NATIONALLY APPROPRIATE MITIGATION ACTION ON

# ACCESS TO CLEAN ENERGY THROUGH ESTABLISHMENT OF MARKET-BASED SOLUTIONS IN GHANA

United Nations Development Programme

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LOW EMISSION CAPACITY BUILDING PROGRAMME

# UNDP LOW EMISSION CAPACITY BUILDING (LECB) PROGRAMME

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The UNDP Low Emission Capacity Building (LECB) Programme is a country-driven initiative that promotes essential cooperation between relevant institutions, engaging the public sector and industry in a concerted effort to design and implement approaches to low emission development that are consistent with national development priorities. National counterparts are supported to strengthen technical and institutional capacities to identify and formulate Nationally Appropriate Mitigation Actions (NAMAs) and Low Emission Development Strategies (LEDS) in the public and private sectors, and to strengthen the underlying greenhouse gas inventory management and Measurement, Reporting and Verification (MRV) systems.

The LECB Programme runs through 2016 and is active in 25 countries: Argentina, Bhutan, Chile, China, Colombia, Costa Rica, the Democratic Republic of Congo (DRC), Ecuador, Egypt, Ghana, Indonesia, Kenya, Lebanon, Malaysia, Mexico, Moldova, Morocco, Peru, Philippines, Tanzania, Thailand, Trinidad and Tobago, Uganda, Vietnam and Zambia.

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More information can be found at www.lowemissiondevelopment.org

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# ABBREVIATIONS

| | |
|---|---|
| **AfDB** | African Development Bank |
| **BAU** | Business-As-Usual |
| **BPA** | Bui Power Authority |
| **₵** | Cedi (Ghanaian currency) |
| **CC** | Clean Cooking |
| **CDM** | Clean Development Mechanism |
| **CIF** | Climate Investment Fund |
| **COP** | Conference of Parties |
| **CSIR** | Council for Scientific and Industrial Research |
| **DFO** | Diesel Fuel Oil |
| **DP** | Development Partners |
| **ECG** | Electricity Company of Ghana |
| **EPA** | Environmental Protection Agency |
| **EPZ** | Energy Productivity Zone |
| **FiT** | Feed-in Tariff |
| **GACC** | Global Alliance for Clean Cookstoves |
| **GCF** | Green Climate Fund |
| **GCMC** | Ghana Cylinder Manufacturing Company |
| **GEDAP** | Ghana Energy Development and Access Programme |
| **GEF** | Global Environmental Facility |
| **GHACCO** | Ghana Alliance for Clean Cookstoves |
| **GLPGP** | Global LPG Partnership |
| **GLSS 6** | Ghana Living Standards Survey Round 6 |
| **GNPC** | Ghana National Petroleum Company |
| **GoG** | Government of Ghana |
| **GPRS** | Ghana Poverty Reduction Strategy |
| **GRIDCo** | Ghana Grid Company |
| **GSA** | Ghana Standards Authority |
| **GSB** | Ghana Standards Board |
| **GSGDA** | Ghana Shared Growth and Development Agenda |
| **GSS** | Ghana Statistical Service |
| **ICS** | Improved Cookstove |

| | |
|---|---|
| **IFC** | International Finance Corporation |
| **INDC** | Intended Nationally Determined Contribution |
| **IPP** | Independent Power Producer |
| **IPRSP** | Interim Poverty Reduction Strategy Paper |
| **JICA** | Japan International Cooperation Agency |
| **KITE** | Kumasi Institute of Technology and Environment |
| **KNUST** | Kwame Nkrumah University of Science and Technology |
| **Ktoe** | Kilotons of oil equivalent |
| **LCO** | Light Crude Oil |
| **LPG** | Liquefied Petroleum Gas |
| **MDGs** | Millennium Development Goals |
| **MESTI** | Ministry of Environment, Science, Technology and Innovation |
| **MoE** | Ministry of Energy |
| **MoF** | Ministry of Finance |
| **MoP** | Ministry of Power |
| **MRV** | Measurement, Reporting and Verification |
| **MSTQ** | Metrology, Standardization, Testing and Quality Assurance |
| **NAMAs** | Nationally Appropriate Mitigation Actions |
| **NCA** | National Coordinating Authority |
| **NDA** | National Designated Authority |
| **NDPF** | National Development Policy Framework |
| **NEDCo** | Northern Electricity Distribution Company |
| **NEEs** | National Executing Entities |
| **NEP** | National Energy Policy |
| **NES** | National Electrification Scheme |
| **NIE** | National Implementing Entity |
| **NPA** | National Petroleum Authority |
| **OMCs** | Oil Marketing Companies |
| **PI & B** | Private Financiers and Beneficiaries |
| **PURC** | Public Utilities Regulation Act |
| **PV** | Photovoltaic |
| **REN 21** | Renewable Energy Policy Network for the 21st Century |
| **RFO** | Residual Fuel Oil |
| **RLF** | Revolving Loan Fund |

| | |
|---|---|
| **SAG project** | SWITCH Africa Green project |
| **SD** | Sustainable Development |
| **SDG** | Sustainable Development Goals |
| **SE4ALL** | Sustainable Energy For All initiative |
| **SEFA** | Sustainable Energy Fund for Africa |
| **SHP** | Small Hydro Power Project |
| **SNEP** | Strategic National Energy Plan |
| **SREP** | Scaling-up Renewable Energy Program |
| **TICo** | Takoradi International Company |
| **TOR** | Tema Oil Refinery |
| **TWG** | Technical Working Group |
| **UNFCCC** | United Nations Framework Convention on Climate Change |
| **VAT** | Value Added Tax |
| **VRA** | Volta River Authority |

# EXECUTIVE SUMMARY

Ghana, currently a lower middle-income country (in the World Bank's classification), envisions becoming a middle-income country by 2020, as stated in its Vision 2020.

The country currently has 2,831 MW of installed generation capacity, including 546 MW of capacity in the hands of independent power producers (IPPs). But actual availability hardly exceeds 2,000 MW. The unavailability of power to meet rising electricity demand leads to massive load shedding and power disruptions in the country.

Ghana uses woodfuel as the dominant form of cooking fuel. The 2012/13 Ghana Living Standards Survey Report reveals that 41.3 per cent of households are dependent on firewood as their primary source of cooking fuel, followed by charcoal (31.5 per cent) and LPG (22.3 per cent). Currently, inefficient and polluting cooking processes are deeply ingrained in Ghanaian culture.

Hence, the Government of Ghana (GoG) has defined the following national targets:

- 200,000 solar PV based systems (200 MW) by 2020 (under the 200,000 Solar Rooftop Programme)
- 55 mini-grids (total capacity of 10 MW) by 2020 (under the Scaling-up Renewable Energy Programme Investment Plan for Ghana)
- 200,000 solar lanterns distributed by 2020 (under the Ghana Solar Lantern Distribution Programme)
- 2 million households supplied with improved cookstoves by 2020 (under the Strategic National Energy Plan document)
- 1,000 improved cookstoves supplied by 2020 for commercial activities (under the Strategic National Energy Plan document)
- Increase LPG penetration to 50 per cent of households by 2020 (under the National Policy of LPG Promotion)

A review of sectoral policies and programmes indicates that there exists a sound policy framework in Ghana for supporting NAMA interventions in energy sector. The Second Ghana Shared Growth and Development Agenda (GSGDA II) (2014-2017) is the current medium-term strategy covering the energy sector in Ghana and providing a supportive framework for the proposed NAMA interventions. The Strategic National Energy Plan (SNEP) sets detailed strategic targets (specifically related to woodfuel and LPG) for energy demand and supply sector over a 20-year period. The National Policy of LPG Promotion is another document setting explicit targets for Ghana, in this case LPG-related ones. Besides these, the programmes for the deployment of 200,000 solar PV systems on rooftops and the distribution of 200,000 solar lanterns in the country are noteworthy with respect to the proposed NAMA.

The Nationally Appropriate Mitigation Action (NAMA) on "Access to clean energy through establishment of market based solutions" has the potential to bring about a transformational change in the sector, resulting in emissions reductions, promoting sustainable development and increased access to clean energy technologies for communities in Ghana.

The following are the overall objectives of the proposed NAMA.

- Objective 1: Enable private sector participation in the manufacturing and distribution of the clean energy technologies in Ghana.
- Objective 2: Create an enabling market environment that encourages the distribution of clean energy technologies to end-users, supported by an appropriate financing model.

The proposed NAMA covers two interventions. Intervention 1 involves the establishment of 28 Energy Productivity Zones (EPZs) in Ghana with their own solar PV power plants. EPZs consist of two components: a Productivity Zone consisting of workspaces (for manufacturing, storage and office spaces designed for private sector enterprises to undertake gainful income generation activity) and supporting infrastructure; and an energy solution that makes electricity available for the activities undertaken in the Productivity Zones.

Intervention 2 will support the distribution of clean energy technologies enabled through consumer finance. The distribution of the following clean energy technologies is proposed over the lifespan of the NAMA:

- Solar PV lanterns (1 million units)
- Solar Solutions (50,000 units)
- Improved cookstoves (1 million units for households and 250 units for commercial activities)
- LPG cookstoves (250,000 units, including gas cylinders).

Implementation of these interventions will be supported by capacity-building. The proposed capacity-building programmes will consist of two components. Component 1 will comprise capacity-building programmes supporting the preparation and implementation of the interventions and Component 2 will foster awareness creation and marketing of the NAMA. It is planned that three external advisors respectively with technical, financial and business expertise should be engaged to build the capacity of the relevant stakeholders.

Implementation of the NAMA will be led by various ministries and government agencies and will include the private sector, communities and cooperatives. The Ministry of Finance will be the focal point for implementation of the NAMA in Ghana. The Ministry of Environment, Science, Technology and Innovation (MESTI) will act as National Coordinating Authority (NCA) and perform all strategic functions relating to this NAMA. The Energy Commission will play the role of the National Implementing Entity (NIE) and perform all planning and management activities relating to the NAMA. The monitoring and reporting cell will have representatives from the Energy Commission, the Environmental Protection Agency and Ghana Statistical Services.

The proposed lifespan of the NAMA is 12 years, from 2017 to 2028. The timeframe for implementation of the NAMA is in line with Ghana's proposed long-term vision framework (Vision 2057) that will be launched in 2017 and be implemented through 10 medium term plans of four years each. The NAMA will cover the first three medium term plans (i.e. 2017-2020, 2021-2024, and 2025-2028). Over the 12-year lifetime of the NAMA, emissions reductions will reach around 9,162,122 tons of $CO_2$ equivalent.

Total cost of NAMA implementation is estimated at US$118.59 million of which US$59.25 million is estimated to be consumer equity (i.e. the upfront payment made by end-consumers for the purchase of goods, estimated at 20 per cent of the selling price). The balance of US$59.34 million is to be covered under NAMA

Finance and includes support to cover the investment costs of the two interventions as well as the capacity-building efforts. NAMA Finance comprises three components, of which the national contribution is assumed to be US$9.49 million primarily covering public procurement of basic solar lanterns and ICSs, the salaries and operating costs of the National Implementing Entity, and installing 250 commercial cookstoves across the country. The remaining US$49.85 million is split between a grant component of US$5.89 million and a loan component of US$43.96 million.

# 1 INTRODUCTION

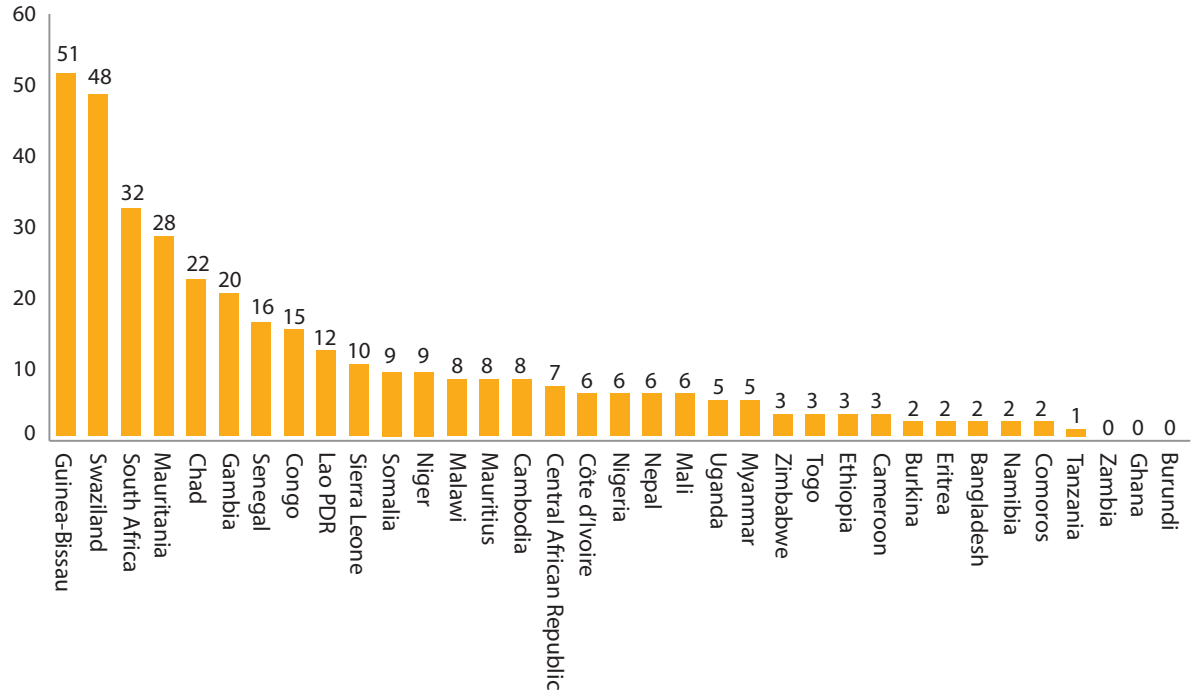
## 1.1 Energy Access and Development

Access to clean energy services is fundamental to accelerate the achievement of the Sustainable Development Goals (SDGs). Yet, globally three billion people still rely on conventional fuels such as coal and biomass (UNDP-WHO, 2009). More than 56 per cent of people in developing countries depend on solid fuel (such as woodfuel, charcoal, coal) (UNDP-WHO, 2009) and globally 1.3 billion people have no access to electricity. Between 2011 and 2013, the total number of people globally without access to electricity remained essentially unchanged (REN21, 2014). A striking two million deaths per year are associated with the indoor burning of these solid fuels in unventilated kitchens, affecting mostly children, who account for 44 per cent of this toll and adult women (60 per cent of the adults who died were women) (UNDP-WHO, 2009).

The demand for electricity in the Ghanaian market is projected to exceed 4,400 MW in 2020 (Ayittey, 2015). Overdependence on conventional energy sources clearly signals the need to tap into renewable energy sources. Consumption of woodfuel, which is mostly used in household and commercial cooking, is expected to rise almost five times from 14 million tons in 2000 to 66 million tons by 2020 (Ayittey, 2015). Currently, inefficient and polluting cooking processes using woodfuel are deeply ingrained in Ghanaian culture, resulting in deforestation and significant environmental impacts. The UNDP-WHO report (UNDP-WHO, 2009) reveals that use of modern cooking technologies, such as Improved Cookstoves (ICSs), is very limited—only 6 per cent of the population in LDCs (44 million) and Sub-Saharan African (33 million) countries using traditional fuels (biomass and coal) have access to ICSs. There are efforts to address this situation through the engagement of several international organizations in the development and dissemination of ICSs. The Global Alliance for Clean Cookstoves (GACC), a public-private partnership, has been formed to create global awareness and to persuade leaders and stakeholders to address the issues. The long-term objective is to migrate to modern cooking fuels, such as LPG, which is more environmentally friendly, safer and affordable than traditional fuels.

Providing people with Renewable Energy (RE) and Clean Cooking (CC) technologies (such as ICSs and LPG) has critical environmental dividends in the form of reduced greenhouse gas (GHG) emissions and a high sustainable development (SD) impact.

**Figure 1-1: Access to Improved Cookstoves in Sub-Saharan Africa and Selected LDCs**




*Source: UNDP-WHO, 2009*

However, making use of these technologies faces certain challenges such as high upfront costs, inadequate access to finance, poor local level manufacturing distribution capability, which pose a significant barrier to raising capacity. Low levels of awareness, limited resources and the lack of a supportive regulatory mechanism are also huge barriers to the increased uptake of these technologies.

Under a sector transforming NAMA, numerous multilateral, bilateral, private sector and civil society initiatives and organizations have an opportunity to cooperate actively with the Government by providing technical, financial, capacity-building and advocacy support for the development and implementation of these low emission technologies.

## 1.2 Nationally Appropriate Mitigation Actions (NAMAs) and Intended Nationally Determined Contributions (INDCs)

NAMAs are voluntary, non-binding policy instruments that provide a framework for pursuing a country's socio-economic and development goals while contributing towards GHG mitigation efforts. NAMAs were first introduced at the 13th Conference of Parties to the Kyoto Protocol (COP13) in Bali in 2007. Many developing countries are taking steps to develop and implement NAMAs; the NAMAs can help countries' achieve their growth objectives and participate in the global climate change mitigation agenda. NAMAs help governments leverage national and international support to achieve appropriate, effective and transformational GHG mitigation and sustainable development targets for the country and within communities.

COP19 in 2013 saw the introduction of Intended Nationally Determined Contributions (INDCs), which are to be submitted by all Parties, developed and developing, to the United Nations Framework Convention

on Climate Change (UNFCCC). The INDCs are for the period following 2020 and detail actions the Parties will take to address climate change. The scope of which types of actions (e.g. mitigation, adaptation) and the means of implementation to be included is yet to be determined. The exact relationship of INDCs and NAMAs is yet to be determined but both comprise short- to medium-term goals, with NAMAs also acting as an implementation tool to translate these goals into action by outlining the means and the vehicle/action plan to achieve them.

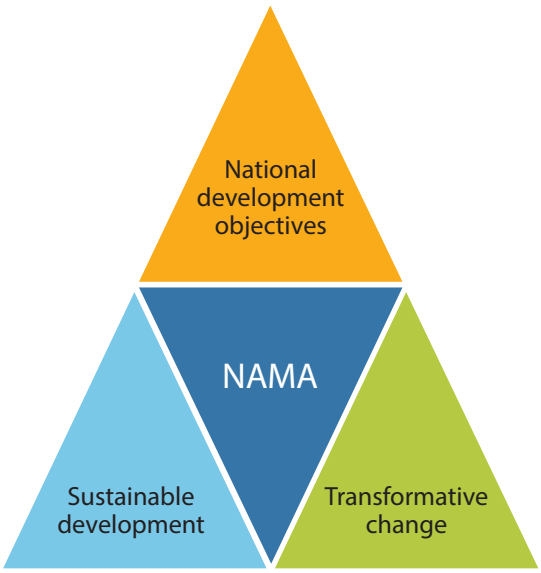
On 23 September 2015, Ghana submitted its INDC to the UNFCCC Secretariat. Under its INDC, the Government of Ghana (GoG) has adopted the target of reducing its economy-wide $CO_2$ emissions by 45 per cent(involving 15 per cent unconditional and 30 per cent conditional emission reduction) by 2030 compared with the business-as-usual scenario (BAU) for 2030 taking 2010 as the base year (Republic of Ghana, 2015).

## 1.3 NAMA as an Opportunity for Ghana

NAMAs differ from traditional funding mechanisms because of the three key components, summarized in Figure 1-2.

- Alignment with national development objectives: The interventions under a NAMA framework must be compatible with the host country's policy and development objectives.
- Focus on sustainable development: The NAMA is designed with sustainable development benefits in mind. The design includes a focus on interventions which allow for income generating activities which can create business opportunities for individuals, households and communities.
- Facilitate transformative change: The NAMA will spur the development of an environment which facilitates a transformative change in the sector. An enticing regulatory and policy environment which incentivizes the private sector will be created. Initial interventions will catalyse private sector development and the creation of local jobs. The business models associated with the NAMA interventions will be easily replicable in other communities across the country.

**Figure 1-2: NAMA Components**



## 1.4 Purpose and Objectives of the NAMA

The overall purpose of this NAMA is to increase access to clean energy solutions (such as clean cooking solutions and renewable energy) in a sustainable manner while leading to transformational change. The purpose will be met through two objectives.

- **Objective 1:** Enable private sector participation in the manufacturing and distribution of the clean energy solutions in Ghana.
- **Objective 2:** Create an enabling market environment that encourages distribution of the clean energy solutions to the end-users supported by an appropriate financing model.

The objectives of NAMA will be met through setting up a network of Energy Productivity Zones (EPZs) across Ghana. EPZs represent a holistic approach to tackling several of the challenges a NAMA faces. The EPZ model simultaneously assures supply of clean energy, socio-economic development of local communities and a business model that is sustainable and able to attract finance.

The model recognizes that the solution to lifting communities out of poverty is access to sustainable modern electricity/energy services, but that the same communities often do not possess the financial capacity to pay for the often high cost of modern electricity/energy services. The EPZs will also create income generating opportunities by establishing an "enabling environment" for the private sector to participate in the manufacturing and distribution of clean energy solutions in Ghana (i.e. PV and clean cooking solutions).

Acting as sector-transforming instrument, the proposed NAMA has the potential to increase access to sustainable energy and provide energy solutions for the population in Ghana and bring about a transformational change in the energy sector. NAMA is expected to have several social, economic and environmental benefits, thereby making it consistent with Ghana's sustainable development objectives and goals by moving a large segment of the population away from practices that cause unacceptably high GHG emissions, indoor air pollution which damages health, and deforestation with its significant environmental impact. Along with these benefits, the NAMA will create jobs for local people.

The proposed business model under NAMA is expected to create a market environment that encourages private sector participation in the manufacture and distribution of clean cooking and RE technologies. Therefore, the proposed NAMA would be able to leverage additional private and/or public funds for its implementation. The funds would comprise directly mobilized funds as well as funding which will be mobilized indirectly, both of which would be acquired through the removal of a variety of barriers—financial, regulatory, market and technological as well as ones related to awareness and outreach—and a viable phase-out concept.

# 2 BACKGROUND ON GHANA

## 2.1 Geography and Administrative Divisions

Ghana is a West African country located along the Gulf of Guinea with an area of 239,460 km2, making it the 82nd largest country in the world by area. It is bordered to the north by Burkina Faso, to the west by Côte d'Ivoire, to the east by Togo and to the south by the Atlantic Ocean (UNDP, 2011).

The capital of Ghana is Accra, located along the Ghanaian Atlantic coast and extending north into Ghana's interior. The administrative divisions of the Republic of Ghana consist of 10 regions (Figure 2-1), divided into six metropolitan areas, 55 municipalities and 212 districts, each with its own assembly. Below the district level, there exist 58 town or area councils, 108 zonal councils; and 626 area councils (Best-Country.com, 2015).

Ghana's climate is tropical, with an overall average temperature between 21°C and 28°C (average annual mean). The climate in the eastern coastal belt is warm and comparatively dry, the south-west corner of Ghana is hot and humid and the northern Ghana is hot and dry (UNDP, 2011).

**Figure 2 1: Map of Ghana and its regions**


*Source: ephotopix.com, 2012.*

## 2.2 The Economy

Ghana is classified by the World Bank as a lower middle income economy. Its economy is ranked 92nd in the world based on GDP (current prices), which was valued at about US$38.5 billion in 2014 (World Bank). The real GDP growth (in percent change) for the year 2014 is 4.2% with GDP per capita (current prices) at US$ 1,353.2 for the same year (Table 2-1) (The World Bank, 2015).

### Table 2-1: Key Economic Indicators, 2014

| Indicator | Value |
|---|---|
| GDP, current prices (US$ billion) | 38.6 |
| Real GDP growth (%) | 4.2 |
| GDP per capita, current prices (US$) | 1,353.2 |

*Source: World Bank, 2015*

The services sector is the economy's largest sector, accounting for about 49.6 per cent of goods and services produced in 2014, followed by industry with 28.4 per cent, and agriculture with 22% per cent. GDP estimates for 2014 showed the services sector growing in real terms by 5.6 per cent, followed by agriculture (4.6 per cent) and the industry (0.8 per cent), yielding a GDP growth rate of 4.0 per cent (Ghana Statistical Service, 2015).

## 2.3 Demography

Ghana's total population was 26.3 million in 2013 with a population density of 109.83 per km2, estimated from 2012-2013 data under Ghana Living Standard Survey Round 6 (GLSS 6, 2014). About 50.2 per cent i.e. approximately 13.2 million are urban inhabitants and rest 13.1 million live in rural areas of Ghana. Table 2-2 provides the main demographic indicators.

### Table 2:2: Key demographic indicators

| Indicator | Value |
|---|---|
| Total population | 26.3 million |
| Urban population | 13.2 million |
| Rural population | 13.1 million |
| Number of Households | 6.6 million |
| Household size | 4 |
| % male of total population | 48.3 |
| % female of total population | 51.7 |
| Population density | 109.83 per km$^2$ |

*Source: GLSS 6, 2014.*

## 2.4 Socio–Economic Conditions

The results of recent round of the Ghana Living Standards Survey show that in 2012/13 more than three-quarters of the population (aged 15 and older) were economically active (77.1 per cent. Of the economically active, about 75 per cent were employed, with majority of them engaged in agriculture (44.7 per cent) and services (40.9 per cent). The unemployment rate was 5.2 per cent. Even though the unemployment rate was low, more than one-third of the working population were underemployed (i.e., these individuals work for less than 35 hours a week) (GLSS 6, 2014).

As discussed above, Ghana is classified by the World Bank as a lower middle income economy, with 28.6 per cent of people living below the poverty line in 2008, including 11.4 per cent in severe poverty; another 21.6 per cent of the population was vulnerable to poverty (UNDP, 2013). Table 2-3 provides the main socio-economic indicators for Ghana.

**Table 2:3: Key socio-economic indicators**

| Indicator | Value |
|---|---|
| GNI per capita (2005 PPPUS$) (2012) | 1,684 |
| Gender Inequality Index (GII) (2012) | 0.565 |
| Population below poverty line (% of total population) (2008) | 21.6 |
| Unemployment rate (2012/13) (%) | 5.2 |

*Sources: GLSS 6, 2014; (UNDP, 2013)UNDP, 2013*

## 2.5 National Development Strategies and Targets

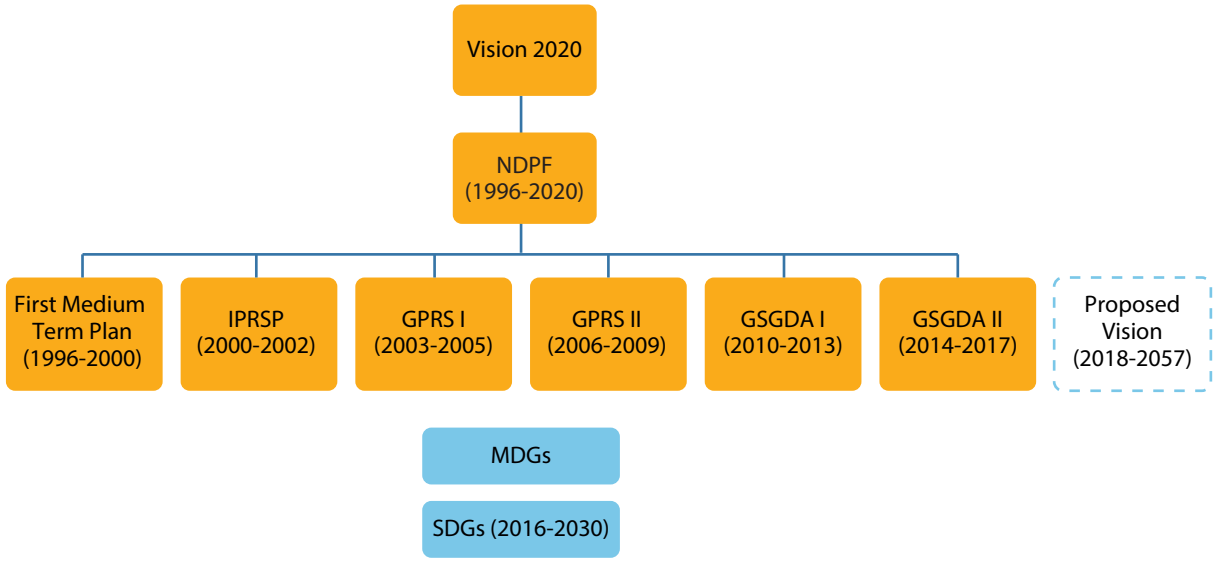
Since the early 1980s, the Government of Ghana has formulated a number of development strategies with the support of the World Bank and the International Monetary Fund. Since 1996, the Government has been reorienting all development policies around the three pillars of sustainable development, i.e. economic, social and environmental development, with a specific focus on sustained poverty reduction.

Ghana's blueprint for sustainable socio-economic development is laid out in the Vision 2020 document. This document presents Ghana's long-term vision to of becoming a middle income country by the year 2020. The details of this vision are documented in the National Development Policy Framework (NDPF), Volume I: Long-Term Development Objectives, which articulates the long-term, 25-year (1996-2020) perspective for Ghana's socio-economic development.

National development initiatives and investment programmes (Figure 2-2), together with consistent economic growth, have contributed to Ghana becoming the first Sub-Saharan African country to meet the UN's Millennium Development Goal of halving its poverty rate by 2015. These programmes and policy initiatives include the Structural Adjustment Programme (SAP) (1983-1999), the First Medium Term Development Plan (1996-2000), the Interim Poverty Reduction Strategy Paper (IPRSP) (2000-2002), the Ghana Poverty Reduction Strategy I (GPRS I) (2003-2005), the Growth and Poverty Reduction Strategy Paper (GPRS II) (2006-2009), the Ghana Shared Growth and Development Agenda I (GSGDA I) (2010-2013)

and the Ghana Shared Growth and Development Agenda II (GSGDA II) (2014-2017). Since 2000, Ghana has incorporated the MDGs into these medium-term national development initiatives.

**Figure 2-2: Ghana's national Development Policies[a]**




*aNDPF=National Development Policy Framework; IPRSP=Interim Poverty Reduction Strategy Paper; GPRS=Ghana Poverty Reduction Strategy; GSGDA=Ghana Shared Growth and Development Agenda; MDGs=Millennium Development Goals; SDGs=Sustainable Development Goals.*

### 2.5.1 Ghana's Vision 2020

Ghana's long-term development programmes and strategies to achieve its national objectives were set out in 1996 in the Vision 2020 document. The goals and objectives of Vision 2020 were discussed in detail in NDPF, Volume I. Vision 2020 focuses on five themes regarded as central to realizing the country's long-term vision of becoming a middle income country by 2020. These five development themes are:

- Human Development
- Economic Growth
- Rural Development
- Urban Development
- An Enabling Environment.

The basic objectives of Ghana's development agenda are to:

- reduce poverty;
- increase employment opportunities and average incomes;
- reduce inequities in order to improve the general welfare and the material well-being of all Ghanaians;

- apply science and technology in increasing labour and natural resource productivity; and
- increase efficiency in all types of production in order to be competitive in local and export markets.

### 2.5.2 Ghana Shared Growth and Development Agenda II (GSGDA II)

The Ghana Shared Growth and Development Agenda (GSGDA) II, 2014-2017 builds on the precursor framework, GSGDA I (2010-2013). The GSGDA II has been prepared against the background of Ghana attaining lower middle income status in 2010 and having attained significant economic expansion over the period of the previous GSGDA (2010-2013).

The Ghana Shared Growth and Development Agenda II (GSGDA II) is the most recent medium-term national development policy framework. GSGDA II serves as a guide to the formulation of medium-term and annual development plans and budgets at sector and district levels. It ensures continued pursuit of macroeconomic stability and the sustainable exploitation of Ghana's natural resources that will enable the country to attain full middle income status by 2020 with a per capita income of US$ 3,000.

