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## TYPE III - OTHER PROJECT ACTIVITIES

Project participants shall take into account the general guidance to the methodologies, information on additionality, abbreviations and general guidance on leakage provided at http://cdm.unfccc.int/methodologies/SSCmethodologies/approved.html.

## *III.X Energy Efficiency and HFC-134a Recovery in Residential Refrigerators*

**Technology/Measure:**

1. This category comprises demand side activities for replacement of existing, functional domestic refrigerators with more efficient units utilising refrigerants and foam blowing agents having no ozone depleting potential (ODP) and low global warming potential (GWP). Refrigerator demanufacturing[1], including recycling of refrigerator materials and recovery[2] of baseline refrigerant (e.g. HFC-134a) and foam blowing agent is an integral part of the project activity.

2. Measures are limited to those that result in emission reductions of less than or equal to 60 kt $CO_2$ equivalent annually.

3. This methodology is applicable under the following conditions:

(a) Project activity complies with national environmental and safety regulations.

(b) All baseline refrigerators are replaced by project refrigerators within the first year of the start of crediting period by way of direct installation.

(c) Neither replacement of refrigerators nor recovery of refrigerants and foam blowing agents are required directly or indirectly by laws or regulations (e.g. to comply with safety or pollution standards), except for situations where non-compliance with the law or regulation is widespread and occurs in more than 50% of the cases.

(d) Measures are taken to ensure that double counting of CERs does not occur. For example, CERs cannot be claimed for the manufacture of the energy efficient refrigerators installed under the project activity.

(e) The baseline refrigerators and the energy efficient project refrigerators are driven by electrical energy.

[1] Demanufacturing is the disassembly and separation of different material fractions.

[2] ***Recover*** means to remove refrigerant in any condition from a system and store it in an external container.
- ***Recycle*** means to extract refrigerant from an appliance and clean it using oil separation and single or multiple passes through filter-driers, which reduce moisture, acidity, and particulate matter. Recycling normally takes place at the field job site.
- ***Reclaim*** means to reprocess used refrigerant, typically by distillation, to specifications similar to that of virgin product specifications. Reclamation removes contaminants such as water, chloride, acidity, high boiling residue, particulates/solids, non-condensables, and impurities including other refrigerants. Chemical analysis of the refrigerant shall be required to determine that appropriate specifications are met. The identification of contaminants and required chemical analysis shall be specified by reference to national or international standards for new product specifications. Reclamation typically occurs at a reprocessing or manufacturing facility.

(f) Project refrigerators installed under the project activity must use a non-halogenated refrigerant together with an insulation foam blowing agent, both of which have:

- No ODP; and
- GWP lower than 15 according to the latest IPCC Assessment Report.

(g) The average volume capacity of the project refrigerators installed is at least 80% of the average volume capacity of baseline refrigerators in order to ensure that service demand is met under the project activity. Baseline refrigerators used to determine the parameter $SEC_{BL}$ in formula 1 shall be considered for this comparison.

(h) Refrigerant recovery or recovery of foam blowing agent is not a predominant practice in baseline situation.

(i) The baseline scenario is continued use of existing inefficient refrigerators. If the baseline refrigerators were to stop functioning, the predominant standard practice must be that they are either repaired, but not to manufacturer standards, or replaced with units having comparable inefficient electricity consumption characteristics. The baseline scenario is documented through a reliable pre installation survey of representative samples of end users and a validation of the prevailing practice of refrigerator repair. The following two criteria must be satisfied to determine compliance with this requirement concerning baseline practices:

- Greater than 90% of targeted baseline refrigerator end-users indicate that they would either repair the existing refrigerator or replace the existing refrigerator with another used refrigerator should their refrigerator stop functioning,
- Baseline refrigerators are predominantly serviced, repaired or supplied by a cottage industry[3] i.e. service shops in the informal sector which cannot be classified as a service centre or franchisee or a dealer of a refrigerator company.

(j) The existing residential refrigerators replaced under the project activity must be functional at the time that they are replaced.

(k) The existing residential refrigerators shall be replaced with efficient project refrigerators at no or low cost to the refrigerator's owner and/or user.

(l) The fluorinated gases used as refrigerants and foam blowing agents in refrigerator insulation material (including CFC-11, CFC-12 and HFC-134a) in the baseline

[3] Such service activities are characterised by low quality service practices such as the use of refrigerant for flushing the refrigeration circuit, inadequate evacuation of the refrigeration circuit as compressors are used for evacuation rather than a vacuum pump of specified capacity and refrigerant charging is by feel or by trial and error rather than by using a charging unit all of which lead to increased direct or indirect GHG emissions.

refrigerators shall be recovered, reclaimed and/or destroyed according to the voluntary WEEE[4] household cold appliance recycling standard or alternatively in accordance with a national or international standard that meets or exceeds the WEEE requirements.

