Indicative simplified baseline and monitoring methodologies
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## TYPE III - OTHER PROJECT ACTIVITIES

Project participants shall apply the general guidelines for the SSC CDM methodologies, information on additionality (attachment A to appendix B) provided at <http://cdm.unfccc.int/methodologies/SSCmethodologies/approved.html> *mutatis mutandis*.

## *III.BA. Recovery and recycling of materials from E-waste*

### Technology/measure

1. This methodology comprises collection and recycling activities of E-waste[1] performed in dedicated facilities with the aim of recovering materials such as ferrous metals, non-ferrous metals, plastics.[2] E-waste contains rare and precious metals that require specific technologies to extract and refine them. These materials are recovered and processed into secondary materials, thus displacing the production of virgin materials, thereby resulting in energy savings and greenhouse gas emission reduction.

2. For the purpose of this methodology the following definitions apply:

***Electrical and electronic equipment (EEE)***: includes large and small household appliances; IT and telecommunications equipment; consumer equipment; lighting equipment; electrical and electronic tools; toys, leisure and sports equipment; medical devices; monitoring and control instruments; and automatic dispensers. It includes all components, subassemblies and consumables which are part of the product at the time of discarding.[3]

***Primary metal or material***: metal or material produced directly from mined ore or from virgin raw materials.

***Secondary metal or material***: metal or material produced utilizing in part or entirely recycled metal or material.

***E-waste sorting***: the separation of collected E-waste into different categories of recyclable materials to facilitate further processing. The categories may include (but are not limited to): plastics, ferrous metals, non-ferrous metals, and glass. The sorting process may include manual sorting and segregation and/or further separation through physical, mechanical and electromagnetic processes. Sorted material requires further processing to complete the recycling process; in some cases this is done within the project activity, otherwise sorted E-waste fractions are sold to specialized processing facilities.

[1] E-waste comprises end-of-life, discarded, surplus, obsolete, or damaged electrical and electronic equipment (EEE).

[2] Other materials found in E-waste, such as glass, can be potentially recycled. Project participants are encouraged to submit a revision of this methodology to include additional materials proposing conservative default values for specific emission factors (or specific energy consumption) for the production from virgin raw materials.

[3] Directive of the European Union <http://ec.europa.eu/environment/waste/weee/legis_en.htm>

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*III.BA Recovery and recycling of materials from E-waste (cont)*

***E-waste processing***: processing of sorted materials converting them into secondary materials substituting virgin materials. The process can include manual, mechanical, electro-chemical processes and technologies.

***Recycling facility***: facility (ies) where a combination of E-waste sorting and processing takes place.

***Processing facility***: facility (ies) that only process pre-sorted material (Case B in paragraph 14) to obtain recycled materials, i.e. marketable secondary materials. These facilities do not sort E-waste.

***Manufacturing facility:*** end-user of recycled materials or facility (ies) that includes industrial processes which transform the processed materials sent from recycling or processing facility (ies) into finished products.

***Formal E-waste recycling***: E-waste recycling activities planned, sponsored, financed, carried out or regulated and/or recognized by the formal local authorities or their agents, usually through contracts, licenses or concessions.

3. The methodology is applicable under the following conditions:

(a) The recycling facility includes E-waste sorting and processing of at least the non-ferrous metals fraction of the waste. Other common materials (ferrous metals, aluminium, plastics, glass) can be processed at the facility after sorting or be shipped to third party processors;

(b) It is possible to measure and record the final output of the recycling facility, i.e. the weight of materials leaving the recycling facility;

(c) It is possible to measure and record the amount of fuel and electricity consumed by the recycling activities performed at the facility;

(d) The output material(s) shall be sold directly to a manufacturing facility, or to a chain of intermediary processors, or retailers that are able to transfer the recycled materials to a final identifiable manufacturing facility;

(e) The emission reductions under this methodology will accrue to any one of the following:

(i) The recycling facility; or

(ii) The processing facility; or

(iii) The collectors of E-waste.

