National action plan to mitigate short-lived climate pollutants

2018 • Republic of Ghana

Foreword

Prof. Kwabena Frimpong-Boateng
Minister of Environment, Science, Technology, and Innovation

Ghana takes issues of climate change and air quality seriously and that is why its recent development plan highlights key policy interventions to combat climate change and improve local air quality in the medium-term. Government firmly believes that taking action now to improve local air quality and tackle climate change makes economic sense. So Ghana's efforts to modernise household cooking by ensuring that citizens get access to affordable clean fuel and efficient device is one of the practical way to reduce exposure to indoor air pollution, minimise the associated health risks and contribute to mitigating global warming.

We can promote economic growth, eradicate extreme poverty, and improve people's health and well-being by acting today on air pollution and climate change. It is for these reasons that Ghana announced its ambitious Nationally Determined Contributions (NDCs). Ghana is ready to hit the ground running and calls on all stakeholders (governments, business and society) to join hands to put the new agreement into action as quickly as possible. We are strengthening our local air quality monitoring capabilities and in the years, the Government of Ghana has invested in the expansion air its monitoring stations particularly in the major cities in Ghana. This has enabled us to collect more ground-level emissions data over a long period of time.

Ghana's National Action Plan (NAP) to combat the emissions of Short-Lived Climate Pollutants (SLCPs) is another milestone Ghana has achieved after ratifying the Paris Agreement in 2015. The action plan has identified and prioritised the policy options that government can adopt to reduce or avoid emission of SLCPs from key economic sectors. In doing so, there are additional benefits on avoided mortality, avoided crop loss and reduction in Ghana's contribution to global temperature increase that the set of SLCP mitigation actions can lead to. These measures strongly resonate and align with the transformation programme of government and so are priorities for action. Ghana also recognised the need to have the SLCP mitigation measures on government's agenda. It is also important that line ministries allocate adequate financial resources to support its implementation.

One way to get the line ministries to allocate budget for the SLCP mitigation measures, is to make sure that they prioritise and incorporate them into their annual plans and strategies. Government will continue to implement the policy actions it has already started that are relevant to SLCP mitigation. In addition, we will strive to mobilise key stakeholders in the country, be it, private sector, civil society, local government and the academia to work in a concerted manner. The active involvement of private sector in raising private capital and technology would be a catalyst for the achievement of the objectives in the action plan. The NAP also contains insightful information on the inventory of SLCPs and long-lived climate pollutants (LLCPs) for the period 2010-2040. This good piece of information will be useful in mobilising financial resources and building capacity. The preparation of the NAP has also offered the country another window to consolidate the gains it made in putting in place a credible national structures for monitoring the SLCP mitigation measures.

Preface

Mr. John Pwamang
(Ag. Executive Director, EPA)

Ghana Environmental Protection Agency (EPA) is delighted to be associated with the preparation of Ghana's action plan to mitigate SLCPs. Our team of experts from the Climate Change and Environmental Quality Department led in the coordination of the processes and preparation of the action plan. The EPA team led the work of the inter-ministerial task-force who provided technical backstopping and facilitated the uptake of the SLCPs mitigation actions at the implementation level. Throughout the preparation of the plan, several experts from the line ministries were trained on the LEAP-IBC tool to create emission inventories and evaluate benefits of SLCP mitigation actions. The Agency also facilitated the compilation of the National Action Plan (NAP).

The inventory section of the NAP covers 30 years from 2010 and 2040 for the 5 main sectors; Energy, Transport, Industrial Process , Agriculture, Forestry and Waste. The accounting was done using the LEAP-IBC developed by Stockholm Environment Institute. The pollutants we have covered include: black carbon, $PM_{2.5}$, methane, carbon dioxide, sulphur dioxide and nitrogen oxides. The inventory results can be put to several uses beyond informing the selection and prioritisation of the SLCPs mitigation actions. First, it is a good source of input information for formulating national policies and measures for reducing greenhouse gas emissions. Secondly, it is a reliable reference material for a variety of users including those in international and national climate change and air quality policy, research and education, climate business development, as well as students and the general public. For researchers, this report provides in-depth information on inventories of short-lived climate pollutants and greenhouse gases for identifiable economic sectors and the linkages between emissions source and economic development. It also identifies a number of gaps where research would be needed. With respect to climate planning and policy-making, this report provides an outstanding basis for identifying, developing and prioritising climate mitigation actions and targets at sectors that have high emission reduction potential and benefits to the broader sustainable development goals. It is hoped that the necessary resources will be found for the implementation of some of the programmes in the specific sectors to improve on activity data collection and emission factors for future inventory preparation.

The final electronic version of this report will be made available to the general public on the website of MESTI (www.mest.gov.gh) and EPA (www.epa.gov.gh).

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At Stockholm Environment Institute (SEI), we are grateful to; Dr. Johan C.I. Kuylenstierna (Policy Director), Dr. Kevin Hicks (Deputy Centre Director, SEI - York), Dr Harry Vallack (SEI- York), Dr. Chris Malley (SEI- York) and Dr. Charlie Heaps (SEI-Boston).

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Staff of Environmental Protection Agency (EPA) who worked this document especially Mr. Ebenezer Appah-Sampong, Dr. Daniel Tutu Benefoh and Mr. Emmanuel Appoh for facilitating technical inputs into the NAP document. We are also grateful to Mrs. Audrey Quaicoo, Mrs. Helen Asiamah, Mr. Samuel Tetteh, Mr. Badu Yeboah and Mrs Esi Nerquaye Tetteh for their inputs.

At the Ministry of Environment, Science, Technology and Innovation (MESTI), Madam Salimata Abdul Salam, Mr. Fredua Agyeman, Mr. Peter Dery and Mr. Mohammed Gyimah need special mention and appreciation for their important contributions.

We are also grateful to the lead consultant, Dr. Eric Twum, Dr. Benedict B. Aligebam and the entire team for contributing to the development this action plan.

With kind support from

CLIMATE & CLEAN AIR COALITION
TO REDUCE SHORT-LIVED CLIMATE POLLUTANTS

UN environment

Abbreviation

AP - Additional PAM

APR - Annual Progress Report

AQMP - Air Quality Management Plan

BC - Black Carbon

CH_4 - Methane

CCAC - Climate and Clean Air Coalition

CES - Cutting Edge Stoves

CPSEDP - Coordinated programme of social and economic development policies

CPF - Current policy failure

CPS - Current policy success

CO_2 - Carbon Dioxide

CSO - Civil Society Organisation

ECK - Efficient Charcoal Kilns

EFE - Eco-Friendly Electricity

ENRAC - Environment and Natural Resources Advisory Council

EPA - Environmental Protection Agency

ESCOs - Energy Service Companies

GEDAP - Ghana Energy Development and Access Project

GCF - Green Climate Fund

GHG - Greenhouse gas

GLSS - Ghana Living Standard Survey

GPI - Gas in Plastic Industry

GSS - Ghana Statistical Service

HFC - Hydro-fluorocarbons

IB - Institutional Biogas

ICS - Improved Cookstoves

IPCC - Inter-governmental Panel on Climate Change

IPPs - Independent Power Producers

LCO - Light Crude Oil

LFM - Landfill Gas Management

LLCP - Long-lived climate pollutant

LPGC - LPG for Cooking

NAP - National Action Plan

NDC - Nationally determined contributions

MESTI - Ministry of Environment, Science, Technology and Innovation

NCCSC - National Climate Change Steering Committee

MDAs - Ministries, Department and Agencies

NDPC - National Development Planning Commission

MICS - Multi-cluster indicator survey

NGE - Natural Gas for Electricity

PAM - Policy and measures

PM - Particulate Matter

PPMEDs - Policy planning, Monitoring and Evaluation Directorate

QLF - Quality Lifestock Feeding

RFB - Reduced Forest Burning

RFO - Residual Fuel Oil

SDGs - Sustainable Development Goals

SLCP - Short-lived climate pollutant

SOB - Stop Open Burning

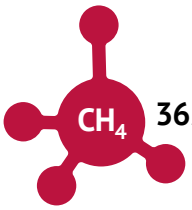
SS - Solar Systems

VTS - Vehicle Testing Standards

VTC - Vehicle Testing Centres

Executive Summary

Ghana's National Action Plan (NAP) to mitigate Short-Lived Climate Pollutants (SLCPs) resulted from a multi-sector consultative process from 2016 to 2018. The NAP exercise led to the identification and prioritisation of 16 SLCP mitigation measures across seven sectors. The implementation of the 16 measures are expected to reduce methane (CH_4), black carbon (BC) and carbon dioxide (CO_2) emissions and lead to substantial rapid health, agriculture and climate benefits. The LEAP-IBC tool was used to conduct inventory and projections of SLCPs from 2010 to 2040. Methane was found to be the most dominant SLCP and the second most important LLCP (greenhouse gas - GHG) after carbon dioxide. The majority of methane is emitted from solid waste disposal to landfills whereas thermal electricity produces most of the carbon dioxide. Black carbon are mostly emitted from cooking with traditional biomass. Below are the national emissions of each pollutant in 2017

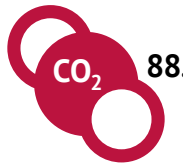


365.7 kt in 2017

Methane

16.5 kt in 2017

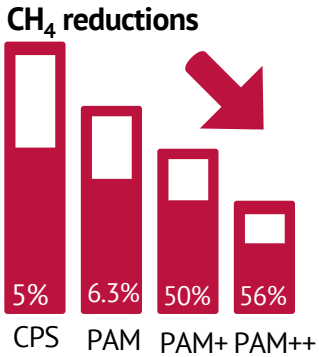
Black Carbon

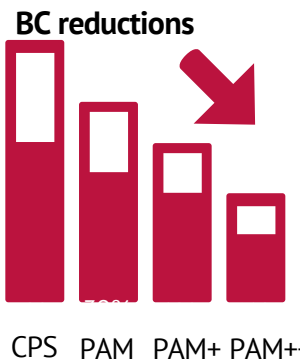


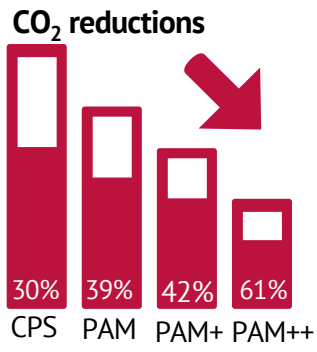
88.9 Gt in 2017

Carbon Dioxide

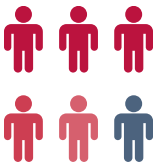
The expected multiple benefits are associated with adopting alternative policy options in future relative to current policy failure scenarios (relative to a scenario where current policies are not successfully implemented). In most cases, the additional PAM+ (implementation of NDC measures) and additional PAM++ (implementation of additional SLCP-focused measures) recorded the most positive effects. Adopting alternative policy options in the future leads to the following emission reductions in 2040 compared with a 'current policy failure' scenario in which both currently agreed policies and additional policies and measures are not successfully implemented.







As a result of these emission reductions, and reductions of other co-emitted pollutants, the implementation of, the implementation of the 16 measures are likely to lead to additional health, crop and climate benefits. The estimated benefits are provided below:



2,560 under PAM++

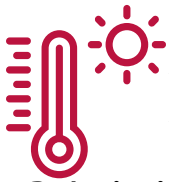
1,500 under PAM+

Premature deaths avoided

40% under PAM++

22% under PAM+

Reduction in crop loss



55% under PAM++

51% under PAM+

Reduction in global warming from Ghana's emissions'

Ghana needs to ensure implementation of the measures by making sure that the entire governmental structure is responsive to the measures by incorporating them into the development agenda. This will be the surest way to get the line ministries to mobilise and commit resources to ensure the timely implementation of the measures.

A summary of the 16 SCLPs and LLCPs mitigation options and the key actions required to implement each measure is presented in the Table below. The table also shows ranking of the mitigation measures in terms of ease of implementation.

Table 1: Summary of SLCP mitigation measures and key actions to get them implemented

SLCP abatement measures	Rank	Key Actions and Specific AssociatedTargets
LPG for cooking	High	Ensure 50% of household adopt LPG for cooking
Solar systems	High	Ensure 10% of electricity mix from renewable energy source.
Reduced forest burning	Low	Reduce regularly or frequent burnt areas by 40% especially in the savannah and transitional zones
Institutional Biogas	Low	Increase methane recovery from well-managed engineered landfill
Promote CNG Buses	High	Ensure successful implementation of soot free buses, Secure funding from GCF to increase ambition of soot free bus policy to get additional 600 buses
Stop open-burning	Medium	Increase collection of municipal solid waste, improve management of solid dumping ground
Landfill gas management	High	Increase installed capacity of bio-digesters in schools
Improved cookstoves	High	Increase access to 2 million improve cookstoves.
Natural Gas for electricity	High	Increase NG fired thermal capacity on the public electricity grid.
Eco-friendly electricity	Medium	Ensure grid capacity addition with natural gas fired thermal plant in lieu of the proposed coal plant
Efficient charcoal kilns	High	Builds on the efforts of introducing efficient kiln (preferably brick kilns) for wood carbonisation among informal charcoal operators.
Quality livestock feeding	Low	Support the introduction of technology improvement in animal manure management and feeding/intake materials by promoting ranch system in areas of the country where livestock (especially non dairy cattle) are common
Vehicle testing standards	Medium	Exclude grossly or big polluting cars of the road through the enforcement of emission testing standards at the PVTs
Cutting-edge stoves	Medium	TBD
Gas in plastic industry	Low	TBD
Coordination of SLCPs	High	Coordinate implementation progress of SLCP and LLCP mitigation actions
National HFC Inventory	High	Conduct nation-wide HFC imports and consumption survey
Harmonise LLCPs & SLCPs inventory	High	Expand scope of GHG inventory system to cover SLCPs

1. Overall Context

For us in Ghana,"tackling SCLP is a smart development and health imperative"

1.0 Background information

Ghana is on an unstoppable path to economic prosperity and in medium-term targeted at doubling it GDP by 2024 . But the impacts of climate change and deteriorating air quality threaten to erode our development gains and worsen the health of Ghanaians. Ghana's strategies to deal with climate change are captured in the National Climate Change Policy (NCCP) and has promised to do even more through the ambitious actions it has committed to in its Nationally Determined Contributions (NDC). Both the NCCP and NDC promise to put Ghana's development on a sustainable transition to green growth which also delivers better air quality.

Short-lived climate pollutants are powerful greenhouse gases and local air pollutants emitted from major economic activities. The dominant sources of SLCPs are transportation, production and utilisation of biomass, oil & gas, bricks industry and the waste management sectors. Once released into the atmosphere, SLCPs have relatively short lifetimes compared to longer-lived GHGs such as carbon dioxide (CO_2), and have a warming impact on the global climate. Examples of SLCPs are methane, hydrofluorocarbons (HFCs), black carbon (BC) and tropospheric ozone. Therefore reducing SLCPs can help achieve Ghana's climate and air quality goals in the near-term and provide rapid local benefits. This is because the measures to cut SLCPs can also reduce other air pollutants responsible for significant detrimental health and environmental impacts.

1.1 Why Ghana needs to take action on SLCPs

Ghana's commitment to pursue sustainable development is not in doubt. At the international stage Ghana has been at the forefront in the advocating for the adoption of sustainable development practices. This has led to Ghana's President serving as co-chair to UN Secretary General's eminent advocate on SGDs. At the national level, SGDs have been integrated into the national development plans. The country has firmly demonstrated in many respects that environment is key and central in its development planning.

Ghana is already implementing a number of policies to improve air quality, reduce GHG emissions and support economic development. These efforts are targeted at ultimately making sure that economic development takes place in a sustainable manner to ensure the well-being of the citizens now and in future. Apart from the fact that environmental sustainability has been mainstreamed into national development, it is also important to recognise the need to ensure synergies among different initiatives on climate change, green economy and sustainable development.

Ghana's SLCP action plan is a culmination of a multi-sectoral collaboration, technical support from Stockholm Environment Institute (SEI) and funding from the CCAC under the SNAP initiative. The action plan outlines a set of comprehensive measures that builds on existing national efforts to better local air quality and reduce GHG emissions. It is also important to stress that Ghana's SNAP process was designed with the view to create a workable platform to stimulate, mobilise and enhance coordination of inter-ministerial efforts to address SLCPs in Ghana.

It was useful to build on existing measures to learn from our successes and failures. In this respect, the NAP process focused on what is really needed and essential to boost SLCP mitigation measures in a targeted manner. The emphasis was on tapping into existing potentials for addressing SLCPs which are complementary to on-going sustainable development initiatives.

Picture 1: Wood fuel collection

1.2 Climate and Clean Air Coalition (CCAC)

Ghana is one of six countries that formed the CCAC in 2012. Currently, the coalition consists of more than 50 state and non-state members. Ghana joined the coalition at the early stages to demonstrate the its seriousness to take concrete action on SLCPs. The CCAC supports country partners to accelerate and scale-up mitigation actions through its 11 initiatives.

The Ministry of Environment, Science, Technology and Innovation (MESTI) is the focal point of CCAC in Ghana and coordinates CCAC activities. The EPA acts as an alternate focal point and provides technical backstop to MESTI and other stakeholders involved in CCAC related activities. As the focal point, MESTI leads Ghana's contribution to the activities of the coalition at the international level and also facilitates the mobilisation of national efforts for integrating SLCP mitigation measures into the overall national development process.

Ghana is participating in 4 out of the 11 CCAC initiatives and these include : (a) Urban Health Initiative (Ghana Health Services and WHO); (b) Reducing SLCPs from Household Cooking and Domestic Heating (Global Cook stove Alliance); (c) Promoting SLCP National Action Plans (SNAP) (MESTI and EPA) and (d) Reducing Black Carbon Emissions from Heavy Duty Diesel Vehicles and Engines (Ghana Port Authority including promotion of soot free buses and fuel economy standards by EPA and UNEP).

Under the SNAP initiative, a multi-sector SLCP task-force team was formed with members from key ministries like MESTI, transport, energy, finance, local government, the media, as well as Ghana EPA. The task-force met every quarter to take stock of progress of work and strategise for the ensuing quarter. In addition, an analytical work on SLCP inventories, emissions and identification of reduction opportunities undertaken with technical support from the Stockholm Environment Institute (SEI).

1.3 Development Goals of Ghana's SNAP

The development goal of the SNAP is to facilitate a systematic national process for formulating action that commit Ghana to increase its efforts for reducing SLCP emissions in the immediate to long-term through:

- Identification, prioritisation and implementation of feasible SLCP abatement measures that are politically correct, economically sound, socially acceptable and environmentally friendly.
- Mobilisation of adequate funding from international and national sources for sustained implementation of specific interventions to control SLCP emissions.
- Integration of SLCP mitigation measures into national and sector plans.
- Creation of national awareness on the immediate and long-term health and food security benefits that Ghana stands to gain by taking necessary steps to address SLCP emissions.

The outcome of Ghana's NAP process is expected to positively impact on the health of Ghanaians . An effective SLCP NAP in Ghana will help:

- Clarify, optimize, streamline and speed the overall mitigation process.
- Identify emission reduction opportunities which Ghana can deliver quickly.
- Generate confidence, promote early results and reduce the scope for early disappointment.
- Deliver the full range of potential benefits from SLCP emission reductions in Ghana, but will do this in a way that is nationally and locally driven, and can be linked to and reinforce other national policies, especially in the field of economic development.

Picture 2: Representatives of first members of CCAC

2. Ghana's SLCP Emissions Profile

2.1 National SLCP Inventory System

The Ghana Environmental Protection Agency (EPA) coordinates the national inventory system for short-lived climate pollutants. The plan is to eventually integrate the SLCP inventory into the GHG inventory arrangement. The integration of the two inventory systems will allow for effective data collection and publication of GHG and SLCP information regularly. Many of the institutions that are involved in GHG emission inventory contributed substantial amount of data toward the SLCP inventory.

As part of the SNAP process, SLCP inventory was conducted using the LEAP-IBC SLCP inventory tool for the period 2010-2040. The tool helped estimate dominant SLCP and GHG using macro-economic, technology and household data for energy and non-energy sectors. Emissions of black carbon, methane, carbon dioxide, nitrogen dioxide, volatile organic compounds, sulphur dioxide and organic carbon were estimated for 2010 as the base year. Emissions scenario and benefits associated with different policy scenarios up to 2040 were determined.

2.2. SLCP Emission Trajectories

Five SLCP and GHG emission trajectories were constructed based on a number of future 'Policy and Measures' (PAMs) options. One of the baseline scenarios depicts absolute failure of current committed SLCP-related PAMs whereas the counterfactual shows varying degree of success of PAMs. The counterfactual scenario describe an incremental least ambition scenario (current PAMs success), through (additional PAMs, additional PAMs+) to the most ambitious scenario (additional PAMs++). Detail description of the SLCP and GHG emission trajectories are provided below:

"Current PAMs failure scenario" (CPF) - Zero implementation or failure to implement agreed government emission-related policies and measures from 2017. Failure to implement government own programmes due to lack of adequate financial resources, inconsistent government priority and technological and regulatory barrier. Policy failure simply means government is unable to fully get its own programmes implemented as planned.

