Indicative simplified baseline and monitoring methodologies for selected small-scale CDM project activity categories

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. Emission reductions through recovery of spent sulphuric acid

Technology/measure

1. The methodology comprises activities for recovering sulphuric acid from 'spent sulphuric acid'[1] generated from manufacturing industries such as chemicals, dyes, pigments, drugs production involving unit operations like sulphonation, nitration, cyclisation, pigment formation. By recovering sulphuric acid, neutralization of spent acid with hydrated lime or lime stone and the associated CO_2 emissions in the existing facility are avoided.

2. The methodology is only applicable when the sulphuric acid is recovered in a new facility implemented by the project activity where steam and/or electricity are produced during the recovery process such that one of the following conditions is satisfied:

   (a) The surplus steam and or electricity is supplied to existing neighbouring industries to displace supply of equivalent quantity of steam/electricity from fossil fuel captive plant and/or grid;

   (b) Electricity is supplied to a grid.

3. The spent acid used for recovery may be contaminated with chloride, nitrites, nitrates and/or other organics irrespective of the manufacturing industries, however the methodology is only applicable for treating spent acid with a concentration ranging from 18% w/w to 80% w/w (weight percentage).

4. The following conditions apply:

   (a) There is no recovery of water or any other chemicals from the baseline neutralized effluent. The wastewater is discharged to water bodies and separated solid wastes are landfilled;

   (b) The recovery of sulphuric acid involves the following steps, with heat recovery accomplished in steps (iii) and (iv):

      (i) Pre-concentration of the spent acid[2];

      (ii) Thermal destruction of spent acid;

      (iii) Cooling and cleaning of the gases generated;

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[1] In the absence of the project activity spent sulphuric acid which is a sulfur bearing effluent will continue to be neutralized with lime or lime stone.

[2] The weighted average concentration of spent sulphuric acid entering the pre-concentration unit requires to be at least 35%. During pre-concentration, the water is removed and concentration is increased to 70% or more.

    - (iv) Catalytic conversion of sulphur dioxide to sulphur trioxide;
    - (v) Conversion of sulphur trioxide to sulphuric acid;
- (c) The sulphuric acid recovery plant will process spent acid alone and will not consume other raw materials such as sulphur and sulphide mineral;
- (d) If the spent sulphuric acid in the baseline is being used in sulphuric acid producing plants as an additional source of sulphur this methodology is not applicable;
- (e) Local regulations do not require recycling of sulphuric acid from spent sulphuric acid.

5. No relevant changes in greenhouse gas emissions other than CO_2 occur as a consequence of the project activity and/or need to be accounted for, except for the possibilities of leakage.

6. Measures are limited to those that result in emission reduction of less than or equal to 60 ktCO_2e annually.

Boundary

7. The project boundary is the physical, geographical sites where:

- (a) Spent sulphuric acid is generated;
- (b) The spent sulphuric acid is neutralized with hydrated lime/lime stone;
- (c) Transport itineraries of hydrated lime or lime stone used for the neutralization process occur in absence of the project activity. The lime stone quarries are also included in project boundary;
- (d) Treatment of the baseline effluent for neutralisation takes place in the absence of the project activity;
- (e) The recovery of the spent sulphuric acid takes place and steam/electricity is generated with the recovered heat;
- (f) Neighbouring industries receive steam/electricity supply from the project activity.

Baseline

8. The baseline *ex ante* shall be determined based on the average of most recent 3 years vintage data. For facilities that are less than three years old, all historical data shall be available (a minimum of one year data would be required). *Ex post*, the monitored quantity of acid generated during the crediting period i.e., $Q_{PJ,ssa,y}$ shall substitute $Q_{BL,ssa}$ in the baseline estimations, where:

$Q_{PJ,ssa,y}$	Quantity of spent sulphuric acid delivered to the acid recovery facility (t $_{effluent/}$y)
$Q_{BL,ssa}$	the amount of spent sulphuric acid neutralised (t $_{effluent/}$y)

9. The baseline emissions comprise of the following[3]:

$$BE_y = BE_{neutr,y} + BE_{transp-lime,y} + BE_{steam,y} + BE_{elec,y} + BE_{gr,y} + BE_{transp-vsa,y} + BE_{transp-ssa,y} \quad (1)$$

Where:

BE_y	Total baseline emissions in year *y*, (tCO_2/y)
$BE_{neutr,y}$	Baseline emissions from neutralization of spent sulphuric acid with hydrated lime or lime stone in year *y* (tCO_2/y)
$BE_{transp-lime,y}$	Baseline emissions from the transport of lime stone/ hydrated lime from the mines to the sites where spent sulphuric acid is neutralised(tCO_2/y)
$BE_{steam,y}$	Where relevant, baseline emissions from steam production at the neighbouring industries in year *y* that is displaced by the project(tCO_2/y)
$BE_{elec,y}$	Where relevant, baseline emissions from electricity consumption at the neighbouring industry in year *y* that is displaced by the project (tCO_2/y)
$BE_{gr,y}$	Where relevant, baseline emissions for export of grid electricity in year *y* (tCO_2/y)
$BE_{transp-vsa,y}$	Baseline emissions from the transport of virgin sulphuric acid from the sulphuric acid manufacturing unit to the project site in year *y* where recovered sulphuric acid is utilised (tCO_2/y)
$BE_{transp-ssa,y}$	Baseline emissions from the transport of spent sulphuric acid from the point of generation to the site where it is neutralised in year *y* (tCO_2/y)