In order to avoid double counting of emission reductions, a contractual agreement between the collectors of E-waste, the recycling facility and the processing facility shall indicate that only one of them will claim emission reductions;

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*III.BA Recovery and recycling of materials from E-waste (cont)*

(f) This methodology applies to the recycling process of the following materials[4] recovered from E-waste:

(i) Metals: Aluminium, steel, copper, gold, silver, palladium, tin, lead;

(ii) Plastics: Acrylonitrile Butadiene Styrene (ABS), High Impact Polystyrene (HIPS);

(g) Emission reductions can only be claimed for the difference between: (a) the energy used for the production of metals and plastics from virgin materials; and (b) the production of the same metals and plastics from E-waste recycling;

(h) The methodology excludes collection of the scraps generated from the production process of primary/secondary/finished metal and materials or in the processing of the finished metal and materials into final products, and it covers only post-consumer obsolete scrap. Project proponents shall provide evidence that the materials recycled under the project activity are recovered only from end-of-life E-wastes;

(i) Project proponents shall demonstrate that the properties of the metals and plastics produced from E-waste recycling are the same as those of the metals and plastics from virgin materials. For recycled metals and plastics, project proponents shall provide documentation (e.g. chemical composition test results or quality certificates) proving that the properties of the metals and plastics produced are comparable according to standard testing methods for each material;

(j) Project proponents shall also demonstrate *ex ante*, using official government data, third party independent surveys and research, academic research/papers, independent market research that the baseline recycling rate of E-waste (including formal and informal sector)[5] is equal to or smaller than 20% of the total amount of E-waste (estimated based on volume or weight basis) that can be potentially recycled in the region/country. In case multiple studies are available showing different pictures/facts/results (including governmental and non-governmental sources), the most conservative one shall be used. Where the baseline recycling rates exceed 20%, project proponents shall demonstrate that the project activity leads to significantly higher rates of recycling in the region/country, including the below proofs at a minimum:

- Project activity does not divert E-waste from any historically existing informal or formal recycling activity;
- Technologies capable of separating higher amounts of individual metals from unit quantity of E-waste are employed by the project activity as compared to prevalent technologies in the pre project situation;

[4] Project participants are encouraged to submit a revision of this methodology to include additional metals and materials proposing conservative default values for specific emission factors (or specific energy consumption) for the production from virgin raw materials.

[5] The data shall include the total in-country generated amount of E-waste that would be recycled by both formal and informal sector, including the amount that would be exported to be recycled abroad.

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- Recycling infrastructure set up by the project activity can potentially lead to at least 50% increase[6] of recycling rates of E-waste in the region/country within the first three years of operation of the facilities.

If the conditions above are satisfied, emission reductions can be claimed for all of E-waste recycled by the project activity. However, if the above conditions are not met, project proponents shall exclude copper and noble metals[7] (i.e. gold, silver and palladium) from the calculation of the emission reductions. Plastics, iron and aluminium remain eligible;

(k) Project proponents shall demonstrate that the proposed project activity does not collect and recycle the E-waste imported from other countries, but from in-country sources;

(l) This methodology is not applicable in cases where recycling of E-waste is required by local regulations and the existing mandatory policy/regulation has a high level of enforcement.

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

**Boundary**

5. The project boundary is the physical geographical sites of:

(a) Waste collection sites;

(b) The recycling and processing facility (ies) where the E-waste is sorted and processed, up to the stage where materials equivalent to virgin materials are produced;

(c) Virgin material production chain, including mining facilities and refining plants.[8]

**Baseline**

6. Baseline emissions are calculated as:

$$BE_y = BE_{m,y} + BE_{p,y} \quad \textbf{(1)}$$

[6] For example, E-waste generation in Country A in the baseline is 100,000 tonnes/year, out of which 25,000 tonnes/year was recycled which amounts to 25% annual recycling rate. Now, the project activity will create infrastructure to enable recycling capacity of 60,000 tonnes per year by the third year of operation of the facilities, which amounts to 50% annual recycling rate if the annual amount of E-waste generation in the third year of operation of the facilities is expected to be 120,000 tonnes/year. In this example the rate of recycling has increased by 100%.