Although there is the possibility that some policies and measures may be implemented to a certain extent it will not lead to the full accomplishment of the intended goals. Change in relation to other economic drivers are not specifically driven by government policy.

"Current PAMs success scenario" (CPS) - This scenario depict a future where government is able to effectively implements its own existing policy choices. Although such policies have development imperatives, they may also benefit the environment. This scenario may not fully transform the economy to future sustainability, but could serve as a basis on which additional actions could be taken.

"Additional PAMs scenario" (AP)- Ghana adopts and fully implement low-hanging measures to achieve 10% renewable energy and 50% LPG penetration in household policy targets. These measures are over and above the ambition of the policy option under the "current PAMs success scenario"

"Additional PAMs+" (AP+)- This represent policy actions contained in Ghana's nationally determined contributions (NDC) which is an incremental of "additional PAMs scenario". This represent a future where government undertake extra measures to cut or reduce SLCPs and GHGs beyond the measures it is committed to. These measures cover eco-friendly electricity, natural gas for electricity generation, reduced forest burning, clean cooking, stopping open burning, CNG buses, landfill gas management,

"Additional PAM++" (AP++) - Incremental SLCP measures are adopted and effectively implemented with the view to bringing about increased benefits to emissions of SLCPs avoided deaths, reduced crops losses and reduced contribution to global temperature. The actions are in the following areas: adoption of cutting-edge stoves, fuel switching in plastic industry, improve livestock feeding, vehicle testing standards, charcoal kilns.

Note - HFC emissions were not included in the SLCP inventory due to the lack of complete dataset. Future update will cover HFC sources.

2.2 Black Carbon (BC)

Black carbon is a constituent of $PM_{2.5}$ and is produced from incomplete burning of fossil fuels and biomass. Black Carbon emission is the third largest contributor to current global warming, after CO_2 and methane (Canada, 2017). BC is estimated to be averagely 3,200 times more potent a warming agent than CO_2 over a 20-year period (Bond et. al, 2013). Persistent exposure to BC has adverse human health effects including respiratory, cardiovascular effects and premature death. The measures that reduce BC emissions from incomplete combustion minimise not only BC but also other emissions that give rise to health impacts.

The SLCP inventory estimates total black carbon emission in Ghana to be 16.5 kilotonnes (kt) in 2017. Residential cooking with inefficient wood/charcoal stoves are the largest source of black carbon contributing 78% of Ghana's total black carbon emissions in 2017. Of the total BC emissions from cooking, 74% were from rural households, particularly those in the forest region, whereas the remaining 26% were from urban cooking (mainly from peri-urban communities). It is also important to note that in most rural areas, wood stoves are a major source of BC emissions because it is the main fuel source as compared to charcoal stoves which dominates in urban households. In most non-electrified homes, kerosene lanterns is also a key source of BC although the overall share of household that use kerosene for lighting is less than 1%. Diesel use in the plastic manufacturing industry is the second largest source of BC accounting for 13% of the national total. The rest are forest burning (6%), transport

Picture 3: Traditional cooking devices

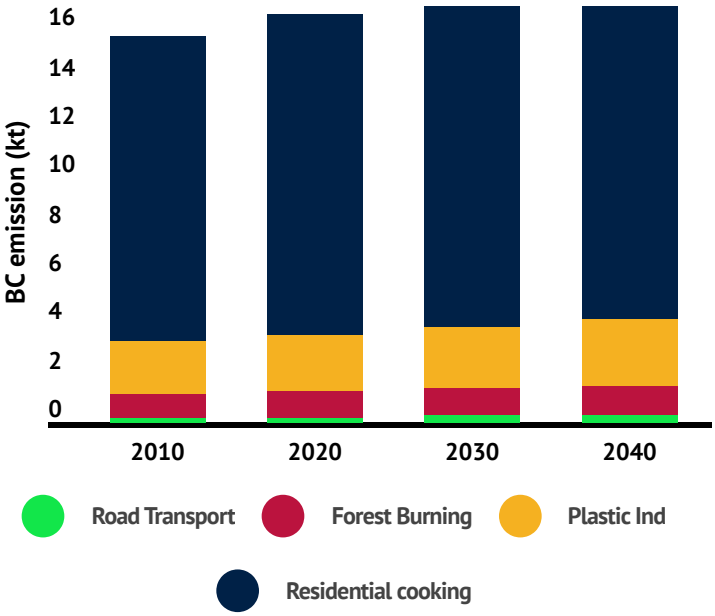


Fig 1: BC emissions trend for the period 2010-2040 under policy failure scenario

The total BC emissions increased from 15.9 kt in 2010 to 16.5 kt in 2017 and expected to increase by 1% annually to 20.7 kt in 2040 under the current policy failure scenario. Generally, Black Carbon emissions recorded a steady and marginal rise for the period 2010-2040 (fig 1). Throughout the period of 2010-2040 residential cooking was consistently the largest source of black carbon in Ghana. Under policy success scenario, total black emissions rather declined to 14.3 kt.

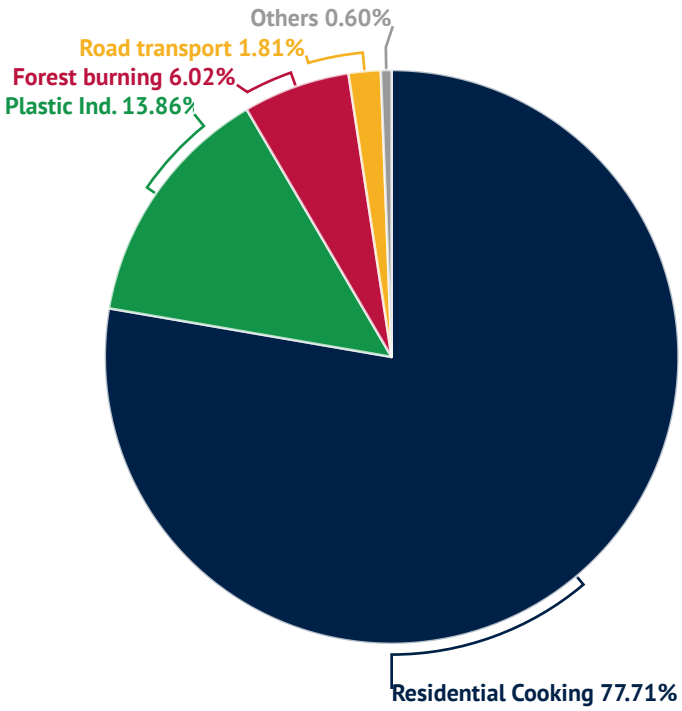


Fig 2: Key sources of black carbon emissions in 2017

2.3 Methane Emission (CH_4)

Methane is one of the powerful greenhouse gases. According to IPCC, 2013, CH_4 is roughly 34 times more potent than CO_2 as a global warming agent over a 100 year period. Beside its significant ability to cause climate change, methane contributes to the formation of ground-level ozone. Under the national GHG inventory, methane gas is also accounted for. The SLCP inventory is therefore an update. There is likely to be differences in CH_4 emissions reported under the GHG and SLCP inventories because the reporting years and source coverage may differ. Overtime, as the two inventories are fully integrated the differences will be ironed out.

In Ghana, the main sources of CH_4 are solid waste disposal (picture 5), animal husbandry (picture 4), cooking and charcoal making. In 2017, the total CH_4 emissions amounted to 365.7 kt. Landfill is the largest source of methane accounting for 43% of the national total in 2017. Currently, there is no clear policy on landfill gas collection making methane recovery and utilisation virtually non-existent. The focus is on improving waste collection and overall landfill management. Livestock rearing (21.1%) through enteric fermentation constitutes the second most important source of methane. The rest are charcoal making (18.3%), residential cooking (11.9%) and gas production (1.5%). For the period 2010-2040, CH_4 emission is projected to increase from 331.7 kt in 2010 to 650.8 kt in 2040 with an annual growth rate of 2.2% (fig 4).

Picture 4. Livestock (sheep) on free range feeding

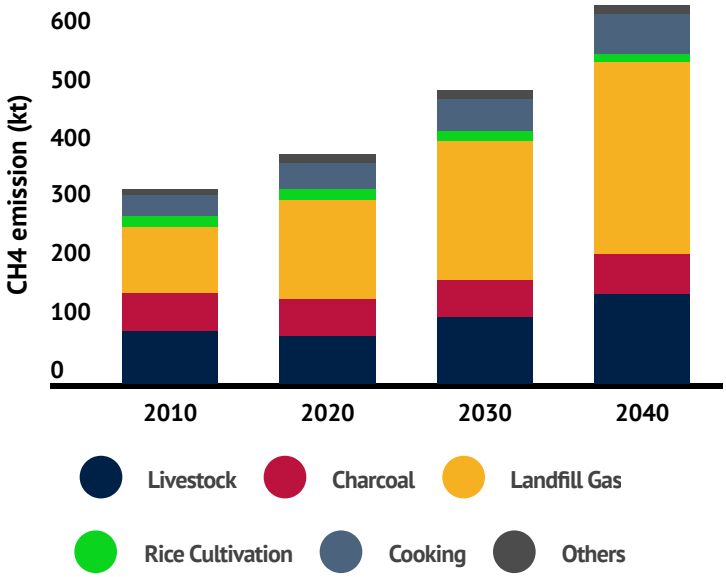


Fig 4. CH4 emissions trend for the period 2010-2040 under policy failure scenario

Picture 5. Waste scavenger on a waste dumping ground

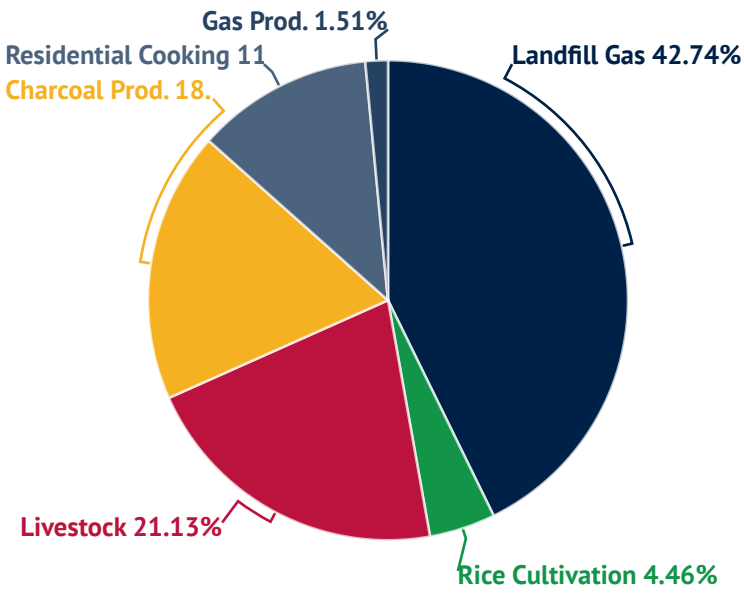


Fig 3: Key sources of methane emissions in 2017

2.4 Fine Particulate Matter ($PM_{2.5}$)

$PM_{2.5}$ are tiny particles with aerodynamic diameter of 2.5 microns in the air that reduce visibility and causes haziness. It is a mixture of solid particles and liquid droplets found in the air. Some particles, such as dust, dirt, soot, or smoke, are large or dark enough to be seen with the naked eye. Others are so small they can only be detected using an electron microscope. Exposure to high levels of $PM_{2.5}$ can pose serious respiratory and cardiovascular diseases. Typically in Ghana, $PM_{2.5}$ levels are measured using gravimetric tactics and high volume samplers located in strategic locations along roadsides, residential, commercial and industrial areas. The estimation of $PM_{2.5}$ using the LEAP-IBC tool based on specific activity data and emission factors is in no way replacing the monitoring figures. It is to complement the measured $PM_{2.5}$ emissions from the technology and sectoral point of view. The $PM_{2.5}$ emission estimates here are only the primary emitted $PM_{2.5}$, and include emissions of black carbon, as well as other $PM_{2.5}$ components. In the atmosphere, concentrations of $PM_{2.5}$ that are monitored are also made up of secondary $PM_{2.5}$ that is formed in the atmosphere from emissions of gases such as nitrogen oxides, sulphur dioxide and ammonia. The main sources of $PM_{2.5}$ are residential cooking, road transport and forest burning. In 2017, the total $PM_{2.5}$ was estimated to be 105.4 kt with the residential cooking being the largest source, contributing 62.4% of the national total. The high $PM_{2.5}$ level from residential cooking contributes significantly to indoor pollution. The second largest sources of $PM_{2.5}$ is road transport from diesel vehicles.

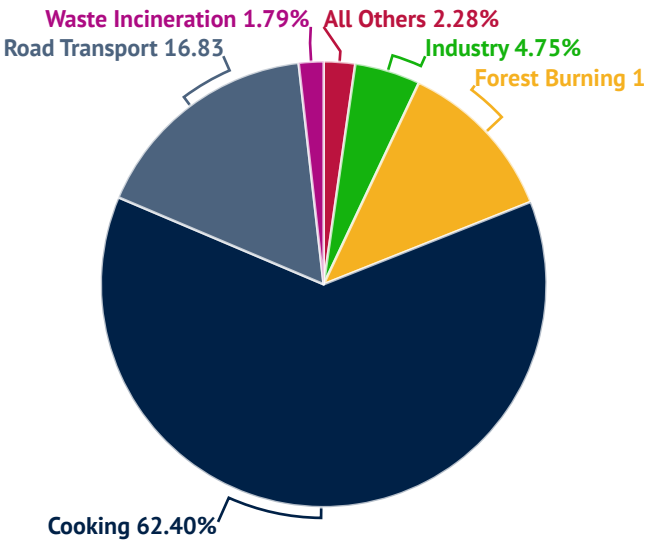


Fig 4: Key sources of $PM_{2.5}$ emissions in 2017

Picture 6: Grossly polluting diesel car

Road transport accounts for 16.8% of the total estimated PM.25 emissions for Ghana.The rest are emitted from forest burning (11.9%), industry (4.8%), waste incineration (1.8%) and others (2.3%). $PM_{2.5}$ emissions are projected to increase from 94.2 kt in 2010 to 128.8 kt under the policy failure scenario. The expected increases in $PM_{2.5}$ will be largely driven by the rising number of diesel vehicles and the large proportion of unpaved road. $PM_{2.5}$ from residential cooking will continue to be the main source for the period 2010-2040.

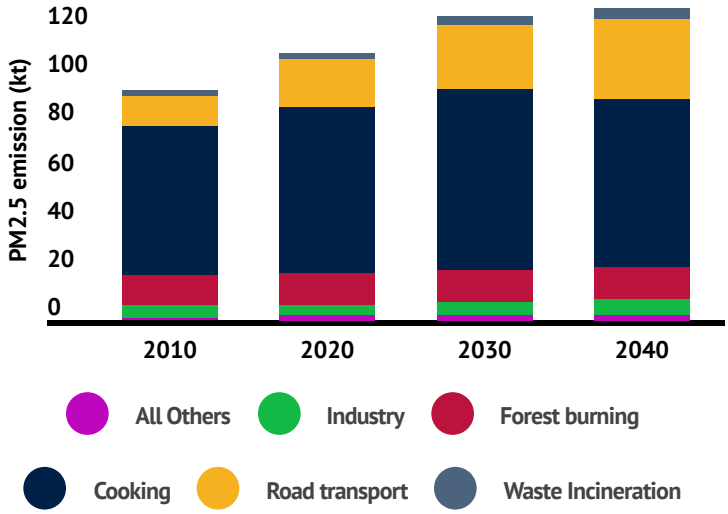


Fig 5. $PM_{2.5}$ emissions trend for the period 2010-2040 under policy failure scenario

For road transport, heavy-duty diesel engine contribute the most of $PM_{2.5}$ emissions. Similarly, for residential cooking, $PM_{2.5}$ emissions are more prevalent in rural households. This is because in most rural areas, inefficient woodstoves are prealent traditional cooking method are common. They use a lot more wood for cooking in relatively inefficient stoves. In most rural households, the motivation to use alternative fuel for cooking is lacking because of:

- Lack of awareness
- Difficulty to access LPG
- High LPG prices
- Perception of high safety risk

2.5 Carbon Dioxide (CO_2)

Technically, CO_2 is not considered as SLCP. It has warming effects on the global climate and can live in the atmosphere for over 100 years. This makes CO_2 the largest contributor to global warming. Hence it is necessary to evaluate the extent to which implementing measures to reduced SLCPs could also reduce carbon dioxide. CO_2 emissions are mainly from burning of fossil fuels (oil, natural gas, and coal), solid waste, and trees and wood products. Changes in land-use also play a role. Deforestation and soil degradation emit carbon dioxide to the atmosphere, while forest regrowth takes it out of the atmosphere. The CO_2 emission inventory under the NAP does not represent the complete sources since the current version of LEAP-IBC tool is not able to model data on deforestation and carbon stock enhancement. Therefore, the CO_2 emission data presented in this report does not include all the sources. The main sources covered include energy, transport, waste, industrial processes, agriculture and selected activities relating to forest burning.

The dominant sources of CO_2 emissions in the Ghanaian economy are electricity generation, residential cooking, energy industries, manufacturing and transport. As at 2017, the total CO_2 emission from the sources covered in this report amounted to 88.9 Gt. Out of which 59.2% are emitted from electricity generation from crude-oil or natural gas fired thermal plants. This is followed by CO_2 emissions from residential cooking and lighting which make up 21.9% of the total emissions. For residential lighting, the use of diesel-fired standby generator produce some level of CO_2 emission in addition to LPG used for cooking.

Picture 7: Sunon Asogli thermal power plant

CO_2 emission from energy industries and manufacturing activities is the third largest source and constitute 15.2% of the overall emissions. The remaining 3.8% of the total CO_2 emissions is contributed by road transport.

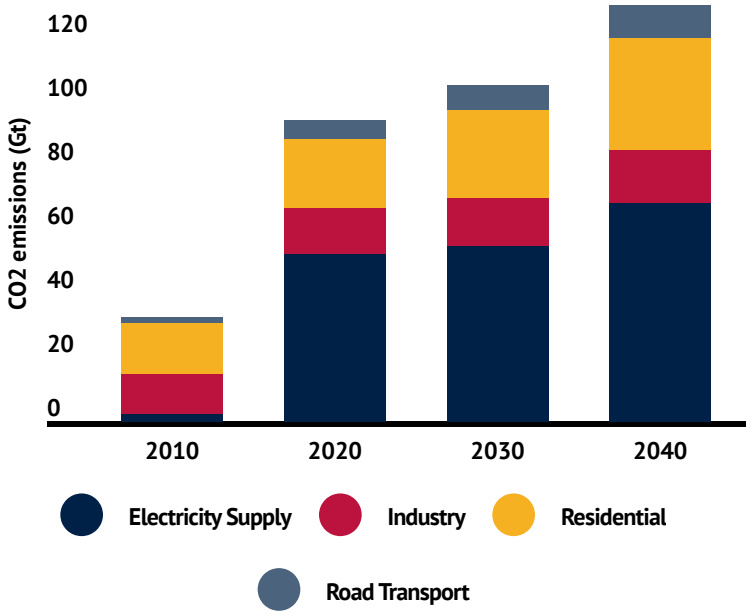


Fig 6. CO_2 emissions trend for the period 2010-2040 under policy failure scenario

Trends of CO_2 emissions under CPF scenario is projected to increase from 22.2 Gt to nearly 120 Gt in 2040. Throughout the period (2020-2040), electricity supply will contribute greatly to the overall CO_2 emissions.

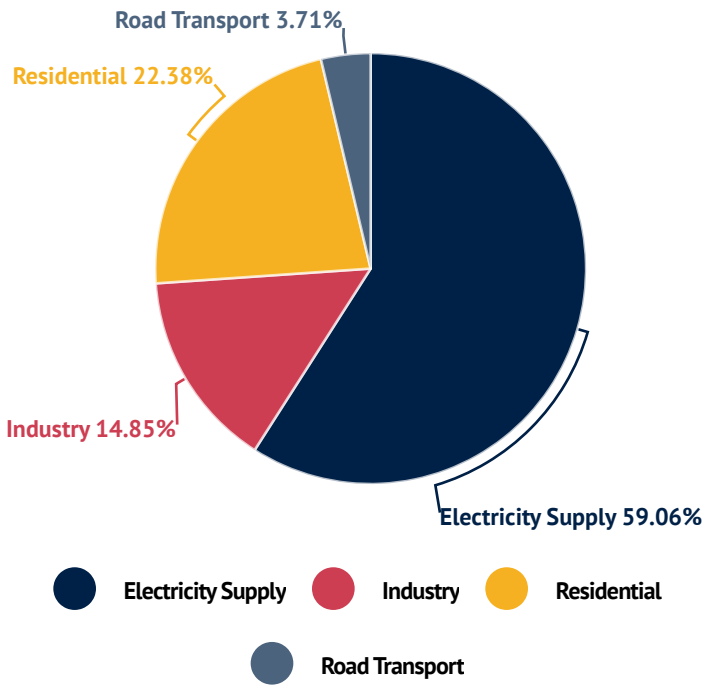


Fig 7: Key sources of CO_2 emissions in 2017

2.6 Sulphur Dioxide (SO_2)

Sulphur dioxide (SO_2) is a strong precursor of $PM_{2.5}$ (participates in a chemical reaction that produces another compound) gas that is produce mainly from power plants (heavy fuel oil and coal fired plant) and industrial facilities. Short-term exposures to SO_2 can harm the human respiratory system and make breathing difficult. Children, the elderly, and those who suffer from asthma are particularly sensitive to SO_2. High concentrations of SO_2 in the air also leads to the formation of other sulphur oxides (SO_4). SO_4 can react with other compounds in the atmosphere to form small particles. These particles contribute to particulate matter (PM) pollution which can cause further respiratory health challenges.

