



REPUBLIC OF MALAWI
Ministry of Natural Resources

REPUBLIC OF MALAWI
Ministry of Natural Resources, Energy and
Mining

Report 2: Guidance Report on Malawi's GHG Projections for Energy, Transport and Agriculture Sectors

**Development of a Framework for Tracking Nationally Determined
Contributions for Malawi**

Submitted to

Initiative for Climate Action Transparency (ICAT)

UN Campus, Platz der Vereinten Nationen 1, Bonn 53113, Germany

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Guidance Report on Malawi's GHG Projections for Energy, Transport and Agriculture

Report 2: Inclusive of Outputs 2.1, 2.2, 2.3 and 2.4

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1. Introduction

1.1. Background

This guidance report has been developed as part of the technical assistance provided through Malawi's ICAT support programme. It outlines the greenhouse gas (GHG) emissions projection modelling conducted across three key sectors – energy, transport, and agriculture. It provides a guidance framework to support the continued development of Malawi's GHG projections, enabling national experts to update the existing projections developed, create new scenarios, and expand modelling efforts to sectors not yet covered, e.g., waste and IPPU sectors. Additionally, this report highlights the capacity-building initiatives implemented during Malawi's ICAT support programme to enhance Malawi's institutional and technical capabilities for maintaining and advancing GHG projection efforts.

The energy, transport and agriculture sectors, which together account for a significant portion of Malawi's GHG inventory (energy 13%, transport 11%, agriculture 54%¹), were identified as priority sectors at project inception due to their pivotal role in achieving Malawi's NDC targets. Under Malawi's 2021 NDC, the country committed to an unconditional emission reduction target of 6% relative to a BAU in 2040, equivalent to an estimated mitigation level of 2.1 million tCO₂e. The conditional target seeks an additional reduction of 45% relative to BAU in 2040, equivalent to 15.6 million tCO₂e.

GHG projection modelling is a critical component of climate action planning, providing policymakers with insights into how different policy choices may influence future emissions as well as helping to demonstrate national ambition towards the Paris Agreement. Under Decision 18/CMA.1 (paragraphs 92 – 102), Parties are required to report GHG emissions projections, while developing country Parties may exercise flexibility based on their capacities. For Malawi, as a developing country, undertaking GHG projection modelling is particularly important for aligning national development priorities with low-carbon pathways, attracting climate finance, and demonstrating transparency and commitment to global climate goals despite the country's national capacity constraints.

Projections are intended to indicate the potential impact of mitigation policies and measures on future emissions trends. Parties reporting projections must provide a 'with measures' projections for all GHGs and may also provide 'with additional measures' as well as 'without measures' projection. Developing countries may use simplified approaches or reduced coverage, but are encouraged to describe the methodologies, models, assumptions, and any changes since their previous reporting. Such transparency within GHG projections not only strengthens national planning and governance but also contributes to the global stocktake process.

1.2. Purpose of this guidance report

This report focuses on the GHG emissions projections developed by the Malawi in-country team using the Greenhouse Gas Abatement Cost Model (GACMO). Following an assessment of

¹ [Malawi First NDC \(Updated submission\) | UNFCCC](#)

various GHG projection tools, GACMO was selected as the most suitable option, aligning with Malawi’s national circumstances as well as ease of use in comparison to other projection models such as the Low Emissions Analysis Platform (LEAP). A bottom-up, sector-specific approach was used to generate specific emissions projections for the energy, transport and agriculture sectors. The modelling for each sector includes both a ‘with measures’ and ‘without measures’ scenarios, providing a comprehensive view of potential emissions. The methodology applied in developing these projections is documented in detail within this report. The GHG projections are scheduled to undergo validation during a stakeholder workshop in December 2025.

This report details the application of GHG emissions projection training delivered by the Ricardo team, as applied by the designated sectoral working groups in Malawi. The sectoral working groups, led respectively by the Ministry of Energy, Ministry of Transport, and Ministry of Agriculture, have contextualised and applied the capacity-building support provided to develop coherent, country-led sectoral projections. This guidance report is designed to serve as a practical reference, enabling sectors to replicate and further build on the modelling achieved, thereby strengthening future GHG projections modelling in Malawi. This report provides practical recommendations for the technical team preparing GHG projections for Malawi’s next 2025 NDC update, with particular emphasis on the short-term integration of the GACMO tool to enable data-driven climate action. The report is structured to guide readers through the technical process undertaken through the ICAT support, including sources of data and key assumptions that have underpinned Malawi’s modelling efforts.

Table 1: Overview of guidance report structure and inputs

Section	Content Summary	Inputs from Malawi Experts
1. Introduction	Sets context for the guidance report, including background and the role of GHG projections in national planning.	N/A
2. Overview of Modelling Tools	Provides guidance on key modelling tools and compares use cases.	Reflections and feedback from national stakeholders on tool relevance and usability.
3. Deep Dive into GACMO	Explores Malawi’s chosen GHG modelling tool, including its functionalities and user experience during hands-on sessions.	Sectoral teams participated in tool demonstrations and shared insights on applicability.
4. Sectoral Working Group Development	Describes the formation and structure of Malawi’s sectoral working groups for GACMO modelling.	Sectoral experts contributed to group formation, coordination, and problem-solving.
5. Energy Sector	Presents the development of projections in GACMO for the energy sector, including sources of data, key assumptions, results, data gaps and challenges.	Energy Working Group finalised chapter outlining methodology, mitigation measures, results, assumptions and limitations.
6. Transport Sector	Presents the development of projections in GACMO for the transport sector, including sources of data, key assumptions, results, data gaps and challenges.	Transport Working Group finalised chapter outlining methodology, mitigation measures, results, assumptions and limitations.
7. Agriculture Sector	Presents the development of projections in GACMO for the agriculture sector, including data sources, key assumptions, results, data gaps and challenges.	Agriculture Working Group finalised chapter outlining methodology, mitigation measures, results, assumptions and limitations.

8. Future Needs and Next Steps	Highlights gaps for future modelling consideration and outlines steps for further institutionalising Malawi’s modelling efforts.	Sectoral working group experts led recommendations on capacity building and institutional ownership.
Annexes 1–4	Supplementary materials including workshop agendas, sectoral inputs, and supporting data.	Includes raw inputs and documentation from Malawi’s technical teams.

A key objective of Malawi’s ICAT support is to build national capacity to ensure that Malawi’s 2025 NDC, as well as other UNFCCC reporting requirements, are grounded in transparent and country-driven processes. This approach recognises that long-term sustainability and credibility of emissions modelling depends on building and retaining capacity within national institutions. It also emphasises the need for individual sectors to take ownership of their own modelling efforts, enabling more accurate, context-specific projections. By promoting sectoral accountability and enhancing inter-institutional coordination, Malawi is better positioned to integrate modelling outputs into national planning processes, strengthening the overall governance framework for climate action, and ultimately delivering technically robust submissions to the UNFCCC.

2. Overview of modelling tools

As part of the ICAT programme support, Ricardo provided a number of capacity building workshop sessions with key sectoral experts. The first workshop, in January 2025, provided next steps on how we can use the causal chain to start estimating GHG effects and provided an overview of the GHG modelling tools available so that experts could understand the wide landscape of modelling tools available, and which one would best suit Malawi’s circumstances.

2.1. Objectives of the session

The first workshop served as an introductory session aimed at familiarising participants with the various modelling tools that could be utilised for national planning and climate strategy development. Designed with a strong capacity-building focus, the workshop brought together key stakeholders to deepen their understanding of tools relevant to GHG emissions modelling. See Annex 1 for the full workshop agenda. The key objectives of the modelling tool training workshop were to:

- a) **Deliver capacity building training to identify with and without policy scenarios:** introduction to scenario development including with and without policy scenarios, as well as with existing measures (WEM) and with additional measures (WAM)
- b) **Enhance understanding on how to quantify GHG effects:** introduction of quantification of GHG effects for priority sectors
- c) **Introduce projection modelling tools including their scope and functionality:** introduction to a range of projection modelling tools, with detailed explanations of each tool’s scope, features and intended applications.
- d) **Enable stakeholders to select the modelling tool that is most appropriate in the national context:** A key outcome of the session was to empower stakeholders to critically assess and select the most suitable modelling tools within their national contexts.

2.2. Introduction to key modelling tools

The key modelling tools that were introduced in Workshop 1 are: Low Emissions Analysis Platform

(**LEAP**); Greenhouse gas Abatement Cost Model (**GACMO**) and the Mitigation-Inventory Tool for Integrated Climate Action tool (MITICA).

LEAP is an integrated, scenario-based modelling tool that can be used to track energy consumption, production and resource extraction in all sectors of an economy, designed for **long-term, comprehensive modelling** of energy systems and emissions across all sectors. Some of the key benefits of the LEAP tool are that it is relatively **simple** and **free** for developing countries, to use, requires **low initial data** inputs, and having been **used in NDCs and LTSSs**, it is **familiar to key stakeholders** around the world, enabling **comparability with previously modelled GHG scenarios**. It supports **detailed scenario analysis, capacity planning, fuel use projections, and cost estimation**.

GACMO is a simple tool that assesses the cost effectiveness of mitigation options across multiple sectors, providing a **rapid but accurate** evaluation of how a variety of mitigation options impact GHG emissions. The key benefits of this tool include that it prioritizes **simplicity and ease of use**, which is particularly beneficial for countries with limited data, as it requires relatively low data inputs. It is tailored for **short-term, simplified assessments** of mitigation options, with a strong focus on **cost-effectiveness** and **GHG reduction potential**.

The following section provides a comparison between these models and their use cases in the context of Malawi.

2.3. Comparative analysis and use cases

Key components of the main two models for consideration, LEAP and GACMO, are compared in this section.

While there are key, general benefits associated with the use of both models, as outlined in the previous section, each model offers distinct advantages depending on the context.

In summary, LEAP is well-suited for countries with access to robust data and modelling expertise, as it is designed to conduct comprehensive modelling and detailed scenario analysis. While it is flexible and can accommodate varying levels of data, LEAP requires relatively more time and resources to implement, especially for complex assessments. Whereas, GACMO requires less data, is relatively easy to use, and is particularly effective for generating marginal abatement cost curves to support quick policy decisions. GACMO is ideal for developing countries or institutions with limited resources and expertise, and it is freely available, further enhancing its accessibility.

Table 2 provides an overview of the key comparative features of the two models.

Table 2: Comparison of the features of the LEAP and GACMO modelling tools

Feature	LEAP	GACMO
Time Horizon	Well-suited for long-term modelling	More appropriate for short-term assessments
Flexibility	Highly flexible and adaptable to different levels of detail and data availability ; can "grow with the user" as expertise and data improve	Designed for simplified assessments ; may not be suitable for complex scenarios requiring high levels of detail
Data Needs	Can accommodate varying levels of data ; includes a technology database that can be used when national-level data is unavailable	Requires less data than many other models and includes default technology costs and data , making it easier to use when country-specific information is limited
Key Outputs	Allows for detailed modelling of energy systems , including capacity planning, fuel use, costs, and emissions across all sectors of the economy	Primarily focuses on analysing costs and benefits of mitigation options , calculating GHG emission reductions , and generating marginal abatement cost curves (MACCs) to compare

		the cost-effectiveness of different mitigation measures
Applications	Widely used in over 160 countries for various applications , including energy planning, climate change mitigation assessments , and GHG inventories	Used in a smaller number of countries , often for NDC development and simplified mitigation assessments , particularly in developing countries like the Maldives and several African nations

Table 3 outlines the considerations for models being used in the context of Malawi, providing examples of models that are appropriate and highlights their relevant attributes, given these considerations.

