# MITIGATION ANALYSIS FOR MALAWI: EXPLORING CDM PROJECT OPPORTUNITIES

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# SCOPE OF PRESENTATION

- Background &Basics of Mitigation Options in various Sectors  in Malawi.

- What are the Project Opportunities in Malawi for Climate Change Mitigation?

# BACKGROUND: GHG EMISSION BURDEN BY SECTOR

- Past inventories [for 2000, 1990-1994]indicate that $CO_2$ contributed the largest amount of GHG emissions, followed by $CH_4$.
- The sectors that emitted the most GHGs were: (i) Forestry and Land-Use Change, (ii) Energy, and (iii) Agriculture.
- The overall findings from the studies were that Malawi is a **net emitter of $CO_2$**.

# MALAWI: NET $CO_2$ EMITTER?

- Although GHG emissions from the Energy and Industrial Processes and Product Use Sectors were smaller, the opening up of limestone processing plants in Balaka, cement manufacturing in Kasungu, and uranium mining at Kayerekera in Karonga, and the prospects of opening a bauxite mine on Mount Mulanje, may significantly increase GHG emissions in these sectors in future.

# TARGETED SECTORS for CLIMATE CHANGE MIGATION IN MALAWI

- Mitigation analyses reported in the Initial and 2nd National Communication Reports of Malawi were therefore conducted in the five sectors:
    - (i) Energy,
    - (ii) Industrial Processes,
    - (iii) Agriculture,
    - (iv) Land Use Change and Forestry, and
    - (v) Waste management.

# SELECTION OF MITIGATION OPTIONS AND SECTORS INVOLVED

- In the analysis, mitigation options for reducing GHGs were developed and evaluated for the following five sectors: (i) Energy, (ii) Industrial Processes and product Use (IPPU), (iii) Forestry and Other Land-Use, (iv) Agriculture, and (v) Waste Management.

- However, when reporting the final GHG Inventory results, the Agriculture and Forestry and Other Land-Use sectors are combined into one sector: Agriculture, Forestry and Other Land-Use [AFOLU].

# ENERGY SECTOR:BACKGROUND [1]

Malawi posses a mix of potential resources including:

- (i) biomass, (ii) coal, (ii) perennial rivers for hydro-electro power generation,
- (iii) solar energy for heat and the generation of electricity, (
- iv) wind energy for water pumping and other minor applications, (v) hot springs for geothermal power generation, and
- (vi) uranium deposits for nuclear power generation.
- All petroleum products are exclusively imported into the country (MEP, 2002).

# ENERGY SECTOR: BACKGROUND [2]

The Department of Energy Affairs categorizes the energy resources into five sub-sectors:

- (i) biomass (firewood, charcoal, crop and industrial residues),
- (ii) electricity (hydro and thermal), (iii) liquid fuel and gas (petrol, diesel, paraffin, ethanol, gel-fuel, avgas, JetA1, liquid petroleum gas (LPG),
- (iv) coal and peat, and (v) other renewable energy resources (solar, wind, biogas, mini and micro-hydros).

# ENERGY SECTOR: BACKGROUND [3]

The mitigation options were assessed using the Long-Range Energy Alternatives Planning (LEAP) Model. The assessments were based on:

- Potential impacts of GHG emissions on various sectors of economic growth,
- Cost benefit ratio, consistency with national environmental goals and objectives,
- Ease of implementation, long-term sustainability,
- Consistency with national development goals, and the availability of data for the evaluation of the identified mitigation option.

# ENERGY SECTOR: BACKGROUND [3] 'LEAP MODEL'

- The LEAP Model is an energy-environment modeling tool, which is based on a comprehensive accounting of how energy is consumed, converted and produced in a given region, or economic sector, under a range of alternative assumptions on the population, economic development, technology and price levels, among many other factors.

- With its flexible data structures, LEAP allows for the analysis of technological specifications and end-use details as the user chooses.