(m) The emission reductions from the avoided direct emissions of refrigerants shall be not greater than 15% of the total emission reduction in any given year of the crediting period.

**Project Boundary**

4. The project boundary comprises the refrigerators in the baseline and project.

**Table 1: Summary of gases and sources included in the project boundary, and justification / explanation where gases and sources are not included.**

| | Source | Gas | Included? | Justification/Explanation |
|---|---|---|---|---|
| Baseline | Grid electricity | $CO_2$ | Yes | Main source of energy baseline emissions |
| | | Other gases | No | Minor source of energy baseline emissions |
| | Refrigerant | HFC-134a | Yes | Remaining refrigerant charge |
| | Refrigerant & foam | CFCs | No | Montreal Protocol gases |
| Project Activity | Grid electricity | $CO_2$ | Yes | Main source of project energy emissions |
| | | Other gases | No | Minor source of project energy emissions |
| | Refrigerant | Isobutane (R600) or other refrigerant that meets eligibility requirements | Yes | Refrigerant charge in new refrigerator |
| | Refrigerant & foam | CFCs & HCFCs | No | Refrigerators containing CFCs/HCFCs are not eligible under the methodology |

[4] The WEEE Forum "Requirements for the Collection, Transportation, Storage, Handling and Treatment of Household Cooling and Freezing Appliances containing CFC, HCFC, or HFC" (http://ec.europa.eu/environment/waste/weee/index_en.htm) refers to the EU Directive 2002/96/EC "Waste Electrical and Electronic Equipment (WEEE)", requires companies to be ISO 9001 and 14001 certified, and provides a performance test to ascertain that >90% of halogenated gases are recovered. The test also assures that recycling technology improvements compete based on their GHG impacts.

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**Baseline Emissions**

5. The baseline scenario is the continued use of inefficient refrigerators without refrigerant recovery.

**Energy Baseline**

6. The energy baseline is calculated as the number of refrigerators installed under the project activity times the average electricity consumed annually per refrigerator, as determined from testing of a statistically valid sample[5] of the baseline refrigerators replaced with project refrigerators:

$$EC_{BL,y} = Q_{PJ,y} \times SEC_{BL} / 1000 \quad \textbf{(1)}$$

Where:

$EC_{BL,y}$ Baseline electricity consumed in year *y* (MWh)

$Q_{PJ,y}$ Number of installed project refrigerators operating as confirmed by ex post monitoring in the year *y*

$SEC_{BL}$ Average annual electricity consumption of the baseline refrigerators (kWh)

7. The same testing standard (e.g. ISO 15502) that is used to determine the annual nameplate energy consumption of the project refrigerators must be utilized when testing the baseline refrigerators. The national or international testing protocol applied shall be specified in the PDD.

**HFC-134a Baseline[6]**

8. HFC-134a refrigerant is recovered from refrigerators that contain that refrigerant, using equipment tested according to ISO 11650 or a similar national or international standard. The vacuum pump of the recovery equipment must attain a pressure of 0.3 bar[7] (absolute) or a lower value.

9. Baseline emissions for the avoided HFC-134a emissions are calculated using the total quantity of reclaimed HFC-134a.

$$BE_{HFC,y} = Q_{HFC,y} * GWP_{HFC} \quad \textbf{(2)}$$

[5] Statistically valid defined as determining an estimate demonstrated to be within ± 10% (error bound) of the actual value with a 90% confidence interval.

[6] HFC -134a recharge that would have occurred in the baseline refrigerators during the crediting period on account of repair/service of the refrigerators (can be several times the original charge quantity) is ignored in this methodology for conservative estimation of reductions. Similarly high-GWP non-Kyoto gases such as CFC 11 and CFC 12 are also recovered, recycled and/or reclaimed for environmental co benefits.)

[7] This value is used in EN 378-4, p. 15 (European Norm issued by the European Committee for Standardization). HFC-134a lubricants require a lower evacuation pressure than other refrigerants.

