/destruction volume
  - Consider utilizing external destruction capacity initially – start operations with focus only on ODS collection, recovery and consolidation
  - Projects with the most narrow scope are most feasible; i.e. destroying only high-GWP refrigerants from existing service/maintenance stockpiles – however this business model yields few other environmental benefits of the service of decommissioning the refrigerator, recycling materials and recovering ODS is really not represented by such a business case

SECTION A: NEFCO ODS PROJECT

Project background

Overview

Existing banks of ozone depleting substances[1] (ODS) presents a vast source of highly potent greenhouse gases which are not regulated by the Montreal Protocol. According to IPCC estimates[2] current global ODS banks are estimated to represent (in GWP) 16 to 18 billion tons of CO2equivalent. These vast quantities of ODS remain in use and storage in e.g. old refrigeration equipment, building and appliance insulation, fire suppression systems and government stockpiles. The UNEP Technical Assessment Panel (TEAP), notes that while ODS banks in foam applications (insulation) may remain intact until 2050 the majority of banks may be emitted much earlier from leaking equipment The flow of ODS into global waste streams is expected to peak in the period of 2018-2020 with the bulk of the ODS being CFC-based refrigerants from old refrigeration equipment in developing countries.

In light of these facts there is an emerging international consensus among international public institutions of the need to manage ODS banks. Recently The Parties to the Montreal Protocol, under decision XX/7 decided upon a series of actions to build capacity and understanding about the issue. As a result, the Executives Committee of the Multilateral Fund has been tasked to initiate ODS management and destruction pilot projects, the Ozone Secretariat has been tasked with exploring new funding opportunities for ODS bank management and destruction and the Ozone Secretariat held a open-ended working group in July 2009 in Geneva to discuss the challenge of ODS banks.

In addition, TEAP, released in 2009 two reports on analyzing the costs and benefits of management and destruction of ODS banks[3] and the development of time-series of flows of global and regional ODS including detailed cost estimates[4].

Finally, the World Bank, with funds from the Multilateral Fund, commissioned a study on "Financing the Destruction of unwanted ozone-depleting substances through the voluntary carbon market"[5]. The Nordic Environment Financing Corporation (NEFCO), with support from the Swedish EPA, Swedish International Development Cooperation Agency (Sida) and the Finnish Ministry of Environment decided to contribute to the practical evaluation of destruction of ODS through the conceptualization of a carbon finance-based pilot ODS management and destruction project for household refrigeration appliances in Russia. In this context, NEFCO's initial concept for a Russian ODS destruction project has been included as a potential pilot case in ICF's study to the World Bank.

As NEFCO's involvement and interest in the Russian ODS market continues to evolve, the need for understanding and exploring the link between the climate benefit of ODS destruction and carbon markets remains a central issue. Without meaningful regulatory incentives, large parts of easily reachable ODS banks in Russia will leak into the atmosphere in the next 5 years. Carbon financing through voluntary carbon markets could provide an incentive for galvanizing action in Russia. However, the merits of the "value proposal" offered by

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[1] For a list of ODSs see Annex 3.

[2] http://www.ipcc.ch/pdf/presentations/briefing-bonn-2005-05/safeguarding-ozone-layer.pdf

[3] http://ozone.unep.org/Assessment_Panels/TEAP/Reports/TEAP_Reports/teap-june-2009-decisionXX-7-taskforce-report.pdf

[4] http://ozone.unep.org/teap/Reports/TEAP_Reports/teap-october-2009-decisionXX-7-task-force-phase2-report.pdf

[5] See Abstract on p.42 in http://siteresources.worldbank.org/INTRES/Resources/ResearchAbstractReportFY-08-09.pdf

voluntary carbon markets remain untested for ODS in Russia and NEFCO is therefore actively looking to test the viability of the carbon market.

Project Aim

NEFCO's main aim with this project is to establish the procedural and methodological foundation for co-financing an ODS management and destruction project in Russia with proceeds from the sale of GHG emission reduction credits. This report, partly in the form of a guide, provides practical guidance to companies evaluating investments in sectors where recovery, storage and destruction of ODS can be undertaken. For project developers, the guide in Section C illustrates the requirements imposed by an existing emission reduction methodology on project design in order for a project to be eligible for carbon financing.

To test the premise of the voluntary carbon market and to provide an incentive for project developers, NEFCO is contemplating the following activities in Russia:

i. Testing the logistical chain for sourcing, managing and destroying stockpiled ODS of a small amount (3t) of ODS and preferably destroying it at a local facility.
ii. Supporting an investment project in Russia by developing and purchasing carbon credits from ODS destruction related to the investment.

The former activity would be undertaken without an attempt at external registration of emission reductions, albeit the reductions would be registered internally[6] using the simplified project data request form in Annex 8. The latter activity would be based on a full development of an emission reduction project as described in this guide. This report should be used to inform and guide potential projects developers, help identify ways in which carbon financing can be integrated into project design and safeguard the quality of any emission reductions.

Structure of report

This report is part of NEFCO's work in exploring the viability of voluntary carbon markets[7] to finance the mitigation of the climate impact of ODS banks. It will take the format of a guide for developing ODS emission reduction projects. The guide is generally based on the management and destruction process steps proposed by the Executive Committee of the Multilateral Fund in its draft report ExCom/58/19: "Criteria and Guidelines for the Selection of ODS Disposal Projects". However, the lists on ODS project data requirement follow the structure and requirements of the EOS Climate ODS destruction methodology[8] which has been chosen as the methodological benchmark for the report.

The starting point for a potential ODS destruction project in Russia has been narrowed down with a few fixed assumptions regarding the baseline situation (~business as usual) in Russia for treatment of ODS. The main background assumptions used in the guide are provided in Annex 1. Section B provides a brief background on emission reduction methodologies in the voluntary carbon markets and narrows down the options to one methodology which is used as the technical reference in Section C.

The guide in section C breaks down the structure of an ODS project into four core activities; collection, storage, transport and destruction. These steps are considered necessary[9] in light of

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[6] Project data is collected internally and used to estimate the CO2e-impact of the destroying the ODS
[7] For a full description of Voluntary Carbon Markets see e.g. http://www.ecosystemmarketplace.com/pages/dynamic/resources.library.page.php?page_id=7082&section=our_publications&eod=1 or http://www.co2offsetresearch.org/
[8] www.eosclimate.com
[9] Draft report on criteria and guidelines for the selection of ODS Disposal Projects (Decision 57/6). ExCom decision 58/19, July 9 2009

the fact that an ODS destruction facility requires ODS in bulk quantities, whereas ODS banks typically reside in small quantities in several applications across a broad geographical area. Therefore intermediate steps are needed to aggregate ODS. Each of these steps is presented separately by responding to the following four questions:

- What are the actions included under the activity definition?
- What requirements are imposed on the activity by the methodology?
- What are the costs for the activity/meeting the requirements?
- What are the key project design issues for meeting viability under the methodology?

Section D provides aggregate cost estimates and viewpoints on viability of ODS destruction projects using carbon financing. The section also summarizes the most important aspects of carbon financing for the design of ODS destruction projects.

ODS management and destruction project types

The guide illustrates ODS management and destruction project developers what kind of requirements are imposed by an existing emission reduction methodology on project design. On a general level, therefore, the manual should serve any type of ODS management and destruction project independent of the type of the ODS (CFC-11, CFC-12, halons), source of the ODS (e.g. household/industrial refrigeration, mobile air-conditioners), destruction technology and destruction location (on-site destruction, domestic destruction or export to a foreign facility).

ODS use scenarios ("baseline[10] scenario)	ODS Destruction project
ODS stored for future use in refrigeration, fire suppression, or other applications	Destruction of ODS contained in storage tanks, cylinders, or other containers for the purpose of stockpiling for future use or for re-sale.
Historical use of ODS as a foam blowing agent and as a refrigerant in the manufacture of residential refrigerators, air conditioners, and other appliances and components.	Destruction of ODS contained in or recovered from insulation foam, and ODS used as refrigerant, in appliances or other equipment that is being disposed.
Historical use of ODS as a blowing agent for insulation foam in buildings and building materials.	Destruction of ODS contained in or recovered from insulation foam in building materials that are being disposed.
Use of ODS as a refrigerant in commercial and industrial refrigeration and air conditioning systems and equipment.	Destruction of ODS recovered from either operational or decommissioned equipment used for commercial refrigeration (e.g., supermarkets and other food storage and transport, vending machines, skating rinks, etc.), industrial process refrigeration, and comfort cooling for commercial and residential buildings, motor vehicle air conditioning, and other refrigeration/ air conditioning applications.
Use of ODS as a fire suppression agent in streaming or total flooding applications.	Destruction of ODS recovered from fire suppression equipment.
Use of ODS as an aerosol propellant and aerosol solvent in consumer, medical, industrial, and other products.	Destruction of ODS contained in products such as medical aerosols.

Table 1 ODS use scenarios and destruction project categories (from EOS Climate Methodology, 2009)

[10] The Baseline scenario represents the most likely way of treating/using the ODS in the absence of the investment in ODS destruction

The guidance given in the manual is largely applicable to all the potential ODS project types described in Table 1 above. However, on a more detailed level the guidance *is focused on the requirements and procedures for collecting, storing, transporting and destroying ODS from refrigeration equipment.* The purpose for this is twofold.

First, the range of products and equipment in which ODS are currently contained is highly diverse when comparing the timing of manufacturing, remaining lifetimes, and the timing of the arrival into the waste stream. Based on this, recent studies in ODS bank management[11] have taken the view that ODS projects could be divided into two major categories; "Domestic Appliances (refrigerant and foam) and Foams" and the decommissioning of "Other Refrigerants". This division is meaningful in that it is also the starting point for dividing ODS destruction projects into "low", "medium" and "high" effort ODS banks. The level of effort is closely tied to the cost of managing the destruction of the ODS. Collection of refrigerants from domestic and industrial appliances is usually associated with wider management of the appliance, thereby reducing the unit cost of collection, transport etc. In other sectors, mainly in the "medium" and "high" effort categories, ODS recovery is more likely to be the only or predominant cause of action. Therefore, refrigeration projects, due to the lower assumed cost-structure are the most likely candidate for early ODS destruction projects. Annex 4 provides a list of ODS categorized according to the level of effort to extract ODS.

The second reason for focusing on destruction of refrigerants is that a potential approach for NEFCO's participation in ODS management and destruction in Russia is in combination with the financing of a greenfield (or brown-field) waste management project (see Box 1. below) rather than a stand-alone ODS destruction project (e.g. pure destruction of stockpiles).

> ***BOX 1. Expansion of municipal waste management practices***
>
> *One of the key prospective projects for NEFCO in Russia involves the financing of a Greenfield (or brown-field) municipal waste management site in the Greater Moscow region.*
>
> *The site could be designed to accommodate a facility for decommissioning household refrigerators at a later stage. As part of the investment consideration of the decommissioning facility, carbon finance could potentially a) provide an additional financial incentive to build the facility, or b) provide a financial incentive for expanding the decommissioning facility to include an on-site ODS destruction solution/technology.*
>
> *As a starting assumption, the ODS investment project would either a) enable the diversion of ODS from fridges heading to a landfill at the new waste management site, or b) enable the new site to accommodate ODS from fridges landfilled at other sites.*

Controlling hydrofluorocarbons

An important inter-relation in the global efforts to limit ozone-depleting substances and greenhouse gases is the adverse impact on global warming caused by hydrofluorocarbons (HFCs). HFC have been widely introduced as replacements for HCFCs and are projected to account to as much as 20% of global CO2 emissions in 2050[12]. Potential future regulation of HFCs is currently torn between the Kyoto Protocol and the Montreal Protocol. Based on a proposal by the small island nations of Mauritius and the Federated States of Micronesia the 21st Meeting of the Parties to the Montreal Protocol, in July 2009, agreed on the need to

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[11] http://ozone.unep.org/teap/Reports/TEAP_Reports/teap-october-2009-decisionXX-7-task-force-phase2-report.pdf

[12] Velders et al (2009) http://www.pnas.org/content/early/2009/06/19/0902817106.full.pdf+html

reduce HFCs but could not agree on whether HFCs should be regulated as an ozone-depleting substance or as a controlled substance under the Kyoto Protocol.

These developments should be observed by ODS management and destruction project developers as the the emission reduction potential of HFC destruction presents a potential close "rival" source of ODS-related carbon credits. There are clear differences though, mostly in benefit of banks of ODS. HFCs destruction projects are mired in controversy under the CDM[13] and crediting based on destruction of HFCs from active production would be challenging from a public approval point of view. ODS banks, on the contrary, are already in use or in the waste-stream, whereby the primary alternative to destruction, on a global scale, is uncontrolled leakage into the atmosphere.

[13] HFC-23 destruction from the waste stream of HCFC-22 production account for 54% of all CERs issued under the CDM and already covers over 80% of year 2000 emissions (http://www.cd4cdm.org) . Many observers have opposed these projects, and subsequently only existing HCFC-22 facilities are eligible under CDM.