(a) Baseline Emissions from the neutralization process with lime stone ($BE_{neutr,y}$)

10. The chemical process to neutralise spent sulphuric acid with hydrated lime/lime stone is as below:
For lime stone:

$H_2SO_4 + CaCO_3 \rightarrow CaSO_4 + H_2O + CO_2$

For hydrated lime:

$CaCO_3 + H_2O \rightarrow Ca(OH)_2 + CO_2$

$H_2SO_4 + Ca(OH)_2 \rightarrow CaSO_4 + 2H_2O$

Considering the molecular weights (H_2SO_4: 98 g/mol; $CaCO_3$: 100 g/mol; $CaSO_4$: 136 g/mol; H_2O: 18 g/mol; CO_2: 44 g/mol; $Ca(OH)_2$: 74 g/mol), the following process and emission factors are derived:

$PF_{lime\ stone} = 1.02$ ($tCaCO_3/tH_2SO_4$) or $PF_{hydrated\ lime} = 0.755$ ($t\ Ca(OH)_2/tH_2SO_4$)

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[3] Recovered sulphuric acid will displace equivalent quantity of production of sulphuric acid from dedicated facilities. Although production of sulphuric acid is an exothermic process, emission reductions on account of avoided sulphuric acid production is not always ruled out, however a revision of this methodology would be required to include that source of baseline emissions.

$EF_{\text{lime stone}} = 0.45 \ (tCO_2/tH_2SO_4)$ or $EF_{\text{hydrated lime}} = 0.45 \ (tCO_2/tH_2SO_4)$

11. The calculations above refer to the neutralisation of the effluent to a pH value of 7. If host country specific or regional-specific regulations allow lower values of pH for the neutralised effluent, the emission factors shall be adjusted accordingly. If higher values than pH 7 are required the emission factors calculated above shall be adopted as a conservative approach.

12. The baseline emissions from the neutralization process with lime stone/hydrated lime are calculated as

$$BE_{neutr,y} = Q_{BL,ssa} * C_{BL,H2SO4} * EF_{lime} \tag{2}$$

Where:

$C_{BL,H2SO4}$	The H_2SO_4 concentration[4] in the effluent for *ex ante* estimation ($t\ H_2SO_4/t_{effluent}$)
$C_{PJ,H2SO4,y}$	The H_2SO_4 concentration in the effluent for recovery in year *y* that will substitute $C_{BL,H2SO4}$ in the *ex post* estimations ($t\ H_2SO_4/t_{effluent}$),
EF_{lime}	Emission factor for the neutralization process with hydrated lime /lime stone as per paragraph 10 (tCO_2/tH_2SO_4)

(b) Baseline emissions from the transportation of lime stone/hydrated lime ($BE_{transp\text{-}lime,y}$)

13. Lime stone is transported from the quarry to the site where neutralisation of sulphuric acid is done. The baseline emissions from this source are calculated as:

$$BE_{y,transp,lime} = Q_{BL,ssa} * C_{BL,H2SO4} * PF_{lime} / CT_{lime,y} * DAF_{lime} * EF_{CO2,trans} \tag{3}$$

Where:

PF_{lime}	The process factor for the lime neutralisation process, as per paragraph 10 ($tCaCO_3/tH_2SO_4$)
$CT_{lime,y}$	The average transport capacity of the transport vehicle ($tCaCO_3$/vehicle)
DAF_{lime}	The average transport distance between the quarry and the site of the neutralisation process (km/vehicle)
$EF_{CO2,trans}$	CO_2 emission factor from fuel use due to transportation (tCO_2/km), IPCC default values of local values may be used

(c) Baseline emissions from steam consumption of neighbouring industries ($BE_{steam,y}$)

14. A contract between the supplier and consumers of the energy will have to be entered into specifying that only the facility generating the energy can claim emission reductions from the energy displacement.

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[4] The sulphuric acid concentration is the measured free acid (H_2SO_4) content and not based on total sulphates.

15. The emissions from existing steam production of neighbouring industries are considered as baseline emissions and shall be identified by means of historical information. Historical information (detailed records) on the consumption of fossil fuels and the element process output (heat) from at least three years prior to project implementation shall be used in the baseline calculations, e.g., information on coal use and heat output by a steam generator (records of fuel used and output can be used in lieu of actual collecting baseline validation data). For facilities that are less than three years old, all historical data shall be available (a minimum of one year data would be required).

The baseline CO_2 emissions from steam consumption of neighbouring industries are calculated as below:

$$BE_{steam,y} = \sum_{g} (HC_{BL,ST,g,y} * EF_{BL,ST,g.y}) \quad \textbf{(4)}$$

Where:

$HC_{BL,ST,g,y}$	Steam consumed by the neighbouring industry *g* from the proposed project facility in year *y* (TJ/y)
$EF_{BL,ST,g,y}$	Baseline CO_2 emission factor for steam of the neighbouring industry *g* in year *y* (tCO_2/TJ)

16. The steam quantity eligible for emissions reduction claim is limited to the maximum generating capacity of the neighbouring industry existing prior to the implementation of the project activity.

$$HC_{BL,ST,g,y} = \min(HG_{PJ,ST,g,y}, HG_{MG,ST,g} - HG_{SG,ST,g,y}) \quad \textbf{(5)}$$

Where:

$HG_{PJ,ST,g,y}$	Steam purchased by the neighbouring industry *g* from the proposed project facility in year *y* (TJ/y)
$HG_{MG,ST,g}$	Total historical capacity of steam generation of the equipment existing at neighbouring industry *g* prior to the implementation of the project activity (TJ/y)
$HG_{SG,ST,g,y}$	Total steam self-generated by neighbouring industry g during year *y* of the crediting period (TJ/y)

17. The steam purchased by the neighbouring industry *g* from the proposed project facility in year *y* is calculated as:

$$HG_{PJ,ST,g,y} = Q_{PJ,ST,g,y} * EN_{PJ,g} \quad \textbf{(6)}$$

Where:

$Q_{PJ,ST,g,y}$	Steam purchased by the neighbouring industry *g* from the proposed project facility in year *y* (t/y)

$EN_{PJ,g}$	Specific enthalpy of the steam purchased by the neighbouring industry *g* (TJ/t).This data shall be obtained from steam tables, using temperature and pressure of the steam purchased, measured at the neighbouring industry *g*.

18. The maximum generation capacity of steam of the pre-project generating equipment is calculated as:

$$HG_{MG,ST,g} = \sum_h GC_{ST,g,h} * (8760 - t_{ST,g,h}) * EN_{BL.g,h} \quad \textbf{(7)}$$

Where:

$GC_{ST,g,h}$	Nameplate capacity of the steam generating equipment *h* existing at neighbouring industry *g* prior to the implementation of the project activity(t/h)
$t_{ST,g,h}$	Normal maintenance and down time hour of the generation equipment *h* existing at neighbouring industry *g* prior to the implementation of the project activity(h/y)
$EN_{BL,g,h}$	Specific enthalpy of steam of the pre-project generating equipment *h* of the neighbouring industry g (TJ/t). This data shall be obtained from steam tables, using temperature and pressure of the steam measured at the pre-project generating equipment of the neighbouring industry *g*.

19. The total steam self-generated by the neighbouring industry *g* in year *y* is calculated as:

$$HG_{SG,ST,g,y} = Q_{SG,ST,g,y} * EN_{BL,g,h} \quad \textbf{(8)}$$

Where:

$Q_{,SG,ST,g,y}$	Total steam self-generated by the neighbouring industry *g* during year *y* of crediting period (t/y)
$EN_{BL,g,h}$	Specific enthalpy of steam of the pre-project generating equipment *h* of neighbouring industry *g* (TJ/t). This data shall be obtained from steam tables, using temperature and pressure of the steam measured at the pre-project generating equipment of neighbouring industry *g*

20. The baseline emission factor for self-generated steam $EF_{BL,ST,g,y}$ shall be calculated as :

$$EF_{BL,ST,g,y} = \frac{\sum_j EF_{FF,g,j} * HC_{BL,FF,ST,g,j}}{\sum_j HG_{BL,ST,g,j}} \quad \textbf{(9)}$$

Where:

$EF_{FF,g,j}$	CO_2 emission factor of fuel *j* used by neighbouring industry *g* to self-generate steam in the baseline scenario (tCO_2/TJ)
$HC_{BL,FF,ST,g,j}$	Energy consumption met with fuel *j* by neighbouring industry *g* to self-generated

	steam in the baseline scenario (TJ/y)
$HG_{BL,ST,g,j}$	Steam self-generated by neighbouring industry *g* with fuel *j* in the baseline scenario (TJ/y)

21. The steam self-generated by neighbouring industry *g* with fuel *j* in the baseline scenario is

$$HG_{BL,ST,g,j} = Q_{BL,ST,g,j} * EN_{BL,g,h} \tag{10}$$

Where:

$Q_{BL,ST,g,j}$	Steam self-generated by neighbouring industry *g* with fuel *j* during the most recent three years prior to the implementation of the project activity (t/y)

22. The energy consumption met with fuel *j* by neighbouring industry *g* to self-generate steam in the baseline scenario is calculated as:

$$HC_{BL,FF,ST,g,j} = FC_{BL,ST,g,j} * NCV_{g,j} \tag{11}$$

Where:

$FC_{BL,ST,g,j}$	Amount of fuel *j* used by neighbouring industry *g* to self-generate steam during the most recent three years prior to the implementation of the project activity (mass or volume units/y)
$NCV_{g,j}$	Net calorific value of fuel *j* at neighbouring industry *g* in the baseline scenario (TJ/mass or volume units).

23. Otherwise, $HC_{BL,FF,ST,g,j}$ shall be calculated as follows:

$$HC_{BL,FF,ST,g,j} = \frac{HG_{BL,ST,g,j}}{\eta_{ST,g,j}} \tag{12}$$

Where:

$\eta_{ST,g,j}$ Fuel consumption rate of self –generation of steam at neighbouring industry *g*, with fuel *j* (TJ/TJ). This parameter shall be one of the following :

(i) Highest of the measured fuel consumption rate of steam generating equipment with similar specification ;or

(ii) Highest of the efficiency values provided by two or more manufactures for steam generating equipment with similar specification; or

(iii) Maximum efficiency of 100%, based on net calorific values of fuels.

(d) Baseline emissions from electricity consumption of neighbouring industries ($BE_{elec.y}$)

24. A contract between the supplier and consumers of the energy will have to be entered into specifying that only the facility generating the energy can claim emission reductions from the energy displacement.