The total sulphur dioxide emissions was estimated to be 61.9 kt in 2017. The sources of sulphur dioxide emissions in the country are; electricity supply (50%), oil refinery (27%), manufacturing industry (17.4%) and other sources (5.6%). SO_2 emissions from power plants are driven by the technology and type of fuel. SO2 emissions are common with power plants that use heavy-fuel-oil and diesel as fuels.

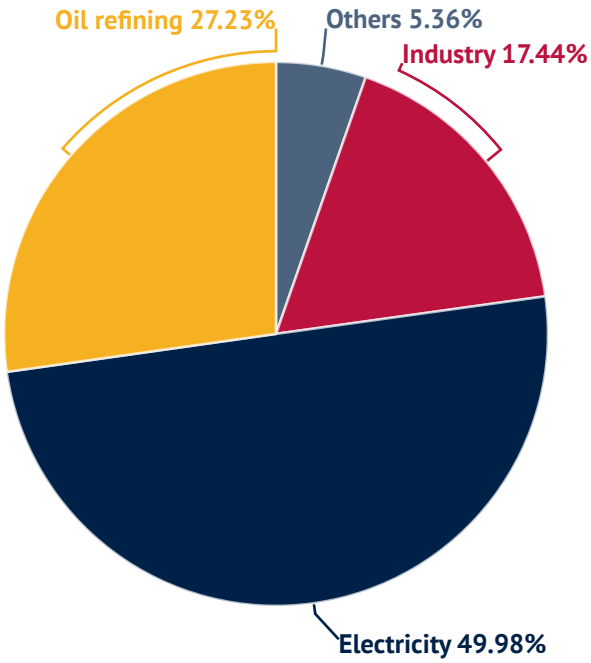


Fig 8. Key sources of SO_2 emissions in 2017

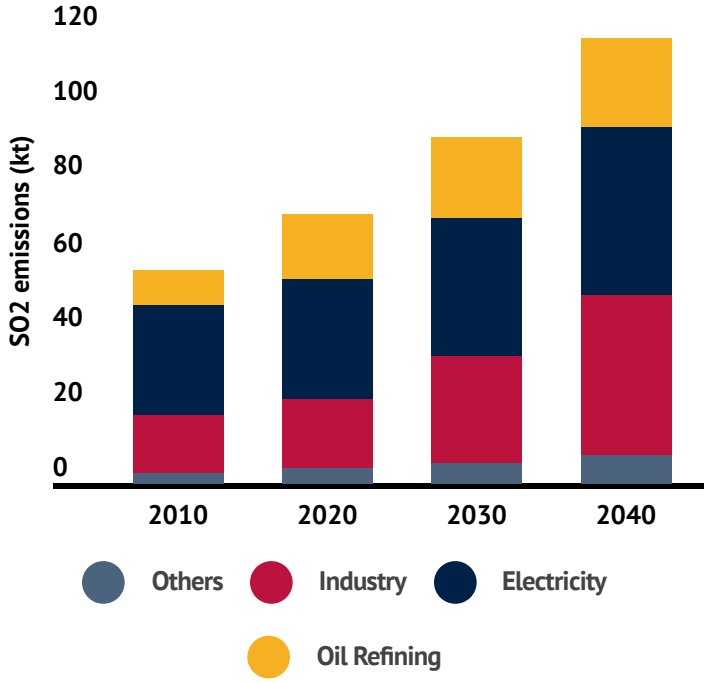


Fig 9. SO_2 emissions trend for the period 2010-2040 under policy failure scenario

SO_2 levels are expected to more than double from the estimated 56.9 kt in 2010 to 118.6 kt by 2040. The emission trends is likely to be driven by the increasing use of HFO in thermal plants (picture 7) or diesel use in standby generators as well as residual fuel oil use in industry. Thermal electricity supply will continue to be the most important source of SO_2 emissions. This will be followed by manufacturing industry due to the high consumption of RFO.

Picture 8: ASKA HFO-fired thermal power plant

2.7 Nitrogen oxides (NOx)

Nitrogen Oxides are a group of poisonous, highly reactive gases. NOx gases form when fuel is burned at high temperatures and are emitted by automobiles, trucks and various non-road vehicles (e.g., construction equipment, boats, etc.) as well as industrial sources such as power plants, industrial boilers, cement kilns, and turbines. It is a strong oxidizing agent and plays a major role in the atmospheric reactions with volatile organic compounds (VOC) that produce ozone (smog) on hot summer days. NOx contributes PM2.5 and is an ozone precursor and therefore contribute to the formation of an SLCP.

The total NOx emissions 222.4 kt in 2017. Industry activities such as thermal power and boilers in the plastic industry are the main sources of NOx emissions in Ghana. Thermal power plants and the boilers in plastic industry contribute 40.4% and 36.8% respectively of the total NOx emissions in Ghana. The rest are from fertilizer application (9.6%), residential cooking (5%), road transport(4.4%) and others(3.8%).

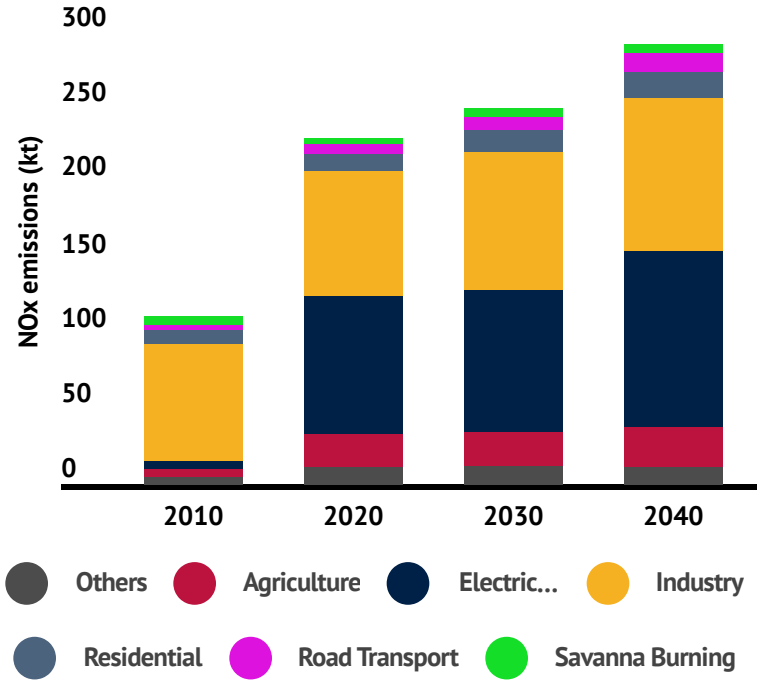


Fig 11.. NOx emissions trend for the period 2010-2040 under policy failure scenario

NOx levels are expected to increase from 111.78 kt in 2010 to 292.78 kt in 2040 at annual growth rate of 3.3%. The projected increasing trends of NOx emissions are likely to be driven by growing fossil-fuel fired thermal electricity and in industrial boilers.

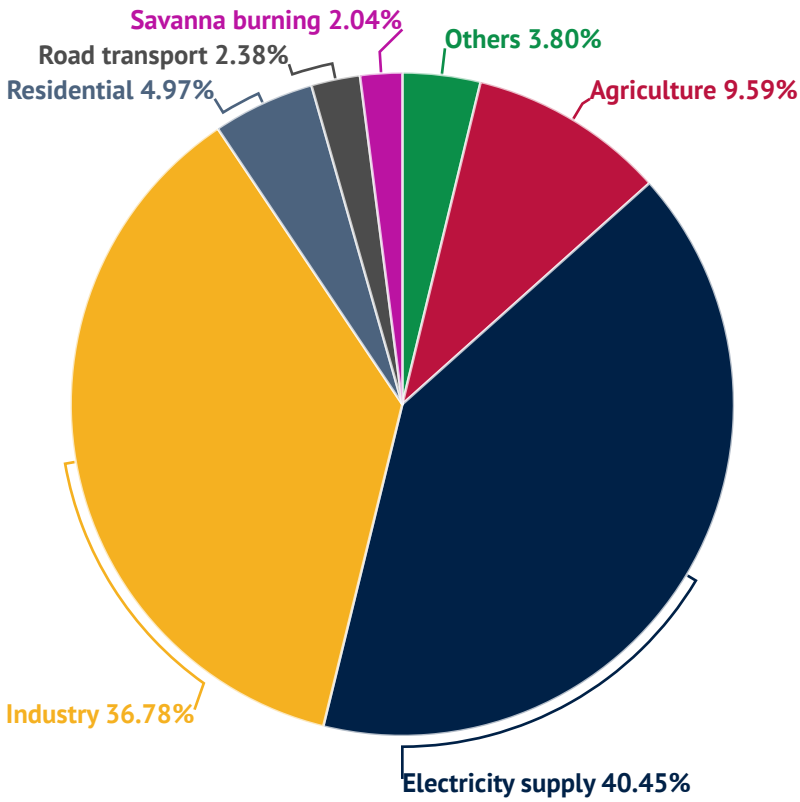


Fig 10. Key sources of NO_x emissions in 2017

3. National Process for formulating Ghana's NAP

3.1 Organising Ghana's NAP Process

The Ministry of Environment, Science, Technology and Innovation (MESTI) coordinated the preparation of Ghana's action plan to mitigate SLCP from the beginning to the end with support from several stakeholders which has culminated into this action plan document. As an Agency of the MESTI, EPA together with the Stockholm Environment Institute (York) provided technical support to the process. The Ministry constituted an inter-ministerial task-team to enhance coordination of SLCP-related activities. The preparation of the NAP was conducted through a combination of stakeholder consultation and analytical work .

The NAP process started with discussions on the operational issues:

- how to design the architecture of the NAP
- identification of who will be involved and at what stage to engage who and how,
- which aspects and issues must be covered in the NAP and by who
- how much will it cost and who will be bear what cost within the operational budget?
- what is the timeframe for this process?

The overall step-wise sequence of the NAP process is provided in the Table 1.

Table 1: Summary of steps for the preparation of Ghana's SNAP

Sequence of steps	Collaborators	Deliverables
Step 1: Set up NAP process		
1.1 Decided on the steps of the NAP process defining who will lead, who will be involved, and how the activities will be carried out.	MESTI, Ministry of Health, Ministry of Transport, EPA, Energy Commission, Ministry of Energy, Ministry of Agriculture, Ministry of Finance, National Development Planning Commission, University of Ghana	Short project initiation report explaining how the NAP process has been organized and which elements has been included.
1.2 Define scope or topics to be covered in the action plan		
1.3 Engage stakeholder by identifying which institutions to be involved, how and when they will be involved, held initial national consultations. The second consultation workshop focused on the identification and prioritization of SLCPs abatement options		
1.4 Draft short project initiation report.		
1.5 Provide inputs into the development of the NAP guidance document - working with SEI and partners to improve the guidance document - improving structure, questions and detail through an iterative process.		Stockholm Environment Institute, CCAC Partners and Secretariat

Sequence of steps	Collaborators	Deliverables
Step 2: Undertake SLCP emission inventory using LEAP-IBC	EPA/MESTI/SEI	Progress Report 1
2.1 Compiled existing dataset as inputs in SCLP-IBC	EPA/MESTI/SEI	Progress Report 2
2.2 Conducted institutional mapping to understand strength and weakness of stakeholders	EPA/MESTI/SEI	Progress Report 3
2.3 Modelled SLCP baseline emissions, different emission scenarios and counterfactual scenarios	EPA/MESTI/SEI	Progress Report 4
Step 3: Identified and prioritized relevant measures to abate emissions and assess benefits of undertaking measures	EPA/MESTI and Taskforce	Checklist of measures
Step 4: Identified likely implementation pathways through expert advice and stakeholder consultation	Tasksforce & SEI	Meeting reports
Step 5: Prepared Ghana action plan to mitigate SCLP	EPA/MESTI	Draft SNAP Document
Step 6: Conducted third party review and stakeholder validation	National Stakeholders/ SEI	Compilation of review comments
Step 7: Ministerial approval and signature of foreword and publication	MESTI	Signed SNAP Document

3.2 Data sources for Ghana's LEAP-IBC Template

The LEAP-IBC tool is a integrated scenario analysis tool that can be used to create emission inventories and future projects. The LEAP-IBC was used to systematically conduct an inventory of key SLCP emission sources, develop plausible emission scenario under different policy mix, as well as quantify the potential health, climate and crop effects of SLCP mitigation measures. This will require a comprehensive and up-to-date dataset from national and international sources.

Majority of the national data sources relied on publicly available statistics from government institutions such as the Ghana Statistical Service, Energy Commission, Ministry of Food and Agriculture, Forestry Commission and Environmental Protection Agency. It is also instructive to note that where data has already been collected and published under the GHG inventory, particularly for the non-energy sectors, the data is reviewed, updated before being analysed with the LEAP-IBC tool.

Below are some of the selected data points:

- Crop residue open-burning
- Rice cultivation
- Municipal solid waste
- Electricity generation
- Charcoal making
- Forest fire
- Commercial and manufacturing industries
- Oil and gas production and processing
- Road transport
- Household energy consumption

Where national data are not readily available, published international data sources were relied on. For instance, projected macroeconomic indicators in terms of GDP and sector value addition were not available in country as such the World Bank economic dataset on Ghana was used. The construction of the baseline and counterfactual scenarios were done using a participatory approach. As much as possible, different plausibilities in the baseline scenario have been captured based on the expectation of policy mix. Table 2 is an inventory of data sources used.

Table 2: LEAP-IBC data list and sources

Data Description		Source
Macro economic	Nominal GDP, sector value addition, GDP projections	World Bank dataset on Ghana, Ghana Statistical Service, Bank of Ghana
Population data	Population, household structure	Housing population census, Ghana Living Standards Survey
Household energy consumption patterns	share of urban and rural households	Energy Commission - SNEP, Energy Statistics & GLSS, IPCC Emission Factor Database
	share of metro urban and other urban households	
	share of coastal rural households	
	share of forest rural households	
	share of savannah households	
	technologies & fuels for cooking, lighting, heating & cooling	
	fuel activity and intensity for each technology type in a typical household	
	emission Factor SLCP, Air Quality Pollutants and GHG	
Industry, commercial and services	share of formal and informal service facilities	
	share of schools, hospitals and hospitality facilities	
	share of water production, mining, construction and manufacturing industries.	
Agriculture	share of irrigation, poultry, land clearing, fishing and ploughing agriculture	
	fuel activity, fuel intensity for each share of industry, agriculture	
	emission Factor SLCP, Air Quality Pollutants and GHG	
Road transport	number of vehicles per technology and fuel type	EPA'S Greenhouse Gas Inventory Report, DVLA Vehicle data, Vehicle emission inventory under transport sector support programme, IPCC default emission factor
	average annual distance per vehicles technology and fuel clas	
	emission Factor SLCP, Air Quality Pollutants and GHG	
Industrial process	Share of mineral, chemical, aluminium, metal, pulp and paper, beverage industries	National GHG Inventory Report by EPA

Data Description		Source
Agriculture	Heads of animals	Agric facts and figures
	Quantity of fertilizer consumption per type	Agric facts and figures, FAOSTATS
	Annual crop production per type	Agric facts and figures
	Residue to crop ratio	IPCC default
	total rice cultivation areas (rainfed and continously flooded)	Agric facts and figures
Forest	Total forest and savannah area burnt annually	Ghana National GHG Inventory Report
Waste	Solid waste generation per person	Ghana National GHG Inventory Report
	Total national population statistics	Ghana National GHG Inventory Report
	Fraction of waste collected	Ghana National GHG Inventory Report
	Fraction of waste openly burnt, incinerated	Ghana National GHG Inventory Report
	Amount of liquid waste generated and disposed via laterine & outside	GLSS by GSS, MICS by GSS
	Amount of waste dumped in Landfill, amount of gas recovered	Ghana National GHG Inventory Report
	Population income group split (either as % or proportion) between Rural, Urban high income and Urban low income for 2010)?	MICS, GLSS
	Also, for each income group, what was the share represented by each treatment system	

3.3 Stakeholders Relevant to the NAP Preparation

Ghana has a local government system with the following decentralised functions: (a) planning, (b) political, (c) administrative and (d) financial. The local government set up and their functions are determined by the Local Government Act 936, 2016. The country is divided into 10 administrative regions and 254 Metropolitan/Municipal/District Planning Authorities (MMDAs) each headed by a Chief Executive. The decentralised structures are made up of the National Development Planning Commission (at the apex), Ministries, Department and Agencies (MDAs), Regional Coordinating Councils, District Assemblies and the Unit Committees.

The National Development Planning Commission (NDPC) by the virtue of its statutory functions coordinates national development planning and monitors implementation of government policies. Accordingly, the NDPC works with the MDAs in the formulation and implementation of government policies and programmes. The NDPC together with the Ministry of Environment, Science, Technology and Innovation (MESTI) and its Agencies ensure that air quality and climate change issues are well integrated into the national development planning and budgeting processes.

3.3.1 Institutions

In Ghana, air quality and climate change issues have received attention from both government, and its development partners (CSOs, donors and the business community). Public institutions can be categorised into five main groups based on the legal mandate and function. They are: (a) strategic/political level; (b) planning and government-wide coordination; (c) finance mobilisation and budgeting; (d) technical ministries; (f) local government. The strategic/political level bodies are mainly the executive, parliament and judiciary and their respective agencies.

Their functions are to set out the development vision for the country and provide the leadership for implementation. The office of government machinery, cabinet and the economic management team define the development agenda for the country by preparing the coordinated programme of economic and social development policies (CPESDP) in response to Article 36(5) of Ghana's constitution. In the previous two CPESDPs prepared by the political administration, climate change issues were addressed as part of economic and inclusive growth policies. Once the government's CPESDP capture climate change as a priority area, it must then trickle down to the various levels of decision-making. Parliament's role is crucial in several respects. It passes laws, approve budgets, scrutinise audit reports of public institutions, monitor implementation of government's policies and planned programmes and have oversight over the executive.

Office of Government Machinery

Ghana's current Coordinated Programme of Social and Economic Development Policies (CPSEDP) (2017-2024) was prepared and presented by His Excellency Nana Addo Dankwa Akufo-Addo to the 7th Parliament of the 4th Republic on the 20th October 2017. Air quality and climate change issues are incorporated in the CPESDP as one of the priority areas. After receiving approval from Parliament, the CPSEDP is expected to inform the medium-term development strategy through which the government's vision is implemented.

The current CPESDP which is expected to be implemented till 2024 reinforces the Government of Ghana's commitment and will to effectively mainstream climate change, environment, and air quality issues in its development agenda. The CPESDP also underscores the government's commitment to take pragmatic steps to pursue the Sustainable Development Goals (SDGs) as well as fulfill Ghana's obligations under the Paris Agreement.

As one of the co-chairs of the Eminent Group of SDG advocates, the President of Ghana is uniquely placed to provide leadership in the region. In the past, the Environment and Natural Resources Advisory Council (ENRAC) - an inter-ministerial body was formed to have broad oversight on issues of environment and climate change. However, in recent times the body has not been active. Although the council is not a creature of law, it has served as a vital platform for environment, natural resources ministries and most development partners to work together. The major challenge facing ENRAC is the uncertainty associated with its functionality under different political administrations. Perhaps, a way forward is to institutionalise ENRAC operations by grounding it in a statute.

Parliament

Parliament has law-making, financial appropriation and oversight functions. The legislature is important in entrenching climate change and air quality issues into the national discourse. The Parliamentary select committee on Environment has been supportive on climate change and air quality issues. For instance, during the ratification of the Paris Agreement, the select committee on Environment supported the entire process until its logical conclusion.