# ENERGY SECTOR: MITIGATION ASSESSMENTS [1]

The mitigation assessments in the study considered two scenarios: (i) the baseline scenario, and (ii) the mitigation scenario:

- The baseline scenario, aka reference scenario, depicts the future emission trends in which there are no policies or measures put in place designed to reduce greenhouse gas (GHG) emissions.

- The mitigation scenario reflects a future in which policies and measures are adapted to reduce GHG sources, or enhance GHG sinks.

- According to UNFCCC, a mitigation scenario should not simply reflect the current plan, but should also assess what would be hypothetically achieved based on the goals of the scenario.

# ENERGY SECTOR: MITIGATION ASSESSMENT [2]

A mitigation assessment is a national-level analysis of the various technologies and practices that have the capacity to reduce GHG emissions.

- Within the Energy Sector, there are a number of GHG emitting sources, which can be potentially analyzed and mitigated upon.

- However, in this study each option was selected based on the important characteristics that included: (i) potential for large impact on GHG emissions, (ii) cost-benefit-ratio, (iii) consistency with national environment goals, (iv) ease of implementation, (v) long-term sustainability, (vi) consistency with national development goals, and

- (vii) data availability for model verification and evaluation.

# ENERGY SECTOR: MITIGATION OPTIONS CONSIDERED[1]

Several mitigation options were identified, and categorized into Policy and Technology based options.

- ✓ The technologies with the highest potential were selected using expert judgment for more detailed analysis and evaluation.

- ✓ Basically, technological potential mitigation options used were based on switching from a high carbon content fuels to low carbon content (or no carbon at all) ones, and adopting those technologies that have higher energy conversion efficiencies.

# ENERGY SECTOR: MITIGATION OPTIONS CONSIDERED[2]

- The selected mitigation options included: (i) cooking using grid electricity, (ii) efficient lighting technologies, (iii) efficient firewood cooking stoves, (iv) increasing the efficiency in ESCOM's capacity and energy balances, (v) increasing the ethanol to petrol blending ratio, and (vi) switching from paraffin (kerosene) lamps to PV lamps.

- The **use of grid electricity for cooking** involves improving access to affordable and modern energy sources. This can be done through: (i) rural electrification (to reach at least 10% in 2010 and 30% in 2020) at an annual electrification rate of 7% (UN, 2005), (iii) reduction in biomass use (from 93% in 2000 to 75% in 2010 and 50% in 2020), and (iii) increasing publicity campaigns on the value of switching from firewood to grid electricity in rural and peri-urban areas.

# ENERGY SECTOR: MITIGATION OPTIONS CONSIDERED [3]

- The use of **efficient lighting technologies (e.g., switching from paraffin (kerosene) to PV lamps** includes the following strategies (i) reducing the use of paraffin (kerosene) lamps for lighting by 50% (both in rural and urban households), (ii) increasing the use of PV solar systems for lighting by 5%, (ii) encouraging all electrified households to use electricity for lighting and cooking.

- The **efficient use of firewood cooking stoves** mitigation option involves the use of technologies that promote the use of Clay and Rocket firewood stoves instead of the 3-stone open fire cooking stoves that is currently used by most family households.

# ENERGY SECTOR: MITIGATION OPTIONS CONSIDERD [4]

Increasing the efficiency of ESCOM's capacity and energy balances mitigation option can be done by:

- ✓ (i) reducing load shedding,
- ✓ (ii) pursuing the electricity import strategy through the interconnection and the development of new power generating plants,
- ✓ (iii) introducing gas-turbine at peak hours, and (iv) rehabilitating the Kapichira II and Tedzani I and II hydro-power generating stations

# ENERGY SECTOR: MITIGATION OPTIONS CONSIDERED [5]

- The **promotion of efficient demand side management** mitigation option can be done through: (i) increasing customer connections by 1,000 per year, (ii) promoting the use of the 3-high efficiency compact fluorescent lamps, (iii) introducing a time-of–use tariff approach as an incentive for medium and low voltage industrial customers, and (iv) increasing the use of prepaid meter connections.