25. Historical information (detailed records) on the use of fossil fuels and the element process output (e.g., electricity) from at least three years prior to project implementation shall be used in the baseline calculations, e.g., information on fuel oil use and electricity generated by a generating unit (records of fuel used and output can be used in lieu of actual collecting baseline validation data). For facilities that are less than three years old, all historical data shall be available (a minimum of one year data would be required).

$$BE_{elec.y} = \sum_{g} (EC_{BL,elec,g,y} * EF_{BL,elec,g,y}) \qquad \textbf{(13)}$$

Where:

$EC_{BL,elec,g,y}$	Electricity consumed by the neighbouring industry *g* from the proposed project facility in year *y* (MWh/y)
$EF_{BL,elec,g,y}$	Baseline CO_2 emission factor for electricity of the neighbouring industry *g* in year *y* (tCO_2/MWh)

26. The amount of electricity eligible for emissions reduction claim is limited to the maximum generation capacity of the neighbouring industry existing prior to the implementation of the project activity.

$$EC_{BL,elec,g,y} = \min\left(EG_{PJ,elec,g,y}, EG_{MG,elec,g} - EG_{SG,elec,g,y}\right) \qquad \textbf{(14)}$$

Where:

$EC_{PJ,elec,g,y}$	Electricity purchased by the neighbouring industry *g* from the proposed project facility in year *y*(MWh/y)
$EG_{MG,elec,g}$	Total historical capacity of electricity generation of the equipment existing at neighbouring industry *g* prior to the implementation of the project activity (MWh/y)
$EG_{SG,elec,g,y}$	Total electricity self-generated by neighbouring industry *g* during year *y* of the crediting period (MWh/y)

27. The maximum generation capacity of the pre-project electricity generating equipment is calculated as:

$$EG_{MG,elec,g} = \sum_{m} GC_{Elec,g,m} * (8760 - t_{elec,g,m}) \qquad \textbf{(15)}$$

Where:

$GC_{Elec,g,m}$	Nameplate capacity of the electricity generating equipment *m* existing at neighbouring industry *g* prior to the implementation of the project activity (MWh/h)
$t_{elec,g,m}$	Average maintenance and down time hour of the electricity generating equipment *m* existing at neighbouring industry *g* prior to the implementation of the

project activity (h/y)

28. The baseline CO_2 emission factor for electricity of the neighbouring industry shall be calculated as:

$$EF_{BL,elec,g,y} = w_{SG,g} * EF_{BL,SG,g,y} + w_{GR,g} * EF_{CO2,elec} \tag{16}$$

Where:

$w_{SG,g}$	Fraction of electricity consumed on-site by neighbouring industry *g* in the baseline that is self generated (fraction)
$w_{GR,g}$	Fraction of electricity consumed on-site by neighbouring industry *g* in the baseline that is purchased from grid (fraction)
$EF_{SG,elec,g,y}$	CO_2 emission factor for self-generated electricity for the neighbouring industries *g* in year *y* (tCO_2/ MWh)
$EF_{CO2,elec}$	The emission factor for the grid electricity calculated following the procedure provided in AMS-I.D (tCO_2/MWh)

29. The fraction of electricity that is self-generated and that produced on-site are calculated as:

$$w_{SG,g} = \frac{\sum_j EG_{BL,SG,g,j}}{EG_{BL,TC,g}} \tag{17}$$

$$w_{GR,g} = \frac{EG_{BL,GR,g}}{EG_{BL,TC,g}} \tag{18}$$

Where:

$EG_{BL,SG,g,j}$	The electricity self-generated by neighbouring industry *g* with fuel *j* during the most recent three years prior to the implementation of project activity (MWh/y)
$EG_{BL,GR,g}$	The total amount of electricity obtained from the grid by neighbouring industry *g* during the most recent three year prior to the implementation of project activity (MWh/y)
$EG_{BL,TC,g}$	The total electricity consumption for neighbouring industry *g* during the most recent three year prior to the implementation of project activity (MWh/y)

30. The CO_2 emission factor for self-generated electricity for each neighbouring industry *g* shall be calculated as:

$$EF_{BL,SG,g,y} = \frac{\sum_j EF_{FF,g,j} * EC_{BL,FF,SG,g,j}}{\sum_j EG_{BL,SG,g,j}} \tag{19}$$

Where:

$EF_{FF,g,j}$	CO_2 emission factor of fuel *j* used by neighbouring industry *g* to self-generate electricity in the baseline scenario (tCO_2/TJ)
$EC_{BL,FF,SG,g,j}$	Energy consumption met with fuel *j* by neighbouring industry *g* to self-generated electricity in the baseline scenario (TJ/y)

31. If data on fuel consumption in the baseline scenario is directly available at neighbouring industry *g*, then

$$EC_{BL,FF,SG,g,j} = FC_{BL,SG,g,j} * NCV_{g,j} \quad \textbf{(20)}$$

Where:

$FC_{BL,SG,g,j}$	Consumption of fuel *j* by neighbouring industry *g* to self-generate electricity during the most recent three years prior to the implementation of the project activity (mass or volume units/y)
$NCV_{g,j}$	Net calorific value of fuel *j* at neighbouring industry *g* in the baseline scenario, (TJ/mass or volume units)

32. Otherwise, $EC_{BL,FF,SG,g,j}$ shall be calculated as follows:

$$EC_{BL,FF,SG,g,j} = \frac{EG_{SG,g,j}}{\eta_{SG,g,j}} \quad \textbf{(21)}$$

Where:

$\eta_{SG,g,j}$ Fuel consumption rate of self-generation of electricity at neighbouring industry *g*, with fuel *j* (MWh/TJ). This parameter shall be one of the following:

- (i) Highest of the measured fuel consumption rate of electricity generating equipment with similar specification, or
- (ii) Highest of the efficiency values provided by two or more manufactures for electricity generating equipment with similar specification, or
- (iii) Maximum efficiency of 100%, based on net calorific values of fuels

(e) Baseline emissions for export of electricity to the grid ($BE_{gr,y}$)

33. The baseline emissions are calculated as:

$$BE_{gr,y} = Q_{elec,export} * EF_{CO2,elec} \quad \textbf{(22)}$$

Where:

$Q_{elec,export,y}$	The net amount of electricity exported to the grid in year *y* (MWh/y)

(f) Baseline emissions from the transport of virgin sulphuric acid from the sulphuric acid manufacturing unit to the project site in year *y* where recovered sulphuric acid is utilised($BE_{transp\text{-}vsa,y}$)

$$BE_{transp-vsa,y} = \frac{\sum_{i}^{n} Q_{BL,VSA,i,y}}{CT_{BL.VSA.i,y}} * DAF_{BL.VSA,i} * EF_{CO2,trans} \tag{23}$$

Where:

$Q_{BL,VSA,i,y}$	The amount of sulphuric acid utilised by the chemical industry *i* (t sulphuric acid/y)
$DAF_{BL,VSA,i}$	The average transport distance between the sulphuric acid manufacturing unit and the sulphuric acid user industry *i* (km/vehicle)
$CT_{BL,VSA,i,y}$	The average transport capacity of the transport vehicle for sulphuric acid (t/vehicle)

(h) Baseline emissions from the transport of spent sulphuric acid from the point of generation to the site where it is neutralised in year *y* ($BE_{transp\text{-}ssa,y}$)

$$BE_{transp-ssa,y} = \frac{\sum_{i}^{n} Q_{BL,SSA,i,y}}{CT_{BL.SSA.i,y}} * DAF_{BL.SSA,i} * EF_{CO2,trans} \tag{24}$$

Where:

$Q_{BL,SSA,i,y}$	The amount of spent sulphuric acid neutralised by the industry *i* ($t_{effluent}$/y)
$DAF_{BL,SSA,i}$	The average transport distance between the site of neutralisation process and the spent acid generating industry *i* (km/vehicle)
$CT_{BL,SSA,i,y}$	The average transport capacity of the transport vehicle for spent sulphuric acid (t/vehicle)

Leakage

34. In cases where equipment for acid treatment including energy generation equipment (e.g., steam/power) is transferred from another activity, leakage shall be accounted for.

Project activity emissions

35. The project activity includes the following six major steps:

(a) Pre-concentration of the spent acid (sulphur bearing effluents) to minimize its water content;

(b) Thermal destruction of spent acid, i.e., formation of sulphur dioxide by the thermal decomposition of pre concentrated spent acid;

(c) Cooling and cleaning of the gases generated, i.e., sulphur dioxide process gas;

(d) Catalytic conversion of sulphur dioxide to sulphur trioxide;

(e) Conversion of sulphur trioxide to sulphuric acid, i.e., absorption of sulphur trioxide in sulphuric acid;

(f) Energy generation.

36. The pre-concentration and the thermal decomposition of spent acid (steps 1 and 2) require external energy sources thus contributing to project emissions. Neutralisation of weak acid effluent and thermal decomposition of non-biodegradable organic content in spent acid[5] also contribute to project emissions. In addition, the transport of spent sulphuric acid from generating industries to project activity and recovered sulphuric acid from project activity to industries contribute to project emissions. The project emissions thus are calculated as:

$$PE_y = PE_{neutr,y} + PE_{th.decom,y} + PE_{nbcc.y} + PE_{transp-ssa,y} + PE_{transp-rsa,y} \qquad \textbf{(25)}$$

Where:

PE_y	The total project emissions in year y (tCO_2/y)
$PE_{neutr,y}$	Project emissions from the neutralization of weak acid effluent with hydrated lime or lime stone in year y (tCO_2/y)
$PE_{th.decom,y}$	Project emissions from pre-concentration and thermal decomposition of spent acid in year y(tCO_2/y)
$PE_{nbcc,y}$	Project emissions from thermal decomposition of non-biodegradable carbon content of spent acid (tCO_2/y)
$PE_{transp-ssa,y}$	Project emissions due to the transport of spent sulphuric acid from industries to project activity in year y (tCO_2/y)
$PE_{transp-rsa,y}$	Project emissions due to transport of recovered sulphuric acid from project site to industries in year y (tCO_2/y)

Project emissions from the neutralization of weak acid effluent with hydrated lime or lime stone or sodium hydroxide ($PE_{neutr,y}$)

37. If the weak acid effluent generated from the project treatment system is neutralised by lime stone /hydrated lime/sodium hydroxide, the related emissions shall be considered.

38. If the neutralisation of weak acid effluent is carried out with lime stone/ hydrated lime consequent project emissions are calculated as:

$$PE_{neutr,y} = Q_{PJ,WAE,y} * C_{PJ,H2SO4,WAE} * EF_{lime} \qquad \textbf{(26)}$$

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[5] Non-biodegradable organic carbon in the spent acid following neutralization and disposal of the solid wastes in landfill would not have degraded resulting in GHGs emissions in the absence of the project activity.