The document spells out the following objectives to achieve this goal:

- Sustained macroeconomic stability
- Enhanced competitiveness in Ghana's private sector
- Accelerated agricultural transformation and sustainable natural resource management
- Oil and gas development
- Infrastructure and human settlements development
- Human development, productivity and employment
- Transparent and accountable governance

GSGDA II focuses on the following areas:

- Socio-economic transformation, involving a change in the structure and composition of the national output in ways that enhance broad-based, inclusive and sustainable growth;
- Process innovation of production through skills and technological upgrading;
- Enhancing the competitiveness of industry and trade;
- Lifting workers from low-productive agriculture to higher productive activities;
- Putting the economy on a growth path that creates jobs, opens up decent work opportunities for all, alleviates poverty and reduces income and social inequalities;
- Creating a conducive environment to propel investment;
- Investing in human capital, infrastructure, human settlements, science, technology and innovation to drive industrialization, in particular manufacturing;
- Strengthening the capacity for effective implementation of government policies and programmes

### 2.5.3 Ghana's Vision 2057

The National Development Planning Commission (NDPC) of Ghana has proposed a long-term development framework with a 40-year time horizon, starting in 2018 and ending in 2057, the year when Ghana would be celebrating its 100th anniversary of independence (National Development Planning Commission, 2015). This framework would be implemented through ten four-year medium-term plans by successive governments that will end in 2057 and would be subjected to four decennial reviews by the Parliament.

### 2.5.4 The Millennium Development Goals (MDGs)

The United Nations Millennium Declaration, adopted by world leaders at the Millennium Summit of the United Nations in 2000, set forth the eight Millennium Development Goals (MDGs) which aimed at transforming the face of global development cooperation (UNDP/NDPC, 2012). In September 2000, Ghana committed itself to tracking these eight time-bound MDGs and associated indicators. In considering the relationship between bringing modern forms of energy the cooking sector and the level of development associated with it, it is essential to analyse Ghana's progress towards the attainment of the relevant MDGs. These are:

- Goal 1: Eradicate extreme poverty and hunger;
- Goal 7: Ensure environmental sustainability; and
- Goal 8: Develop a global partnership for development.

In this section the progress towards achieving these three goals is analysed, as captured in the Ghana's fifth MDGs progress report (UNDP/NDPC, 2015) and UN data on the MDGs (UN Statistics Division, 2015).

#### Goal 1: Eradicate extreme poverty and hunger

Although Ghana has made progress in achieving the MDG-1 target of reducing by half the proportion of the population living in extreme poverty at the national level and in rural and urban areas, the depth of its poverty remains a challenge. Poverty is still prevalent in the three northern savannah regions and among food crop farmers. The depth of poverty is high, particularly in the urban areas and six regions indicating that the poor in these areas are well below the poverty line (Refer to Annex 1 for details on the status of this goal).

The interventions identified in the 2015 Ghana MDG Report that could help in addressing the high rate of poverty in the country are:

- attract private investment;
- an increased commitment of resources to the Savannah Accelerated Development Authority (SADA);
- deepen the targeted social intervention programmes in the northern savannah regions; and
- improve infrastructure particularly the roads network.

### Goal 7: Ensure environmental sustainability

Although Ghana has already achieved the target of halving the proportion of the population without access to safe water, challenges still exist in achieving the targets of reducing biodiversity losses, halving the proportion of people without access to improved sanitation, and achieving significant improvement in the lives of people living in slum areas.

Key interventions suggested in the 2015 Ghana MDG Report to achieve the targets are:

- enforcement of key policies;
- developing infrastructure especially reliable energy sources to power and pump water to households;
- improving access to adequate financial resources to undertake and maintain huge water projects; and
- expanding improved and affordable housing units as well as upgrade slum areas.

(Refer to Annex 2 for details on the status of this goal).

### Goal 8: Develop a global partnership for development

This goal includes a target increasing aid from developed countries to 0.7% of their Gross National Income (GNI). Aid inflows to Ghana increased in nominal terms from US$578.96 million in 2001 to US$1,433.23 million in 2008 (UNDP/NDPC, 2010). However, since 2009 aid inflows have been falling.

Key interventions associated with this goal needed for achieving the targets are:

- formulate a national aid policy;
- improve service delivery by the telecom service providers which has been abysmal in recent times;
- continue expansion of internet services to senior high schools and junior secondary schools across the country;
- develop standards for mast construction and ensure compliance with such standards through the National Communication Authority (NCA); and
- intervene in the internet market through the regulator to promote growth of the industry.

(Refer to Annex 3 for details on the status of this goal.)

## 2.5.5 The Sustainable Development Goals

At the Sustainable Development Summit held in September 2015, UN Member States adopted the 2030 Agenda for Sustainable Development, which includes a set of 17 Sustainable Development Goals (SDGs)/ Global Goals. The SDGs build on the Millennium Development Goals (MDGs) and target an end to poverty, fighting inequality and injustice, and tackling climate change by 2030.

### 2.5.6 Ghana's INDC

On 23 September 2015, Ghana submitted its Intended Nationally Determined Contribution (INDC) to the UNFCCC Secretariat. The Government of Ghana has set a target of unconditionally reducing its economy-wide $CO_2$ emissions from 2010 (base year) by 15 per cent relative to BAU scenario emissions of 73.95 tons of $CO_2$ equivalent by 2030 (target year). However, with external support available to cover the full cost of implementing the mitigation action (finance, technology transfer, capacity-building), an emissions reduction of an additional 30 per cent is attainable, bringing the total emission reduction to 45 per cent below the BAU emission levels by 2030. In the 10-year period of its post-2020 enhanced climate action plan, Ghana needs US$22.6 billion in investments from domestic and international public and private sources to finance these actions.

- US$6.3 billion is expected to be mobilized from domestic sources
- US$16.3 billion is expected to be mobilized from international sources

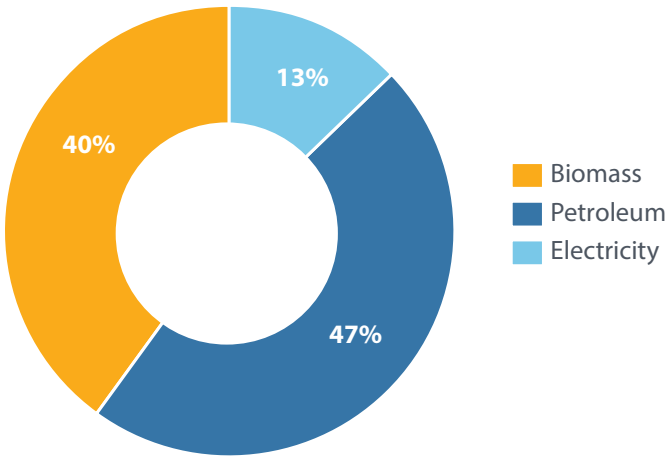
Details of policy actions as defined in INDC are provided in Annex 5.

## 2.6 Current Situation and Trends in the Energy Sector

### 2.6.1 Sector Overview

Energy in Ghana is consumed in three main forms: 1) Biomass[1] in the form of firewood and charcoal for cooking and to a lesser extent for co-generation; 2) petroleum fuels; and 3) as electricity (Figure 2-3). The country's total energy consumption in 2014 stood at 7,016.4 ktoe, of which consumption of petroleum product accounted for 3,271.7 ktoe (46.6 per cent), followed by biomass (2,791.7 ktoe, 39.8 per cent) and electricity (953 ktoe, 13.6 per cent) (Energy Commission of Ghana, 2015a).

**Figure 2 3: Primary Energy Consumption in Ghana, 2014**




*Source: Energy Commission, 2015a.*

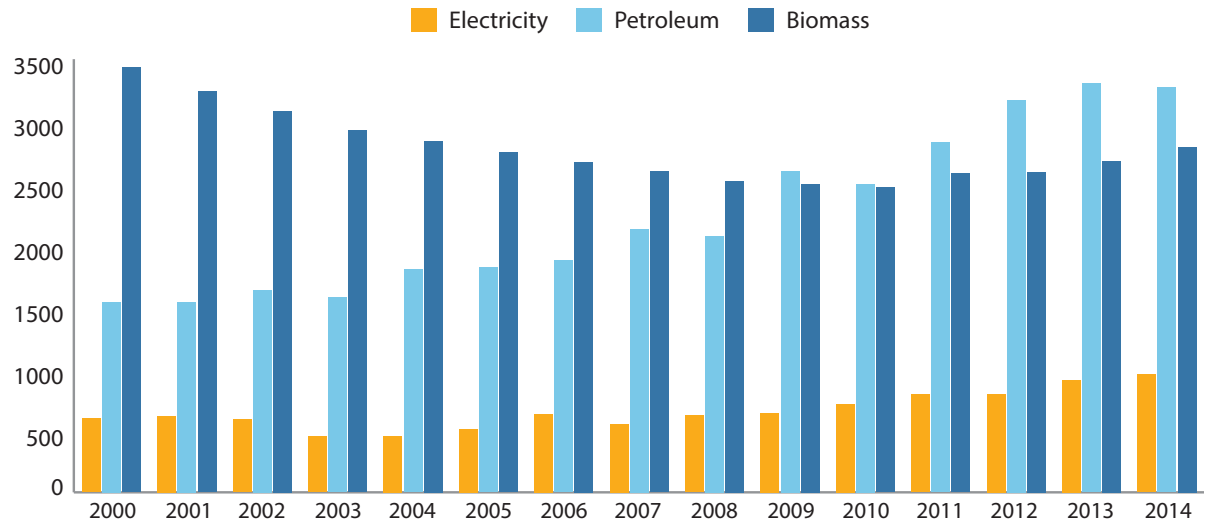
1 In Ghana, biomass energy is primarily derived from wood, so the words "biomass" and "woodfuel" are used interchangeably in this report.

About 3 per cent of the total volume of petroleum products consumed in the economy was supplied by the nation's only petroleum refinery, Tema Oil Refinery (TOR), while the remaining 97 per cent were imports (85 per cent) or from the national stock (12 per cent). Petroleum products mainly comprise liquefied petroleum gas (LPG), kerosene, gasoline, diesel and residual fuel oil (RFO) (Energy Commission of Ghana, 2015).

Energy consumed in the form of woodfuel, as noted above, was 2,791.7 ktoe in year 2014. This consisted almost entirely of firewood (1,579.7 ktoe, 56.6 per cent) and charcoal (1,212.0 ktoe, 43.4 per cent). Firewood consumption includes a small percentage (approximately 1 per cent) of sawdust and sawmills residues (Energy Commission of Ghana, 2015).

In the past decade, Ghana has seen significant growth in total energy consumption. While the share of woodfuel in overall energy consumption has come down, the percentage shares of electricity and petroleum gradually increased between 2000 and 2014, and in 2009 petroleum overtook biomass as the leading source of energy consumed (Figure 2-4).

**Figure 2 4: Primary energy consumption in Ghana, 2000-2014**




*Sources: Energy Commission, 2015a; Energy Commission, 2015b.*

### 2.6.2 Electricity Supply and Electrification

Electricity is produced from two main sources in Ghana—hydro and thermal. Hydro and thermal constituted 56 per cent and 44 per cent respectively of total installed electricity generation capacity in 2014, whereas solar energy contributed a marginal ~0.1 per cent (Energy Commission of Ghana, 2015).

Table 2-4 provides an overview of the major electricity generation plants with their installed capacity and the amount of electricity they generated along with the fuel they used in 2014.

### Table 2-4: Grid Electricity: Installed Capacity and Electricity Generation by Plant, 2014

| Plant | Fuel type | Installed capacity (MW) | Share of total installed capacity (%) | Electricity generation by plant (GWh) | Share of electricity generated (%) |
|---|---|---|---|---|---|
| **HYDRO** | | | | | |
| Akosombo | Water | 1,020 | 36 | 6,509 | |
| Bui | Water | 400 | 14.1 | 730 | |
| Kpong | Water | 160 | 5.7 | 1,148 | |
| *Sub-Total* | | *1,580* | *55.8* | *8,387* | *64.70* |
| **THERMAL** | | | | | |
| Takoradi Power Company (TAPCO) | LCO/ Natural Gas | 330 | 11.7 | 890 | |
| Takoradi International Company (TICO) | LCO/ Natural Gas | 220 | 7.8 | 712 | |
| Sunon Asogli Power (Ghana) Limited (SAPP) - IPP | Natural Gas | 200 | 7.1 | 1,255 | |
| Cenit Energy Ltd (CEL) - IPP | LCO | 126 | 4.5 | 513 | |
| Tema Thermal 1 Power Plant (TT1PP) | LCO/ Natural Gas | 110 | 3.9 | 697 | |
| Tema Thermal 2 Power Plant (TT2PP) | DFO/ Natural Gas | 50 | 1.8 | 223 | |
| Takoradi T3 | LCO/ Natural Gas | 132 | 4.7 | 87 | |
| Mines Reserve Plant (MRP) | DFO/ Natural Gas | 80 | 2.8 | 195 | |
| *Sub-Total* | | *1,248* | *44.3* | *4,572* | *34.75* |
| **RENEWABLES** | | | | | |
| VRA Solar | Solar | 2.5 | 0.1 | 4 | |
| *Sub-Total* | | *2.5* | *0.1* | *4* | *0.05* |
| **TOTAL** | | **2,831** | | **12,963** | |

*Source: Energy Commission, 2015a.*

National average electricity coverage was about 72 per cent at the end of 2012, but access rates varied between regions (Figure 2-5) (Reegle, 2015). The vision for the energy sector is to ensure availability of and universal access to energy services and for export by 2020. In line with this vision, in 1989 the then Ministry of Energy (now the Ministry of Power) instituted the National Electrification Scheme (NES) as the Government's principal policy to extend electricity to all parts of the country over a 30-year period from 1990 to 2020. In 2012,

another 643 communities were connected to the national grid, bringing the total number of communities connected nationally to about 5,500 (Energy Commission of Ghana, 2015) (Table 2-5).

### Table 2-5: Electrification Status by Region, 2010

| Regions | No. of Communities | Population | Number of households | Electricity access, 2010 (%) | Electricity access, 2015[a] (%) |
|---|---|---|---|---|---|
| Greater Accra | 11 | 4,010,054 | 1,036,426 | 97 | 96 |
| Ashanti | 221 | 4,780,380 | 1,126,216 | 82 | 90 |
| Central | 175 | 2,201,863 | 526,764 | 81 | 87 |
| Brong-Ahafo | 195 | 2,310,983 | 490,519 | 67 | 77 |
| Eastern | 247 | 2,633,154 | 632,048 | 70 | 80 |
| Western | 319 | 2,376,021 | 553,635 | 68 | 82 |
| Volta | 179 | 2,118,252 | 495,603 | 65 | 79 |
| Northern | 660 | 2,479,461 | 318,119 | 50 | 58 |
| Upper East | 299 | 1,046,545 | 177,631 | 44 | 55 |
| Upper West | 294 | 702,110 | 110,175 | 40 | 76 |

*Sources: Abavana, 2010; unpublished Ministry of Power document.*

### 2.6.3 Modern Energy Services for Cooking

The 2012/13 GLSS-6 Report (Table 2-6) revealed that 41.3 per cent of households in Ghana were dependent on firewood as their primary source of cooking fuel, followed by charcoal (31.5 per cent) and LPG (22.3 per cent). Charcoal is the main source of cooking fuel for 43.6 per cent of households living in urban areas, while LPG is the primary source of cooking fuel for 35.8 per cent of urban households. The major charcoal consumers are the coastal regions with Greater Accra and Ashanti accounting for more than 50 per cent of the country's consumption (GLSS 6, 2014c).

### Table 2-6: Households by Source of Cooking Fuel, 2012/13

| | Urban Areas | | | Rural Areas | | | | Ghana |
|---|---|---|---|---|---|---|---|---|
| Sources | Accra (GAMA) | Other Urban Areas | All Urban Areas | Rural Coastal | Rural Forest | Rural Savannah | All Rural Areas | |
| Firewood | 0.8 | 20.5 | 14.3 | 57.6 | 72.4 | 87.4 | 74.8 | 41.3 |
| Charcoal | 38.9 | 45.8 | 43.6 | 30 | 17.9 | 7.6 | 16.5 | 31.5 |
| LPG | 52.7 | 28 | 35.8 | 9.8 | 6.7 | 1.3 | 5.5 | 22.3 |
| Electricity | 0.6 | 0.5 | 0.5 | 0.1 | 0.1 | 0.1 | 0.1 | 0.3 |
| Kerosene | 0.5 | 0.1 | 0.2 | 0.3 | 0.1 | 0.1 | 0.1 | 0.2 |

| | Urban Areas | | | Rural Areas | | | | Ghana |
|---|---|---|---|---|---|---|---|---|
| **Sources** | **Accra (GAMA)** | **Other Urban Areas** | **All Urban Areas** | **Rural Coastal** | **Rural Forest** | **Rural Savannah** | **All Rural Areas** | |
| Crop residues | — | 0.2 | 0.1 | — | 0.1 | 2.2 | 0.7 | 0.4 |
| Other | — | 0.1 | -— | — | — | — | — | — |
| None, no cooking | 6.4 | 4.9 | 5.4 | 2.1 | 2.7 | 1.3 | 2.2 | 3.9 |

*Source: GLSS 6, 2014.*

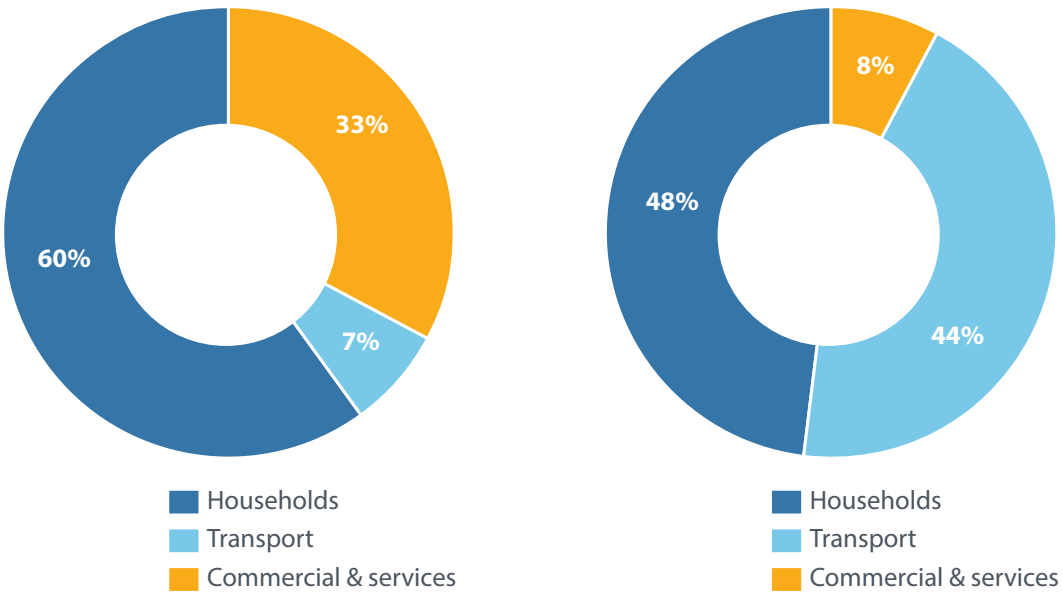
Heavy dependence on woodfuel as the primary source of cooking energy has raised serious health and environmental concerns among Ghanaians. It has become a serious threat to the ecosystem of the country as Ghana's tropical forest area is today only 25 per cent of its original size (World Bank, 2011). Yet, almost 2 per cent of forests are being depleted every year. With the growing population, in the long run, this will lead to ecological disaster.

Modern energy services for cooking such as ICSs and cleaner fuels like LPG are the tools for addressing the social and environmental burdens arising from woodfuel usage.

#### *2.6.3.1 LPG for Cooking*

In Ghana, LPG is primarily used for cooking in the residential sector, and commercial and institutional establishments. In recent times, LPG demand has been growing rapidly in the transport sector primarily for use in the taxi cabs and commercial vehicles (Figure 2-5).

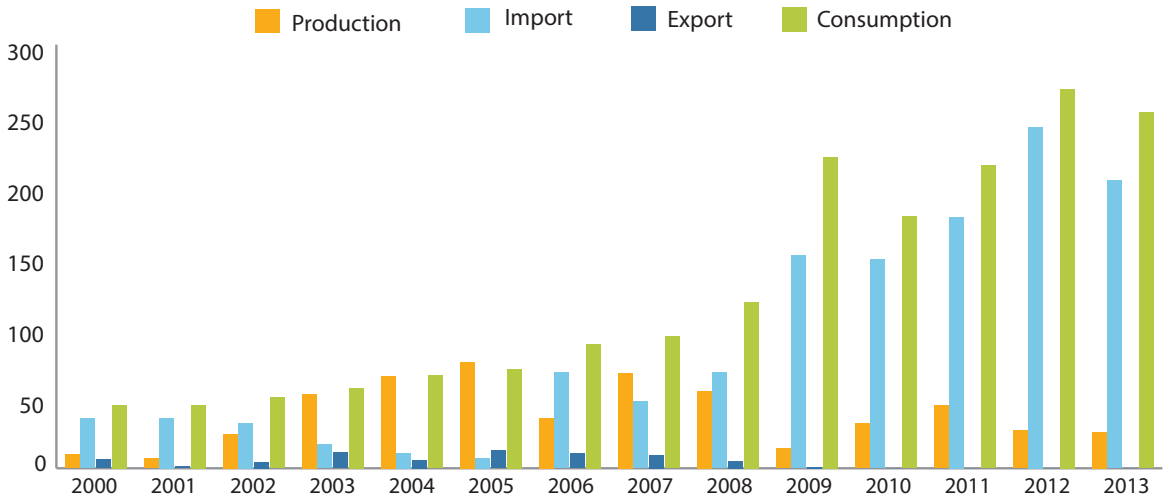
**Figure 2-5: LPG Consumption by Type of Consumer, 2000 and 2010**




*Source: Energy Commission of Ghana, 2015a.*

LPG is supplied to the Ghanaian market from both domestic production and imports. However, domestic LPG production is limited and imports account for the overwhelming majority of the total supply to the market. Until 2014, the company, Tema Oil Refinery (TOR), was responsible for all domestic supplies as well as imports. TOR's refinery produced about 25,600 tons in 2013, while net imports were approximately 203,900 tons (Figure 2-6) (Energy Commission of Ghana, 2015a).

### Figure 2-6: LPG Consumption, 2000-2013




*Source: Energy Commission, 2015a.*

The consumption of LPG has been rising steadily, from 45,000 tons in 2000 to 251,800 tons in 2014 (Energy Commission, 2015a. Household LPG penetration increased from 6 per cent in 2000 to 22.3 per cent in 2012/13 (GLSS 6, 2014). However, LPG shortages are a common phenomenon in the country. Persistent shortages are leading both domestic and commercial users of the product to go back to using charcoal and firewood. The Energy Commission believes that the shortage of LPG could be partly overcome in 2015 after the newly built Atuabo gas processing facility has become operational (Table 2-7) (Energy Commission of Ghana, 2015a).

### Table 2-7: Operating Performance of the Atuabo Gas Processing Plant

| Sources | Value |
|---|---|
| Technical capacity in million standard cubic feet of gas per day (mmscfd) | 150 |
| Operational statusa | Processing of 80 mmscfd of the wet gas started in April 2015 with supply of 300 tons per day of LPG |
| Products | |
| LPG (tons/day) | 500 |
| Condensate (tons/day) | 30 |

*[a]As of April 2015 when the Energy Commission's report was drafted.*
*Source: Energy Commission, 2015a.*

The Ministry of Petroleum has set a target of achieving 50 per cent household penetration of LPG by 2020. To achieve this penetration level, the Energy Commission has estimated, LPG demand will reach at least 450,000 tons by 2020, based on an estimated population of 31-32 million by the end of the decade. The Energy Commission has also estimated that this demand could be met from the following sources:

- operating Tema Oil's refinery at over 90 per cent capacity on average during the year;
- processing wet gas at the Atuabo gas processing plant to supply 500 tons of LPG per day; and
- maintaining imports, but at below the current level.

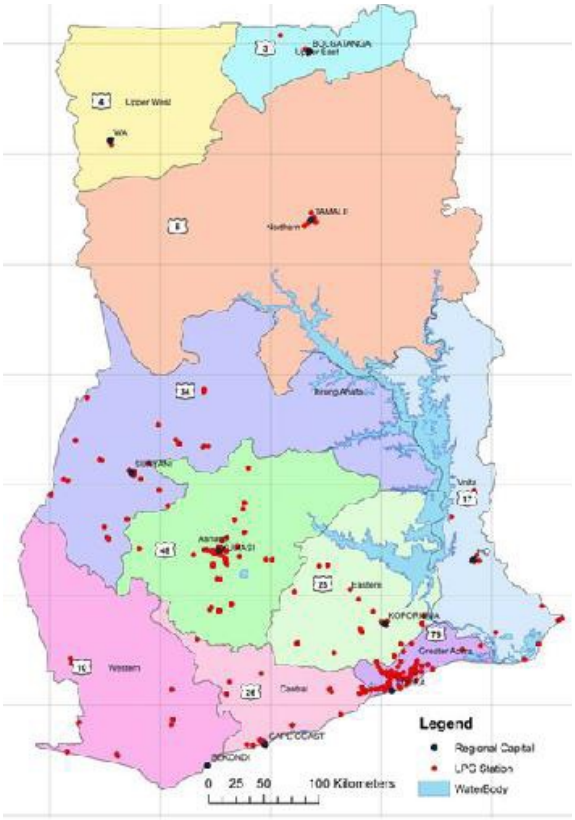
Although national supplies along with current level of imports would be enough to meet medium-term demand, national LPG storage and distribution capacity constitutes a challenge to achieving this target. In Ghana, LPG storage and distribution are carried out at two levels before it reaches the final consumers, first at national bulk level (i.e. storage at TOR and the Atuabo gas processing plant) and second at dealer and retailer level. The retailers serve as the main link between consumers and the oil marketing companies (OMCs) because OMCs are licensed to procure and sell petroleum products to bulk customers and the general public through retail stations. Ghana has a bulk LPG storage capacity of about 6,400 tons at TOR (the storage capacity of Atuabo gas processing plant is not currently known) and the distribution points are largely found in southern Ghana, at Kumasi and Koforidua and along the coast (Figure 2-7).

The Government of Ghana has taken various steps to increase LPG penetration. It launched the LPG Promotion Programme in 1989 to promote the use of LPG as a cooking fuel. The programme targeted households, institutions and small-scale food sellers. As a promotional strategy, 14.5kg and 5kg LPG cylinders were distributed free to the public and free transportation services were offered. Consumers were required to pay for the cost of the gas only. A fund called the LPG Fund was also created to fund the purchase and maintenance of cylinders, LPG tanks and kitchen equipment for institutions. The LPG Fund was used to partly finance the construction cost of the Ghana Cylinder Manufacturing Company (GCMC) factory in Accra.

The programme was initially successful: the number of households using LPG increased from 4 per cent in 1998 to 9.5 per cent in 2006 (according to the estimates of Ghana Statistical Services). However it failed to attain its goal for the following reasons:

- Insufficient supply of LPG due to a long shutdown of TOR—because of regular shortages of LPG, people preferred firewood and charcoal, which were cheap and reliable;

**Figure 2-7: Location of LPG retail stations, 2010**




*Source: SE4All, 2012.*

- Limited storage and distribution capacity in the country; and
- Inability to benefit the intended beneficiaries, i.e. households, when vehicles notably taxi cabs and commercial buses switched to LPG use due to its subsidized price.

The Government also introduced the National Policy of LPG Promotion as part of its efforts to reduce deforestation and to control the environmental hazards associated with firewood and charcoal. The 2015 energy outlook report published by the Energy Commission proposes implementation of following measures to attain the 50 per cent LPG penetration target by 2020:

- Speeding up the establishment of a Natural Gas Processing Plant to produce LPG from the associated gas to be produced from the Jubilee Oil and Gas Field;
- A deliberate government policy to make the LPG produced domestically available for local consumption rather than export;
- Removal of price distortions;
- Recapitalizing the Ghana Cylinder Manufacturing Company (GCMC) to expand its production capacity with the production of cylinders focused on small sized cylinders that would be portable and affordable to households in rural communities; and
- Constructing LPG storage and supply infrastructure in all regional and district capitals in the long term, and developing district capital LPG infrastructure in the medium term.

### *2.6.32 Improved Cookstoves*

The use of woodfuel for cooking is a common cause of concern among Ghanaian households. In Ghana, cooking is predominantly done on traditional cookstoves or open fires. Charcoal stove usage is dominated by the traditional stove locally called a "coal pot" which is used by approximately 85 per cent of all charcoal stove users. Despite the government's subsidization programme, progress in achieving the large-scale adoption and use of ICSs has been remarkably low.

The most commonly used ICS in Ghana market is the improved Kenyan Jiko type stove (locally it is known as the Gyapa) distributed and manufactured by three main players: Gyapa Enterprise, Toyola Energy, and Man & Man Enterprise. There are regular instances of new entrants to the market, such as Envirofit and CookClean Ghana. CookClean Ghana, which produces a locally researched and developed charcoal stove branded CookMate (Figure 2-8, Table 2-8). These ICS manufacturers produce thousands of cookstoves annually for the Ghanaian market, especially for the urban and peri-urban markets located in the southern region, rather neglecting rural households and the northern regions. Due to unaffordability and low accessibility to ICSs, the traditional open fire, three stones stove and coal pot cooking stoves remain extremely popular within Ghana, especially in rural areas.

In Ghana, ICS initiatives began in 1989 with the Ahibenso Coal Pot Programme of the Ministry of Energy (now the Ministry of Power). Though the project appeared to be successful initially, it was discontinued due to limited funding. The Ahibenso was known to have an efficiency of 39 per cent compared to the traditional coal pot stove and dissemination focused on Accra only.

### Figure 2-8: Traditional and Improved Cookstoves in Use in Ghana

Traditional open fire

Coal pot

Cookmate


Gvapa/Toyola/Man & Man

### Table 2-8: Specifications of Main Types of Traditional and Improved Cookstoves

| Parameters | Coal pot | Gyapa | CookMate |
|---|---|---|---|
| Primary fuel | Charcoal | Charcoal | Charcoal |
| Available size | Smaller size<br>Medium size<br>Large | Small<br>Medium<br>Large<br>Commercial Small<br>Commercial Large | S1 - small<br>S2 - medium<br>S3 – large<br>S4 – X/large |
| Combustion efficiency | ~15% | ~40% | ~50% |
| Cost in GH₵ | Smaller size: 5-10<br>Medium size:10-25 | Smaller size:16-30<br>Medium size:18-40 | Smaller size:40-45<br>Medium size:50-55 |
| Lifetime | 4 year | 4 year | 4 year |

An assessment of the current ICS market in Ghana, based on discussions with stakeholders in May 2015, reveals the following.

i. The ICS market in Ghana is not regulated. However, UNDP under the SE4ALL program is assisting the Government in developing and enforcing a regulatory framework for the ICS market. Technical standards for ICSs are under development in collaboration with the Ghana Standards Authority to ensure that all cookstoves available on the market are efficient and have low emission levels. A testing, certification and expertise centre has been established at the Kwame Nkrumah University of Science and Technology (KNUST) in Kumasi to conduct tests for efficiency, performance, technical and emission levels on improved cookstoves manufactured or imported into the country. In addition, the Council for Scientific and Industrial Research (CSIR) owns a facility for testing and certification of cookstoves, which serves the cookstoves market in the southern part of the country.

ii. Although the government is supportive of ICS initiatives, funding is not readily available, especially for the working capital requirement for ICS manufacturing. The import duty on sheet metal required for cookstove manufacturing adds to the working capital requirement, as does the value added tax (VAT) on stoves. Due to the high capital costs involved in the manufacture of ICSs, their adoption has been remarkably low. There is also inadequate funding research and development of ICSs.

iii. Although Ghana is home to many ICS manufacturers, still its domestic manufacturing capability as well as its sales and distribution networks needs to be up-scaled for wider adoption of ICSs.

iv. Awareness of the benefits of ICSs is still low among the people. The Global Alliance for Clean Cookstoves (GACC) is working with the Government of Ghana and the Ghana Alliance for Clean Cookstoves (GHACCO) on various targeted awareness raising campaigns. Under the SE4ALL programme, UNDP in collaboration with GHACCO is assisting the Government in conducting these campaigns.

## 2.7 Relevant Stakeholders

A variety of key players ranging from government institutions to the private sector to NGOs and research institutions are involved in the energy sector. Under the purview of NAMA the interventions to be undertaken are ones promoting improved cookstoves (ICS) and widening the use of LPG, solar PV home systems, mini grids and solar lanterns.

