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NATIONAL GREENHOUSE GAS INVENTORY SYSTEM OF MALAWI

ENERGY EMISSIONS CALCULATOR

Standard Operating Procedures



EMMANUAL THUWALA - MBC

March 2019

This publication was produced for review by the United States Agency for International Development. It was prepared by Winrock International and the Government of Malawi for Tetra Tech.

This publication was produced for review by the United States Agency for International Development by the Government of Malawi and Winrock International, through USAID Contract number AID-612-TO-14-00003, Protecting Ecosystems and Restoring Forests in Malawi (PERFORM) under the Restoring the Environment through Prosperity, Livelihoods, and Conserving Ecosystems (REPLACE) Indefinite Quantity Contract.

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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
TJ	Terajoule
IPCC	Intergovernmental Panel on Climate Change
UNFCCC	United Nations Framework Convention on Climate Change
GWP	Global Warming Potential
AR5	Fifth Assessment Report
EAD	Environmental Affairs Department
PERFORM	Protecting Ecosystems and Restoring Forests in Malawi
USAID	United States Agency for International Development



I.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 Energy Emissions Calculator produces estimates for reporting part of the annual emissions from the energy sector in Malawi. To derive the total estimated annual emissions from the energy sector in Malawi, outputs from the separate Fuelwood Emissions Calculator are also needed.

This SOP provides comprehensive guidance on the Energy 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 energy sector in Malawi are accounted following the Intergovernmental Panel on Climate Change (IPCC) Tier I approach and accounts for emissions resulting from the combustion of fuel to produce energy as well as emissions from surface coal mining, referred to as fugitive emissions. The greenhouse gases (GHGs) emitted from these sources include CO₂, CH₄, and N₂O. Only emissions from fuel use and coal production from within Malawi are included, and therefore data on fuel imports and exports are important to complete the accounting of emissions from the energy sector in Malawi.

The main Government entity responsible for the GHG-IS Energy 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 energy 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 ENERGY EMISSIONS CALCULATOR

The Energy Emissions Calculator is currently built to accommodate data entry and estimate emissions from 2013 to 2040. It includes the following tabs (i.e., Excel worksheets):

Table 1 ENERGY 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	Lists 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	Total annual emissions in CO _{2e} from energy, based on the AD entered and the EF used. The tab includes a 'Button' to copy automatically relevant values into the IPCC reporting tables of the Emissions Aggregator Calculator.
Fugitive Emissions	Total annual fugitive emissions in CH ₄ and CO _{2e} from surface coal mining in the country (during mining and post-mining process).
Fuelwood Emissions	Emissions from fuelwood residential and commercial consumption, in CH ₄ and N ₂ O, and automatically converts it to CO _{2e} . CH ₄ and N ₂ O data on the commercial and residential tables originates from the Fuelwood Emissions Calculator and is copied and pasted here by the tool administrator.
Fossil Fuel AD	AD for estimating emissions from fossil fuel production, imports, exports, international bunkers (fuel consumed internationally), fuel stock change, and excluded carbon (carbon not combusted in fuel) in Malawi. AD: Liters or kilograms of fossil fuels (petrol, diesel, paraffin, liquified petroleum gas, jet fuel, coal, and aviation gas).
Fossil Fuel EFs	Emission factors (EF) associated to fossil fuels (petrol, diesel, paraffin, liquified petroleum gas, jet fuel, coal, and aviation gas). Emission factors should only be updated if improved information is made available on emissions from cement or lime production.
Lists	General coefficients used throughout this calculator.



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.
Red	Summary 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.
Purple	Coefficients developed in the reporting format and units that other inventory calculators require as inputs.
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 Energy 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 3.5) these will be noted here.

3.0 GHG ACCOUNTING USING THE ENERGY 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 energy use, data on fossil fuel, production, consumption, imports, exports and storage are needed. Specific AD needs are given in

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>



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 NEEDED FOR THE ENERGY EMISSIONS CALCULATOR

FUEL TYPE AS REPORTED IN MALAWI	FUEL TYPE IN IPCC 2006 GUIDELINES	UNIT
Petrol	Motor Gasoline	Liters per year ($l\ y^{-1}$)
Diesel	Diesel/Gas Oil	Liters per year ($l\ y^{-1}$)
Paraffin	Kerosene	Liters per year ($l\ y^{-1}$)
Liquefied Petroleum Gas	Liquefied Petroleum Gas	Liters per year ($l\ y^{-1}$)
Jet A-I Fuel	Jet Kerosene	Liters per year ($l\ y^{-1}$)
Coal	Subbituminous Coal	Kilograms per year ($kg\ y^{-1}$)
Aviation Gas	Aviation Gasoline	Liters per year ($l\ y^{-1}$)

These data are produced by the Department of Energy Affairs, in the Department of Mines, Economic Planning, and Development and by the Malawi Energy Regulatory Authority. The specific sectoral focal points to contact for these data are listed in the *GHG-IS Master Document*.