Table 3: Example models and their appropriateness in the context of Malawi

Criteria	Malawi's Considerations	Example Models
Functions	A hybrid model combining optimization and simulation capabilities could be beneficial for Malawi. Simulation models can be useful for exploring technology choices and their impacts. Accounting models offer a good starting point, especially if data and expertise are limited.	Optimization: MARKAL/TIMES Simulation: LEAP, GACMO, POLES, MEDPro Accounting: LEAP
Resources	As a developing country, Malawi may have limited resources. Choosing a model that aligns with available resources is crucial.	LEAP and GACMO are highlighted as being suitable for countries with limited resources. MARKAL/TIMES requires extensive resources and may not be the most suitable option for Malawi.
Expertise	Malawi should consider models with a lower skill requirement, minimizing the need for specialized training.	LEAP is known for its user-friendliness and lower skill requirements. GACMO is a relatively simple model that can be used with limited expertise. CGE models and MARKAL/TIMES require a high level of expertise.
Data	Malawi may face data constraints. It's important to choose a model that can work effectively with limited data availability.	LEAP and GACMO are designed to work with limited data and often include default data that can be used. CGE models and MARKAL/TIMES require extensive datasets.
License Cost	Prioritize models with free or low-cost licenses to minimize the financial burden.	LEAP offers free licenses for students, developing country governments, NGOs, and academic organizations. GACMO is also free. Other models like POLES may have high licensing costs associated with consultancy agreements.
Hardware Necessities	Choosing a model with modest hardware requirements can be advantageous, especially if access to high-performance computing is limited.	LEAP and GACMO have limited hardware requirements due to their simpler modelling approach

Scope	Prioritize a national-level model for Malawi that allows for a detailed analysis of its specific circumstances, sector contributions, and mitigation potentials.	EPPA and ICES are global models. LEAP , GACMO , TIMES , POLES , and GLOBIOM can be applied at national and sub-national levels.
Flexibility	Choose a model that allows for flexibility in scenario development and analysis, enabling exploration of various policy options and uncertainties.	LEAP is known for its flexibility in scenario development and analysis. GACMO , while being simple, allows for some adjustments to input parameters and scenarios. MARKAL/TIMES may have limitations in flexibility due to its optimization focus and data intensity.

The information presented in both Tables 1 and 2 were presented to the key stakeholders during Workshop 1 to enable a decision to be made on which tool to use. Their feedback and insights are outlined in the following section.

2.4. Participant feedback and insights

The session successfully met its objectives through a structured and interactive agenda that guided participants through key components of climate reporting and modelling. **GACMO** was selected as the tool of choice by the EAD. It was chosen as it covers mitigation measures across a variety of sectors, ensuring this model is suitable for analysis across the range of sectors included, is more easily accessible, and is free to use. This was preferred, as **LEAP** is highly focused on mitigation measures for the energy sector, which would reduce the scope of analysis, and is more complex and expensive.

3. Deep dive into GACMO Tool

Through a comprehensive online training session, Malawi has received technical support to enhance its capacity in utilising GACMO effectively. This training aimed to address key areas of interest and build confidence among participants. Prior to the in-depth training, participants indicated their primary interests in GACMO (Participants were asked on priority features they want to explore further in GACMO as part of pre-training engagements. Figure).² Participants highlighted strong interest in data inputs, mitigation databases, and reporting outputs. Multiple selections were allowed, with percentages reflecting the share of total category selections. This feedback helped tailor the training content to the specific needs of the Malawi country team. Participants were asked on priority features they want to explore further in GACMO as part of pre-training engagements. Figure 1 presents these priority features or aspects.

² Note: Participants were allowed to select multiple categories. No limit was placed on the number of options chosen. Percentages reflect the proportion of total selections (not total respondents).

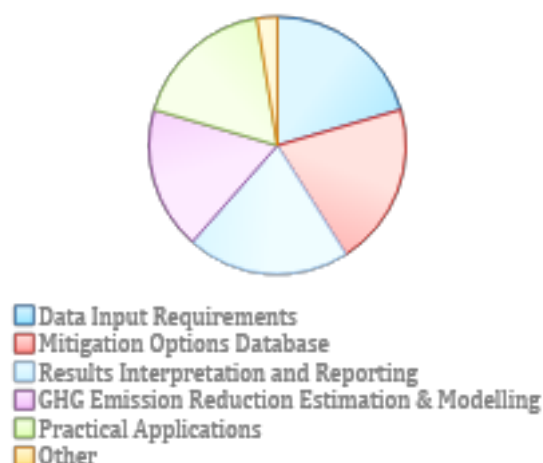


Figure 1: Priority features or aspects of GACMO for exploration in the session as indicated by participants before training

As it can be seen from Figure 1, interpretation of results and reporting, data inputting, mitigation option database, and GHG emission reduction estimation and modelling were the most indicated features by the participants. This provided direction towards preparation and presentation of the training materials on GACMO.

3.1. Objectives of the session

The main objective of this session was to train and support the Malawi country team in using the GACMO tool. The session was designed and delivered by the Ricardo team and featured a series of practical, live exercises and troubleshooting opportunities. Specifically, the workshop aimed to:

- a) Familiarise participants with the navigation and functionality of the GACMO tool.
- b) Provide hands-on experience working through key tables and relevant tool tabs.
- c) Evaluate mitigation options aligned with measures in Malawi's NDC.
- d) Interpret results generated by GACMO.

3.2. Introduction to the GACMO tool

The GACMO tool is a modelling tool developed by UNEP Copenhagen Climate centre to support countries in estimating GHG emissions. It is a user-friendly, Excel-based bottom-up modelling tool designed to support countries in assessing the impact and cost of mitigation actions. Developed in alignment with IPCC and CDM methodologies, GACMO plays a crucial role in helping countries define their NDC target levels by evaluating GHG emissions scenarios and corresponding abatement options. Resources available for the GACMO tool include detailed user guides, country-specific data inputs, and technical assistance from the Ricardo team. These materials provide step-by-step guidance and support the adaptation of the tool to specific national contexts, including Malawi. During the workshop, participants were introduced to the following: the overall scope and functionality of the GACMO tool; key input data requirements (e.g. sectoral emissions, fuel consumption, growth rates); and use of the tool for NDC planning and tracking.

3.3. Hands on demo and user experience

As part of the capacity-building component of this workshop, participants engaged in a hands-on

demonstration of the GACMO tool. This practical session aimed to enhance understanding of the tool's structure, functionalities, and application in evaluating mitigation options relevant to Malawi's NDCs. There were breakout group sessions, with guidelines, as follows.

Breakout Group Guidelines

Participants were divided into three thematic groups to collaboratively input Malawi-specific NDC measures into the GACMO tool: **Group 1** – Energy Sector; **Group 2** – Transport Sector, and **Group 3** – Agriculture Sector. Participants reviewed the relevant GACMO technology sheets to understand the default assumptions used in GHG emission reduction calculations. Each group critically examined adoption trajectories (e.g., gradual uptake vs. rapid implementation) and entered values for expected implementation units across four target years: 2025, 2030, 2035, and 2050. They discussed on the focus on identifying where default data could be improved or replaced with country-specific data to better reflect the Malawian context.

Key Outcomes from the Breakout Session were the following: All groups successfully navigated the GACMO interface, familiarised themselves with key tables, and demonstrated capacity to input data and interpret preliminary results; participants highlighted the tool's flexibility in adjusting scenarios and assessing mitigation potential across different time horizons; and the exercise sparked useful debate around data gaps. The live demonstration provided participants with a valuable opportunity to not only apply the theoretical content introduced in the session but also to engage in collaborative problem-solving, paving the way for more informed decision-making and analysis in future NDC tracking activities.

3.4. Application for Malawi context

The session marked an important milestone in enhancing national capacity for evidence-based climate planning and reporting. Key outcomes included strengthening the understanding of modelling tools and their application in national policy processes; increasing confidence among government and technical stakeholders in using the GACMO tool; creating a pathway for integrating GACMO into Malawi's future BTRs and other national communications. The next Steps are the following: continue developing national datasets and refining inputs to improve model accuracy; conduct follow-up sessions to apply GACMO across multiple sectors and ensure institutional memory.; and use GACMO outputs to support the development of costed mitigation plans and support access to climate finance.

4. Institutional Arrangements: Development of Sectoral Working Groups

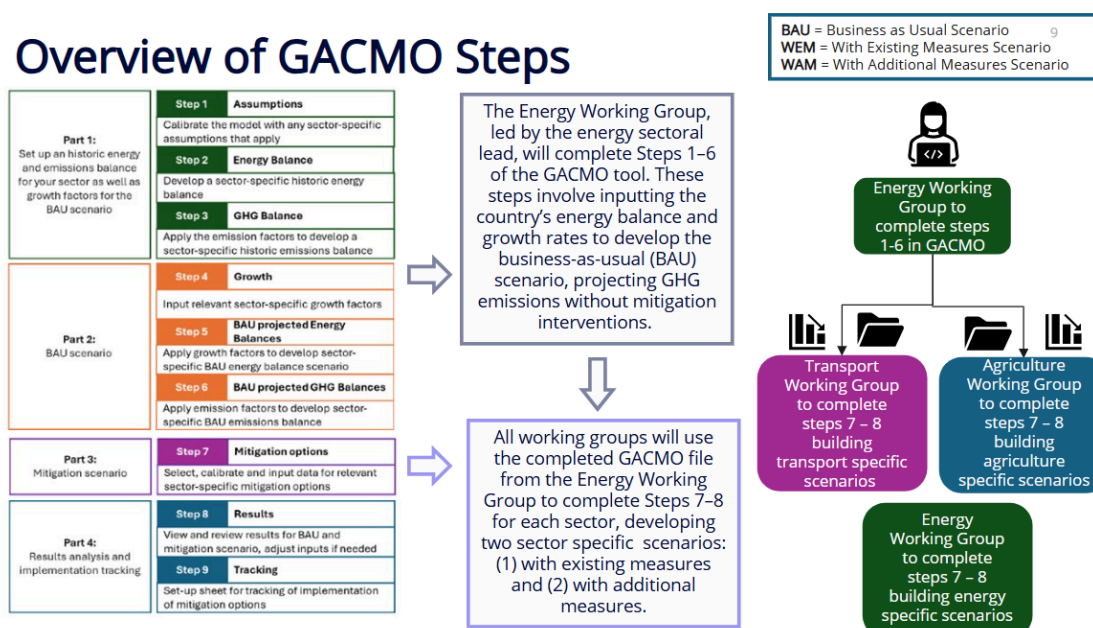
4.1. Structure and formation of sectoral groups

The sectoral working groups were established as part of a broader process to support the development of Malawi's GHG emissions projections. Each working group is composed of a designated **Sectoral Lead** and several **key members**, drawn from relevant government departments and agencies with expertise in the respective sectors. Membership was extended to individuals identified as key stakeholders, based on their roles and technical expertise. These individuals were formally invited to join the working groups following their successful completion of training on the GACMO Projections Modelling Tool. The structured composition of each group ensured strong leadership and cross-institutional representation, fostering informed and collaborative policy analysis across the energy, transport, and agriculture sectors. See Annex 3 for a list of the members within each sectoral working group.

The working groups receive technical support from the Ricardo technical expert team. Once the working groups deliver their outputs, the Ricardo team is responsible for the review and quality assurance process. Following this, the Ricardo team will integrate the results from across the different sectors, acknowledging the interconnectivity of the projections between the sectors. This integrated outcome is crucial for finalising a unified version of the GACMO tool for Malawi, which will then underpin the update of Malawi's NDC.

- a) The potential impact of individual mitigation options on reducing greenhouse gas emissions was evaluated using the GACMO tool
- b) The tool has quantified the emission reduction potential of each identified mitigation option and analysed the extent of emission reduction across sectors, projecting future years.
- c) The findings from the emission reduction potential may inform the decision-making in the prioritisation and selection of mitigation options for inclusion in the NDC update.