Table 2-9 gives an indicative list of the players involved in the Ghana's energy sector who could play a role in these interventions.

### Table 2-9: Institutions in the Energy Sector

| INSTITUTIONS INVOLVED IN PROMOTION OF ICSs IN GHANA | | | |
|---|---|---|---|
| **Ministries/ Regulators** | **Government Institutions** | **NGOs/Research Institutions** | **Private Sector** |
| ■ Ministry of Environment, Science, Technology and Innovation<br>■ Ministry of Power<br>■ Ministry of Finance<br>■ Ministry of Trade & Industry | ■ Energy Commission<br>■ Ghana Statistical Services<br>■ Environmental Protection Agency<br>■ Ghana Standards Authority<br>■ The Council for Scientific and Industrial Research (CSIR) | ■ Kumasi Institute of Technology and Environment (KITE)<br>■ Ghana Alliance for Clean Cookstoves<br>■ Kwame Nkrumah University of Science and Technology (KNUST)<br>■ SE4All Secretariat | ■ Toyola Energy Limited<br>■ Man & Man Enterprise<br>■ Cookclean Ghana Limited<br>■ Anomena Ventures<br>■ Gyapa Enterprise |
| **INSTITUTIONS INVOLVED IN PROMOTION OF LPG IN GHANA** | | | |
| ■ Ministry of Environment, Science, Technology and Innovation<br>■ Ministry of Power<br>■ Ministry of Finance<br>■ Ministry of Trade and Industry<br>■ National Petroleum Authority (NPA) (downstream regulation)<br>■ Petroleum Commission (upstream regulation) | ■ Energy Commission<br>■ Ghana Statistical Services<br>■ Environmental Protection Agency<br>■ Ghana Standards Authority<br>■ The Council for Scientific and Industrial Research (CSIR)<br>■ Ghana National Petroleum Corporation<br>■ (GNPC) | ■ KITE<br>■ Global LPG Partnership<br>■ KNUST<br>■ SE4All Secretariat | ■ Kosmos Energy<br>■ Tullow Oil |
| **INSTITUTIONS INVOLVED IN PROMOTION OF RE IN GHANA** | | | |
| ■ Ministry of Power<br>■ Energy Commission<br>■ Public Utility Regulatory Commission | ■ Volta River Authority<br>■ Bui Power Authority<br>■ Ghana Grid Co<br>■ Electricity Company of Ghana<br>■ Northern Electricity Department | ■ SE4All Secretariat | ■ IPPs |

The detailed roles and responsibilities of entities actively involved in energy development in Ghana are described in the following section.

### 2.7.1 Government Ministries/Departments/Agencies

**The Ministry of Environment, Science, Technology and Innovation (MESTI)**

The Ministry of Environment, Science, Technology and Innovation provides leadership and guidance on the environment, science and technology across the economy through sound policy formulation and appropriate incentives. In addition, it is responsible for establishing a regulatory framework and setting standards to govern scientific and technological activity and the management of the environment for sustainable development; the promotion of activities needed to underpin the standards and policies required for planning and implementation of sound scientific and technological development activities; the initiation, stimulation and coordination of research work, including the continuous development and review of policies, laws, rules and regulations for the environment, science and technology (MESTI, 2012).

**The Ministry of Power (MoP)**

The key role of the Ministry of Power (formerly the Ministry of Energy) is to extend and ensure reliable supply of high quality energy services to all sectors of the economy in an environmentally friendly atmosphere to facilitate productivity and reduce poverty. It plays a vital role in policy formulation for the energy sector (MoE, 2015).

**The Ministry of Finance (MoF)**

The Ministry of Finance is involved in the formulation and implementation of sound fiscal and financial policies, the effective mobilization and efficient allocation of resources and the improvement of public financial management in the cooking sector (MoF, 2015).

**The Ministry of Trade and Industry**

The Ministry of Trade and Industry is responsible for both internal and external trade as well as the promotion of Ghanaian industries (Ministry of Trade and Industry, 2015).

**The National Petroleum Authority (NPA)**

The National Petroleum Authority, instituted under NPA Act 2005 (Act 691), is a statutory body set up by the Government of Ghana to regulate, oversee and monitor the Ghanaian petroleum downstream industry for efficiency, growth and stakeholder satisfaction (NPA, 2015).

**The Petroleum Commission**

The Petroleum Commission is an upstream petroleum regulator, mandated to regulate, manage and co-ordinate all activities in the upstream petroleum industry for the overall benefit and welfare of Ghanaians (Petroleum Commission of Ghana, 2015).

**The Energy Commission**

The functions of the Energy Commission, set up by an Act of Parliament, the Energy Commission Act, 1997 (Act 541) include regulation, management, development and utilization of energy resources in Ghana. The Energy Commission is the technical regulator of Ghana's electricity, natural gas and renewable energy industries, and the advisor to Government on energy matters (Energy Commission, 2015).

**SE4All Secretariat**

The SE4All Secretariat is involved in monitoring and reporting progress towards universal access to sustainable energy sources (African Development Bank Group, 2015).

**Ghana Statistical Services (GSS)**

The Ghana Statistical Services is responsible for the efficient production and management of quality official statistics based on international standards, using competent staff for evidence-based decision-making, in support of national development (Ghana Statistical Services, 2015b).

**The Environmental Protection Agency**

The Environmental Protection Agency, an agency of Ghana's Ministry of Environment, Science Technology and Innovation established by EPA Act 490 (1994), is a regulatory body and a catalyst for change to sound environmental stewardship. The EPA is dedicated to improving, conserving and promoting the country's environment and striving for environmentally sustainable development with sound, efficient resource management, taking into account social and equity issues. It oversees the implementation of the National Environment Policy (EPA, 2015).

**Ghana Standards Authority (GSA)**

The Ghana Standards Authority, formerly the Ghana Standards Board (GSB), is a government agency responsible for the maintenance of acceptable standards for products and services and sound management practices in industries and public institutions in Ghana. The GSA includes the following divisions: Meteorology, Standards, Testing, Certification, Inspectorate, Administration & Organizational Development, and Finance & Corporate Planning. The Authority uses four strategies in performing its functions namely: Metrology, Standardization, Testing and Quality Assurance (MSTQ). It certifies products and runs test training for industries to promote the compliance of industries to the standards set by the Authority. It reviews industry conformity to regulations and calibrates weighing and measuring instruments, such as fuel pumps, and performs physical analysis of products before they can be sold (GSA, 2015).

**The Council for Scientific and Industrial Research (CSIR)**

The Council for Scientific and Industrial Research pursues the implementation of government policies on scientific research and development. It is involved in reviewing, monitoring and periodically evaluating the work of the institutes administered by the Council (CSIR, 2015).

**The Ghana National Petroleum Company (GNPC)**

The Ghana National Petroleum Company is the state agency responsible for petroleum exploration, licensing and distribution in Ghana. It promotes the training of Ghanaians in petroleum-related activities and ensures environmental protection in this field (GNPC, 2015).

**The Public Utilities Regulatory Commission (PURC)**

The Public Utilities Regulatory Commission is a fully independent body established under the Public Utilities Regulation Act (Act 538) responsible for regulating electricity and gas tariffs and enforcing the customer

service obligations of all public utilities. Under the Energy Commission Act 1997 (Act 541), PURC is also required to approve charges for the supply, transmission and distribution of electricity and the wholesale supply and transmission of natural gas, as well as the bulk storage and transportation of petroleum products. PURC's regulatory responsibilities for public utilities are to:

- provide guidelines on rates chargeable for utility services;
- examine and approve tariffs charged by public utilities;
- protect the interests of consumers and providers of public utility services;
- monitor the standard of performance of these utilities;
- receive and investigate complaints and settle disputes between consumers and public utilities;
- promote fair competition among service providers in electricity and water (PURC, 2015).

**The Volta River Authority (VRA)**

The Volta River Authority was established on 26 April 1961 under the Volta River Development Act (Act 46 of the Republic of Ghana). Its core responsibilities include the generation and supply of electrical energy based on hydro (the main source), thermal and solar plants for industrial and commercial use in the local and export markets (VRA, 2015).

**The Bui Power Authority (BPA)**

The Bui Power Authority was established by the Act of Parliament, BPA Act 740, 2007 with a mandate to plan, execute and manage the Bui hydroelectric project, which covers:

- generation of electrical power for general industrial and domestic use;
- the construction of a transmission system linked to the national grid; and
- the supply of electrical power to certified and licensed utility companies (BPA, 2015).

**The Electricity Company of Ghana (ECG)**

The Electricity Company of Ghana is a public electricity distribution company under the Ministry of Power, responsible for distributing electricity in the southern part of Ghana (including the Ashanti, Central, Eastern, Greater Accra, Volta and Western regions) (ECG, 2015).

**The Northern Electricity Distribution Company (NEDCo)**

The Northern Electricity Distribution Company is a wholly owned subsidiary of VRA responsible for the distribution of electricity in the northern part of Ghana (including the Northern, Upper West, Upper East, Brong-Ahafo, Sunyani and Techiman regions) (NEDCo, 2015).

**The Ghana Grid Company (GRIDCo)**

The Ghana Grid Company established in accordance with the Energy Commission Act, 1997 (Act 541) and the Volta River Development (Amendment) Act, 2005 (Act 692), was incorporated on 15 December 2006 as

a private limited liability company under the Companies Code, 1963 (Act 179) and became operational on 1 August 2008. Its main responsibilities include:

- undertaking the economic dispatch and transmission of electricity from wholesale suppliers (generating companies) to bulk customers (which include the Electricity Company of Ghana (ECG), the Northern Electricity Department (NED) and the mines);
- providing fair and non-discriminatory transmission services to all power market participants;
- acquiring, owning and managing the assets, facilities and systems required to transmit electrical energy;
- provide metering and billing services to bulk customers;
- carrying out transmission system planning and implementing necessary investments to provide the capacity to reliably transmit electric energy; and
- managing the wholesale power market (GRIDCo, 2015).

### 2.7.2 NGOs/Research Institutions

**Kumasi Institute of Technology and Environment (KITE)**

The Kumasi Institute of Technology and Environment (KITE) is a Ghanaian NGO committed to the development of technological capabilities for sustainable energy and industrial development, in harmony with the environment. It has a mission to influence policy formulation and implementation in favor of sustainable development through research, capacity building, project development and implementation in the areas of energy, technology and environment (KITE, 2015).

The organization pursues programmes in five thematic areas:

- The Rural Energy Supply and Utilization Programme (RESUP), which focuses on the sustainable production and utilization of energy, the identification of alternative energy feedstocks and improved conversion technologies;
- The Energy and Productivity Programme (EPP);
- The Energy and Environment Programme (EEP);
- Clean Energy and Technology Investment Programme (CETIP); and
- The Knowledge Management and Advocacy Programme (KMAP).
- The Ghana Alliance for Clean Cookstoves (GHACCO)

The Ghana Alliance for Clean Cookstoves (GHACCO) is a non-profit organization operating with the support of the United Nations Foundation. Its main focus is on improving health and the environment through encouraging changes in cooking methods and the types of stoves used in developing countries to pollute less and reduce indoor air pollution. The Ghana Alliance for Clean Cookstoves aims to strengthen local actors working in the cookstoves sector, help the Government to achieve its renewable energy policy and

climate change programme goals, and increase consumer awareness of the importance of fuel efficient and clean cookstoves. The Alliance could play a decisive role in providing support and ensuring effective implementation of cookstoves programmes in Ghana (GHACCO, 2015).

**The Global LPG Partnership**

The Global LPG Partnership (GLPGP) was set up to effect the transition of 1 billion persons in developing countries from solid fuels to LPG on a sustainable basis, by 2030, with an estimated US$12-15 billion of cumulative investment in order to:

- substantially reduce the 4 million deaths caused annually by cooking with solid fuels;
- substantially reduce the rampant deforestation caused by cooking with solid fuels;
- reduce the waste of human labour due to the time spent on gathering biomass for fuel; and
- provide affordable access to modern energy as part of the transition to a sustainable future.

GLPGP is partnering with the government and the private sector to plan and implement US$200 million of coordinated reforms, interventions and investments to transition 4 million users to a new, scalable and sustainable national LPG system and to create at least 7 million new LPG users within six years (GLPGP, 2014).

**Kwame Nkrumah University of Science and Technology (KNUST)**

Kwame Nkrumah University of Science and Technology (KNUST) is the largest public university in the country. It is located in Kumasi Metropolis in Ashanti region (KNUST, 2015). A testing, certification and expertise centre has been established at KNUST to conduct tests for efficiency, performance, technical and emission levels on improved cookstoves manufactured or imported into the country.

### 2.7.3 Private Sector Entities

**Independent Power Producers (IPPs)**

Independent Power Producers (IPPs) have begun to come into the electricity generation market. Wholesale Electricity Supply Licences have been issued to the following Independent Power Producers (IPP) to construct and operate thermal plants in Ghana:

- Takoradi International Company (TICo)—90 per cent owned by the Abu Dhabi National Energy Company and 10 per cent owned by the Volta River Authority, it was the first IPP to be established in Ghana (capacity: 330 MW;
- The Sunon Asogli power plant—owned by the Shenzhen Group of China (capacity: 200 MW); and
- The Tema Cenit Thermal Power Plant (TCTPP)—owned by CENIT Energy, a subsidiary of the Social Security and National Insurance Trust (SSNIT) (capacity: 126 MW)

**Toyola Energy Limited**

Toyola Energy Limited is a private energy efficient stove manufacturer focused on profitably serving Ghana's urban poor and low income rural households. They have run an ICS programme since 2007. Toyola Energy, along with E+CO, SNV and KITE, trains and pre-finances ceramicists, producers, marketers and end users to disseminate the Toyola Coalpot stove to urban and rural communities in Ghana. It received funding from E+CO in 2007 to help finance its Gold Standard carbon finance programme (Toyola Energy Limited, 2015).

**Man & Man Enterprise**

Man & Man Enterprise is responsible for the product development, manufacturing and marketing of the energy efficient charcoal stove, the Holy Cookstove, mainly in Accra and Kumasi. The organization trains local men and women across the value chain (GHACCO, 2015).

**CookClean Ghana Limited**

CookClean Ghana Limited is a social entrepreneurship with a mission to improve social, environmental and economic conditions for low income families. Founded in 2010, it has developed an ICS tailored to the Ghanaian market, the CookMate. The organization employs local women to directly distribute the stoves and has applied to the Gold Standard for registration in their carbon finance programme (Cook Clean Ghana Limited, 2015). About 50,000[2] stoves till date have been manufactured and sold by the organization in Ghana.

**Anomena Ventures**

Anomena Ventures is a private enterprise, registered in 2004, which is committed to improving the health, livelihood and quality of life of Ghanaians by increasing access to clean and efficient energy technologies to households, institutions, street food vendors and communities by seeking to promote access to clean energy. Its ICS programme focuses on distributing LPG stoves for street vendors in Northern Ghana. Its other activities include: awareness creation workshops, rural appraising methods to gather data on the perception and use of LPG, training on safe use of LPG appliances, and a pilot micro-finance scheme that has enabled some women to purchase gas cylinders and stoves (Anomena Ventures, 2015).

**Gyapa Enterprise**

Gyapa Enterprise is a private energy efficient stove manufacturer focused on marketing and distributing high-impact alternative technologies to low-income households across Ghana and West Africa. Among the products it manufactures is the Gyapa Fuel-Efficient Cookstove (Gyapa Enterprises, 2015).

2 According to market information collected through stakeholder consultation in May 2015.

**Kosmos Energy**

Kosmos Energy is an oil and gas exploration and production company. It is involved in the discovery and development of the Jubilee oilfield off the coast of Ghana and has LPG loading facilities (Kosmos Energy, 2015).

**Tullow Oil**

Tullow Oil is an oil and gas exploration and production company (Tullow Oil Company, 2015). Its current downstream activities include refinement of crude as well as the bulk and retail distribution of different petroleum products, including LPG, premium gasoline, kerosene, gas oil, residual fuel oil, and premix.

**Financial Institutions/Development Partners**

Financial Institutions like Fidelity Bank, GH Bank Ghana, Ghana Commercial Bank and Energy Bank would be essential sources for the mobilization of private sector funds for NAMA projects. In addition development partners are prospective providers of foreign funds to support NAMA implementation, some already having done so.

### 2.7.4 Barriers Facing the Energy Sector

The energy sector of Ghana faces a number of barriers. If these barriers persist, Ghana's commitment to improve access to clean energy through establishment of market-based solutions will not be carried out. As part of the stakeholder consultation, these barriers were identified. The barriers identified are broken down into categories—financial, regulatory, market-related, technological, and consumer awareness and outreach—in Table 2-10.

**Table 2-10: Barriers Faced by the Energy Sector**

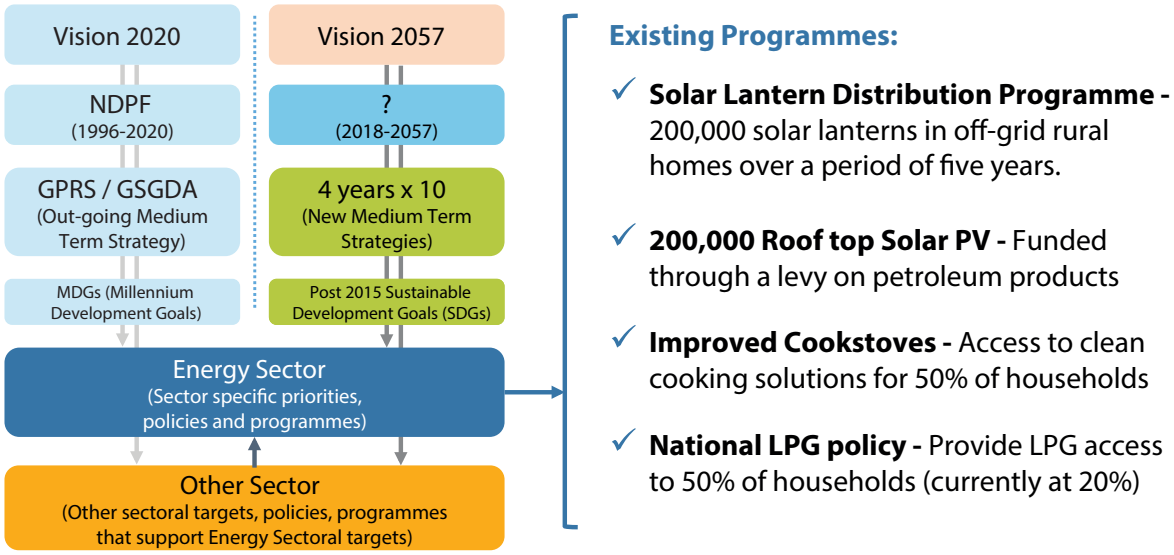
| | |
|---|---|
| Financial | ■ High cost of solar PV components.<br>■ Higher cost of ICSs compared with traditional cookstoves.<br>■ High interest on loans preventing cookstove manufacturers from scaling up their business and reaching greater production numbers, inhibiting their growth.<br>■ High import duties on materials such as sheet metal used in ICS manufacture preventing larger production scale.<br>■ Poor access to finance. Banks are not willing to give loans to individual investors in PV because of lack of confidence in the viability of the technology. Even when banks are willing, affordability remains an issue due to banks charging higher-than-usual interest rates. In addition, the loan application process is complex, raising overhead costs for installing PV systems. |
| Regulatory | ■ Inefficient LPG cylinder management and lack of standards on LPG cylinders, raising safety concerns regarding storage and use of LPG.<br>■ Lack of technical and quality control standards and inadequate testing and monitoring mechanisms, resulting in poor quality cookstoves with low performance and low durability.<br>■ Lack of technical standards for solar PV components and systems.<br>■ Market is flooded by low-quality products from the informal market, which hampers business in the formal market, as reported by the Association of Ghana Solar Industries. |

| | |
|---|---|
| Market-related | ■ Limited support to strengthen and expand local manufacturing of ICSs and limited variety of proven quality ICSs catering to the needs of different local consumer segments.<br>■ Inadequate supply of LPG to meet increasing demand, including inadequate storage, filling and distribution infrastructure, with an overconcentration of distribution outlets in regional capitals and major urban settlements (especially in Southern Ghana).<br>■ LPG is unaffordable for and inaccessible to rural populations.<br>■ The small size of most of the private enterprises operating in the lighting sector could prove to be a constraint in scaling up the market because of an absence of needed investment and their inability to gain access to credit.<br>■ Markets for PV in residential and commercial buildings are fragmented and limited in scale, contributing to a higher cost per watt of capacity.<br>■ There is a limited number of outlets selling solar PV components. |
| Technological | ■ Limited technology transfer and diffusion of technical knowhow in manufacturing of renewable energy (RE) and clean cooking (CC) technologies.<br>■ Solar PV components (such as batteries, lamps, and regulators) are in short supply in the local market.<br>■ Lack of technicians trained in the manufacture, operation and installation of solar PV systems. |
| Consumer Awareness and Outreach | ■ Low education, awareness and understanding of the health and economic risks related to the use of traditional cookstoves.<br>■ Limited outreach efforts to existing and potential consumers (on benefits and safety). |

# 3 POLICY ANALYSIS

A review of the policy environment in Ghana relevant to the proposed NAMA is presented in this section. There are several initiatives which are aligned with the energy sector as a whole (Figure 3-1).

**Figure 3-1: Energy Sector Policies and Programmes**




There have also been many initiatives and regulatory and financial instruments specifically aimed at the energy sector with varied degrees of success. They throw some light on what local capacity to implement this NAMA.

The following initiatives were reviewed in Section 2.5 of the report:

- Ghana's Vision 2020
- Ghana's Vision 2057
- Ghana Shared Growth and Development Agenda (GSGDA)
- The Millennium Development Goals (MDGs)
- The Sustainable Development Goals (SDGs)
- Ghana's Intended Nationally Determined Contribution (INDC)

The following NAMA specific policies and initiatives are reviewed in this section.

- The Ghana National Climate Change Policy (NCCP) — an umbrella programme ensuring a climate-resilient and climate-compatible economy while achieving sustainable development through equitable low carbon economic growth.
- The National Energy Policy (NEP) — sets a target of 10 per cent of total energy supply coming from renewable energy sources by 2020.
- The Ghana Shared Growth and Development Agenda (GSGDA-II) — the most recent medium term strategy in Ghana.
- The Ghana Sustainable Energy for All Action Plan (SE4ALL) — sets the target of achieving universal access to modern forms of energy by 2030.
- The National Policy of LPG Promotion—aims to provide 50 per cent of Ghanaians access to LPG by 2020.
- The Strategic National Energy Plan (SNEP)—sets woodfuel and LPG related targets to be achieved by 2020..
- The National Electrification Scheme (NES)—sets a target of 100 per cent electrification by 2020.
- The Renewable Energy Act 2011 (Act 832)—envisages different policy instruments, such as feed-in tariffs (FIT), a Renewable Energy Fund and tax exemptions, to encourage use of renewable energy sources.
- Ghana Energy Development and Access Project (GEDAP).
- Solar Lantern Distribution Programme.
- 200,000 Solar Rooftop Programme.
- SWITCH Africa Green (SAG) project.
- Scaling-up Renewable Energy Program in Ghana (SREP) Investment Plan.

## 3.1 Relevant National and Sector Strategies and Policies

This section gives an overview of each of the policies and regulations mentioned above.

### 3.1.1 The Ghana National Climate Change Policy (NCCP)

The National Climate Change Policy was developed under the aegis of the National Climate Change Committee (NCCC), with technical guidance from EPA and MESTI. The NCCP was accepted by the GoG Cabinet in 2013 and was formally launched by the President in 2014.

The NCCP divides Ghana's policy response to climate change into three phases. Phase 1 covered the process of producing the NCCP document (which is currently being reviewed). Phase 2 will result in the presentation in greater detail of the initiatives and programmes identified in the NCCP in the form of an action programme for implementation. Finally, Phase 3 of the NCCP will detail out how the climate change programmes and actions identified in Phase 2 can be mainstreamed and embedded, in a time-bound and budgeted manner, in the annual work plans of implementing units (MESTI, 2014). As of April 2014, a draft six-year implementation schedule for the NCCP had been established (Sova and others, 2014). NCCP envisages ensuring a climate-resilient and climate-compatible economy while achieving sustainable development through equitable low carbon economic growth for Ghana. The focus is on low carbon growth, effective adaptation to climate change and social development.

### 3.1.2 The National Energy Policy (NEP)

The National Energy Policy outlines the Government's policy direction for the energy sector. It was adopted in 2010. The policy envisages Ghana becoming a net exporter of oil and power by 2012 and 2015 respectively. (Ministry of Energy, 2010).

The following policy actions, relevant to this NAMA, are envisaged under the NEP.

- Support for sustained regeneration of woody biomass resources through legislation, fiscal incentives and attractive pricing.
- Promoting the establishment of dedicated woodlots for woodfuel production.
- Promoting the production and use of improved and more efficient biomass utilization technologies, such as improved cookstoves.
- Promoting the use of alternative fuels such as LPG as substitutes for fuel wood and charcoal by addressing the institutional and market constraints that hamper increasing access to LPG in Ghana.
- Introducing taxes and levies on woodfuels to promote alternative fuels such as LPG.
- Improving the cost-effectiveness of solar technologies.
- Creating favourable regulatory and fiscal regimes.
- Supporting indigenous research and development to reduce the cost of solar energy technologies.

- Supporting the use of decentralized off-grid alternative technologies (such as solar PV) where they are competitive with conventional electricity supply.

The NEP is Ghana's most significant framework policy for the development of renewable energy technologies. In the NEP, the Government set an ambitious target of deriving 10 per cent of total energy supply from renewable technologies by 2020.

### 3.1.3 Ghana Sustainable Energy for All Action Plan (SE4ALL)

Globally Sustainable Energy for All (SE4All) works globally to extend energy's reach with the goal of ensuring universal access to modern energy services by 2030. In Ghana, the SE4ALL Action Plan was adopted in 2012 and runs to 2030. Relevant to this NAMA, the SE4ALL in Ghana outlines actions to ensure access to modern energy for cooking, particularly the promotion of LPG and improved cookstoves. There exists an inbuilt evaluation scheme within the action plan.

The main objective of Ghana SE4All Action Plan in Ghana is to ensure universal access to modern energy for cooking (through the promotion of LPG and improved cooking stoves) (Energy Commission/SE4All/UN, 2012).

### 3.1.4 The National Policy of LPG Promotion

The fundamental goal of the National Policy of LPG promotion is to ensure that at least 50 per cent of Ghanaians have access to safe and environmentally friendly LPG for commercial, industrial and domestic use by 2020. The policy sets out measures and actions to develop a safe, standard and market based structure for LPG with the adoption of the cylinder recirculation model as the basis for marketing domestic LPG.

### 3.1.5 The Strategic National Energy Plan (SNEP)

In 2006, the Energy Commission published the Strategic National Energy Plan, a policy document that defined the role of various energy sources, setting targets for each within a 15-year span with strategic targets for both energy demand and supply. The plan seeks to identify the optimal path for the development, use and efficient management of the country's energy resources (Energy Commission, 2006).

**Residential Consumption Targets**

- To reduce the average woodfuel energy intensity per urban household by 30 per cent by 2015 and by 50 per cent by 2020.
- To reduce woodfuel intensity per rural household by 10 per cent by 2020.
- To achieve universal electrification nationally by 2020.
- To achieve 15 per cent penetration of rural electrification by decentralized renewable energy complementation by 2015, expanding to 30 per cent by 2020.
- To reduce the average electricity intensity per urban household by 50 per cent by 2020.

- To introduce energy efficiency measures that can free about 5,000 GWh nationwide by 2015 expanding to about 8,000 GWh by 2020.

**Commercial and Services Consumption Targets**

- To increase LPG penetration by 20 per cent by 2015 and 30 per cent by 2020.
- To curtail woodfuel's share of energy at 50 per cent by 2015 with a subsequent reduction to 40 per cent by 2020.
- To achieve 5 per cent penetration in the use of improved efficiency cookstoves by 2015 and 10 per cent penetration by 2020.
- To achieve 1 per cent penetration of biogas for cooking in hotels, restaurants and institutional kitchens by 2015 and 2 per cent by 2020.
- To achieve 1 per cent penetration of solar energy in hotels, restaurants and institutional kitchens using solar water heaters by 2015 and 5 per cent penetration by 2020.
- To reduce electricity consumption in military and police barracks, residential halls and the hostels of public tertiary institutions by 50 per cent by 2015.

**Supply Side Targets**

- To reduce the wood intensity of charcoal production (ratio of wood input to charcoal) from the existing 4:1 to 3:1 in the savannah zone and from 5-6:1 to 4:1 in the forest zone by 2015.
- To ensure that the share of traditional biomass in the national final energy mix is reduced from about 60 per cent to at most 50 per cent by 2015 and to 40 per cent by 2020.
- To increase the supply of renewable energy and modern biomass in the Ghanaian final energy supply to achieve at least 10 per cent penetration by 2020.

### 3.1.6 The National Electrification Scheme (NES)

The National Electrification Scheme (1989) instituted by the Ministry of Energy (now the Ministry of Power) sets the target of achieving 100 per cent electrification by 2020 by expanding electricity supply to all communities with population of more than 500 inhabitants. The NES also supported research and development in the field of renewable energies, and promotes renewable rural systems mainly wind, solar, biogas, and small and mini hydro.

### 3.1.7 The Renewable Energy Act 2011 (Act 832)

The Renewable Energy Act of Ghana formulated in 2011 aims to provide for the development, management, utilization, sustainability and adequate supply of renewable energy. The act aims at stimulating massive investment in the renewable energy sector through feed-in tarrifs (FiTs), a renewable energy purchase

obligation (RPO), connection of renewable energy systems to the distribution and transmission systems;and the promotion of biofuels. The Act establishes the legal basis for the creation of the support programmes for deployment of renewable energy sources such as feed-in tariffs and net metering. The Act provided for the establishment of a Renewable Energy Fund (which is yet to be capitalized) to supply financial resources for the promotion, development, sustainable management and utilization of renewable energy sources (Energy Commission, 2011).

### 3.1.8 The Ghana Energy Development and Access Project (GEDAP)

Ghana Energy Development and Access Project (GEDAP) is a co-operative project to improve electricity sector performance, undertaken by the Ghanaian government and a set of international institutions, the World Bank's International Development Agency (IDA), the Global Environment Facility (GEF), the African Development Bank (AfDB), the Global Partnership on Output-Based Aid (GPOBA), the Africa Catalytic Growth Fund (ACGF) and the Swiss Agency for Development and Cooperation (SECO). It began in 2007 and was initially to run until 2015. One component of the project was to promote mini grids and grid-connected renewable energy systems as well as off-grid electrification using solar PV systems (Ministry of Energy, 2007).

Initial funding for the programme was US$235 million. In 2010 the World Bank agreed to provide additional funding of US$70 million to the Electricity Company of Ghana (ECG) under the programme (The World Bank, 2010).

### 3.1.9 The Solar Lantern Distribution Programme

The Government began distributing solar lanterns through the then Ministry of Energy (now the Ministry of Power) to rural off-grid communities to replace kerosene lanterns in 2013, in an attempt to mitigate the effect of the partial removal of subsidies on fuel on the rural poor.

The programme aims to provide 200,000 solar lanterns in off-grid rural homes over a period of five years. The solar lantern distribution project was to be implemented in three phases (Ministry of Petroleum, 2013).

- The first phase targeted remote communities on island and lakeside communities with no access roads over a period of 18 months (January 2013-June 2014). During this phase, a total of 20,000 high quality solar lanterns of two different models were distributed nationwide through a trade-in or subsidy scheme. That is, households in the target communities were required to turn in their kerosene lanterns or pay a subsidized fee in cash for the solar lanterns.

- The second phase of the project spans a period of two years (July 2014-June 2016), during which support is to be given to establishing the local assembly of solar lanterns. A total of 50,000 solar lanterns are to be assembled and distributed through a 50 per cent grant subsidy package to ensure a sustainable market for solar lanterns in the country. The project is to use commercial mass media and social marketing concepts to create a critical mass of demand and awareness of solar lanterns.

- The third phase, which spans a period of 18 months, will see the distribution of 130,000 solar lanterns with a reduced subsidy. During this phase, the project will continue to include capacity-building and awareness-raising activities so as ensure that the market for the product is sustained.