[7] This is to mitigate the likelihood of business-as-usual recycled quantities being included for emission reduction calculation.

[8] Virgin material production is formally included in the project boundary, even though it is not necessary to identify the production sites, because the emission reductions are based on the assumption that virgin material production is displaced because of the project activity.

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*III.BA Recovery and recycling of materials from E-waste (cont)*

Where

$BE_y$ Total baseline emissions in year *y* ($tCO_2e$)

$BE_{m,y}$ Baseline emissions in year *y* from recycling metals, see below ($tCO_2e$)

$BE_{p,y}$ Baseline emissions in year *y* from recycling plastics, see below ($tCO_2e$)

7. Baseline emissions include emissions associated with energy consumption for the production of metals and plastics from virgin raw materials. Only the baseline emissions which would take place in non-Annex I countries shall be credited. Therefore the baseline emissions calculated for the total amount of recycled materials obtained in the project activity are discounted by a correction factor "Bi", calculated as the ratio of the production of the material "i" in non-Annex I countries and the total production of this material in the world. See the Table 1 below. These correction factors shall be updated at each renewal of the crediting period, and project participants shall use the values from the latest version of the methodology at renewal of the crediting period.

**Table 1: Baseline correction factor for production of metals or plastics from virgin materials**

| Metal/Plastic | $B_i$ correction factor based on the share of the production in non-Annex I countries |
|---|---|
| Aluminium | 0.63 |
| Steel | 0.65 |
| Copper | 0.71 |
| Gold | 0.59 |
| Silver | 0.67 |
| Palladium | 0.47 |
| Tin | 0.97 |
| Lead | 0.62 |
| ABS | 0.50 |
| HIPS | 0.50 |

Source: For metals, U.S. Geological Survey, 2012.[9] For plastics, Plastics Europe, 2011[10]

[9] U.S. Geological Survey, Mineral commodity summaries 2012, <http://minerals.usgs.gov/minerals/pubs/mcs/2012/mcs2012.pdf >

[10] Plastics Europe, Plastics the Facts 2011, <http://www.plasticseurope.org/documents/document/20111107101127-final_pe_factsfigures_uk2011_lr_041111.pdf>

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*III.BA Recovery and recycling of materials from E-waste (cont)*

**Baseline emissions from recycling of metals**

8. Baseline emissions for the production of metal *i* from virgin inputs are calculated using equation (2).

$$BE_{m,y} = \sum_i \left[ Q_{i,y} * B_i * SE_i \right] \quad \textbf{(2)}$$

Where:

| | |
|---|---|
| $i$ | Indices for metal type *i* |
| $Q_{i,y}$ | Quantity of metal type *i* recycled and sent to a processing or manufacturing facility in year *y* (t)[11] |
| $B_i$ | $B_i$ correction factor based on the share of the production in non-Annex I countries |
| $SE_i$ | Specific $CO_2$e emission factor for production of metal i, measured in $tCO_2e/t$. Take values specified in paragraph 9 |

9. Baseline emissions for the production of primary metals from virgin inputs are calculated making the following conservative assumptions. These values shall be updated at each renewal of the crediting period, and project participants shall use the values from the latest version of the methodology at renewal of the crediting period.