- Finally, **increasing the ethanol to petrol blending ratios option** can be done by simply increasing the ethanol to petrol blending ratio to 20% ethanol and 80% petrol.

# ENERGY SECTOR: MITIGATION OPTIONS CONSIDRED [6]

- The Malawi energy mix is heavily dominated by biomass. Some 96% of the biomass come form firewood and charcoal, which are primarily used for cooking and heating by the majority of family households.

- Based on the four mitigation options which were identified and evaluated using the LEAP Model, the use of cooking stoves is more efficient than the traditional three-stone open fire cooking system.

- The reductions in GHGs can be achieved by implementing all the identified mitigation options.

# INDUSTRIAL SECTOR: BACKGROUND

- The Industrial Processes and Product Use (IPPU) Sector was not included in the Initial National Communication (NC) of Malawi, yet its associated emissions are very important and significant in warming the atmosphere.

- Globally, 50% of the energy is used in industries for iron, steel, cement, pulp, paper and chemical manufacturing, and the refining of petroleum products (IPCC, 2007).

- In Malawi, most of the industrial GHGs are due to cement, lime, ethanol, beverage, and fertilizer production, beside bio-digesters, and the paint, and wood industries.

# INDUSTRIAL SECTOR: MITIGATION OPTIONS CONSIDERED [1]

- The main mitigation options for reducing GHG emissions were categorized into: (i) industrial options, (ii) technical options, and (iii) other options.

- The industrial options for reducing GHG emissions include:
  - (i) provision of regulation: permits to firms to operate depending on meeting environmental standards, so that failure to do so, results into financial or criminal penalties;
  - (ii) voluntary engagement of programme regulators with firms so as to share and disseminate information and expertise interactively;
  - (iii) use of market-based instruments, such as of taxes, tariffs and subsidies so as to shift the financial calculations of firms toward environmentally beneficial decisions.

# INDUSTRIAL SECTOR: MITIGATION OPTIONS CONSIDERED [2]

- The main technical options include the promotion of:
  - ✓(i) industries that use carbon capture and storage,
  - ✓(ii) technologies that blend cement with rice husks,
  - ✓(iii) industries that use $CO_2$ as a raw material, and
  - ✓(iv) industries that add value to lime via the Solvay process

# INDUSTRIAL SECTOR: MITIGATION OPTIONS CONSIDERED [3]

- Industrial processes and manufacturing are responsible for large quantities of GHG emissions, contributing some 43% of global $CO_2$ released in 1995.

- In Malawi, most industrial GHGs are due to cement and lime production. The mitigation options identified for reducing GHGs in the sector are: (i) carbon capture and storage, (ii) cement blending with rice husks, (iii) use of $CO_2$ as a raw material, and (iv) value addition of lime via the Solvay process.

- However, the utilization of these mitigation options will depend on the effective removal of barriers that constrain the adoption of the mitigation option technologies.

# AGRICULTURE SECTOR CONTRIBUTION TO THE GHG BURDEN: BACKGROUND[1]

- At a national level, agriculture contributes 26% of the total $CH_4$, 91% of the total $N_2O$, 9% of the total NOx, and 8% of the total CO emissions,

- As a whole, the sector contributes some 12.4% of the total $CO_2$ equivalent of the GHGs

- The total $CO_2$ emissions were 60.22 Gg in 2000, which is about half for that of 1999.

# AGRICULTURE SECTOR: MITIGATION OPTIONS CONSIDERED [1]

- The mitigation options identified for the Second National Communication (SNC) of Malawi include the following:

  - ✓ (i) improved rice cultivation practices,
  - ✓ (ii) improved animal husbandry practices,
  - ✓ (iii) improved manure management practices,
  - ✓ (iv) improved fertilizer management practices,
  - ✓ (v) application of zero tillage or conservation farming, and (vi) application of agro-forestry practices, which include crop rotations, mixed cropping and intercropping systems.

# AGRICULTURE SECTOR: MITIGATION OPTIONS CONSIDERED [2]

- Nearly all agricultural activities contribute to GHG emissions, but the burning of agricultural residues, the application inorganic fertilizer materials, manure management and enteric fermentation are the main emitters of GHGs.