### 3.1.10 The 200,000 Solar Rooftop Programme

In an effort to contribute to solving the current power crisis, in 2015 the Energy Commission, with its mandate to promote the development and use of the country's renewable energy resources, launched the 200,000 Rooftop Solar Programme, which aims to install 200,000 solar PV systems on rooftops across the country.

The specific objectives are to:

- deploy up to 200,000 solar systems in the residential, public, commercial and industrial sectors by 2016;
- deploy up to 100,000 solar systems in the residential, public, commercial and industrial sectors in 2015;
- shave off up to 200 MW of peak load at the completion of the programme in 2016;
- reduce market information barriers; and
- build capacity in stakeholder institutions, including commercial banks, vendors and service providers, to manage implementation of the programme.

### 3.1.11 The SWITCH Africa Green (SAG) project

The SWITCH Africa Green (SAG) project is implemented by United Nations Environment Programme (UNEP) in collaboration with United Nations Office for Project Services (UNOPS) and the United Nations Development Programme (UNDP) and with funding from the European Union. The overall objective of SWITCH Africa Green is to support six countries in Africa (Burkina Faso, Ghana, Kenya, Mauritius, South Africa and Uganda) to achieve sustainable development by making the transition to an inclusive green economy, based on sustainable consumption and production (SCP) patterns, while generating growth, creating decent jobs and reducing poverty. The objective will be achieved primarily through support to private sector led inclusive green growth (Switch Africa Green, 2015).

### 3.1.12 Scaling-up Renewable Energy Program (SREP)

The Scaling-up Renewable Energy Program's objective is to assist the Government of Ghana in meeting its 10 per cent renewable energy target by 2020, as well as its universal electrification goal, through the implementation of flagship renewable energy investments that would provide models for scaling-up and leveraging additional private and public financial resources for the country's RE sector (SREP Investment Plan for Ghana, 2015). Ghana's SREP Investment Plan comprises the following four project components:

RE mini-grids and stand-alone solar PV systems: construction of 55 renewable energy-based mini-grids and 35,250 stand-alone PV electrification systems installed in 500 rural communities.

Solar PV based net metering with battery storage: installation of 15,000 solar PV net metering systems.

Utility-scale solar PV/wind power generation: providing finance for Ghana's first private sector utility-scale wind and solar plants that are expected to leverage substantial investments from the private sector.

Technical assistance to scale-up RE: capacity-building for key renewable energy players and policy support to the Government of Ghana.

## 3.2 National Policies: Observations and Gaps

This section provides an overview of observations/gaps in the policies described in earlier sections which are relevant to the sector. The gaps, if addressed, will facilitate the development of a supportive framework for the sector (Table 3-1).

**Table 3-1: Policy: Observations and Gaps**

| Policy | Observations/Gaps |
|---|---|
| Ghana National Climate Change Policy (NCCP) | Ghana's NCCP provides a broad overview of climate change issues and of interventions to tackle them. However, it does not give specific emphasis to the modern energy service sector. This policy document highlights a variety of interventions needed to address the myriad climate change challenges. The timelines, however, for these interventions are not been explicitly laid out. Also, there are no clear goals and targets provided in the policy document. In addition, there is no mention of any plans for evaluating outcomes or details on data collection, reporting and implementation mechanisms. |
| National Energy Policy (NEP) | Although the policy calls for the adoption of LPG and ICSs for cooking, targets are missing in the document. Evaluation and data collection or reporting mechanisms are missing from the NEP. |
| Ghana Shared Growth and Development Agenda (GSGDA-II) | Based on the precursor framework, GSGDA I (2010-2013), the GSGDA II builds on its predecessor, drawing lessons from its successes and challenges to improve overall development management, and is the operational framework of the President's Coordinated Programme of Economic and Social Policies, 2014-2020 (Republic of Ghana, 2014).[4] Thus, this is one of the recent guidance documents which provides a supportive framework for the proposed NAMA interventions. No major gaps identified. |
| Ghana Sustainable Energy for All Action Plan (SE4ALL) | The document gives targets and an action plan for increasing access to modern energy for cooking, particularly through the promotion of LPG and improved cookstoves in Ghana. However, performance indicators to track the success of the policy against the listed goals and targets are not defined. A well defined implementation mechanism to encourage the adoption of the policy and for achieving its specific goals and targets has not been clearly spelt out. |
| National Policy on LPG Promotion | This policy document outlines various interventions to promote the use of LPG. However, the timelines for the interventions have not been explicitly laid out. Also there are no details on implementation mechanisms or an evaluation methodology for tracking progress. |
| Strategic National Energy Plan (SNEP) | This is a well defined policy document giving detailed information on all the parameters given above (including timelines and implementation mechanisms) except for an evaluation scheme. No major gaps identified. |

3 The President's Coordinated Programme of Economic and Social Policies, 2020-2014 was submitted to Parliament in December 2014 in fulfilment of Article 36, Section 5 of the Constitution, which requires him to present such a programme within two years of beginning his term of office.

| Policy | Observations/Gaps |
|---|---|
| National Electrification Scheme (NES) | National Electrification Scheme (NES) is a well defined programme document, which contains an implementation schedule, and refers to the key actors involved and sources of finance. However, the document does not discuss evaluation mechanisms. NES aimed at connecting all communities with a population above 500 in 1989 to the national grid. At that time there were 4,221 communities in Ghana that had a population higher than 500, of which only 478 had access to electricity. The electrification rate in Ghana had risen to 72 per cent by 2010. No major gaps identified. |
| The Renewable Energy Act 2011 (Act 832) | The Act does not spell out the goals and targets for the energy sector. Nor does it have any evaluation scheme or defined mechanisms for data collection or reporting. Although implementation of the Act would lead to many sustainable sustainable development benefits, the Act itself does not mention any targeted sustainable development benefits. The Renewable Energy Fund envisaged under the Act is not yet capitalized and operational. |
| Ghana Energy Development and Access Programme (GEDAP) | No evaluation scheme or data collection mechanisms are defined in the programme. |
| Solar Lantern Distribution Programme | Only recently started (in 2013), the programme aims to distribute 200,000 solar lanterns to off-grid rural homes over five years. No gaps have been identified. |
| 200,000 Solar Rooftop Programme | This policy document targets the deployment of up to 200,000 solar systems in the residential, public, commercial and industrial sectors by 2016. No major gaps identified. |
| SWITCH Africa Green (SAG) project | The project supports the development of green businesses and eco-entrepreneurship and provides enabling conditions in form of clear policies, sound regulatory frameworks, incentives structures, tax, and other fiscal and market-based instruments. |
| Scaling-up Renewable Energy Program (SREP) | It is envisaged that previous and ongoing efforts by the Government to develop the RE sector and build the capacity of Ghanaian players in the sector. In addition, the programme will ensure effective implementation of newly instituted policy, regulatory measures and incentives to accelerate RE deployment across the country; and replicate innovative approaches that have proved successful in stepping up RE dissemination in Ghana. |

## 3..3 NAMA Alignment with National and Sectoral Strategies and Policies

This section describes the relationship between the NAMA's objectives and the national strategies and polices as set out in Section 3.1 (Table 3-2).

### Table 3-2: NAMA Alignment with National and Sectoral Strategies and Policies

| NAMA objectives | National strategies and policies |
|---|---|
| Establish an enabling environment for the private sector to participate in the manufacture and distribution of clean energy solutions. | The Ghana National Climate Change Policy lays emphasis on how to leverage private sector investment into climate-change-proof social and physical infrastructure, such as low-emissions electricity generation, the use of renewable energy as a means of promoting energy access and enhancing energy efficiency. Also, the policy describes opportunities that exist for the private sector, such as for product and service innovation and diversity; technology adaptation and access; the potential benefits to companies from addressing climate change. |
| Establish an enabling environment for the private sector to participate in the manufacture and distribution of clean energy solutions. | Promotion and encouragement of private sector participation in the energy sector is one among the ten policy objectives mentioned in the National Energy Policy document to achieve the goal of "making energy services universally accessible and readily available in a sustainable manner". The policy document also emphasizes that it is essential to create an environment conducive to private investment in the sector.<br><br>The Sustainable Energy For All Action Plan notes the absolute need for private sector participation in energy infrastructure development and service delivery to ensure the long-term sustainability of projects. The policy document also proposes that the Government support the private sector in providing decentralized renewable energy systems for individual and commercial needs.<br><br>The Ghana Shared Growth and Development Agenda II is the most recent medium-term national development policy framework which serves as a guide to the formulation of medium-term and annual development plans and budgets at sector and district levels. It seeks to ensure enhanced competitiveness in Ghana's private sector.<br><br>The Sustainable Development Goals' targets include encouraging innovation, enhancing the number of scientific research and development workers per one million people, and upgrading technological capabilities through public-private partnerships (Goal 9, Target 9.5 and Goal 17, Target 17.7).<br><br>The Solar Lantern Programme aims at promoting a sustainable approach carried out by and with equity from the private sector based on a system of incentives that assures a fair return to private participants while minimizing government subsidies.<br><br>The Scaling-up Renewable Energy Program in Ghana will catalyse strong private sector engagement. Specifically, the programme will result in private sector investment in stand-alone solar PV systems to benefit 33,000 households, 1,350 schools, 500 health centres and 400 communities. |

| NAMA objectives | National strategies and policies |
|---|---|
| Create an enabling market environment that encourages distribution of clean energy solutions by end-users supported by an appropriate financing model. | The Ghana Energy Development and Access Programme has stimulated the market for off-grid systems. The project's objectives include the introduction of new financing systems and institutions to encourage the development of small, private energy businesses and make electricity access more affordable to consumers.<br><br>The Strategic National Energy Plan aspires to develop a sound energy market that provides adequate, viable and efficient energy services. It notes that the involvement of private finance in the energy sector is becoming increasingly important globally. The plan identifies the need, therefore, to create an energy policy or identify business models that can effectively attract and channel funding so as to ensure the achievement of overall national policy objectives.<br><br>The National Policy of LPG Promotion describes measures and actions to develop a safe, standard and market-based structure for LPG in order to allow at least 50 per cent of Ghanaians to have access to safe and environmentally friendly LPG for commercial, industrial and domestic use by 2020. The policy aims at the adoption of the cylinder recirculation model as the basis for marketing domestic LPG. |
| Create an enabling market environment that encourages distribution of clean energy solutions by end-users supported by an appropriate financing model. | Ghana Shared Growth and Development Agenda II seeks to create an environment conducive to boosting investment, enhancing the competitiveness of industry and trade, and putting the economy on a growth path that creates jobs.<br><br>There are many sector working groups (as mentioned in the Ghana National Climate Change Policy), led by the Government, which provide a platform for the coordination of development assistance and the alignment of that assistance with national priorities. This ensures that international support for climate finance, programmes and projects preserves Ghana's strong relationship with donors and fosters synergies with international institutions and programmes.<br><br>The National Energy Policy sets out policy directions likely to encourage the capital markets, including the Ghana Stock Exchange, to raise finance for investment in the energy sector.<br><br>The Renewable Energy Act provides for the establishment of a Renewable Energy Fund to provide financial resources for the promotion, development, sustainable management and utilization of renewable energy sources. In addition, the Act aims to stimulate large-scale investment in the renewable energy sector.<br><br>Targets of the Sustainable Development Goals include increasing the access of small-scale industrial and other enterprises to financial services, including affordable credit, and their integration into value chains and markets; improving the regulation and monitoring of global financial markets and institutions; and ensuring sustainable consumption and production patterns by rationalizing inefficient fossil fuel subsidies that encourage wasteful consumption (Goal 9, Target 9.3; Goal 10, Target 10.5 and Goal 12, Target 12c). The SDGs also target the mobilization of additional financial resources through the revitalization of global partnerships (Goal 17, Target 17.1 and Target 17.3). |

## 3.4 National Targets

The interventions and measures proposed under the NAMA (in Chapter 5) are fully in line with Ghana's national targets (Table 3-3) for renewable energy and clean cooking solutions.

**Table 3-3: Ghana's National Targets for Renewable Energy and Cooking Solutions**

| National Targets | Policy/programme |
|---|---|
| **Renewable energy technologies** | |
| 200,000 solar systems (200 MW) by 2020 | 200,000 Solar Rooftop Programme |
| 200,000 solar lanterns distributed by 2020 | Solar Lantern Distribution Programme |
| 55 mini grids (10 MW) by 2020 | SREP Investment Plan for Ghana (Climate Investment Funds) |
| **Clean cooking technologies** | |
| 2 million households supplied with ICSs by 2020 | Strategic National Energy Plan |
| 1,000 commercial cookstoves supplied by 2020 | Strategic National Energy Plan |
| LPG penetration of 50 per cent of households by 2020 | National Policy of LPG Promotion |

# 4 BASELINE INFORMATION AND NAMA TARGETS

## 4.1 The NAMA Boundary

The geographical boundary of the NAMA covers the whole of Ghana. It is targeted at the entire population of Ghana with its various economic needs. The groups defined by these needs have different energy requirements (for cooking, lighting and other household activities) and different levels of ability to pay for goods and services. The proposed intervention under this NAMA will make sure that the right product is made available to the right user group according to an appropriate pricing model. Under the proposed NAMA the following interventions would be implemented.

**Intervention 1:** Establish 28 Energy Productivity Zones (EPZs) in Ghana with their own solar PV based electricity generating plants.

The Energy Productivity Zones (EPZ) would generate clean energy through solar PV based electricity generation plants, whose output would be made available for consumption in the Productivity Zones. The Productivity Zones would be well lit and well ventilated buildings with power supplied to its production rooms, warehouses and workplaces where undertake gainful income generation activity would take place, including in manufacturing and distribution facilities using renewable energy (RE) and clean cooking (CC) technologies which, it is envisaged, would be distributed under Intervention 2. It is proposed to establish PV based power plants with a total capacity of 400kWp in the 28 EPZs.

**Intervention 2:** Distribute "clean energy solutions", funded through consumer finance.

Intervention 2 will facilitate the distribution of the following RE and CC technologies across Ghana

RE technologies:

- Distribution of solar PV based lanterns, totalling 1 million units
- Distribution of solar home systems, totalling 50,000 units

CC technologies:

- Distribution of 1 million improved cookstoves for household use and of 250 units for commercial activities.
- Distribution of LPG cooking solutions totalling to 250,000 units.

Details of the NAMA interventions are provided in Chapter 5.

## 4.2 Baseline Scenario

### 4.2.1 Baseline Scenario for Intervention 1

The baseline is a current or an expected business-as-usual (BAU) scenario. A significant percentage of the population in Ghana is already connected to the national grid but the country persistently faces erratic supplies of electricity. Power failures are of widespread concern among Ghanaians, as demonstrated by the public protests and criticism they inspire. Intervention 1 establishes solar PV based electricity generation plants and connects consumers who, in the business-as-usual scenario, would not be connected to the electricity grid or would be faced with continual power failures. The business-as-usual scenario for Intervention 1 is taken from the Clean Development Mechanism (CDM) approved "Small-scale Methodology: AMS-I.L.: Electrification of rural communities using renewable energy, Version 03.0" (CDM, 2014a). The baseline scenario assumes the use of fossil fuel-based off-grid power generators.

Significant GHG emissions arise from the use of fossil fuels in the baseline scenario of the NAMA Intervention 1. A fossil fuel based off-grid electricity generation system, such as a diesel generator, emits carbon dioxide into the atmosphere. Therefore the generated electricity is directly linked to carbon dioxide ($CO_2$) emissions that can be expressed as the emission factor ($tCO_{2eq}$/MWh).

The baseline scenario must also take into consideration the issue of suppressed demand. To take account of suppressed demand, the baseline may include a scenario where future anthropogenic emissions are projected to rise above current levels, due to the specific circumstances of the host party (UNFCCC, 2012). This principle can be specifically applied to the methodology AMS-I.L.:

"A suppressed demand situation is applicable when a minimum service level[4] to meet basic human needs[5] was unavailable to the end user of the service prior to the implementation of the project activity. Hence, these guidelines are applicable when basic human needs were not met. For example, in the pre-project scenario, households may have had only very few kerosene lamps in place that were only operated for short

4 Defined as a service level that is able to meet basic human needs. In some situations, this service level may not have been provided prior to the implementation of the CDM project activity, indicating suppressed demand with a consequent future emissions increase due to income effect, rebound effect or other technical factors such as limited availability of a service (e.g. connection to a very weak grid) or low quality of a service (e.g. aversion to pollution caused by kerosene lanterns).

5 Defined for the purpose of the guidelines to include physical and physiological needs such as basic housing, basic energy services (including lighting, cooking, drinking water supplyand space heating), sanitation (waste treatment/disposal) and transportation.

time periods, thereby only partially meeting the basic lighting demand of the household" (UNFCCC, 2012).

In the Ghanaian situation, the application of suppressed demand translates into the baseline scenario assuming that all people's basic human needs are met through the use of fossil fuel technologies.

In line with CDM "Small-scale Methodology AMS-I.L and considering the challenges for the NAMA actors of monitoring electricity generation at each facility, the conservative default emission factor of 1.0 $tCO_{2eq}$/MWh is applied as the emission factor for the NAMA Intervention 1.

### 4.2.2 Baseline Scenario for Intervention 2

As noted above, the following technologies are considered under the Intervention 2.

- RE technologies:
  - Solar PV based lanterns
  - Solar PV based home system
- CC technologies:
  - Improved cookstoves for households and commercial activities
  - LPG cooking solutions

The section below presents the baseline scenario for these technologies.

#### *4.2.2.1 RE Technologies*

**Solar PV based lanterns**

Grid electricity is the main source of lighting and in 2012/13 was accessed by seven in ten households (70.6 per cent), compared with the 24.3 per cent who use flashlights (mostly charged by grid electricity), the 3.6 per cent who use kerosene lamps and the 1.5 per cent who use other sources of lighting (such as gas lamps, candles, etc.). Thus, in the absence of the NAMA intervention the primary energy source for lighting would be electricity from the national grid and kerosene. Therefore, the baseline scenario for solar PV based lantern system is taken from following CDM methodologies:

- "Large-scale Methodology AM0113: Distribution of compact fluorescent lamps (CFL) and light-emitting diode (LED) lamps to households -Version 1.0" (CDM, 2013a);
- "Small-scale Methodology AMS-II.J.: Demand-side activities for efficient lighting technologies -Version 6.0" (CDM, 2013b); and
- Small-scale Methodology AMS-III.AR.: Substituting fossil fuel based lighting with LED/CFL lighting systems -Version 5.0" (CDM, 2014b),

The calculation of the emission factor for the identified baseline scenario is provided in Section 4.3 based on these CDM methodologies.

**Solar PV based home system**

As noted above, although a significant percentage of the population in Ghana is connected to the grid, the country faces a major challenge with power failures. Under this technology intervention, consumers will be provided with solar PV home systems that, in the business-as-usual scenario, will not be connected to an electricity grid or vulnerable to power failures. Therefore, for this technology intervention, the business-as-usual scenario is taken from the Clean Development Mechanism (CDM) approved "Small-scale Methodology: AMS-I.L.: Electrification of rural communities using renewable energy, Version 03.0". The baseline scenario assumes the use of fuel-based stand-alone power generators. In line with methodology AMS-I.L, a conservative default emission factor of 1.0 $tCO_{2eq}$/MWh is applied as baseline emission factor for this technology intervention.

#### 4.2.2.2 CC Technologies

**ICSs for households & commercial activities and LPG cooking solutions**

Ghana has an estimated 6.6 million households (GLSS 6, 2014c) and the current penetration of ICSs in the country is at a meagre ~0.15 million.[6] The most prevalent form of cooking fuel in Ghana is wood with 41.3 per cent of the population using it as their main cooking fuel. Charcoal is the second most used fuel source with over 31.5 per cent of the population using it, followed by LPG (22.3 per cent) (GLSS 6, 2014c). Cooking is predominantly done on traditional cookstoves or open fire. Charcoal stove usage is dominated by the traditional stoves locally called the "Coal Pot", which is used by about 85 per cent of all charcoal stove users.

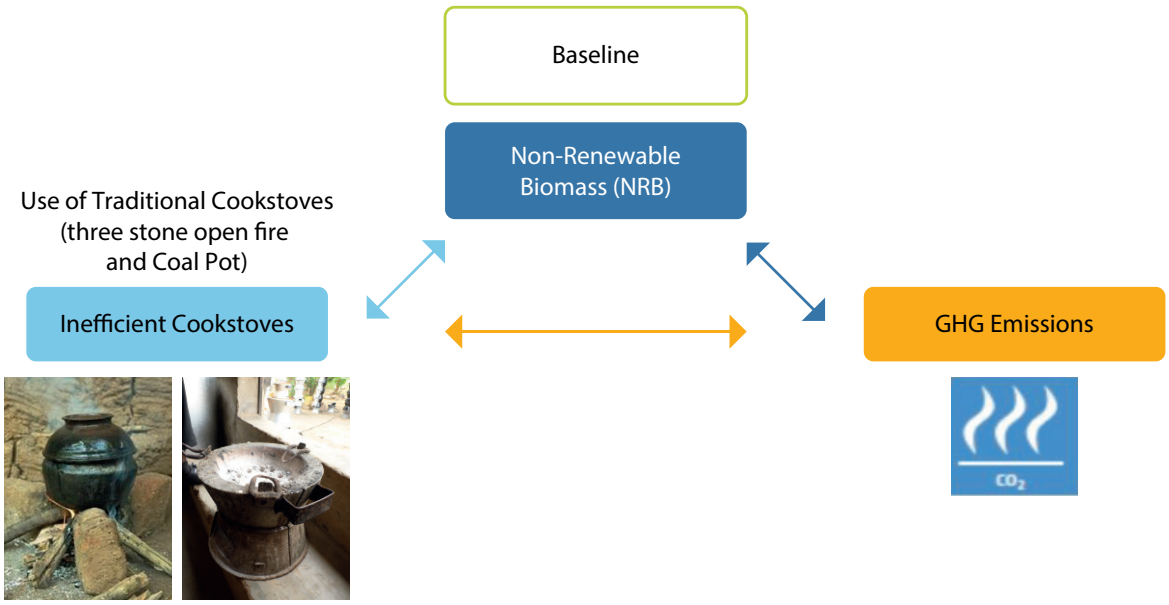
As noted above, the baseline is a current or an expected business-as-usual (BAU) scenario. In Ghana, the BAU scenario reflects the usage of firewood and charcoal as fuel in the traditional three stone, open fire and Coal Pot stoves without an improved combustion system. The efficiency of these stoves is less than 10 per cent.[7] In the baseline, households and commercial groups in Ghana will continue the established practice of consuming predominantly non-renewable biomass (firewood or charcoal) using conventional cookstoves to generate the heat demanded for cooking with only marginal use of ICSs and LPG stoves.

The baseline scenario (Figure 4-1) for GHG emissions is derived using the UNFCCC approved CDM methodology "AMS-II.G: Energy efficiency measures in thermal applications of non-renewable biomass, version 07.0" (CDM, 2015). In accordance to the AMS-II.G methodology, the baseline scenario assumes the projected use of fossil fuels to meet similar thermal energy needs as those provided by the project devices. The methodology AMS-II.G also addresses the issue of suppressed demand.

6 According to market information collected through stakeholder consultation in June 2015.

7 Efficiency is defined as the amount of energy utilized per unit of fuel energy consumed. It is expressed in per centage terms.

**Figure 4-1: Baseline Scenario for Cooking Activity**




In line with the AMS-II.G methodology, it is assumed that in the absence of the NAMA interventions, the baseline scenario would involve the use of fossil fuels for meeting similar thermal energy needs. As specified in the methodology, a value 81.6 $tCO_{2eq}$/TJ is used as the emission factor for the substitution of non-renewable biomass by similar consumers. This value represents the emission factor of the substitution fuels likely to be used by similar users, on a weighted average basis. It is assumed that the mix of present and future fuels used would consist of a solid fuel (lowest in the ladder of fuel choices), a liquid fossil fuel (representing a progression over solid fuel in the ladder of fuel use choices) and a gaseous fuel (representing a progression over liquid fuel in the ladder of fuel use choices). Thus a 50 per cent weight is assigned to coal as an alternative solid fossil fuel (96 $tCO_{2eq}$/TJ) and a 25 per cent weight is assigned to both liquid and gaseous fuels (71.5 $tCO_{2eq}$/TJ for kerosene and 63.0 $tCO_{2eq}$/TJ for LPG).[8]

## 4.3 GHG Baseline and Mitigation Targets

In deriving the GHG baseline and mitigation targets the following definitions are used.

**Definition of Renewable and Non-Renewable Biomass:** Woody biomass is "renewable" if one of the conditions mentioned in Annex 18 of the report of the 23rd meeting of the CDM Executive Board. Otherwise where none of these conditions applies, the biomass is considered as "non-renewable" (UNFCCC, 2006).

**Definition of System Boundary:** The system boundary encompasses significant anthropogenic GHG emissions by sources under the control of the project participant that are reasonably attributable to the NAMA intervention as a project activity.

8 Default values as per the UNFCCC-approved AMS II.G methodology (CDM, 2015).

The total GHG emissions reductions of this NAMA in a given year y ($ER_y$) is the sum of the emissions reductions achieved through implementation of Intervention 1 and Intervention 2. The emission reductions are calculated as:

Equation 1: $ER_y = ER_{1,y} + ER_{2,y}$

Where:

| Variable | Description |
|---|---|
| $ER_y$ | Emissions reductions achieved under this NAMA in year y ($tCO_{2eq}$) |
| $ER_{1,y}$ | Emissions reductions achieved through implementation of Intervention 1 in year y ($tCO_{2eq}$) |
| $ER_{2,y}$ | Emissions reductions achieved through implementation of Intervention 2 in year y ($tCO_{2eq}$) |

The emission reductions achieved by the NAMA interventions are calculated by comparing the project emissions ($PE_y$) with the emissions under the baseline scenario ($BE_y$):

Equation 2: $ER_y = BE_y - PE_y$

Where:

| Variable | Description |
|---|---|
| $ER_y$ | Total emissions reductions achieved under this NAMA in year y ($tCO_{2eq}$) |
| $BE_y$ | Baseline emissions in year y ($tCO_{2eq}$) |
| $PE_y$ | Project emissions in year y ($tCO_{2eq}q$) |

### 4.3.1 Mitigation Targets under Intervention 1

GHG emission reductions achieved by installation of an EPZ's solar PV based mini grid i in a given year y ($ER_{EPZ,i,y}$) are calculated by comparing actual (project) emissions ($PE_{EPZ,i,y}$) with the emissions under a baseline scenario ($BE_{EPZ,i,y}$).

Equation 3a: $ER_{EPZ,i,y} = BE_{EPZ,i,y} - PE_{EPZ,i,y}$

Where:

| Variable | Description |
|---|---|
| $ER_{EPZ,i,y}$ | Emissions reductions achieved by implementation of EPZ mini grid i over the time period y in year y ($tCO_{2eq}$) |
| $BE_{EPZ,i,y}$ | Baseline emissions at EPZ mini grid i over the time period y ($tCO_{2eq}$) |
| $PE_{EPZ,i,y}$ | Project emissions at EPZ mini grid i over the time period y ($tCO_{2eq}$) |

### Assumptions

- An EPZ is characterized by the short distance between the source of electricity generation and the consumer of electricity. Thus the grid losses are minor and can be neglected. Therefore, all the generated electricity under the intervention will be consumed, i.e. the electricity generated is equal to the electricity consumed.
- The operating life time of the power plant is considered to be 20 years based on the lifetime of solar modules.

### System Boundary

The project activity is defined by the intervention establishing a power plant under the EPZ. Thus the project boundary encompasses the source of electricity generation and the consumer of the electricity, connected through a mini grid.

### Baseline Emissions ($BE_{EPZ,i,y}$)

In the absence of the solar PV based power plant, the supply and consumption of electricity would rely on a fossil fuel based off-grid electricity system(s).

As discussed above, the CDM methodology AMS-I.L is applied for calculating emissions reductions, and with a view to conducting accurate and cost effective monitoring, a conservative default emission factor of 1.0 $tCO_{2eq}$/MWh is applied. The baseline emissions are calculated as follows.

Equation 3b: $$BE_{EPZ,i,y} = \sum_{F=1}^{m} EG_{R,i,y} + \sum_{F=1}^{m} EG_{F-Basel,i,y}) * EF_{CO2}$$

Where:

| Parameter | Description |
|---|---|
| $EG_{R,i,y}$ | Electricity generated and delivered by renewable electricity generation system R to the EPZ mini grid i connected consumers over the time y (MWh) |
| $EG_{F-Basel,i,y}$ | Electricity generated and delivered by fossil fuel based electricity generation system F to the EPZ mini grid i connected consumers over the time y (MWh) |
| $R$ | Renewable energy system, from which the electricity is generated and delivered to the EPZ mini grid i connected consumers over the time y. |
| $F$ | Fossil fuel based energy system (backup), from which the electricity is generated and delivered to the EPZ mini grid i connected consumers over the time y. |
| $n$ | Total number of renewable energy systems, from which the electricity is generated and delivered to the EPZ mini grid i connected consumer over the time y. |
| $m$ | Total number of fossil fuel based energy systems (backup), from which the electricity is generated and delivered to the EPZ mini grid i connected consumer over the time y. |
| $i$ | EPZ identification |
| $EF_{CO2}$ | Fossil fuel emissions default factor = 1.0 $tCO_{2eq}$/MWh |

### Project Emission ($PE_{EPZ,i,y}$)

The electricity generated by the renewable energy systems, which can be based on solar, hydro or wind, causes no greenhouse gas emissions. Thus the project emissions are considered to be zero.

Where there are installed fossil fuel based electricity generation backup system(s) (that generate and deliver electricity to the consumer connected to the EPZ mini grid), the project emissions are calculated as follows:

Equation 3c: $$PE_{EPZ,i,y} = \sum_{F=1}^{m} EG_{F-\mathrm{Project},i,y} * EF_{CO2}$$

Where:

| Parameter | Description |
|---|---|
| $EG_{F-\mathrm{Project},i,y}$ | Electricity generated and delivered by fossil fuel based electricity generation backup system F to the EPZ mini grid i connected consumer over the time y (MWh) |
| $EF_{CO2}$ | Fossil fuel emissions default factor = 1.0 $tCO_{2eq}$/MWh |

### Emission Reduction ($ER_{EPZ,i,y}$)

Applying the formula given under the baseline and project emission scenario in Equation 3a:

$$ER_{EPZ,i,y} = \left( \sum_{R=1}^{n} EG_{R,i,y} + \sum_{F=1}^{m} EG_{F=Basel,i,y} \right) * EF_{CO2} - \sum_{F=1}^{m} EG_{F=\mathrm{Project},i,y} * EF_{CO2}$$

The electricity generated by the fossil fuel based energy system (backup) within the project scenario is equal to the baseline scenario, because in the absence of the NAMA intervention, the consumer will use fossil fuel based electricity as backup.

Therefore: $$\sum_{F=1}^{m} EG_{F=Basel,i,y} = \sum_{F=1}^{m} EG_{F=\mathrm{Project},i,y}$$

Thus the emissions reductions formula can be simplified to:

$$ER_{EPZ,i,y} = \sum_{F=1}^{n} EG_{R,i,y} * EF_{CO2}$$

The emissions reductions over all the EPZs are calculated as follows:

Equation 3d: $$ER_{1,y} = ER_{EPZ,sum,y} = \sum_{i=1}^{z} \sum_{R=1}^{n} EG_{R,i,y} * EF_{CO2}$$

Where:

| Parameter | Description |
|---|---|
| $ER_{EPZ,sum,y}$ | Emission reductions of all EPZ mini grids i over the time period y ($tCO_{2eq}$) |
| $z$ | Total number of EPZs |
| $EG_{R,i,y}$ | Electricity generated and delivered by renewable electricity generation system R to the EPZ mini grid i connected consumer over the time y in MWh. This parameter will be monitored ex post. |
| $EF_{CO2}$ | Fossil fuel emissions default factor = 1.0 $tCO_{2eq}$/MWh. This is fixed ex ante. |

### 4.3.2 GHG Emissions Targets under Intervention 1

Using the formulae given in the previous section, the GHG emissions targets for Intervention 1 are estimated and it is shown in Table 4-1.