Summary of Voluntary Carbon Market Project Cycle

This section briefly describes the steps involved in developing a voluntary carbon market project. For a detailed description of the steps included, please see e.g. ICF[14] or Bayon[15]. The development cycle of a voluntary carbon project can be broken down to a few key separate steps as highlighted in the illustration below:

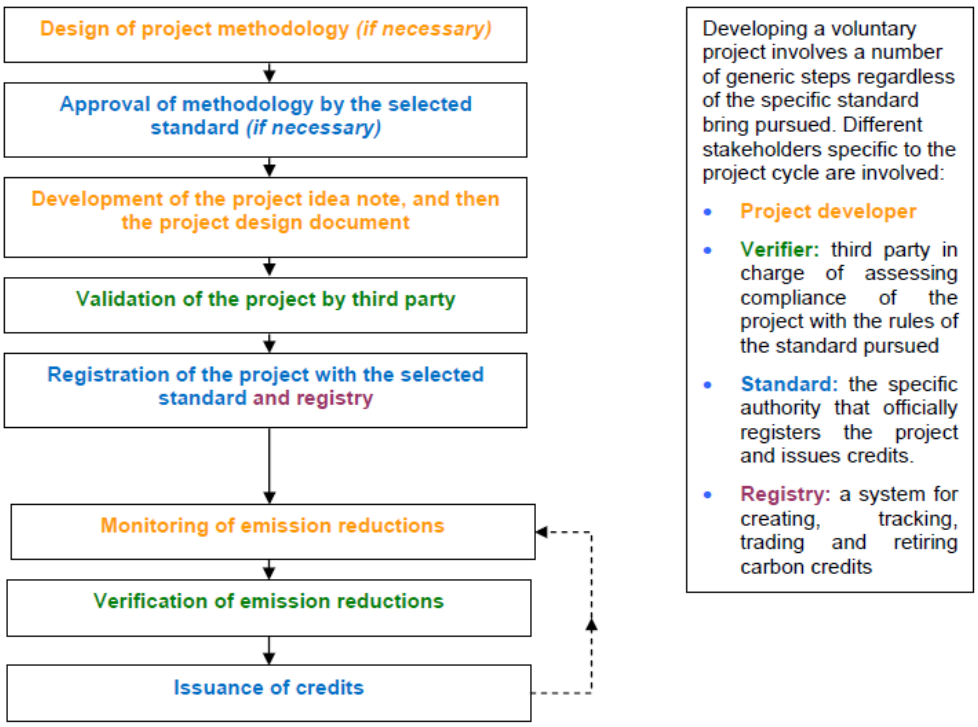

Figure 1 Voluntary carbon market development cycle (from ICF, 2009)

The first step in the development process is to match or develop an emission reduction methodology with the project activity. In case an existing methodology can not be used, the developer has the choice of developing a proprietary methodology for the project and, aim to get the methodology approved by an accreditation body overseeing one of the voluntary standards.

Upon matching a project with a methodology approved by one of the voluntary standards the project needs to be validated against a methodology by an independent third-party. The validation process ensures that the project meets all the requirements of the chosen methodology and any further registration criteria imposed by the standard. Once a project has been validated it is cleared for registration onto an electronic registry affiliated with the standard.

[14] Section 5 in "Study in Financing the Destruction of Unwanted ODS", ICF 2009
[15] EarthScan: Ricardo Bayon, Amanda Hawn, and Katherine Hamilton, Voluntary Carbon Markets: An International Business Guide to What They Are & How They Work, 2nd edition. 2009.

In the final phase of crediting a project, the emission reductions from the project have to verified against the methodology, i.e. proven that emission reductions have occurred as specified in the methodology. Typically a standard certifies the emission reductions based on a third-party verification report and a monitoring protocol that details the data tracking and collection system underpinning the emission reduction calculations. Upon certification the standard body issues emission reduction credits into the project developer's account on the affiliated registry – thereby enabling such credits to be transferred to the account of the buyer of the credits.

Voluntary Market Opportunities

In order for the guide to provide sufficient resolution on the requirements imposed by carbon financing it needs to be based on a specific emission reduction methodology. Such methodologies are tied to a particular standard or a market. For a detailed review of the market opportunities provided by the voluntary markets please see ICF[11]. At the moment there are three[16] broad market opportunities in the voluntary market for a project developer to commercialize emission reductions from an ODS destruction project.

1. **Voluntary Carbon Standard,** the leading global standard for voluntary market projects. The VCS has extended its scope to include ODS from January 26, 2010 onwards. The VCS has published a set of eligibility requirements[17] that ODS emission reduction methodologies need to meet prior to approval by the VCS. There are no approved ODS methodologies under the VCS yet, but according to our information at least two methodologies have been presented to the VCS Association: the Tanzer/ARGE/USG methodology on "Recovery and destruction of CFCs from domestic refrigerators", and the EOS Climate methodology for ODS destruction projects.

2. **Chicago Climate Exchange,** the first trading platform to offer a methodology for ODS reduction projects. The CCX is an exchange based voluntary cap-and-trade program for North American corporate entities, cities and state governments. CCX is a private market that is open for project developers who are members of the exchange. CCX members with commitments can use Carbon Finance Instruments (CFIs) as an offset credit against their voluntary targets. ODS destruction projects are eligible for producing CFIs under a proprietary methodology approved by the CCX Committee on Offsets

3. **Climate Action Reserve,** a US-based offset program that develops and manages emission reduction methodologies and maintains an offset registry for over-the-counter trades in Climate Reserve Tonnes (CRTs). Methodologies are developers in-house on the basis of proposals from offset project developers. An ODS project protocol was approved by the CAR board on February 3, 2010[18].

For a project developer the above market opportunities represent a diverging set of options to approach the voluntary market. CCX represents the narrowest opportunity in that it is a closed market, i.e. the resulting emission reductions can only be used by entities that have an obligation on the CCX platform. This has led to a situation where the value of a CFI (in t

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[16] NOTE: The review only includes established platforms/standards for voluntary emission reduction projects. Under current voluntary market practices it is fully possible to develop an emission reduction project based on proprietary methodologies which are not accredited by standard body. However, this approach was not deemed appropriate for a Russian ODS project given the high costs associated with drafting a new methodology and a likely discount on the price of an emission reduction based on a non-accredited methodology.

[17] http://www.v-c-s.org/docs/VCS-Program-Update_Extension-of-Scope-to-Include-ODS.pdf

[18] http://www.climateactionreserve.org/2010/02/05/climate-action-reserve-releases-standards-for-destruction-of-ozone-depleting-substances/

CO2e) has plummeted from a high of US$ 7.50 in May 2008 to US$ 0.1 January 2010[19]. The CFI offset protocols are also restricted to a limited number of foreign countries such as Mexico, Brazil and China.

Based on these observations CCX is excluded as a viable market option/methodology for any ODS management and destruction projects in Russia. A more detailed comparison of the remaining two alternatives, VCS and CAR, is provided in the section below.

Selection of methodology

The main selection criterion for choosing a technical reference for the manual is the availability of detail and the applicability of the reference in a Russian context. Given the nascent status of ODS management and destruction in the voluntary carbon market the "boundaries" between a "Standard", "Protocol" and a "Methodology" are still somewhat vague. In strict sense the VCS is currently a "Standard" without a specific ODS "Methodology" for projects. CAR is an offset program (very similar to a "Standard") with a ODS "Protocol" for projects. The CAR ODS Protocol is in effect a "Methodology", i.e. it specifies how an ODS reduction project should draw its boundaries, identify a baseline, utilize ODS destruction technology and measure key variables. In other words, VCS and CAR are very similar despite different terminology.

To further mix up the choice of a technical reference for guidance in section C, one should note that both methodologies listed in the section above[20], the Tanzer/ARGE/USG methodology and the EOS Climate methodology have been developed independent of VCS/CAR. Both methodologies can be used to seek approval as a new "Methodology" under the VCS – thereby making the methodology eligible for global use under the VCS. Although CAR develops its protocols in-house and with the help of an external working group, the pending CAR ODS methodology is largely based on the EOS Climate methodology. This means that a project developed under the EOS Climate methodology would by-and-large conform with the technical requirements of the CAR ODS Protocol.

In addition, the voluntary market is also inter-connected, as VCS has approved CAR as an "Approved GHG Program" meaning that CAR emission reduction units, CRTs, can be cancelled and converted into a Voluntary Carbon Unit, the reduction unit of the VCS. In addition, methodology elements from CAR can be used for VCS projects. In effect this means that an approval of an ODS protocol by CAR indirectly also enables the creation of VCUs.

Table 2 highlights some differences between Standards and Methodologies from project developer's perspective. The Tanzer/ARGE/USG methodology is left out of further evaluation given that it is not publicly available at the time of writing the reference.

[19] http://www.chicagoclimateexchange.com/market/data/monthly.jsf

[20] No representation is made that these are the only privately-developed ODS methodologies in existence. There may be other methodologies under development.

Criteria	Voluntary Carbon Standard	Climate Action Reserve	EOS Climate methodology
ODS eligibility	Stakeholder review on inclusion of ODS as an eligible GHG held in June 2009. As of Jan 26 2010 ODS included in the Scope of VCS.	No specific ruling on ODS eligibility needed	Designed specifically for ODS management and destruction projects
ODS methodology availability	No methodology currently available, methodology requirements published, two methodologies discussing potential validation	CAR Protocol on ODS available, approved by CAR Board on Feb 2 2010	Methodology available and used as a basis for CAR Protocol
Access to methodology	n.a. / Methodology eligibility criteria public	Public	Private, available on request
Methodology scope	n.a.	Generic ODS management and destruction methodology	Generic ODS management and destruction methodology
International scope, incl. Russia	International, if/when approved	Domestic US and import from Article 5 countries for destruction in US	International

Table 2. Select differences between ODS carbon market opportunities

On the account of the facts and analysis presented above the VCS and the EOS Climate methodology provide available market opportunities for ODS management and destruction in Russia. The EOS methodology will be used as the technical benchmark for the guide in section C. This decision was specifically made for the following reasons:

- The methodology is an international methodology, allowing for use in Russia
- The methodology is closely referenced to the CAR ODS Protocol allowing for the methodology to be used as a benchmark for export of ODS into the US
- The methodology can be used for various types of ODS management and destruction projects
- The methodology presents the opportunity for a project developer to use the methodology and project for VCS accreditation

SECTION C: GUIDE FOR ODS MANAGEMENT AND DESTRUCTION PROJECTS

General guidance

Scope and limitations

This guide assists project developers contemplating an investment in ODS management and destruction project in Russia. Its generic purpose is to help project developers understand the specific needs, requirements and costs associated with the development of a GHG emission reduction project based on ODS destruction. Specifically, the guide should assist project developers in making an initial assessment of whether their investment project meets the technical requirements of a recognized ODS emission reduction methodology. On the back of this feasibility analysis developers and investors should be able to make a first informed decision on the financial and technical attractiveness of enabling ODS destruction through their project.

The structure of the guide allows the project developer to separate the various steps in a voluntary ODS management and destruction project to better match these steps with the operational processes contemplated by the developer. The guidance can be used for stand-alone ODS management and destruction projects as well as for ODS management and destruction projects in municipal or industrial waste streams.

The information provided is agnostic to the physical location of the destruction facility. The ODS may be destroyed domestically, but could also be exported into another country for destruction[21]. In such cases more emphasis should be applied on understanding the risks of inadvertent leakage of ODS during longer international transportation

The EOS methodology is broadly applicable for management and destruction of ODS that involves any of the following scenarios:

a. Destruction of bulk ODS contained in storage tanks, cylinders, or other containers for the purpose of stockpiling for future use or for re-sale.
b. Destruction of ODS contained in insulation foam and used as refrigerant in appliances or other equipment that is being disposed.
c. Destruction of ODS contained in insulation foam in building materials that are being disposed.
d. Destruction of ODS as a refrigerant in commercial and industrial refrigeration and air conditioning systems and equipment.
e. Destruction of ODS recovered from fire suppression equipment.
f. Destruction of ODS contained in products such as medical aerosols.

The guidance in the sections below does not replace the need for a detailed review of matching the used methodology with a specific ODS management and destruction project. Given the generic nature of the manual it is not meant to replace the need to use methodology-specific documentation and forms when evaluating the suitability of a specific project. The guide should only serve as general guidance for project evaluation based on which a first project-specific technical/financial evaluation could be made.

Although guidance is based on the EOS Climate ODS methodology it doesn't necessarily mean that this methodology is best suited for a Russian ODS project in the future. The chosen

[21] The manual does not elaborate on the legal / custody requirements for exporting ODS from Russia.

methodology represents the most detailed methodology available at the time of writing, however, any ODS management and destruction project should revisit the choice of methodology at the time of making the decision of progressing with ODS destruction.

The relationship between voluntary destruction of ODS and regulated GHG markets may also change in the future, both locally and internationally. Reductions of ODS banks could, under some scenarios, become intertwined with a US cap & trade market and/or the international flexibility mechanisms under the UN's Kyoto Protocol. This means that the market situation could change significantly, whereby it is advisable for ODS destruction project developers to understand the implications of changes in global and regional policies to regulate GHGs and ODS banks.

Basic eligibility criteria and eligible gases

The basic eligibility criteria provided in Table 3 below should serve as a first checklist for any project developer. These criteria present the most important requirements that a project should meet prior to the start of the ODS management and destruction project.

Subject	Eligibility criteria	Note
Start date of project activity to avoid ODS emissions.	▪ Operational activities must have commenced after the production phase-out deadline specific to the ODS and the country where the ODS has resided. ▪ Exception is ODS that is not phased out and is contaminated and would be reclaimed for subsequent use in equipment, or would be released.	
ODS destruction mandated by any law or regulation.	▪ ODS destruction must not be required under regulation or law in the State, province, or country where the project is conducted for project to be eligible. ▪ In case ODS destruction is, or will be, required, the project developer must be able to prove that destruction is voluntary provide the anticipated date of regulatory compliance date.	Currently no laws require ODS destruction in Russia
ODS destruction common practice	▪ Even if not required under regulation or law, ODS destruction must not be common practice in the sector. ▪ Common practice is defined as greater than 10% per year of recovered ODS in the country where the ODS destruction project is executed.	Unlikely to be an issue in Russia, no known ODS bank destruction projects
Ownership of ODS	▪ Project developer must demonstrate ownership or control of the ODS ▪ Double-counting of emission reductions must be prevented, i.e. the developer must prove that GHG credits generated are not accounted for in more than one GHG market.	

Table 3 Basic eligibility criteria (freely adopted and modified from EOS ODS methodology, p.14)

The eligible gases for ODS destruction activities are listed in Annex 3.

ODS project boundaries and management and destruction cycle

It is important to consider a potential ODS management and destruction project candidate from several angles prior to initiating a project. Most importantly, the developer must be able to clearly identify and separate the activities under the baseline scenario and the project scenario. Only through transparent description of activities under the two scenarios can verifiable emissions reduction be produced with highest environmental integrity. In order to establish the two scenarios the physical boundary of the project must be delineated so that the quantity of ODS that is being captured and destroyed in the project scenario can be measured, and thereby be distinguished from ODS not being captured and destroyed under the baseline scenario.

The physical boundary of a project includes all equipment, processes and facilities necessary to undertake the project activity:

- Equipment, products, and storage containers that use or contain the ODS;
- Equipment that use ODS substitutes;
- Equipment used for the recovery and reclamation of ODS;
- Transportation system where it is part of the project activities and is not owned by an independent third party; and
- The destruction and power generation facilities.