- Therefore, concerted efforts are required to implement all the available mitigation options to reduce GHG emissions, especially methane and nitrous oxide.

# FORESTRY SECTOR: BACKGROUND [1]

- Forests in Malawi play an important role in the socio-economic growth and development of the country.

- Forests supply about 93% of the country's energy needs, provide timber and poles for construction and industrial use, supply non-timber forest products for food security and income, support wildlife and biodiversity, and provide recreational and environmental services.

# FORESTRY SECTOR GHG BURDEN

- The destruction of forests through burning and the decaying of woody biomass results directly into significant contribution of $CO_2$ to the atmosphere.

- However, the expansion of forests and the maintenance of existing stands can capture a lot of $CO_2$ from the atmosphere and maintain it on land over decades.

- During 2000, the GHG emissions from the forestry and land-use sector totaled 17,512 Gg $CO_2$ equivalent, mainly through changes in forest and woody biomass, forest conversion and soil out-gassing.

# FORESTRY SECTOR: MITIGATION OPTIONS CONSIDERED [1]

- The proposed mitigation options can be classified into two basic types:
  - ✓ (i) expanding the stand of trees and the pool of carbon in wood products, and
  - ✓ (ii) maintaining the existing stands of the trees and the proportion of forest products currently in use.
- A tree captures $CO_2$ from the atmosphere and maintains it on land. Maintaining existing tree stands can be achieved through reduced deforestation, forest protection, or more efficient conversion and use of forest products.
- It, therefore, keeps the avoided $CO_2$ emissions from entering the atmosphere for the duration of the pool maintenance.

# FORESTRY SECTOR: MITIGATION OPTIONS CONSIDERED [2]

- An alternative way of reducing carbon emissions includes the use of wood obtained from renewable energy sources (e.g., forest plantations) or the use of a substitute for non-renewable emission sources, such as fossil fuel.

- This substitution delays the release of $CO_2$ from the fossil fuel for as long as one continues to use wood from a renewable energy source instead of the fossil fuel.

- In this same way, wood derived from sustainable sources, can be used as a substitute for wood-fuel derived from depletable natural forests.

# FORESTRY SECTOR: MITIGATION OPTIONS CONSIDERD [3]

- Malawi requires two interventions in order to check forest depletion and degradation, (i) forest protection and conservation, and (ii) reforestation and afforestation.

- Afforestation is the planting of forests on bare land, whereas reforestation is the replanting or natural regeneration of deforested land.

# FORESTRY SECTOR: MITIGATION OPTIONS CONSIDERED [4]

- The reforestation and afforestation mitigation option depends on the availability of suitable land for the planting of trees.

- However, the question that is often raised is as to whether Malawi has enough and sufficient land for climate change mitigation activities.

# FORESTRY SECTOR: MITIGATION OPTIONS CONSIDERD[5]

- i) Forestry protection and conservation, and (ii) Reforestation and afforestation, have the desired potential to significantly reduce GHG emissions through various tree planting programmes that enhance carbon storage, which may increase the carbon pool to 756 million t C by 2040.

# WASTE MANAGEMENT SECTOR: BACKGROUND [1]

- Waste treatment and disposal produce GHGs, which are emitted into the atmosphere and contribute to global warming (IPCC, 2006).

- This can be achieved by reduction in generation of waste, recovery of GHGs, and adopting waste management practices that minimize the overall emission of GHGs.

# WASTE MANAGEMENT SECTOR: CONTRIBUTION TO THE GHG BURDEN

- The key GHGs emitted in the Waste Management Sector include carbon dioxide ($CO_2$), methane ($CH_4$) and nitrous oxide ($N_2O$). By 1977, $CO_2$, $CH_4$ and $N_2O$ contributed 70%, 24% and 6%, respectively, of the enhanced global GHG effect.