Where:

$BE_{HFC,y}$ Baseline HFC-134a emissions in year *y* (t $CO_2$ equivalent)

$Q_{HFC,y}$ Quantity of HFC-134a reclaimed in year *y* (t HFC-134a)[8]

$GWP_{HFC}$ Global Warming Potential of HFC-134a

10. The quantity of reclaimed HFC-134a ($Q_{HFC,y}$) is established by weighing[9], and this value must meet the following two requirements:

(a) The ratio of the quantity of HFC-134a to the total number of refrigerators with HFC-134a is less than or equal to 0.115 kg per refrigerator:[10]

$$Q_{HFC,y} \leq n_{HFC,y} * 0.115 \quad \textbf{(3)}$$

Where:

$n_{HFC,y}$ Number of baseline refrigerators from which HFC-134a refrigerant is recovered and subsequently reclaimed during year *y*

0.115 Control ratio of HFC-134a per refrigerator (kg)

(b) The recycled quantity of HFC-134a is consistent with the measured total weight of the recovered synthetic polyolester (POE) lubricant used in baseline HFC-134a refrigerators. The ratio of $Q_{HFC,y}$ to $Q_{LUB,y}$ cannot exceed 2.087 (i.e.0.24 kg lubricant per refrigerator divided by 0.115 kg of HFC-134a):

$$Q_{HFC,y} \leq Q_{LUB,y} / 2.087 \quad \textbf{(4)}$$

Where:

$Q_{LUB,y}$ Quantity of refrigerant lubricant recovered in year *y* (kg )

2.089 Control ratio of qty lubricant per refrigerator and the qty of refrigerant per refrigerator

**Emission reductions**

The total emissions reductions in year *y* are calculated as follows:

$$ER_{TOTAL,y} = ER_{EC,y} + ER_{RF,y} \quad \textbf{(5)}$$

[8] The recovered amount of HFC-134a that is reclaimed reduces the sale and corresponding production of virgin HFC-134a.

[9] This involves use of special purpose container (refrigerant cylinder) and subtracting the container's empty weight

[10] This value is used in RAL-GZ 728 (Deutsches Institut für Gütesicherung und Kennzeichnung e.V., (www.ral.de) and the WEEE Forum standard cited in Footnote 1.

Where:

$ER_{ECy}$ Emission reductions from electricity component in year *y* (t $CO_2$)

$ER_{RF,y}$ Emission reductions from refrigerant component in year *y* (t $CO_2$e). This component shall not be greater than 15% of total emission reductions ( $ER_{TOTAL,y}$ ) in year y.

11. Emission reductions from electricity component is calculated as the difference of electricity consumed by the project activity and the electricity consumed in the baseline scenario, multiplied by the emission factor of the grid, adjusted for transmission losses, using the following formulas:

$$ER_{EC,y} = \left[EC_{BL,y} - EC_{PJ,y}\right] * EF_{grid,y} * \left(1 + TD_y\right) \quad \textbf{(6)}$$

Where:

$EC_{BL,y}$ Baseline electricity consumed in year *y* (MWh) as per Equation 1

$EC_{PJ,y}$ Project electricity consumed in year *y* (MWh)

$EF_{grid,y}$ Emission factor for the grid in year *y* (tCO2/MWh), calculated using the Tool to Calculate the Emission Factor for an Electricity System

$TD_y$ Average annual technical grid losses (transmission and distribution) during year *y* for the grid serving the locations where the devices are installed, expressed as a fraction. This value shall not include non-technical losses such as commercial losses (e.g. theft/pilferage). The average annual technical grid losses shall be determined using recent, accurate and reliable data available for the host country. This value can be determined from recent data published either by a national utility or an official governmental body. Reliability of the data used (e.g. appropriateness, accuracy/uncertainty, especially exclusion of non technical grid losses) shall be established and documented by the project participant. A default value of 0.1 shall be used for average annual technical grid losses, if no recent data are available or the data cannot be regarded accurate and reliable.

$$EC_{PJ,y} = \left(Q_{PJ,y} * SEC_{PJ,y} * 1.05\right)/1000 \quad \textbf{(7)}$$

Where:

$SEC_{PJ,y}$ Average annual nameplate electricity consumption of the project refrigerators installed (kWh). The nameplate electricity consumption of the project refrigerators must be determined in accordance with a national or international testing standard (e.g. ISO 15502).

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12. Emission reduction from the refrigerant components is based on:

- The amount of reclaimed HFC-134a associated with the baseline refrigerators. The algorithms for this calculation are provided under the baseline section above (refer to equations 2, 3 and 4);
- The quantity of refrigerant in the project refrigerators (GWP <15). It is assumed that all of the refrigerant charge in the project refrigerators is released to the atmosphere during the crediting period and the calculations are done as below:

$$ER_{RF,y} = BE_{HFC,y} - \left(\left(Q_{PJ,y} * Q_{REF} * GWP_{REF}\right)\right) \quad \textbf{(8)}$$

Where:

| | |
|---|---|
| $BE_{HFC,y}$ | Baseline HFC-134a emissions in year *y* ($tCO_2e$) |
| $Q_{REF}$ | Amount of refrigerant in each new refrigerator installed under the project activity (t refrigerant) |
| $GWP_{REF}$ | Global Warming Potential of the refrigerant used in the project activity refrigerators ($CO_2e$) |

**Leakage**

13. Leakage is considered negligible under this methodology and hence not considered.

**Monitoring**

Monitoring activities address both the energy efficiency aspect of the project activity and the HFC-134a reductions.