Where:

$Q_{PJ,WAE,y}$	The amount of weak acid effluent neutralised with lime in year *y* (t_{WAE}/y)
$C_{PJ,H2SO4,WAE}$	The H_2SO_4 concentration in the weak acid effluent (tH_2SO_4/t_{WAE})
EF_{lime}	emission factor for the neutralization process with hydrated lime/lime stone as per paragraph 10 (tCO_2/tH_2SO_4)

39. If the neutralisation of weak acid effluent is carried out with sodium hydroxide consequent project emissions are calculated as:

The chemical process to neutralise weak acid effluent with sodium hydroxide is:

$H_2SO_4 + 2\ NaOH \text{->} Na_2SO_4 + 2H_2O$

Considering the molecular weights (H_2SO_4: 98 g/mol; NaOH: 40 g/mol; Na_2SO_4: 142 g/mol; H_2O:18), the following process factor will be obtained:

$PF_{NaOH} = 0.816$ ($tNaOH/tH_2SO_4$)

$$PE_{neutr,y} = Q_{PJ,WAE,y} * C_{PJ,H2SO4,WAE} * PF_{NaOH} * EC_{NaOH} * EF_{CO2,elec} \tag{27}$$

Where:

$Q_{PJ,WAE,y}$	The amount of weak acid effluent neutralised with sodium hydroxide in year *y* (t_{WAE}/y)
$C_{PJ,H2SO4,WAE}$	The H_2SO_4 concentration in the weak acid effluent ($t\ H_2SO_4/t_{WAE}$)
PF_{NaOH}	The process factor for the sodium hydroxide neutralisation process ($tNaOH/tH_2SO_4$)
EC_{NaOH}	The amount of electricity being used in the manufacturing process of the sodium hydroxide (MWh/tNaOH). The procedure described in paragraph 9 of AMS.III-M may be used for determining this parameter.

Project emissions from thermal decomposition of spent acid ($PE_{th.decom,y}$)

40. The CO_2 emissions from fuel combustion in the thermal decomposition process are calculated as

$$PE_{th.decom,y} = FC_{th.decom,y} * NCV_{FF,th.decom} * EF_{FF,th.decom} \tag{28}$$

Where:

$FC_{th.decom,y}$	The fuel consumption for thermal decomposition in year *y* (Nm^3/y)
$NCV_{FF,th.decom.}$	The net calorific value of fuel (TJ/Nm^3)
$EF_{FF,th.decom.}$	The emission factor for fuel (tCO_2/TJ)

Project emission from thermal decomposition of non-biodegradable carbon content of solid waste generated from neutralisation of spent acid ($PE_{nbcc,y}$)

41. The CO_2 emission from combustion of non-biodegradable carbon content of spent acid in the thermal decomposition process are calculated as:

$$PE_{nbcc,\,y} = \sum_{i} Q_{PJ,SSA,\,i,y} * TOC_{PJ,SSA,i} * \frac{M_{CO_2}}{M_C} \qquad \textbf{(29)}$$

Where:

$Q_{PJ,SSA,i,y}$	The amount of spent sulphuric acid generated by the industry *i* in year *y* ($t_{effluent}$/y)
$TOC_{PJ,SSA,i}$	The total organic carbon of spent sulphuric acid generated by the industry *i* (tC/y)
M_{CO2}	Molecular weight of carbon dioxide (44 g/mol)
M_C	Atomic weight of carbon dioxide (12 g/mol)

Project emissions due to the transportation of spent sulphuric acid ($PE_{transp-ssa,y}$)

$$PE_{transp-ssa,y} = \frac{\sum_{i} Q_{PJ,SSA,i,y}}{CT_{PJ.SSA.i,y}} * DAF_{PJ.SSA,i} * EF_{CO2,trans} \qquad \textbf{(30)}$$

Where:

$DAF_{PJ,SSA,i}$	The average transport distance between the site of recovery process and the industry *i* (km/vehicle)
$CT_{PJ,SSA,i,y}$	The average transport capacity of the transport vehicle for spent sulphuric acid (t/vehicle)

Project emissions due to the transportation of recovered sulphuric acid ($PE_{transp-rsa,y}$)

$$PE_{transp-rsa,y} = \frac{\sum_{i} Q_{PJ,RSA,i,y}}{CT_{PJ.RSA.i,y}} * DAF_{PJ.RSA,i} * EF_{CO2,trans} \qquad \textbf{(31)}$$

Where:

$Q_{PJ,RSA,i}$	The amount of recovered sulphuric acid utilised by industry *i* in year *y* (t/y)
$DAF_{PJ,RSA,i}$	The average transport distance between the site of recovering process and the recovered sulphuric acid using industry *i* (km/vehicle)
$CT_{PJ,RSA,i,y}$	The average transport capacity of the transport vehicle for recovered sulphuric acid (t/vehicle)

42. In case where the emissions occurring from delivering spent sulphuric acid to the project plant ($PE_{transp-ssa,,y}$) are equal or smaller than from delivering spent sulphuric acid to the effluent treatment plant in the baseline case ($BE_{transp-ssa,y}$), both can be neglected. Similarly, where transportation emissions of recovered sulphuric acid ($PE_{transp-rsa,y}$) are equal or smaller than transportation emissions of virgin sulphuric acid ($BE_{trans-vsa,y}$) both can be neglected.