These data are produced every year. 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 the second trimester of the year, every year.

3.2 ACTIVITY DATA ENTRY

Once EAD personnel have collected the AD for the reporting period, they must be entered in into the following green tables in the ‘Fossil Fuel AD’ tab of the Energy Emissions Calculator:

- **Fossil Fuel Produced in the country**
- **Fossil Fuel Imports to the country**
- **Fossil Fuel Exports from the country**
- **International Bunker (consumed in international aviation and maritime transport)**
- **Stock Change (net increases or decreases in stocks of fossil fuels)**
- **Excluded Carbon (non-combusted carbon)**

Data should be entered in either liters or kilograms (depending on the unit indicated on the tables) and the calculator will convert the units automatically to TJ.

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 emission factors (EFs), balancing production and imports with exports and storage. The Total Emissions tabs compile the results of calculations generated in Activity Data tabs, by fossil fuel type and total, in tons of CO₂e for each year. This tab also generates a graph to visually describe the information offered in the Total Emissions tables.

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, “Energy Emissions 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 Energy Emissions Calculator.

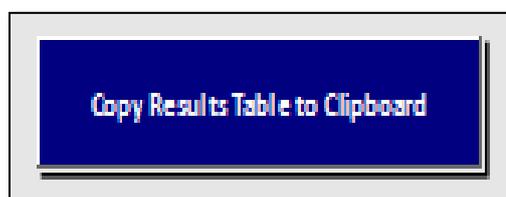


1. Whenever a change or a series of changes are made to the emissions calculator, review the new version of the workbook by reading entries in the **Change Log** tab.
2. If there are any new changes that have not been reviewed yet, do so considering the following:
 - For all activity data tables (green), confirm the values entered for the current year have been correctly entered and are plausible. If a large change is shown since the previous reporting period, make sure that the reason for this difference has been identified and documented in the **Change Log** notes.
 - Confirm that the conversion of units from L or kg of fossil fuel to kg and TJ on the grey tables has been done using the appropriate conversion factor from the coefficient table (blue).
 - Confirm that the emission factors (blue) are appropriately converting AD to tons of CO₂e.
3. On the emissions reporting tab (orange) confirm that all emissions estimates for the current year are within a reasonable range ($\pm 20\%$) 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 EMISSIONS FROM THE ENERGY SECTOR USING THE REFERENCE APPROACH

Once reviewed, appropriate EAD personnel should enter the emissions estimated using the Energy 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 CO₂e and per GHG (i.e., CO₂, CH₄, and N₂O), if applicable.

To facilitate the entry of the sectoral emission results into the IPCC reporting tables, the Energy 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 Energy Emissions Calculator are pasted in the Emissions Aggregator Calculator.



This button is located in the Total Emissions tab, in the emissions by Gg of reporting gas section of the Energy Emissions Calculator.



3.5 ASSUMPTIONS MADE IN ACTIVITY DATA, COEFFICIENTS, AND EMISSION FACTORS

While the IPCC 2006 Guidelines were followed when choosing equations and default factors, it was necessary to make some additional assumptions for Malawi due to data gaps or expert opinion. To ensure transparency and consistency, these assumptions are listed in the 'Notes' cell of the relevant coefficients and are further elaborated in Table 4 below.

Table 4 LIST OF ASSUMPTIONS

COEFFICIENT	ASSUMPTION
Fugitive emissions	This is the sum of surface mining emissions and post-mining emissions. Assumes average CH ₄ emission factors for 1.2 m ³ per ton of coal mining, and 0.1 m ³ per ton for post-mining processes. CH ₄ 100-year Global Warming Potential (GWP) used is 28 (AR5).
Excluded carbon	This is the carbon for the fossil fuel that is not combusted. It is assumed that 100% is combusted unless otherwise noted and thus, the excluded carbon is zero.
Carbonization factor (COF)	Value of 1, because it assumes that all material (100%) is combusted
Density	Conversion of liters to kilograms based on specific fossil fuel density, from www.statcan.gc.ca/pub/57-601-x/2010004/appendix-appendice1-eng.htm
Conversion factors (L to kg)	Emission factors (EF) associated to fossil fuels (petrol, diesel, paraffin, liquified petroleum gas, jet fuel, coal, and aviation gas). Emission factors should only be updated if improved information is made available on emissions from cement or lime production.