**Table 2: Specific $CO_2$e emission factor for production of metals**

| Metal | Specific $CO_2$e emission factor for production of metals ($tCO_2e$/tonne of output metal) |
|---|---|
| Aluminium | **5.1** |
| Steel | **1.2** |
| Copper | **2.8** |
| Gold | **11,000** |
| Silver | **140** |
| Palladium | **7,200** |
| Tin | **16** |
| Lead | **2.1** |

**Baseline emissions from recycling of plastics**

10. Baseline emissions for the production of plastic type *i* from virgin inputs are calculated as:

$$BE_{p,y} = \sum_i [Q_{i,y} * L_{p,i} * B_i * (SEC_{Bl,i} * EF_{el,y} + SFC_{Bl,i} * EF_{FF,CO2})] \quad \textbf{(3)}$$

[11] For aluminium and steel which is sent to a processing facility, impurities associated with the metal that is sold should be accounted for and discounted, or a net-to-gross adjustment factor of 0.8 shall be applied to the $Q_{i,y}$.

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*III.BA Recovery and recycling of materials from E-waste (cont)*

Where:

| | |
|---|---|
| $i$ | Indices for material type $i$ (ABS, HIPS) |
| $Q_{i,y}$ | Quantity of plastic type $i$ recycled and sent to the processing or manufacturing facility in year $y$ (t) |
| $L_{p,i}$ | Net to gross adjustment factor to cover degradation in material quality and material loss in the processing of the sorted material. Use 0.75[12] if $Q_{i,y}$ is the sorted plastic sent to the processing facility, Use 1 if $Q_{i,y}$ is the processed plastic sent to the manufacturing facility |
| $B_i$ | $B_i$ correction factor based on the share of the production in non-Annex I countries |
| $SEC_{Bl,i}$ | Specific electricity consumption for the production of plastics type $i$ made from virgin material (MWh/t), take value specified in paragraph 11(a)(iii) |
| $EF_{el,y}$ | Emission factor for grid electricity ($tCO_2$/MWh), determined in accordance with the provisions in AMS-I.D |
| $SFC_{Bl,i}$ | Specific fuel consumption for the production of plastics type $i$ made from virgin material (GJ/t), take value as specified in paragraph 11(a)(i) and (ii) |
| $EF_{FF,CO2}$ | $CO_2$ emission factor for fossil fuel ($tCO_2e$/GJ) |

11. Baseline emissions associated with energy consumption for the production of plastic are calculated according to the framework indicated in AMS-III.AJ "Recovery and recycling of materials from solid wastes". Plastic recycling is limited to ABS, HIPS, since these are the most common plastics found in E-waste.

(a) Baseline emissions for the production of plastic type $i$ from virgin inputs are calculated as below making conservative assumptions. These values shall be updated at each renewal of the crediting period:

(i) It is assumed that natural gas supplies the process energy required for the steam reforming producing ammonia and the steam cracking necessary to produce ethylene and propylene, the main components of ABS; a default specific energy consumption of 15 GJ/t shall be used;

(ii) It is assumed that natural gas supplies the process energy required for the thermal cracking to produce ethylene, styrene and butadiene and other olefins contained in HIPS; a default specific energy consumption of 15 GJ/t shall be used;

[12] As per AMS-III.AJ, version 03, para. 10.

(iii) It is assumed process energy for polymerization and extrusion is supplied with electricity. The following default values shall be used:

- 7 GJ/t (1.94 MWh/t) for ABS;
- 1.35 GJ/t (0.38 MWh/t) for HIPS;

(iv) The remaining steps of virgin pellet production (melting and shaping, pelletizing, compounding) require relatively negligible amounts of energy and hence ignored.

**Leakage**

12. No leakage due to project activities is expected, therefore no calculation is required.

**Project activity emissions**

13. Project emissions are calculated using equation (4). As per paragraph 3(j), if project proponents exclude copper and noble metals (i.e. gold, silver and palladium) from the baseline calculation, they may also exclude them from the project emission calculation.

$$PE_y = PE_{r,y} + PE_{p,y} \quad \textbf{(4)}$$

Where:

| | |
|---|---|
| $PE_y$ | Project emissions in year $y$ ($tCO_2e$) |
| $PE_{r,y}$ | Project emissions from sorting and processing of E-waste in the recycling facility in year $y$ ($tCO_2e$) |
| $PE_{p,y}$ | Project emissions from processing of E-waste in the processing facility in year $y$ ($tCO_2e$) |