**Table 4-1: GHG Emissions Targets under Intervention 1**

| Year | Cumulative capacity implemented (kWp) | Total electricity generated (kWh) | Annual GHG emissions reduction achieved through Intervention 1 ($tCO_{2eq}$/year) |
|---|---|---|---|
| 2017 | 125 | 240,900 | 241 |
| 2018 | 200 | 385,440 | 385 |
| 2019 | 325 | 626,340 | 626 |
| 2020 | 400 | 770,880 | 771 |
| 2021 | 400 | 770,880 | 771 |
| 2022 | 400 | 770,880 | 771 |
| 2023 | 400 | 770,880 | 771 |
| 2024 | 400 | 770,880 | 771 |
| 2025 | 400 | 770,880 | 771 |
| 2026 | 400 | 770,880 | 771 |
| 2027 | 400 | 770,880 | 771 |
| 2028 | 400 | 770,880 | 771 |
| **Total** | | | **8,191** |

### 4.3.3 Mitigation Targets under Intervention 2

The GHG emission reductions under Intervention 2 in a given year y ($ER_{2,y}$) are calculated by comparing project emissions ($PE_{2,y}$) with the emissions under the baseline scenario ($BE_{2,y}$).

Equation 4: $ER_{2,y} = BE_{2,y} - PE_{2,y}$

The mitigation target under this intervention is calculated for the following technology categories.

#### 4.3.3.1 Mitigation Target for Solar PV Based Lanterns

GHG emission reductions achieved through distribution of solar lanterns (also referred to as "lamps") in a given year y ($ER_{lamp,y}$) are calculated by comparing actual (project) emissions ($PE_{lamp,y}$) with the emissions under a baseline scenario ($BEl_{amp,y}$).

Equation 5a: $ER_{lamp,y} = BE_{lamp,y} - PE_{lamp,y}$

**Assumptions**

- Solar lanterns sold under the NAMA will be considered to be operational for 365 days in a year.
- The "date of sale" will be considered as the "date of commissioning" of a solar lantern. The date of commissioning of the project devices sold in month "m" will be the first day of month "m+1".
- The operating lifetime of the solar lantern system is considered to be 20 years, based on the lifetime of solar modules and the lifetime of a LED lamp of 50,000 hours.

**System Boundary**

The project activity is defined by the distribution of solar lanterns as NAMA intervention, thus the project boundary encompasses the distribution and application area of the solar lanterns.

**Baseline Emission ($BE_{lamp,y}$):**

The GHG emissions that have been avoided due to use of solar lanterns are calculated as follows:

Equation 5b: $ER_{lamp,y} = N_y \times \frac{\mu_y}{365} \times EF_{lamp}$

As noted above, grid electricity is the main source of lighting and in 2012/13 was accessed by 70.6 per cent of households in Ghana, followed by the 24.3 per cent who use flashlights (mostly charged by grid electricity), the 3.6 per cent who use kerosene lamps and the 1.5 per cent who rely on other sources. Thus, the baseline scenario includes two primary fuel sources, grid electricity and kerosene. Hence, the lamp emission factor ($EF_{lamp}$) can be derived by applying the following equation:

Equation 5c: $ER_{lamp,y} = \left( EF_{A,y} \times \frac{n_{A,y}}{N_y} \right) + \left( EF_{B,y} \times \frac{n_{A,y}}{N_y} \right)$

Where:

| Parameter | Description |
|---|---|
| $N_y$ | Total number of project lamps (lanterns) sold in the year y. As noted above, all solar lanterns sold under the NAMA are considered to be operational and the date of commissioning of the lanterns sold in month "m" will be the first day of month "m+1". This will be monitored ex post. |
| $\mu_y$ | Number of days of utilization of the solar lantern during the year y. This will be counted from the date of commissioning of the project device. |
| $EF_{lamp}$ | Lamp emission factor ($tCO_{2eq}$ per lamp per year). A value of 0.023 $tCO_{2eq}$ per lamp per year is used. This is fixed ex ante. Please refer to Box 1 for calculation of EFlamp. |
| $EF_{CO2,\ker osene,y} = EF_{A,y}$ | $CO_2$ lamp emission factor based on kerosene ($tCO_{2eq}$/project lamp). A value of 0.092 $tCO_{2eq}$/project lamp is used, as in the UNFCCC approved CDM methodology AMS-III.AR. This is fixed ex ante. The calculation is provided below. |
| $n_{A,y}$ | Number of distributed project lanterns in the year y, which have the baseline scenario emission factor, $EF_{A,y}$ . A value of 3.6 per cent of total lanterns sold is used as per the GLSS 6. This is fixed ex ante. |
| $EF_{CO2,nationalgrid,y} = EF_{B,y}$ | $CO_2$ lamp emission factor based on national grid supply ($tCO_{2eq}$/project lamp). A value of 0.0204 $tCO_{2eq}$/project lamp is used in accordance with the UNFCCC approved CDM methodologies AM0113 and AMS-II.J. This is fixed ex ante. The calculation is provided below. |
| $n_{B,y}$ | Number of distributed project lanterns in the year y, which have the baseline scenario emission factor, $EF_{B,y}$. A value of 94.9 per cent (the sum of the 70.6 per cent of households which depend on grid electricity and the 24.3 per cent households which use flashlights mainly charged by grid electricity) of total lanterns sold is used as per the GLSS 6. This is fixed ex ante. |

### Estimation of $EFC_{O2,kerosene,y}$:

In line with the UNFCCC's "AMS-III.AR.: Substituting fossil fuel based lighting with LED/CFL lighting systems - Version 5.0" (CDM, 2014b), the emission factor is calculated as follows:

Equation 5d: $$EF_{CO2,kerosene,y} = DV_{kerosene} \times GF_y \times DB_y = 0.092 \times 1 = 0.092$$

Where:

| Parameter | Description |
|---|---|
| $DV_{kerosene}$ | Lamp Emission Factor. Default of 0.092 $tCO_{2eq}$ /project lamp per year is applied. |
| $GF_y$ | Grid Factor in year y. Default of 1 is applied due to charging by a renewable energy system included as part of the project lamp. |
| $DB_y$ | Dynamic baseline factor due to change in baseline fuel, fuel use rate, and/or utilization over the time. Default value of 1 is applied due to the absence of relevant information. |
| $y$ | Period of time defined by a lighting utilization rate of 3.5 hours per day over 365 days. |

Estimation of $EF_{CO2,national\text{-}grid\text{-}lamp,y}$:

In line with the UNFCCC's

- "Large-scale Methodology AM0113: Distribution of compact fluorescent lamps (CFL) and light-emitting diode (LED) lamps to households - Version 1.0",
- "Small-scale Methodology AMS-II.J: Demand-side activities for efficient lighting technologies - Version 6.0", and
- "Tool to calculate the emission factor for an electricity system - Version 4.0",

The emission factor is calculated as follows:

Equation 5e: $$EF_{co2,national-grid-lamp,y} = P_{i,BL} \times EF_{national-grid,y} \times 10^{-6} \times Y = 0.0204$$

Where:

| Parameter | Description |
|---|---|
| $P_{i,BL}$ | Power (in watts) of the baseline lamp type (e.g. incandescent lamps) that would be used in the absence of the project lamp (solar lantern) to provide an equal lumen output as the project lamp. A 50W incandescent lamp (average of 40W and 60W lamp) is used for the calculation. |
| $EF_{national-grid,y}$ | $CO_2$ emission factor of national grid electricity in year y. A value of 0.320 $tCO_{2eq}$/MWh is applied as per Energy Commission, 2015b. |
| $y$ | Period of time defined by a lighting utilization rate of 3.5 hours per day over 365 days. Thus y=365 x 3.5 = 1,277.5 hours. |

### Box-1: Estimation of $EF_{lamp}$

Applying the values taken from equation 5c

$$EF_{lamp} = \left(0.092 \times \frac{3.6\%}{98.5\%}\right) + \left(0.0204 \times \frac{94.9\%}{98.5\%}\right) = 0.023 tCO_{2eq} per\ lamp\ per\ year$$

### Project Emissions ($PE_{lamp,y}$):

There are no project emissions if the project lamps are:

- charged by a renewable energy system included as part of the project lamp (e.g. a photovoltaic system or mechanical system such as a hand crank charger); or
- charged by a stand-alone distributed renewable generation system.

The project lamps are solar lanterns, which are charged by a photovoltaic system included as part of the package, thus $P_{Elamp,y} = 0$

#### *4.3.3.2 Mitigation Target for Solar PV Based Home Systems*

GHG emissions reductions achieved through the distribution of solar PV home systems in a given year y ($ER_{PV\text{-}home,y}$) are calculated by comparing actual (project) emissions ($PE_{PV\text{-}home,y}$) with the emissions under a baseline scenario ($BE_{PV\text{-}home,y}$).

Equation 6a: $ER_{PV-home,i,y} = BE_{PV-home,i,y} - PE_{PV-home,i,y}$

Where:

| Parameter | Description |
|---|---|
| $ER_{PV-home,i,y}$ | Emissions reductions due to PV home system i over the time period y in $tCO_{2eq}$ |
| $BE_{PV-home,i,y}$ | Baseline emissions due to fossil fuel based electricity generation in absence of the PV home system i over the time period y in $tCO_{2eq}$ |
| $PE_{PV-home,i,y}$ | Project emissions from the operation of the PV home system i over the time period y in $tCO_{2eq}$. Due to renewable source of power generation PEPV-home,i,y=0 |

**Assumptions**

- The PV home systems are characterized by short distances between the places where the electricity is generated and the places where the electricity is consumed or recharging takes place. Thus no losses will be taken into account. All the electricity generated by the system will be consumed, that is the electricity generated is equal to the electricity consumed.
- Solar PV home systems sold under the NAMA will be considered to be operational for 365 days in a year.
- The "date of sale" will be considered as the "date of commissioning" of a system. The date of commissioning of the project devices sold in month "m" will be the first day of month "m+1".
- The operating lifetime of the solar home system is considered to be 20 years based on lifetime of solar modules.

**System Boundary**

The project activity is the installation of solar PV based home system. Thus, the project boundary encompasses the PV home system, encompassing electricity generation and consumption on the same site.

**Baseline Emission ($BE_{EPZ,i,y}$)**

In the absence of the solar PV based home system, the supply and consumption of electricity would rely on fossil fuel based off-grid electricity system(s).

As discussed above, the CDM methodology AMS-I.L is applied for the calculation of emissions reductions; and with a view to accurate and cost-effective monitoring, a conservative default emission factor of 1.0 $tCO_{2eq}$/MWh is applied. The baseline emissions are calculated as follows.

Equation 6b: $BE_{PV-home,i,y} = EG_{PV-home,i,y} * EF_{CO2}$

Where:

| Parameter | Description |
|---|---|
| $EG_{PV-home,i,y}$ | Electricity generated by PV home system i, supplied to consumer appliances or used for internal home consumption over the time y in MWh. Average electricity output per kWp per year will be determined and fixed ex ante based on manufacturers› data and/or international or equivalent national standards. For the ex ante estimation a value of 1927.20 kWh per kWp per year is used. Please refer to Chapter 9 for details. |
| $EF_{CO2}$ | Fossil fuel emissions default factor = 1.0 $tCO_{2eq}$/MWh |
| $y$ | Period of time defined by the project participant |
| $i$ | PV home system identification |

#### *4.3.3.3 Mitigation Target for ICSs*

GHG emissions reductions achieved through the distribution of ICSs in a given year y ($ER_{ICS,y}$) are calculated by comparing actual (project) emissions ($PE_{ICS,y}$) with the emissions under the baseline scenario ($BE_{ICS,y}$).

Equation 7:

$$ER_{ICS,y} = BE_{ICS,y} - PE_{ICS,y}$$

**System Boundary**

The project boundary is the physical, geographical site of the efficient cookstoves (ICSs) that utilize firewood and/or charcoal.

The potential leakage due to the use/diversion of non-renewable woody biomass saved under the project activity by non-project households/users that previously used renewable energy sources will not be considered.

**Baseline Emissions ($BE_{ICS,y}$)**

As described in Section 4.1, the baseline scenario is the continuation of the current or an expected business-as-usual (BAU) scenario. In Ghana, the current situation involves the use of non-renewable biomass in the form of firewood or charcoal as fuel in the existing/conventional less efficient cookstoves such as the three stones, open-fire cookstove and the Coal Pot.

In line with CDM methodology AMS-II.G, it is assumed that in the absence of the NAMA intervention, the baseline scenario would be the projected use of fossil fuels to meet similar thermal energy needs as those provided by the project devices. The methodology yields an emission factor 81.6 $tCO_{2eq}$/TJ for the projected use of fossil fuels. Therefore, by reducing the amount of fuel required for cooking, the replacement of the traditional stoves by ICSs reduces the amount of $CO_2$ emitted into the atmosphere due to the reduction of non-renewable woody biomass used by the improved stoves.

**Assumptions**

- ICSs sold under the NAMA will be considered to be operational for 365 days in a year and consumers (households and institutions) are assumed to be using ICSs exclusively.

- The "date of sale" will be considered as the "date of commissioning" of an ICS. The date of commissioning of the project devices sold in month "m" will be the first day of month "m+1".
- Number of ICSs per household is considered to be one.

The baseline emissions ($BE_{ICS,y}$) are calculated as follows:

Equation 7a: $$BE_{ICS,y} = \sum_{a=1}^{a-y} B_{old,i} \times N_{y,i,a} \times \frac{\mu_{y,i}}{365} \times f_{NRB,y} \times NCV_{biomass} \times EF_{projected\_fossilfuel}$$

Where:

| Variable | Description |
|---|---|
| $a$ | '$a$' is the index for the age (in years) of the cookstoves that are operating in the year y. Since the lifetime of cookstoves is often shorter than the project lifetime and cookstoves are likely to show significant efficiency losses over time, this aspect needs to be captured. The operating lifetime of the project device is considered to be four years as confirmed by various manufacturers. So, values of $a$ will be either 1, 2, 3 or 4 depending on the date of commissioning of the project devices. This is fixed ex ante. |
| $B_{old,i}$ | Annual quantity of woody biomass that would be used in the absence of the NAMA intervention to generate thermal energy equivalent to that provided by the ICS type i, if the ICS operates throughout the year y. A default value of 0.5 tons per capita per year is used to derive this parameter for household cookstoves. Number of persons served per cookstove is based on GLSS-6 report. Please refer to Box 2 for a detailed calculation of $B_{old,i}$. This is fixed ex ante. |
| $N_{y,i,a}$ | Number of ICSs type i and age — operating in year $y$. As noted above, all ICSs sold under the NAMA are considered to be operational and the date of commissioning of the ICSs sold in month "m" will be the first day of month "m+1". This will be monitored ex post. |
| $\mu_{y,i}$ | Number of days of utilization of the ICS during the year $y$. This will be counted from the date of commissioning of ICSs. |
| $f_{NRB,y}$ | Fraction of woody biomass saved by the ICS in year $y$ that can be established as non-renewable biomass. A value of 99 per cent is used for calculation of baseline emission from UNFCCC approved country report. This is fixed ex ante. |
| $NCV_{biomass}$ | The net calorific value of the non-renewable woody biomass (TJ/ton). IPCC default for woodfuel, 0.015 TJ/ton, based on the gross weight of the "air-dried" wood that is used and this is fixed ex ante. |
| $EF_{projected\_fossilfuel}$ | The emission factor for the fossil fuels projected to be used to substitute for non-renewable woody biomass by similar consumers ($tCO_{2eq}$/TJ). A value of 81.6 $tCO_{2eq}$/TJ is adopted from the UNFCCC approved CDM methodology AMS-II.G. This is fixed ex ante. |

### Box 2: Estimation of $B_{old,i}$

$B_{old,i}$ is determined by using a default value of 0.5 ton woody biomass per capita per year. The value is taken from UNFCCC approved CDM methodology AMS-II.G. The mean household size for the country is considered to be four, in accordance with the findings of GLSS 6. The number of stoves per household is considered to be one. $B_{old,i}$ is calculated as:

$$B_{old,i} = 0.5 * 4 * 1 = 2 \frac{tons}{device}$$

### Project Emission ($PE_{ICS,y}$)

Project emissions will be due to the use of firewood or charcoal in the project scenario.

### Assumptions

ICSs sold under the NAMA intervention must have minimum thermal efficiency of 0.35 for the first year of operation and their efficiency will be based on certification by a national standards body or an appropriate certifying agent recognized by that body. Therefore, an efficiency of 0.35 for all ICSs sold under the NAMA will be assumed for the calculation of project emissions.

The project emissions ($PE_{ICS,y}$) are calculated as follows:

Equation 7b:

$$PE_{ICS,y} = \sum_{a=1}^{a=y} B_{old,i} \times \frac{\eta_{old}}{\eta_{new,i,a=1} \times (1 - \nabla\eta)} \times N_{y,i,a} \times \frac{\mu_{y,i}}{365} \times f_{NRB,y} \times NCV_{biomass} \times EF_{projected\_fossilfuel}$$

Where:

| Variable | Description |
|---|---|
| $\eta_{old}$ | Efficiency of the baseline (pre-project) cookstoves (fraction). A default value of 0.14 is used and this is fixed ex ante. Please refer to Box 3 for details of the calculation |
| $\eta_{new,i,a=1}$ | Thermal efficiency of ICSs of type i being deployed as part of the NAMA intervention (fraction), based on certification by a national standards body or an appropriate certifying agent recognized by that body. A value of 0.35 is used in the year of its installation (a=1) and this is fixed ex ante. |
| $\Delta\eta_{i,y}$ | Efficiency derating factor of ICSs type i being deployed as part of the NAMA intervention (fraction) in year y. An annual efficiency derating factor of 0.10 is assumed from the second year of operation due to the efficiency loss of ICS type i due to its ageing in year y. This is fixed ex ante. |

### Box 3: Estimation of $\eta_{old}$

$\eta_{old}$ is the weighted average of efficiencies of pre-project devices taking the amount of woody biomass consumed by each device as the weighting factor. In accordance with the finding of GLSS 6, it is assumed that 41.3 per cent of households in Ghana use firewood as fuel for cooking; Charcoal is the second most used fuel source with 31.5% of households using it. Cooking based on firewood is predominantly done on traditional three stones cookstoves or open fire. Charcoal stove usage is dominated by the traditional stoves locally called Coal Pots. To estimate $\eta_{old}$, a default efficiency value of 0.10 and 0.20 is used for the three-stone cookstoves/open fire and the Coal Pots respectively, as in CDM methodology AMS-II.G. The calculation is as follows:

$$\eta_{old} \frac{(41.3\% \times 0.10) + (31.5\% \times 0.20)}{(41.3\% + 31.5\%)} = 0.14$$

#### *4.3.3.4 Mitigation Targets for LPG Usage*

GHG emission reductions achieved through the distribution of LPG cooking solutions in a given year y ($ER_{LPG,,y}$) are calculated by comparing actual (project) emissions ($PE_{LPG,y}$) with the emissions under a baseline scenario ($BE_{LPG,y}$).

Equation 8:

#### System Boundary

Under this intervention, conventional cookstoves will be replaced by LPG stoves. Thus the system boundary is the physical, geographical site of the stoves that utilize LPG i.e. an LPG stove and cylinder. Together the LPG stove and cylinder will be termed the "LPG connection" hereafter.

The potential source of leakage due to the use/diversion of non-renewable woody biomass saved under the project activity by non-project households/users that previously used renewable energy sources will not be considered.

#### Baseline Emissions ($BE_{LPG,y}$)

In the absence of Intervention 2, households in Ghana will continue to use non-renewable biomass as fuel in the existing/conventional less efficient cookstoves such as the three stones, open fire cookstove and the Coal Pot. Under this intervention, households will be provided with LPG connections. In this way, LPG stoves will replace the traditional cookstoves. By doing this, the amount of $CO_2$ emitted into the atmosphere due to the reduction of non-renewable woody biomass used by the conventional cookstoves will be saved.

In line with CDM methodology AMS-II.G, it is assumed that in the absence of the NAMA intervention, the baseline scenario would be the projected use of fossil fuels to meet similar thermal energy needs as those provided by the project devices. The methodology posits an emission factor 81.6 $tCO_{2eq}$/TJ for the projected use of fossil fuels.

### Assumptions

- All LPG connections provided under the intervention will be considered to be operational and there will be one LPG connection per household.
- It is assumed that households provided with LPG connections under this NAMA intervention are using LPG exclusively and that LPG stoves are used for 365 days in a year.
- The "Date of the first time sale" of LPG connections will be considered as the "date of commissioning" of that LPG connection. The date of commissioning of a LPG connection will be the first day of month "m+1" if the first time sale of that LPG connection is in the month "m".

The baseline emissions ($BE_{LPG,y}$) are calculated as follows:

Equation 8a: $$BE_{LPG,y} = B_{old} \times N_y \frac{\mu_y}{365} \times f_{NRB,y} \times NCV_{biomass} \times EF_{projected\_fossilfuel}$$

Where:

| Variable | Description |
|---|---|
| $B_{old}$ | Annual quantity of woody biomass that would be used in the absence of the NAMA intervention to generate the thermal energy equivalent to that provided by the LPG stove, if the LPG stove operates throughout the year y. A default value of 0.5 tons per capita per year is used to derive this parameter for household cookstoves. The number of persons served per cookstove is based on the findings of the GLSS6. Please refer to Box 1 for details on the calculation of $B_{old,i}$. This is fixed ex ante. |
| $N_y$ | The number of "LPG connections" operating in year $y$. This will be monitored expost. |
| $\mu_y$ | The number of days of utilization of the LPG connection during the year $y$. This will be counted from the date of commissioning of the connection. |
| $f_{NRB,y}$ | The fraction of woody biomass saved by the ICS in year $y$ that can be established as non-renewable biomass. A value of 0.99 is used for calculation of baseline emission, on the basis of the UNFCCC approved country report. This is fixed ex ante. |
| $NCV_{biomass}$ | Net calorific value of non-renewable woody biomass (TJ/ton).<br>IPCC default for wood fuel, 0.015 TJ/ton, based on the gross weight of the "air-dried" wood that is used and this is fixed ex ante. |
| $EF_{projected\_fossilfuel}$ | Emission factor for the fossil fuels projected to be used for substitution of non-renewable woody biomass by similar consumers ($tCO_{2eq}$/TJ). A value of 81.6 t $CO_{2eq}$/TJ is used, based on the UNFCCC approved CDM methodology AMS-II.G. This is fixed ex ante. |

### Project Emission ($PE_{LPG,y}$):

Project emissions will be due to the use of LPG in the project scenario.

**Assumption:**

The total quantity of LPG supplied under the intervention will be consumed. Thus the quantity of LPG supplied under the intervention in year y is equal to quantity of LPG consumed in year y.

The project emissions ($PE_{2,y}$) are calculated as follows:

Equation 8b: $$PE_{LPG,y} = N_y \times \sum_i \left(Q_{cyl,LPG,i} \times i\right) \times NCV_{LPG} \times EF_{LPG}$$

Where:

| Variable | Description |
|---|---|
| $Q_{cyl,LPG,i}$ | The number of LPG cylinders of capacity i supplied to each LPG connection (or household) during the year y. This will be monitored ex post. |
| $i$ | Capacity of LPG cylinder in tons. This will be monitored ex post. LPG consumption of 0.12 tons/ household per year is used as an ex ante estimate. |
| $NCV_{LPG}$ | Net calorific value of LPG (TJ/ton). IPCC default for LPG, 0.0473 TJ/ton, is used and this is fixed ex ante. |
| $EF_{LPG}$ | Emission factor of LPG ($tCO_{2eq}$/TJ). IPCC default value 63.1 $tCO_{2eq}$/TJ is used. This is fixed ex ante. |

### 4.3.4 GHG Emission Targets under Intervention 2

Using the formulae given in section above, the GHG emission targets for Intervention 2 are estimated and shown in Table 4-2.

**Table 4-2: GHG Emissions Targets under Intervention 2**

| Year | Annual GHG emissions reductions achieved through distribution of solar lanterns ($tCO_{2eq}$/year) | Annual GHG emissions reductions achieved through distribution of solar PV home system ($tCO_{2eq}$/year) | Annual GHG emissions reductions achieved through distribution of ICSs ($tCO_{2eq}$/year) | Annual GHG emissions reductions achieved through distribution of LPG ($tCO_{2eq}$/year) | Annual GHG emissions reductions achieved through Intervention 2 ($tCO_{2eq}$/year) |
|---|---|---|---|---|---|
| 2017 | 833 | 2,621 | 51,878 | 18,708 | 74,040 |
| 2018 | 2,167 | 6,809 | 131,144 | 48,641 | 188,760 |
| 2019 | 4,333 | 13,617 | 256,274 | 97,282 | 371,506 |
| 2020 | 7,000 | 21,996 | 402,441 | 157,147 | 588,584 |
| 2021 | 9,667 | 30,375 | 499,069 | 217,013 | 756,123 |
| 2022 | 12,333 | 38,754 | 565,147 | 276,879 | 893,113 |
| 2023 | 15,000 | 47,133 | 588,967 | 336,744 | 987,845 |

| Year | Annual GHG emissions reductions achieved through distribution of solar lanterns ($tCO_{2eq}$/year) | Annual GHG emissions reductions achieved through distribution of solar PV home system ($tCO_{2eq}$/year) | Annual GHG emissions reductions achieved through distribution of ICSs ($tCO_{2eq}$/year) | Annual GHG emissions reductions achieved through distribution of LPG ($tCO_{2eq}$/year) | Annual GHG emissions reductions achieved through Intervention 2 ($tCO_{2eq}$/year) |
|---|---|---|---|---|---|
| 2024 | 17,667 | 55,512 | 588,967 | 396,610 | 1,058,756 |
| 2025 | 20,333 | 63,891 | 588,967 | 456,475 | 1,129,667 |
| 2026 | 23,000 | 72,270 | 588,967 | 516,341 | 1,200,579 |
| 2027 | 23,000 | 72,270 | 418,641 | 516,341 | 1,030,252 |
| 2028 | 23,000 | 72,270 | 263,095 | 516,341 | 874,706 |
| **Total** | **158,333** | **497,518** | **4,943,557** | **3,554,522** | **9,153,931** |

## 4..4 NAMA Sustainable Development Baseline and Targets

This NAMA is designed to produce sustainable development (SD) benefits in addition to GHG mitigation. SD benefits are a central element for climate finance and for encouraging country ownership, as well as having an important impact on the long-term sustainability of a NAMA. For this NAMA, a number of SD indicators have been selected based on the Sustainable Development Evaluation Tool (SD Tool) of UNDP (UNDP, 2014).[9] The SD Tool defines the following five SD domains. Each of the domains has a set of indicators against which the impact of the NAMA intervention can be measured.

1. Environment
2. Social
3. Growth and Development
4. Economic
5. Institutional

Monitoring the SD impacts on all the indicators of the respective five domains will be challenging and resource intensive and in some cases not feasible. Therefore, just five SD indicators have been selected, which will be part of the MRV system (Table 4-3).

9 The tool requires that for each of the interventions a decision should be made whether an indicator (such as air pollution, biodiversity, health, etc.) is selected. The impact of the intervention on the chosen indicator can then be identified and explained, and the effects (positive, negative, both) pinpointed. Whether monitoring has been undertaken is also indicated.

### Table 4-3: Indicators for the SD baseline

| SD Domain | SD Indicator |
|---|---|
| Growth and development | 1. Access to clean and sustainable energy<br>2. Capacity-building |
| Economic | 3. Job creation |
| Institutional | 4. Policy and planning<br>5. Law and regulation |

GHG emissions could be included as an indicator under the Environment domain. However, instead, it will be monitored through the MRV system and will be covered there. Similarly the quantity of fuel saved under the NAMA could be included in the Economy domain under the indicator "Energy Security" but will be monitored as part of the MRV process under GHG emission reductions. There are several impacts which are attributable to the interventions under this NAMA which are difficult to incorporate into the MRV system and have therefore not been included there. For ready reference these impacts are listed in Table 4-4 below.

### Table 4-4: Unmonitored SD Indicators

| SD Domain | SD Indicator |
|---|---|
| Environment | 1. Air pollution/ air quality<br>2. Biodiversity and ecosystem balance |
| Social | 3. Livelihood of poor, poverty alleviation, peace<br>4. Affordability of electricity<br>5. Health<br>6. Time savings/time availability due to project |
| Growth and development | 7. Education<br>8. Empowerment of women<br>9. Access to sustainable technology<br>10. Energy security |
| Economic | 11. Income generation/expenditure reduction/balance of payments |

A detailed list of indicators and their respective parameters for Interventions 1 and 2 is given in Annex 6 and Annex 7 respectively. Table 4-5 below provides the baseline and targets for the identified indicators.

### Table 4-5: The SD Indicators: Baseline and Targeted Impacts

| Parameters | Baseline Value | Target Value (estimated ex ante) |
|---|---|---|
| Number of manufacturing and distribution facilities of RE and CC technologies using energy from EPZs | 0 | 36 |
| Number of people trained from private sector | 0 | 80 |
| Number of technical staff and workers trained in skill development in manufacturing, distribution and aftersales services related to RE and CC technologies | 0 | 808 |

| Parameters | Baseline Value | Target Value (estimated ex ante) |
|---|---|---|
| Number of jobs and business opportunities created | 0 | 478 men and 477 women |
| Number of households using clean cooking technologies | 0 | 1,050,000 |
| Number of households using RE based electricity for lighting and other activities | 0 | 1,250,000 |
| NCA organizational structure | 0 | 1 |
| Capacity development programme for the NCA, the NIE and the MRV cell | 0 | 15 |
| Marketing and awareness-raising campaigns, including demonstration activities | 0 | 250 |
| Overall operation management system of NCA | 0 | 1 |
| NIE operations management system | 0 | 1 |
| NEE operations management system | 0 | 1 |

## 4.5 Summary of NAMA Targets

A summary table of the NAMA targets for GHG emissions reductions and its contribution to Sustainable Development is shown in Table 4-6.

**Table 4-6: Summary of NAMA targets**

| Target | Indicators |
|---|---|
| Reduce GHG emissions | Target emissions reductions of 9,162,122 tons of $CO_{2eq}$ over the 12-year lifetime of the NAMA. |
| Contribute to sustainable development | ■ Establishment of 36 manufacturing and distribution facilities of RE and CC technologies using energy from EPZs<br>■ A total of 80 people from the private sector trained in EPZ operations<br>■ A total of 808 technical staff and workers trained in skill development in manufacturing, distribution and aftersales services of RE and CC technologies<br>■ 478 jobs created for men and 477 jobs for women<br>■ 1,050,000 households using CC technologies<br>■ 1,250,000 households using RE based electricity for lighting and other activity<br>■ One NCA organizational structure created<br>■ 15 capacity development programmes for the NCA, the NIE and the MRV cell<br>■ 250 marketing and awareness-raising campaigns including demonstration activities<br>■ One NCA operations management system<br>■ One NIE operations management system<br>■ One NEE operations management system |

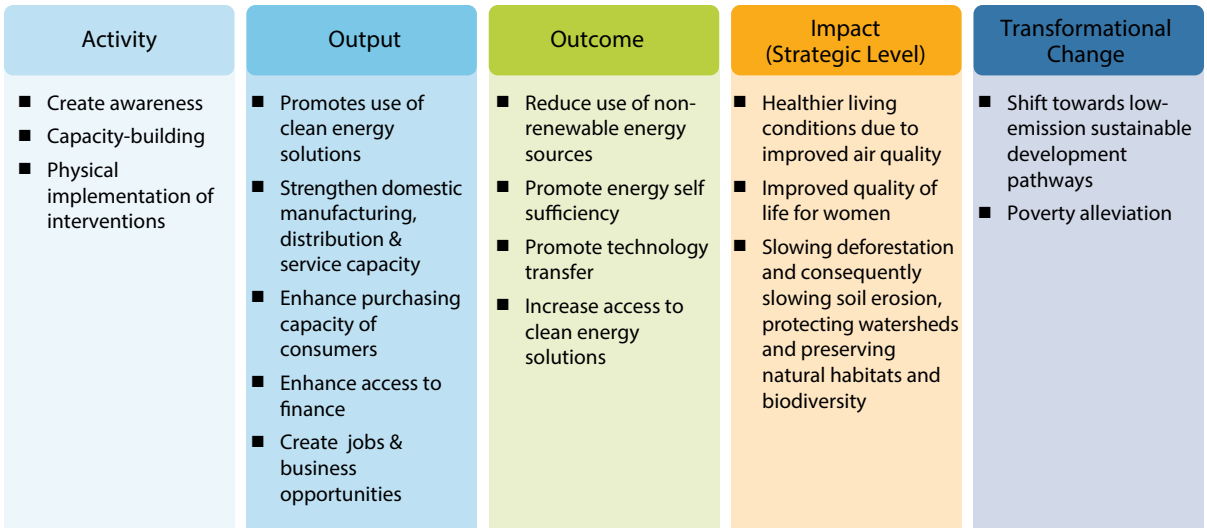
## 4.6 Transformational Change

The transformative change of the NAMA can best be seen through the application of a theory of change approach.[10] The theory of change approach "defines all building blocks required to bring about a given long-term goal. This set of connected building blocks—interchangeably referred to as outcomes, results, accomplishments, or preconditions—is depicted on a map known as a pathway of change/change framework, which is a graphic representation of the change process" (Center for Theory of Change, 2013).