The data collection requirements at each step of the ODS management and destruction cycle aim at identifying all relevant emission sources for the scenarios. Such emission sources are either controlled, i.e. they can be monitored and measured by the project developer or related/indirect whereby conservative estimates using public references must be made. Relevant emission sources include:

- Emissions arising from fuel and electricity consumed by the treatment facility
- Emissions due to transport of ODS
- Emissions due to destruction of ODS
- Emissions due to ODS banks within the project boundary
- Emissions due to ODS substitute technologies

The main purpose of the emission reduction methodology is to quantify each emission source. Quantification takes place on the basis of monitoring or estimation based on the requirements set in the methodology and availability and quality of data. A principle of conservativeness must preside over all quantification.

Annex 6 provides an example of emission sources and boundaries for destruction of ODS contained in insulation foam and used as refrigeration in appliances that are disposed.

ODS management and destruction project baselines – key considerations

The baseline for an ODS project will vary according to project type and national circumstances. The project developer will need to choose and justify the most appropriate baseline – this baseline will be closely scrutinized by third-party validation experts during the certification of the emission reduction project. In general the following generic principles should be observed when determining the ODS baseline for various project types.

1. The baseline scenario must, at the minimum, comply with local law and regulation even if the project specific baseline is less conservative
2. Applicable ODS leak rates should be observed. ODS leaks naturally from equipment Leak rates vary substantially, and can be anything between 8-100%[22]. Annual leak rates for domestic fridges (CFC 12) vary between 8-14% and 58-70% for commercial refrigeration.
3. Blowing agents (CFCs and HFCs) represent end-of life emission sources, whereby ODS is released at the time appliances and building materials are disposed of onto landfills.
4. It is important to note that the EOS methodology assumes end-of-life emissions for these blowing agents (i.e. everything that would be released is destroyed)

[22] TEAP, 2007 TEAP 2007 Report of the Task Force on HCFC Issues and Emission Reduction Benefits Arising from Earlier HCFC Phase-Out and Other Practical Measures – Response to Decision XVIII/12

5. Projects where the baseline is storage would normally apply for halon, because halon reserves are needed for maintaining fire suppression systems (CFCs are seldom stockpiled for future use). The benchmark leak rates for halon 1301 (fire suppression) and halon 1211 (portable extinguishers) are between 1-6%. Given the purpose of these stockpiles – to be released in the event of a fire – baselines for halon is usually 100% release.
6. For refrigerants the starting assumption, in most places, including Russia – is that if refrigerants are required to be recovered, yet there is no requirement for the CFCs to be destroyed. CFC 12 usually has a market value which indicates demand re-use in older equipment, e.g. mobile air conditioning systems. This used methodology assumes that the baseline scenario for ODS refrigerant recovered from household appliances will be resold into the market and subsequently fully released.
7. A more conservative approach of point 6 is to limit the baseline period to the "life-time" of the ODS in the appliance in which it is re-used (CAR uses 10-years).
8. Defining the baseline for foam insulation is more complex. Prior to putting foams into landfills, they could be shredded, or dumped as intact blocks in the refrigerator units. With shredding, over a 50% of the blowing agent could be released. The remainder of the ODS is slowly emitted over time and consumed/"neutralized" by soil microbes. The rate of degradation, outside laboratory conditions, remains purely theoretical. The recent CAR ODS Protocol takes a highly conservative view of the ratio of ODS off-gassing vs. "natural" neutralization by microbes[23] when compared to the approach in the used methodology[24].
9. To determine the destroyed amount of ODS from foams (e.g. CFC-11), the amount of ODS blowing agent in the foam must be calculated. There are a number[25] of indicative benchmarks for CFC-11; 85g/kg foam, 400-600 grams/refrigerator, 13-16% of foam weight. The methodology assumes a default foam-to-CFC blowing agent ratio, by weight, of 0.085.

A complete list of baseline scenarios is provided in Annex 5.

The above principles should be used only as a starting point when evaluating a project. The project developer should always define the baseline scenario based on a conservative interpretation of actual circumstances of ODS treatment in the absence of an investment in management and destruction.

Accounting for leakage and replacement technologies

Under the EOS Methodology project developers need also to account for the emissions arising from the replacement chemical used instead of the destroyed ODS. This is a measure of added conservativeness, and adds an incentive for project participants to move towards low-GWP alternatives. Leakage calculations are typically mostly attributable to projects where the old equipment stays intact while the ODS is replaced. Such systems are e.g. mobile air-conditioners, industrial refrigeration and fire suppression.

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[23] The CAR Protocol, requires project developers to use a foam baseline that assumes a significant portion (65% of CFC-11) of the ODS in the foam is degraded in the landfill, not released. See. P. 21. http://www.climateactionreserve.org/wp-content/uploads/2009/06/U.S._ODS_Protocol_V.1.0_Draft_Redline.pdf

[24] This methodology makes the conservative assumption that under the baseline scenario where foam in the appliance is landfilled, 24% of ODS blowing agent is released from the insulation foam of discarded appliances upon shredding of the foam, plus an additional 37% of the initial blowing agent content from off-gassing of the discarded shredded waste (50% * 75%), for a total of 61% of the initial blowing agent content.

[25] RAL Institute, TEAP and various scientific papers respectively

Under the leakage principle a project that destroys e.g. halon 1301 and replaces the fire suppression equipment with a GWP 1 substitute (H2O or hydrofluoroether) has no leakage. However, if the halon is replaced with heptafluoropropane (HFC-227 with GWP of 3660[26]) the replacement technology emissions are subtracted from the emission reductions claimed from destruction.

The obvious challenge for project developers is the identification and determination of replacement technologies, especially if there are multiple sources of ODS (e.g. from service technicians). Table 4 below shows alternatives for ODS in some select refrigeration solutions and also shows the diversity of alternative cooling agents.

Sub-Sector	ODS Used	100-yr GWP	Average Annual Emission Rate	Leading Alternatives	100-yr GWP
Domestic Refrigeration	CFC-12	10,720	5%	HFC-134a	1410
				Hydrocarbons	<20
Commercial Refrigeration	CFC-12	10,720	18%	HFC-134a	1410
	HCFC-22	1780		R-404A	3900
				R-407C	1800
				R-417A	2300
				CO_2	1
Food Processing, Cold Storage, Industrial Refrigeration	CFC-11	4750	17%	HFC-134a	1410
	CFC-12	10,720		R-404A	3900
	R-502	4700		R-407C	1800
				R-507A	4000
				R-410A	2100
				Ammonia/CO_2	1
				Hydrocarbons	<20
				Water	0

Table 4 ODS alternatives for select refrigeration categories (EOS ODS Methodology)

Step 1: Collection

Definition of collection

The draft report ExCom/58/19 defines “collection” as all efforts to extract ODS from an application or product, covering for example collection of refrigerators, foams to a central disassembly site where CFCs are compressed and transferred into transport containers. The ExCom/59/18 draft report further defines collection as aggregating a significant amount of ODS, where significant amount is defined as 145t of CO2e. This has its basis in that a standard refrigerant container for CFC-12 contains 13.6kg of refrigerant, which, multiplied with the CFC-12Global Warming Potential of 10,720, equals 145t Co2e[27]. These limits, beyond being used as reference, impose no practical restrictions on project development.

The definition of collection is somewhat vague in that its features depend very much on the type of ODS project. For instance, collection from refrigeration/AC units undergoing servicing would entail a certified service technician using specialized pumping equipment to remove the refrigerant and store it in a recovery cylinder on-site. However, for obsolete household and industrial appliances, collection could include a) the collection and storage of the ODS in the original frames in an intermediate storage facility prior to transport to a demanufacturing facility, or b) collection, storage and transfer of ODS into transport cylinders

[26] www.epa.gov/ozone/geninfo/gwps.html
[27] 145t CO2e translates o 31.2kg CFC-11, 113.9kg halon 1211.

at an intermediate storage facility or, c) immediate transport of obsolete equipment to the demanufacturing facility (avoiding the separate collection step). In the last example there would be no aggregation[28].

For larger industrial stockpiles of ODS held in facilities and warehouses collection would entail a simple pick-up of storage tanks and perhaps a transfer of ODS from tank to tank.

In situations where the source of the ODS differs in type, quantity and quality the role of collection becomes significant in that one of the main aims of the collection function is to ensure a consistent supply of ODS to the storage or destruction facility. An increase in the homogeneity of the equipment containing ODS will reduce sampling and monitoring costs at later points in the destruction process.

BOX 2. Collection of old household refrigerators

For the prospective investment case the emphasis of the collection step is highly dependent on the whether the proposed waste management site would receive ODS (i.e. old refrigerators) regardless of a separate investment into ODS destruction. In this case the "supply" of ODS would be managed by the waste delivery procedures agreed with the municipality/ties. Refrigerators could be brought-in in bulk by retailers, and/or by standard waste collection procedures. Under this scenario the ODS management and destruction project would need to include the setting up of a consolidation/storage facility with the destruction plant.

In the other scenario, where collection of household refrigerators in not part of the offered service to the municipality, then the consolidation could take place at (an) existing facility/ies outside the boundaries of the new waste management site. ODS would then be supplied in bulk to the destruction site, either for immediate or later destruction.

For the investment case the collection entails one of the following actions:

1. Collection of fridges as a municipal service on the new site (receipt of fridges based on municipal service contract)

2. Collection of fridges from fridge manufacturers/retailers under a swapping program to the new site or to an intermediate storage centre

3. Collection of ODS from an external disassembly and storage site to the new site

As highlighted in the section above, collection can also encompass refrigerant recovery, especially in the situation where collection serves as a function to transfer ODS into larger tanks for destruction. For refrigerant and foam recovery from household appliances the refrigerant recovery can also take place at the site of the destruction facility. For the purposes of this manual, recovery is presented as a separate step from collection.

Meeting specific ODS methodology requirements

The following information would typically need to be identified at the time of collecting the ODS/appliances from e.g. the end-user, retailer, technician, landfill operator or government entity. The information need is similar regardless of whether the collection takes place as a separate step outside the destruction facility or if the collection happens at the facility itself. In most cases there would be some intermediate step of collection prior to taking the ODS to the destruction facility.

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[28] For instance, Ekokem Oy's incineration facility in Riihimäki, Finland, destroys the ODS from refrigerators without aggregation; refrigerants are sucked into the incineration kiln on directly from their cylinders, and the foams are crushed with the refrigerator frames prior to incineration.

Appliance Profile – basic data on the appliances collected (This information should be collected by appliance type)	
Data/Parameter	**Notes**
Appliance type	For example, domestic fridge, domestic fridge-freezer, domestic chest freezer and upright freezer.
Manufacturer	
Model #	Appliance rating plate
Year manufactured	
Dimensions (interior volume)	
Type of refrigerant used in the appliance	Manufacturers data or technical literature can be used; direct measurement of recovered ODS should be done on at least a sample of appliances
Quantity of refrigerant used in the appliance	
Type of ODS foam blowing agent used in appliance insulation	
Quantity of ODS foam blowing agent used in appliance insulation	
Total number of appliances of each model or category collected	
Total number of appliances of each model or category from which ODS is recovered	

From the above list it is easy to see that the more homogenous the lot of ODS, or the equipment the ODS resides in, the easier the task to test, identify and label the ODS. The methodology requires the developer to have a high level of understanding of the source of the ODS and confidence in volumes and quality.

Cost estimates

Of all cost variables the cost of collection is the most sensitive variable to local circumstances and strategy for collection of ODS. A dedicated ODS collection strategy e.g. collecting refrigerators from numerous retailers is much less efficient than a collection strategy where the ODS is integrated to other waste management streams. TEAP estimates refrigerant collection costs in densely populated areas to be around €4.3 – 7.2 per kg ODS for domestic refrigerators and €5.7 – 8.6 per kg ODS for commercial refrigerators. A kilo of ODS roughly represents 1-2 refrigerators.

Based on information from the Russian Scientific Research Engineering Center “Syntez”[29] the cost of collection, without personnel costs, but including coolant collection equipment (coolant regeneration unit, vacuum pump, connection hoses) and transport cylinders (rated for R22 - 900 kg); is €2.5-3/kg ODS. However, this figure doesn’t include the cost of purchasing the ODS from the owners of the equipment, which may be required from time to time, especially if purchasing ODS from service technicians/service centers. According to Syntez the cost of a kg of R12 is around €7. Piani[30] estimates similar prices; the cost of bulk CFC gases is €3-7 in Russia. In the US the market value for CFC 12 is around €3-4/kg.

[29] Communication between Yury A. Treger and Husamuddin Ahmadzai (NEFCO) January 21, 2010.
[30] Gianguido Piani (2009) ”Final Report: Bulk ODS collection and destruction in Russia, project proposal and critical aspects”

Key observations

- As a starting point, collection of ODS should aim at utilizing existing service and collection schemes. The ability to reduce unit costs on the back of existing ODS management, waste management or energy efficiency infrastructure is highly important.
- A greenfield ODS management and destruction project should lock in a steady supply of ODS through partnership agreements with e.g. municipalities, white-good retailers, industrial companies, retail chains and refrigeration service companies.
- Purchasing ODS in bulk would typically mean that the collection cost is factored into cost of purchase and thereby making use of benefits of scale of existing service networks for equipment containing ODS.
- Management and destruction is likely to compete with recycling and should focus on older equipment with high leak rates that make less sense to be “topped-up”.
- A high purity/quality of the ODS increases the relative attractiveness of recycling; Mixture of ODSs and contaminated substances support destruction[31]. This provides an interesting “win-win” incentive for service networks in that all ODS recovered would have some value – either as reclaimed ODS or destroyed ODS.

Step 2: Recovery, consolidation and storage

Definition and demand for consolidation

Recovery and storage is not defined as a separate step by the ExCom/58/19 draft report. In fact, collection includes all efforts to extract ODS until the significant quantity (145kg CO2e) has been aggregated. This means that recovery and consolidation (also known as transfer) is by and large covered by “Collection” in the ExCom report. However, given the importance of the activities involved in this step, it is covered as a separate step here.

ICF refers to this step as “consolidation and storage”, highlighting the fact that in some project types ODS might be collected from a large number of smaller units, e.g. household refrigerators or small cylinders. To avoid increased transportation costs from trucking or shipping many small containers, the ODS should be aggregated before sending it for destruction. The drawback of consolidation is that in the process of transferring ODS into larger containers there may damages to original containers which can cause leaks. All this will reduce the amount of ODS destroyed at the end.

