NATIONAL GREENHOUSE GAS INVENTORY SYSTEM OF MALAWI

INDUSTRIAL PROCESSES CALCULATOR
Standard Operating Procedures

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March 2019
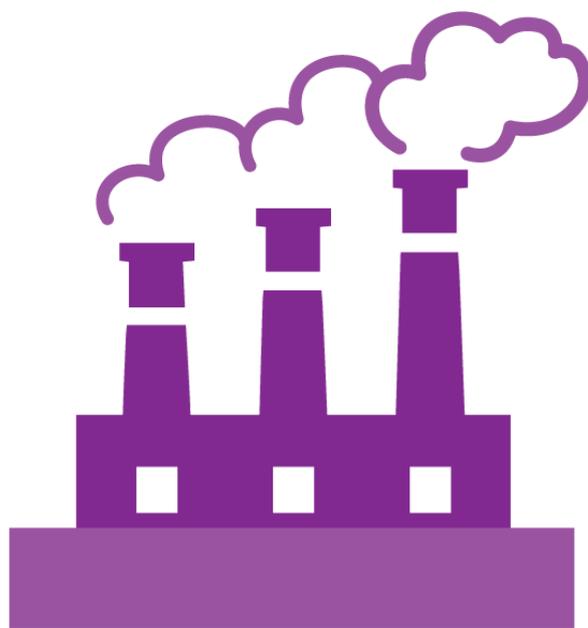
TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS

AD	Activity Data
EF	Emission Factor
GHG-IS	Greenhouse Gas Inventory System
QA/QC	Quality Assurance/Quality Control
SOP	Standard Operating Procedure
IPCC	Intergovernmental Panel on Climate Change
UNFCCC	United Nations Framework Convention on Climate Change
EAD	Environmental Affairs Department
PERFORM	Protecting Ecosystems and Restoring Forests in Malawi
USAID	United States Agency for International Development

1.0 INTRODUCTION

The Government of Malawi with USAID's Protecting Ecosystems and Restoring Forests in Malawi (PERFORM) has developed the Greenhouse Gas Inventory System (GHG-IS) to support Malawi's Low Emissions Development Strategy. The GHG-IS uses a series of Microsoft Excel emissions calculators that combine methods and data from Intergovernmental Panel on Climate Change (IPCC) Guidelines (2006) with Malawi-specific data to produce estimates of emissions from each sector (see box). These emission calculators are accompanied by Standard Operating Procedures (SOPs) which provide comprehensive guidance on using the calculators.

The Industrial Processes Emissions Calculator produces all necessary estimates for reporting annual emissions from the industrial processes sector in Malawi. This SOP provides comprehensive guidance on the Industrial Processes Emissions Calculator and serves to: (1) provide overview of steps required to operate the Energy Emissions Calculator; (2) direct analysts through the collection and entry of activity data; and (3) guide the interpretation and reporting of resulting emission estimates.

Under the GHG-IS, emissions from the industrial processes sector in Malawi are accounted following the Intergovernmental Panel on Climate Change (IPCC) Tier 1 approach and accounts for emissions resulting from cement production and lime production. The greenhouse gases (GHGs) emitted from these sources only include CO_2.

The main Government entity responsible for the GHG-IS Industrial Processes Emissions Calculator is the Environmental Affairs Department (EAD). Personnel responsible for collecting, entering, and analyzing data for the GHG-IS will need to be assigned in accordance with the guidance set forth in the *GHG-IS Master Document* and will need to work with relevant government agencies to collect appropriate data for evaluating emissions from the industrial processes sector.

Sectors accounted for in Malawi's GHG-IS

Energy: Emissions resulting from production and use of fuels for energy.

Industrial Processes and Product Use: Emissions from producing cement, lime, and ceramics.

Agriculture, Forestry, and other Land Use: Emissions from livestock and agricultural soil management (i.e., fertilizer application), forests remaining forests (degradation from unsustainable fuelwood harvest), and land use change.

Waste: Emissions from wastewater treatment and discharge, incineration and open burning of waste, and solid waste disposal.