Overview of GACMO Steps



4.2. Sectoral working group troubleshooting sessions

As part of the capacity-building process, dedicated troubleshooting sessions were conducted with each of the sectoral breakout groups to address technical challenges and provide targeted support. These sessions allowed the sectoral teams to engage in detailed discussions on specific measures that required further clarification or assistance from the Ricardo team. During the sessions, the Ricardo team also carried out quality assurance checks on the modelling work and engaged with the Malawi teams to review and validate the underlying assumptions used in the application of the GACMO tool. In cases where certain policies and measures were not pre-defined within the GACMO tool – such as several interventions in the agriculture sector – the agriculture team collaborated closely with Ricardo to develop and refine the necessary parameters for modelling these measures accurately. These interactions played a critical role in enhancing the robustness and credibility of the sectoral modelling outputs.

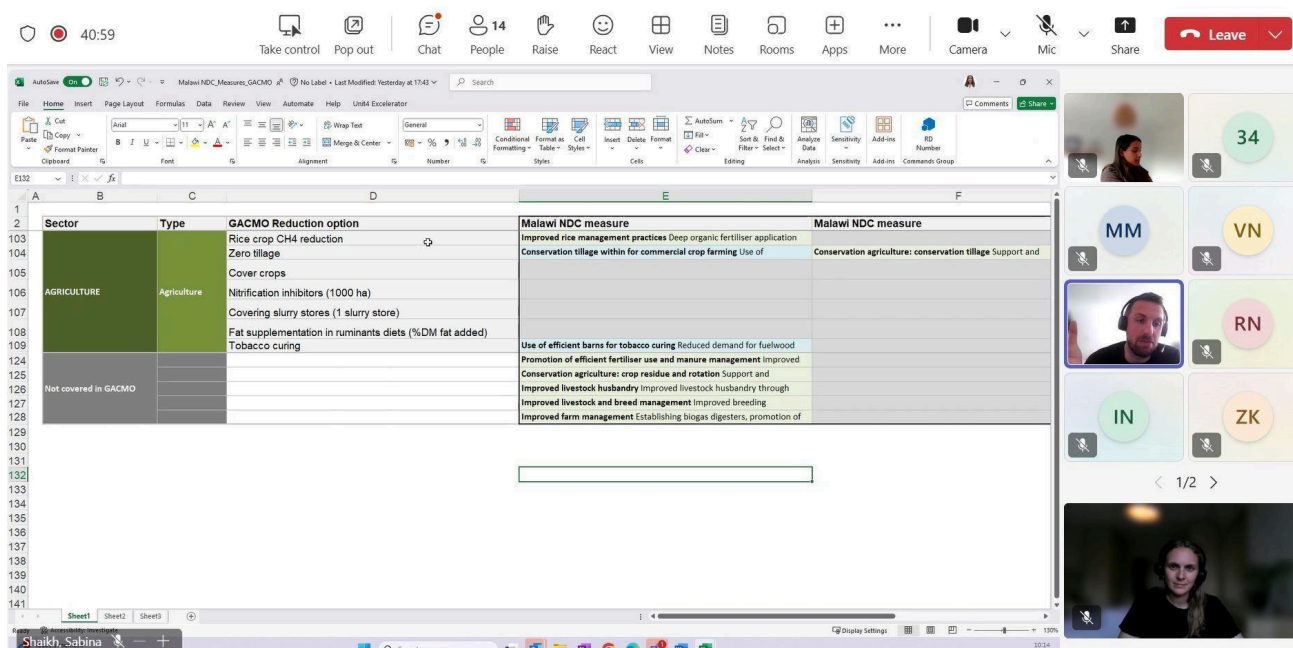


Figure 2: Screenshot from the Agriculture Working Group Troubleshooting Session.

5. Energy Sector

5.1. Introduction

Following completion of the GACMO training and targeted sectoral sessions (outlined in Sections 3 and 4), the Energy Working Group (WG) applied Steps 1–6 of the GACMO model using Malawi’s energy balance to develop both the Business-as-Usual (BAU) and projected BAU scenarios. These scenarios represent estimated GHG emissions in the absence of mitigation interventions, based on sector-specific growth rates and activity data.

Building on this foundation, the Energy WG proceeded to develop the With Existing Measures (WEM) scenario for the energy sector. The WEM scenario captures the impact of mitigation actions that are already planned, committed, or underway within Malawi. This process involved selecting mitigation options within the GACMO model that reflect the national energy context, including electricity generation, biomass use, and energy efficiency measures; Inputting adoption rates for each selected measure, informed by national policies, strategic plans, and stakeholder consultations; and Estimating the associated GHG reduction potential across defined timeframes, using GACMO’s embedded calculation methodologies.

Section 5.2 outlines the Energy WG’s approach in detail, including the mitigation options selected, data sources consulted, and adoption rates applied. Section 5.3 presents the key results generated by the GACMO model, including estimated GHG reductions from the selected energy sector measures. Section 5.4 discusses limitations encountered during the modelling process, particularly in relation to data availability and gaps in sector-specific data management systems.

5.2. Approach and Summary of Results

The Energy WG selected measures from the GACMO model for inclusion in the WEM scenario, drawing on Malawi’s NDC and sectoral expert judgement. Error! Figure 3. presents the full list of selected measures, inputted into GACMO.

ICAT Malawi Guidance Report on Sectoral GHG Projections

Total GHG mitigation in Malawi								Emission reduction in 2025			
Type	Reduction option	Sub-type unit	Emission reduction tCO ₂ e/unit	Investment Million US\$	Annual cost \$ M\$/year	Units penetrating in 2025	Net option tCO ₂ e/year	Net option tCO ₂ e/year	Frac of total	Added	
EE households	Efficient residential air conditioning	1000 airconditioners	766	-	-	-	-	77.31	0.6%		
	Efficient lighting with CFLs	1000 bulbs	37	-	-	-	-	77.31	0.6%		
	Efficient lighting with LEDs	1000 bulbs	36	-	-	-	-	77.31	0.6%		
	Efficient lighting with LEDs replacing CFL	1000 bulbs	6	-	-	-	-	77.31	0.6%		
	Efficient wood stoves	1000 stoves	1,434	8	-	1,298.6	1,859.28	1,936.57	13.8%		
	Efficient charcoal stoves	1000 stoves	293	18	-	37.6	86.54	2,023.11	14.4%		
	IP stoves replacing wood stoves	1000 stoves	2,055	7	-	36.68	219.0	2,073.59	17.7%		
	Efficient electric stoves	1000 stoves	152	11	-	0.82	25.93	2,099.33	17.8%		
	Industrial based cooking	1000 stoves	11	-	-	-	-	2,099.33	17.8%		
	New passive home	1000 new homes	8,344	-	-	-	-	2,099.33	17.8%		
Efficient refrigerators	1000 refrigerators	11,914	-	-	-	-	2,099.33	17.8%			
EE industry	Efficient electric motors	1 kW	0.6	-	-	-	-	2,099.33	17.8%		
	Energy efficiency in industry	10% red. of energy demand	41,382	-	-	-	-	2,099.33	17.8%		
EE own generation	Battery storage	1 million bolts	530	-	-	-	-	2,099.33	17.8%		
	Waste heat recovery at cement plant	1 cement plant	39,853	-	-	-	-	2,099.33	17.8%		
EE service	Waste heat recovery at steel plant	1 steel plant	26,704	-	-	-	-	2,099.33	17.8%		
	Efficient electric motors	1 kW	0.6	-	-	-	-	2,099.33	17.8%		
EE service	Efficient office lighting with CFL	1000 lights	38	-	-	-	-	2,099.33	17.8%		
	Efficient office lighting with LEDs	1000 lights	44	-	-	-	-	2,099.33	17.8%		
	Efficient street lights	1000 lights	385	-	-	-	-	2,099.33	17.8%		
	Efficient water pumping	4 million m ³ water	749	-	-	-	-	2,099.33	17.8%		
	IMC	100,000 m ² floor area	4,557	-	-	-	-	2,099.33	17.8%		
	Efficient Chiller > 300 TR	1 TR	2.0	-	-	-	-	2,099.33	17.8%		
	Efficient Chiller < 300 TR	1 TR	0.8	-	-	-	-	2,099.33	17.8%		
	Efficient room air conditioner	1 air conditioner	0.7	-	-	-	-	2,099.33	17.8%		
	Efficient commercial dehumidifier machine	1000 machines/day	109	-	-	-	-	2,099.33	17.8%		
	Efficient hotel refrigerator	1 refrigerator	0.4	-	-	-	-	2,099.33	17.8%		
	Efficient hotel washing machine	100 Guest Nights (GN)	0.06	-	-	-	-	2,099.33	17.8%		
	Energy efficiency in service	10% red. of energy demand	9,003	-	-	-	-	2,099.33	17.8%		
	New office building with central cooling	1000 m ²	34	-	-	-	-	2,099.33	17.8%		
	EE supply side	New natural gas power plant	1 MW	159	-	-	-	-	2,099.33	17.8%	
		Switch from fuel oil to diesel	1 MW	134	-	-	-	-	2,099.33	17.8%	
Switch from fuel oil to natural gas		1 MW	1,464	-	-	-	-	2,099.33	17.8%		
Cogeneration in industry		1 MW	542	-	-	-	-	2,099.33	17.8%		
Energy distribution	Single cycle to combined cycle	100 MW increase	75,738	-	-	-	-	2,099.33	17.8%		
	Efficient electric grids	1 GWh loss reduction	484	-	-	-	-	2,099.33	17.8%		
	Connection of solar grids to central grid	1 GWh consumption	484	-	-	-	-	2,099.33	17.8%		
	Power factor increases	1000 commerce/industry buildings	84,590	-	-	-	-	2,099.33	17.8%		
	District heating network rehabilitation (100,000 flats supplied)	100,000 flats supplied	33,648	-	-	-	-	2,099.33	17.8%		
	District cooling network (1 million m ² new city area covered)	1 million m ² new city area covered	132,226	-	-	-	-	2,099.33	17.8%		
Fight fire	Reduced flaring at oil field	1 MMSCF/day	22,813	-	-	-	-	2,099.33	17.8%		
	Reduced flaring at oil refineries	1 MMSCF/day	20,797	-	-	-	-	2,099.33	17.8%		
	Leak reduction in natural gas pipelines	1 Mm ³ CH ₄ /year leaking	15,078	-	-	-	-	2,099.33	17.8%		
	Chemical production	100,000 tons/year	149,805	15	-	3,235	6,57	4,337.85	24.5%		
Hydro	Hydro power connected to main grid	1 MW	1,923	453	-	3230	368	765.38	4,337.86	30.0%	
	Mini hydro power connected to main grid	1 MW	1,942	-	-	-	0	4,337.86	30.0%		
	Mini hydro power off grid	1 MW	2,232	3	0.08	0.24	0.78	4,337.74	30.0%		
	Solar water heater, residential	1000 locations	804	0	0.00	0	22.97	4,345.51	30.3%		
	Solar water heater, large	1 unit	30	-	-	-	-	4,345.51	30.3%		
	Solar PV, large grid	1 MW	886	1.24	8.60	1.24	106.87	4,355.38	31.1%		
	Solar PV, large grid with 2 hrs storage	1 MW	886	-	-	-	-	4,355.38	31.1%		
	Solar house PV	500 W	0.4	-	-	-	-	4,355.38	31.1%		
	Solar cottage PV	50 W	0.04	-	-	-	-	4,355.38	31.1%		
	Solar/ diesel mini-grid	40 kW from solar	58	-	-	-	-	4,355.38	31.1%		
	Solar LED lamps	1000 lamps	84	-	-	-	-	4,355.38	31.1%		
	Solar PV, small isolated grid, 10% solar	2,638	1	0.27	0	0.29	0	4,355.67	31.1%		
	Solar street lights	1000 locations (0.05 MW)	454	-	-	-	-	4,355.67	31.1%		
	Parabolic trough CSP, no storage	1 MW	738	-	-	-	-	4,355.67	31.1%		
	Solar tower CSP, with storage	1 MW	738	-	-	-	-	4,355.67	31.1%		
Wind	Wind turbines, onshore	1 MW	1,214	-	-	-	-	4,572.23	32.7%		
	Wind turbines, onshore with 24 storage	1 MW	1,328	-	-	-	-	4,572.23	32.7%		
	Wind turbines, off-shore	1 MW	1,554	-	-	-	-	4,572.23	32.7%		

Figure 3: GACMO Mitigation options for Energy sector

Figure 4 presents emissions under two scenarios: without measures and with measures in the energy sector, as well as emission reduction potential as modelled by GACMO. Emissions with measures (mitigation options) are always below emissions without measures (BAU scenario). Emissions without measures are projected to reach 16,648.89 ktCO₂e in 2050, while if all the listed measures are implemented, the emission would reach 11,062.41 ktCO₂e in 2050 contributing an emission reduction potential of 5,586.45 ktCO₂e in 2050.