The need for consolidation is determined by the project type, location of the ODS and destruction technology. Consolidation is especially needed when the destruction facility has a minimum volume requirement whereby the recovery, consolidation and storage process needs to be measured to provide sufficient amounts of ODS for destruction. Depending on the source of the ODS, consolidation may be needed at several places. For example, commercial refrigeration technicians may consolidate ODS from small cylinders into larger transport cylinders that are used for taking to ODS to a regional/national storage facility. If ODS is then further e.g. exported for destruction a second consolidation step would transfer the ODS from transport cylinders into pressure vessels for shipping.

[31] This doesn’t mean that contaminated ODS should be preferred by destruction project, quite the contrary, project monitoring is simpler with better quality ODS.

BOX 3. Recovery of ODS from household refrigerators

We assume here that an investment into a municipal waste management facility includes capacity for manual disassembly of the fridges for stripping metals (copper, aluminum, steel) for recycling. Plastics would be landfilled and ODS stored/sold/landfilled. Through an additional investment the waste management plant would incorporate an ODS destruction facility.

The key benefit of incorporating a destruction plant into the original facility designs (rather than a later add-on) is that ODS identification, scaling and measuring procedures can be developed to meet the verification requirements of the ODS emission reduction methodology.

As an intermediary step the recovery facility could test, measure and consolidate ODS from received appliances for external destruction or export. This could be a first stage in a longer investment process where the destruction facility is only added once the recovery volumes have stabilized.

The key challenge for an ODS destruction project based on collection of ODS from refrigerators received through municipal collection streams is that the project will receive a great variety of old fridge models , with greatly differing specifics as to their ODS contents (type, volume and quality). For these reasons, application of generalized or averaged assumptions in the design and documentation of the voluntary emission reduction project under the chosen emission reduction methodology will be challenging and counterproductive as estimates would need to err towards the conservative. Therefore, original plant design should take into account the need of on-site consolidation, testing and measurement for both foams and refrigerants. This will enable robust emission reduction calculations and determination of total destruction efficiency.

Meeting specific ODS methodology requirements

The following information would typically need to be identified at the time of collecting the ODS/appliances from e.g. the end-user, retailer, technician, landfill operator or government entity. The information need is similar regardless of whether the recovery takes place at an intermediary collection centre/storage facility or at the destruction site.

Refrigerant Recovery	
Data/Parameter	**Notes**
Equipment used to recover ODS refrigerant from appliances	Quality and accuracy of recovery equipment must be recognized and conform to applicable EU, US EPA, ASHRAE[32], and NIST[33] requirements or equivalent. All scales need to be calibrated regularly by the relevant verification bodies.
> Method and frequency of calibration	
Scales used to weigh ODS refrigerant	
> Method and frequency of calibration	
Method used to identify ODS refrigerant	
> Method and frequency of calibration	
Scales used to weigh storage cylinders	
> Method and frequency of calibration	

[32] American Society of Heating, refrigerating and Air-Condition Engineers www.ashrae.org/technology/
[33] National Institute of Standards and Technology www.nist.gov

Weight of cylinders used to store recovered ODS refrigerant when empty	Applicable when ODS needs to be transferred to storage cylinders
Weight of cylinders used to store recovered ODS refrigerant when filled	
Total quantity of ODS recovered from compressors and refrigerant lines in all appliances	Ideal if directly measured when emptying compressors and refrigerant lines; if not, information on appliances will be used to calculate recovered ODS
Number of appliances sampled to quantify ODS refrigerant recovery rate	If there direct measurement of total refrigerant recovered is not possible, that measurements should be based on refrigerant recovered from a statistically relevant number sample of appliances.
Type(s) of appliances sampled	Each type and model of appliances should be included in sampling.
Quantity of ODS refrigerant recovered from sampled appliances	

From the list above it is easy to see that setting up the process and ensuring the accuracy of weighing the refrigerant forms the major aspect of the recovery step. Sampling creates a second big component of recovery in situations where direct measurement is not possible. The quality of measurement technology and procedures is vital for increasing the confidence in the estimated destruction volumes. In situations where the project developer is not in direct control of the recovery process, the quality of recovery should be contractually safeguarded.

Foam Recovery	
Data/Parameter	**Notes**
Equipment/method used to separate foam insulation from appliances	Manual or mechanical
Scales used to weigh insulation foam	Must conform to applicable quality standards (e.g. NIST)
> Method and frequency of calibration	
Equipment/method used to separate ODS blowing agent from foam insulation	Technology is available but may not apply to this project
Method used to identify ODS foam blowing agent	Must conform to applicable ASHRAE or equivalent standards
> Method and frequency of calibration	
Weight of cylinders used to store recovered ODS blowing agent when empty	
Weight of cylinders used to store recovered ODS blowing agent when filled	
Total quantity of ODS recovered from foam insulation in all appliances	Ideal if directly measured; if not, information on appliances will be used to calculate recovered ODS
Number of appliances sampled to quantify ODS blowing agent recovery rate	Same appliances can be used for refrigerant and insulation foam sampling
Type(s) of appliances sampled	
Quantity of ODS blowing agent recovered from sampled appliances	

The requirements for foams are broadly similar to foams as with refrigerants. Weighing foam blocks is an essential starting point for baseline data collection. Unless direct measurements cannot be made from the estimates should be based on provided baseline factors.

Cost estimates

Given the bigger need for manual or mechanical labor, the cost of ODS recovery from foams is markedly higher than for refrigerants. Based on TEAP estimates recovery cost of ODS from foams from household and commercial refrigeration is around €14 – 25 per kg ODS. The recovery cost depends on the type of destruction method. According to TEAP task force direct incineration of foams is the least cost alternative but this is only applicable Municipal Solid Waste and Rotary Kiln Incinerators. Adequate destruction of CFCs requires strict control of the share of ODS in the waste flow (max 5%) in order to ensure sufficient amounts of energy are available for destruction. Mechanical extraction of ODS from foams is the other destruction alternative – it is more costly, due to the fact that manual or mechanical labor is needed to separate the foams from the appliance frames.

Recovery cost for refrigerants is similar, or slightly lower, than TEAP collection costs estimates at around €4.3 – 7.1 per kg ODS for household, commercial and industrial refrigerators. Recovery costs for stationary air-conditioning can vary to a greater degree between €3 – 18 per kg ODS, whereas recovery costs for mobile air-conditioning are at a lower range between € 3 – 4.3 per kg ODS.

According to TEAP estimates there is a plausible chance that global capacity in ODS recovery will become a bottleneck much before limits in global destruction capacity. Table 4 below illustrates the cost of recovery equipment for domestic refrigerators. The table illustrates clearly the rapid increase in cost when moving ODS management from refrigerant to blowing agent; investment costs can be over 20 times higher for recycling systems that include full degassing equipment for blowing agents. There is also a significant cost increase when moving from manual handling of foams towards a mechanical system.

ODS Managed	***Equipment Type***	***Investment***	***Throughput***	***ODS Quantity***
		(€ ,000)	*('000/yr)*	*(tonnes/yr)*
Refrigerant Only	Stage 1	180-285	250-350	40-50
Refrigerant + BA	Stage 1 + Manual	430-715	150-200	50-70
Refrigerant + BA	Stage 1 + Stage 2	2,850-4,285	150-250	50-85

Table 5 Investment costs for Refrigerator Recycling Equipment (Stage 1 = collection, and de-gassing for storage and consolidation, Stage 2 = Blowing Agent (BA) degassing, manual/mechanical). Adopted from TEAP, with USD/EUR conversion at 1.4USD/EUR

Key observations

- The ODS recovery process is the costliest part of the ODS management chain and most likely to gain from benefits of scale.
- Globally, high-quality recovery capacity could become a premium service as need for ODS bank management increases.
- A recovery facility alone, without destruction capacity, provides tremendous value to the ODS management process in that it provides ODS quality control and ODS volume aggregation.
- A recovery facility has the flexibility of utilizing dormant domestic and foreign destruction capacity - especially in projects where supply of ODS is not constant.
- For ODS management and destruction investment planning the current cost of managing foams and refrigerators is not substantially different. This is largely because there is more foam than refrigerant per appliance.

- TEAP suggests[34] that over time it may become more attractive to consider refrigerant recovery in isolation given the better cost efficiency (lower management costs and higher GWP of CFC-12 vs CFC-11).
- By 2020 the cost of recovery of ODS from foams is expected to be at least 3 times higher than costs for refrigerant recovery.

Step 3: Transport

Definition of transport

The draft report ExCom/58/19 defines "transport" as the actual transportation of significant quantities (i.e. 145t CO2e), in transport containers, within a country and for export for destruction. Transport would also cover the transfer of ODS in cylinders to a central facility for extraction into transport containers. ODS may be transported several times before its ultimate destruction, often as it moves through the consolidation process. All permitting required for transport of ODS would also be included in this section.

As noted above, under "collection" some appliances and smaller containers may be also transported as-is, depending on the project type and location of the consolidation site vis-a.vis the destruction plant.

> ***BOX 4. Transport of ODS from household refrigerators***
>
> *For the prospective investment case the ODS transport step is likely to be almost negligible in the case where the recovery/destruction facility supply of ODS comes through municipal waste collection systems. The "ODS share" of total transport emissions would be minimal when considering total waste transport volumes.*
>
> *However, if the recovery/destruction facility contracts ODS from other suppliers the emissions associated with transporting the ODS from e.g. service centers and storage facilities would need to be accounted for. Transport of ODS from the planned recovery facility (in the absence of a destruction plan on site) to the destruction plant would likely be very small as the ODS would be in highly concentrated form at that point.*

Meeting specific ODS methodology requirements

Most ODS projects will include some transportation of cylinders, appliances or pressurized containers. The emissions associated with the transport of ODS need to be deducted from the total amount of claimed emission reduction from the destruction. Usually this is based on a simple distance or fuel-based calculation under which the emission factor (CO2e / km) of the transport mode is multiplied with the distance travelled. The WBCSD GHG protocol provides guidance on the calculation of transport emissions[35].

[34] Please see section 6.4 in http://ozone.unep.org/teap/Reports/TEAP_Reports/teap-october-2009-decisionXX-7-task-force-phase2-report.pdf

[35] "GHG emissions from transport and mobile sources at www.ghgprotocol.org/calculation-tools/all-tools

Transport	
Data/Parameter	**Notes**
Transport Providers Name	
Transport Provider Address (address, city, state, zip, country)	
Transport Party Contact Name	
Transport Party Contact Number	
Transport Party Users (names, contact #, and level of access (all or site specific))	
Site # Transport has access to (all or specific)	
Vehicle Type(s) (Manufacturer, Vehicle Category, Model, Model Year, Fuel Type, highway mileage rating)	Detailed data is needed of the transport vehicles or vessels to calculate the fuel consumption during transport.
Vehicle(s) Identification Number	
Initial and Ending Mileage in km	For each trip between the appliance processing/reclamation/ODS storage facilities and the destruction facility
Weight of gas cylinders or foam transported	
Time/date of transfer of custody of containers to ODS storage tanks to await destruction	

The owner or handler of the ODS must ensure that proper documentation exists on the movement of the ODS material from point of origin to the destruction facility. This includes transport and shipping documents needed for transfer of ODS material including weight of ODS material transported. Transfer of custody needs to be marked with the time and date of transfer of containers from the project developer to ODS storage tanks located in a controlled area awaiting destruction by owner or handler.

Cost estimates

Transport cost estimates are fraught with uncertainties due to the many variables included. A 10-year old EU study estimates appliance transport costs at €1 per tonne/km , €0.05-0.15 per tonne/km for condensed cargos (pipes, tubes, electrical equipment) and €0.04-0.06 per tonne/km for general waste [36]. Using these estimates TEAP concludes that at a cost of €1/km would allow the transport of 5-10 refrigerators (each 100-200kg). If the refrigerator frames have been pre-cut (for transportation) the cost could be over five times lower.

For concentrated shipments (refrigerants and fire suppressants) the transport cost is €0.085-0.11 per tonne/km, or almost a tenth of the cost of transporting ODS in appliance frames.

The impact of concentration on transport cost is highly evident from TEAP's summary cost estimates from October 2009. Transport costs associated with the recovery of ODS, i.e. from the appliance owner/user, is between €4.3-7.15 per kg ODS for domestic and commercial refrigerators. Transport costs associated with destruction of ODS, i.e. after eventual consolidation, are as low as €0.01-0.06 per kg ODS up to 1000km distances. It should also be noted that the cost of transport of ODS in full frames (i.e. intact refrigerators) is 3-8 times more expensive than transporting ODS cylinders and/or foams.

[36] http://ozone.unep.org/Assessment_Panels/TEAP/Reports/TEAP_Reports/teap-june-2009-decisionXX-7-taskforce-report.pdf

Based on information from the Russian Ministry of Natural Resources, the cost of transporting CFCs in Russia, using a 6.1t capacity truck up to 500km is around €0.083per kg ODS[37]. This price is roughly in the range provided by the TEAP estimates.

Key viability criteria

- Piani notes that, in Russia there is a large number of transport companies and prices for ODS transport are competitive, i.e. there is not likely a need for developing any “in-house” transport capacity.
- Where possible one should utilize the transport capabilities of the municipal waste collection services, the retailer transporting refrigerators, the service company collecting the gases, or of the [chemical] company destroying the gases (if destruction is “outsourced”).
- Transport losses are recognized by the emission reduction methodology, and can be significant if quality of transport is not made one priority in the development of the ODS destruction project. This means essentially minimizing the distance ODS is transported prior to consolidation.
- The t/km transport cost is minimal after consolidation and bares little impact on project economics.
- Cost of transport of full refrigerator frames is significantly higher than transporting ODS cylinders and/or foams. An ODS management and destruction project based on transport of full refrigerator frames is only possible in the context of a broader waste management program.

Step 4: Destruction

Definition of destruction

The draft report ExCom/58/19 defines “destruction” as the preparation of ODS for destruction and the destruction itself. This includes, for example, testing ODS containers for content, purification, effectiveness measurement, destruction and monitoring. Destruction can only take place with technologies that have been approved by the Meeting of the Parties (“MOP”) to the Montreal Protocol (see Table 6 below).