National Development Planning Commission

The National Development Planning Commission (NDPC) leads national planning process taking government agenda into consideration. The NDPC is a body created by articles 86 and 87 of the 1992 Constitution of the Republic of Ghana and established by Acts 479 and 480 (1994) of Parliament. In the formulation of national medium-term plans, the NDPC uses the cross-sectorial planning groups (CSPGs) to obtian technical inputs from the line ministries, CSOs and academia. It is an iterative process, which NDPC coordinates on behalf of the central government. Previous medium-term development plans have dedicated sections for climate change and promoted the mainstreaming of climate change into development activities. The preparation of the current plan for period 2018-2021 is underway and climate change issues are captured under the section on "Safeguarding the Natural Environment and Ensuring A Resilient Built Environment".

The air quality and climate change issues raised in the new medium-term development policy framework are consistent with the Ghana's NDC. It is a further elaboration of the sectorial NDC actions with clear target over the implementation period. After government accepts the framework, both the line ministries and local governments are required to include the identified climate changes issues in their respective annual plans and budgets. The entire plan-preparation process is guided by the planning guidelines issued by NDPC to direct the line ministries and local governments in the preparation of the medium-term and annual plans. Additionally, the NDPC has responsibility to coordinate the M&E (result framework) of the medium-term plans. Therefore, during the formulation of the plans, the CSPGs outline a set of indicators and targets that are adopted for the monitoring and reporting on progress of implementation. The line ministries have dedicated Policy Planning and Monitoring Evaluation Directorate (PPMEDs) that are responsible for M&E activities in the respective sectors. The M&E data the MDAs collect is used in the compilation of the sector annual progress report (APR) for submission to the NDPC and Parliament.

Ministry of Finance

The Ministry of Finance is responsible for government finances and uses a wide range of fiscal policy instruments to manage the economy. The Ministry mobilises financial resources, makes allocation to the sector ministries to execute government programmes and tracks public and private expenditure. With the resource mobilization function, the Ministry collects domestic revenue, sources funds from the domestic and international development partners. With respect to climate change, the Ministry's Real Sector Division is the National Designated Authority (NDA) for the Green Climate Fund (GCF), coordinates the multi-donor budget support and recently initiated an environmental fiscal reform programme with the view to establish a Ghana Green Fund. Individual Ministries, Agencies and non-state actors can access other climate funds (GEF, World Bank, Bilateral sources, Markets, Philanthropist etc.) without going through the Ministry of Finance. The Ministry has deployed a climate finance tracking tool to help monitor climate finance inflows and expenditure from local and international sources to government entities and non-state actors.

Budgeting is an important process through which government resources are allocated to support implementation of climate change and SCLP mitigation programmes. During the preparation of the national budget, the Ministry of Finance ensures that the budget guidelines submitted to the MDAs/MMDAs capture climate change programmes. All the budgets are subjected to policy-hearing to give the MDA/MMDAs the opportunity to defend what they submitted. Due to scare resources, the Ministry of Finance use the policy hearing process to prune down some the budget items that are not a priority of government as indicated in the current medium-term development policy framework.

Other Ministries, Departments and Agencies - MDAs

Aside the MoF, other MDAs specialise in specific sectors and currently numbering thirty-eight (38). The ministries are determined and established by executive instruments as deemed fit by the government of the day. Their core mandate could also be tweaked to suit the agenda of the political administration in power. Under each sector, the responsible Ministry (ies) make policies and strategic decisions for the Department and Agencies under them to implement. There are MDAs that do direct implementation of government programmes, whereas other purely have regulatory functions at different segment of the service delivery. For instance, in the Energy Sector, whereas the Energy Commission has technical regulation functions over the electricity sub-sector, the Petroleum Commission and National Petroleum Authority focus on upstream and downstream market and technical regulation of the petroleum sector. On the other hand, the Volta River Authority is a major public-sector electricity producer. The Agencies under the various Ministries have the freedom to make operational decisions.

The Ministry of Environment, Science, Technology and Innovation (MESTI) is the lead Ministry for environment and climate change issues in the country. The Environment Directorate specifically responsible for the implementation of the National Climate Change Policy and the master plan approved by cabinet in 2015. In addition, MESTI hosts an inter-sectoral National Climate Change Steering Committee (NCCSC) that oversees the implementation of the Climate Change Policy. The NCCSC is made of 14 representatives of line ministries, CSOs, Private Sector and the Academia.

The Environmental Protection Agency (EPA) is the lead institution for UNFCCC activities in the country and is the main Country Implementation Institution (CII) for the technical coordination of activities on climate change and other environmental conventions ratified by Ghana. The Agency is the technical wing of MESTI and implements policy set out by the Ministry. The National Climate Change focal point heads the Climate Change Unit within EPA. The climate change unit coordinates the activities of climate change technical working group under the national communication/biennial update reports. The EPA is responsible for international reporting and provide technical backstopping to the Ministry. Thus, the EPA leads the compilation of Ghana national communications, biennial update reports and the preparation greenhouse gas inventory report as and when resources are made available. The preparation and compilation of these reports involves the collaboration of nearly 20 organization that play different roles. The unit also provide information on climate change to the Ghanaian public.

The Agency's work also boarder on air quality management led by its Air Quality Department. It has air monitoring equipment installed at vantage points (residential, industrial and road corridors) in selected cities. The monitored data is used to inform air quality management and enforcement of environmental standards. The sector ministries (Health, Transport, Energy, Agriculture, Water, etc.) are crucial for the implementation of climate change and SLCP mitigation actions. This is because the investments into the various climate change and SLCP mitigation measures cuts across all these Ministries. A number of MDAs have set up either a unit or a desk to work on climate change within the sector. Currently, the Ministry of Finance, Forestry Commission, National Disaster Management Organisation, EPA, MESTI, Ministry of Local Government and Rural Development, Ministry of Agriculture and Energy Commission have either established units or desk to give special attention to specific climate change issues.

Some universities and research institutions have introduced climate change or SLCP relevant courses to support capacity building and knowledge generation. They include; University of Ghana, University of Development Studies, Koforidua Technical University, Kumasi Technical University, KNUST and University of Energy, Natural Resources and Institute of Local Government Studies.

SLCP source sectors	Transport	Energy	Waste	Industry	Agriculture	Forestry
SLCP source activities	Road transport	Cooking Lighting Charcoal making Electricity generation Gas flaring	Open burning Incineration Landfill gas Liquid waste disposal	Fuel use Process Refigerant use	Animal enteric fermentation Fertilizer use Rice cultivation Crop residues	Forest burning
SLCP impact sectors	Climate change	Health	Crop loss	Economic damage		

Line Mininstries

Ministry of Transport • DVLA • Metro Mass Transit Ltd. • Private Inspection Centres	Ministry of Agriculture • Crop services directorate • Livestock directorate • Animal Research Institute	Ministry of Energy (MoE) • REAE Directorate of MoE • Energy Commission • National Petroluem Authority
Ministry of Sanitation • Sanitation Dept. • Waste Service Providers • Local Government	Ministry of Health • Public health Directorate	Coordinating bodies • NDPC • Ministry of Finance • MESTI • EPA

Policies & measure support SCLP mitigation

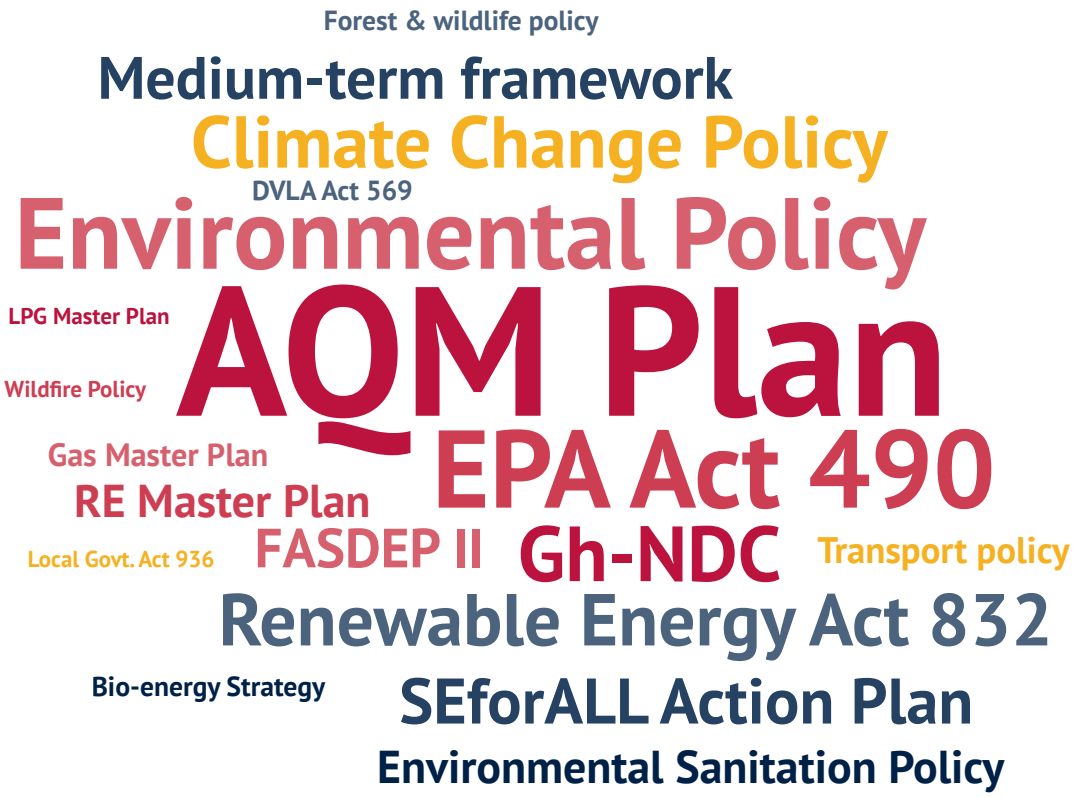


Fig 12 -Map of institutions and policy measures supporting SLCP

4. Strategies to Mitigate SLCP Emissions

4.1 Identification and Prioritisation of SLCP Measures

Stakeholder participatory method was used to identify and prioritize measures to abate SLCP emission in three stages. At the first stage, stakeholders identified possible SLCP mitigation measures by relying on UNEP/WMO assessment, emission levels and national reports. At the second stage, a multi-criteria tool was used to rank the initially selected SLCP abatement measures using both quantitative and qualitative criteria. Last but not the least, some selected stakeholders were convened to validate the scope and decide if the selected SLCP abatement measures fall in line with the agenda of the line ministries. The selection criteria have been explained as follows:

(a) contribution to sustainable development goals

This criterion is used to assess the extent to which the selected measure is economically viable, socially acceptable and environmentally friendly. The stakeholders agreed not to adopt for implementation, measures whose long-term sustainability was not guaranteed. The selected SLCP abatement measures must have the potential to deliver multiple benefits during implementation.

(b) alignment with national, sector priorities and NDCs

It is important that measures align well with sector and national policies and the NDCs to ensure buy-in and effective implementation. This criteria evaluate if a measure is within the priority areas of the selected line ministries. This is based on the notion that if a measure falls within the priority area of the line ministry, there is a high possibility it will be implemented within the stated period.

(c) SLCP emission reduction potential

This criteria determine the 'potential' of a measure to reduce emission and result in multiple health, climate and agricultural benefits. This was done using the emissions reduction estimate using the LEAP-IBC tool by comparing the emissions associated with the selected SCLP measure relative to the current policy failure scenario.

(d) time for introduction

This criterion summarizes the potential time required to fully implement the measure. Here, short-term means within 3 years, medium-term means between 4 to 8 years, while long-term means more than 8 years. Since there was no strict technical evaluation, the timeline was based on judgment rather than on specific calculations, and has uncertainties associated with it.

(e) technical effectiveness

This criterion evaluates the effectiveness or certainty of the measure to reduce emissions once it is fully implemented using the right technology. A technically effective measure implies that if the measure is properly implemented, the projected reduction in emissions is almost certain.

(f) financial effectiveness

This criterion measures the cost-effectiveness, ease to mobilise funds and financial attractiveness of selected SLCP mitigation actions.

All the pre-selected SLCP mitigation measures were subjected to prioritisation process using the criteria above. After the prioritisation, the selected mitigation measures were modelled using LEAP-IBC to evaluate their potential effects individually and together as aggregated package of measures. Three SLCP aggregate mitigation scenarios, "additional PAMs", additional PAMs+ and additional PAMs++, made of two or more measures with increasing ambition were modelled. The overall effect of these measures, including estimated emission reductions and reductions in impacts on global temperature rise, avoided premature deaths and agricultural crop yield loss associated with air pollution exposure

The following 16 SLCP mitigation measures were selected and modelled in LEAP-IBC following the prioritization process.

Table 3: List of selected SLCP mitigation measures

Sector	SLCP abatement measures	Rank	SLCP policy package	Measure outlook	Implementation target
Energy	LPG for cooking (LPGC)	High	Additional PAMs	Low hanging fruits	50% households using LPG for cooking by 2030
Energy	Solar systems (SS)	High	Additional PAMs		10% of installed capacity being renewable by 2030
Forest	Reduced forest burning (RFB)	Low	Additional PAMs+		40% of regularly burnt areas in savannah and transition zone avoided by 2040
Waste & energy	Institutional Biogas (IB)	Low	Additional PAMs+		Promote adoption of biogas fired institutional stoves in schools
Transport	Promote CNG Buses (CNG)	High	Additional PAMs+		800 public buses powered by CNG in four cities in Ghana
Waste	Stop open-burning (SOB)	Medium	Additional PAMs+		Reduce total amount of openly-burnt waste of 11276 tonnes per year in 2010 by 80% by 2040
Waste	Landfill gas management (LFM)	High	Additional PAMs+	NDC measures	Recover 350,000 tonnes per year methane from well- engineered landfill by 2030
Energy	Improved cookstoves (ICS)	High	Additional PAMs+		Increased access to improved stoves in 2 million households and 1million in the commercial sector by 2030
Energy	Natural Gas for electricity (NGE)	High	Additional PAMs+		80% of grid electricity produced from natural gas fired thermal plants instead of light crude oil heavy fuel oil
Energy	Eco-friendly electricity (EFE)	Medium	Additional PAMs+		Avoid the coming on line of 770 MW super critical T5 coal plant as planned by 2035 or 2040.
Energy & forest	Efficient charcoal kilns (ECK)	High	Additional PAMs+		Increase capacity of efficient charcoal kiln by 10% by 2040
Agriculture	Quality livestock feeding (QLF)	Low	Additional PAMs++	SLCP measures	Increase by 20% feeding of livestock with high quality feed
Transport	Vehicle testing standards (VTS)	Medium	Additional PAMs++		Taking out grossly or big polluting cars of the road through the enforcement of emission testing standards at the PVTs.
Energy	Cutting-edge stoves (CES)	Medium	Additional PAMs++		To be determined
Industry	Gas in plastic industry (GPI)	Low	Additional PAMs++		To be determined

4.2 Potential impacts of SLCP measures

Generally, implementing SLCP abatement measures can lead to multiple results in areas of air quality improvements, better public health, reduced crop loss and climate benefits. The potential impacts of the SLCP abatement policy mix were evaluated by comparing them along the following sequence:

(a) current PAMs failure vrs. "current PAMs success"
- Assesses the expected benefits of successful implementation of government own agreed SLCP related measures as against the situation of absolute failure. It is important to showcase the voluntary steps government is taking and benefits to SLCP mitigation though it may not sufficiently be ambitious.

(b) current PAMs failure vrs. "additional PAMs"
Compares the incremental benefits of incorporating solar system and LPG for cooking in the SLCP mitigation policy mix against current PAMs failure. The assumption is that both policy options would be implemented in addition to current PAMs success.

(c) current PAMs failure vrs. "additional PAMs+"
Evaluates the benefits of increasing the ambition of SCLP mitigation by achieving NDC actions over and above the measures attained under additional PAMs relative to current PAMs failure scenario (Table 3).

(d) current PAMs failure vrs. "additional PAMs++"
Compares the "current PAMs failure" to the most ambitious scenario of "additional PAMs++" covering both NDC and SLCP measures.

4.2.1 Black Carbon emission savings

Black Carbon emissions associated with "current PAMs failure" trajectory will be highest compared to alternative policy option scenarios. Black carbon is expected to rise from 15.9 kt in 2010 to 20.7 kt in 2040 under the "current PAM failure" scenario. Under the alternative scenarios, there is projected incremental avoided BC emissions of 30%, 39%, 42% and 61% under "current PAMs success, "additional PAMs", "additional PAMs+ and PAM++ respectively (Fig 13).

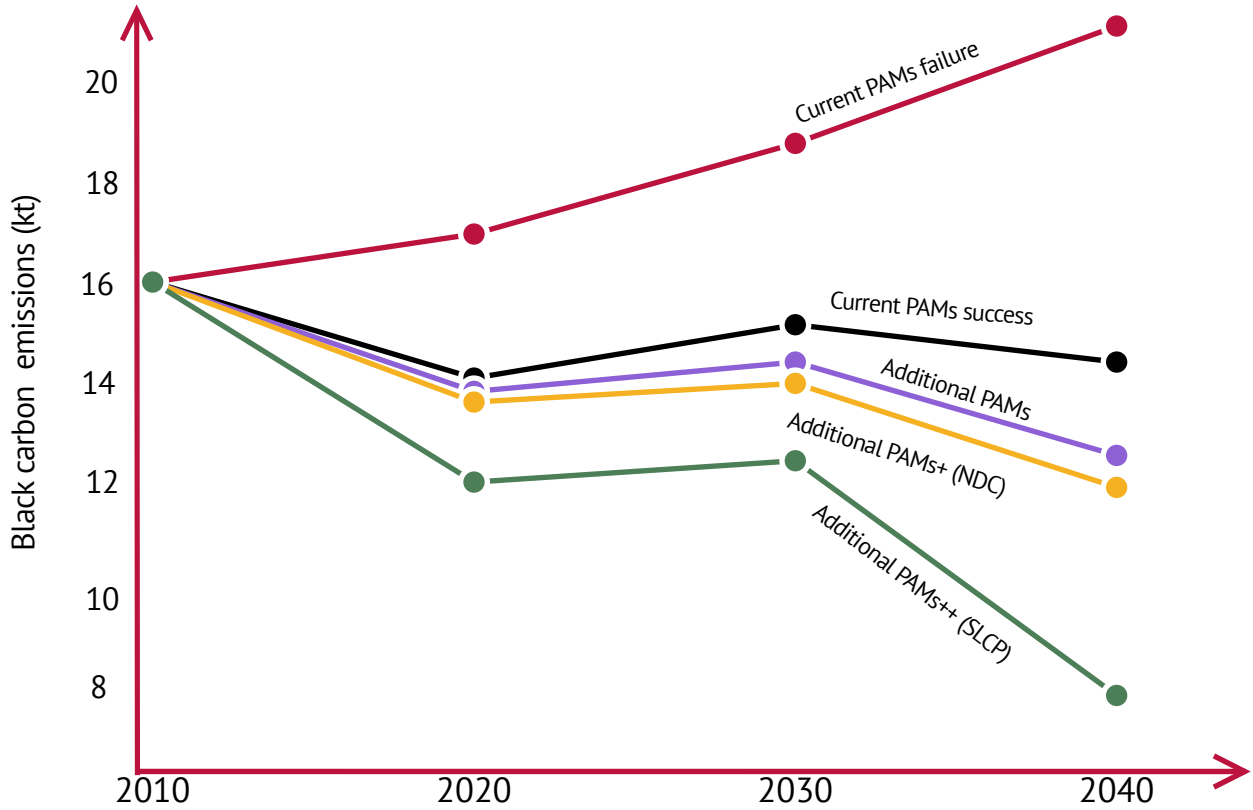


Fig 13 - Black carbon emission trajectories for five SLCP mitigation policy option

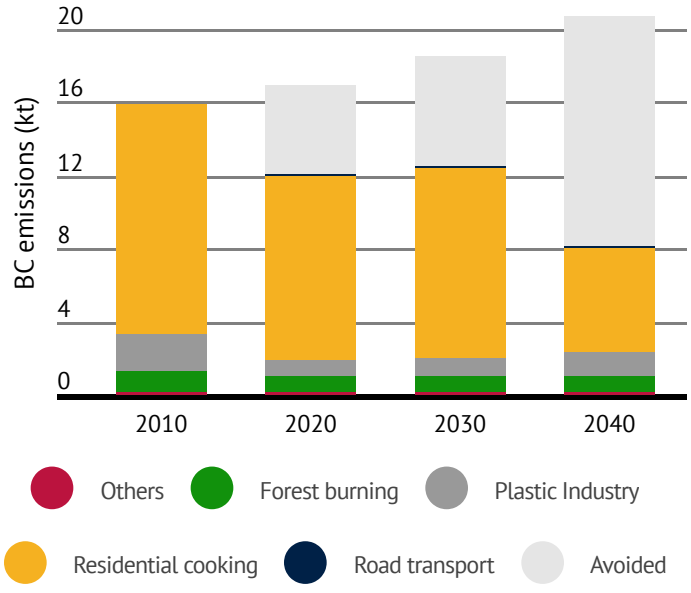


Fig 14 - Avoided BC emissions across the time series under AP+ scenario

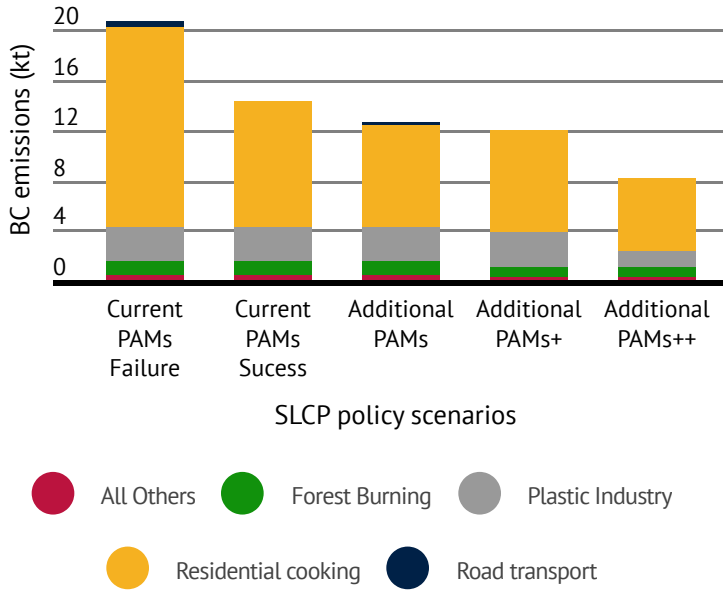


Fig 15 - BC emission by SLCP mitigation options in 2040

Throughout the period, projected BC emissions savings increased from 28.3% in 2020 to 32.6% in 2030 and further by 60.7% in 2040 (Fig 14). Substantial BC emission saving was made from residential cooking activities. BC emissions from the rest of sources largely remained unchanged.