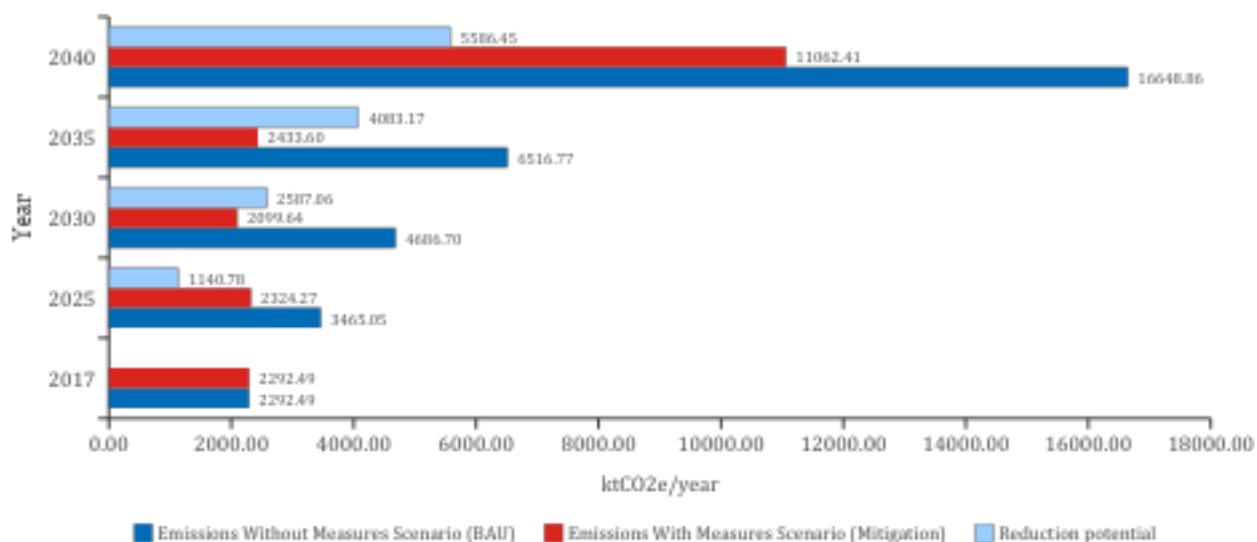


Figure 4: Analysis of emissions under measures and without measures in the Energy Sector

Emission reduction potential as in Figure 4, indicates that if implemented, Malawi would be on track to achieve its NDCs by 2040. In the energy sector, the significant contributor to emission reduction is large scale hydropower project in the power generation category.

In coming up with emission with measures scenario (mitigation), measures in terms of penetration units were inputted in GACMO in the “mitigation option” module. This is an important part of emissions analysis using GACMO because it describes the measures that Malawi has put in place to reduce GHG emissions through its actions, policies, strategies and projects. Table 4 shows descriptions on the mitigation options (measures) in GACMO with penetration units obtained from Malawi’s strategic documents and methodology used to estimate penetration units in future. Table 4 is a useful framework that stakeholders could use to enhance transparency of the resulting emissions calculation results, hence determining progress and ultimately achievement of NDCs.

Table 4: Description on mitigation options (measures) in terms of penetration units, data sources and methodology to estimating penetration in the energy sector

Mitigation Options as in GACMO	Sub-unit	Yearly Penetration units				Data sources	Methodology to estimating the units of penetration for each year and assumptions
		2025	2030	2035	2050		
Efficient wood stoves	1000 stoves	1,296.6	2,056	2,985	4,502	Malawi Energy Compact, Department of Energy	Extrapolation using linear growth

Efficient charcoal stoves	1000 stoves	295.4	278	248	390	Malawi Energy Compact, Department of Energy	Extrapolation using linear growth
LPG stoves replacing wood stoves	1000 stoves	219.0	833	1,607	2,808	Malawi Energy Compact, Department of Energy	Extrapolation using linear growth
Efficient electric stoves	1000 stoves	170.4	444	819	3,109	Malawi Energy Compact, Department of Energy	Extrapolation using linear growth
Hydro power connected to main grid	1 MW	398	618.6	894.4	982	Department of Energy. Revised Integrated Resource Plan	Extrapolation using linear growth
Mini hydro power connected to main grid	1 MW	0	0	0	0.63	Department of Energy	Extrapolation using linear growth
Mini hydro power off grid	1 MW	0.24	0.30	1	1.5	Malawi Energy Compact, Department of Energy	Extrapolation using linear growth
Solar water heater, residential	1000 locations	27	40	53	91	Malawi Energy Compact, Department of Energy	Extrapolation using linear growth
Solar PVs, large grid	1 MW	124	395	940	956	Malawi Energy Compact, Department of Energy	Extrapolation using linear growth
Solar PVs, small isolated grid, 100% solar	1 MW	0.110	0.352	1.187	2.632	Malawi Energy Compact, Department of Energy	Extrapolation using linear growth
Wind turbines, on-shore	1 MW	0	167	415	615	Revised Integrated Resource Plan	Extrapolation using linear growth

Table 4 also provides space to document the data sources, methodologies, and assumptions used to estimate technology penetration. It makes future revision of the mitigation options have relevant foundation for reference. A critical issue was raised during discussions with the Energy Working Group was that emissions from the burning of charcoal and firewood in the household sector have not been allocated in the Energy Balance hence GHG balance in GACMO. To address this, as an improvement in the emissions analysis using GACMO, future analysis should consider to allocate these biomass sources appropriately using available national data or estimates consistent with the GHG Inventory. By doing so,

the model will provide a more accurate reflection of household sector emissions, ensuring consistency with national reporting and enabling a more robust assessment of mitigation options related to clean cooking and biomass use. Currently, the emissions associated with the burning of charcoal and firewood are not reflected in the household sector, leading to an underestimation of emissions.

Further, it is recommended, as an improvement to categorise emissions with measures into existing and planned measures that are part of Malawi's NDC (WEM Scenario) vs With Additional Measures (WAM Scenario). This has to be done using the Malawi's NDC-3 (being revised at the time of carrying out this work). These additional actions can be explored under a separate, third mitigation scenario called the WAM. This distinction ensures that the mitigation pathway remains consistent with national commitments and provides a clear baseline for evaluating enhanced ambition in the future.

5.3. Gaps in data availability, management, institutional arrangements, and resources

Creation of a firm GHG emission analysis framework requires having quality data and their access. There are gaps in accessing data and this challenge is mentioned in many documents related to GHG Inventory and Emissions reduction in Malawi. Through discussions, the following gaps in data availability, management, institutional arrangements and resources were unearthed.

- a) Difficulty in finding disaggregated data by sectors (e.g Agriculture, Mining, Industry, etc.) especially on Fossil Fuels and Electricity consumption.
- b) Lack of a centralised and standardised data platform leads to data inconsistencies as information is sourced from multiple documents and institutions. While this is a common challenge in many developing countries, the absence of single, integrated energy data management and sharing system impedes analysis and policy development.
- c) Data accuracy and reliability- data in the model was different from the data that we found from different institutions.
- d) Lack of dedicated officers to collect and manage data in institutions and those that are there don't have adequate capabilities.
- e) Lack of regulations on collection and management of energy data.
- f) Limited data management infrastructure in institutions.
- g) Limited funding allocated for data collection and management in institutions.

5.4. Challenges experienced during the development of the GACMO model

GACMO as a tool for analysis GHG emissions under different scenarios, projecting emissions under assumptions and calculating their effects. Being a tool introduced in the country through the training of key stakeholders, challenges were there, as follows as reported by the energy sector working group:

- a) Time given was limited for completing the GACMO development task
- b) Limitation in prior GACMO knowledge or capacity for experts who joined the team at Sectoral Working Group level since they did not attend the GACMO training
- c) Lack of sources of pre-filled data rendering data validation and verification difficult.
- d) Limitations in financial resources to convene physical meetings to collect and input data into the GACMO model. We therefore resorted to virtual meetings which were not very effective.
- e) Other data challenges included limited data availability and inconsistent data sources

5.5. Recommendations related to QA/QC procedures

The following recommendations, related to quality assurance and quality control are made, according to energy sector working:

- a) Capacity building for the Working Group members who were not trained on the GACMO model,
- b) There is a need to have single integrated platform for Energy data management and dissemination
- c) ESCOM, MERA, NOCMA and Ministry of Mining should be capacitated so that they are able to collect electricity and fossil fuel consumption data that is disaggregated by sectors such as mining, Agriculture, Industry, Service, etc.
- d) As part of NDC enhancement, there is a need to consider increasing investment in energy data collection and management.

6. Transport Sector

6.1. Introduction

Once the GACMO training and targeted sectoral sessions were completed (as outlined in Sections 3 and 4), the Energy Working Group (WG) undertook Steps 1–6 in the GACMO model to develop the Business-as-Usual (BAU) and projected BAU scenarios, that is. projected GHG emissions in the absence of mitigation interventions. Using the GACMO file prepared by the Energy WG, the Transport WG developed the With Existing Measures (WEM) scenario for the transport sector. The WEM scenario shows the impact of actions that are already planned and committed within Malawi. This involved selecting mitigation options within the GACMO model that reflect the Malawian context, inputting adoption rates for each measure, and estimating the associated GHG reduction potential across defined timeframes. Building on the transport-specific Step 7 guidance the Transport WG undertook the following steps:

- a) Navigated the GACMO file developed by the Energy WG, reviewing and validating the growth rates and projected GHG emissions for the transport sector.
- b) Identified transport-specific mitigation measures from national policies and plans, including Malawi's NDC, and mapped them to the predefined options available in GACMO for alignment between NDC measures and GACMO options).
- c) Where alignment existed, the Transport WG translated the NDC measures and targets (where specified) into GACMO-compatible units and entered adoption rates across specified timeframes.

Section 6.2 provides an overview of the approach taken by the transport WG, including what mitigation options the WG selected, data sources and adoption rates. Section 6.3 then presents a summary of the key results generated by the GACMO model, including estimated GHG reductions from the selected mitigation measures in the transport sector. Section 6.4 highlights the limitations encountered during the modelling process, specifically relating to data availability, and gaps in sector-specific data management systems.

6.2. Approach

The approach used was similar to the one the Energy Working Group followed. For the development of with- existing-measures (WEM) scenario, the Transport Working Group (WG) firstly mapped Malawi's transport-related NDC measures to the predefined mitigation options available in the GACMO model. Overall, the Transport WG selected five GACMO mitigation options to model under the WEM scenario, as

these are reflected in Malawi's NDC. Table 5 presents the description of the mitigation options under the WEM scenario, covering penetrations units for 2025, 2030, 2035 and 2050 including data sources and methodology for estimating projection of penetration units.