Depending on the type of destruction facility the transported ODS can be either pumped into a holding tank, sucked directly out cylinders into destruction, or destroyed directly from the container it arrives in. However, before any material is destroyed, it needs to be tested with a gas chromatographer to verify the type, quality and amount of ODS. Destruction itself can use any of the technologies approved by the MOP, as long as destruction efficiency is 99.99% or higher.

According to Piani there are approximately 300 thermal destruction plants in Russia, which also include facilities that are used for destroying a variety of chemical waste and toxics.

BOX 5. Destruction of ODS from household refrigerators

Under the destruction scenario the municipal waste management site would include a destruction facility. This facility would either destroy the ODS provided from the storage facility of the on-site recovery unit or destroy ODS received from external recovery or storage facilities. The selection of destruction technology would depend on volume of ODS received, energy availability, investment budget, additional permitting requirements, size of the site etc.

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[37] Quote, in US dollars, was for a 3t transport in Russia ((USD350/1.4)/3000)

Summary of destruction technology options

The Parties to the Montreal Protocol evaluate and approve technologies for the destruction of ODS. TEAP taskforces periodically review and update[38] the list of technologies. The last review took place in 2005, which resulted in separate lists for concentrated sources (largely refrigerant) and for dilute sources (foam ODS). A list of approved technologies is provided in the table below.

There are over 150 known ODS destruction facilities in the world, most of which are located in developed countries. Russia has 3 facilities but only two plants, in Perm and in Volgograd, are able to burn CFCs[39]. The plant in Perm is a privately held modern facility whereas the plant in Volgograd is partially owned by the state and in need of refurbishment/ repairs.

It should be noted that there are a large number of facilities operating globally for the destruction of PCBs – some of which are jointly used for ODS and PCB destruction. There is global backlog of PCB awaiting destruction so while the PCB capacity is technically capable of ODS destruction, it is unlikely to be widely available for ODS destruction. But local availability should always be checked prior to an investment in destruction technology.

Overall, global destruction capacity currently exceeds the demand for destruction, when accounting for both “low” and “medium” effort banks. As shown by ICF[40], global destruction capacity is evenly spread between several developed countries and between technologies. See Annex 7 for further information.

			Applicability
	Concentrated sources		Dilute sources
Technology	Annex A, Gp. I, Annex B, Annex C, Gp. I	Halon (Annex A, Gp. II)	Foam
Destruction and removal efficiency (DRE)	99.99%	99.99%	95%
Cement kilns	Approved	*Not approved*	
Liquid injection incineration	Approved	Approved	
Gaseous fume oxidation	Approved	Approved	
Municipal solid waste incineration			Approved
Reactor cracking	Approved	*Not approved*	
Rotary kiln incineration	Approved	Approved	Approved
Argon plasma arc	Approved	Approved	
Inductively coupled radio frequency plasma	Approved	Approved	
Microwave plasma	Approved		
Nitrogen plasma arc	Approved		
Gas phase catalytic dehalogenation	Approved		
Superheated steam reactor	Approved		

Table 6 List of approved ODS destruction processes and technologies

[38] The list of eligible technologies is presented in section 3.1. of the 2006 Montreal Protocol Handbook at ozone.unep.org/Publications/MP_Handbook_2006.pdf

[39] Piani

[40] ICF International, 2008, ”Study on the Collection and Treatment of Unwanted Ozone-Depleting Substances in Article 5 and Non-Article 5 Countries.

Meeting specific ODS methodology requirements

Destruction Facility Emissions and Operating Parameters	
Data/Parameter	Notes
Quantity of ODS received at destruction facility	Summary report, for every shipment of material designated for destruction. Facility **must check in each cylinder or tank, or in the case of intact foam, each bag.** Inventory tag will be attached to every cylinder at time of receipt, **each cylinder will be weighed and checked for leaks, and cylinders will be sampled to verify that ODS matches delivery documentation.** Samples should be analyzed by US EPA methods 5030 and 8240, or equivalent methods.
Cylinder inspection	Inspection report to identify each cylinder and determine accuracy of identifaction labels, and physical condition and integrity.
Quantity of each ODS fed into destruction unit	**Measured with scales at ODS source, at point of transport, at destruction facility, and mass flow meters at input to destruction unit**
Method and frequency to calibrate scales used to quantify ODS	Conform with NIST or equivalent standards
Molecular composition of ODS fed intro destruction unit	Measured by gas chromatograph or comparable instrumentation
Destruction efficiency[41]	Measured on an annual basis at minimum with mass flow meters at destruction unit outlet (stack) or other operational parameters, measured on a periodic basis, as specified under EPA regulations (40 CFR 63.1209 and 63.1211) or comparable standards

[41] Please see section 6.1.4. in "May 2005 Task Force Report on Foam End-of-Life Issues" for a discussion on destruction efficiency calculation for foams.

Monitor and record following parameters: • ODS storage tank weight, pressure and temperature • ODS feed rate • Residence time for ODS above 8500C • Oxygen content in flue gas • Gas temperature in combustion chamber • Flue gas flow rate • Feed rates of any consumables to facilitate the destruction, such as water, steam, air, oxygen, argon, acid and caustic solutions • Reaction zone pressure and temperature • Coolant temperature and flow rates • Air flow, steam pressure and temperature • Exhaust gas flow rate, pressure and temperature to scrubber/stack • Scrubber pressure and temperature • Effluent solution pressure and temperature, pH value and concentration of chloride, fluoride and bromide salts in the solution • Concentration of carbon monoxide, NOx, and dioxins (PCDD and PDCF) in exhaust gas	Gas temperature and the exhaust gas and effluent pH value and flow rate monitoring system shall be continuously monitored and calibrated on a daily basis and meet the performance specifications of the associated US EPA measurement method. For the purposes of this standard, carbon monoxide must be continuously monitored. For the other pollutants listed below, the frequency and method of sampling shall be conducted based on standards established by national regulatory agencies or ISO standards. The destruction facility shall have the mechanisms that will automatically cut-off the operation of the unit and feed system when whenever:• The temperature in the reaction chamber is below 2300 F operating conditions• The required minimum destruction conditions stated in the performance specifications cannot be maintained.The destruction facility shall meet the emission limits for dioxin, acid gases, CO, and particulates specified by the UNEP TEAP Task Force on Destruction Technologies
Electricity consumption for the project	Emission from electricity consumption associated with the project need to be accounted for in project emissions. This is done by multiplying the quantity of electricity consumed with the emission factor (t CO2e/kWh) of the grid.
Type and volume of fuel used in process by the project	In case process energy/electricity is sources from a captive power plant the emissions from power production need to be accounted for in project emissions. The emissions are calculated by measuring the heat content of the fuel consumed in the plant and calculating the emissions by multiplying the volume of fuel consumed with an emission factor (t CO2/MJ and an oxidation factor (99.5%)
Heat content of fuel consumed for the project	

In addition to the emission sources listed in the table above the project also needs to account for fugitive ODS (although assumed insignificant above destruction efficiencies above 99.99%) and CO2 formation during the ODS destruction process. The EOS Methodology specifies the measurement of CO2 emissions that result from the carbon in the ODS reacts to form CO2.

From the table above it is clear that the measurement and testing requirements prior to and after ODS destruction are highly rigorous to ensure full confidence in the volume destroyed and the destruction efficiency of the process. From a project development point of view a reduced need for measurement and testing reduces costs if it can be done without compromises to quality. A potential benefit of an ODS management and destruction project at a municipal waste management site is that ODS collection, consolidation and storage can take place on one site. This not only simplifies project design but reduces possibility for inadvertent emissions from leaks during transportation. However the counter-side to this is that by relying on ODS from domestic refrigerators the volume and quality of supply is highly unsecure in the beginning of the project.

Cost estimates

The costs of destruction of concentrated sources of ODS is quite well-established. The TEAP Task Force on Destruction Technologies reported, in 2002, costs for CFCs in the range of €2.1-3.6/kg and for halons around € 5/kg. TEAP estimates from 2009 are slightly higher at €3.5-5 but constant across various project types. ICF found[42] that ODS cost range between €1.4 – 9.3 per kg of ODS, with an average of roughly €5/kg.

Syntez in Russia[43] provided a cost estimate of €2.1-2.5/kg ODS, which is clearly lower than TEAP estimates. However, the disposal of the CFCs would be carried out at a thermal toxic waste treatment plant of "TechEnergoChimprom" and it is not clear to what extent this plant meets the destruction requirements listed above.

The above costs relate to the cost of destruction at existing sites. Costs for new destruction infrastructure are not included in the above destruction cost. A new destruction facility is a significant investment with costs starting at around €0.5 million.

Destruction technology	***Cost***	***Destruction capacity***
Plasma arc (Australia)	*~€ 1 million*	*65kg/hr*
Catalyst dehalogenation	~€250.000	6kg/hr
Superheated steam reactor	~€360.000	25kg/hr
Microwave plasma	~€45.000	2kg/hr

Table 7 Investment cost for selected ODS destruction technologies (ICF, 2008)

In some cases, modifications to existing management and destruction facilities may be the most efficient alternative. ICF reports of upgrade cost of €35.000 for upgrading a cement kiln for ODS destruction. Piani states an expected technology upgrade and certification cost of €0.2 – 1 million for existing plants in Russia.

In some cases, even for modern plants, the ODS destruction monitoring poses a problem. In recent discussions with a rotary kiln destruction facility NEFCO e.g. found out that measuring the efficiency of foam incineration after the foam has been crushed with the fridge frame in an air tight crushing chamber is unlikely to meet the accuracy requirement of destruction. Similarly, determining the total destruction efficiency from exhaust gases can pose a problem for sites incinerating multiple types of waste. The efficiency of CFC destruction would require that the feed of any other chlorinated or fluorinated materials is halted, which is practically very difficult. Feeding only CFC into incineration at the waste incineration site would breach limits for exhaust gas cleaning process.

Key viability criteria

- The main purpose of the destruction step in the emission reduction project is to provide clear proof what has been destroyed and that destruction has taken place.
- Process measurement and monitoring is as important as the actual destruction. Poor measurement can jeopardize the whole emission reduction project.
- A new facility is a better solution than an refurbished old plant for ensuring accurate process measurement and control
- Cost of destruction technology varies substantially, but presents a high investment to be based on a voluntary carbon project alone.

[42] Appendix E in "Collection and Treatment of Unwanted Ozone-Depleting Substances in Article 5 and Non-Article 5 Countries" at www.ozone.org/Meeting_Documents/oewg/28oewg/ICF_Study_on-Unwanted_ODS-E.pdf

[43] Personal communication between Yury Treger and Husamuddin Ahmadzai (NEFCO) January 21, 2010

- The cost of destruction is fairly predictable whereby it is also the most “predictable” cost item in the ODS destruction chain.
- Destruction usually represents the largest component of the direct GHG emissions caused by the ODS destruction project.
- Minimizing energy plant energy consumption will increase the amount of emission reduction credits generated under the methodology.

SECTION D: VIABILITY OF ODS MANAGEMENT AND DESTRUCTION PROJECTS

Aggregated cost estimates

Cost of ODS management

The above sections have provided an overview of the actions required to undertake an ODS management and destruction project for the purposes of creating carbon credits. The table below only cost estimates on select project types. Based on the aggregated data average refrigerant management cost would start around 16€/kg and potentially increase to 28€/kg. Foam management, as explained above, is markedly more expensive due to the higher recovery costs. Average foam management costs could start around 26€/kg and be almost twice as high in some projects.

Information obtained from Russia suggest significantly lower ODS management cost. Both Russian cost estimates for management of refrigerant are less than 10€/kg, or almost 50% less than the estimates based on industry averages. This is likely due to the fact that collection and recovery costs embedded in the acquisition cost of bulk ODS (as assumed by both projects) are not priced on a "sole" ODS basis. Instead the cost is included in the service cost of maintaining old equipment. Similarly, a collection costs that can be embedded in broader waste management programs are likely be more price competitive.

<table>
<tr><th>ODS type</th><th>Acq.</th><th>Collection</th><th>Recovery</th><th colspan="2">Transport</th><th>Destr.</th><th>Total (€/kg ODS)</th></tr>
<tr><td>Refrigerant / domestic</td><td></td><td rowspan="2">4,3 – 7,2</td><td>4,3-7,1</td><td rowspan="4">4,3-7,1</td><td rowspan="4">0,01 – 0,06</td><td rowspan="4">3,5 - 5</td><td>16,4 – 26,5</td></tr>
<tr><td>Foam / domestic</td><td></td><td>14-25</td><td>26,1 – 44,4</td></tr>
<tr><td>Refrigerant / commercial</td><td></td><td rowspan="2">5,7 – 8,6</td><td>4,3 – 7,1</td><td>17,8 – 27,9</td></tr>
<tr><td>Foam / commercial</td><td></td><td>14 - 25</td><td>27,5 – 45,8</td></tr>
<tr><td>Syntez[41] quote (refrigerant)</td><td>7.1</td><td></td><td></td><td></td><td>0,083</td><td>2,1-2,5</td><td>9,3 – 9,7[44]</td></tr>
<tr><td>Piani (refrigerant)</td><td>3-7</td><td></td><td></td><td>2</td><td></td><td>1</td><td>6-10</td></tr>
</table>

Table 8 Cost of ODS management (in €/kg ODS)

Management and destruction cost in CO2e

For the purposes of converting the above costs to CO2e/t TEAP has estimated sector-specific average GWPs of the recovered ODS[45]. For the sectors in table 9 the estimated GWPs are 1932/2856 and 2772/4142 for commercial and domestic refrigeration in developed/developing countries respectively. This is a conservative estimate considering that the GWP of CFC-12 is 10900. The highest average GWPs can be found in the mobile A/C sector where GWPs are over 7000. In the same report TEAP estimates the CO2-equivalent cost of the ODS management process to be €6,4 – 8,8/t CO2e in developed countries and 10,3 – 11,4/t CO2e in developing countries.

Table 9 converts the cost estimates from table 8 into CO2-equivalent average costs, i.e. the price, in €/t CO2e needed from the voluntary carbon market to cover the cost of destruction.

[44] The quote also included an arrangement fee / administrative cost of 20% of total cost, which has not been accounted for here

[45] See pages 44-45 in http://ozone.unep.org/teap/Reports/TEAP_Reports/teap-october-2009-decisionXX-7-task-force-phase2-report.pdf

The table clearly illustrates the cost benefit of solely destroying high-GWP refrigerants; the unit cost for destroying pure R-12 or CFC-12 is significantly lower that the average cost for a domestic or commercial refrigeration unit. The identified cost are as low as 1,15 and 1,5 for the two examples.