2.0 OVERVIEW OF THE THE INDUSTRIAL PROCESSES EMISSIONS CALCULATOR

The Industrial Processes Emissions Calculator is currently built to accommodate data entry and estimate emissions from 2010 to 2040. It includes the following tabs (i.e., Excel Worksheets):

Table 1 INDUSTRIAL PROCESSES EMISSIONS CALCULATOR TABS

TAB NAME	PURPOSE
Workbook Overview	Provides an overview of the calculator and basic instructions on how to utilize the workbook
Change Log	List of all changes made to the calculator, and documents if they have been QA/QC'ed. The change log must be updated every time the calculator is updated or modified.
AD-Tracker	Displays all the AD that needs to be entered in the calculator, per year of inventory. Clicking on the name of the AD shows the tab where the AD must be entered. Staff responsible for updating the calculator with new data must update the table in this tab to indicate whether the AD on a given year was complete, assumed to be 0, partially entered, missing, or entered but still requiring validation and QA/QC - these options appear in the dropdown menu in each cell of the table.
Total Emissions	Reports total annual emissions in CO_2e for industrial processes, based on the AD entered and the EF used.
AD - Cement	Activity Data (AD): tons of cement produced (converted to tons of clinker produced), tons of clinker imported, and tons of clinker exported.
AD – Lime and Ceramics	Activity Data (AD): tons of lime produced, and tons of carbonate consumed in ceramics production.
Emission Factors	Emission factors (EF) for cement, lime, and ceramics production. Emission factors should only be updated if improved information is made available on emissions from cement, lime, or ceramic production.

The tabs and tables are color-coded to indicate their function following this key:

Table 2 COLOR KEY FOR TAB AND TABLE FUNCTIONS

TABLE COLOR	FUNCTION
Orange	Results of total yearly emissions estimates, either by sector or aggregated.
Yellow	Quality Control checks for specific data-entry tasks that are likely to have errors, and Activity Data Tracker.
Green	Activity data.
Blue	Default coefficient factors that contribute to emission factors. Should be periodically reviewed by sectoral experts and updated as new information are developed.
Grey	Products of equations that represent intermediary steps between activity data and final emissions estimates. For review only, should not need update unless the formula has been corrupted. To recover the formula, the calculator manager should visit the reference listed on the table heading (usually an equation from the IPCC Guidelines).

The tables within each tab of the Industrial Processes Emissions Calculator include a heading that describes:

- The IPCC-defined coefficient name (i.e., activity data, IPCC coefficient, etc.)
- A plain-language definition of the coefficient name
- Units of measurement
- Reference to where the coefficient is referred to in the IPCC 2006 Guidelines
- Frequency of review
- Notes where additional context is needed. Where deviations from IPCC 2006 Guidelines or assumptions have been made (see section 0) these will be noted here.

3.0 GHG ACCOUNTING USING THE INDUSTRIAL PROCESSES EMISSIONS CALCULATOR

Malawi's GHG-IS is designed to allow for clear and consistent accounting for emissions by limiting data entry in the emissions calculators to activity data (AD)[1]. The process for collecting, entering, and reviewing those data are described below.

3.1. ACTIVITY DATA PRODUCTION

To account for emissions from industrial processes, data on cement and lime production, as well as the amount of cement imported and exported are needed. Specific activity data needs are given in Table 3 below.

The full list of activity data needs and activity data sources are detailed in Annex III of this SOP and on the *GHG-IS Master Document*.

Table 3 ACTIVITY DATA NEEDS FOR ESTIMATING EMISSIONS FROM INDUSTRIAL PROCESSES

Data Category	DATA DESCRIPTION	UNITS
Cement Activity Data	Cement produced	*Tonnes per year (t y^{-1})*
	Clinker imports	*Tonnes per year (t y^{-1})*
	Clinker exports	*Tonnes per year (t y^{-1})*
Lime Activity Data	Lime production	*Tonnes per year (t y^{-1})*
Ceramics Activity Data	Carbonate used in production	*Tonnes per year (t y^{-1})*

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[1] The magnitude of human activity resulting in emissions or removals taking place during a given period of time
https://unfccc.int/process/transparency-and-reporting/greenhouse-gas-data/greenhouse-gas-data-unfccc/definitions

These data are produced by the <u>Department of Mines and the Department of Industry and Trade, in the Department of Mines, Economic Planning, and Development</u>. The specific sectoral focal points to contact for these data are listed in Annex I of this SOP and on the *GHG-IS Master Document*. Note that there is currently no source for ceramics AD in the country.