14. During project activity implementation, the following data shall be recorded:

- Number of refrigerators distributed under the project activity. Data collected for each refrigerator shall include nameplate data (serial number, date of manufacturer, annual rated energy consumption, volume, etc.) and the date of supply to a project participant;
- The number and specifications (e.g. volume) of the baseline refrigerators collected;
- Data to unambiguously identify the recipient of the equipment distributed under the project activity.

15. Monitoring shall include annual survey of a statistically valid representative sample of receipients to determine the number refrigerators operating[11]. The results of the survey shall be used to determine $Q_{,PJ,y}$ annually.

[11] Statistically valid defined as determining an estimate demonstrated to be within ±10% (error bound) of the actual value with a 90% confidence interval.

16. The specific electricity consumed i.e. average annual electricity consumption of refrigerators in the baseline ($SEC_{BL}$) is determined by measuring the energy consumption of a representative sample of baseline refrigerators taken back under the project activity using the sampling requirement defined in paragraph 6. A complete description of the test procedure, including sample selection, instrumentation, test standard, and data archiving and reporting shall be provided in the project design document. The test standard used to determine baseline energy consumption should be the same as that used to derive the nameplate value of yearly energy consumption of the project refrigerators.

17. Monitoring consists of counting the HFC-134a refrigerators entering the recycling facility, weighing reclaimed HFC-134a in liquid form and chemical analysis of HFC-134a samples and lubricant samples. If substances are sold or destroyed, proper records shall be maintained.

18. A project database records each HFC-134a containing refrigerator, including identification of the transport batch of refrigerators, the model name of the refrigerator and the serial number when these can be found on the refrigerator.

19. Each HFC-134a container will be clearly marked and identified. Scales will be used to weigh empty and full containers. The scales will be appropriately calibrated and the uncertainty in the measurements will be recorded.

20. Ten samples of 120 g each[12] are taken from each full container before it is removed. These samples have to be stored on-site until the end of the crediting period.

21. ARI Standard 700 of 2006 "Standard for Specifications for Fluorocarbon Refrigerants" or other national or international standard that meets or exceeds these requirements shall be employed.

22. The samples of recovered HFC-134a have to be analysed with gas chromatography, acidity titration and water coulometric titration according to the selected standard. The chromatography result assures that the HFC-134a is of re-usable quality. The acidity test assures that smaller vessels used in the recovery process are checked before these are emptied to the main HFC-134a storage tank.[13]

23. Written documentation on any sales of the recovered lubricants is required.[14] The residual HFC-134a content of the lubricant must be below 0.1% by weight.[15] This residual content shall be measured by methods that comply with the DIN 51727 and EN ISO 10304-1 or other equal or more stringent national or international standards.

[12] This value is used in EN 378 and by ARI 700 (Air-Conditioning & Refrigeration Institute, Arlington, www.ari.org).

[13] See Cartlidge and Schellhase 2003 "Using Acid Number as a Leading Indicator of Refrigeration and Air Conditioning System Performance", ARTI-21 CR/611-50060-01, for a comparison of methods.

[14] Current EU regulation (Directive 75/439/EEC) follows the results of life cycle analyses, showing that re-use and use as fuel oil have similar environmental impact, and recommends both.

[15] As in RAL-GZ 728, irrespective whether the oil is sold as fuel oil or for re-use as lubricant.

24. The company operating the recycling plant should give the buyer of the recovered HFC-134a the chromatography result, besides the other specifications a buyer might require.

**Project activity under a programme of activities**

The following conditions apply for use of this methodology in a project activity under a programme of activities:

25. If the leakage effect of the use of the replaced equipment in another activity is neglected, because the replaced equipment is scrapped, an independent monitoring of scrapping of replaced equipment needs to be implemented. The monitoring should include a check if the number of project activity equipment distributed by the project and the number of scrapped equipment correspond with each other. For this purpose scrapped equipment should be stored until such correspondence has been checked. The scrapping of replaced equipment should be documented and independently verified.

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**History of the document**

| Version | Date | Nature of revision |
|---|---|---|
| 01 | EB 44, Annex 17<br>28 November 2008 | Initial adoption. |