14. Project emissions calculation is dependent on the type of activities performed at the recycling facility.

**Case A:** the project activity owns and manages the recycling and processing facilities up to the production of the virgin-equivalent material:

$$PE_y = PE_{r,y} \quad \textbf{(4A)}$$

Project emissions include emissions from electricity and fuel consumption at the recycling and processing facilities for all the materials sorted and processed. Emissions for each output material are calculated as per equation (5), as the electricity and fuel consumption apportioned to each material, multiplied by the respective electricity or fuel emission factor. The total project emissions are calculated as the aggregate emissions produced by all materials recycled.

**Case B:** The project activity owns and manages the recycling and processing facility, but the materials are further processed by third parties up to the production of the virgin-

equivalent material. For plastics, the processing up to virgin equivalent plastics shall be directly managed by the project proponents. If processing of plastics is not managed by the project proponents, no emission reductions for plastic recycling are claimed:

$$PE_y = PE_{r,y} + PE_{p,y} \quad \textbf{(4B)}$$

Project emissions include

(a) Emissions from electricity and fuel consumption at the recycling facility for all the materials that are either sorted or sorted and processed in the recycling facility. These are calculated using equation (5), as the electricity and fuel consumption apportioned to each material, multiplied by the respective electricity or fuel emission factor;

(b) Additional processing emissions for those materials that are only sorted at the recycling facility and then sent to further processing facilities. Such emissions are calculated according to equation (8) using specific default energy consumption factors provided in Table 3. These values shall be updated at each renewal of the crediting period.

**Table 3: Specific energy consumption factor for E-waste processing (MWh/t)**

| Metal/Plastic | Specific energy consumption factor for E-waste processing (MWh/t) |
|---|---|
| Aluminium | 0.66 |
| Steel | 0.90 |
| ABS | 0[13] |
| HIPS | 0[13] |

15. Project emissions from processing of E-waste in the recycling facility are calculated using equation (5)

$$PE_{r,y} = \sum_i \left[ EC_{i,y} * EF_{el,y} + FC_{i,y} * NCV_{rec,ff,y} * EF_{rec,ff,CO2,y} \right] \quad \textbf{(5)}$$

Where:

$EC_{i,y}$ Share of the electricity consumption of the recycling facility apportioned to the production of the output material type *i* in year *y* (MWh)

$FC_{i,y}$ Share of the fossil fuel consumption of the recycling facility apportioned to the production of the output material type *i* in year *y* (unit of mass or volume)

[13] As per AMS-III.AJ, emissions associated with transportation of recyclable materials and processing/manufacturing under the project activity are considered as equivalent to the corresponding emissions for the virgin materials and therefore ignored in this methodology.

$NCV_{rec,ff,y}$ Net caloric value of the fossil fuel consumed in the recycling facility in year *y* (GJ/unit of mass or volume)

$EF_{rec,ff,CO2,y}$ $CO_2$ emission factor of the fossil fuel consumed in the recycling plant in year *y* ($tCO_2e/GJ$)

16. The electricity and fuel consumption at the recycling facility ($EC_y$, $FC_y$) shall be directly monitored. The electricity and fuel consumption may be allocated to each mass unit of recycled material *i* ($EC_{i,y}$, $FC_{i,y}$) by market prices, i.e. apportioning the electricity and fuel consumption in proportion to the market prices of metals, plastics, glass, etc. recycled at the facility. The market prices may be either monitored ex post or be determined once for the crediting period. This rule can be applied only if transparent and reliable information on market prices is available.