Table 5: Description on mitigation options (measures) in terms of penetration units, data sources and methodology to estimating penetration in the transport sector

Mitigation Options as in GACMO	Sub-unit	Yearly Penetration units				Data sources	Methodology to estimating the units of penetration for each year and assumptions
		2025	2030	2035	2050		
20% Bioethanol blend in all gasoline	15% blend in transport	0.667	0.8	0.9333	1.332	Ministry of energy, MERA, NOCMA projections	Extrapolation using linear growth
Bus Rapid Transit (BRT)	1 km BRT line	41.72	73.72	98.29	215.29	Using the projections from BRT Routes summary sheet	Extrapolation using linear growth
Electric cars	1000 cars	0.05	1	2	5	Ministry of energy, MRA, DRTSS data from registrations and taxations	Extrapolation using linear growth
New bicycle lanes	1 km bicycle lane	41.72	73.72	98.29	215.29	Dual carriage roads SATCC design accommodates lane for bicycles	Extrapolation using linear growth
Electric two-wheelers	1000 two-wheelers	0.28	2	5	10	Ministry of energy, MRA, DRTSS data from registrations and taxations	Extrapolation using linear growth

Some of the mitigation options that are in Malawi's NDC were not analysed because of limitation in data in penetration units. It is recommended that since the transport sector is the significant emitting source of GHG in Malawi, NDCs for transport sector should be analysed accordingly. For the five mitigation options in Table 5, the penetration units were inputted in the GACMO accordingly, describing WEM emission scenario, whose summary of results are presented in the following section.

6.3 Summary of results

Summary of emissions and mitigation potential in the transport sector from GACMO modelling is presented in Table 6. The emissions under BAU scenario reach 3,874.94 ktCO₂e in 2050 from 1,008.69 ktCO₂e in 2017. Of course, it is expected that BAU could be more than this considering that fuel consumption in the transport sector could grow exponentially reflecting increase in number of vehicles. Therefore, an improvement in the assumption in the BAU could be made.

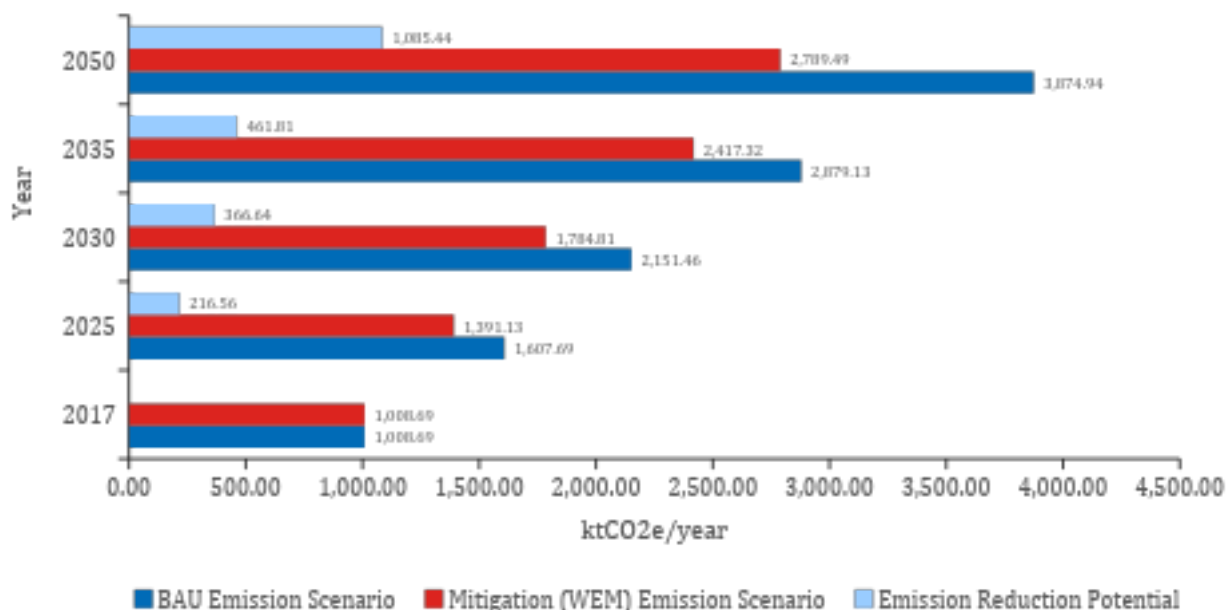


Figure 5: Summary of emissions analysis in the transport sector using GACMO

Emission under WEM scenario (mitigation scenario with existing measures) show that the emissions are in all years below the BAU emission scenario. This indicate the potential of emission reduction. In 2050, the emission reduction potential from the 5 mitigation options resulted in reduction of 1085.44 ktCO₂e in 2050. If all mitigation options in Malawi NDC are analysed, significant mitigation reduction potential would be achieved.

7. Agriculture Sector

7.1 Introduction

Similarly, to the Transport Sector, using the GACMO file prepared by the Energy WG, the Agriculture WG developed the With Existing Measures (WEM) scenario specific to the agriculture sector. The WEM scenario shows the impact of actions that are already planned and committed within Malawi in the agriculture sector. This involved selecting mitigation options within the GACMO model that reflect the Malawian context, inputting adoption rates for each measure, and estimating the associated GHG reduction potential across defined timeframes. Building on the agriculture-specific Step 7 guidance the agriculture WG undertook the following steps:

- a) Navigated the GACMO file developed by the Energy WG, reviewing and validating the growth rates and projected GHG emissions for the agriculture sector.
- b) Identified agriculture-specific mitigation measures from national policies and plans, including Malawi’s NDC, and mapped them to the predefined options available in GACMO alignment between NDC measures and GACMO options).
- c) Where alignment existed, the Agriculture WG translated the NDC measures and targets (where specified) into GACMO-compatible units and entered adoption rates across specified timeframes.

7.2 Approach

To develop the WEM scenario, the Agriculture WG first mapped Malawi's agriculture-related NDC measures to the predefined mitigation options available in the GACMO model. Table 6 presents the alignment between the NDC measures and the corresponding GACMO mitigation options. Overall, the Agriculture WG selected four GACMO mitigation options to model under the WEM scenario, because these are reflected in Malawi's NDC. It is important to note, from Table 6, that there are five NDC measures under the agriculture sector that do not easily align to a mitigation option in GACMO.

Table 6: Mapping of Malawi agriculture specific NDC measures to GACMO's pre-defined mitigation options

Sector	GACMO Reduction option	Malawi NDC measure	Malawi NDC measure
	Rice crop CH ₄ reduction	Improved rice management practices Deep organic fertiliser application and improved biomass and fertilizer management in rice and nitrification inhibitors application, resulting in reduced N ₂ O emissions from mineral N-fertilizer use.	
	Zero tillage	Conservation tillage within for commercial crop farming Use of conservation or zero tillage farming, resulting in avoided GHG emissions from diesel use in tractors used in ploughing and tilling before crop planting.	Conservation agriculture: conservation tillage Support and implementation of the planned expansion targets for conservation tillage to improve soil conservation, resulting in increase of soil carbon stock and improved crop yields.
	Cover crops	N/A	
	Nitrification inhibitors (1000 ha)	N/A	
	Covering slurry stores (1 slurry store)	N/A	
	Fat supplementation in ruminants diets (%DM fat added)		
	Tobacco curing	Use of efficient barns for tobacco curing Reduced demand for fuelwood required in tobacco curing from 2025-2040 by use of efficient barns, resulting in avoided CH ₄ and N ₂ O emissions from fuelwood combustion.	
		Promotion of efficient fertiliser use and manure management Improved fertiliser management through increased use of organic waste in soil fertilizers and compost manure, increasing carbon stock retention in soils, and reduced N ₂ O emissions from mineral N-fertilizer use.	

		Conservation agriculture: crop residue and rotation Support and implementation of the planned expansion targets for crop residue and crop rotation to improve soil conservation, resulting in increase of soil carbon stock and improved crop yields.	
		Improved livestock husbandry Improved livestock husbandry through expansion of new fodder area under <i>Brachiaria</i> and <i>Napier</i> , reducing CH ₄ emissions from enteric fermentation and increasing biomass carbon stock.	
		Improved livestock and breed management Improved breeding management to increase meat and milk yields, including through species replacements, encouragement of semi-intensive feeding system and diversification, resulting in reduced CH ₄ emissions from enteric fermentation.	
		Improved farm management Establishing biogas digesters, promotion of collective farms, improved manure management and promotion of slurry systems, resulting in reduced or avoided N ₂ O and CH ₄ emissions.	

The Agriculture Working Group described the mitigation options in terms of units and their penetration for 2025, 2030, 2035 and 2050, including sources of data and methodology for estimating penetration units. It can be seen from Table 7, that the Agriculture Working Group presented description of mitigation measures including those that are not included in GACMO. From these mitigation options, only two of them were inputted into GACMO because the data was readily available. These are Rice crop CH₄ reduction, and Fat supplementation in ruminants diets (%DM fat added).

Table 7: Description of mitigation options in Agriculture sector including those in GACMO in terms of penetration units and their projection

Mitigation reduction options	Sub type unit	Years	Penetration units	Data Sources	Methodology to estimating the units of penetration for each year and assumptions
Solar powered water pump (Climate Smart Farm Mechanization)	Add the penetration units selected by the agriculture team for each year	2025	7,000	UNDP Malawi 2023 report	Linear growth as National agriculture Policy demands implementation of climate smart Agriculture interventions by all stakeholders and also expert judgement was
		2030	10000	Sun Culture Kenya 2023	
	1 Solar pump	2035	15000	Ministry of energy (Q1 2024)	
		2050	18000	WFP resilience program 2024	
Promotion of Hermetic bags for effective grain storage	Percentage with access to hermetic bags	2025	20%	WFP Malawi 2023 report	
		2030	27%	AGRA 2024 Policy briefs	
		2035	34%	NASFAM field data 2024	

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		2050	55%		used in solar powered water pumps, integrated pest and disease management, migratory pest control, fat supplementation
Integrated Pest and Disease Management	1000Ha	2025	1500	FAO Malawi IPDM surveys 2021	
		2030	1350	NASFAM impact reports 2022	
		2035	1200	Min of Agric . Quarterly Bulletins period 2023/24 period	
		2050	1150	AGRA policy briefs 2024	
Migratory pest control		2025	400	FAO Malawi	
	1000Ha	2030	370	IPDM surveys 2021	
		2035	320	NASFAM Impact reports 2022	
		2050	290	Min. of Agric. Quarterly Bulletins 2024	
Improved farm management through promotion of biogas plants usage		2025	2200	Ecogen Reports 2025	
	1 biogas plant	2030	4000		
		2035	7500	FAO Malawi bioenergy for Resilience Report 2021	
		2050	11500		
Rice crop CH4 reduction	1000ha	2025	30	Min of Agriculture; APES reports, DCD reports, Dol reports	
		2030	35		
		2035	40		
		2050	55		
Improved livestock husbandry through fodder management		2025	30	World bank climate smart agriculture report 2023	
	1000 ha	2030	35		
		2035	40	Ministry of Agric. DAHLD report 2022	
		2050	55		
Fat supplementation in ruminants diets (%DM fat added)	Percentage	2025	1	Expert judgement	
		2030	1.5		
		2035	2		
		2050	3		
Breed management improvement	1 head of animal	2025	800	Agric. Reports 2024, NGO reports eg CREMPA, K2 Tasso organization reports	
		2030	1600		
		2035	2400		
		2050	4800		

Inputting units penetrating in the years 2025, 2030, 2035, and 2050 for the two mitigation options as in Figure 6 produced results that are discussed in the following section.