Using this approach will help to ensure that the NAMA focuses not just on GHG emissions reduction but also on sustainable development, national development goals and transformative change. This approach is also aligned with the Green Climate Fund (GCF) results framework.

The overall hierarchy of activities, outputs, outcomes, impacts and the overall paradigm shift for the NAMA can be seen in Figure 4-2.

**Figure 4-2: Application of the Theory of Change Approach to NAMAs**




Acting as sector-transforming instruments, NAMAs have the potential to increase access to sustainable energy and energy solutions for the population in Ghana and bring about a transformational change in the sector. The potential for transformational change is closely linked to the specific context of the project, the sector and the broader strategies (mitigation, green growth, sustainable development, poverty reduction) of the country. The following section provides a description of the NAMA's potential for transformational change in terms of innovation, private sector involvement, impact (beyond the scope of the project), ability to replicate and scalability.

10 Built around the pathway of change, the Theory of Change describes the types of interventions that bring about the outcomes depicted in a pathway of change map. Each outcome in the pathway of change is tied to an intervention, revealing the often complex web of activity that is required to bring about change.

With the energy resources depleting, enhancing energy security and energy access is one of the major challenges facing Ghana. RE systems including solar PV systems and mini-grids are envisaged as useful tools for addressing the challenge, as they reduce reliance on extending grid-connected generation capacity, which is a much more resource intensive and longer term undertaking. These solutions foster local business development, create jobs, enhance energy access, and reduce transmission and distribution losses. As air pollution become a serious concern locally, the benefits of solar PV and mini grids become increasingly obvious.

In addition, modern energy services for cooking such as improved cookstoves (ICSs) and cleaner fuels like LPG are useful for addressing the social and environmental costs burdens arising from non-renewable woodfuel use. ICSs achieve fuel savings of 35-50 per cent compared with to conventional stoves. In addition to saving fuel, the stoves directly reduce household expenditure: an average family saves 300 kg of charcoal per year (Dresen and others, 2014). The benefits of ICSs and LPG fuel for cooking include health improvements from better household air quality, cooking time savings, aesthetic improvements and environmental benefits to society, such as reduced greenhouse gas emissions and deforestation.

Currently, inefficient and polluting cooking processes are deeply ingrained in Ghanaian culture. Using climate finance, this NAMA aims to break this trend and move a large part of the population away from practices that are resulting in unacceptably high GHG emissions, household air pollution which damages health and deforestation with its significant environmental impact. The finance coming through the NAMA will provide a means to increase the affordability of stoves by lowering their retail price while introducing quality guarantees and an ongoing monitoring and evaluation component.

The NAMA envisages the private sector playing the key role in mobilizing finance, upgrading technology through research and development, enhancing manufacturing capacity, providing jobs and implementation on the ground. At present, the majority of research and development, awareness and training is performed by the private sector, whose role would be further enhanced under this NAMA. The business model proposed for this NAMA would create a sustainable environment for end-users of these technologies.

# 5 MEASURES & INTERVENTIONS UNDER THE NAMA

This chapter focuses on the key element of the NAMA, namely the interventions or physical actions that will be undertaken to reduce emissions, increase access to energy, and make the development of communities within Ghana more sustainable, as well as the measures (supporting activities) that will allow the country to implement the interventions successfully.

The interventions and measures proposed under the NAMA are fully in line with Ghana's national targets for renewable energy and clean cooking solutions, namely:

- 200,000 solar systems (200 MW) by 2020
- 2 million households supplied with ICSs by 2020
- LPG penetration of 50 per cent of households by 2020
- 1,000 commercial cookstoves supplied by 2020
- 55 mini grids (10 MW) by 2020
- 2 million solar lanterns distributed by 2020.

The technical interventions will directly contribute towards these national targets.

The overall purpose of the NAMA is to increase access to clean energy technologies (i.e. renewable energy and clean cooking solutions) in a sustainable manner while leading to transformational change. This purpose will be met through fulfilling two objectives.

- **Objective 1:** Enable the private sector to participate in the manufacture and distribution of clean energy technologies in Ghana.
- **Objective 2:** Create an enabling market environment that encourages the distribution of the clean energy technologies to end-users supported by an appropriate financing model.

The two objectives are linked to two distinct interventions:

- **Intervention 1:** Establish 28 Energy Productivity Zones (EPZs) with their own PV power plant.
- **Intervention 2:** Distribute clean energy technologies with the support of consumer finance.

The concept of EPZs is elaborated in further detail in Section 5.2. It provides a crucial building block for the overall NAMA.

The proposed technical interventions under the NAMA, namely the PV power plant and clean energy technologies will contribute directly to emissions reductions and support the achievement of Ghana's national targets for renewable energy and clean cooking solutions.

Table 5-1 summarizes the NAMA targets and their contribution towards meeting the national targets.

### Table 5-1: NAMA Targets and Contribution to National Targets

| NAMA Target | National Target |
|---|---|
| **Intervention 1** | |
| Establish 28 PV power plants with a total capacity of 400 kWp | Contribute towards the 10 MW target for mini-grids |
| **Intervention 2** | |
| Enable distribution of the following clean energy technologies: | Contribute towards the RE and Clean Cooking targets as given below. |
| ***Renewable Energy*** | |
| Solar PV Lanterns: 1 million | Contribute towards the target of 2 million solar PV lanterns |
| Roof-top Solar Systems: 50,000 | Contribute towards the target of 200,000 solar systems |
| ***Clean Cooking*** | |
| Improved Cookstoves (ICS): 1 million | Contribute towards the target of 2 million ICSs |
| LPG Cooking Solutions: 250,000 | Contribute towards the target of 50 per cent of households with access to LPG |
| Commercial Cookstoves: 500 | Contribute towards the target of 1,000 commercial cookstoves |

## 5.1 Setting the Context

As shown in Table 5-1 above, the interventions under the NAMA are intended to provide renewable energy and clean cooking solutions for homes and at the same time contribute towards the achievement of various energy related targets set out in the policies and programmes of the Government of Ghana. The NAMA will contribute to the following:

- Increasing the total energy supply from renewable technologies in Ghana

- Increasing the penetration of improved efficiency cookstoves
- Stimulating investment in the renewable energy sector
- Reducing the average woodfuel energy intensity
- Improving access to modern energy for cooking
- Increasing in the penetration of LPG cooking solutions
- Contributing to universal access to energy
- Developing a well-functioning energy market.

### 5.1.1 The Boundary Conditions for the NAMA Interventions

Through the two interventions, the NAMA will support the creation of a private sector enabled sustainable business model with the EPZs acting as hubs for the manufacture and distribution of clean energy technologies to end consumers. It must be noted that this NAMA document is developed on a set of assumptions that help define the NAMA boundary as listed below. But the actual implementation of the NAMA will be defined through a detailed Techno-Commercial Analysis (see Section 5.3.3 for additional information) and subject to the approval of the Government of Ghana based on availability of finance and the actual requirements on ground. The interventions under this NAMA document are limited by the following boundary conditions.

- **Mitigation technologies under the NAMA:** The NAMA promotes access to two types of clean energy technologies – namely renewable energy (RE - solar PV lanterns and roof top solar systems) and clean cooking solutions (CC - improved cookstoves, LPG cooking solutions and commercial cookstoves) (see Section 5.4.1 on Clean Energy Technologies for additional information).
- **Other technologies and income generating activities:** The proposed NAMA framework can be used to promote other income generating activities and technologies but it is beyond the current scope of the NAMA boundary to estimate the financial requirements, emissions reductions, sustainable development benefits and other NAMA "building blocks" of these activities.
- **NAMA beneficiaries - Private sector:** Participation in the NAMA is limited only by the eligibility criteria to be developed by the Government of Ghana aimed at selecting stakeholders who have the required capability to ensure the overall success of the NAMA objectives (see Private Sector Stakeholders in Section 5.1.3).
- **NAMA beneficiaries - Consumers:** The end-users whom the clean energy technologies aim to reach are the entire population of Ghana across its socio-economic groups and administrative areas, including the "poorest of the poor".
- **NAMA lifespan:** NAMA implementation will run for a 12-year period from 2017 to 2028. This ensures alignment with the new Vision 2057, to be launched in 2017, and with the first three four-year medium term plans (covering 2017-2020, 2021-2024 and 2025-2028).

- **Guiding principle:** The proposed interventions and measures under the NAMA is designed as a model framework for improving access, affordability and appropriate choice of technology which will lead to emissions reduction, sustainable development benefits and the transformation of the energy sector in Ghana.

- **MRV and finance:** The interventions and measures listed in this chapter form the basis for estimating the emissions reduction, sustainable development benefits, financing requirement and other building blocks of this NAMA.

### 5.1.2 Synergies offered by Two Types of Clean Energy Technologies

The above conditions lead to several synergies that are advantageous for the development of a robust NAMA framework that makes it attractive to the potential sources of finance and private sector participants that are essential for the overall success of the NAMA.

- **Economies of scale:** The two technologies are aimed at a single market segment, namely households, but collectively they involve the distribution of over 2.25 million individual technology units for renewable energy and clean cooking solutions. The economies of scale will make the technologies more affordable to end users, many of who can benefit from both types of technologies.

- **Private sector participation:** The proposed volumes and the dedicated market segment will make the NAMA attractive to private sector participants considering investment in the manufacturing and distribution activities. The range of technologies and products will make it attractive to businesses who can benefit from the cost synergies.

- **Improved opportunities for existing players:** As elaborated in Section 5.1.3 below on Private Sector Participation, there is no limit on the type of participants in the EPZs, thus making it particularly attractive for existing players to broaden their business activities (e.g. cookstoves manufacturers wishing to participate in assembly of lanterns as they target the same market segment for both products).

- **Shared infrastructure and services:** In addition, the concentration of activities in the EPZs makes it easier to carry out awareness creation, capacity-building and training, and access to consumer finance, and to avoid duplication of NAMA related support activities such as MRV.

- **MRV system:** Although the NAMA promotes several types of technologies and products (lighting, electricity, cooking with charcoal, LPG) from an emissions reduction perspective, the many similarities between them allow the NAMA to propose a simplified MRV system based on existing CDM methodologies. In addition, the large number of units, technologies and infrastructure facilities will increase the sustainable development benefits (e.g. employment, availability of finance, capacity building etc.) and the potential for mitigation.

- **Institutional set-up:** Both the technologies relate to energy sector in Ghana and the NAMA involves institutions that have an interest in both technologies (e.g. the Ministry of Power, the Energy Commission etc.). Hence the NAMA will benefit from shared resources, manpower from existing institutions (as well as proposed ones, such as the MRV Cell'), systems and processes. This in turn will contribute to developing a more cost effective NAMA attractive to finance.

### 5.1.3 Private Sector Participation

One of the key challenges to building wider access to energy is Ghana's dependency on imports. The NAMA aims to stimulate the participation of the private sector in Ghana to create supply, as well as an enabling market environment that will enhance demand. By creating demand for and a supply of clean energy solutions through a sustainable business model, building institutional capacity and benefitting from the synergies described above, the NAMA aims to maximize the social, economic and environmental impact for every dollar invested and create the momentum for private sector entrepreneurs to participate in the transformation of the energy sector. The NAMA places no restriction on participation and is open to all, including the following.

- **Existing players** in Ghana involved in the manufacture and distribution of renewable energy and clean cooking solutions, including improved cookstoves. The NAMA puts no limitation in terms of the size of existing actors (i.e. based on production capacity). The Government will strive to make it easier for current stakeholders to integrate their business activities into the NAMA in an appropriate manner (see Section 5.1.4 on Eligibility Criteria for more details).
- **Future players and businesses** can be both national and international stakeholders willing and capable of participating in the NAMA.
- **Local communities/cooperatives** may register with the appropriate government authorities to participate in the NAMA.

### 5.1.4 Eligibility Criteria

While there is no restriction on the type of participants, the Government of Ghana will establish a set of eligibility criteria to ensure that interested private sector participants have the minimum level of capability required to undertake the activities under the business model and ensure the overall success of the NAMA. A proposed idea is to develop a scoring system, based on such criteria as the following.

**Financial capacity:** While the NAMA has provision for extending loans to the private sector, the eligibility criteria can define the equity contribution required for various types of commercial activities (e.g. manufacture or distribution, size of EPZ etc.). The equity contribution of existing players can be different from that of new entities (e.g. the equity limit for existing players could be set at 20 per cent, while for new players it could be higher, at, say, 25 per cent, to reflect the higher risk associated with lack of previous experience).

**Technical capacity:** Any income generating activity requires an appropriately trained and skilled work force. While the NAMA supports several types of capacity-building and training, the eligibility criteria can require that participants already have a specified skills and knowledge base (e.g. entities interested in assembling PV lanterns may be required to have existing skills such as soldering of electrical circuit boards). This can also benefit existing players and ensure that future businesses bring significant value addition to the NAMA.

**Measures:** The Government can choose to sign a compliance agreement with private sector participants (e.g. limit the maximum number of units produced by a manufacturer in the initial years) to ensure a level playing field and make it attractive to private sector. The compliance agreements will ensure that measures

covering quality standards, product identification protocols, awareness creation, MRV and so on are effective (see Sections 5.3.3 and 5.4.3).

**Sustainable development benefits:** The activities under the NAMA require other types of hard and soft resources and sustainable development benefits such as land for the construction of EPZs, ability to reach out to remote communities, women and youth employment etc. The eligibility criteria can have provisions to ensure that an interested participant brings a certain type of value addition (e.g. a preference can be given to women's empowerment groups) that can ensure that the sustainable development benefits proposed under the NAMA are realized.

### 5.1.5 International Context

The NAMA will strengthen the quality of Ghana's INDCs, its ability to meet the post-2015 SDGs and its capacity to benefit from existing and new sources of climate finance. Ghana will need several billion dollars worth of investment from domestic and international public and private sources to finance its climate mitigation and adaptation actions as outlined in the INDC submitted to the UNFCCC Secretariat in 2015. By undertaking a NAMA, the country can make direct contributions to its INDC commitments while seeking international finance that is applicable for actions developed under NAMA frameworks.

### 5.1.6 NAMA Outcomes

Implementing the NAMA interventions will result in the following outcomes.

- Scaled up emissions reduction over the 12-year life span of the NAMA.
- Establishment of the physical infrastructure and facilities for manufacturing, distribution and finance under the NAMA will lead to significant sustainable development sustainable development benefits, particularly ones related to employment creation, capacity-building and training, and access to finance.
- Participation of the private sector.
- This in turn will lead to a transformational change of the energy sector in Ghana
- International finance will play a key role in driving this change.

## 5.2 Understanding the Concept of EPZs

The NAMA interventions and activities are centred on a set of physical infrastructure facilities termed Energy Productivity Zones (EPZs). As the name suggests, EPZs consist of two components – a productivity zone, consisting of workspaces and supporting infrastructure, and an energy solution that makes electricity available for the activities undertaken in the productivity zone.

- **Work spaces:** Consisting of a well-lit and well-ventilated group of buildings, the work spaces comprise areas for manufacturing and storage as well as offices where businesses and private sector enterprises can undertake gainful income generation activities. When fully realized, the work areas will support a broad variety of economic activities through micro, small and medium scale enterprises that can support and be supported by the local economy.

- **Supporting services and infrastructure:** Supporting services and infrastructure will be required to ensure the overall success of the EPZ and the NAMA. These will include:
  - facilities for training, capacity-building and raising awareness;
  - shops or stores for the sale of goods and services;
  - IT infrastructure and facilities for data collection and recording (e.g. undertaking the NAMA MRV); and
  - office space for supporting activities (e.g. microfinance institutions).
- **Energy solutions:** To enable the commercial activities to take place, every EPZ will be provided with an assured supply of electricity. In line with the national target of increasing the contribution of renewable energy sources, the energy solutions can be of the following types:
  - stand-alone solar PV power plant (i.e. 100 per cent solar power);
  - solar PV power plant with AC hybrid (i.e. connected to national grid);
  - solar PV power plant with diesel generator hybrid (i.e. connected to diesel generators);
  - other types of technology using renewable energy (e.g. pico-hydro, small wind etc.),

  For the purpose of this NAMA, a stand-alone solar PV power plant is the chosen solution. Typically, the power plant will consist of solar PV modules of required capacity, inverters, battery banks and power outlets for the individual workspaces. The emissions reductions, NAMA finance and other building blocks are based on this being the technology used in this NAMA.

  *Additional provisions for energy solutions*

  The size of PV Power Plants in EPZs will be determined by the varied nature of activities and power requirements (e.g. welding, painting, punching holes into sheet metals, assembly of systems etc.) (see Table 5-2 on the types of EPZ). The actual power requirements will be determined under the proposed Techno-Commercial Analysis and, depending on the availability of finance and of connections to the grid, the additional power requirement can be met through the national grid or adding capacity to that of the solar PV.

  In line with the Government's ambition of extending the national grid, it is proposed that appropriate technical provision is made in the energy solution to allow it to be connected to the national grid. The provisions may include electric sub-stations, net-metering, additional module capacity for the development of mini grids to power local communities, and so on. However, for the purpose of defining the NAMA boundaries, the scope of the stand-alone PV power plant is limited to generating electricity for the EPZs at a defined capacity, as noted in Section 5.3.2.

### 5.2.1 The Business Models of EPZs

EPZs present a holistic approach to tackling several challenges under a NAMA. The EPZ model simultaneously addresses three interconnected issues that will collectively contribute to the success of the NAMA objectives:

- access to an assured supply of clean energy technology;
- the socio-economic development of local communities; and
- a business model that is sustainable and attractive to finance.

The model recognizes that the solution to lifting communities out of poverty is access to sustainable modern electricity services, but that the same communities often do not possess the income streams to pay for the relatively high cost of electricity. In creating, an income generating opportunity the EPZs will have a positive impact on the livelihoods of people directly or indirectly employed in the manufacture of clean energy technologies and in the EPZs, but also on the community at large. As incomes rise, it will generate additional disposable income, which is known to have a direct relationship to improved standards in education, healthcare and sanitation.

The EPZ business model looks at three types of private sector participation:

- **EPZ Business Model 1:** Participation in building the physical infrastructure related to the EPZ;
- **EPZ Business Model 2:** Participation in the manufacture of clean energy technologies;
- **EPZ Business Model 3:** Participation in the distribution of clean energy technologies.

While a single private sector entity can participate in all the three business models, this NAMA document elaborates the three models separately, as the activities and capabilities required to build, own and operate each is distinct, as are the revenue streams. Business Models 1 and 2 relate to Intervention 1, while Business Model 3 relates Intervention 2, as further elaborated below.

## 5.3 Intervention 1: Establish 28 EPZs with their own PV Power Plants

Objective one calls for private sector participation in the manufacture and distribution of clean energy solutions in Ghana. This objective will be met through setting up a network of EPZs. Under this intervention, this NAMA document proposes to establish 28 Energy Productivity Zones (EPZs) across Ghana.

**EPZ Business Model 1 – Participation in building the physical infrastructure related to the EPZ**

Any private sector participant investing in the EPZ will invest in two "hard" infrastructure facilities, the workspaces and the supporting infrastructure. The eligibility criteria can set a minimum level of equity investment required, with the remainder financed through a commercial loan under the NAMA Financing Facility. The participant will generate income by renting out workspaces to other entities in the EPZ, e.g. the manufacturer and distributor of clean technologies, by engaging in other income generating activities and by charging for the electricity consumed.

The energy solution is intended to be 100 per cent financed by grants, which will cover the costs of procurement and installation and of two years of operations and maintenance. As the cost of an assured supply of energy (e.g. US$/kWh) in remote and rural areas can be high, grant financing has the benefit of lowering energy costs, which can allow manufacturers and distributors to make technologies more affordable to the end-users. The private participant is responsible for the upkeep and maintenance of the solar PV plant as it in their commercial interest to ensure a stable supply of electricity.

**EPZ Business Model 2 – Participation in the manufacture of clean energy technologies**

The EPZs with their workspaces, energy and supporting services will allow private sector participants to manufacture the clean technologies. Under the NAMA it is proposed that eight of the 28 EPZs will have the capacity (e.g. physical areas, power plant capacity etc.) to establish manufacturing facilities. It must be noted that "manufacturing" is used to describe both assembly (e.g. of solar PV technologies) and manufacturing (e.g. of ICSs and LPG cookstoves) activities.

The EPZs will support the assembly and manufacture of all technologies (excluding LPG cylinders), some of which may require installation on site (e.g. solar systems for homes and commercial cooking solutions).

Any private sector participant investing in manufacturing activity will invest in rental space, machinery, the workforce (training, salaries etc.) for one or more of the above-mentioned manufacturing activities. The eligibility criteria can define a minimum level of equity investment required, with the remainder financed as a commercial loan through the NAMA Financing Facility. The participant will generate income by bulk sale of units either to distributors or to the Government under a public procurement scheme (see Section 7.2.2, Item 5A for more details.)

### 5.3.1 Establishing 28 EPZs

The NAMA recognizes that a "one size fits all" approach may not be appropriate, given the wide socio-economic disparities in Ghana. It is therefore proposed to establish three categories of EPZs, namely large (L), medium (M) and small (S) in the following numbers:

- EPZ-L – 4
- EPZ-M – 4
- EPZ-S – 20.

The intent of categorizing EPZs in this way is to ensure that their design and scope are optimal for local conditions. While the Techno-Commercial Analysis will determine the number of EPZs and their specifications, the table below provides a list of indicative characteristics assumed under the NAMA.

### Table 5-2: Types of EPZs and their Characteristics

| EPZ details | EPZ-L | EPZ-M | EPZ-S |
|---|---|---|---|
| Catchment area | Greater than 200,000 | 100,000-200,000 | 50,000- 100,000 |
| No. of EPZs | 4 | 4 | 20 |
| Manufacturing facility (8) | Yes | Yes | No |
| Distribution hub (28) | Yes | Yes | Yes |
| | | | |
| PV Power Plant (per EPZ) | 50kWp | 25kWp | 5kWp |
| MRV point for data collection | Yes | Yes | No |
| Internet enabled IT facility | Yes | Yes | Yes |
| Training facility (e.g. audiovisual equipment) | Yes | Yes | No |
| Finance (e.g. office for micro-finance) | Yes | Yes | No |

**Location of EPZs**

The intent of having 28 EPZs is to ensure that the EPZs are spread across the entire country. While the Techno-Commercial Analysis will determine the exact locations of the EPZs and their technological potential, the table below provides a list of 28 towns where EPZs could be located along with their populations to determine their "catchment areas".

### Table 5-3: Potential Locations of EPZs by type

| S. No. | Code | City | Population | Region | EPZ Type |
|---|---|---|---|---|---|
| 1 | A | Accra | 2,291,352 | Greater Accra | L |
| 2 | K | Kumasi | 2,069,350 | Ashanti | L |
| 3 | T | Tamale | 562,919 | Northern | L |
| 4 | S | Sekondi-T | 445,205 | Western | L |
| 5 | | Ashiaman | 298,841 | Greater Accra | S |
| 6 | | Sunyani | 248,496 | Brong-Ahafo | S |
| 7 | | Cape Coast | 227,269 | Central | S |
| 8 | | Obuasi | 180.334 | Ashanti | S |
| 9 | | Tema | 161,612 | Greater Accra | S |
| 10 | | Koforidua | 130,810 | Eastern | S |
| 11 | W | Wa | 105,821 | Upper West | M |
| 12 | | Techiman | 104.212 | Brong-Ahafo | S |
| 13 | H | Ho | 99,375 | Volta | M |
| 14 | | Nungua | 86,431 | Greater Accra | S |

| S. No. | Code | City | Population | Region | EPZ Type |
|---|---|---|---|---|---|
| 15 | | Dome | 84,904 | Greater Accra | S |
| 16 | | Gbawe | 80,991 | Greater Accra | S |
| 17 | | Oduponkpehe | 80,820 | Central | S |
| 18 | | Ejura | 75,390 | Ashanti | S |
| 19 | | Bawku | 71,074 | Upper East | S |
| 20 | | Aflao | 69,284 | Volta | S |
| 21 | | Agona Swedru | 68,216 | Central | S |
| 22 | B | Bolgatanga | 68,183 | Upper East | M |
| 23 | | Tafo | 62,382 | Ashanti | S |
| 24 | | Berekum | 62,364 | Brong-Ahafo | S |
| 25 | | Akim Oda | 60,604 | Eastern | S |
| 26 | | Winneba | 60,331 | Central | S |
| 27 | | Hohoe | 58,155 | Volta | S |
| 28 | X | Yendi | 52,774 | Northern | M |

### 5.3.2 Energy Solution – PV Power Plant

As shown in the Table 5-3 above, the three types of EPZs have solar PV power plants with distinct capacities. Assuming a daily electricity generation potential of 4 kWh/day and 350 days of sunshine for a 1kWp solar PV plant, the table below summarizes the electricity potential and total capacities assumed under Intervention 1.

**Table 5-4: Electricity Generating Potential under Intervention 1**

| Type of EPZ | Capacity | No. of EPZs | Generation per EPZ | Total |
|---|---|---|---|---|
| EPZ-L | 50 kWp | 4 | 70,000 kWh/year | 280,000 kWh/year |
| EPZ-M | 25 kWp | 4 | 35,000 kWh/year | 140,000 kWh/year |
| EPZ-S | 5 kWp | 20 | 7,000 kWh/year | 140,000 kWh/year |
| **Total** | **400 kWp** | **28** | | **560,000 kWh/year** |

**Grid connectivity:** On the above assumptions, 20 kWh/day (EPZ-S), 100 kWh/day (EPZ-M) and 200 kWh/day (EPZ-L) of electricity will available for undertaking activities within the EPZs. The actual electricity requirement will depend on the type of machinery used and the actual activities undertaken, and will be determined through the Techno-Commercial Analysis before NAMA implementation.

As the PV power plants are intended to be 100 per cent grant financed, the availability of finance will determine the actual capacity of the power plants and usable power. Moreover, the PV power plants will be fitted to draw additional power from the national grid. The NAMA's MRV system assumes that no additional power is drawn from the national grid and that the solar PV power plants are self-sufficient in meeting the power requirements of the EPZ.

## 5.4 Intervention 2: Distribute Clean Energy Technologies with the Support of Consumer Finance

Objective 2 calls for creating an enabling market environment that encourages the uptake of clean energy solutions by end-users in Ghana with the support of an appropriate financing model. While Objective 1 addresses the supply side, the second objective focuses on the demand side. The key drivers of this for demand side management are the 28 EPZs, which will act as the distribution hubs and be supported through appropriate measures.

**EPZ Business Model 3: Participation in the distribution of clean energy technologies**

The EPZs with their workspaces and energy and supporting services will allow private sector participants to distribute the clean technologies. Under the NAMA it is proposed that all 28 EPZs will have the capacity to carry out this function (e.g. physical areas, power plant capacity etc.). "Distribution" is used here to describe retail, after sales and support, community level demonstration projects and awareness creation, and the on-site assembly of solar systems and commercial cooking solutions. While the proposed Techno-Commercial Analysis will determine the potential sales of each type of technology for individual EPZs based on their location, their size, the socio-economic characteristics of the local community etc., the NAMA proposes the distribution of the following Clean Energy Technologies over the lifespan of the NAMA:

- solar PV lanterns: 1 Million units solar solutions (actual assembly will happen on site): 50,000 Units
- improved cookstoves: 1 Million units
- LPG cookstoves: 250,000 units (including gas cylinders)
- commercial cookstoves (actual assembly will happen on site): 250.

Any private sector participant investing in a distribution activity will invest in rental space for shops and display, IT infrastructure and supporting services (e.g. ensuring that a certain number of units are kept in stock), the workforce (training, salaries etc.). The eligibility criteria could define a minimum level of equity investment required, with the remainder financed as a commercial loan through the NAMA Financing Facility. The participant will generate income by the direct sale of units to end users with the support of a Consumer Finance Model.

### 5.4.1 Clean Energy Technologies

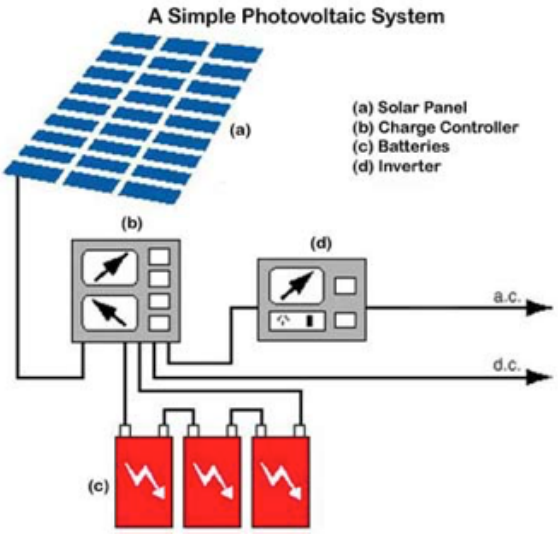
To tackle the challenge of lighting and cooking, Ghana currently has several national targets based on renewable energy and clean cooking solutions and the NAMA aims to contribute to these targets. The NAMA is open to all existing players (e.g. members of Ghana Alliance of Clean Cookstoves), new businesses and local communities/cooperatives. The focus will be on the following types of technologies.

**PV solar lanterns**

A typical solar lantern consists of a few light-emitting diodes (LEDs), a solar panel and a small rechargeable battery, encased in a durable plastic shell. A standardized product that can be sold off the shelf,

the solar lanterns can offer 3-4 hours/day of run-time (i.e. the number of hours the lamp is operational on a full day charge). Solar powered lanterns are poised to improve incomes, educational attainment and health across the developing world.

**Solar solutions for homes**




A rooftop solar solution for homes consists of a set of solar panels, a battery bank and electronics and is able to provide electricity for home use. The size of the PV modules and the battery bank will determine the amount and duration of electricity available. The power can operate regular appliances such as lights, fans, refrigerators, televisions, computers etc. The systems can be made into hybrid power solutions by making provision for the battery bank to be charged through grid power or some other power source. For the purpose of this NAMA, systems with an average of 500 Watt peak (Wp) capacity are used for estimating costs and emissions reductions.

**Improved cookstoves**

Improved cookstoves are cooking solutions that use a significantly lower quantity of fuel (fuel wood or charcoal) than traditional cookstoves (such as three stone cooking arrangements). There are several improved cookstoves programmes in the developing world. The largest global programme is the Global Alliance for Clean Cookstoves with a target of reaching 100 million households by 2020. Currently, the interest in ICSs focuses on the "triple benefits" they provide: in improved health and time saved for households, in preserving forests and associated ecosystem services, and in reducing emissions that contribute to global climate change. Despite the socio-economic benefits of such technologies, however, progress in achieving large-scale adoption and use has been slow.

**Community cookstoves**

The community cookstoves are similar in principle to the ICSs for home use except for its size and portability. Community cookstoves are used in schools, hospitals or hotels to cook larger volumes of food that in turn demands heavier design requiring them to be fixed. Cmmunity cookstoves are also offer a highly attractive way of demonstrating the benefits of improved cookstoves to a large audience as the cooking are typically undertaken by women and there is a significant difference in fuel usage, smoke and other harmful effects.

**LPG cooking solutions**

The SE4All programme looks at LPG as a model solution to make clean cooking solutions available to several millions of people across the world. LPG cooking systems typically consist of a LPG gas burner and a gas cylinder connected via a rubber gas pipe. The gas cylinder, which consists of LPG under pressurized conditions, needs replacing once the fuel is consumed. The LPG systems release no smoke or soot, and generate lower emissions than other types of hydrocarbon fuel.