The following formulas may be used to allocate electricity and fuel consumption to each mass unit of recycled materials *i* by market prices:

$$EC_{i,y} = EC_y * \frac{Q_{i,y} * \$_{i,y}}{\sum_r [Q_{r,y} * \$_{r,y}]} \quad \textbf{(6)}$$

$$FC_{i,y} = FC_y * \frac{Q_{i,y} * \$_{i,y}}{\sum_r [Q_{r,y} * \$_{r,y}]} \quad \textbf{(7)}$$

Where:

*i* Indices for output material type *i* (metals and plastics listed at paragraph 3(f))

*r* Indices for each material recycled at the facility

$EC_y$ Electricity consumption at the recycling facility in year *y* (MWh)

$FC_y$ Fossil fuel consumption at the recycling facility in year *y* (unit mass or volume)

$Q_{r,y}$ Quantity of material type r recycled in the recycling facility in year *y* (t)

$\$_{i,y}$ Market price of the recycled material type *i* in year *y*

$\$_{r,y}$ Market price of the recycled material type r in year *y*

17. Project emissions from processing of E-waste in the processing facility are calculated using the following equation:

$$PE_{p,y} = \sum_i [Q_{i,y} * EFP_i * EF_{el,y}] \quad \textbf{(8)}$$

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Where:

| | |
|---|---|
| $PE_{p,y}$ | Project emissions from processing of E-waste in the processing facility(ies) in year *y* ($tCO_2e$) |
| $EFP_i$ | Energy consumption factor for E-waste processing of material *i* (MWh/t). Use values provided in Table 3 |

**Monitoring**

18. The emission reductions achieved by the project activity shall be determined as the difference between the baseline emissions and the project emissions and leakage using equation (9).

$$ER_y = BE_y - PE_y - LE_y \quad \textbf{(9)}$$

Where:

| | |
|---|---|
| $ER_y$ | Emission reductions in year *y* ($tCO_2e$) |
| $BE_y$ | Baseline emissions in year *y* ($tCO_2e$) |
| $PE_y$ | Project emissions in year *y* ($tCO_2e$) |
| $LE_y$ | Leakage emissions in year *y* ($tCO_2e$) |

19. The following parameters shall be monitored and recorded during the crediting period. The applicable requirements specified in the "General Guidelines for SSC CDM methodologies" are also an integral part of the monitoring guidelines specified below and therefore shall be referred by the project participants.

**Table 4: List of parameters monitored**

| No | Parameter | Description | Unit | Monitoring / recording frequency | Measurements methods and procedures |
|---|---|---|---|---|---|
| 1 | $Q_{i,y}$ | Quantity of material *i* recycled and sent to a processing or manufacturing facility in year *y* (i=1,2,3,4,5,6,7,8,9,10 for aluminium, steel, copper, gold, silver, palladium, tin, lead, ABS and HIPS ) | Metric tons | Each time the sorted/processed material leaves the recycling facility | Direct weighing and recording of the weight, cross check with company records e.g. invoices |
| 2 | $EC_y$ | Electricity consumption at the recycling facility in year *y* | MWh | Continuous | Metering with calibrated equipment |

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*III.BA Recovery and recycling of materials from E-waste (cont)*

| No | Parameter | Description | Unit | Monitoring / recording frequency | Measurements methods and procedures |
|---|---|---|---|---|---|
| 3 | $FC_y$ | Fossil fuel consumption at the recycling facility in year *y* | Unit of mass or volume | Continuous | Weight or volume & density and calorific value |
| 4 | $\$_{i,y}$ and $\$_{r,y}$ | Market price of materials type *i* or material *r* in year *y* | Market Currency | As per paragraph 16 | Cross check with sale invoices/receipts |
| 5 | | Evidence that the materials recycled under the project activity are post-consumer obsolete scrap and are recovered only from end-of-life E-wastes | | | As per applicability condition 3(h), e.g. the PDD shall describe the collecting area and identifiable sources of the E-wastes for each recycling plant |

**Project activity under a programme of activities**

20. The methodology is applicable to a programme of activities, no additional leakage estimations are necessary other than that indicated under leakage section above.

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**History of the document**

| Version | Date | Nature of revision |
|---|---|---|
| 01.0 | 11 May 2012 | EB 67, Annex 16<br><br>Initial adoption. |
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