Monitoring

43. The total emission reduction (ER_y) achieved by the project activity is the difference between the baseline emissions and the sum of the project emissions and leakage.

$$ER_y = BE_y - PE_y \tag{32}$$

44. The following parameters shall be measured, recorded and monitored under the project activity, taking into account requirement of paragraph 8 with regard to the data vintage for baseline:

No.	Parameter	Description	Unit	Monitoring/recording Frequency	Measurement Methods and Procedures
1.	$Q_{PJ,SSA,i,y}$	Quantity of spent sulphuric acid delivered to acid recovery facility	$t_{effluent}$/y	Each consignment sent to recovery facility	Direct measurement of weight or measurement of volume & density. Cross check with company records e.g., invoice issued containing quantity, acidity & COD of spent sulphuric acid.
2.	$Q_{BL,SSA}$	Quantity of spent acid neutralised in the baseline	$t_{effluent}$/y		Through historic company records e.g., invoice issued containing quantity, acidity & COD of spent sulphuric acid.
3.	$Q_{PJ,RSA,i,y}$	Quantity of recovered sulphuric acid supplied to the industry *i*	t/y	Each consignment supplied to industry i	Direct measurement of weight or volume & density. Cross check with industry *i*

III.x. Emission reductions through recovery of spent sulphuric acid (cont)

No.	Parameter	Description	Unit	Monitoring/recording Frequency	Measurement Methods and Procedures
					company records
4.	$Q_{BL,VSA,i,y}$	Quantity of sulphuric acid supplied to the industry *i*	t/y		Monitored through industry *i* records
5.	$Q_{PJ,WAE,y}$	The amount of weak acid effluent neutralised with lime in year *y*	t/y	Continuous	Using flow meters, cross check through company records
6.	$C_{BL,H2SO4}$	Acidity of sulphuric acid/the H_2SO_4 concentration in the effluent	$tH_2SO_4/t_{effluent}$		Monitored through company records e.g., invoice issued from the facility containing acidity of spent sulphuric acid
7.	$C_{PJ.H2SO4,y}$	Acidity of sulphuric acid/the H_2SO_4 concentration in the effluent for recovery in year *y*	$tH_2SO_4/t_{effluent}$	Representative sampling	Laboratory test, cross check through company records
8.	$C_{PJ,H2SO4,,WAE}$	The H_2SO_4 concentration in the weak acid effluent	tH_2SO_4/t_{WAE}	Representative sampling	Laboratory test, cross check with company records
9.	$C_{PJ,H2SO4,RSA}$	Acidity of recovered sulphuric acid	tH_2SO_4/t recovered sulphuric acid	Representative sampling	Laboratory test, cross check through company records
10.	$CT_{lime,y}$ $CT_{BL,SA,i,y}$, $CT_{BL,SSA,i,y}$	The average transport capacity of the transport vehicle for lime, sulphuric acid and spent sulphuric acid in the baseline	t/vehicle		Monitored through transport records.
11.	$CT_{PJ,RSA,i,y}$ $CT_{PJ,,SSA,i,y}$	The average transport capacity of the transport vehicle for recovered sulphuric acid and spent sulphuric acid in	t/vehicle		Monitored through transport records.

III.x. Emission reductions through recovery of spent sulphuric acid (cont)

No.	Parameter	Description	Unit	Monitoring/recording Frequency	Measurement Methods and Procedures
		sulphuric acid recovery practice			
12.	DAF_{lime}	The average transport distance between the quarry and the site of the neutralisation process in the baseline case	km/vehicle		Monitored through records of transporter
13.	$DAF_{BL,SA,i}$	The average transport distance between industry *i* and manufacturing unit of virgin sulphuric acid	km/vehicle		Monitored through records of transporter
14.	$DAF_{BL,SSA,i}$	The average transport distance between industry *i* and site of neutralisation process in the baseline	km/vehicle		Monitored through records of transporter
15.	$DAF_{PJ,SSA,i}$	the average transport distance between industry *i* and site of recovery of sulphuric acid process during the project	km/vehicle		Monitored through records of transporter
16.	$DAF_{PJ,RSA,i}$	The average transport distance between industry *i* and site of neutralisation process during the project	km/vehicle		Monitored through records of transporter
17.	$EF_{CO2,trans}$	CO_2 emission factor from fuel use due to transportation	tCO_2/km		IPCC default values or local values may be used.
18.	$FC_{th.decom,y}$	The fuel and electricity consumption for the thermal decomposition process during the project	Nm^3/y	continuous	Using flow meter, energy meter, cross check with company records
19.	$NCV_{FF,th.decom}$	The net calorific value of the fuel used for the thermal decomposition process	MJ/Nm^3		Monitored through records of fuel supplier or Local, regional or national data

No.	Parameter	Description	Unit	Monitoring/recording Frequency	Measurement Methods and Procedures
20.	$Q_{elec,export,y}$	The net amount of electricity exported to the grid during the project	MWh/y	continuous	Metering, cross check with sales record and invoice
21.	$Q_{elec.treat}$	The amount of electricity being used at treatment plants	MWh/$t_{effluent}$	Continuous	Electricity recording meter, cross check with company records
22.	$EF_{CO2,elec}$	The emission factor for the production of grid electricity	tCO_2/MWh		As per the procedure provided in AMS-I.D.
23.	$EF_{FF,th.decom}$	The emission factor for the fuel used for thermal decomposition process	tCO_2/kWh		Local, regional or national data if available, or IPCC default values
24.	$Q_{SG,ST,g,y}$	The total steam self-generated by neighbouring industry *g* during year *y* of crediting period	t/y		Steam data log available at neighbouring industry *g*
25.	$Q_{PJ,ST,g,y}$	The steam purchased by neighbouring industry 'g' from proposed project activity	t/y		Measured at project facility or at neighbouring industry 'g' by steam meter
26.	$EN_{PJ,g}$	Specific enthalpy of steam purchased by neighbouring industry *g*	TJ/t		Use monitored temperature and pressure of steam to obtain specific enthalpy from steam tables.
27.	$Steam_{temp}$	The temperature of steam purchased by neighbouring industry *g*	°C		Temperature meter at neighbouring industry *g*
28.	$Steam_{pres.}$	The pressure of steam purchased by neighbouring industry	MPa		Pressure meter at neighbouring industry *g*