### 5.4.2 Technology Models and Distribution Plan

The key driver of Intervention 2 is the consumer finance model. While Chapter 7 on finance deals with the details of loans, equity and total financing required, this section describes the various technology models proposed under the NAMA and an annual distribution plan, which will include annual cash flow over the lifespan of the NAMA. As clean energy technologies benefit the entire population of Ghana, the NAMA looks into three aspects of the development of a sustainable business model:

- Ability: The financial ability of end consumers
- Appropriateness: The choice of model available to consumers
- Affordability: The price point for each model

Financial ability determines whether households are able to pay for the technologies. The NAMA considers two categories of people: the "poorest of poor" who have very little or no ability to pay for technology, and the remaining members of Ghana's socio-economic pyramid who can benefit from consumer loan finance.

Affordability and appropriateness deal with the question of how to make the right technology available at the right price to the right people. Corresponding to the categorization mentioned above, the NAMA proposes two types of model, "basic" (aimed at the "poorest of the poor") and "general" (aimed at the rest of the population). While the Government can choose whether to define the "basic" model as a product with fewer features to allow it to be more competitively priced, or to retain the identical technical specifications as those of the general model but with some differentiation built in (e.g. colour), the NAMA makes a case for the basic models to be directly procured by the government from the manufacturers under the public procurement scheme. The table below summarizes the models, the target consumer and the financing scheme.

**Table 5-5: Distribution of Technology Models by Financing Method**

| Model and Number of Units | Target Audience | Comments |
|---|---|---|
| Basic PV Lantern<br>20 per cent of 1 million<br>= 200,000 Units | The «poorest of the poor»' sections of society | Distributed under a grant based model under public procurement scheme |
| General PV Lantern<br>80 per cent of 1 million<br>= 800,000 Units | All sections of society | Distributed through the consumer finance model |
| General Solar Solutions<br>100 per cent of all units<br>= 50,000 Units | All sections of society | Distributed through the consumer finance model |

| Model and Number of Units | Target Audience | Comments |
|---|---|---|
| Basic ICSs<br>20 per cent of 1 million<br>= 200,000 Units | The «poorest of the poor» sections of the society | Distributed under a grant based model under public procurement scheme |
| General ICSs<br>80 per cent of 1 million<br>= 800,000 Units | All sections of society | Distributed through the consumer finance model |
| LPG Cookstoves<br>100% of all units<br>= 250,000 Units | All sections of society | Distributed through the consumer finance model |
| Commercial Cookstoves<br>= 250 Units | Schools and other village level community institutions | Distributed under a grant based model under the public procurement scheme |

For the purposes of NAMA financing, the cash flow is based on an annual distribution plan, which gives the number of units distributed in a given year as percentage of the total number of units to be produced over the lifetime of the NAMA.

### Table 5-6: Percentage of Total Units Distributed per Year

| Year | EPZ-L | EPZ-M | EPZ-S | TOTAL |
|---|---|---|---|---|
| 2017 | 2.90 | 0.00 | 0.72 | 3.62 |
| 2018 | 2.90 | 1.45 | 1.45 | 5.80 |
| 2019 | 5.80 | 1.45 | 2.17 | 9.42 |
| 2020 | 5.80 | 2.90 | 2.90 | 11.59 |
| 2021 | 5.80 | 2.90 | 2.90 | 11.59 |
| 2022 | 5.80 | 2.90 | 2.90 | 11.59 |
| 2023 | 5.80 | 2.90 | 2.90 | 11.59 |
| 2024 | 5.80 | 2.90 | 2.90 | 11.59 |
| 2025 | 5.80 | 2.90 | 2.90 | 11.59 |
| 2026 | 5.80 | 2.90 | 2.90 | 11.59 |
| 2027 | 0.00 | 0.00 | 0.00% | 0.00 |
| 2028 | 0.00 | 0.00 | 0.00 | 0.00 |

## 5.5 Measures for Interventions 1 and 2

### 5.5.1 Measures for Intervention 1

To establish 28 EPZs in Ghana along with solar PV power plants with a total capacity of 400 kWp, the following measures need to be undertaken.

#### *5.5.1.1 Financial Measures*

**Loans for private sector actors:** This activity will focus on creating a loan facility that will make finance available at market rates to private sector entities investing in any of the three business models. The loans will be over and above a minimum equity investment required from each of the actors looking to invest in the business models.

**Grants for PV power plants:** The NAMA will finance the following costs of the PV power plants:

- the capital investment required for the procurement of the technology and its installation; and
- the operation and maintenance of the power plants for a period of two years.

Once these grants have been made, the operation and maintenance of the PV power plant will be the responsibility of the private sector actor investing in the construction and operation of the EPZ.

#### *5.5.1.2 Policy Measures*

**Detailed techno-commercial analysis:** The first step in establishing the EPZs is to undertake a detailed techno-commercial analysis. This will be carried out under a consultancy contract by an appropriate international or national entity (e.g. a consultancy company). Its outputs will include (but not be limited to):

- identifying the potential locations of the 28 EPZs, including the EPZs that will have manufacturing and distribution facilities;.
- assessing the potential demand for clean energy solutions within a defined "catchment area" based on the type of technology, annual demand over the lifespan of the NAMA, socio-economic indicators of the purchasing power of the local population etc.;
- providing the technical specifications of the design and costing of the 28 EPZs (land acquisition, cost of construction, design options, etc.);
- establishing the PV power plant's capacity based on the assessed power requirement and its cost;
- estimating operating costs (salaries, hardware requirements, internet etc.);
- drawing up an implementation schedule;
- determining other SD parameters (potential employment, capacity building etc.).

The analysis will be prepared and submitted to the Ministry of Power for final approval and will provide a clear roadmap for the construction and operation of the EPZs. The analysis will also provide a sound basis for determining the financial aspects of the NAMA including the financing facility, cash flow, and potential sources of funding.

As the analysis will provide a roadmap for decision-making on and implementation of the NAMA that in turn will contribute to the achievement of the national targets, the Techno-Commercial Analysis is treated as a policy measure. The NAMA financing plan will make a dedicated budgetary provision for this analysis.

### 5.5.2 Measures for Intervention 2

To ensure the distribution of 2 million clean energy solutions (PV lanterns, ICSs and LPG Cooking solutions), a series of measures needs to be undertaken:

#### *5.5.2.1 Financial Measures*

**Revolving loan fund:** This is a key mechanism to ensure that finance is available to the end-users at the point of purchase. This will be done by establishing a revolving loan facility where money paid back over a two-year cycle by the end-users will be used to replenish the fund. This model will allow the establishment of a loan facility with a relatively small capital base, making it attractive to international finance. This is further elaborated in Chapter 7 (Section 7.2.1, Item 5B)

#### *5.5.2.2 Quality Standard*

Ghana has well established national quality standards for several of the technology interventions being discussed in the NAMA interventions and can enforce these standards on manufacturers to develop products of acceptable quality.

#### *5.5.2.3 Policy Measure – Return of Goods*

Based on the principle of 'Circular Economy' – a generic term used to describe an industrial economy that is restorative by nature (i.e. promotes the use of renewable energy, recycling, re-use, re-design etc.), the Government will initiate a policy to ensure that the technologies are returned to the distribution points at the end of the technical lifespan of the product. This will ensure that precious components and materials, such as PV modules and sheet metal, are recycled back into the system as appropriate, and that waste emerging from the products is reduced.

### 5.5.3 Common Measures for Interventions 1 and 2

#### *5.5.3.1 Capacity-Building Measure – Business Model and Stakeholder Awareness*

This activity will focus on the appointment of a technical advisor who will then be responsible for reaching out to private sector actors and informing them about the three business models, the eligibility criteria, standards, procedures, financing and the institutional system for the NAMA.

As already mentioned (see Section 5.2.1), there are three business models of private sector participation in the EPZs based on the type of commercial activity undertaken. Private sector actors can be invited to invest in one or more of the three business models. The three models are explained in further detail below.

- **Model 1—EPZ:** This focuses on private sector entities participating in the construction of the EPZ (i.e. the physical infrastructure) and operating it. The business model is based on generating revenues from rental incomes (renting space to entities investing in commercial activities within the EPZ) and selling electricity to EPZ users.

- **Model 2—Manufacturing:** This focuses on private sector actors investing in the manufacture of ICSs and/or the assembly of PV lanterns. The businesses will generate revenue from the bulk sale of clean energy solutions to distributors and/or to the Government under public procurement rules see Public Procurement in Section 7.2.1, Item 5A for additional information)

- **Model 3—Distribution:** All 28 EPZs will act as distribution hubs where end-users can purchase the clean energy solutions. The distributors will be responsible for awareness creation and marketing, and will sell the clean energy solutions under normal market terms (competitive pricing).

#### *5.5.3.2 Institutional Measures*

Two key institutions will need to be established to ensure the success of the NAMA, one is the financial entity that will be responsible for the management and operation of the Financing Facility and the second is the Coordinating and Implementing Entity that will placed under the Energy Commission with two distinct responsibilities—overall management of the non-financial and technical issues of the NAMA, and the NAMA MRV.

#### *5.5.3.3 Other Income Generating Activities*

While the business model for EPZs under this NAMA focuses on manufacturing and distribution of clean energy solutions and related activities (e.g. data collection for MRV, consumer finance etc.). The EPZs may invite private sector actors to invest in other types of income generating activity by establishing micro or small-scale enterprises.

While such entities are expected to pay rent and for the electricity they consume, the terms and nature of their participation are not elaborated on in this NAMA document. Neither is the financing and capacity-building of such entities.

Refer to Annex 8 for a detailed list of NAMA Measures and Interventions along with their inputs, activities and outputs.

# 6 CAPACITY DEVELOPMENT

There exist a number of barriers in terms of capacity to the implementation of the measures and interventions described in the Chapter 5. Ghana's commitment to provide access to clean energy through the establishment of market based solutions under this NAMA cannot be fulfilled if these barriers remain. As a result, addressing these capacity development needs becomes imperative for the success of the NAMA.

The proposed capacity-building programmes will consists of two components.

Component 1: This will comprise capacity-building programmes which support the preparation and implementation of the measures and interventions

Component 2: This consists of an awareness creation and marketing campaign

## 6.1 Component 1

Under this component, capacity-building support will be provided to the Government and semi-government organizations, private sector actors and financial institutions involved in the implementation of the interventions. This capacity-building will take place at two levels, the institutional and individual levels.

### 6.1.1 Institutional Level

There are a number of capacity development activities which will occur as part of the NAMA. The main form of institutional capacity development will focus on institutional strengthening.

#### *6.1.1.1 Institutional Strengthening*

Under this component, capacity building support will be provided to the NAMA governing entities, specifically to the staff of the National Coordination Authority (NCA) and the National Implementing Entity

(NIE). The focus of this component will be to set up a sound institutional structure for governance of the interventions through monitoring and evaluation.

As discussed in Chapter 5, a technical adviser will be appointed for the initial three years of the NAMA (2017-2019) for developing the capacity of the NCA, the NIE and the MRV cell.

The following training sessions are envisaged:

1. At least 15 full-day training sessions with about 20 target participants will be held on NAMA related activities and processes. Staff from the NCA, the NIE and the MRV cell will be trained on the following topics:

    a. objectives, activities and procedures of the NAMA;

    b. basics of the RE and CC technologies to be promoted under the NAMA;

    c. project approval processes (business permits and the loan approval process) and verification;

    d. MRV for GHG emissions reductions and SD indicators;

    e. data management and reporting.

The staff will also be trained to prepare the following:

    a. documents relating to regulatory frameworks, such as land acquisition documents, building permits, techno-commercial design of EPZs etc;

    b. drafting of contractual conditions and documents setting out the relationships between the NAMA stakeholders;

    c. drafting of contracts to be signed by the NIE and the NEEs;

    d. MRV templates;

    e. drafting of application forms for business permits, tender documents etc.

All these 15 training sessions will be provided over the course of the first three years (five training sessions per year) of the NAMA. These training sessions will be led by the technical adviser.

2. A total of 12 training and refresher course sessions with about eight target participants will be held on MRV related activities. In these training sessions, staff from the MRV cell will be trained on following:

    a. MRV for GHG emissions reductions and SD indicators;

    b. data management and reporting;

    c. monitoring report preparation; and

    d. preparation of MRV templates.

All these training sessions (one session per annum) will be provided over the course of the lifetime of the NAMA.

### 6.1.2 Individual Level

These capacity building programmes will develop the capacity of individuals in the private sector, financial institutions, and workers and technical staff in the EPZs.

#### *6.1.2.1 Private Sector*

As proposed in Chapter 5, the EPZs and businesses under the EPZs will be owned and operated by private sector firms, cooperatives and communities. Under the NAMA, potential private sector participants, cooperatives and communities will be identified and EPZ specific training will be provided to them (so that they can own and operate the EPZs).

A business adviser will be appointed for the first three years of the NAMA's lifetime, who will be responsible for reaching out to private sector entities and informing them about the following topics:

a. introduction to NAMA and core concept of EPZs;

b. policy and regulatory framework for setting up EPZs and businesses in EPZs;

c. eligibility criteria for companies for owning and operating an EPZ;

d. business models and financing;

e. 6.1.2.2 Business plan writing.

In addition, the adviser will oversee the implementation of 28 EPZs' manufacturing and distribution activities.

#### *6.1.2.2 Financial Institutions*

The commercial banks/financial institutions will provide finance to private sector entities, communities and cooperatives participating in the construction and operation of the EPZs and private sector actors willing to set up businesses in the EPZs. Therefore it is important that banks understand the NAMA interventions as a new business opportunity.

A financial adviser will be appointed for the first three years of the lifetime of the NAMA, who will be responsible for reaching out to the financial institutions. The adviser will also be responsible for building the institutional capacity of the Trustee (see Section 8.1). The adviser will approach the banks to inform them about:

a. the concepts and benefits of the NAMA;

b. the role of financial institutions;

c. joint development of loan products under the NAMA;

d. the client screening process/client eligibility criteria etc.

#### *6.1.2.3 Technical staff and workers in EPZs*

The technical staff and workers in businesses in the EPZs will be trained on the following topics:

a. product pricing;

b. product coding and quality standards (eligibility criteria);

c. basic skills on product development (manufacturing), technology implementation;

d. the operation and maintenance of PV plants;

e. after-sales services; and

f. sales and product marketing.

At least 53 training sessions with about 25 target participants will be held over the course of the NAMA's lifetime. These training sessions will be led by a representative of the NIE.

## 6.2 Component 2

This component will focus on the awareness creation and marketing side of the NAMA. It will include:

- a radio campaign (awareness information will be broadcasted on radio for two minutes 125 times a year over the entire NAMA period);
- promotion in the print media (awareness information will be published in national newspapers 10 times a year for the entire NAMA period);
- the design of NAMA pamphlets and billboards; and
- community-level demonstrations in the EPZs.

At least 250 community level demonstration activities on institutional and commercial ICSs will be conducted during first 10 years of the NAMA's lifetime.

# 7 NAMA FINANCIAL REQUIREMENTS AND MECHANISMS

This chapter provides details about the financial requirements for the NAMA and the financial mechanisms which will be used to meet those requirements. It must be noted, that the financing of this NAMA, and particularly the financial mechanisms, are indicative and based on the assumptions made in Chapter 5 on Interventions and Measures (e.g. kWp capacity of the solar PV plants, number of units of each technology, etc.). The purpose of this chapter is to provide an indication of the costs by intervention, the financial requirements, the potential sources of finance (e.g. national vs. international) and a model of how financing the NAMA could be made attractive to donors.

First, the financial requirements are summarized for the overall NAMA, to provide an overview of the total financial requirement by intervention and measure. It should be noted that the NAMA financing requirement is described for the 12-year life span of the NAMA (2017-2028), divided into three phases: Phase 1: The Build-Up Phase (2017-2020); Phase 2: The Full Capacity Phase (2021-2024); and Phase 3: The Closure Phase (2025-2028). The subsequent sections further elaborate on the various components of NAMA financing.

## 7.1 Overview of NAMA Finance

This section provides an overview of the financing required from national and international sources for implementing the NAMA. Given the nature of the overall NAMA design, a significant equity contribution is also expected from end-consumers, which is discussed in some detail in Section 7.2.2.

### Table 7-1: Overview of NAMA Finance

| SN | Intervention/Measures | Description | NAMA Finance Required (US$) |
|---|---|---|---|
| 1. | PV Power Plants of 400 kWp total capacity | Cost of procurement, installation and two years operations and maintenance | 2,200,000 |
| 2. | Financing for EPZ - Business Model 1 | Loans for private sector investing in physical infrastructure for the EPZs | 1,200,000 |
| 3. | Financing for Manufacturing - Business Model 2 | Loans for private sector investing in manufacturing in the EPZs | 700,000 |
| 4. | Financing for Distribution - Business Model 3 | Loans for private sector investing in distribution channels in the EPZs | 840,000 |
| | **Total - Intervention 1 (A)** | | **4,940,000** |
| 5A. | Public Procurement | Direct purchase of basic models from manufacturers | 6,000,000 |
| 5B. | Consumer Finance | Financing for end-consumers to ensure uptake of technologies | 41,217,391* |
| 5C. | Commercial ICSs | Grant finance for installation of commercial ICSs | 750,000 |
| | **Total - Intervention 2 (B)** | | **47,967,391** |
| 6. | Techno-Commercial Analysis | One-time consultancy for a study based on ground realities | 300,000 |
| 7. | Institutional Capacity-Building | Salaries and costs of three international consultants over a three-year period | 1,350,000 |
| 8. | Operating Costs—National Implementing Entity | Salaries and Costs for personnel employed in the National Implementing Entity | 2,737,200 |
| 9. | Awareness Creation and Local Capacity-Building | Costs of training programmes, ads in media and marketing materials and community level demonstrations | 1,545,000 |
| 10. | Operating Cost of Financing Facility | Lump sum (approx. 10 per cent of the total grant component) | 500,000 |
| | **Total - Measures (C)** | | **6,432,200** |
| | **Total (A+B+C)** | | **59,339,591** |

**The US$ 41.22 million value under Intervention 2, Item 5B, represents the amount of finance that will needed to be covered through international finance for establishing the Revolving Loan Fund (see Section 7.2.2, Item 5B).*

## 7.2 Financial Requirements for the Technology Interventions

This NAMA Financing will directly contribute to the two interventions and their supporting measures. Both interventions will be executed under a long-term agreement between a private party and the appropriate governing authority of the NAMA (e.g. the Implementing Entity or the Financial Trustee). It is assumed that the private party of the Public-Private-Partnerships will be chosen through an appropriate selection process (e.g. using the point-based eligibility criteria described in Chapter 5). The measures are supporting activities that will enable the interventions to take place.

### 7.2.1 NAMA Finance for Intervention 1

The financial requirements for Intervention 1 are for establishing the 28 large, medium and small EPZs across Ghana with their own solar PV power plants with a total capacity of 400 kWp. The financing required for Intervention 1 can be categorized into two broad categories.

**Grant Finance for the Solar PV Power Plants:** Energy is the key driver for economic growth, but in the case of solar PV plants, the cost of electricity per unit of electricity (i.e. US$/kWh) is high. As the commercial activities in the EPZ business models, primarily the manufacture and distribution of RE and CC technologies, the costs of which are heavily influenced by the input cost of electricity, it is proposed that the cost of procuring the PV technology, and the installation and operation and maintenance of the PV power plants for the first two years are covered by international grant finance. This would have a direct impact on the overall RE and CC technologies manufactured in the EPZs, making them affordable to the end-consumers and thus having a positive impact on the overall objective of the NAMA.

The total finance required for solar PV plants with a total of 400 kWp of capacity is US$2.2 million, based on an assumed capital cost of US$5,000 per kWp and an assumed annual O&M cost of US$250 per kWp installed.

**Table 7-2: NAMA Finance - Grants for Solar PV Plants (US$)**

| EPZ Type | Capacity | Capital Cost | 2-Year O&M |
|---|---|---|---|
| EPZ-L (4) | 50 kWp | 1,000,000 | 100,000 |
| EPZ-M (4) | 25 kWp | 500,000 | 50,000 |
| EPZ-S (20) | 5 kWp | 500,000 | 50,000 |
| **Total** | **400 kWp** | **2,000,000** | **200,000** |
| **Grand Total** | | **2,200,000** | |

**Commercial Loans for the Private Sector:** There are three types of business model considered under the EPZ based on type of commercial activity undertaken and the private sector actors can be invited to either invest in either one or all of the three business models in each EPZ as elaborated in Section 5.2.1.

As the actual finance required in the different business models described in Section 5.5 for establishing the EPZs, setting up manufacturing facilities and creating distribution outlets can vary greatly depending on several factors (e.g. cost of construction, machinery, equipment, technical specifications, production

capacity etc.), in estimating the finance required for the private sector, a fixed loan amount based solely on the type of EPZ is assumed. In reality, the actual NAMA finance required for the three business models will be determined initially by conducting the proposed detailed Techno-Commercial Analysis and the agreement reached between the private sector entity and its lending institution. The NAMA recommends an equity contribution from the private sector entity with the balance covered through commercial loans (i.e. lent at prevailing market rates) by approved banks and other financial institutions. The finance for these commercial loans will be extended by international finance with the involvement of the National Implementing Entity (e.g. for the approval process), the Financial Trustee and approved national banks.

For the purpose of estimating the required NAMA finance, the following loan amounts have been assumed which will be covered through international loans.

**Table 7-3: NAMA Finance - Loans for the Private Sector (US$)**

| EPZ Type | Business Model 1 | Business Model 2 | Business Model 3 |
|---|---|---|---|
| EPZ-L (4) | 100,000 | 100,000 | 50,000 |
| EPZ-M (4) | 75,000 | 75,000 | 35,000 |
| EPZ-S (20) | 25,000 | — | 25,000 |
| **Total** | **1,200,000** | **700,000** | **840,000** |
| **Grand Total** | **2,740,000** | | |

### 7.2.2 NAMA Finance for Intervention 2

In this section, a distinction is made between the NAMA revenue and NAMA finance. While the former provides an indication of the total revenue generating potential of the NAMA activities over the lifespan of the NAMA, including the equity contribution from end consumers, the latter looks into the potential financing to be raised for the NAMA from a combination of national and international sources. The distinction is made to enable potential donors to have an overview of the overall financial opportunity that this NAMA provides.

**NAMA Revenue vs NAMA Finance:**

'NAMA Revenues' is an indication of the 'economic' opportunity offered by the NAMA from a sustainable development perspective. While there are several factors that will determine this economic potential, for the purpose of this NAMA, 'NAMA Revenues' are calculated based on unit selling price of the individual technology interventions multiplied by the total number of units targeted for sale under the NAMA. The selling price has been derived from the prevailing market price of similar technologies, as reported on two key websites, the World Bank supported Lighting Global website that focuses on PV technology and the Global Alliance for Clean Cookstoves website that covers ICSs.

This document recognizes that the actual selling price of the various technologies will diverge from the selling price assumed in this section. However the purpose of this exercise is to highlight the amount of 'consumer equity' in the total finance required for the NAMA. Consumer equity is the upfront payment that

an end-consumer is expected to make at the time of purchasing the technology. The balance amount which typically consists of a loan financing extended to end-consumers will be covered under NAMA Finance. The NAMA Finance for consumers is itemized under 5A, 5B and 5C in the section below.

### Table 7-4: NAMA Finance Required for Intervention 2

| NAMA Targets and Selling Price | Total NAMA Revenue (US$) | Equity Contribution1 (US$) | Consumer Finance to be covered under NAMA Finance (US$) |
|---|---|---|---|
| Basic PV lanterns: 200,000 at US$15 per unit | 3,000,000 | Nil2 | 3,000,000 (Item 5A) |
| General PV lanterns: 800,000 at US$25 per unit | 20,000,000 | 4,000,000 (at 20 per cent of total) | 16,000,000 (Item 5B) |
| Solar Home Systems: 50,000 at US$5,000 per kWp | 231,250,000 | 46,250,000 (at 20 per cent of total) | 185,000,000 (Item 5B) |
| **Total for RE (A)** | **254,250,000** | **50,250,000** | **204,000,000** |
| Basic ICSs: 200,000 at US$15 per unit | 3,000,000 | Nil2 | 3,000,000 (Item 5A) |
| General ICSs: 800,000 at US$25 per unit | 20,000,000 | 4,000,000 (at 20 per cent of total) | 16,000,000 (Item 5B) |
| LPG Solutions: 250,000 at US$100 per system | 25,000,000 | 5,000,000 | 20,000,000 (Item 5B) |
| Commercial ICSs: 250 at US$3,000 per installation | 750,000 | Nil3 | 750,000 (Item 5C) |
| **Total for CC (B)** | **48,750,000** | **9,000,000** | **39,750,000** |
| **Total RE+CC (A+B)** **(Item 5A+5B+5C)** | **303,000,000** | **59,250,000** | **243,750,000** |
| **Total for Item – 5A** | | | **6,000,000** |
| **Total for Item – 5B** | | | **237,000,000** |
| **Total for Item – 5C** | | | **750,000** |

Notes:

1. The equity contribution is assumed to be 20 per cent of the total selling price. Any change in this percentage will be reflected in the size of the equity contribution and hence in the NAMA finance required.

2. The NAMA assumes that the basic PV lanterns and ICS models will be distributed to the "poorest of the poor" at zero cost, to reflect the assumed financial inability of this target consumer segment. While the NAMA acknowledges that the Government of Ghana has to date never considered distributing technologies free of charge, for the purpose of NAMA Finance it is assumed that the Government will procure the basic models at US$15 per unit cost directly from the manufacturers. It is then the prerogative of the government to levy an equity contribution from the end consumers. However, for the purposes of the NAMA Finance, this charge is assumed to be beyond the scope of the NAMA boundary.

Any equity contribution from end-consumers for the basic models will directly benefit the Government by lowering the national contribution to procuring the technology from the manufacturer.

The commercial ICSs are assumed to be installed in schools at no cost to the beneficiary, and hence there is no consumer equity contributed.

**Summary**

Table 7-4 suggests that the NAMA has the potential to generate US$303 million of revenue from sale of technologies over the lifespan of the NAMA. Of this US$59.25 million is expected to be generated in the form of the consumer equity contribution of 20 per cent of the selling price for certain types of technologies. The balance of the revenue, US$243.75 million, will need to be covered under NAMA finance and this value also represents the enabling financial mechanism indicated in Intervention 2.

This enabling consumer finance is broken down into three components as elaborated below.

**Item 5A - Public Procurement: US$6 million**

Of the three financing components amounting to US$ 243.75 million, the first, equivalent to US$6 million, represents the finance required for public procurement.

Public procurement is an enabling mechanism that allows the government to procure the basic models of PV Lanterns and ICSs directly from manufacturers at a fixed price. The purpose of public procurement in this context is to ensure that the poorest of the poor with very little or no ability to pay for goods or services are provided with a minimum level of access to clean energy by supplying PV lanterns and ICSs on a 100 per cent grant based model. Under this NAMA it is proposed that 20 per cent of the total number of units (i.e. 200,000 of 1 million units each of PV lanterns and ICSs) are procured directly by the Government from the manufacturers at a fixed price. The fixed price for procurement of the basic models is assumed at to be US$15 per unit, which translates to US$6 million for 400,000 units of PV lanterns and ICS.

As the models acquired through public procurement have a price cap, the Government could require the manufacturers to develop a "basic" version of the models as a cost effective solution (e.g. a PV lantern that unlike the "general" version is without a mobile charging facility) or could choose to buy a set number of the "general" model at a pre-agreed price.

Financing for the public procurement can be arranged through either of the three financing methods. The first involves direct procurement by the Government from the national budget. In this case the Government will have to allocate a total of US$6 million over 12 years (or an average of US$250,000/year per type of technology) to purchase the PV Lanterns and ICS directly from manufacturers and distribute them through an appropriate government distribution scheme. The government may choose to charge a small equity contribution from beneficiaries which in turn will reduce the impact on the national budget. However this is considered beyond the scope of NAMA finance.

The second method would be to draw on existing national/international grant based programmes to finance the procurement. For example, an US based non-profit organization, One Million Lights, plans to distribute one million PV lanterns to end consumers in various countries through public donations received from individual contributors. The Government could reach a cooperation agreement with such international organizations to facilitate the procurement and distribution of the technologies through the EPZs.

The third method would be to cross-subsidize the price of the "basic" models by charging a premium on the pricing of the "general" models, as shown in the simplified example in Table 7-5 below. This would allow public procurement to be financed without any additional budgetary support.

While these alternatives provide pathways for the Government of Ghana to pursue the public procurement option, from the NAMA finance perspective, it is considered as a national contribution.

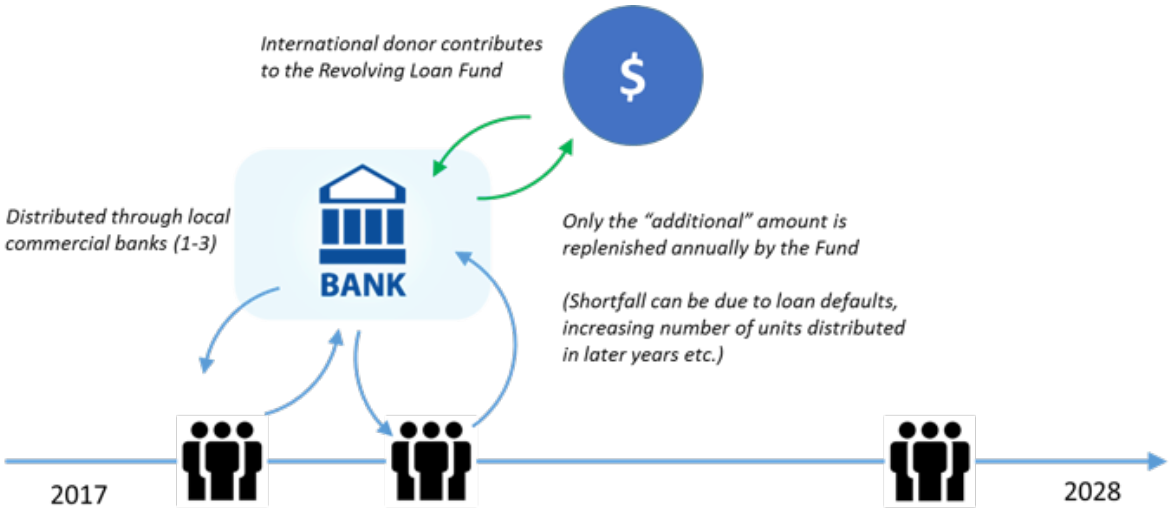
### Table 7-5: Cross-subsidizing the Basic Model: An Example

| Item | Value |
|---|---|
| Manufacturing cost of basic model | US$10 |
| Selling price of basic model (incl. profit) (A) | US$15 |
| Total no. of units (at 20 per cent of total units) (B) | 200,000 |
| Public procurement finance required over NAMA life span (C=A x B) | US$3,000,000* |
| Average annual finance required | US$250,000 |
| No. of general category models (D) | 800,000 |
| Additional premium (E=C/D) | US$3.75 |
| Manufacturing cost of general model | US$15 |
| Selling price (incl. profit margin for manufacturer/distributor + premium 'E') | US$25 |

**Item 5B – Revolving Loan Fund: US$41.22 million**

The second component amounting to US$243.75 million represents the consumer financing extended to end consumers through commercial loans for purchase of technologies, over and above the consumer equity contribution. The total amount of financing required over the 12-year lifespan of the NAMA is US$237 million and will be lent through a financing model known as a Revolving Loan Fund.

### Figure 7-1: The Revolving Loan Fund Model



The concept of Revolving Loan Fund works by establishing a pool of financial resources assumed to be financed through international finance for the purpose this NAMA and circulating the money to end-consumers based as loans to be repaid. The table below provides an indication of the number of units for employing the various technologies sold annually over the lifespan of the NAMA and the financing expected for their purchase.