Total GHG mitigation in Malawi		Sub-type unit	Emission reduction tCO ₂ e/unit	Investment Million US\$	Annual costs MUS\$/year	Units penetrating in 2025	Emission reduction in 2025		
Type	Reduction option						Per option ktCO ₂ e/year	Added ktCO ₂ e/year	Frac. of total
Agriculture	Rice crop CH ₄ reduction	Rice crop CH ₄ red.(1000 ha)	2,566	39	7.46	30	76.99	76.99	0.5%
	Zero tillage	1000 ha	86	-	-	-	76.99	76.99	0.5%
	Cover crops	1000 ha	1,490	-	-	-	76.99	76.99	0.5%
	Nitrification inhibitors (1000 ha)	1000 ha	790	-	-	-	76.99	76.99	0.5%
	Covering slurry stores (1 slurry store)	1 slurry store	0.20	-	-	-	76.99	76.99	0.5%
	Fat supplementation in ruminants diets (%DM.fat.added)	%DM fat added	325	-	0.03	1	0.33	77.31	0.6%
	Tobacco curing	100 t tobacco/yr	562	-	-	-	-	77.31	0.6%

Figure 6: Mitigation options for Agriculture sector as in GACMO for year 2025

It is expected that in future, remaining mitigation options as in Table 7 will be inputted in GACMO so that complete analysis of mitigation measures in the Agriculture sector is possible.

7.3 Summary of results

Figure 7 summarises the key outputs from the GACMO modelling for the agriculture sector. It presents estimates of Business-as-Usual (BAU) in 2017 and projected BAU scenarios up to 2050. Under the projected BAU, the total greenhouse gas emissions are expected to increase to 57,728 ktCO₂e by 2050 from 4,900 ktCO₂e in 2017, making the Agriculture sector the major emitter of GHG emission, as per this GHG emission analysis using GACMO. Mitigation options analysed were only two and the emissions reductions are correspondingly small. The emissions under mitigation scenario (with existing measures) are below BAU emission scenario, but close to the BAU. In 2050, the emissions under mitigation scenario are projected to be 57,456 ktCO₂e with an emission reduction potential of only 272 ktCO₂e. It is expected that if all mitigation options in the Agriculture Sector are analysed in GACMO, the emission reduction potential would significantly increase.

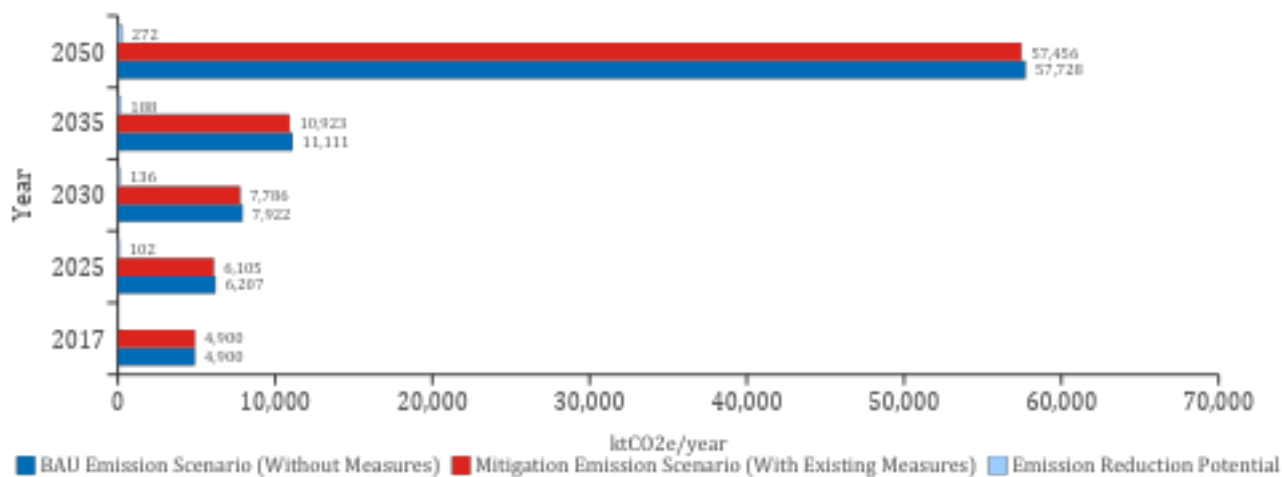


Figure 7: Emissions analysis in Agriculture sector using GACMO

Table 8 presents Malawi NDC measures that are not included in GACMO. It is recommended that GACMO developers assist to include the measures for the Malawi GACMO file.

Table 8. NDC measures not included in the WEM scenario in GACMO currently

Sector	GACMO Reduction option	Malawi NDC measure

Not covered in GACMO	N/A	Promotion of efficient fertiliser use and manure management Improved fertiliser management through increased use of organic waste in soil fertilizers and compost manure, increasing carbon stock retention in soils, and reduced N ₂ O emissions from mineral N-fertilizer use.
	N/A	Conservation agriculture: crop residue and rotation Support and implementation of the planned expansion targets for crop residue and crop rotation to improve soil conservation, resulting in increase of soil carbon stock and improved crop yields.
	N/A	Improved livestock husbandry Improved livestock husbandry through expansion of new fodder area under <i>Brachiaria</i> and <i>Napier</i> , reducing CH ₄ emissions from enteric fermentation and increasing biomass carbon stock.
	N/A	Improved livestock and breed management Improved breeding management to increase meat and milk yields, including through species replacements, encouragement of semi-intensive feeding system and diversification, resulting in reduced CH ₄ emissions from enteric fermentation.
	N/A	Improved farm management Establishing biogas digesters, promotion of collective farms, improved manure management and promotion of slurry systems, resulting in reduced or avoided N ₂ O and CH ₄ emissions.

8. Emissions analysis from Energy, Transport and Energy Sectors

Mitigation options from the three sectors: energy, transport and agriculture were analysed in GACMO consolidated file, as in Figure 8. The consolidated emissions analysis results from consolidated GACMO are presented in Table 9 for each of the sectors.