Fig 15. shows projected BC emissions associated different SLCP mitigation policy mix. It is evident that in all cases, BC emission from residential cooking would be a major source. Among all the policy options, the most BC emission reduction would occur under "additional PAMs++" scenario by 2040.

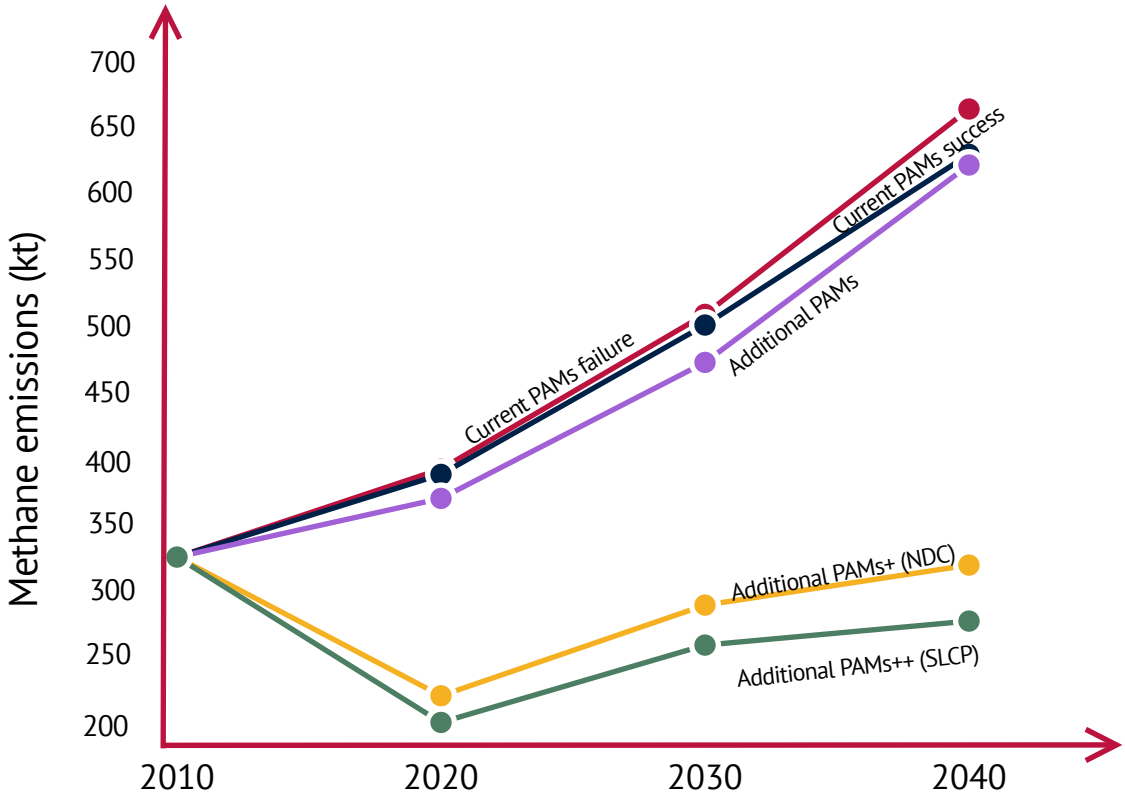


Fig 16 - Methane emission trajectories for five SLCP mitigation policy options

4.2.2 Methane emissions savings

Similar to BC emissions, the largest methane emission reduction will occur along the additional PAM++ trajectory where both NDC and SLCP measures are fully implemented (Fig 10). Overall, the results show that Ghana stand the chance of benefitting more if NDC and SLCP measures are adopted. The least methane reduction of 5.1% compared to the projected 2040 emissions is likely to occur if only already agreed government programmes are implemented under "current PAMs success scenario".

Generally, the ambition of the methane emission reduction associated with the different SLCP mitigation policy mix increases from 6.3% (additional PAMs) and substantially by 50% (additional PAMs+) and further to 56% under additional PAMs++. Hence the majority of the methane emission reductions would be achieved from the full implementation of measures included within Ghana's NDC. It is also important to note that the projected methane savings will occur at different stages of the trajectory even though CH_4 emissions from livestock will still be a dominant source. Substantial methane emission reduction from different set of mitigation actions compared to BC. The current policies can have large effects on BC emissions but it is the NDC actions that have largest effect on CH_4 emissions.

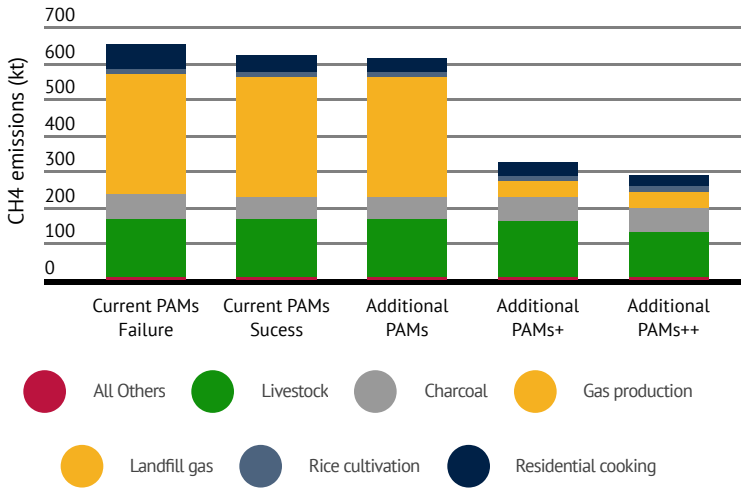


Fig 17 - CH_4 emissions by SCLP mitigation options in 2040

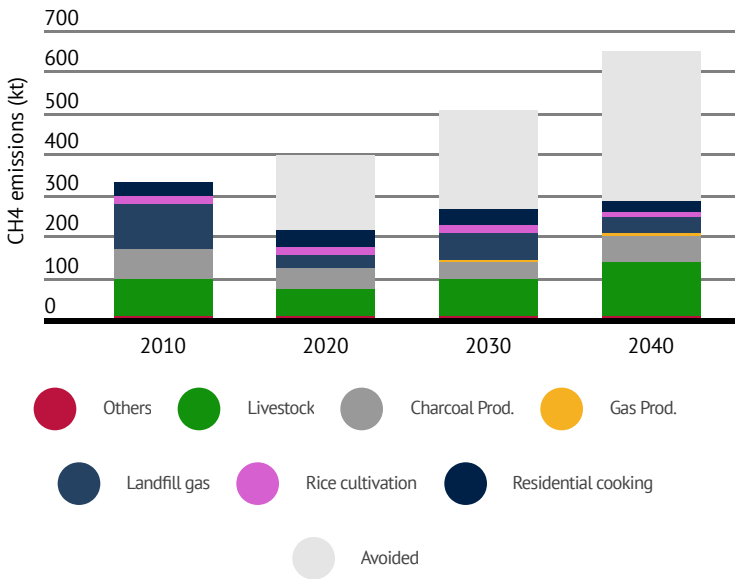


Fig 18 - Avoided CH_4 emissions across the time series

4.2.3 Climate, Health, Agriculture Benefits and Avoided Economic loss

4.2.3.1 Climate benefits

Though emissions from Ghana seems insignificant compared to the global average there is great concerns about the pace at which emissions has increased over the past two decades. Based on the past emission trends, future emissions are mostly likely to grow at a greater pace along the same trajectory in the past if no action is taken as soon as possible. There would be substantial reduction in the contribution of Ghanaian emissions to global average temperature increases by 46% under "additional PAM (AP), 51% under additional PAM+ (AP+) and further to 55% under additional PAM++ (AP++) scenarios (Fig 19).

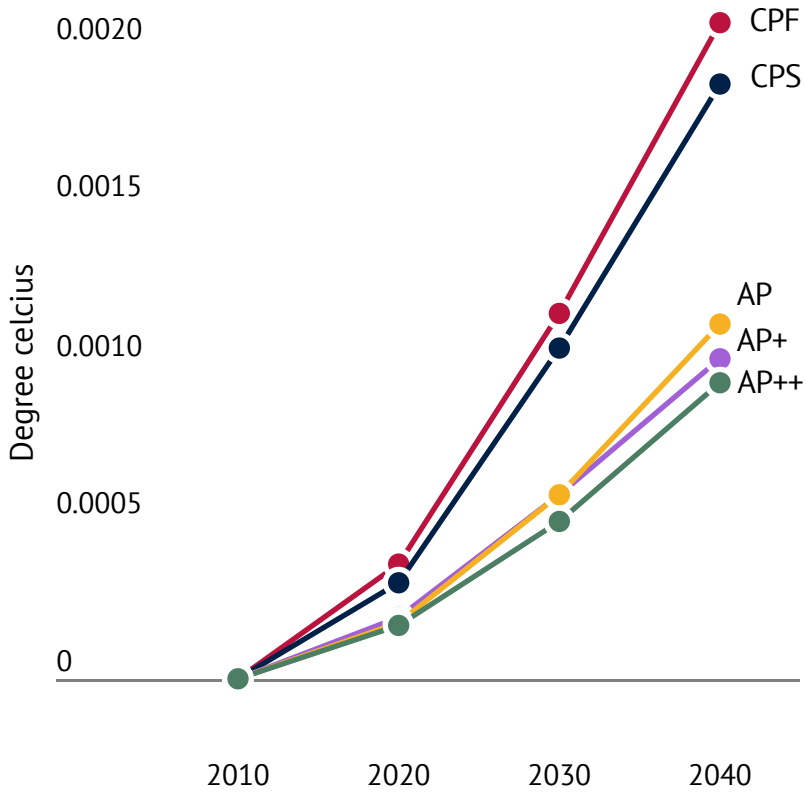


Fig 19 - Climate impacts expressed in avoided temperature change

4.2.3.2 Health benefits

Figures 20 and 21 show the health impacts associated with the PAMs++ and PAMs+ emission trajectory. Although there is a large gap, the efforts from the rest of the world must be felt. If the results is viewed from national perspective, the health benefits of the proposed SLCP mitigation measures is encouraging. Under PAM++, 31.7% of total estimated premature deaths associated with $PM_{2.5}$ exposure due to Ghanaian emissions could be avoided as compared to 18.5% under PAM+ scenario.

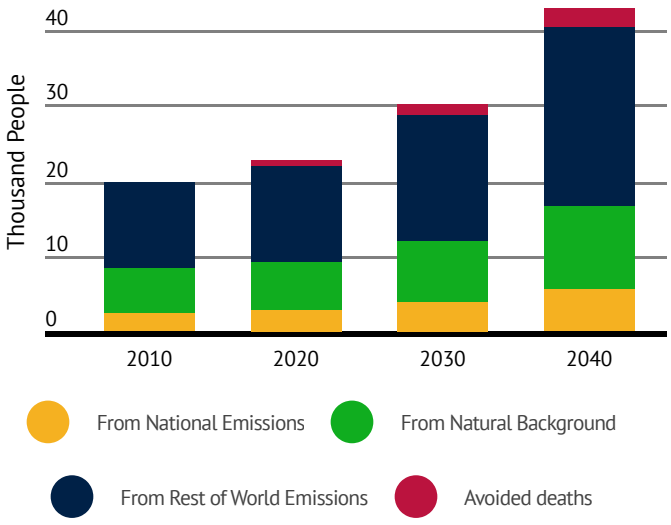


Fig 20 - Avoided deaths under Additional PAMs++

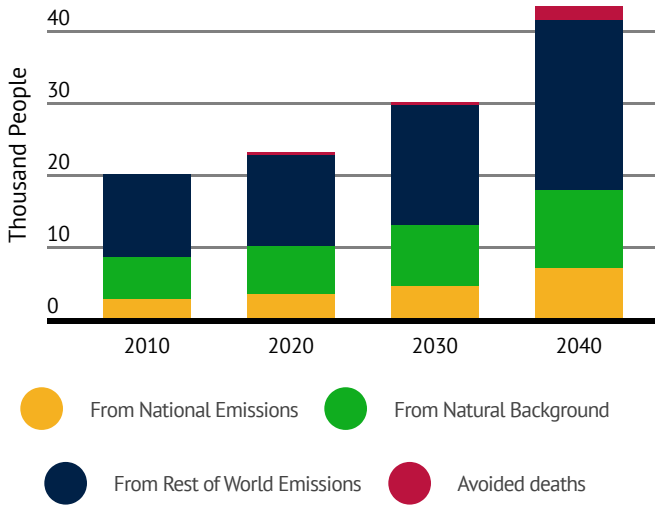


Fig 21 - Avoided deaths under Additional PAMs+

4.2.3.3 . Agricultural benefits

The agricultural benefits of the combined effects of the 16 SLCP mitigation measures are expressed in term of avoided crop losses of major staples like maize and rice which are sensitive to climatic conditions. The effects of ozone on crop loss are associated with emissions from Ghana and rest of the world. The expected SLCP emissions associated with the CPF scenario are to lead to total loss of 520,000 tonnes of maize and 3,758 tonnes of rice by 2040. The SLCP emission savings will have a positive effect on crop losses. In all, the policy measures under PAM+ scenario are likely to lead to 22% reduction in the projected maize and rice losses. There will be additional reduction in crop loss up to 40% of the expected crops loss associated with CPF scenario.

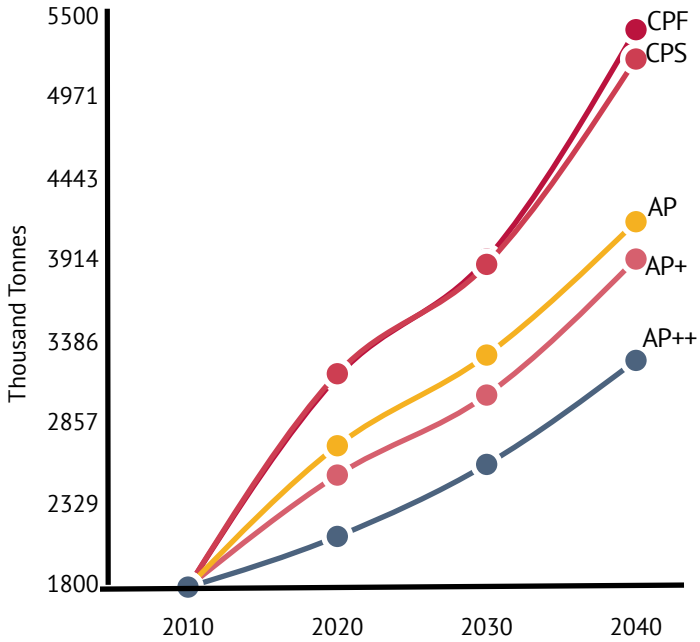


Fig 24 - Crop loss under different policy scenario

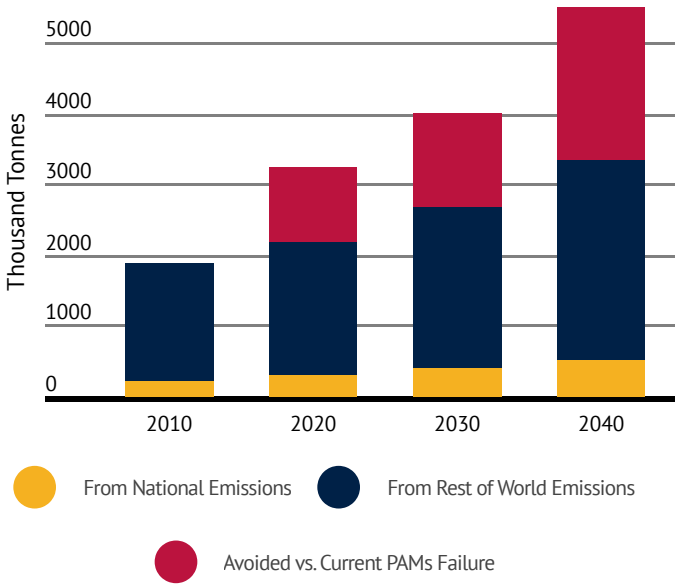


Fig 22 - Crop loss under Additional PAMs++

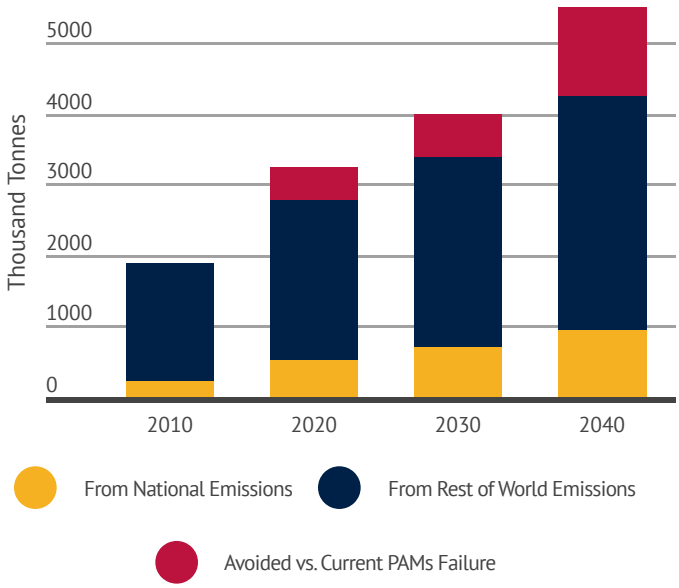


Fig 23 - Avoided crop loss under Additional PAMs+

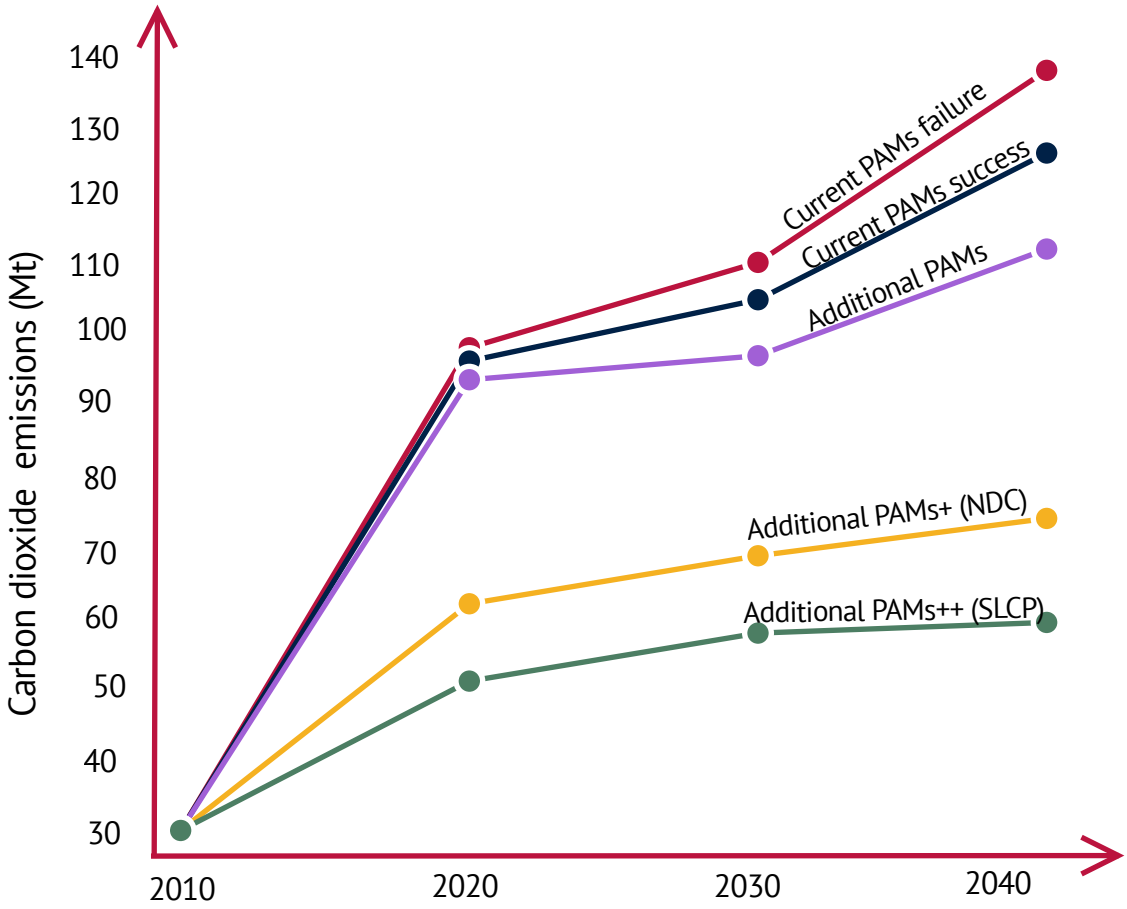


Fig 25 - Carbon Dioxide emission under different policy scenarios

4.2.4 Carbon dioxide emission savings

Carbon dioxide is a major greenhouse gas that has long-term global warming effects. In Ghana, CO_2 emissions are mostly associated with electricity supply, transport and land-use change. The CPF emission trajectory projects an increase in CO_2 emission from 32.2 Mt in 2010 to 94.1 Mt in 2020, 105 Mt in 2030 before peaking at 129.8 Mt in 2040. The emission trends under the CFP scenario will be due to economic development model that continue to depend on energy-intensive and technologies with high rates of deforestation.