ODS type	Total cost (€/kg ODS)	GWP	Average cost (€/t CO2e)
Refrigerant only (CFC-12)	16,4 – 26,5	10900	**1,5 – 2,4**
Refrigerant / domestic	16,4 – 26,5	4142	**4 -10,7**
Foam / domestic	26,1 – 44,4		
Refrigerant / commercial	17,8 – 27,9	2856	**6,2 - 16**
Foam / commercial	27,5 – 45,8		
Syntez[46] quote (refrigerant)	9,3 – 9,7	8100 (Quote R12)	**1,15 – 1,2**
Piani (refrigerant)	6-10	4142	**1,4 – 2,4**

Table 9 Average cost of ODS management and destruction in CO2-equivalent

It should be noted that all cost estimates are based on gross destruction, i.e. emissions related to the management and destruction process itself are not factored into the calculation, as required by the methodology. The calculations also take no account of the fact that carbon finance is typically recovered after the emission reductions are achieved. I.e. the flows of revenue from carbon credits only accrue to the project developer once the emission reductions have been verified and the carbon credits transferred to the buyer.

Project Description	Project Size	Total Project Cost (thousands of US$)†	Carbon Credits Generated (tCO_2e)‡	Break-even Carbon Market Price (US$/$tCO_2e$)
Refrigerator Collection:* Collection of CFC-containing refrigerators, and recovery and destruction of CFC-12 refrigerant and CFC-11 foam	1,000 units collected	$151	3,599	$41.96
	10,000 units collected	$426	35,990	$11.83
	100,000 units collected	$3,173	359,900	$8.82
Bulk ODS: Destruction of stockpiled CFC-12	0.5 tonnes destroyed	$124	5,450	$22.72
	1 tonne destroyed	$127	10,900	$11.67
	10 tonnes destroyed	$187	109,000	$1.72
Large AC Units: Recovery and destruction of CFC-12 refrigerant from large stationary AC units	1 tonne per system/facility	$132	10,900	$12.13
	1,000 tonnes per system/facility	$11,810	10,900,000	$1.08
	10,000 tonnes per system/facility	$117,011	109,000,000	$1.07

Table 10 Break even of ODS projects (from ICF, 2009, p.33)

ICF used the same GWPs to calculate sector specific average CO2e-costs and found that the abatement cost for refrigerants from domestic refrigeration was €4,3 – 5,7/tCO2e, for foams €6,5 – 9,3/t CO2e. The lowest costs were found in mobile A/C systems where the abatement costs were as low as €0,7 – 1,4/t CO2e. Industrial refrigeration presented another cheap abatement opportunity at a cost of €2,1 – 3,6/t CO2e. ICF then further tested the impact of project size on the required break-even price of a carbon credit. These results are reproduced in table 10 above.

Table 10 above illustrates the benefit of scale of ODS management and destruction operations and also highlights the vast differences in cost between project types. At current exchange rates the break-even carbon market price for refrigerator collection is anywhere between €6-30/t CO2e depending on plant size. For destruction of CFC-12 from large refrigeration units the break-even price could be as low as €0,75/t CO2e.

[46] Russian Scientific Research Engineering Center ("Syntez")

Market Demand for ODS credits

Assumptions on future prices for carbon credits are an integral component of evaluating the potential of financing ODS management and destruction with sales of carbon credits. This segment looks at expected future prices of voluntary carbon credits and discusses quality aspects between ODS and non-ODS based emission reductions from a buyer's perspective. Up-to-date price projections are compare against the cost of ODS management and destruction reported above. For an exhaustive analysis of the viability of carbon financing for ODS management and destruction please see ICF's recent report on the subject to the World Bank[47].

Price expectations,

Projections on future carbon prices, are typically depicted in a forward price curve. A forward curve illustrates the market's aggregated view on how the price of an asset will develop. In liquid markets forward pricing is widely available. However, as price projections become longer, e.g. 2012-2020, forward pricing even for compliance credits such as EU ETS EUAs and CERs [48] becomes highly speculative. Commodity forward curves typically can only be relied upon for any meaningful information 2-3 years forward. The task becomes even more speculative when forecasting prices for voluntary credits, due to the diversity of standards and quality of projects, lack of defined demand or mandates on buyers, little transparency in existing transaction volumes and prices, and comparative lack of any regulatory framework. There are very few independent forward curves for VCUs, and established market surveys such as New Carbon Finance's State of the Voluntary Carbon Markets 2009[49] do not venture into forward price projections.

Figure 2 below draws a crude forward curve based on ask prices from a basket of voluntary market projects[50] and assuming a long-term cost of carry[51] of 4%. This forward curve, depicted in blue the figure below, is a rough estimation of prices asked for renewable energy based Voluntary Carbon Units. Methane projects and forestry projects have been omitted. The blue line depicts real ask prices for credit vintages 2006 – 2009 and the dashed blue line represents the forward curve.

[47] http://siteresources.worldbank.org/INTRES/Resources/ResearchAbstractReportFY-08-09.pdf

[48] EU Emissions Trading Scheme Allowances and Certified Emission Reductions

[49] http://carbon.newenergyfinance.com/?p=list&t=NCF_downloads&id=1048 (registration required)

[50] Evolution Markets, weekly VER prices 29.01.2010, 9-21 projects per vintage in 2006-2009

[51] In-line with numerous long-term price forecasts for various global carbon markets including CDM (see e.g. "Chapter and Verse: EU ETS Rules for CER/ERU Use Beyond Copenhagen", Deutsche Bank Global Markets Research, November 16, 2009)

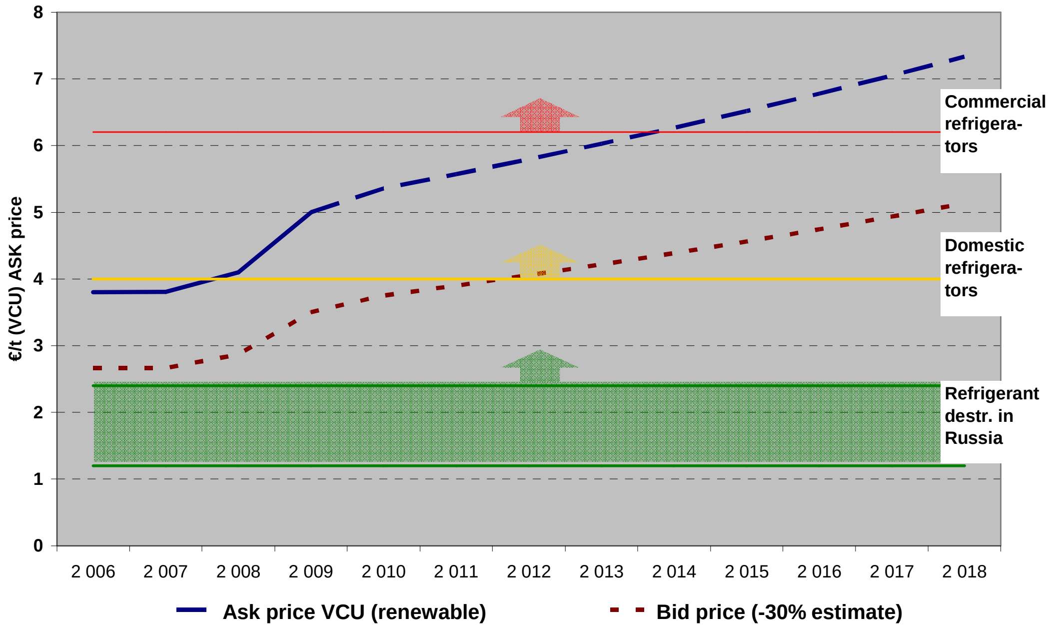


Figure 2 Forward VCU price curve and ODS destruction cost levels (green, yellow and red)

Prior to making any conclusions from the above price information, one should note that the voluntary carbon market in its current form is a "buyer's market", meaning that price levels are more likely to be set by demand than supply. This influences pricing in that closing prices are likely to be closer to by buyer's bids rather than the ask-prices in Figure 2 above. Independent data on bid-ask spreads for the voluntary market is largely unavailable, but we estimate bid prices to be -20 – 30% lower than published ask prices. Figure 2 also includes a price curve for a hypothetical -30% bid price (dark red dashed curve).

Based on the depicted curve, forward VCU prices would remain anchored within a rough price band of €3 – 5.5 in the 2010- 2012 timeframe, and then gradually increase to €4.5- 7 in 2016 -2019. Given that voluntary market demand is not based on regulation, rather on individual buyer's perceived utility value of an emission reduction, we would deem the price forecasts highly speculative. In addition, the voluntary market is also prone to large bouts of supply from CDM projects ("pre-CDM VERs") as a result of delayed registration of projects.

Figure 2 shows that ODS management and destruction costs for pure refrigerant destruction in Russia (*in green*) are lower than the ask prices for VCUs. Management and destruction costs for domestic fridges start at €4 (*in yellow*), or around the same level as the ask price for older VCUs. Commercial refrigerant destruction cost begin at around €6 (*in red*), at a higher level than today's VCU prices. The illustration shows that the cost of destroying (only) refrigerants appears to be below the price of a VCU, making this project type likely most feasible for financing through carbon credits. The cost of destroying ODS from household refrigerators appears to be roughly within the higher price boundaries for VCUs.

Finally, and importantly, it should be noted that there are potentially vast differences between the pricing of ODS destroyed under VCS or CAR. CRTs produced under CAR, in California, including ODS destruction, embed a "pre-compliance value"[52], and are therefore expected to

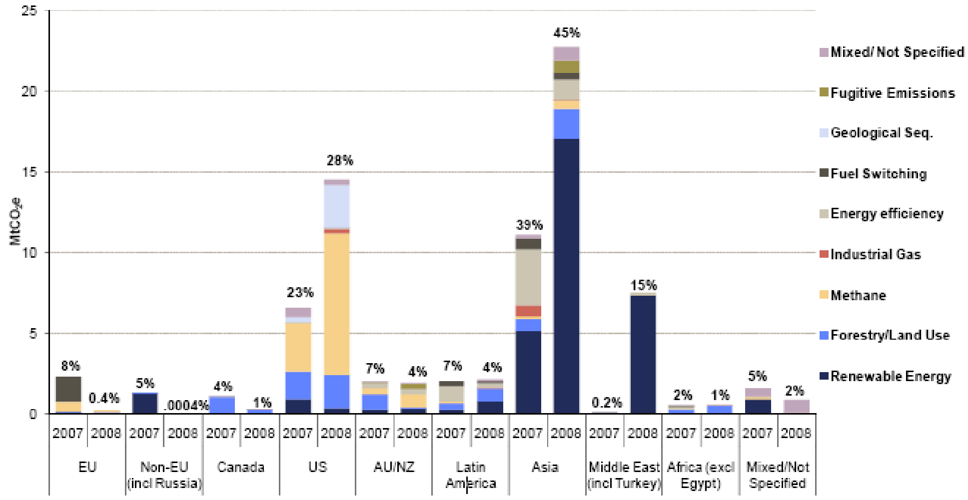
[52] Pre-compliance credits are emission reductions that are expected to meet the requirements of future regulatory frameworks. For instance, a CRT, it is expected, can be used against future regulatory targets under a US state- or federal cap & trade system.

trade on a higher price level than VCUs. Bid prices[53] for Californian CRTs range between \$5.7-8, or €4-5.75t CO2e. Non-Californian CRTs trade at a \$2 discount.

Quality considerations

ODS management and destruction project developers should also be aware of the impact of "quality" on pricing voluntary emission reductions. Unlike, regulatory credits, voluntary market reductions do not provide a standard utility value to holders (i.e. use against compliance targets). This means that buyers' subjective preferences and interpretation of "quality" are the key determinants of demand for voluntary credits. In this context, the voluntary market buyers have traditionally favored projects with high "visibility", "pr value" and ones that are easy to communicate to stakeholders. As a result, renewable energy- projects have been the most favored project type in the voluntary market. This is clearly illustrated in Figure 3 below.

Emission reduction credits represent a new project category in the voluntary market. Industrial gas projects have featured very sparsely in voluntary carbon transactions. This further reduces the resolution of price projections for carbon credits from ODS management and destruction projects. The strength in ODS-based carbon credits lies in the fact that the projects are by-and-large only driven by the revenues from sale of carbon credits and the high level of verifiability of the management and destruction process. Both facts increase the perceived environmental "quality" of the reductions. The main drawback of ODS-based reductions is the relatively unattractive project characteristics for the purposes of marketing the emission reduction activity or promoting the visibility of corporate use of such emission credits. Whether these factors have a net-negative or net-positive effect on the price of an ODS-based carbon credit versus other project types remains untested in the voluntary market.



Source: Ecosystem Marketplace, New Carbon Finance.(1) Based on 335 observations

Figure 3 Project types in observed voluntary carbon market trades

Carbon project cost impact

The development of an emission reduction project incurs direct expenses to the project developer. These expenses are not related to the physical handling of the ODS, but are incurred as a result of documenting, validating, verifying, certifying and registering emission reductions in the voluntary carbon market. In addition further costs may be incurred by the

[53] Evolution Markets weekly price summary, January 22 and February 5, 2010.

monitoring requirements set by the emission reduction methodology, if the requirements are beyond normal operating procedures. The main cost categories are:

- **Project development costs (optional).** These are mainly external consultancy costs for designing and documenting the project to meet the requirements. Documentation can also be done in-house if suitable resources are available. The cost of full voluntary project documentation is likely to be in the range of €15-40.000 depending on the size, location and complexity of the projects. In some cases the development costs can be replaced by success-fees, whereby the costs are only charged if the project is successfully validated or registered. Typically the fee would be at least 20-30% higher in such cases.
- **Third-party project validation (mandatory).** The VCS requires projects to be validated prior to verification which incurs a mandatory cost (but reduces verification costs). This one-time charge is likely to be around €10-25.000 and is non-recoverable in case the project is not validated/registered.
- **Annual third-party verification cost (mandatory)**. A fixed cost associated with verifying the amount of emission reductions produced by the project. Usually around €15.000 for standard verifications, without excessive travel or technically complex projects. Could be higher if verification replaces need for a separate validation step (CCX and CAR).
- **Registry membership fees (mandatory).** Most registries charge a nominal joining/annual fee. This is typically about €500.
- **Registration and issuance fees (mandatory)**. All registries charge fees for issuing carbon credits. These fees range between €0.035 (VCS) and €0.14 (CAR) per issued credit. VCS also charges an €0.03 administrative fee upon issuance.