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Selected year: 2025

Total GHG mitigation in Malawi

Type	Reduction option	Sub-type unit	Emission reduction tCO2e/unit	Investment Million US\$	Annual abate MMBtu/year	Units per abating in 2025	Emission reduction in 2025		
							Per option	Added	Frac. of total
							ktCO2e/year	ktCO2e/year	Frac. of total
Agriculture	Rice crop CH4 reduction	Rice crop CH4 and (1000 ha)	2,396	59	746	50	76.99	76.99	0.3%
	Coarse rice	1000 ha	96	-	-	-	76.99	76.99	0.3%
	Coarse rice	1000 ha	1,490	-	-	-	76.99	76.99	0.3%
	Nitric acid inhibitors (1000 ha)	1000 ha	200	-	-	-	76.99	76.99	0.3%
	Covering slurry stores (1 slurry store)	1 slurry store	70	-	-	-	76.99	76.99	0.3%
	Butylamine application in rumen (0.5% DM feed)	%DM (at add-on)	525	-	0.05	1	0.55	77.51	0.4%
	Biogas cooking	1000 L (kWh/year)	392	-	-	-	77.51	77.51	0.4%
	Biogas cooking plants	1 MWh (energy value)	9,719	-	-	-	77.51	77.51	0.4%
	Biogas power from biomass (at plant)	1 MWh (CH4 plant)	2,458	-	-	-	77.51	77.51	0.4%
	Biogas power	1000 L (kWh/year)	9,291	-	-	-	77.51	77.51	0.4%
CCS	CCS plant	1 MWh	3,412	-	-	-	77.51	0.4%	
Cement	CCS replacement	1000 tons (cement/day)	199,384	-	-	-	77.51	0.4%	
Coal bed methane	Coal mine methane	10 M (M3 CM4/year)	27,535	-	-	-	77.51	0.4%	
Households	Efficient lighting with CFLs	1000 Appliances	766	-	-	-	77.51	0.4%	
	Efficient lighting with LEDs	1000 Bulbs	57	-	-	-	77.51	0.4%	
	Efficient lighting with LEDs replacing CFL	1000 Bulbs	76	-	-	-	77.51	0.4%	
	Efficient wood stoves	1000 Stoves	1,454	3	1,296.6	1,339.26	1,339.26	1.3%	
	Efficient charcoal stoves	1000 Stoves	295	10	576	202.4	202.4	1.4%	
	LPG stoves replacing wood stoves	1000 Stoves	2,033	7	56.68	219.0	430.00	2,475.19	1.7%
	Efficient electric stoves	1000 Stoves	132	11	632	170.4	23.35	2,499.15	1.7%
	Induction based cooking	1000 Stoves	11	-	-	-	2,499.15	1.7%	
	New passive to me	1000 New to me	3,544	-	-	-	2,499.15	1.7%	
	Efficient refrigerator	1000 Refrigerators	1,193.4	-	-	-	2,499.15	1.7%	
	Industry	Efficient electric motors	1 MW	0.6	-	-	-	2,499.15	1.7%
		Energy efficiency in industry	10% red. of energy demand	41,182	-	-	-	2,499.15	1.7%
		Building materials	1 million bricks	320	-	-	-	2,499.15	1.7%
	Power generation	Waste heat recovery at cement plant	1 Cement plant	39,335	-	-	-	2,499.15	1.7%
		Waste heat recovery at steel plant	1 Steel plant	26,764	-	-	-	2,499.15	1.7%
Service	Efficient electric motors	1 MW	0.6	-	-	-	2,499.15	1.7%	
	Efficient office lighting with CFLs	1000 lights	53	-	-	-	2,499.15	1.7%	
	Efficient office lighting with LEDs	1000 lights	44	-	-	-	2,499.15	1.7%	
	Efficient street lights	1000 lights	533	-	-	-	2,499.15	1.7%	
	Efficient water pumping	4 Million m3 water	749	-	-	-	2,499.15	1.7%	
	Efficient chillers 300 TR	10000 m2 floor area	4337	-	-	-	2,499.15	1.7%	
	Efficient chillers 300 TR	1 TR	4	-	-	-	2,499.15	1.7%	
	Efficient room air conditioner	1 Air conditioner	0.7	-	-	-	2,499.15	1.7%	
	Efficient commercial washing machine	1000 wash/day	10.9	-	-	-	2,499.15	1.7%	
	Efficient home refrigerator	1 refrigerator	0.4	-	-	-	2,499.15	1.7%	
	Efficient home washing machine	1000 Wash (G/M)	0.09	-	-	-	2,499.15	1.7%	
	Energy efficiency in service	10% red. of energy demand	3001	-	-	-	2,499.15	1.7%	
	Efficient building with central cooling	1000 m2	24	-	-	-	2,499.15	1.7%	
	Supply side	New renewable power plant	1 MWh	130	-	-	-	2,499.15	1.7%
		Switch to fuel oil to diesel	1 MWh	124	-	-	-	2,499.15	1.7%
Switch to fuel oil to natural gas		1 MWh	1,434	-	-	-	2,499.15	1.7%	
Cogeneration in industry		1 MWh	342	-	-	-	2,499.15	1.7%	
Energy distribution	Single cycle to combined cycle	1000 MWh increase	73,750	-	-	-	2,499.15	1.7%	
	Efficient electric grids	1000 MWh reduction	496	-	-	-	2,499.15	1.7%	
	Connection of isolated grid to central grid	1000 kWh savings/year	406	-	-	-	2,499.15	1.7%	
	Power factor increase	1000 kWh savings/year	34,300	-	-	-	2,499.15	1.7%	
	District heating network rehabilitation (100,000 flats supplied)	100,000 flats supplied	52,940	-	-	-	2,499.15	1.7%	
	District cooling network (1 million m2 new city area covered)	1 million m2 new city area covered	15,226	-	-	-	2,499.15	1.7%	
	Reforestation	Reforestation of 1000 ha	5997	-	-	-	2,499.15	1.7%	
Forest	REDD: Avoided deforestation	Reforestation of 1000 ha	5997	-	-	-	2,499.15	1.7%	
	REDD: Reduced emissions from deforestation and forest degradation	Reforestation of 1000 ha	5997	-	-	-	2,499.15	1.7%	
	Reforestation with agroforestry	Reforestation of 1000 ha	5997	-	-	-	2,499.15	1.7%	
	Reforestation with agroforestry	Reforestation of 1000 ha	5997	-	-	-	2,499.15	1.7%	
Fossil fuel switch	Switch to coal to natural gas in industry	1000 t (fuel use/year)	4330	-	-	-	2,499.15	1.7%	
	Switch to fuel oil to natural gas in industry	1000 t (fuel use/year)	2,127	-	-	-	2,499.15	1.7%	
	Reduced fueling at oil field	1 M M3CJ/day	2,291.5	-	-	-	2,499.15	1.7%	
Fugitive	Reduced fueling at oil refineries	1 M M3CJ/day	20,797	-	-	-	2,499.15	1.7%	
	Leak reduction in natural gas pipelines	1 M M3CJ/year leakage	13,078	-	-	-	2,499.15	1.7%	
	Chemical production	100000 t (chemicals/year)	141,000	16	5.29	6.32	5,452.38	24.3%	
	Geothermal	Geothermal power	1 MWh	2,099	-	-	0	5,452.38	24.3%
Hydro, PNO, SM6	Geothermal heat	1000 m2 heated area	17	-	-	-	5,452.38	24.3%	
	Reduced PFC from aluminum production	100000 tons Al (annual mty)	11,1330	-	-	-	5,452.38	24.3%	
Hydro	Hydro power connected to main grid	1 MWh	1,925	435	52.50	593	763.50	4,197.96	50.0%
	Mini hydro power connected to main grid	1 MWh	1,942	-	-	0.00	-	4,197.96	50.0%
	Mini hydro power off-grid	1 MWh	2,252	1	0.03	0.24	0.78	4,198.74	50.0%
Land fill	Landfills plant with power production	200 t/day plant	1,244.13	-	-	-	4,198.74	50.0%	
	Landfills plant	1 t/day plant	1,244.13	-	-	-	4,198.74	50.0%	
	Incineration plant	200 t/day plant	1,593.31	-	-	-	4,198.74	50.0%	
	Recycling of plastics	1000 t M3M/year plant	1,093	-	-	-	4,198.74	50.0%	
	Re-use of used fuel (ROF) from MEW	200 t/day plant	20,209	-	-	-	4,198.74	50.0%	
	Biogas from Municipal Solid Waste	1000 t/year plant	12,187	-	-	-	4,198.74	50.0%	
Methane	Gas capture at industrial sites (at plant)	1 MWh of value power	4,129,292	-	-	-	4,198.74	50.0%	
	Waste	1 MWh of value power	1,279	-	-	-	4,198.74	50.0%	
Methane avoidance	Biogas at rural farms using renewable	1000 units	1,220	-	-	-	4,198.74	50.0%	
	Biogas at rural farms using non-renewable fuel wood	1000 units	11,274	1	0.12	2.2	24.30	4,223.34	50.2%
	Biogas at big farms	34000 pigs	71,521	-	-	-	4,223.34	50.2%	
	Biogas from industrial waste water	1 plant	23,903	-	-	-	4,223.34	50.2%	
	Biogas at plant (1000 m3/day)	1000 tons (M3/day)	39,003	-	-	-	4,223.34	50.2%	
	Solar water heater, residential	1000 locations	304	0	0.00	27	21.97	4,245.31	50.5%
	Solar water heater, large	1 unit	50	-	-	-	4,245.31	50.5%	
	Solar PV, large grid	1 MWh	339	124	3.60	1.24	109.97	4,335.28	51.1%
	Solar PV, large grid with 24h storage	1 MWh	339	-	-	-	4,335.28	51.1%	
	Solar home PV	300 W	0.4	-	-	-	4,335.28	51.1%	
Solar	Solar home PV	30 W	0.04	-	-	-	4,335.28	51.1%	
	Solar water heating kit	40 L (from solar)	30	-	-	-	4,335.28	51.1%	
	Solar LED lamps	1000 lamps	94	-	-	-	4,335.28	51.1%	
	Solar PV, small to medium grid, 1000 solar	2 MW	2,620	1	0.27	0	0.20	4,335.97	51.1%
	Solar street lights	1000 locations (0.03 MW)	434	-	-	-	4,335.97	51.1%	
	Plug and charge through CSP, no storage	1 MWh	720	-	-	-	4,335.97	51.1%	
	Solar tower CSP, with storage	1 MWh	720	-	-	-	4,335.97	51.1%	
	10% bio level blend in 4 diesel	10% bio level blend in 4 diesel	18,531.5	-	-	-	4,335.97	51.1%	
	20% bio level blend in 4 diesel	20% bio level blend in 4 diesel	13,330.0	-	-	40.65	0.9667	4,400.15	51.9%
	Bus Rapid Transit (BRT)	1 km BRT lane	1,985	133	20.53	41.72	32.75	4,345.48	52.3%
	More efficient gasoline cars	1000 cars	409	-	-	-	4,345.48	52.3%	
	More efficient diesel cars	1000 cars	180	-	-	-	4,345.48	52.3%	
	Natural Gas cars	1000 cars using natural gas	770	-	-	-	4,345.48	52.3%	
	Electric cars	1000 cars	935	0	0.05	0.03	0.00	4,345.55	52.3%
	Electric 10m buses	1000 buses	29,717	-	-	-	4,345.55	52.3%	
Electric 12m buses	1000 buses	15,575	-	-	-	4,345.55	52.3%		
Electric heavy trucks	1000 trucks	10,490	-	-	-	4,345.55	52.3%		
Electric light trucks	1000 trucks	6,090	-	-	-	4,345.55	52.3%		
Electric mail	1 Million letters/year	2,282	-	-	-	4,345.55	52.3%		
Shifting message from air to mail	1 Million person km/day	33,430	-	-	-	4,345.55	52.3%		
Shifting the message from road to rail	1000 tons m/day	241	-	-	-	4,345.55	52.3%		
Restrictions on import of used cars	1000 cars	951	-	-	-	4,345.55	52.3%		
New bicycle lanes	1 km bicycle lane	987	2	4.20	41.72	28.94	4,372.17	52.7%	
Electric three-wheelers	1000 three-wheelers	295	-	-	-	4,372.17	52.7%		
Electric two-wheelers	1000 two-wheelers	196	0	0.10	0.28	0.09	4,372.25	52.7%	
Restrictions on use of motorbikes	1000 bikes	116	-	-	-	4,372.25	52.7%		
Wind	Wind turbines, onshore	1 MWh	1,214	-	-	0	-	4,372.25	52.7%
	Wind turbines, on-shore with 24 storage	1 MWh	1,529	-	-	-	-	4,372.25	52.7%
	Wind turbines, offshore	1 MWh	1,334	-	-	-	-	4,372.25	52.7%

Figure 8: Mitigation options for 2025 in a consolidated GACMO file

Table 9 and Figure 9 present overall GHG emissions in the BAU and mitigation scenario for energy, transport and agriculture sectors. Table 9 further shows how emissions vary with key drivers such as population and economy (GDP) upto 2050. Under BAU emission scenario, in 2050, the population is projected around 35 million: with an emission of 112,214 ktCO₂e in 2050, it gives an emission per capita of around 3,200 ktCO₂e. It is also seen from Table 9 under BAU, energy emissions were relatively much small compared to all other emissions. Emission from Forestry Sector were not considered in this GACMO training; with unsustainable deforestation in Malawi, Forestry could dominate emissions.

Table 9: Summary of GHG emission using GACMO for Energy, Transport and Agriculture Sectors

GHG emissions from all sectors		2017	2025	2030	2035	2050
Population (thousands)		18,039	21,757	24,222	26,782	35,103
GDP (Current US\$)		3,745	5,525	7,393	9,987	24,622
BAU energy CO ₂ emissions (ktCO ₂)	Fossil fuel emissions	1,443	2,115	2,830	3,791	5,892
BAU other gases GHG emissions (ktCO ₂ e)	Other emissions	8,769	11,887	15,456	21,588	106,322
BAU GHG emissions (ktCO₂e)	All GHG emissions	10,212	14,001	18,286	25,379	112,214
Emissions Reduction in Mitigation Scenario (ktCO ₂ e)	All GHG emissions	0	4,572	8,477	13,017	19,527
Total emissions in Mitigation scenario (ktCO₂e)	All GHG emissions	10,212	9,429	9,809	12,362	92,687
Mitigation scenario reduction (%)	All GHG emissions	0.0%	32.7%	46.4%	51.3%	17.4%
Total tCO ₂ -e/capita in BAU	All GHG emissions	0.566	0.644	0.755	0.948	3.197
Total tCO ₂ -e/US\$ in BAU	All GHG emissions	2.727	2.534	2.473	2.541	4.557

The mitigation emission scenario gives an emission reduction of 19,527 ktCO₂e in 2050 (with emissions under mitigation scenario being 92,687 ktCO₂e) from mitigation options in the 3 sectors. This represents an emission reduction of 17.4% of 2050 BAU emission. The NDC-2 for Malawi has a target to reduce 51% of BAU emission in 2040. The GACMO training gives capacity to track this target.

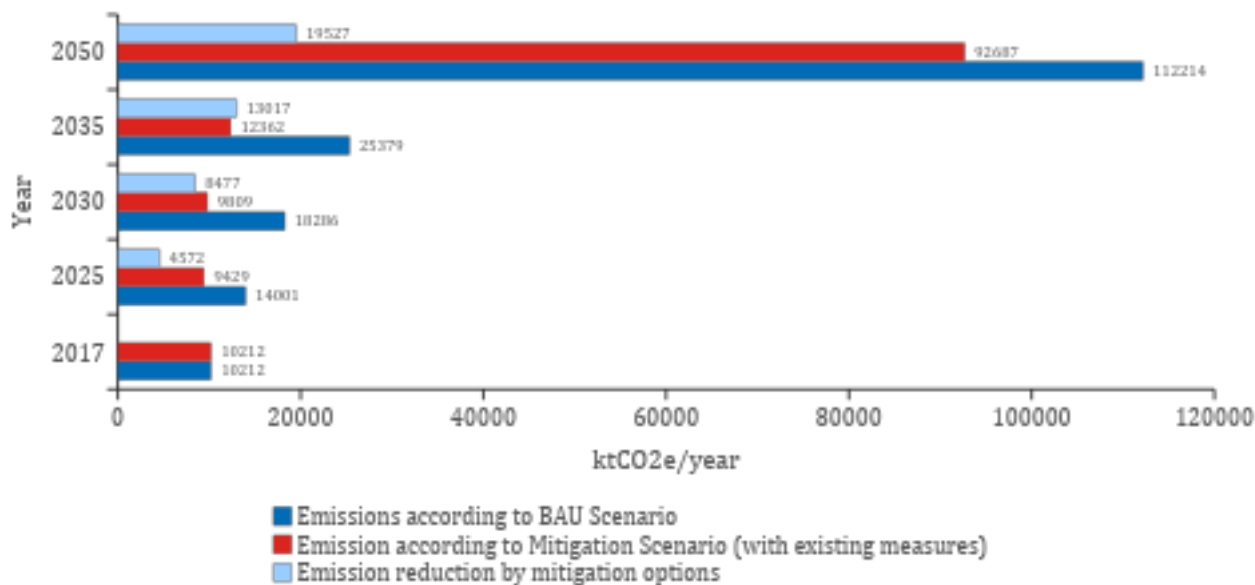


Figure 9: GHG emissions under BAU and Mitigation Scenarios for Energy, Transport and Agriculture Sectors as modelled by GACMO

Also, as seen in Figure 9, the emission reductions are relatively considerable, but the complete picture is possible if all the mitigation measures in Malawi’s NDC are modelled in GACMO.