Adopting alternative sets of climate-SLCP policy options will have greater emission reduction effects. If government limits it efforts in implementing existing policies together with low-hanging measures, the CO_2 reduction benefits will not be as ambitious as adopting both the NDC and SCLP measures. CO_2 emission under CPS and AP will amount to 8% and 18% reduction compared to the projected CFP emissions in 2040.

The full implementation of Ghana's NDC actions under AP+ scenario is expected to lead to 45% CO_2 emission reductions relatively to the CO_2 emissions associated with CFP scenario. Additional 10% CO_2 reductions will be possible if SLCP-specific interventions under AP++ are to be adopted. This shows that the NDC measures will have greater effects on CO_2 emission reduction compared to the marginal incremental benefits from the SLCP measures. BC emissions reduction is expected to increase from 17.6% in 2020, 22.2% in 2030 to 55.4% compared to the projected BC emissions associated with CPF trajectory. The implementation of the same packages of measures recommended in this SLCP plan would also have substantial benefits in reducing CO_2 emissions. Therefore, to reduce its contribution to climate change, Ghana does not need to choose to focus only on short lived climate pollutants or long-lived greenhouse gases, but that the same group of measures can have substantial benefits to both. This shows that the national SLCP plan, and Ghana's climate plans in general present an integrated strategy to tackle Ghana's contribution to climate change in the near and long-term.

5. Making SLCP Mitigation Measures Work

5.1 Translating SLCP Options to Concrete Programmes

The selection of SLCP mitigation measures and the evaluation of their expected effects on emission reduction, health and temperature is an important first step. It must be backed by a concrete implementation strategy for mobilising key actors, resources and where necessary retarget existing policies. Consistent implementation of the identified SLCP measures is the approach to realise the potential benefits. It means that priority SLCP mitigation measures must be integrated into sectoral policies and above all into the national development framework.

Integrating the SLCP measures into the national and sectoral plans will help to garner buy-in among policy leaders and authorities in the line ministries, align the measures to government priority areas, as well as getting the line ministries to dedicate human and financial resources to the implementation of SLCP measures. The integration process involves the following four iterative steps: (a) embedding SLCP measures into plans; (b) budgeting and appropriation; (c) implementation and (d) monitoring and evaluation. It is only when the identified SLCP measures are taken through the four steps that they stand the chance of being fully implemented.

The role of the National Development Planning Commission (NDPC) and the line ministries in implementing the SLCP measures that have been selected are crucial. The NDPC will make sure that the national policy framework accommodates the SLCP measures. The line ministries will lead the actual implementation by ensuring that the measures form part of each respective sector's priorities before public funds are appropriated for its implementation. Once the SLCP measures are accepted as official government activities, the relevant ministries will begin to incorporate them into their annual plans for budgeting. The role of the Ministry of Finance is important in allocating financial resources to fund implementation of SLCP abatement measures.

5.2 Description of SLCP Abatement Measures

Through the NAP process, sixteen SLCP abatement measures have been selected spanning across seven sectors (Table 3). Detailed description of the measures are provided below;

5.2.1 Energy sector SLCP abatement measures

Seven energy-related SLCP abatement measures have been selected. The focus is on promoting environmentally-sound end-user energy technologies (cleaner fuel and cooking devices) and low carbon electricity supply. Two of them, LPG for cooking (LPGC) and Solar systems (SS) are part of the low-hanging fruit measures because government has shown massive commitment to facilitate greater uptake through policies, incentives and innovative fiscal instruments. In addition, there are three NDC actions relating to Improved cookstoves (ICS), Natural Gas for electricity (NGE), Eco-friendly electricity (EFE) that are primarily focussed on CO_2 emission mitigation. Cutting-edge stoves (CES) and Efficient charcoal kilns (ECK) technologies are SCLP-specific measures and would have bigger impacts on air quality. In all, the set of energy-related SLCP measures have greater effects on BC and CO_2 than CH_4. The energy measures are expected to lead to BC emission reductions of 55% relative to the 2040 BC emission associated with the CPF trajectory. The aggregate effects on CO_2 emissions is projected to be 48.1% reduction of 2040 CO_2 emissions. CH_4 savings is estimated to be 9.9%.

A. Promotion of clean cooking

The clean cooking measures combines emphasise the adoption of efficient device and clean fuel for cooking in residential homes. It covers three SLCP abatement measures namely: LPG for cooking (LPGC), improved cookstoves(ICS) and cutting-edge stove (CES).

B. LPG for cooking (LPGC)

This measure focuses on promoting LPG for cooking in place of wood-fuel or charcoal in peri-urban and rural household in line with the 50% LPG adoption target by 2040. The strategies that are being implemented in relation to measures include: affordable LPG cylinders, improved LPG supply to the local marker and safety campaigns.

Government plans to roll-out of a "cylinder re-circulation market model" by 2018 to increase access to LPG through end-to-end distribution. With this model, instead of filling LPG into empty canisters at the retail outlet, they will be exchanged with already filled cylinder of the same volume. Access to LPG in rural areas is crucial since biomass consumption is predominant in such areas.

The rural LPG Promotion Programme being implemented by the Ministry of Energy seeks improve access to cylinders and LPG product at affordable price. All these measures are captured in the national LPG master plan. Within the residential sector, the LPG for cooking measure is expected to lead to 70.4% , 68.7% and 46.3% reductions in BC, CH_4 and CO_2 emissions respectively compared to 2040 levels associated with CPF trajectory.

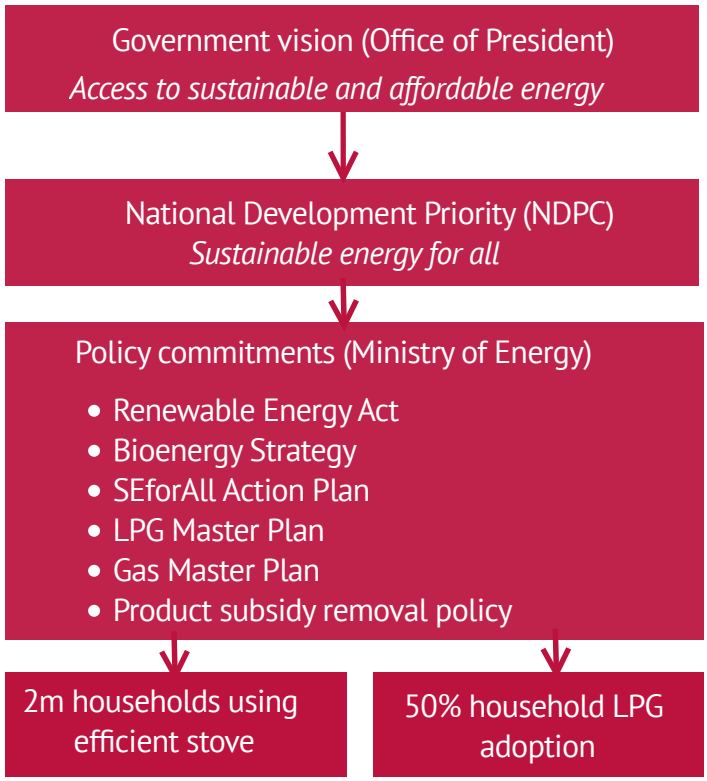
Improved and Cutting-Edge Cookstove

These are technology improvement measures that seek to promote the adoption of fuel efficient cookstoves for household cooking. This policy option is one of the high impacts priority actions in the SEA4ALL accelerated agenda. The target is to promote improve energy efficient smoke-free for cooking in rural areas. Ahibenso or Gyapa have been selected to represent all ranges of efficient cooking stove in the market. The target for 2 million households to adopt improved stoves by 2040.

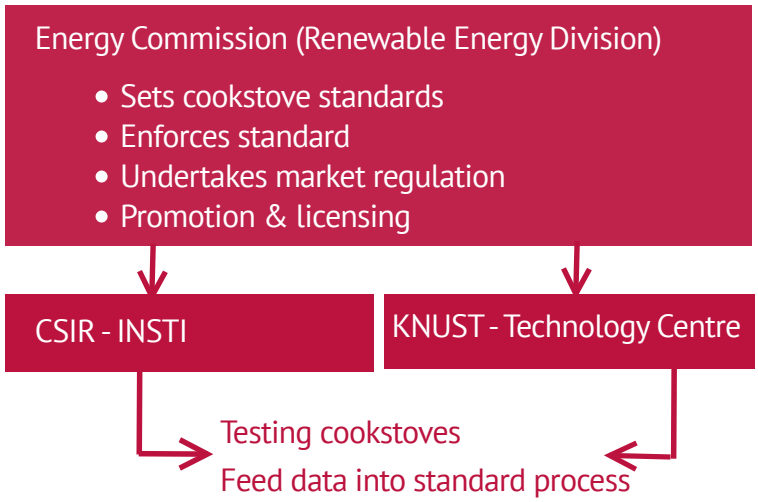
In addition, the measure further aims at introducing highly efficient ultra-clean biomass cookstoves such as pellet stove into the Ghanaian market. Pellet stoves have proven to be successful in the East Africa Market which could be replicated in the Ghanaian market. The combined effects of improved and cutting-edge stove on emission reductions is not as high as that of fuel switch. It will have more SLCP effects of 53.1% BC and 48.7% CH_4 reduction than 22.1% CO2 compared to the 2040 emissions associated with the CPF scenario.

Institutional and policy enablers of clean cooking solution implementation pathways

1. Policy environment

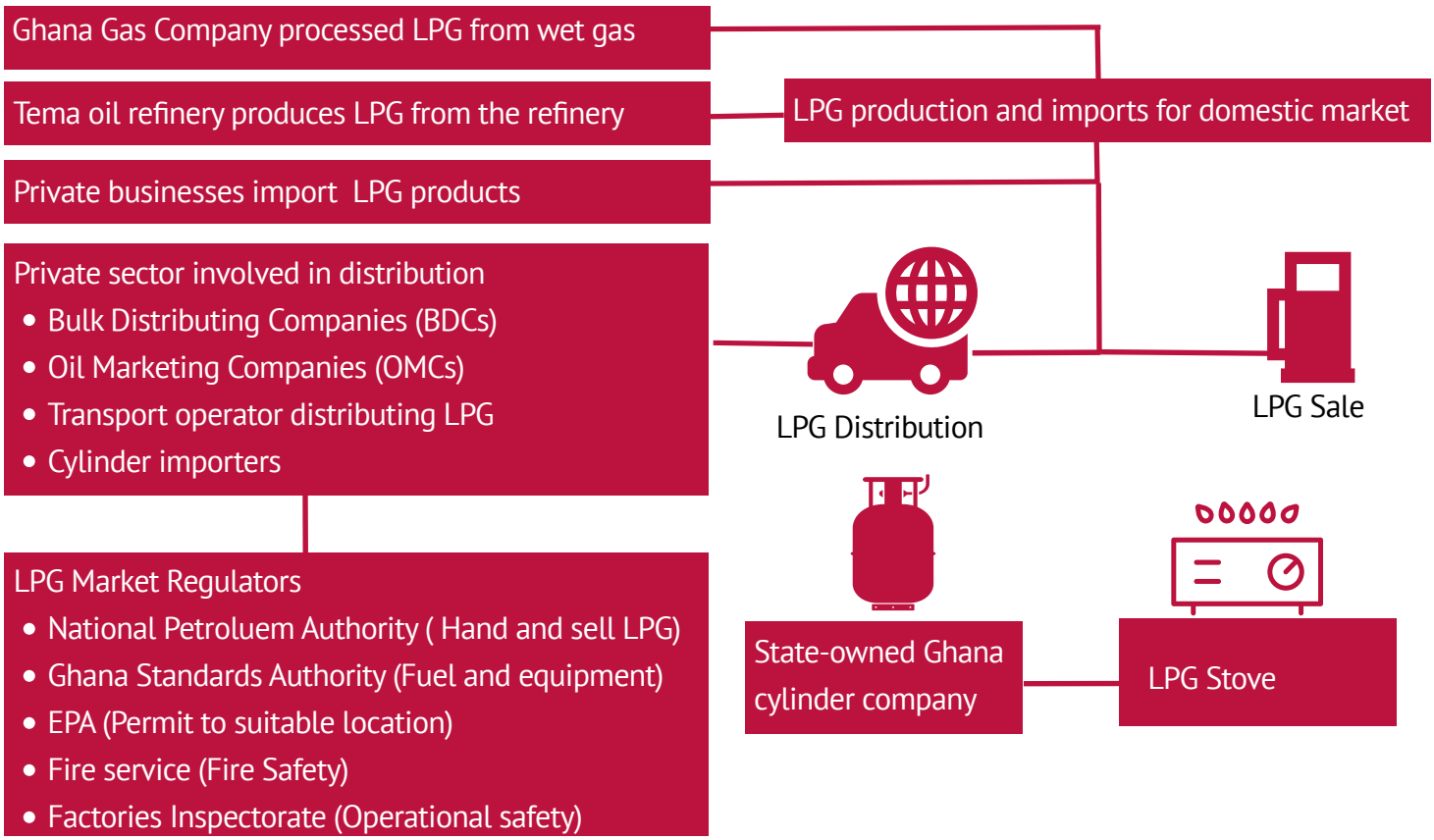


2. Getting stoves to market - standards & market regulation

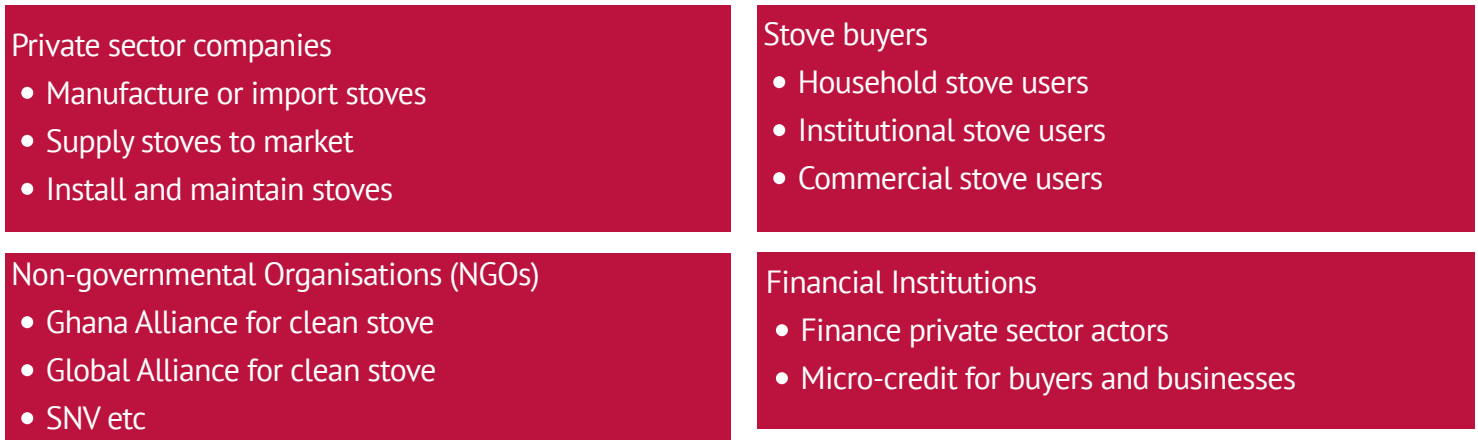


Picture 9: Cooking on Gyapa fuel efficient stove. Credit: Climatecare

3. Required investment for LPG fuel



4. Required investment and infrastructure development for efficient stoves



The implementation pathways for the household energy measures are outlined above. The following steps describe the extent to which the actions in these pathways have been achieved, and what actions are now required to increase the degree of implementation of these measures'

5. Current progress and remaining steps to implement 50% LPG Adoption and 2 million improved stoves

(i). Vision and commitment

- All steps for vision and commitment are in place.

(ii). Policy and standards

- Need to finalise modalities for the implementation of the cylinder re-circulation policy
- Need for coordination for standardisation and regulation to enhance permit issuance and inspections.

(iii). Investments

- Improved access to finance for stove manufacturers– finance by banks and other financial institutions;
- Reduce / wave taxes on materials for construction (e.g. fans) by Ministry of finance and customs.
- Enable more collection points to be developed quickly in relation to the re-circulation model.

- Enable mobile collection points as well.
- Need for a plan to design improved stoves for national manufacturers.
- Awareness creation for consumers on advantages - cost effectiveness, health benefits simple calculator.
- Develop business plans for improved stoves / fuels.

(iv). Coordination

- Develop strategy for improved cookstove technology – pilot schemes etc

(v). Efforts towards implementation of current PAM

- Monitor of implementation of recirculation model envisaged and how it could/ should be enhanced.
- Check degree of ambition for Rural LPG programme– for distribution of stoves and LPG.
- Awareness raising - fill gap in information flow – quantifying benefits and other gains – safety health costs.

(vii). Efforts towards implementation of increased PAM ambition

- Define what increased ambition is e.g. 60% coverage by 2030 and create road map. Increased PAM ambition means when Ghana is able to considerably implement its LPG interventions to the extent that majority of household have access to affordable LPG for cooking beyond which the efforts of promoting the adoption of technologically efficient device started yielding results.

- Idea of increased PAM ambition for clean cooking imply refocusing government policies to develop a new market for cutting-edge cooking devices which has great experience for both the end-user, the technology provider and the government. It will require policy changes, market awareness, research and development and above all concrete incentives to attract private sector involvement.

- The other steps include the following - Identify possible improved biomass stove technology and fuel – i. screening; ii. feasibility studies; iii. pilot projects; scaling up plans and promotion in government.

- Work with designers / manufacturers to test new stove designs which meets the needs of users and reduce costs.

B. Efficient charcoal kilns (ECK)

Majority of charcoal consumed in Ghana are produced from inefficient kiln (earth mound pit) using wood harvested from unmanaged sources. Typically, charcoal is produced from the location where the wood is collected from before it is transported to the demand centres in large cities. The earth mound pit is widely known to be highly inefficient (<35%) (picture 7). This means that for every tonne of wood input, only a third comes out as the charcoal. The inefficiencies are due to excessive heat loss from the poorly designed earth mound pit. More than 90% of charcoal produced in Ghana are from unsustainable sources. It is unsustainable because the wood is taken from an unmanaged source and converted to charcoal using inefficient kilns. The remaining less than 1% of charcoal is deemed to have been produced from a relatively efficient kilns (brick kilns) using wood waste for exports. According to the 2016 Energy statistics, a total of 1,214 ktoe of charcoal was produced by informal operators. Only 2.4 ktoe of charcoal was produced from regulated source.