These data are produced <u>every year</u>. In accordance with the timelines and guidance set forth in the established master GHG-IS Calendar, data should be entered into the Energy Emissions Calculator during <u>the second trimester of the year,</u> <u>every year</u>.

3.2. ACTIVITY DATA ENTRY

Once EAD personnel have collected the activity data for the necessary period, they must be entered in the following green activity data tabs in the Industrial Processes Emissions Calculator:

- **AD – Cement**
- **AD – Lime and Ceramics**

Data should be entered as tonnes of cement and/or lime produced, and tonnes of clinker imported and exported in their corresponding green tables on the AD tabs.

The grey and blue tables in the tabs will populate automatically, according to the equations and assumptions indicated in each table heading. Once AD are entered, the total emissions are automatically calculated multiplying AD by corresponding EFs. The Total Emissions tab compiles the results generated from industrial processes, in tons of CO_2e for each year and generates a graph to visually describe the information offered in the Total Emissions table.

When the calculator has been updated and/or the AD has been entered, rename the file to be saved file with today's date. **Do not overwrite existing versions**. For example, "Industrial Processes Calculator – July_17_2018".

3.3. QA/QC & APPROVAL OF EMISSION ESTIMATES

It is imperative that quality assurance/quality control measures are undertaken to ensure data are correctly entered. The following steps must be followed by the individual responsible for QA/QC every time AD are entered into the Industrial Processes Emissions Calculator.

1. Whenever the data entry analyst makes a change or a series of changes, review the new version of the workbook by reading the **Change Log** tab.

2. If there are new changes that have not been reviewed yet, do so considering the following:
   - Ensure data appear correct and plausible. If there is a large discrepancy in values since the previous reporting period, make sure the reason for this difference has been identified and documented in the **Change Log** notes.
   - Confirm that the emission factors (blue) are appropriately converting AD to tons of CO_2e.

3. In the **Total Emissions** tab (orange) confirm that all emissions estimates for the current year are within a reasonable range (± 20%) from previous year. If a change over this threshold is observed, the reason must have been identified and documented in the **Change Log** by the person responsible of entering the data. Note in the **Change Log** tab any comments related to changes that have been QA/QC'd. If any errors were resolved, note the change and set the status to 'OK'd'.

4. If any errors could not be resolved immediately, change the status to 'needs resolution' while a solution is determined. Seek out the expertise of teammates to resolve unexplained errors. Once resolved, update the change log again for this entry and change status to **'OK'd'**.

5. Update the status of the AD entered on the **AD_Tracker** tab.

3.4. REPORTING OF EMISSIONS FROM INDUSTRIAL PROCESSES

Once reviewed, appropriate EAD personnel should enter the emissions estimated using the Industrial Processes Emissions Calculator into the **Emissions Aggregator Calculator**, which compiles all sectoral emissions for UNFCCC reporting purposes. The total emissions calculated will also need to be included in Malawi's GHG Inventory Annual Report, both as total tons of CO_2e and per GHG (i.e., CO_2, CH_4, and N_2O), if applicable.

To facilitate the entry of the sectoral emission results into the IPCC reporting tables, the Industrial Processes Emissions Calculator includes a 'Button' that automatically selects and copies the results that are needed as inputs in the sectoral reporting table of the **Emissions Aggregator Calculator**. The Emissions Aggregator Calculator and its SOPs instruct the calculator manager to simply paste these values in the indicated cells of the Emissions Aggregator Calculator; the Emissions Aggregator Calculator will automatically create uncertainty estimates and emissions graphs and tables for reporting purposes once values from the Industrial Processes Emissions Calculator are pasted in the Emissions Aggregator Calculator.