4 UPDATING DEFAULTS AND EMISSION FACTORS

It is not expected that the GHG-IS operators will be responsible for refining or updating default values or emission factors. However, developments in the availability of information and new research may justify updating coefficients to allow emissions estimates to better reflect national circumstances. The process through which equations or default factors are updated may involve a combination of expert review, literature 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:

- I. Decide if the update should apply to all or only some years. Applying to all years (including past) may necessitate the recalculation of emissions from past years. For example, the availability of new research that offers a more accurate way to account for emissions may necessitate recalculating emissions from past years, whereas changes related to new economic developments in Malawi should only be applied to years that these developments are believed to be 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 fossil fuel):
 - a. Changes to a single table must be made to all tables that reflect 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 copied into new row for that table.
 - e. Check intermediary tables (grey) and final results (orange) to ensure that change causes an anticipated result.
4. Document any changes in the **Change Log** tab.
5. Update the status of the AD entered on the **AD_Tracker** tabs.
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 EXTERNAL RESOURCES

2006 IPCC Guidelines for National Greenhouse Gas Inventories. Volume 2. Energy, available at <http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.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
Energy Calculator - Reference Approach	Yasinta Ganiza	Golivati Gomani	Department of Energy Affairs; Malawi Energy Regulation Authority (MERA)	Thokozani Malunga (Energy Affairs); Emmanuel Kamangira (MERA)	Gift Chiwayula (Energy Affairs); Nelson Mandala (MERA)



ANNEX II. SAMPLE DATA REQUEST LETTER

[EAD letterhead]

[name of primary sectoral FP]
[position]
[name of secondary sectoral FP]
[position]
Department of Energy Affairs
[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 agriculture 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 information on total mass imported, produced, and exported of petrol, diesel, paraffin, LPG, Jet A-1 fuel, coal, aviation gas for [year]. All this information is available in the Annual Economic Report recently released, in tables 6.1, 6.3, and 7.5, except for the coal import data that can be facilitated by the Department of Trade.

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

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	Units	AD relevant in Malawi (2010-2017)	Source of collected AD (2010-2017)
Fossil Fuel Imported	Energy Calculator - Reference Approach	types of fossil fuel (petrol, diesel, paraffin, LPG, Jet A-1 fuel, coal, aviation gas)	all in liters (L) except coal (reported in kilograms kg)	all	All except coal in Annual Economic Report ² , table 7.5; Coal imports data directly shared by Dep. of Trade and NSO
Fossil Fuel Produced	Energy Calculator - Reference Approach	types of fossil fuel (petrol, diesel, paraffin, LPG, Jet A-1 fuel, coal, aviation gas)	all in liters (L) except coal (reported in kilograms kg)	only coal	Department of Mines Economic Report, Annual Economic Report, table 6.1 for 2014, 2015, 2016 and 2017
Fossil Fuel Exported	Energy Calculator - Reference Approach	types of fossil fuel (petrol, diesel, paraffin, LPG, Jet A-1 fuel, coal, aviation gas)	all in liters (L) except coal (reported in kilograms kg)	only coal	Department of Mines Economic Report, Annual Economic Report, table 6.3 for 2014, 2015, 2016 and 2017
International Bunker (fuel used internationally)	Energy Calculator - Reference Approach	types of fossil fuel (petrol, diesel, paraffin, LPG, Jet A-1 fuel, coal, aviation gas)	all in liters (L) except coal (reported in kilograms kg)	none	not available
Stock Change (stored fossil fuel)	Energy Calculator - Reference Approach	types of fossil fuel (petrol, diesel, paraffin, LPG, Jet A-1 fuel, coal, aviation gas)	all in liters (L) except coal (reported in kilograms kg)	none	not available
Excluded Carbon (non-combusted carbon)	Energy Calculator - Reference Approach	types of fossil fuel (petrol, diesel, paraffin, LPG, Jet A-1 fuel, coal, aviation gas)	Gg C	none	not applicable

² https://www.finance.gov.mw/index.php?option=com_docman&task=cat_view&Itemid=114&qid=98&orderby=dmdate_published&asc=DESC



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