The ECK measure aims at building on the efforts of introducing efficient kiln (preferably brick kilns) for wood carbonisation among informal charcoal operators. The idea is not limited to facilitating technology transfer of efficient kilns but also creating enabling conditions to modernise the entire charcoal sector. The strategies that will be be adopted to promote this measure will be fiscal, regulatory, financial, training and awareness. This measure although is specific to the supply side of the clean cooking value-chain, falls within the objectives set out in the SEforAll action agenda as well as the bioenergy strategy. Black carbon, PM2.5, Nitrogen oxides and Methane are the main emissions from charcoal production. BC, PM2.5, NOx and CH4 emissions have been projected to increase to 14. 6 Mt, 199.9Mt, 13.8Mt and 66.5 Kt respectively in 2040

Picture 10: Earth mound Pit kiln for charcoal making

The adoption of a well-designed brick kiln will be one of the efficient charcoal production methods. It is a proven technology with relatively low capital cost and labour requirements and produces good quality charcoal for all domestic uses. With the increased adoption of brick kilns for charcoal production, the projected BC, $PM_{2.5}$, NOx and CH_4 emissions for 2040 is expected to reduce by an average of 29%.

Institutional and policy enablers of efficient charcoal implementation pathways

1. Policy environment

Government vision (Office of the President)

Access to sustainable and affordable energy

↓

National Development Priority (NDPC)
Sustainable energy for all

↓

Policy commitments (Ministry of Energy & Ministry of Lands and Natural Resources)

- Bioenergy Strategy
- SEforAll Action Plan
- National Plantation Development Program
- Bamboo and Rattan Development Programme

↓

No specific commitment

No specific commitment from Ministries, but list of actions in Bioenergy strategy to achieve modernisation of charcoal value chain.

2. Feedstock and charcoal production

Private sector (commercial and domestic) 98% informal harvesting for domestic and industrial uses

Private sector 2% regulated formal harvesting for export:

- Regulated woodlots (licensed get wood from sustainable sources).
- Wood offcuts from saw mills (provide offcuts to licensed charcoal producers

Private companies (Produce charcoal)

- Informal (use inefficient mud kilns)
- Formal (use more efficient beehive kilns

Market Regulators

- Energy commission - Licensed formal producer to export charcoal.
- EPA - issues permit covering carbonisation process
- Forestry Commission - Conveyance fee
- District Assembly - Handling levy
- Ghana Customs - Export charges

3. Transportation, handling and distribution

Private companies (Transport charcoal to market centre

Retailers - sell charcoal in communities in bags
Super market - sell charcoal in big provision stores

Charcoal producers - Export charcoal

Picture 11. Left to right: Bagged charcoal ready for transportation. Charcoal packed for retail

4. Current progress and remaining steps to implement efficient charcoal kilns

(i) Vision and Commitment

There is no specific commitment, but actions have been identified in the bioenergy strategy. These actions now need to be implemented.

(ii) Supply of feedstock

- There is need for more sustainable way of managing feedstock – ensure that roadmap is produced.
- Initiate process for the modernisation of the technology used by the majority of informal charcoal producers.
- Land tenure arrangements; create charcoal banks; implement sustainable harvesting practises (how much, method used for harvesting).
- Use 80% informal in export market (they would then be licensed, forced to use more efficient kilns).
- EPA/Energy Commission/Forestry Commission is currently exploring ways to set up a centre of excellence for sustainable charcoal. This however needs private investment.
- There is not an ongoing process to develop a roadmap for regulation of informal sector.

(iii) Production

- Pilot projects on efficient kiln. These have taken place but there has been no uptake.
- Efficient kilns are currently too expensive.
- Costs could be reduced by building kilns using local materials.
- Greater access to credit
- Sawdust for production as pellets but occurring at very limited scale.

(iv) Transportation

- Local government and forestry commission charge a fee/ Ministry of Energy want to charge a fee also green haulage
- Bulk transportation– lake transport (currently not happening)

(v) Retailing

- Better packaging – sold in supermarkets (reduce exposure of sellers) Can be certified and then sold in supermarkets and sold for premium

(vi) Investments

- Local authorities and businesses need to invest in community based woodlots
- Invest in diversfying feedstocks (e.g. bamboo).
- Need to promote energy woodlots.
- Enable access to affordable and innovative credit for businesses that invest in efficient kilns.
- Favourable tax regime for operators wanting import efficient kilns.
- Need to encourage local assembly or manufacture of efficient kilns using local materials and labour to reduce cost.

(vii) National steps to help implement current PAMs

- Continue effort to ensure greater institutional coordination.
- Awareness on better ways of charcoal carbonisation for informal producers.
- Continue with mapping efforts on preferred species in oder to improve estimation of the resource base.

(viiii) National steps to help implement increased PAMs ambition

- Enhanced coordination between EPA/Forestry Commission/Energy Commission/local government.
- Define clear goals along regulation of the supply chain to avoid duplication of functions.
- Improve market outlook (Energy Commission) by including date on exports, better able to track revenue.
- Ensure activities within bioenergy strategy are undertaken to drive modernisation of the charcoal value chain.
- Ensure roadmap is produced for mapping of feedstock
- Raise awareness for sustainable supply
- Enact law for registration and licensing of woodfuel operators (producers, suppliers and sellers)

B. Green Electricity Supply

Currently, the public grid electricity at peak hours is dominated by thermal (65%) and hydro (35%) sources. Thermal electricity is mostly generated from crude-oil and/or natural gas fired plants. The increasing use of hydrocarbons for electricity contribute to the considerable proportion of the CO_2 emissions and relatively low levels of BC, PM2.5 and methane. The discovery of more indigenous natural associated gas (490 Billion cubic feet (Bcf) from Jubilee field, 363 Bcf from TEN fields) and non-associated gas (1,107 Bcf from Sankofa) in commercial quantities will result in more reliable supply of gas would available for electricity generation instead of depending on expensive imported light crude oil.

In order to meet the growing electricity demand and to secure the base load of grid electricity to support Ghana's industrialisation agenda, government announced a policy on coal electricity in 2015. The green electricity measures focus on harnessing more domestic natural gas for electricity in lieu of light crude oil (LCO) and considering alternative cleaner fuels for the intended coal thermal plant. Both measures are expected to have greater benefits on CO_2 reductions than direct SLCPs.

Natural Gas for electricity (NGE)

Under this measure, the base LCO fuel which is utilised in most of the active thermal plant is expected to be replaced with domestic lean natural gas processed and supplied by the Ghana Gas Company. It is assumed that Ghana Gas Company will have the capacity to produced optimum gas volumes for the Volta River Authority (VRA) and other independent power producers(IPPs). This is in line with government commitment of making priority allocation of gas to electricity generation stated in the national gas master plan.

Within the electricity supply sub-sector, the projected 2040 baseline CO_2, CH_4 and BC emissions associated with the CPF scenario amount to 9,659.1 t, 0.25 Kt and 0.012 Kt respectively. On the other hand, the Natural Gas for electricity measure when fully implemented is expected to large CO_2 emissions reduction of 57.7% of the projected 2040 CO_2 emissions relative to CPF scenario. Similarly, potential CH_4 and BC emission reductions are in the regions of 66.5% and 69.4% compared to the projected CPF emission in 2040.

Eco-friendly electricity (EFE)

Eco-friendly electricity is a measure where the intended coal electricity additions to the national grid is avoided throughout the period of 2010-2040. It means that instead of generating coal electricity from 700MW thermal plant by 2020 as planned, it will be generated with alternative fuel preferably domestic natural gas. All capacity expansion plants will be added on the national grid except the coal plant. In the event that government proceeds to invest in coal electricity the corresponding CO_2, CH_4 and BC levels would be the same as CPF baseline emission for NGE.

Conversely, when the generation of coal electricity is avoided there is the potential to reduce CO_2, CH_4 and BC emissions by 62.8%, 19.5% and 100% respectively compared to the 2040 emissions associated with CPF scenario.

Institutional and policy enablers of green electricity implementation pathways

1. Policy environment

2. Upstream and downstream market regulation and alternative fuel for coal thermal plant

1. National Petroluem Commission (oil and gas upstream regulator)
- Licensing & permitting
- Petroleum Measurement Regulation and Guidelines
- Local Content
- Community Relationships

2. Environmental Protection Agency
- Permit for the commencement and operations of oil and gas undertaking (exploitation, transportation and gas processing) as well as electricity plants.
- Monitoring of environmental conditions including ensuring zero or allowable flaring or venting.
- Oil spills and contamination management.

3. National Petroluem Authority (downstream market regulator)
- Issues gas bulk distribution license

4. Energy Commission (Technical regulator of electricity market)
- Licensing for operation of electricity plants.

3. Natural gas production supply stream

Oil and gas companies & GNPC
(producers of associated & non-associated gas)
Jubilee, TEN and Sankofa fields

Ghana Gas Company
(producer of domestic lean gas)

West Africa Gas Pipeline Company
(importer of Nigerian Gas)

Tema Oil Refinery
Receiving natural gas holding tanks

Ghana gas company

Natural gas pipeline owners

4. Natural gas for electricity generation & investment

Volta River Authority (VRA) &
Independent Power Producer

(Natural gas-fired thermal plants)

Commercial Banks
Letter of credit (LC) VRA to off-take lean gas

GridCo
(Electricity transmission and dispatch)

Electricity Company of Ghana & NEDCO
(Green electricity distribution)

Public utility regulatory commission (PURC)
(Electricity tarrifs)

5. Current progress and remaining steps to implement efficient charcoal kilns

(i) Vision and commitment

There is no specific policy commitment on natural gas and alternative fuel for coal thermal plants but there are some Ministerial Directives on government vision to increase investment in gas infrastructure development so as to increase supply and allocation of domestic natural gas to thermal power plants. Even though government has announced its intention to explore the use of coal and nuclear electricity to augment the base load of the public grid, it is still at the preparatory stage.

(ii) Natural gas production and supply

- Ghana Gas Company commissioned operations of its gas processing planting in 2012 at Atuabo in Western Region of Ghana.
- Jubilee field operators started producing associated gas for transmission to Ghana Gas in 2013 for production of lean gas, LPG and condensates.
- VRA has been the main off-taker of processed lean natural gas in 2014
- VRA import natural gas from Nigeria lifted and shipped by third party (N-Gas,) through the West Africa Gas Pipeline.

(iii) National steps to help implement current PAMs

- Natural Gas from TEN Field started flows to Ghana Gas in 2016.
- Ghana's expansion plan and investment to increase gas intake, processing capacity and diversify products.
- Increased number of power purchase agreements to add to the grid capacity.
- Existing thermal plant technology efficiency improvements (single cycle to combined cycle plants).

(iv) National steps to help implement increased PAMs ambition

- Need to invest in Ghana gas capacity expansion programme to increase production levels.
- Implement commissioning plan for the production of additional non-associated gas from the Sankofa fields.
- Need to increase utilisation of domestic gas in thermal facilities operated by other independent power producers.
- Need for EPA to speed up comprehensive environmental permit decision on the coal power plan Environmental and Social Impact Assessment Application.

C. Solar development and access programme

The solar development and access measure focuses on scaling-up solar systems in the form of off-grid, grid-connected and utility scale options. This is in line with the overall government agenda of attaining 10% renewable electricity in the public grid mix. The need to develop the indigenous energy resources (solar and natural gas) to meet the growing electricity demand has attracted attention in Ghana because of their long-term economic and environmental benefit. This measure covers an aggregate solar PV installation (grid-connected, small hydros and mini-grid systems) through GEDAP, Rooftop solar programme, corporate and individual initiatives.

Within LEAP-IBC, this measure is modelled as the combined effect of avoided fuel-based capacity addition including four mini-grid network for island communities, mini hydros (hemang, Juale, Pwalugu), grid-connected PV (VRA solar plant, BXC solar plant, Savannah Solar Plant) and Wind (Upwind Ayetapa). This is likely to lead to CO_2 emission reduction of32.5% compared to the projected emission associated with CPF of 58.6 Gt.

Institutional and policy enablers of green electricity implementation pathways

1. Policy environment

Government vision (Office of President)

Access to sustainable and affordable energy

↓

National Development Priority (NDPC)

Sustainable energy for all

↓

Policy commitments (Ministry of Energy)

- National Energy Policy,
- National Climate Change Policy
- Renewable Energy Act 832, 2011
- Renewable Energy Master Plan
- Strategic National Energy Plan (SNEP)
- Integrated Power Sector Master Plan
- Scaling renewable energy programme - Investment programme (SREP-IP)

↓

Specific commitment

Renewable energy constitute ten percent (10%) of national electricity mix

Policy instruments

- National electricity grid code for renewable energy.
- Renewable energy feed-in tariffs.
- Guidelines for renewable energy purchase obligation.
- Net-metering Code developed.
- Off-grid electrification and pricing policy being developed.
- Establishment of renewable energy fund.

2. Standards and regulations of solar PV installations

Energy commission

- Issues license to project owners for construction and operation of solar plants.
- Monitoring performance of solar plants.
- Solar resource mapping

Environmental Protection Agency

- Issues environmental permit to solar project.

District Assembly

- Location permit or ground rent.

3. Bringing solar to market - required investment

Registered solar dealers or companies
- Imports solar assembly parts
- Local solar manufacturing plant
- Retail solar in local market

Energy service companies (ESCOs)
- Installation and maintenance of Solar PVs to homes and bulk consumers

Energy Commission
- Manages government solar subsidy programme for residential homes.

Financial institutions
- Provide credit to ESCOs, dealers, homes and companies to install solar PV and run solar businesses

4. Current progress and remaining steps to implement the solar development and access programme

(i) Vision and commitment

All steps under vision and commitment are in place except that the pace for translating the policy instruments such as the establishment of renewable energy fund and net metering scheme into concrete programme is slow.

(ii) National steps to help implement current PAMs

- Solar rooftop programme need larger capitalisation to scale up.
- GEDAP funded mini-grid to provide access to renewable energy to island communities need to be scaled to cover more non-electrified communities.
- Regular training for artisans and ESCOs
- Local financial companies need to adopt innovative financing instruments.
- Incentive or tax breaks for solar part imports.

(ii) National steps to help implement increased PAMs ambition

- Operationalise and capitalise renewable energy fund.
- Government proposed policy to put moratorium on new power purchase agreement except renewable electricity.
- Implement government proposal to provide the electricity needs of all government buidings through solar.
- Scale up government subsidy on solar programme on solar.
- Improve tax regime for solar part importation

D. Sustainable urban transport

Diesel-powered cars are a significant source of black carbon and $PM_{2.5}$ emissions. Even though fuel quality may influence emission levels from road transport, other factors such as traffic situation and engine conditions of the vehicle play a major role. Therefore, any intervention that target reducing emission from road transport must consider the fuel, technology and human factors. Under the sustainable urban transport measure, there two SLCP mitigation actions. These are measures on "soot free bus" and "vehicle testing standards (VTS)" The soot free bus measure at the promotion and adoption of technology-free euro 5 bus fired by compressed natural gas (CNG).

The VTS is a fleet renewal measure through effective enforcement of vehicle emission standards. Generally, black carbon, PM2.5, NOx and CO_2 emissions from road transport are expected to increase from 2010 to 2040. For instance under CPF, black carbon emissions are to increase from 142.5 tonnes to 475.9 tonnes. In 2017, urban buses was the largest source BC emission followed by heavy duty and light commercial vehicles.

The overall expected benefits for implementing the two SLCP mitigation measures are expressed in terms of avoided Black carbon (BC) emission since the actions target diesel cars. When the two measures are implemented together, it is expected to averagely reduce 2040 BC emission associated with CPF scenario by 58.2%.

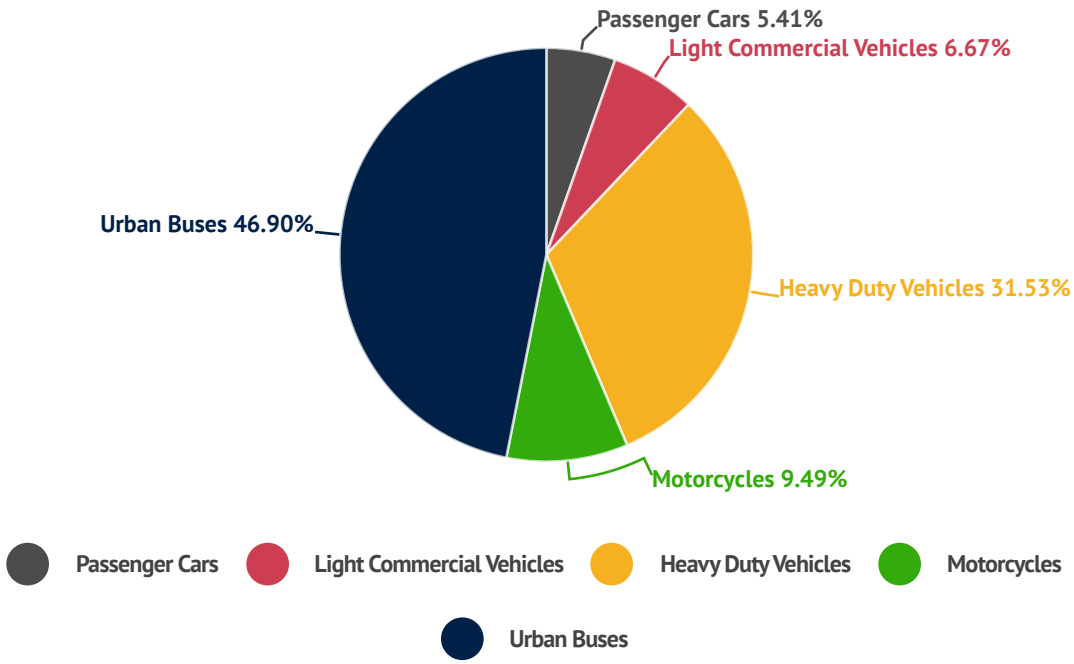


Fig 26: Black carbon emissions from road transport in 2017

Soot free buses (CNG-Buses)

This SLCP measure aims at promoting the adoption of soot free buses for public transport in major cities and inter-cities like the Metro Mass Transport buses. The idea is to import Euro 5 CNG-based buses instead of expanding the existing diesel-based fleet. Currently the Ministry of Transport is working with a Private Business (Daewoo Agent in Ghana) through an Exim Korea Facility to import 200 Euro 5 CNG buses to run in Accra with the possibility of scaling it up to 800 buses to cover additional cities like Kumasi, Tema, Takoradi and Tamale. The CNG buses will run on 4 main corridors (Denta, Motor Way, Ofankor and Weija) supported by 4 CNG stations and a depot. In Leap-IBC, this measure was evaluated by replacing future fleet addition of diesel run buses with CNG buses.

Vehicle testing standard

The vehicle testing policy option aims at taking out grossly or big polluting cars of the road through the enforcement of emission testing standards at the PVTs. (Private Vehicle Testing Centre). The idea is to make sure that vehicles that high polluting are either scrapped or be maintained to the point that it can pass the emission test. This approach is consistent with the fleet renewal policy.

Institutional and policy enablers of sustainable transport implementation pathways

1. Policy environment

Office of President (Defines government vision)

Morden and integrated transport

National Development Priority (NDPC) - (Development priority based on government vision)

Transport hub and gateway to the West Africa sub-region.

Ministry of Transport (Policy commitment)

Sustainable means of transport

2. Setting and enforcing standards

EPA & Standards Authority

(Set vehicle emission standards)

- Rigorous data collection of emissions from different cars including buses
- Set upper and lower limit of standards (within range of existing Ghana bus emissions)
- Prepare cabinet memo through their respective line ministries
- Ministry of Justice and Attorney General checks draft the standards for the bill.
- Parliament vote on law on vehicle emission standards

Ghana Customs

(Enforces emission standards at port of entry)

- Vehicle tests at point of entry – need measurement equipment
- Review the tax regime to encourage low emission imports (at the moment only based now on size of engine)

Driver Vehicle Licensing Authority

(Vehicle registration, road worthy certification & emissions testing)

- Need to include emissions in Road worthiness tests decisions
- Need to have testing stations nationwide (currently Accra only).
- Need to train /upgrade garages to be able to maintain engines to required standards –
- Certification of garages needed (by State Transport

Ghana Police Service

(Enforcement of standards on the road)

- Need equipment to check certificates of road worthiness
- Need to upgrade police vehicles
- Increase transparency in vehicle enforcement – e.g.. issuing tickets rather than fines on the road

3. Investment required and infrastructure development

Ghana Gas Company Limited

(Production and supply domestic CNG)

- Ghana Gas Company and private companies running the buses need an MoU guaranteeing supply (quantity and quality)

Private sector

(Import Buses, Establish CNG Fuelling Stations & Terminals)

- Importing soot-free buses - of transport and private company need an MoU on the number of improved buses they will import and run (PPP arrangement).
- Infrastructure - Need permits from AMA to private companies to construct CNG fuelling stations and routes

Association of transport service & Metro mass transit company

(Running of buses)

- Given opportunity to purchase buses
- Discounted price agreed between Daewoo and people driving the buses (informal or MMT).
- Road worthiness tests every 6 months
- Regular check on-road by police

4. Current progress and remaining steps to implement the soot free buses (CNG)

Vision and commitment

Almost all steps for vision and commitment are in place – the following needs to be finalised;

- responsibility of NDPC and Minister of planning to make national planning framework publicly available
- Commitment made by transport ministry

Standards

EPA has provided gazetted emission guidelines and DVLA is implementing it on a voluntary basis – but not customs (apart from ban on >10 year old bus imports).