- The manmade compounds, such as chlorofluorocarbons (CFSs), hydrofluorocarbons (HFCs) and perfluorinated carbons (PFCs) also act as GHGs.

# WASTE MANAGEMENT SECTOR: GHG SOURCE CATEGORIES

- In the Waste Management Sector the GHG emissions considered are from the following source categories:

  - (i) solid waste disposal,
  - (ii) biological treatment of solid waste,
  - (iii) incineration and open burning of waste, and
  - (iv) wastewater treatment and discharge.

# WASTE MANAGEMENT SECTOR: COMPOSITION OF THE WASTE STREAM CONSIDERED

- In Malawi, solid waste, on average, mainly consists of: (i) organic matter (90%), (ii) plastic rubber (4%), (iii) paper (4%), (iv) metal (1%), (v) textile (0.5%), and (vi) glass.

- The food, beverage and tobacco industries are the major sources of food waste. Paper and cardboard are generally produced in offices, schools, and packaging industries.

- The critical solid waste components are: (i) organic matter; (ii) food waste, (iii) wood, and (iv) paper because they contain most of the degradable organic compounds in municipal solid waste (IPCC, 2006).

# WASTE MANAGEMENT SECTOR: MITIGATION OPTIONS CONSIDERED [1]

- The proposed mitigation options selected for assessment include the following:

  - ✓ (i) Reduction in the generation of waste,
  - ✓ (ii) Composting,
  - ✓ {iii) Mechanical-biological treatment,
  - ✓ (iv) Disposal of waste in sanitary landfills, and
  - ✓(v) combustion.

# WASTE MANAGEMENT SECTOR: MITIGATION OPTIONS [2]

- The mechanical-biological (MB) treatment of waste is aimed at reducing the volume of waste for disposal and subsequent gas emissions from final disposal of the waste (IPCC, 2006).

- Mechanical operations separate the material into: (i) fractions for composting, (ii) anaerobic treatment, (iii) combustion, and (iv) recycling. They include the processes of separation, crushing and shredding.

- The MB treatment reduces the amount of organic material by 40-60% and on average, MB treated waste produces up to 95% less $CH_4$ gas than untreated waste when deposited.

- The sanitary landfill mitigation option is an engineered method for the disposal of solid and hazardous waste in a manner that protects the environment. Sanitary landfill facilitates gas recovery, thus reducing emissions to the atmosphere.

# WASTE MANAGEMENT SECTOR: MITIGATION OPTIONS [3]

- The major design components of a controlled landfill to be included in  landfill include:

  - ✓(i) a liner,
  - ✓(ii) leachate collection and management system,
  - ✓(iii) gas management facilities,
  - ✓(iv) storm water management, and
  - ✓(v) the final cap.

# WASTE MANAGEMENT SECTOR: SUMMARY [4]

- Waste treatment and disposal contribute to the production of GHGs, which contribute to global warming.

- The reduction of GHG emissions from this sector can be achieved by reducing the generation of waste, recovery of GHGs, and adopting waste management practices that minimize the overall effect of GHG emissions into the atmosphere.

- Important mitigation options for GHG emissions under this sector include: (i) reduction in generation of waste; (ii) composting; (iii) mechanical-biological treatment; (iv) disposal of waste in sanitary landfills, and (v) combustion.

# WASTE MANAGEMENT SECTOR: MITIGATION OPTIONS [5]

- Sanitary landfills are the most effective option for the mitigation of $CH_4$, composting is the second best, whereas the incineration option is the least effective mitigation option.

- Reduction of waste generation has the least mitigation effect on the national GHG emissions. However, reduction of waste generation is the most economically and environmentally viable option in mitigating GHGs. It is recommended that the reduction of waste be adopted as the mitigation option of choice.

- The waste that is generated can be treated using mechanical-biological treatment, depending on availability of resources. Otherwise, the degradable waste can be composted or disposed at sanitary landfills that have GHG recovery systems.