In total then the optional and mandatory development costs are €40-80.000 plus a variable cost of approximately €0.08-0.14/t CO2e for registration and issuance. Table 11 below provides an estimate of the impact of the carbon project development costs on average ODS project destruction costs. The data shows that the cost of developing a carbon project can be negligible versus ODS management costs when developing large (+10t ODS) refrigerant projects. For smaller and lower GWP projects the cost of the carbon development project could double the break-even point for the projects. It should be noted that the table below conservatively assumes a fixed cost of €60,000 and a variable cost of €0,1/t CO2e.

ODS type	**Average cost (€/t CO2e)**	**GWP**	**Impact of carbon credit development costs (in €/t CO2e)**		
			5t ODS	10t ODS	20t ODS
Refrigerant only (CFC-12)	1,5 – 2,4	10900	**1,02**	**0,65**	**0.37**
Refrigerant / domestic Foam / domestic	4 -10,7	4142	**2,98**	**1,55**	**0,82**
Refrigerant / commercial Foam / commercial	6,2 - 16	2856	**4,3**	**2,2**	**1,15**
Syntez[54] quote (refrigerant)	1,15 – 1,2	8100 (Quote R12)	**1,58**	**0,84**	**0,47**
Piani (refrigerant)	1,4 – 2,4	4142	**2,98**	**1,55**	**0,82**

Table 11 Estimated impact of carbon development costs on ODS management projects (in €/t CO2e)

[54] Russian Scientific Research Engineering Center ("Syntez")

Summary views on the viability of ODS projects

The voluntary carbon market represents a potential avenue for funding ODS management and destruction in the absence of legal or other market incentives. The high GWP of ODS mean that their destruction can generate large volumes of carbon credits. In very simple terms, the destruction of 1 tonne of CFC-12 with a GWP of 10,900 yields 10,900 carbon credits. However, in reality the carbon economics of ODS management and destruction are influenced by a number of other variables.

First, the total amount of reductions is measured against an emission baseline that is constructed to represent the emissions in the absence of management and destruction. The baseline needs to account for such facts as emissions from replacement technologies, leakage from appliances and natural mitigation of ODS. As a result the baseline emissions could be as low 50% (landfilling of building materials) of the total embedded ODS in the targeted supply stream. The choice of baseline has the biggest single impact on the carbon economic of an ODS project. In general baselines for refrigerants are more attractive than baselines for foam and halon.

Second, the total emissions are also influenced by the emissions from the management and destruction project itself. This means that that transport emissions, leakage, emissions from fossil energy consumption and electricity consumption are deducted from the total volume of emission reductions.

Third, the emission reduction quantity is directly linked to the verified volume of destroyed ODS. The emission reduction methodology puts a lot of emphasis on the completeness and accountability of the monitoring system. Any departures from the approved monitoring protocol would lead to the application of a default conservative value or, at worst, rendering the project ineligible.

However, this also means that project design and planning can alleviate a number of concerns; project type selection influences baseline, ODS supply source influences quality and volume, and plant design influences recovery and destruction costs as well as process control.

The sections above presented the cost of a carbon reduction from an ODS project to be anywhere between €1.2- €6.4 for pure refrigerant projects and up to €16 when foam collection and destruction is included in project design. Comparing these figures with the existing and projected voluntary market prices in Figure 2 suggests that projects at the lower end of the cost scale should be viable for financing destruction through the voluntary carbon market. This view should hold true also when factoring in the cost of carbon project development from Table 11, which adds a variable cost factor that decreases as the size of the project and the GWP of the ODS increases.

The above pricing would, initially, favour primarily ODS management and destruction projects that can utilize low-cost waste streams for ODS supply and only focus on recovery and consolidation (with destruction taken place externally) or projects that destroy (using external capacity) existing low-cost stockpiles, e.g. low-quality or contaminated ODS from service networks.

However, the best way of improving the viability of an ODS project is to integrate it with other services or waste management processes. This will reduce the cost of collection, transport and storage, and in some cases also recovery. In short this implies that the economical evaluation for e.g. destroying ODS at an integrated waste management plant is vastly different than the "in-situ" ODS management and destruction projects discussed above. This is particularly important when considering the investment cost of a new recovery and/or destruction plant. The payout from carbon credits takes place ex-post, i.e. after the reductions have been verified – thereby being mainly suitable for covering operational costs of the facilities (assuming they are not bankable in advance to reduce cost of finance). This means that financing a greenfield recovery and/or destruction facility will be very difficult in the absence of any other revenues. Integrating the ODS management and destruction facilities into a larger investment will reduce the investment cost, lower the ODS destruction operating costs and diversify the future revenue potential of the waste management site.

ANNEX 1 - Key background assumptions

ODS in Russia

As part of its exploratory work on ODS management and destruction opportunities in Russia, NEFCO commissioned a study on the state of ODS bank management and availability of domestic ODS destruction options in 2009[55]. Some of the key finding from this work are summarized below and form the basis for the assumed state of ODS bank management in Russia.

Legislation and ODS bank management

Current legislation prohibits venting of ODS in Russia, however, there is little information of how this prohibition is sanctioned. Legislation supporting ODS bank management from small units (e.g. household refrigerators and car air conditioners) is lacking. Similarly, there are no incentives to promote the collection and proper disposal of household refrigerators at end-of-life. The Russian Ministry of Natural Resources and Ecology has indicated[56] that an emerging need to align Russian waste management practices with the European Union's (Waste Electrical and Electronic Equipment Directive (WEEE Directive) will provide a new incentive to collect and manager household refrigeration waste – and enable a more centralized approach to managing ODS banks. This could e.g. take the form of public/private collection programs under which retailers and municipalities work to develop programs to collect unused equipment and/or equipment in use through an appliance swapping-program.

In the absence of regulation, there are no appliance de-manufacturing facilities in Russia to process refrigeration equipment. The management of ODS therefore faces three primary obstacles in Russia: 1) there is no policy to encourage centralized management of white good waste, 2) there are no facilities to de-manufacture refrigeration units and, 3) there is no policy to mandate the capturing of ODS from refrigeration units.

Nevertheless, given that refrigerants have a re-sale value , there is commercial interest in collection programs for ODS from large refrigeration units retired from hotels, grocery stores, and restaurants etc. Under such programs refrigerants are removed on site by trained technicians, and CFCs are topped-up or replaced with an alternative refrigerant. Any collected ODS are by-and large stockpiled at private service centers for industrial refrigeration equipment. ODS from these stockpiles are either re-used or leaked over time. So unlike small household refrigeration units, where emissions from ODS banks are broadly dispersed, the industrial refrigeration sector, to some extent, offers more concentrated sources of ODS due to an established network of refrigeration technicians.

ODS destruction facilities

In addition to the lacking infrastructure described above, Russia currently possesses only few ODS destruction facilities that are accessible and available for destruction of privately collected ODS. As highlighted in Piani's study, the bulk of current existing facilities (over 300) are not specifically designed for CFC destruction but rather for destruction of toxic waste, chemical and military stockpiles. This doesn't, however, mean that ODS management and destruction is not technologically possible, but simply that an ODS management and destruction project would be of secondary importance at these facilities as their operation is geared to other businesses.

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[55] Gianguido Piani (2009) "Final Report: Bulk ODS collection and destruction in Russia, project proposal and critical aspects".
[56] NEFCO discussions with Andrey S Peshkov

Barriers

The Multilateral Fund[57] lists a number of general obstacles to ODS reduction in both Annex 5 and non-Annex 5 countries. These include e.g. lack of regulatory frameworks, technical skills and logistical complexities. Any ODS management and destruction project in Russia similarly faces several barriers to implementation, above and beyond cost considerations. Section C below will make the following assumptions about barriers for the collection and destruction of ODS banks:

- First, there are no regulatory incentives or policy frameworks is in place to support a broad-based and centralized collection of old household refrigeration equipment;
- Second, there are no regulatory incentives or policies to mandate the collection of ODS from household refrigerators, industrial refrigerators and mobile air-conditioning units.
- Third, industrial ODS collection takes only place for purposes of servicing old equipment only.
- Fourth, lack of a refrigerator recycling/demanufacturing facility in Russia,
- Fifth, current ODS destruction facilities do not provide a technically, legally and commercially viable alternative for management and destruction of collected ODS.
- Sixth, designing the project around re-injection of ODS from refrigerators into transport cylinders locally was deemed an unfeasible option for the pilot project, because foams would be left outside the project and refrigerators would not be recycled.
- Countries undertaking ODS management and destruction need the proper tools and access to the infrastructure to collect, transport, store, and destroy the ODS. The process for developing this infrastructure can be significant, presenting a barrier for some A5 countries.
- For countries without domestic management and destruction facilities, shipping ODS to another country for destruction may be the best option. In some countries the logistical and legal complexities of shipment may present a barrier

The existence of any such barriers must be verified prior to initiating a project.

Cost estimates

In the absence of regulatory obligations to destroy ODS, the main driver for investing in the collection, storage, transport and destruction is the economical cost/benefit of selling carbon credits based on the GHG equivalent of the destroyed ODS.

The guide will base this cost/benefit analysis firstly on the cost of destroying the ODS according to the pre-requisites in the chosen methodology. The manual will provide a summary of costs associated with each step of the management and destruction process based on recent public estimates (e.g. TEAP, ICF). The cost estimates will be provided as a range, with a more specific elaboration of refrigerator projects.

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[57] Multilateral Fund. 2008. Study on the Collection and Treatment of Unwanted Ozone-Depleting Substances in Article 5 and Non-Article 5 Countries. http://ozone.unep.org/Meeting_Documents/oewg/28oewg/ICF_Study_on-Unwanted_ODS-E.pdf

It should be noted that cost estimates are typically categorized according to the level of effort to recover the ODS (see above). Given the manual's focus on "low" effort project types, the cost estimates will also be for low-effort project types. By focusing on "low" effort cost-estimates the cost levels are thereby primarily applicable for collection of ODS in densely populated areas/regions.

As a result, the cost estimates provided in the guide should provide a benchmark carbon price range, in €/t CO2 equivalent, that would be needed to finance ODS destruction. It should be noted that the cost estimates are provided as stand-alone generic estimates and should therefore only be used for initial guidance in investment analyses. The cost estimates do not include any cost benefits from integrating an ODS management and destruction project with an existing waste management project. For instance, the cost of collection of ODS from household refrigerators would likely be lower for an integrated municipal waste management practice than for a stand-alone ODS recovery and destruction project because the ODS collection and transport costs would be part-covered for by municipal waste management handling fees.

ANNEX 2 - Background information on methodology

The chosen methodology has been developed by EOS Climate, a US-based company specialized in producing high-quality carbon offsets through the destruction of ODS. The EOS ODS methodology was written to the ISO 14064 Greenhouse Gas International Standard and has undergone an extensive expert review by industry experts[58]. The methodology can be used both in the regulatory and voluntary carbon markets. In December 2008 EOS submitted its methodology to CAR which initiated CAR's development of an ODS protocol.

The methodology defines potential sources of ODS emissions and specifically defines the approach to mitigating these emissions through project ODS management and destruction activities. The main purpose of the methodology is to ensure that project activities will result in verifiable destruction of ODS in a manner that results in the creation of GHG credits. Specifically, the methodology applies to destruction of ODS for which there are no regulatory controls mandating their recovery and destruction, and that would otherwise be emitted through use and leakage from equipment or through disposal of products, storage containers, or other materials containing ODS.

Importantly, before any GHG credits can be developed from an ODS management and destruction project, the project must be evaluated to determine that emission reductions are voluntary and not the result of any international, regional, national, or local regulatory requirements. GHG emission reduction activities from ODS management and destruction must represent reductions that are achieved outside of those achieved by existing regulatory drivers. As explained in Section A.2. the starting assumption for pilot projects in Russia is that ODS is not regulated.