Investment

- Feasibility studies done by Daewoo for 200 Euro 5 CNG Buses
- GCF bid to cover other 600 buses made by private sector - Daewoo agent in Ghana
- 4 Corridors for BRT are agreed between Ministry of Transport and Accra Metropolitan Assembly
- All other infrastructure steps still need to be done.

E. Innovative solid waste management

There are three innovative solid waste management technologies under this policy option. Two of them (LFM & IB) focus on methane reduction whereas the other one (SOB) contributes to reducing BC emission. All these measures align well with the National Environmental Sanitation Strategy, Ghana NDCs, the Local Government Act and the Environmental Policy.

Landfill Gas Management (LFM)

LGM is a proven technology or waste management practice in many parts of the world. LGM works better when there is a well functioning or managed engineered landfill where proper controls are in place to collect and cover the waste materials to allow for anaerobic decomposition of the organic fraction of the waste in order to cap the gas from the waste pile.

Ghana has no or inadequate well-engineered and operated landfill sites that can allow for the immediate rolling out of this intervention. Therefore, it is assumed that as the waste sector continues to expand to allow more private sector participation (for instance, recently government allowed or permited some private waste service providers to operate selected dumping facilities in Accra and Kumasi), the business conditions will improve to allow for more investment.

It is also important to indicate that currently, the waste service providers mostly focus on waste collection and transportation while disposal is still dominantly managed by the local government. Based on the current trends and capacities of the waste management service providers, LGM measure has been modelled in LEAP-IBC by projecting that 350,000 tonnes of methane per will be captured by 2040 from well engineered landfill or even the existing dumping grounds. It must be noted that this estimate is a conservative one based on the interviews with the private sector businesses involved in waste management. When the LFM measure is fully implemented, it is expected to lead to 49.5% reduction in methane emission of 650.9 kt associated with the CPF scenario by 2040 . Although there might be additional emission reductions of SLCP or LLGHG (BC and CO_2), the impacts are not as much as CH_4.

Stop Open-Burning (SOB)

Open-burning of municipal solid waste occur at the dumping ground and the informally designated sites. Open-burning of solid waste contribute to BC and PM levels in the atmosphere. Therefore the SOB measure aims at reducing or even better stopping indiscriminate open-burning of municipal solid waste by enforcing bye laws, improving waste collection and ensuring effective management of solid waste dumping grounds.

Realistically, it is not possible to totally eliminate open-burning of municipal solid waste within the next 22 years considering the kind of waste management practices in the country. Therefore within the LEAP-IBC template, the aim is to progressively reduce the total amount of 11,276 tonnes openly-burnt waste per year by 80% by 2040. This measure relates to the NDC goal of effective solid waste collection and disposal to engineered landfill sites. In terms of the emission reduction effects of the measure, the full implementation of SOB is projected to reduce the 2040 BC emissions from waste burning under CPF (20.81 kt) by 31.5%.

Institutional biogas

This measure aims at installing and operating biogas digesters to produce methane gas which otherwise would have been allowed to escape or flare into the atmosphere to be captured and processed for use as cooking fuels in 200,000 institutional wood-stove and charcoal stoves in secondary boarding schools, nursing training and teacher trining colleges nationwide. Although biogas technology is popular in the country, it has not been particularly successful when it comes to using it as a bioenergy source. It is seen pretty much as sanitation facility for which the by-product (methane) can be used as fuel in cooking or lighting. However, the technology is challenged with the design and operational risk. The recent effort to construct biogas in schools and prisons was initiated under the switch Africa Green Programme implemented by MESTI and EPA. The EU is in partnership with EPA and EC to pilot a set of biogas programme with 30 schools and hospitals in Greater Accra, Ashanti, Western and Eastern Regions.

Depending on the design and the operational efficiency of the biogas plant, the expected CH_4 emission impacts will amount to 36.1% reduction of the total project demand-side CH_4 emission associated with the CPF scenario.

Institutional and policy enablers of innovative solid waste management implementation pathways

1. Policy environment

Office of President (Defines government vision)

Promote waste recycling & waste-to-energy technologies

National Development Priority (NDPC) - (Development priority based on government vision)

Promoting effective waste management through PPP

Ministry of water and sanitation (Policy commitment)

Environmental sanitation policy (ESP)

2. Solid waste management value chain

Since 2010, the implementation of the ESP enabled increased private sector participation in waste management activities in the country. Franchise contracts allowed environmental sanitation service providers (ESSP) to bring resources and innovation to improve waste collection and final disposal.

The ESSPs are assigned specific coverage area to collect waste. They give free waste bin to the homes and recoup the cost through waste collection fees paid by households. The collection is done using donkey carts, tricycles and waste trucks. Where the services of the ESSP do not cover, the DA provide a transfer station where the households commute to dump waste manually. Generally, the DAs manage the waste dumps sites. Where they do not have the capacity, the ESPA are allowed to operate their own, charge tipping fee from users and pay rent fee to the DA.

Majority of uncollected waste are dumped crudely or openly burnt. In a typical poorly managed dumping site waste scavengers salvage vital part from the waste heap and in certain instances, waste are burnt. At properly managed sites, methane gas is mostly allowed to escape into atmosphere. The EPA is required by the EPA Act 490 to issue permit to cover the construction and management of dump site.

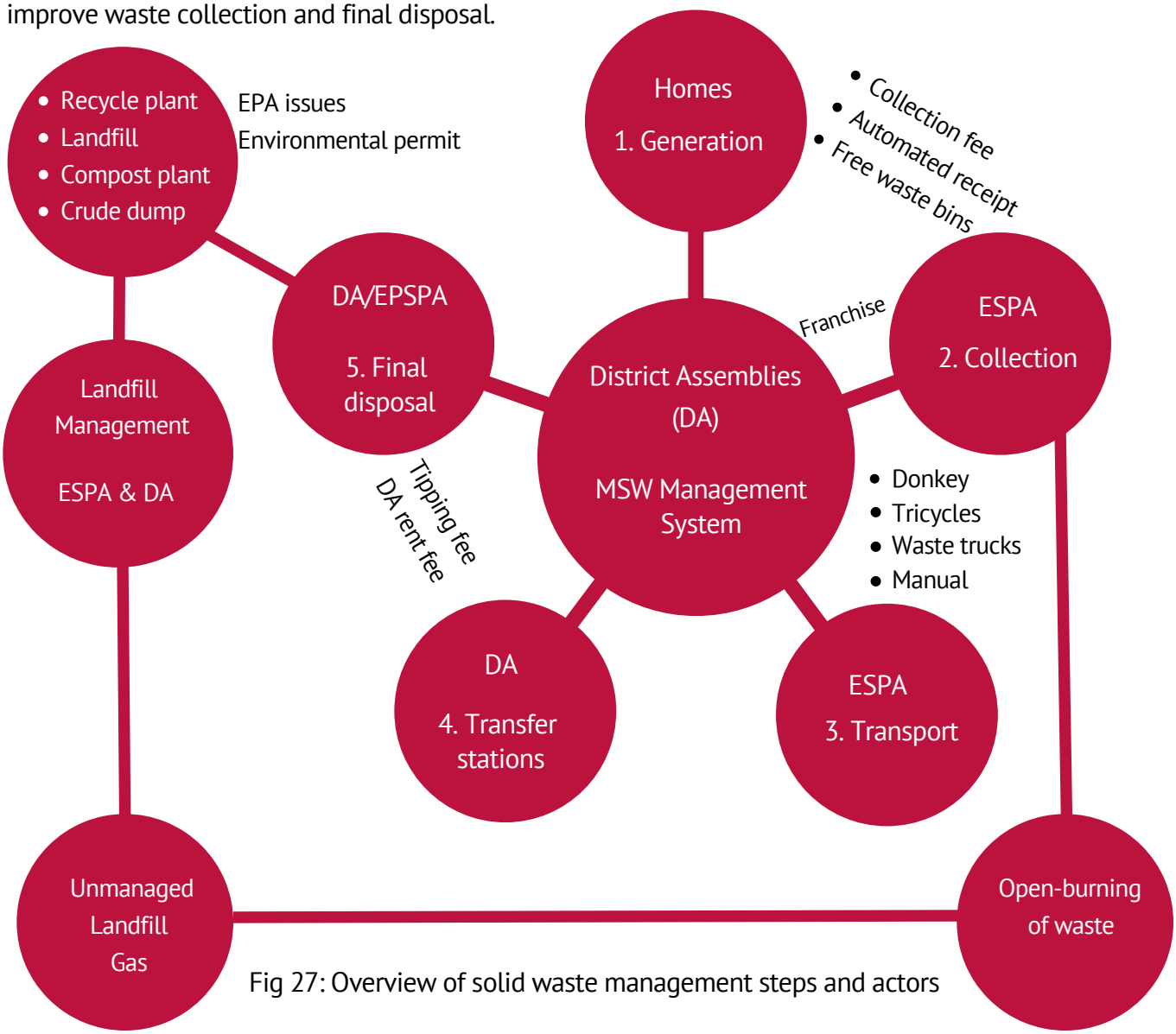


Fig 27: Overview of solid waste management steps and actors

4. Current progress and remaining steps to implement the innovative waste management

Vision and commitment

Almost all steps for vision and commitment are in place. Although there are no specific target for LGM, stopping open-burning and institutional biogas the NDCs provide milestones that can guide the implementation and monitoring of this measure.

Standards

- The EPA has developed guideline for the management of landfill or waste dump sites. The guidelines make general reference to LGM and reduced waste burning along the value chain, the DA and ESPA do not have the capacity to fully comply. Most of the operators do not have the requisite sources to manage the dump site to minimise methane emissions and waste burning.
- Established system for the certification of standard biogas designs.
- Certification process for biogas installers, artisans and inspectors.

Investment

- Investment in technology to promote LMG.
- Increase solid waste collection to reduce unaccounted waste which are likely to be burnt openly.
- Need for incentives for innovative techniques for waste treatment.
- Feed-in-tarrif for bio-energy need to be more attractive and predictable for ESSPs.
- Tax breaks or access to competitive credit for ESSPs in the LGM and Biogas sectors
- Awareness on littering and sorting of waste at source can reduce cost of pre-processing.

F. Best practices in land management

This policy option is made of measures on reducing forest burning (RFB) and promotion of quality livestock feeding (QLF). Both measures would require different strategies for implementation. Whiles RFB may include a set of incentives, compliance and awareness strategies that of QLF may required policy reforms on land-use, investment in ranch facilities. There are some efforts on the ground when it comes to RFB in the areas of policy. The Ministry of Lands and Natural Resources and Forestry Commission are implementing the national wildfire policy. According to the FRA Ghana Country Report, a total of 4,640ha of forest areas was burned in 2012.

Reducing forest burning (RFB)

In the LEAP-IBC template, the scope of the RFB measure is focussed on instituting measures, enforcing bye-laws and regulation, promoting adoption of technologies and creating measures to reduce or prevent grass or forest burning in savannah and forest areas. The target is to reduce regularly or frequent burnt areas by 40% especially in the savannah and transitional zones (NDC target under wildfire management).

Promotion of quality livestock feeding (QLF)

This policy option aims at supporting the introduction of technology improvement in animal manure management and feeding/intake materials by promoting ranch system in areas of the country where livestock (especially non dairy cattle) are common. The idea is that when the feed quality of non-dairy livestock are enriched, it is expected to increase efficiency of digestion and thereby reduce methane gas from enteric activities. This will be backed by proper management of the manure from non-dairy cattle. In the LEAP-IBC software, this intervention was modelled by reducing emission factor by 20% to non-dairy cattle, sheep, pig and

Institutional and policy enablers of innovative best practices in land management implementation pathways

1. Policy environment

6. Tracking progress and impacts of SLCP mitigation measures

6.1 Workplan

The implementation of the prioritised 16 SLCP mitigation measures will be guided by the list of key activities that have been identified based on the gaps in the current progress made as well as additional steps that are needed to be undertaken in order to realise the full ambition of the measures. It is important to note that the 16 measures are not the same level of implementation from the policy, regulation and investment standpoint. Therefore the level of attention given to specific activities would depend on the level of implementation on the ground. The work plan has been prepared with clear milestones and timelines. The figure below shows the summary work programme of the SLCP mitigation measures. A detailed version of the work programme is attached to the Annex.

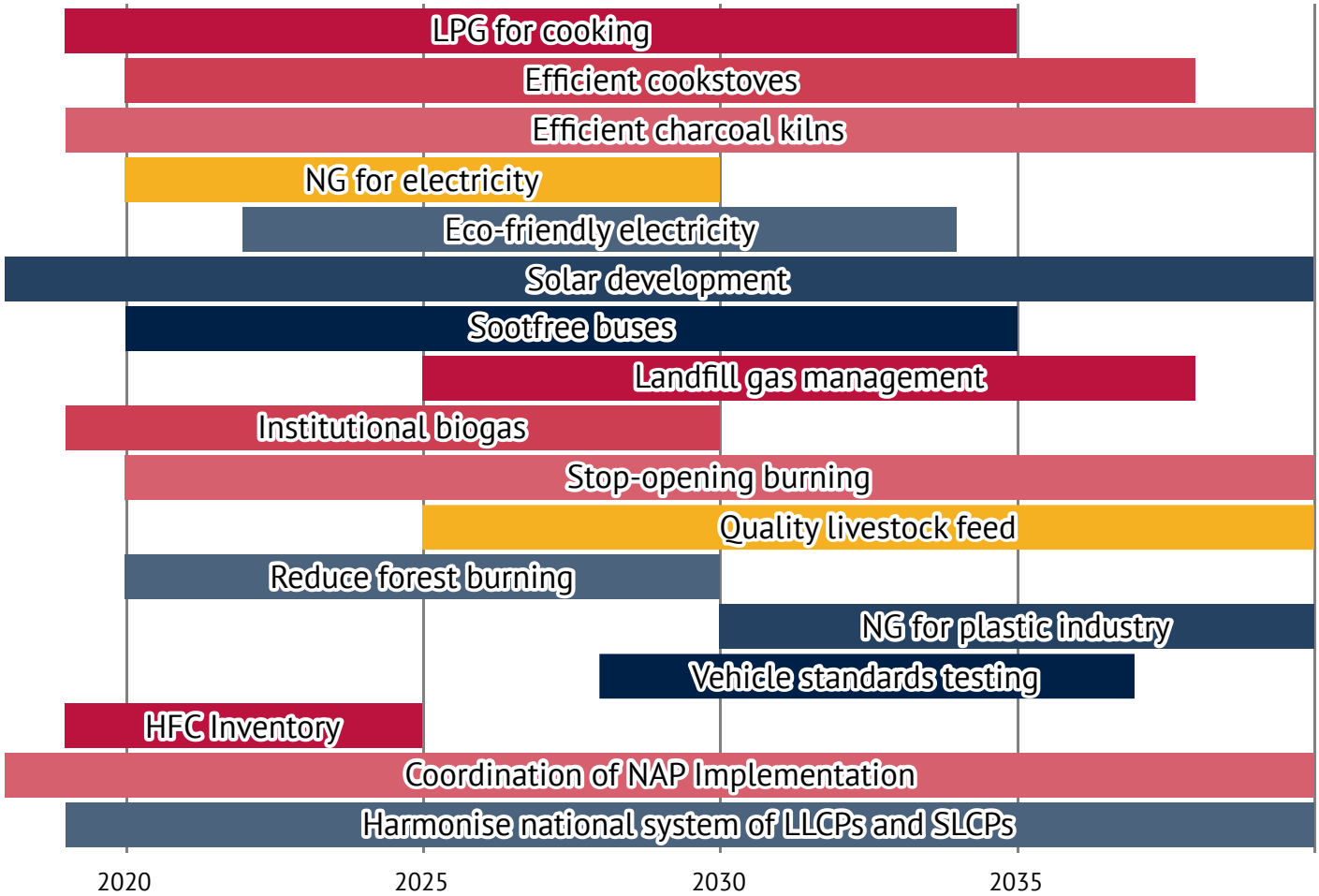


Fig 28: Summary of work programme

Under each measure, additional information on the scope, specific activities to be implemented to achieve the set goals, institutional roles and the timelines have been provided in the expanded table. There is no doubt that implementation of such a transformational programme will require the collaboration of key partners involved in the sector. While government mainly focuses on shaping and streamlining its policy commitments as well as investing in public infrastructure and regulation, the private sector (businesses and financial institutions) will provide the investment, technology, skills and innovations to take advantage of the good business environment created by government policies. The local government authorities, CSOs and the academia have unique roles to play with respect to creating public awareness, advocacy, grass-root mobilisation, community engagement and the long-term development of human resource. Generally, the specific activities that underlie the measures are categorise into; policy alignment; market development; standard setting and enforcement; investment; training and awareness; enforcement; tax incentives, infrastructure development and coordination of functions.

6.2 Monitoring, Evaluation and Reporting (MER)

MER is an important part of the whole implementation agenda of the SLCP mitigation measures. It will help Ghana to know at any point in time, how much success has been achieved within a specific sector, the key challenges the implementing institutions are facing, how the challenges are being addressed, the track and communicate overall impacts and resources allocated. This means putting in place an MER plan with clearly defined roles and responsibilities, reporting lines, indicators and a mechanism for disclosure. The MER system should be capable to tracking progress, evaluating successes and challenges and communicate impacts. The existing national M&E system (Annual Progress Report - APR) that is coordinated by the National Development Planning Commission can be used as the MER system for the SLCP.

The advantage of using the APR system is that almost all the relevant government institutions are involved in preparing their sectoral or district APR as required by law. Therefore, integrating the MER for the SLCP measures into the sector APR preparation will make practical sense. The process of integration will start with the development of core and specific indicators to be included into the result framework. After that, the line ministries wil be trained on the collection and processing of data on the progress of SLCP measures. The collected data would then be used as input in the sectoral APR and a copy sent to the EPA for further processing. The data from the line ministries will be evaluated into impact statement that captures the extent of implementation of the SLCP measures and benefits thereof. All these information and the dataset will be uploaded onto the online climate data hub. The online data hub will have a special portal dedicated to SLCP issues. A detailed MER framework is attached in the annex. A summarised version is provide below

SLCP Measure	Core Indicators	Lead institution
LPG for cooking	Household LPG consumption	National Petroluem Authority (NPA)
Solar system	Share of grid electricity mix	Energy Commission (EC) & Ministry of Energy
Reduced forest burning	% area burnt	Forestry Commission (FC)
Institutional biogas	Installed biogas capacity	Energy Commission (EC)
CNG Buses	Passenger-km on CNG bus	Ministry of Transport (MoT)
Stop open-burning	Rate of open-burning	Ministry of Local Government and Rural Development (MLGRD)
Landfill gas management	% of methane recovery	Ministry of Water and Sanitation (MoWS)
Efficient cookstoves	Number of efficient stove in use	Energy Commission (EC)
Natural gas for electricity	Share of NG-fired thermal electricity	Ghana Gas Company Limited (GGCL)
Eco-friendly electricity	Share of coal-fired thermal electricity	Environmental Protection Agency (EPA), Volta River Authority(VRA)
Efficient charcoal kilns	Number of efficient charcoal kilns in use	Energy Commission (EC)
Quality livestock feed	Number of ranch	Ministry of Food and Agriculture (MoFA)
Vehicle testing standards	Vehicle emission standard in use	Driver Vehicle and Licensing Authority (DVLA)
Cutting edge stoves	Cutting edge stove in market	Energy Commission (EC)
Natural gas in plastic industry	Not determined	Not determined

7. Concluding remarks

Ghana takes its commitment to reduce emissions of carbon dioxide and other long-lived GHGs as well as SLCPs seriously. It is in this regard that a comprehensive plan has been formulated to mitigate climate change, improve local air quality and at the same time promote inclusive economic growth. Ghana's NDCs, National Climate Change Policy and the latest Coordinated Programme For Social and Economic Development emphasis the importance of tackling climate change and reducing air pollution aggresively. Reducing emissions of SLCPs supports Ghana's commitments under the Paris Agreement, and domestic priorities for clean air and a healthier society. Comprehensively addressing SLCPs requires new, coordinated actions among national entities, sub-national institutions, business and industry.

All of the SLCP mitigation actions identified in this plan will be undertaken in the short-to-medium term. However, many of the actions will require scaling up of on-going government efforts through policy alignment and deepened regulatory functions. Others will also require collaboration with key partners such as CSO, businesses deliver. Engaging other line ministries and local government will be a key next step. Implementation of new near-term actions will represent an important step forward in addressing SLCP mitigation and knowledge gaps. Implementation will be coordinated with implementation of the actions behind the NDCs . Sustained efforts will be required to advance the implementation of a holistic approach to SLCPs, and to generate the SLCP emissions reductions required to achieve climate mitigation and air quality goals.