# WASTE MANAGEMENT SECTOR: MITIGATION OPTIONS [6]

- Some key barriers that constrain the adoption and implementation of these mitigation options that will need to be eliminated in order to realize the benefits of the mitigation options.
- The key ones include: (i) high capital investment, operational and maintenance costs, (ii) adverse environmental effects, (iii) limited institutional capacity for the city and town assemblies, and (iv) limited political will.

# MITIGATION OPTIONS: SUMMARY [1]

- **Energy Sector.** In the Energy Sector, three options (i) efficient technologies for cooking, (ii) fuel switch for lighting in the household sector, and (iii) increasing the petrol to ethanol blend ratio in the transport sector offered better and promising results.

- The use of efficient cooking stoves instead of the traditional three-stone open fire cooking system is the most important mitigation option; about 650 Gg of GHG emissions ($CO_2$ equivalent) in 2040 in the household sector are reduced.

- Increasing the blend ratio from 90% petrol: 10% ethanol to 80% petrol: 20% ethanol would mitigate about 90 Gg of total GHG emissions ($CO_2$ equivalent) in 2040 in the transport sector. The utilization of efficient lighting technology mitigates about 20 Gg of GHG emissions ($CO_2$ equivalent) in the same year.

# MITIGATION OPTIONS: SUMMARY [2]

- **Industrial Processes and Product Use (IPPU) Sector.** In the Industrial Processes and Product Use Sector, the production of lime, cement, molasses and ethanol are important contributors to GHG emissions.
- Carbon capture and storage, value addition of lime, rice husk cement production and the use of $CO_2$ as a raw material, are the best options that may reduce GHG emissions from the sector.
- The effective removal of barriers is expected to contribute to greater reduction of industrial GHG emissions by up to 40% in 2040.

# MITIGATION OPTIONS: SUMMARY [3]

- **Agriculture Sector.** In the Agriculture Sector, at an interest rate of 5%, the best option is the growing of upland rice, which results in 9.0 million tons of GHG emissions (as equivalent to $CO_2$) being avoided by using a combination of the mitigation options.

- These are improved fertilizer application, improved cultivation methods, improved manure management and agro-forestry practices.

# MITIGATION OPTIONS SUMMARY [4]

- **Forestry and Other Land-Use (FOLU) Sector.** In the Forestry and Other Land-Use Sector, two options (i) forestry protection and conservation, and (ii) reforestation and afforestation, have the desired potential to significantly reduce GHG emissions by increasing the various tree planting programmes that enhance carbon storage.

- In the mitigation option, the carbon pool increases to 756 million t C by 2040.

# MITIGATION OPTIONS: SUMMARY [5]

- **Waste Management Sector.** Sanitary landfills is the most efficient option in reducing $CH_4$ emissions, while composting and combustion or incineration are the next best for waste management.
- Although the reduction of waste generation has the least mitigation effect at national level, it is the most economically and environmentally viable option.

# RECOMMENDATIONS [1]

The various mitigation options reported in this study have enormous potential to reduce total GHG emissions in the various sectors of the economy. However, in order to achieve the national developmental goals and objectives, it is recommended that Government should aggressively:

- Involve all partners and practitioners, using participatory approaches under the current decentralization policy, in the use and implementation GHG mitigations options,
- Promote the use of affordable and user-friendly alternative renewable energy technologies (RETs),
- Reduce dependence on biomass energy through capital subsidies, tax breaks, and technical, financial and institutional support
- Strengthen tree planting programmes throughout the country;
- Strengthen the implementation modalities of the current policies and legal instruments that increase access to affordable, user-friendly RETs at both household and institutional levels

# GENERAL RECOMMENDATIONS [2]

- Strengthen the implementation modalities of the current policies and legal instruments that increase access to affordable, user-friendly RETs at both household and institutional levels.

- Enhance capacity building and training programmes for communities and professionals, especially in the selection of appropriate RETs, systems analysis and computer simulation modelling, including the training in climatology, meteorology, and atmospheric sciences within local universities and other institutions, and

- Provide funding for the proposed climate change projects, starting with the proposals in the National Adaptation Programmes of Action (NAPA).