[58] http://www.eosclimate.com/about-advisors.htm

ANNEX 3 - Common ODS and their characteristics

GAS	*Ozone Depleting Potential*	*Global Warming Potential*
CFC-11	1	*4750*
CFC-12	1	10900
CFC-13	1	14400
CFC-113	0.8	6130
CFC-114	1	10000
CFC-115	0.6	7370
Halon 1301	10	7140
Halon 1211	3	1890
Carbon tetrachloride	1.1	1400
Methyl bromide	0.6	5
HCFC-22	0.055	1810
HCFC-123	0.02	77
HCFC-124	0.022	609
HCFC-141b	0.11	725
HCFC-142b	0.065	2310

GWPs: IPCC (2007); ODPs: UNEP (2009)

ANNEX 4 - Common ODS and their characteristics

Sector	*Low Effort*	*Medium Effort*	*High Effort*
Domestic Refrigeration – Refrigerant	DP	SP	
Domestic Refrigeration – Blowing Agent	DP	SP	
Commercial Refrigeration - Refrigerant	DP	SP	
Commercial Refrigeration – Blowing Agent	DP	SP	
Transport Refrigeration – Refrigerant	DP/SP		
Transport Refrigeration – Blowing Agent	DP/SP		
Industrial Refrigeration – Refrigerant	DP/SP		
Stationary Air Conditioning – Refrigerant	DP	SP	
Other Stationary Air Conditioning – Refrigerant	DP	SP	
Mobile Air Conditioning – Refrigerant	DP	SP	
Steel-faced Panels – Blowing Agent		DP	SP
XPS Foams – Blowing Agent			DP/SP*
PU Boardstock – Blowing Agent			DP/SP*
PU Spray – Blowing Agent			DP*/SP*
PU Block – Pipe		DP	SP
PU Block – Slab		DP	SP
Other PU Foams – Blowing Agent			DP/SP*
Halon – Fire Suppression	DP	SP	

ANNEX 5 – Examples of baseline scenarios for select project categories

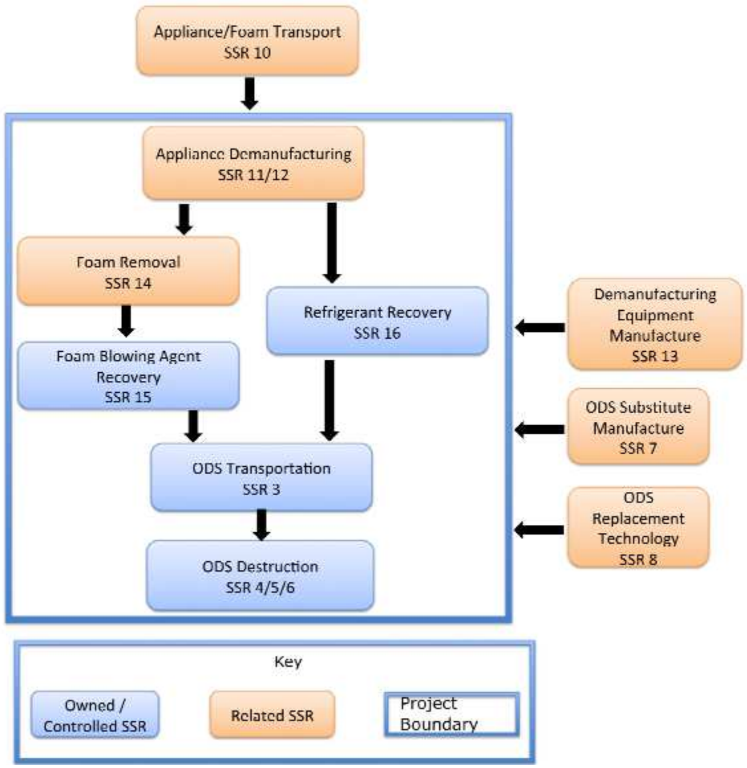
ODS Destruction Scenario	ODS Destroyed	Baseline Scenario	Baseline Emission Rate	References
1. Destruction of ODS contained in storage tanks, cylinders, or other containers for the purpose of stockpiling for future use or for re-sale	CFCs, HCFCs, halons	100% eventual emission	Halon 1301: 9% per year until full discharge	EPA Vintaging Model (2008)
			Halon 1211: 5% per year until full discharge	
			CFCs and HCFCs: 100%	
2. Destruction of ODS contained in insulation foam and used as refrigerant in appliances or other components that are being disposed	CFCs, HCFCs	A. Separation and shredding of **foam** and disposal in landfill	61%	Scheutz et al., (2007a,b); TEAP (2007)
		B. Separation of **foam** and recovery/reclaim of blowing agent to recharge refrigeration or air conditioning equipment	100%	TEAP (2007)
		Reclaimed ODS **refrigerant** is used to recharge other refrigeration or air conditioning equipment	100%	
3. Destruction of ODS contained in insulation foam in building materials that are being disposed	CFCs, HCFCs	A. Direct landfill disposal (no separation of foam from other debris)	50%	Scheutz et al., (2007a, b)
		B. Separation of foam and recovery/reclaim of blowing agent to recharge refrigeration or air conditioning equipment	100%	TEAP (2007)
4. Destruction of ODS recovered from commercial and industrial refrigeration and air conditioning systems and equipment.	CFCs, HCFCs	ODS refrigerant is continued to be used in refrigeration or air conditioning equipment, or reclaimed refrigerant from decommissioned equipment is used to recharge other refrigeration or air conditioning equipment	100%	TEAP (2007)

From: EOS ODS Methodology (2009)

ANNEX 6 – Illustration of emission sources and boundaries for destruction of ODS

Case: insulation foams and appliance refrigerants

PROJECT EMISSIONS

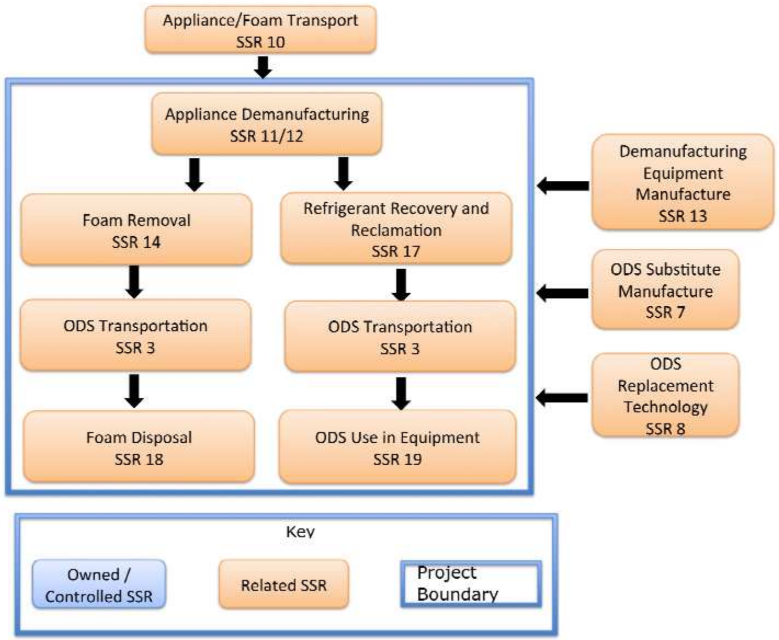


Copied (with permission) from: EOS ODS Methodology, 2009, p 29-32

PROJECT EMISSION SOURCES

SSR Identifier	SSR name	Controlled, Related, or Affected	SSR Description
SSR 10	Appliance Transport	Related	GHG emissions resulting from collection and transport of appliances to de-manufacturing facilities
SSR 11	De-manufacturing electricity	Related	GHG emissions that stem from electricity production and distribution for the demanufacturing of the appliances, including ODS recovery.
SSR 12	De-manufacturing fuel combustion	Related	GHG emissions that are generated from natural gas, diesel, or other fuel combustion for the demanufacturing of appliances, including ODS recovery.
SSR 13	De-manufacturing Equipment Manufacture	Related	GHG emissions generated during the manufacture of the equipment used to de-manufacture appliances
SSR 14	Foam Removal	Related	GHG emissions that result from removal of foam from appliance
SSR 15	Foam blowing agent recovery	Controlled	GHG emission that stem from separating ODS blowing agent from insulation foam from appliance
SSR 16	Refrigerant recovery	Controlled	GHG emission that stem from recovering ODS refrigerant from appliance
SSR 3	ODS Transport	Controlled	GHG emissions resulting from transport of ODS or transport of insulation foam containing ODS, from collection facility or storage location to destruction facility
SSR 4	Destruction Facility Electricity	Controlled	GHG emissions that stem from electricity production and distribution needed for destruction of project materials.
SSR 5	Destruction facility fuel combustion	Controlled	GHG emissions that are generated from natural gas combustion needed for destruction of project materials.
SSR 6	Destruction Facility Emissions	Controlled	GHG emissions resulting from the destruction of ODS
SSR 7	ODS Substitute Manufacture	Related	GHG emissions generated during the manufacture of insulation foam and refrigerants for new appliances.
SSR 8	ODS Replacement Technology	Related	GHG emissions resulting from use of new appliances.

BASELINE EMISSIONS



Copied (with permission) from: EOS ODS Methodology, 2009, p 29-32

BASELINE EMISSION SOURCES

SSR Identifier	SSR name	Controlled, Related, or Affected	SSR Description
SSR 10	Appliance transport	Related	Appliances may be scrapped (with the foam intact) after removal of salvageable materials or disassembled (de-manufactured) with foam put into landfill and refrigerant recovered for re-entry to market. This methodology requires documentation on which practice would be the normal baseline scenario in the region where the appliances originate. Appliances that are de-manufactured would be expected to have a slower release rate of blowing agent (compared to intact foam disposal) but would be accompanied by greater energy related GHG emissions.
SSR 11	De-manufacturing electricity	Related	
SSR 12	De-manufacturing fuel combustion	Related	
SSR 13	De-manufacturing Equipment Manufacture	Related	
SSR 14	Foam Removal	Related	
SSR 17	Refrigerant Recovery and Reclamation		GHG emissions resulting from reclamation of refrigerant from compressor and refrigerant lines, and in some cases, separated from the insulation foam, back to virgin quality and transport for subsequent re-entry to market.
SSR 3	ODS Transport	Related	GHG emissions resulting from transport of ODS refrigerant and ODS blowing agent, or transport of insulation foam containing ODS, from collection facility or storage location to destruction facility
SSR 18	Foam disposal	Related	GHG emissions resulting from the release of ODS blowing agent during shredding of foam during de-manufacturing, if de-manufacturing occurs, and off-gassing of ODS blowing agent in insulation at the landfill.
SSR 19	ODS use in equipment	Related	GHG emissions resulting from use of recovered ODS refrigerant, and if ODS foam blowing agent is separated from insulation foam in appliance, the use of recovered ODS blowing agent as a refrigerant in refrigeration or air conditioning equipment.
SSR 7	ODS Substitute Manufacture	Related	GHG emissions generated during the manufacture of insulation foam and refrigerants for new appliances.
SSR 8	ODS Replacement Technology	Related	GHG emissions resulting from use of new appliances.

ANNEX 7 – Availability of ODS destruction technologies globally

Category of Technology	*Technology*	*Operating Country*	*Reported ODS Destruction Capacity*	*Reported ODS Destruction Price*
Hazardous Waste Incineration	Rotary Kiln	Belgium, Brazil, Canada, Czech Republic, Finland, France, Hungary, Russia, Sweden	40 – 545 MT/year	US$4 - 12/kg
	Liquid Injection Incineration	Hungary, Japan, USA	> 13 MT/year	
	Gaseous/Fume Oxidation	Japan	2,600 MT/year	
	Fixed Hearth Units	USA		
	Lightweight Aggregate Kiln	USA		
Destruction with production	Cement Kiln	Indonesia, Japan, USA	600 MT/year	
	Lime Rotary Kiln	Japan		

Category of Technology	*Technology*	*Operating Country*	*Reported ODS Destruction Capacity*	*Reported ODS Destruction Price*
Destruction Dedicated to ODS	Reactor Cracking	Germany	1,600 MT/year	
	Argon Plasma Arc	Australia, USA	318 – 600 MT/year	US$ 7/kg
	Nitrogen Plasma Arc	Japan		US$ 9/kg
	Inductively Coupled Radio Frequency Plasma	Japan		
	Microwave Plasma	Japan		
	Air Plasma	Sweden	100 MT/year	
	Solid-Phase Alkaline Reactor	Japan		
	Gas-Phase Catalytic Dehalogenation	Japan		US$ 5-7/kg
	Superheated Steam Reactors	Japan		US$ 5kg/kg

ANNEX 8 – Specific guidance for trial ODS management and destruction projects in Russia

This Annex lists information that NEFCO requires for its pilot projects from stakeholders in ODS collection, management and destruction projects. The data provide by stakeholders will give NEFCO oversight of key details of the management and destruction process for purposes of internal accounting of related emission reductions and for further evaluation of information needs for project registration. *It should be noted that for meeting the requirements of a voluntary carbon market ODS methodology the pilot project need to complement the information below with the registration requirements defined in section C*[i]. The purpose of a trial project for NEFCO is to test the logistical chain for sourcing, transporting and destroying ODS in Russia and to document this using a narrow scope for monitoring project parameters .

For project developers, this annex is intended to be used as a first benchmark for the creation of carbon credits. Specifically, items 1-5 in the table below lists the set of information needed for choosing a suitable methodology and enabling the certification and registration of carbon credits. The information collected on the basis of the list below is best usable for projects destroying primary/bulk ODS, but is also applicable to other project types.

The measured and reported information should be verified by an external consultant to provide further comfort in a trial project's performance parameters. For completing a full registration of the ODS project an accredited independent local or international verification or certification agency must be used.

Information requirements for trial ODS collection and destruction projects in Russia

Requirement	***Action***	***Measurement***
1. Supplier data	a. Name and location of supplier of ODS	Supplier data
	b. Source of ODS (equipment type, location(s))	Supplier records
	c. Name of company/technician supplying ODS (if different than 1.a)	Supplier records
	d. Year(s)of recovery	Supplier/technician records
	e. Type and amount of refrigerant used to replace the ODS (if applicable)	Supplier/technician records
2. Determination of the type of ODS	a. Take gas samples from each cylinder	Gas chromatographer
	b. Determine gas composition and ODS type	Gas chromatographer
	c. Determine level of impurity of ODS (% contaminants)	Gas chromatographer
3. Weight/volume of ODS	a. Determine the type (model) of cylinder used	Manufacturer data
	b. Determine the dry (empty) weight of cylinder used	Manufacturer data
	c. Measure weight of full cylinder at storage facility	Measured at site
	d. Label and seal weighted cylinders (ODS, weight)	Measured at site
	e. Ensure cylinders are not leaking/faulty	Tested on site
	f. Determine the model of scales used to measure cylinders/ODS	Operator data
	g. Determine the method and frequency of scale calibration	Operator data
	h. Measure the weight of full cylinder at the destruction facility	Measured at site

Information requirements for trial ODS collection and destruction projects in Russia		
Requirement	***Action***	***Measurement***
4. Transport	a. Define the mode of transport	Supplier data
	b. Name of transport company	Supplier data
	c. Calculate the distance between ODS storage site and destruction facility	Measured
5. Destruction	a. Location of destruction facility	Operator data
	b. Name of plant and operator	Operator data
	c. Description current destruction activities	Operator data
	d. Determine destruction efficiency of facility based on mass flow measurements at the outlet of the destruction facility	Operator data or operator calculations
	e. Inspect cylinder seals and cylinder condition for leaks	Inspected at site
	f. Measure quantity of ODS fed into destruction unit	Mass flow meters
	g. Measure molecular composition of ODS fed into destruction unit	Gas chromatographer
	h. Determination of the duration of destruction	Measured at site
	i. Estimation of external electricity input for ODS destruction based on plant's annual consumption electricity.	Calculated (kWh/t ODS)
	j. Estimate of external fuels consumed during ODS destruction based on the annual average heat content of fuels consumed	Calculated (MJ/t ODS)

[i] The information provided in the table above only includes select parts of information required by the EOS methodology. Applying the full methodology, each of the 5 steps above need to be complemented with further data points that need to be referenced, attested or verified. Please see section C of this report for full details of the information need. The effort for developing a full scale carbon credit project (including all documentation) would require 150-200 man hours depending on the project type and complexity of verifying project data.