9. Future needs and next steps

9.1. Gaps identified during the process

The process of developing Greenhouse Gas (GHG) projections for Malawi's energy, transport, and agriculture sectors using the GACMO tool highlighted several significant gaps and challenges that need to be addressed for more robust and accurate modelling and reporting. These gaps primarily relate to data, institutional arrangements, resources, and tool compatibility, and are presented as follows:

- a) Data Availability and Quality
 - i). Difficulty in finding disaggregated data by sectors (e.g., agriculture, mining, industry) for fossil fuels and electricity consumption.
 - ii). Lack of a centralised and standardised data platform, leading to inconsistencies as information is sourced from multiple documents and institutions. The absence of a single, integrated energy data management and sharing system impedes analysis and policy development.
 - iii). Data accuracy and reliability issues, with discrepancies between data in the model and data found from different national institutions.
 - iv). Limited availability of specific data required for comprehensive modelling.
 - v). Inconsistent data sources.
 - vi). Challenges in getting sources of pre-filled data, making data validation and verification difficult.
- b) Institutional Arrangements and Capacity:
 - i). Lack of dedicated officers to collect and manage data in institutions, and those existing often lack adequate capabilities.
 - ii). Limited data management infrastructure within institutions.

- iii). Lack of regulations specifically for the collection and management of energy data.
- iv). Limited GACMO knowledge for experts who joined the Sectoral Working Groups but did not attend the initial training.
- c) Resource Constraints:
 - i). Limited time allocated for completing the GACMO development task.
 - ii). Limited financial resources within the working groups to convene physical meetings for data collection and input, leading to less effective virtual meetings.
 - iii). Limited funding specifically allocated for data collection and management within institutions.
- d) Tool Compatibility and Scope:
 - i). Absence of corresponding mitigation options within the GACMO model for several of Malawi's agriculture sector NDC measures. This limitation means that the current modelling outputs likely underestimate the full mitigation potential of the With-Existing-Measures (WEM) scenario for the agriculture sector.

9.2. Next steps for institutionalising modelling efforts

- a) To effectively institutionalise GHG projections modelling and enhance Malawi's climate action capabilities, the following next steps are proposed, building on lessons learned and identified gaps:
- b) Capacity Building and Knowledge Transfer:
 - i). Continue developing national datasets and refining inputs to improve model accuracy across all sectors.
 - ii). Conduct follow-up sessions to apply GACMO across multiple sectors, ensuring institutional memory and sustained expertise.
 - iii). Provide targeted capacity building for Working Group members who did not attend the initial GACMO training, to ensure a consistent level of knowledge and skill across the teams.
- a) Data Management and Infrastructure Enhancement:
 - i). Establish a single, integrated platform for energy data management and dissemination to centralize information and address inconsistencies.
 - ii). Capacitate key institutions such as ESCOM, MERA, NOCMA, and the Ministry of Mining to collect electricity and fossil fuel consumption data that is disaggregated by sector (e.g., mining, agriculture, industry, service).
 - iii). Consider increasing investment in energy data collection and management as part of NDC enhancement efforts.
- b) Integration into National Climate Governance:
 - i). Develop a clear pathway for integrating GACMO outputs into Malawi's future Biennial Transparency Reports (BTRs) and other national communications. This is crucial for strengthening the national capacity to achieve climate commitments and enhance transparency under the Paris Agreement's Enhanced Transparency Framework (ETF).
 - ii). Utilise GACMO outputs to support the development of costed mitigation plans and facilitate access to climate finance.
 - iii). Integrate modelling results into national climate governance frameworks, ensuring that the development of Malawi's NDC 3.0 is firmly grounded in transparent, country-led processes.
 - iv). Foster sectoral responsibility and inter-institutional coordination to enable more accurate, context-specific projections and integrate modelling outputs into national planning processes.
 - v). Finalise the indicator set, integrate it into the NDC tracking framework, and outline data protocols for collection, processing and QA/QC procedures.

- c) Refinement of Modelling Inputs and Scenarios:
- i). Encourage working groups to thoroughly document data sources, methodologies, and assumptions for estimating technology penetration for each mitigation option, clarifying links to NDC targets and national strategies.
 - ii). Review and revise the selection and level of deployment of mitigation actions within the WEM scenario, especially for the Energy sector, to ensure realism and alignment with national implementation capacities, considering a more conservative and phased approach.
 - iii). Sense-check GHG totals in GACMO against Malawi's GHG Inventory for reference years (e.g., 2017) to ensure consistency and accuracy of energy balance data.
 - iv). Correctly allocate emissions from household sectors (e.g., charcoal and firewood burning) within the energy balance to ensure accurate reflection of emissions and robust assessment of mitigation options.
 - v). Clearly distinguish between existing/planned measures (WEM) and additional, more ambitious measures (WAM) to maintain consistency with national commitments and provide a clear baseline for future ambition.
 - vi). For unmodelled measures in sectors like agriculture, provide guidance and support for the working group to manually edit the GACMO model to include custom mitigation actions using proxy options, ensuring a more comprehensive representation of sectoral measures.

Annex 1: Additional Information on Modelling Tools Workshop

Table 10: Workshop 1 Agenda

Time	Session	Sections	Presenter
9:00 – 9:30	Arrival and registration		
9:30 – 10:00	Introduction and setting the scene	<ol style="list-style-type: none"> 1) Setting the scene 2) Introduction to key reporting elements of the BTR 3) Indicators 4) Projections 	Ricardo
10:00 – 11:00	Using causal chains to start estimating effects	<ol style="list-style-type: none"> 1) Scenario building 2) Data requirements 	Ricardo
11:00 – 11:10	Health break		
11:10 – 11:30	Interactive exercise: Data availability	Data availability for projections and tracking	Interactive
11:30 – 11:50	Detailed overview of projection tools	<ol style="list-style-type: none"> 1) Model types 2) Comparison of modelling tools 	Ricardo
11:50 – 12:30	Overview of LEAP vs GACMO	<ol style="list-style-type: none"> 1) LEAP Overview 2) GACMO Overview 	Ricardo
12:40 – 12:50	Interactive exercise: Projection models for Malawi	Which model might be more useful	Interactive
12:50 – 13:00	Closing remarks		

Annex 2: Additional Information on GACMO Workshop

Table 12: Workshop 2 Agenda

Time	Session	Sections	Presenter
9:00 – 9:15	Arrival and registration		
9:15 – 9:45	Introduction and setting the scene	Opening remarks by Deputy Director of Environmental Affairs	Mr. Benon Yassin
		Setting the scene	Ricardo
9:45 – 10:15	Technical introduction	Overview of GACMO	
10:15 – 10:30	Refreshment break		
10:30 – 11:00	Live tool Demonstration	GACMO demonstration steps 1-5	Ricardo
11:00 - 11:30		GACMO demonstration steps 5-9	
11:30 – 12:00	Q&A		All
12:00 – 13:00	Lunch		
13:00 – 13:15	Breakout groups	Introduction	Ricardo
13:15 - 14:15		Breakout session	Interactive
14:15 – 15:00	Closing out	Group presentations	Interactive
15:00 – 15:30		Closing remarks and next steps	Ricardo

Annex 4: Transport Working Group: BRT Supporting Data

CITY	ROUTE NUMBER	YEAR	DESCRIPTION	LENGT H (km)	TOTAL LENGT H 2025	TOTAL LENGT H 2030	TOTAL LENGT H 2035	TOTAL LENGT H 2050
MZUZU	ROUTE 1	2025	Mzuzu High court R/About - Shoprite Katoto R/About (Along M5 road)	1.28	1.28			
	ROUTE 2	2030	Shoprite R/About - Geisha Market (Along M1 road)	3.00		3.00		
	ROUTE 3	2035	Shoprite R/About - Luwanga T/Junction (Along M1 road to Rumphu)	3.98			3.98	
	ROUTE 4	2050	Luwanga T/Junction - Dunduzu Road block (Along S108 road)	8.96				8.96
	ROUTE 5	2050	Luwanga T/Junction - Dunduzu Road block (Along M1 road)	6.31				6.31
LILONGW E	ROUTE 1	2025	Bingu Stadium - Interchange - Capital Hotel R/About (Along Presidential highway)	5.34	5.34			
	ROUTE 2	2025	Crossroads R/About - Interchange - Kanengo T/Junction (Along M1 road)	9.91	9.91			
	ROUTE 3	2025	Crossroads R/About - Amina R/About - KCH R/About (Along Mzimba Street)	3.13	3.13			
	ROUTE 4	2025	Parliament R/About - KCH Interchange - Shoprite R/About (Along kenyatta street)	4.26	4.26			
	ROUTE 5	2030	Cross roads R/About - LL Bridge R/About (Along M1 Road)	2.35		2.35		
	ROUTE 6	2030	LL Town hall R/About - Chidzanja T/Junction (along M1 road)	3.50		3.50		
	ROUTE 7	2030	Gateway mall R/About - Bingu Stadium - Chendawaka T/Junction - Kanengo T/Junction	13.30		13.30		

	ROUTE 8	2030	Cross roads R/About - Gateway mall R/About (Along M12 road)	1.85		1.85		
	ROUTE 9	2035	Kanengo T/Junction - KIA T/Junction (Along M1 road)	11.30			11.30	
	ROUTE 10	2035	LL Bridge R/About - Likuni R/About (Along LL Western bypass)	2.90			2.90	
	ROUTE 11	2035	KCH R/About - Mchesi - PMF HQ (Along M1 road)	2.26			2.26	
	ROUTE 12	2050	Gateway mall R/About - Likuni R/About - Bunda T/Off (LL Western bypass road)	13.40				13.40
	ROUTE 13	2050	Chidzanja T/Off - Bunda T/Off (Along M1 road)	5.78				5.78
	ROUTE 14	2050	LL Sanctuary T/Off - Kamuzu Institute - Chidzanja T/Off	7.13				7.13
	ROUTE 15	2050	Chendawaka T/Off - Sungwi - Chitukula CDSS - M1 Road (Along D190 road)	20.30				20.30
	ROUTE 16	2050	KIA T/Junction - Nalikule - Statehouse - TA Tsabango - Bunda T/Off (LL Eastern bypass road)	38.31				38.31
BLANTYRE	ROUTE 1	2025	Blantyre CBD - Chichiri - Limbe CBD (along chipembere highway)	10.00	10.00			
	ROUTE 2	2025	Clocktower R/About - Nyambadwe - Kameza R/About (Along Chileka road)	6.46	6.46			
	ROUTE 3	2025	Hynde Road R/About - Limbe Cathedral - Chiradzulu T/Off (Along M3 road)	1.34	1.34			
	ROUTE 4	2030	Limbe CBD - Limbe cathedral R/About	8.00		8.00		
	ROUTE 5	2035	Ginner Corner R/About - KUHES - CI Catholic Church	2.28			2.28	
	ROUTE 6	2035	Blantyre CBD - CI Catholic church	1.85			1.85	
	ROUTE 7	2050	Kameza R/About - Chileka International Airport (along S137 road)	7.48				7.48
	ROUTE 8	2050	KUHES - Chitawira - Kanjedza - Limbe CBD (Along Kapeni - kenyatta drive)	9.33				9.33

TOTAL LENGTH OF BRT ROUTES	215.29	41.72	32.00	24.57	117.00
TOTAL ACCUMULATIVE LENGTH OF BRT ROUTES		41.72	73.72	98.29	215.29