Copy Results Table to Clipboard
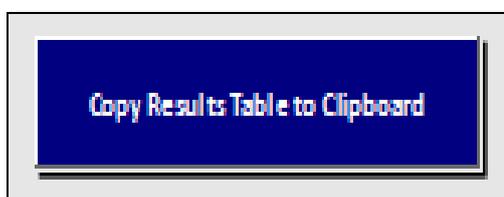
This button is located in the Total Emissions tab of the Industrial Processes Calculator.

3.5. ASSUMPTIONS MADE IN ACTIVITY DATA, COEFFICIENTS, & EMISSION FACTORS

Each coefficient, activity data, or emission factor table in the calculator has a heading describing its name, source, units, and additional relevant information. While the IPCC 2006 Guidelines were followed when choosing equations and default factors, it was necessary to make some additional assumptions for Malawi. To ensure consistent adherence to the methodology, these additional key assumptions are indicated on the 'Notes' cell in these headings and are elaborated below in Table 4.

Table 4 ASSUMPTIONS MADE IN THE INDUSTRIAL PROCESSES EMISSIONS CALCULATOR

COEFFICIENT	ASSUMPTION
Domestic clinker production (tonnes)	Calculated following the IPCC 2006 Guidelines as the sum of produced and consumed clinker, minus the imported clinker. Cements imports AD is not to be used on this equation, only cement production (after it is converted to clinker).
Clinker production EF (EF$_{clc}$)	Assumes calcium carbonate ($CaCO_3$) is the source of the calcium oxide (CaO) used on the clinker production process.
Lime production EF (EF$_L$)	The tier 1 default emission factor assumes an 85% production of high calcium lime and 15% production of dolomitic lime.

Ceramic production EF (EF$_C$)	The tier 1 default emission factor assumes that the carbonate used for ceramic production contains 85% limestone (calcite) and 15% dolomite.

4.0 UPDATING DEFAULTS AND EMISSION FACTORS

It is not expected that the GHG-IS operators will be responsible for refining or updating default emission factors. However, due to newly available research, there may come a time where existing coefficients no longer appropriately represent national circumstances. The process through which default factors are be updated could be a combination of expert review, literate review, original research, and comparison to neighboring countries. Guidelines for updating these factors are not provided here. However, in the event that any factors require updating, the following steps should be followed:

1. Decide if the update should apply to all or only select years. Applying to all years (including past) will result in past years being recalculated. Changes due to new research may be appropriate to apply to past years. Changes related to new economic developments in Malawi should only be applied to years that these developments are believed to significant (including future years if appropriate).

2. Directly change the values in the corresponding emission factor table for the appropriate years.

3. For additions or removal of strata (i.e., types of cement):
    a. Change to one table must be made to all tables that express that stratification.
    b. An appropriate value for each coefficient relevant to that strata must be developed or adopted.
    c. Add a row by inserting a new row across the entire workbook intersecting with the table.
    d. Ensure all formulas are coped into new row for that table.
    e. Check intermediary tables (grey tab) and final results (orange tab) to ensure that change is having anticipated result.

4. Document any changes in the **Change Log** tab.

5. Update the status of the AD entered on the **AD_Tracker** tab.

6. Deliver any documentation, studies, references etc. that support why the particular change was made to EAD, including a summary of the rationale for the change.

5.0 EXTERNAL RESOURCES

2006 IPCC Guidelines for National Greenhouse Gas Inventories. Volume 4. Industrial Processes and Product Use, available at http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol3.html.

National Greenhouse Gas Inventory System of Malawi. Master Document. October 2018.

ANNEX I. SECTORAL FOCAL POINTS

The sectoral focal points as presented below reflect institutional arrangements implemented for the 2017 Annual Greenhouse Gas Inventory. Future cycles may necessitate adjustments to the table to accurately reflect personnel changes.