No.	Parameter	Description	Unit	Monitoring/recording Frequency	Measurement Methods and Procedures
29.	$GC_{ST,g,h}$	Nameplate capacity of the steam generating equipment *h* existing at neighbouring industry *g* prior to the implementation of the project activity	t/h		Nameplate capacity of equipment at neighbouring industry *g*.
30.	$t_{ST,g,h}$	Normal maintenance and down time hour of the generation equipment *h* existing at neighbouring industry *g* prior to the implementation of the project activity	H		Maintenance data log available at neighbouring industry
31.	$EN_{BL,g,h}$	Specific enthalpy of steam of the pre-project generating equipment *h* of neighbouring industry ’g’	TJ/t		Use monitored temperature and pressure of steam to obtain specific enthalpy from steam tables
32.	$EF_{FF,g,j}$	CO_2 emission factor of fuel *j* used by neighbouring industry *g* to self-generate steam	tCO_2/TJ		Local, regional or national data if available, or IPCC default values
33.	$FC_{BL,ST,g,j}$	Amount of fuel *j* used by neighbouring industry *g* to self-generate steam during the most recent three years prior to the implementation of the project activity	mass or volume units/y		Fuel data log/purchase receipts available at neighbouring industry *g*
34.	$NCV_{g,j}$	Net calorific value of fuel *j* at neighbouring industry *g* in the baseline scenario	TJ/mass or volume units		Monitored through records of fuel supplier or local, regional or national data

No.	Parameter	Description	Unit	Monitoring/recording Frequency	Measurement Methods and Procedures
35.	$Q_{BL,ST,g,j}$	Steam self-generated by neighbouring industry *g* with fuel *j* during the most recent three years prior to the implementation of the project activity	t/y		Steam data log available at neighbouring industry *g*
36.	$\eta_{ST,g,j}$	Fuel consumption rate of self-generation of steam at neighbouring industry *g*, with fuel *j*	TJ/TJ		Fuel and steam data logs available at neighbouring industry *g*.
37.	$EC_{PJ,elec,g,y}$	Electricity purchased by the neighbouring industry *g* from the proposed project facility	MWh/y		Electricity recording meter at company records or neighbouring industry *g*
38.	$EG_{SG,elec,g,y}$	Total electricity self-generated by neighbouring industry *g*	MWh/y		Electricity recording meter at neighbouring industry *g*
39.	$GC_{Elec,g,m}$	Nameplate capacity of the electricity generating equipment ’m’ existing at neighbouring industry *g* prior to the implementation of the project activity	MWh/h		Nameplate capacity of the equipment ’m’ existing at neighbouring industry *g*
40.	$t_{elec,g,m}$	Average maintenance and down time hour of the electricity generating equipment ‘m’ existing at neighbouring industry *g* prior to the implementation of the project activity	h/y		Maintenance data log available at neighbouring industry

No.	Parameter	Description	Unit	Monitoring/recording Frequency	Measurement Methods and Procedures
41.	$EG_{BL,SG,g,j}$	The electricity self-generated by neighbouring industry *g* with fuel *j* during the most recent three years prior to the implementation of project activity	MWh/y		Electricity data log available at neighbouring industry *g*
42.	$EG_{BL,GR,g}$	The total amount of electricity obtained from the grid by neighbouring industry *g* during the most recent three year prior to the implementation of project activity	MWh/y		Electricity data log available at neighbouring industry *g*
43.	$EG_{BL,TC,g}$	The total electricity consumption for neighbouring industry ‘ g’ during the most recent three year prior to the implementation of project activity	MWh/y		Electricity data log available at neighbouring industry *g*
44.	$FC_{BL,SG,g,j}$	Consumption of fuel *j* by neighbouring industry *g* to self-generate electricity during the most recent three years prior to the implementation of the project activity	mass or volume units/y		Fuel data log/purchase receipts available at neighbouring industry *g*.
45.	$\eta_{SG,g,j}$	Fuel consumption rate of self-generation of electricity at neighbouring industry *g*, with fuel *j*	MWh/TJ		Fuel and electricity data logs available at neighbouring industry *g*.
46.	$TOC_{PJ,SSA,i}$	The total organic carbon of spent sulphuric acid generated by industry *i*	tC/y	Representative sample	Lab test with Standard Methods for the examination of water & waste water

No.	**Parameter**	**Description**	**Unit**	**Monitoring/recording Frequency**	**Measurement Methods and Procedures**
47.	EC_{NaOH}	The amount of electricity being used in the manufacturing process of the sodium hydroxide	MWh/tNaOH		Local, regional or national data

Project activity under a programme of activities

45. The proposed methodology is not intended for application to a project activity under a program of activities.

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