GHG-IS Calculator name	Primary EAD Focal Point	Secondary EAD Focal Point	Sectoral focal point Institution	Primary Sectoral Focal Point	Secondary Sectoral Focal Point
Industrial Processes Calculator	Hannah Kasongo	Biswick Mlaviwa	Department of Mines and Department of Industry and Trade, in the Department of Mines, Economic Planning, and Development	Madalitso Chinduwi (Dep. of Mines); Martin Magalasi (Dep. of Industry and Trade)	Chimwemwe Bandazi (Dep. of Mines); Joseph Chimseu Phiri (Dep. of Industry and Trade)

ANNEX II. SAMPLE DATA REQUEST LETTERS

INDUSTRIAL PROCESSES - I

[EAD letterhead]

[name of primary sectoral FP]
[position]
[name of secondary sectoral FP]
[position]
Department of Mines, in the Department of Mines, Economic Planning, and Development
[address]

[date]

Dear [name of primary sectoral FP] and [name of secondary sectoral FP],

Through this letter, Environmental Affairs Department formally requests that you share sectoral data necessary to estimate annual greenhouse gas emissions from the livestock sector. As you know, Malawi has now formalized its annual greenhouse gas accounting and reporting, managed by the Environmental Affairs Department, and we reach out to all sectors every year seeking their collaboration to complete the annual multisectoral greenhouse gas emission estimates.

We request that you kindly share with us the annual cement and lime production (mass) for [year], included in the recently released Annual Economic Report in table 6.1.

Please share this data in an excel format, indicating in the headings the corresponding units.

Do not hesitate to reach out to us if this request raises any questions or concerns. We appreciate your collaboration and thank you in advance for your prompt reply to this request.

Regards,

[signature]

[name]
[position]
Environmental Affairs Department

INDUSTRIAL PROCESSES - 2

[EAD letterhead]

[name of primary sectoral FP]
[position]
[name of secondary sectoral FP]
[position]
Department of Industry and Trade, in the Department of Mines, Economic Planning, and Development
[address]

[date]

Dear [name of primary sectoral FP] and [name of secondary sectoral FP],

Through this letter, Environmental Affairs Department formally requests that you share sectoral data necessary to estimate annual greenhouse gas emissions from the livestock sector. As you know, Malawi has now formalized its annual greenhouse gas accounting and reporting, managed by the Environmental Affairs Department, and we reach out to all sectors every year seeking their collaboration to complete the annual multisectoral greenhouse gas emission estimates.

We request that you kindly share with us the annual amount of clinker imported and exported for cement production for [year], as well as the annual amount of cement exported.

Please share this data in an excel format, indicating in the headings the corresponding units.

Do not hesitate to reach out to us if this request raises any questions or concerns. We appreciate your collaboration and thank you in advance for your prompt reply to this request.

Regards,

[signature]

[name]
[position]
Environmental Affairs Department

ANNEX III. ACTIVITY DATA NEEDS & SOURCES USED IN 2010-2017

Activity Data (AD) needed	GHG-IS Calculator Name	AD subcategories	Required AD input units	AD relevant in Malawi (2010 - 2017)	Source (2010-2017)
Cement production	Industrial Processes Calculator	blended and portland cement	tons (metric) of cement	only portland cement, no data available for blended cement	Department of Mines Economic Report, Annual Economic Report, table 6.1
Imports of clinker for cement production	Industrial Processes Calculator	clinker for blended and portland cement	tons (metric) of clinker for cement	only portland cement, no data available for blended cement	Data in Excel file directly shared by Ministry of Trade/NSO
Exports of clinker for cement production	Industrial Processes Calculator	clinker for blended and portland cement	tons (metric) of clinker for cement	only portland cement, no data available for blended cement	Data in Excel file directly shared by Ministry of Trade/NSO
Lime production	Industrial Processes Calculator	lime production	tons (metric) of lime produced	yes (only data on agricultural lime available)	Department of Mines Economic Report, Annual Economic Report, table 6.1
Ceramics production	Industrial Processes Calculator	Carbonate consumed	tons (metric) of carbonate consumed in ceramics production	no, assumed to be zero until activity is practiced in Malawi	Not available/not applicable