### Table 7-6: Annual Financing Required for Loans to Consumers

| Year | % of Total Units | NAMA Finance (US$) |
|---|---|---|
| 2017 | 3.6 | 8,586,957 |
| 2018 | 5.8 | 13,739,130 |
| 2019 | 9.4 | 22,326,087 |
| 2020 | 11.6 | 27,478,261 |
| 2021 | 11.6 | 27,478,261 |
| 2022 | 11.6 | 27,478,261 |
| 2023 | 11.6 | 27,478,261 |
| 2024 | 11.6 | 27,478,261 |
| 2025 | 11.6 | 27,478,261 |
| 2026 | 11.6 | 27,478,261 |
| 2027 | 0.0 | 0 |
| 2028 | 0.0 | 0 |
| **TOTAL** | **100** | **237,000,000** |

Assuming that the amount lent is primarily in the form of micro-finance and is paid back by end-consumers over a two-year period with no loan defaults, the table below summarizes the actual NAMA finance required from international donors to establish the capital base for the Revolving Loan Fund.

### Table 7-7: Recirculating Loan Repayments for Loans to Consumers (US$)

| Year | NAMA Finance (A) | Loans Re-paid Yr 1 (B) | Loans Re-paid Yr 2 (C) | Funds Available D=B+C | Finance Required E=A-D |
|---|---|---|---|---|---|
| 2017 | 8,586,957 | | | 0 | 8,586,957 |
| 2018 | 13,739,130 | 4,293,478 | | 4,293,478 | 9,445,652 |
| 2019 | 22,326,087 | 6,869,565 | 4,293,478 | 11,163,043 | 11,163,043 |
| 2020 | 27,478,261 | 11,163,043 | 6,869,565 | 18,032,609 | 9,445,652 |
| 2021 | 27,478,261 | 13,739,130 | 11,163,043 | 24,902,174 | 2,576,087 |
| 2022 | 27,478,261 | 13,739,130 | 13,739,130 | 27,478,261 | 0 |
| 2023 | 27,478,261 | 13,739,130 | 13,739,130 | 27,478,261 | 0 |
| 2024 | 27,478,261 | 13,739,130 | 13,739,130 | 27,478,261 | 0 |
| 2025 | 27,478,261 | 13,739,130 | 13,739,130 | 27,478,261 | 0 |

| Year | NAMA Finance (A) | Loans Re-paid Yr 1 (B) | Loans Re-paid Yr 2 (C) | Funds Available D=B+C | Finance Required E=A-D |
|---|---|---|---|---|---|
| 2026 | 27,478,261 | 13,739,130 | 13,739,130 | 27,478,261 | 0 |
| 2027 | 0 | 13,739,130 | 13,739,130 | 27,478,261 | -27,478,261 |
| 2028 | 0 | 0 | 13,739,130 | 13,739,130 | -13,739,130 |
| **TOTAL** | **237,000,000** | | | | **Nil*** |

**Actual NAMA Financing Required for Revolving Loan Fund**

Table 7-8, provides break down of the NAMA finance required for the Revolving Loan Fund into the three phases of the NAMA and thus gives an overview of the actual international financing required to enable US$ 237 Million to be lent over the 12-year period with the entire amount being paid back by the end of the NAMA. This would make this model highly attractive to international lenders.

### Table 7-8: NAMA Finance Required by Phase (US$)

| Year | NAMA Finance (A) | Finance Required E=A-D | Sum Total by Phase | NAMA Phase |
|---|---|---|---|---|
| 2017 | 8,586,957 | 8,586,957 | 38,641,304 | Build Up Phase |
| 2018 | 13,739,130 | 9,445,652 | | |
| 2019 | 22,326,087 | 11,163,043 | | |
| 2020 | 27,478,261 | 9,445,652 | | |
| 2021 | 27,478,261 | 2,576,087 | 2,576,087 | Full Capacity Phase |
| 2022 | 27,478,261 | 0 | | |
| 2023 | 27,478,261 | 0 | | |
| 2024 | 27,478,261 | 0 | | |
| 2025 | 27,478,261 | 0 | -41,217,391 | Closure Phase |
| 2026 | 27,478,261 | 0 | | |
| 2027 | 0 | -27,478,261 | | |
| 2028 | 0 | -13,739,130 | | |
| **TOTAL** | **237,000,000** | **Nil*** | | |

From a NAMA finance perspective, international donors will be required to make a total contribution of US$41.22 million, of which US$38.64 million will be required over the first four years of NAMA implementation in order to get the Revolving Loan Fund operational. There are several combinations and business models that a donor can explore such as a four-year financial commitment using the results based financial model or a scheme where each phase is financed by different donors.

However, from a donor perspective what is important is to understand that if appropriately structured, the donors can expect to get the entire amount back by the end of the NAMA period making it highly attractive

to them. Alternatively, donors can agree for the revolving loan fund can continue to operate beyond the lifespan of the NAMA.

**Item 5C – Commercial Cookstoves: US$750,000**

The last component of Intervention 2 is the installation of 250 commercial cookstoves. At an average price of US$3,000 per installation, the total financing required is US$750,000 over the 12-year lifespan of the NAMA. Retaining the pattern of distribution similar to the percentage of total units distributed annually represented in Table 7.6, the table below represents the annual financing required to install the commercial cookstoves. As the primary beneficiaries of the commercial cookstoves are schools, which can greatly facilitate community level demonstration of the stoves, the NAMA financing requirement can be covered through national contribution.

**Table 7-9: Financing Required for Installation of Commercial ICSs (US$)**

| Year | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 |
|---|---|---|---|---|---|---|---|---|---|---|
| Financing Required | 27,174 | 43,478 | 70,652 | 86,957 | 86,957 | 86,957 | 86,957 | 86,957 | 86,957 | 86,957 |

## 7.3 Financial Requirements for the Supporting Measures

**Item 6: Techno-Commercial Analysis: US$300,000**

It is proposed that before the start of the NAMA activities, a detailed Techno-Commercial Analysis be undertaken and an implementation plan be developed to substantiate the financing requirements along with the technical requirements. This is expected to be a one-time amount payable directly to a management consultancy (national or international) for services rendered.

The amount is estimated at US$300,000 for a one-year consultancy contract.

**Item 7: Institutional Capacity-Building: US$1,350,000**

The initial capacity-building for the NAMA will be undertaken by three technical advisers (either international or national management consultants) with a focus on business (raising awareness of the three business models among private stakeholders to encourage investment in the EPZs and their activities), finance (the adviser will be responsible for building the capacity of the Financial Trustee managing the NAMA Financing Facility) and technical implementation (capacity-building for the National Implementing Entity).

A grant will be required to cover the costs of salaries/consultancy and operations (travel, expenses etc.) Assuming an annual salary/consultancy charge and expenses of US$150,000/year for each adviser, the total amount required is US$1.35 million over a three-year period.

**Item 8: Operating Costs—National Implementing Entity: US$2,737,200**

This covers the salaries and operating costs of personnel employed by National Implementing Entity (NIE) for the entire duration of the NAMA. As these personnel are expected to be government employees, the entire item is expected to be funded by a national contribution amounting to US$2,737,200. This assumes that the NIE employs one director (annual salary US$24,000), two managers (annual salaries US$18,000),

four senior level clerks (annual salaries US$12,000) and eight junior level clerks located in eight MRV points (annual salaries US$7,200).

In addition to salaries, the operating costs also include costs related to hardware (e.g. computers and IT facilities for the NAMA MRV system), averaging US$50,000 annually, and training programmes at an average of US$20,000 per year.

**Item 9: Awareness Creation and Local Capacity-Building: US$1,545,000**

The success of the NAMA is based on the the technologies being acceptable to the population across the country. Apart from marketing campaigns run by the Government through print and other media, the donors will finance the holding of community level demonstrations for the entire duration of the NAMA. The demonstrations will be carried out by the distributors in all 28 EPZs before and after they are built, and can be combined with the installation of commercial ICSs as they offer a ready audience.

The total budget of US$1.35 million will consist of 12 training programmes annually at an average cost of US$5,000 per program. There can be a variety of programmes involving training of different stakeholders. Publicity will be done through newspaper ads (US$2,500 x 20 ads) and radio (US$100 x 250 ads) and the distribution of pamphlets and other marketing material (lump sum US$10,000 per year). The final item will be the community level demonstrations linked to the installation of commercial ICSs, budgeted at US$500 per installation.

**Item 10: Operating Cost of Financing Facility: US$500,000**

The cost of operating the grant component of the NAMA financing facility is calculated as a percentage (10 per cent) of the total value of the grants distributed. As most of the grants are intended to be extended in the first four years of the NAMA, most of this amount will be required during the initial build-up phase. Based on the assumptions made about the amount of grant finance expected under the NAMA (US$ 5.4 Million) the operating cost is estimated at approximately US$500,000 over the lifespan of the NAMA.

## 7.4 National and International Finance

Section 7.2 and 7.3 provided an indication of potential sources of finance for the interventions and measures. As the financing for NAMA is subject to negotiation with various parties, the sources of national and international finance that we have outline are only indicative at this point of time. Table 7-10 below summarizes the proposed sources of finance by the various line items under the NAMA.

### Table 7-10: Sources of NAMA Finance by Intervention and Measure

| Item | Intervention/Measures | NAMA Finance Required (US$) | Financing Source (Indicative) |
|---|---|---|---|
| 1. | PV Power Plants with total capacity of 400 kWp | 2,200,000 | International grant finance |
| 2. | Financing for EPZ - Business Model 1 | 1,200,000 | International loan finance |
| 3. | Financing for Manufacturing - Business Model 2 | 700,000 | International loan finance |
| 4. | Financing for Distribution - Business Model 3 | 840,000 | International loan finance |

| Item | Intervention/Measures | NAMA Finance Required (US$) | Financing Source (Indicative) |
|---|---|---|---|
| | **Total - Intervention 1 (A)** | **4,940,000** | |
| 5A | Public Procurement | 6,000,000 | National contribution |
| 5B | Revolving Loan Fund | 41,217,391 | International loan finance |
| 5C | Commercial ICSs | 750,000 | National contribution |
| | **Total - Intervention 2 (B)** | **47,967,391** | |
| 6. | Techno-commercial Analysis | 300,000 | International grant finance |
| 7. | Institutional Capacity-Building | 1,350,000 | International grant finance |
| 8. | Operating Cost – National Implementing Entity | 2,737,200 | National contribution |
| 9. | Awareness Creation and Local Capacity-Building | 1,545,000 | International grant finance |
| 10. | Operating Cost of Financing Facility | 500,000 | International grant finance |
| | **Total - Measures (C)** | **6,432,200** | |
| | **Total (A+B+C)** | **59,339,591** | |
| | Of which: | | |
| | International Grant Finance | 5,895,000 | Items 1, 6, 7, 9, 10 |
| | International Loan Finance | 43,957,391 | Items 2, 3, 4, 5B |
| | National Contribution | 9,487,200 | Items 5A, 5C, 8 |
| | Consumer Equity | 59,250,000 | Table 7-4 |
| | **TOTAL Cost of NAMA** | **118,589,591** | **(Incl. Consumer Equity)** |
| | **Cost of NAMA (excluding. Consumer Equity)** | **59,339,591** | **Total amount required for NAMA Finance** |

Total cost of NAMA implementation is estimated at around US$118.59 million of which US$59.25 million is estimated to be consumer equity (i.e. the upfront payment made by end-consumers for the purchase of goods, estimated at 20 per cent of the selling price). The balance of US$59.34 million is to be covered under NAMA Finance and includes support to cover the investment costs of the two interventions as well as the capacity-building efforts. NAMA Finance comprises three components, of which the national contribution is assumed to be US$9.49 million, primarily covering public procurement of basic solar lanterns and ICSs, the salaries and operating costs of the National Implementing Entity, and installing 250 commercial cookstoves across the country. The remaining US$49.85 million is split between a grant component of US$5.89 million and a loan component of US$43.96 million. The latter will primarily be used to establish a Revolving Loan Fund which works on the principle that the loan amounts paid back by end-consumers will be «re-circulated» to pay for additional loans in subsequent years. The Revolving Loan Fund takes advantage of the fact that the technology units will be distributed over the lifespan of the NAMA, thus allowing the required end-consumer finance to be made available over a number of years.

# 8 NAMA IMPLEMENTATION STRUCTURE

The coordination and management of the NAMA requires an institutional structure meeting the following requirements.

- It is embedded in national and sectoral policies and strategies.
- It ensures effective communication and reporting as required by international agencies (e.g. the UNFCCC Secretariat).
- It provides an interface with international bilateral and multilateral NAMA funding entities (e.g. the Green Climate Fund).
- It ensures proper management of financial flows between the NAMA funding entities and the recipients.
- It ensures the achievement of NAMA targets in terms of energy savings, GHG mitigation and sustainable sustainable development benefits.
- It allows transparent monitoring of GHG emissions reductions and Sustainable Development indicators.

The recommended institutional structure of the NAMA is based on the following principles.

- It ensures strong involvement of national stakeholders to create country ownership and political commitment.
- It utilizes existing and experienced entities' organizational systems which are already in place and allow for prompt and smooth implementation of the NAMA.
- It ensures that the institutional structure is appropriate for receipt of international private and/or public donor funding.

The operation and management of the NAMA has to be designed giving due consideration to the following functions:

- Political
- Strategic
- Financing
- Execution
- Monitoring, Reporting, and Verification (MRV)

These functions are described in detail below:

**Political Function**

The relevant ministries and government institutions would play a role in providing policy direction and oversight. They would oversee overall NAMA supervision in the host country by receiving inputs and providing feedback to the relevant line ministries.

**Strategic Function**

The body appointed to carry out this function will ensure successful implementation of the NAMA projects by coordinating all financing, execution, and MRV functions as well being the point of contact for international reporting at the United Nations Framework Convention on Climate Change (UNFCCC).

**Financing Function**

The appointed body will play a major role regarding the NAMA implementation in the area of budgetary allocation and disbursement of funds from the public purse for NAMA related projects. Private sector institutions and financial institutions will play a role in mobilizing private fund[11] for NAMA investments. Development Partners are an important source of international public funds.

**Execution Function**

The execution function will be carried out by entities that will be responsible for implementing action plans regarding specific NAMA projects on the ground.

**MRV Function**

The responsibilities of MRV functional entities among others, will involve;

- establishing standards, guidelines and procedures for the monitoring and reporting of GHG and non-GHG indicators;

11 Private funds may be either provided by local private sector entities or by multinational entities through foreign investment.

- establishing systems and procedures for the verification of reported indicators;
- establishing guidelines to ensure the quality control and quality assurance of collected data.

## 8.1 Key operational bodies and implementing partners

The institutional structure of a NAMA will include the following bodies, which will perform roles and responsibilities corresponding to the functions mentioned above:

- the National Focal Point or National Designated Authority (NDA)
- the National Coordinating Authority (NCA)
- the National Implementing Entity (NIE)
- the Financial Implementing Entity (FIE) or Trustee
- the National Executing Entities (NEEs)

The roles, responsibilities and functions of each of these entities are discussed in detail below.

### The National Focal Point or National Designated Authority (NDA)

The national NAMA Focal Point will among other things:

- approve NAMAs which shall be registered at the UNFCCC;
- report to the NAMA technical working group about international developments and the status of the national NAMA portfolio;
- provide guidance to sectoral NIEs (on access to climate finance, financial flows, MRV etc);
- introduce measures to avoid double counting of emission reductions from implemented NAMAs;
- act as the primary contact for international donor(s).

The Ministry of Finance (MoF) has already been appointed as the National Designated Authority (NDA) to the Green Climate Fund (GCF). It plays the key political function and is involved in programme oversight, country programming, country level coordination and coherence with national climate change and development pathways.

### The National Coordinating Authority (NCA)

The NCA is the entity which coordinates the proposed NAMA. Its main tasks include:

- managing and directing the NAMA;
- coordinating with the UNFCCC Secretariat;

- approving NAMA targets; Managing the implementation process with regard to the submission of project applications and the disbursement of funds (in close collaboration with the NAMA Technical Working Group, the NAMA Focal Point, the NIE and the Trustee);
- approving and updating eligible interventions;
- approving annual monitoring reports prepared by the MRV Cell (covering among othe things: the number of projects implemented, calculation of emissions reductions etc.);
- supervising the financial flows between donors and beneficiaries.

In Ghana, the Ministry of Environment, Science, Technology and Innovation (MESTI) will be acting as NCA for this NAMA and will perform all above strategic functions relating to this NAMA.

### The National Implementing Entity (NIE)

The National Implementing Entity (NIE) is the main operative body of the NAMA in Ghana. Its main tasks include:

- performing planning and management of NAMA activities;
- coordinating with the Trustee and NEEs;
- preparing reports to donor about e.g. –
  - Use of funds,
  - Number of projects implemented,
  - Targets achieved etc.
- building capacity for institutions and companies involved in the implementation of the NAMA;
- Developing technical standards for equipment/installations used under the NAMA;
- coordinating promotion and awareness raising campaigns to support the implementation of the NAMA;
- integrating the private sector into NAMA implementation.

In Ghana, the Energy Commission will be acting as NIE for this NAMA and perform all the above functions relating to this NAMA.

### The MRV Cell

A designated MRV Cell will be created under the NIE and this MRV cell will be the central actor in the MRV structure. The main tasks of MRV Cell will include:

- data collection and compilation;
- coordinating monitoring activities and the preparation of monitoring reports;

- facilitating and coordinating verification through the external entity designated for this task.

The MRV team will comprise 15 members from the NIE (the Energy Commission), the Environmental Protection Authority (EPA) and the Ghana Statistical Service (GSS). Eight members of the team will be based in the eight large and medium EPZs.

### The Trustee

The Trustee will be responsible for handling flows of finance from funding entities to the beneficiaries. The main tasks of the Trustee are:

- ensuring the proper transfer and disbursement of funds from the donors to the recipients based on an agreed set of criteria (e.g. money will be held in a trust account with limited access, money will be disbursed only after project has been implemented, etc.);
- responsibility for coordinating with commercial banks in the distribution of loans to private sector entities and of microfinance to end users through the Revolving Loan Fund;
- coordinating with the Government to secure grants for EPZ implementation under public procurement schemes;
- supporting the NIE to prepare reports to donor about e.g. –
  - Use of funds,
  - Number of projects implemented,
  - Targets achieved etc.
- coordinating with the NIE in monitoring activities and in the preparation of monitoring reports;
- reporting to the NCA to fulfill reporting requirements to donors;
- cooperating with financial internal and external auditors.

The Trustee needs to have a strong background and good track record in financing. There are a number of organizations which have the capability to act as the Trustee for this NAMA. The following is a list of potential Trustees who meet the criteria, but it is not exhaustive.

- **Banks and corporations:**
  - The African Development Bank
  - The World Bank
  - The ECOWAS Bank for Investment and Development
  - The Nordic Environmental Finance Cooperation
  - KFW Development Bank

- Access Bank
- Fidelity Bank

- **Development programmes:**
  - The United Nations Development Programme
  - The United Nations Environment Programme
  - The Acumen Fund.

### The National Executing Entity/ies

The National Executing Entities (NEEs) are the organization(s) and/or institution(s) which implement projects under NAMA. NEEs should perform execution and MRV functions. Each NEE will:

- implement projects in compliance with the rules of each intervention;
- inform the NIE about the performance of their projects;
- collect data for monitoring purposes.

NEEs will include private sector firms, communities and cooperatives which own and operate the EPZs and invest in the manufacture and distribution of RE and CC technologies.

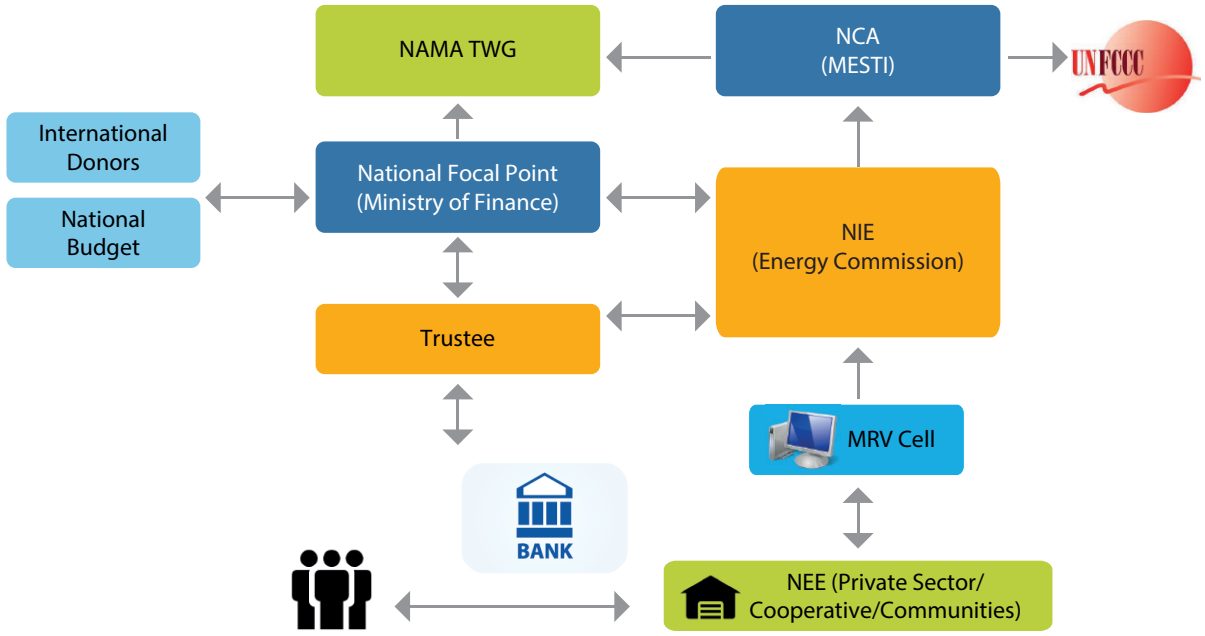
### The NAMA Technical Working Group (NAMA TWG)

The NAMA TWG will act as a supervisory body providing guidance to the NDA and the NCA in all functional areas. The NAMA TWG will comprise representatives from the Ministry of Power, the Energy Commission, the EPA, the Electricity Company of Ghana (ECG), MESTI, the Ministry of Finance and Biogas Technologies Africa Limited (BTAL). The NAMA TWG has the power to establish working groups and subcommittees as needed.

## 8.2 NAMA Operational and Management System

Figure 8-1 illustrates the recommended institutional structure for the operational and management system for this NAMA. The Ministry of Finance will be the focal point for coordination between the donor and the Trustee. The Trustee will be the point through which international funds will be routed in Ghana. The actual implementation of the NAMA is carried out by the NEE comprising the private sector actors, cooperatives and communities. The NAMA Technical Working Group acts as the body for providing supervision to the NDA and NCA.

**Figure 8-1: NAMA Operational and Management System**




## 8.3 Implementation Schedule

As already mentioned in Section 5.1.1 the proposed lifespan of the NAMA is 12 years extending from 2017 to 2028.

The implementation of the NAMA will be carried out in five main steps. As an initial step, the institutional structure for NAMA implementation will be established. In parallel, the capacity of the key entities will be developed and awareness at the community level will be built. Once these steps are accomplished, implementation of the two interventions will start.

### a) Establish and operationalize institutional structure for NAMA implementation

The institutional structure proposed in Sections 8.1 and 8.2 needs to be established as a basis for the interventions. It is suggested that implementation should start with an initial meeting of the NAMA TWG, which is to act as a kind of supervisory board for the NAMA. At this stage, two main tasks would be accomplished.

Firstly, an international technical advisor would be appointed. The technical adviser will then be responsible for building the capacity of the members of the NCA, the NIE and the MRV Cell. Secondly, the coordination and management structure of the NAMA would be established and operationalized.

Both, these tasks will be accomplished in the first year of the NAMA, which is currently envisaged to be 2017.

### b) Develop the capacity of stakeholders

To ensure the overall success of the NAMA, the capacity of the relevant stakeholders (as identified in Chapter 6) needs to be built. Therefore, at this stage, training of different durations would be conducted. For example, training for the coordination and management entities' staff, private sector investors and commercial banks would be conducted in the initial phase of NAMA implementation.

### c) Create awareness and implement a marketing campaign

This step focuses on carrying out awareness raising campaigns administered via radio, newspaper advertisements, billboards and community level demonstration projects.

Carrying out these tasks would begin as soon as the project starts and would continue till end of the NAMA's lifetime.

### d) Implementation of Intervention 1

Once the institutional structure has been operationalized and the capacity of the relevant stakeholders has been built, implementation of Intervention 1 will start. Under this step, a financial adviser will be appointed and funds will be secured from national and international sources by 2019.

The national funding will come from the national budget. The potential international sources of funds include the NAMA Support Facility, the Global Environmental Facility (GEF), the Green Climate Fund (GCF), the Japan International Cooperation Agency (JICA), through the EU. The implementation plan for 28 EPZs will be developed and approved by 2017 allowing their physical implementation to be completed by 2021.

### e) Implementation of Intervention 2

Once the institutional structure has been operationalized and the capacity of the relevant stakeholders has been built, implementation of Intervention 2 will start. , A Revolving Loan Fund (RLF) facility is envisaged to have been capitalized by 2019. The RLF facility will ensure that finance is available to the end consumers at the point of purchase.

Meanwhile, the quality standards for technologies to be employed under the NAMA and policy measures on the return of goods (see Subsection 5.5.2.3) will be developed by 2017. The final task under this step involves manufacturing and distribution of the RE and CC technologies, which is expected to begin in 2018 and run until the end of 2026.

Figure 8-2 shows the timeline for implementation of each of the five steps along with the associated tasks.

## Figure 8-2: NAMA Implementation Plan

| Activities | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Establish and operationalize institutional structure for NAMA implementation | | | | | | | | | | | | |
| Appoint international technical adviser | | | | | | | | | | | | |
| Establish and operationalise coordinating and managing entities | | | | | | | | | | | | |
| Develop capacity of the stakeholders | | | | | | | | | | | | |
| Conduct training of staff of coordination and management entities | | | | | | | | | | | | |
| Conduct training and refresher course for MRV staff | | | | | | | | | | | | |
| Build capacity of private sector investors | | | | | | | | | | | | |
| Conduct training for workers and staff (EPZ+manuf+distb+PV O&M etc.) | | | | | | | | | | | | |
| Conduct training for commercial Banks | | | | | | | | | | | | |
| Creat awareness and implement marketing campaign | | | | | | | | | | | | |
| Conduct community level demonstration in each EPZ | | | | | | | | | | | | |
| Create awareness (Radio, newspaper ads, billboards etc.) | | | | | | | | | | | | |
| Implementation of Intervention-1 | | | | | | | | | | | | |
| Appoint international financial adviser | | | | | | | | | | | | |
| Secure national and international finance for loans and grants | | | | | | | | | | | | |
| Develop implementation plan for 28 EPZs and submit it for approval | | | | | | | | | | | | |
| Physical implementation of EPZs | | | | | | | | | | | | |
| Implementation of Intervention-2 | | | | | | | | | | | | |
| Capitalize revolving loan fund | | | | | | | | | | | | |
| Develop quality standards for technologies considered under the NAMA and policy measures on "'return of goods" | | | | | | | | | | | | |
| Manufacture and distribute RE and CC technologies | | | | | | | | | | | | |

# 9 MEASURING, REPORTING AND VERIFICATION

A comprehensive MRV system is a crucial component of a NAMA. As a NAMA is a results based instrument, its results need to be measurable, reportable and verifiable (MRV) to guarantee the sustainable success of the interventions.

The MRV system proposed under this NAMA uses the approved CDM methodologies and a single MRV Cell consisting of representatives from the Energy Commission, the Environmental Protection Agency and the Ghana Statistical Service, which will carry out the MRV activities for the both technology interventions (i.e. RE and CC technologies), thereby reducing the total cost of MRV. The MRV system focuses on emissions reductions, sustainable development (SD) and financial support, which are described in the following sections.

## 9.1 Measuring

The methodology for measuring the impacts of this NAMA will follow the general principles of transparency, reliability, and conservativeness. Hence, measurement of the following components will be carried out as part of MRV system:

- GHG emissions reductions,
- SD impacts, and
- finance (support)

However, measurement of these three components will be approached differently and with distinct sets of parameters and indicators. In addition to measuring the impacts of the NAMA, it will also monitor progress in implementing the activities under the NAMA.

### 9.1.1 GHG Emissions Reductions

The monitoring of GHG emissions reductions includes measurement of the parameters used in the calculation of emissions reductions. The methodology for calculating emissions reductions has already been described in Chapter 4. The total GHG emissions reductions from this NAMA in a given year y (ERy) is the sum of the emissions reductions achieved by introducing all the RE and CC technologies. The calculation of emissions reductions uses both default values and measured data. The technology specific default values and parameters to be monitored for the emission reduction calculation are described below.

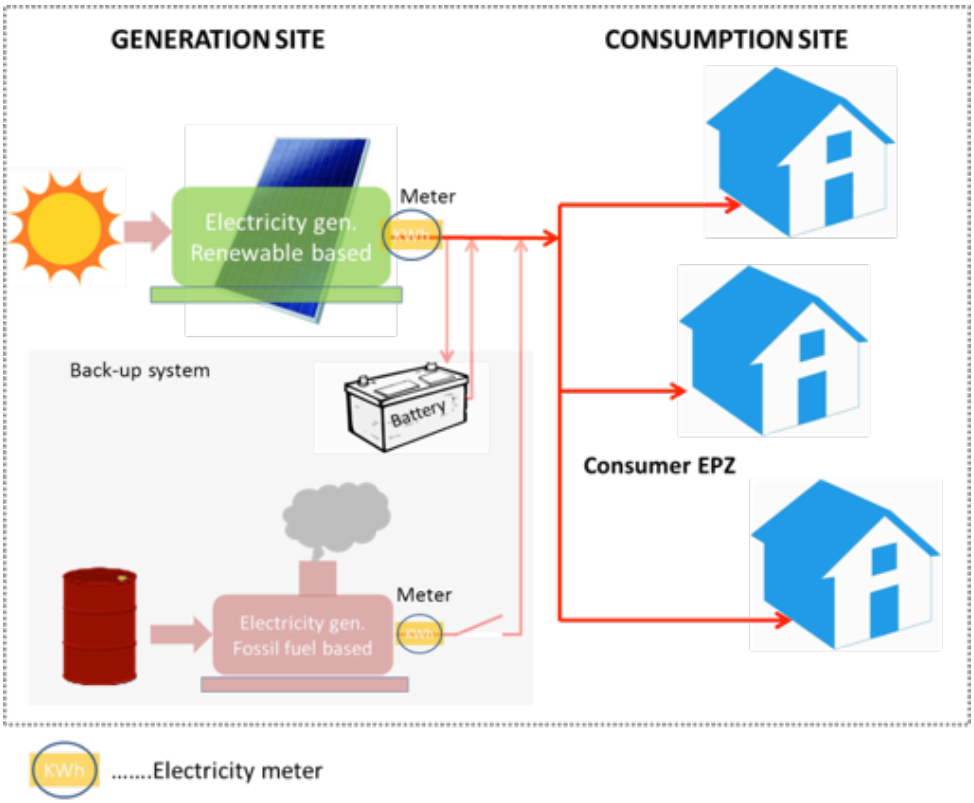
#### *9.1.1.1 EPZ Solar PV power plant*

The default values that are fixed ex ante are provided below.

| Variable | Description | Default Value | Unit |
|---|---|---|---|
| $EF_{co2}$ | Fossil fuel emission default factor. This is fixed ex ante. | 1 | $tCO_{2eq}$/MWh |

As all the electricity generated by the energy generation system (i.e. through both renewable energy and fossil fuel (R & F) systems) will be consumed by consumers connected to the EPZ mini grid, only the generated electricity will be monitored via electricity meter. The data parameters which will be monitored can be seen in Figure 9-1 below.

**Figure 9-1: Data Parameters for Monitoring Electricity Generated in EPZ**



The description of the parameters is provided below.

| | |
|---|---|
| **Data/Parameter:** | $EG_{R,i,y}$ |
| **Data Unit:** | MWh |
| **Description:** | Electricity generated and delivered by renewable electricity generation system R to consumers connected to the EPZ mini grid i over the time y in MWh. |
| **Measurement and QC procedures (if any):** | Each electricity generation system R of the EPZ mini grid i will be equipped with a calibrated electricity meter to monitor the generated electricity $EG_{R,i,y}$ over the time y. NEEs operating the EPZ power plant monitor the data. The reading of the electricity meter(s) will be recorded at least weekly by the duty operator on a data sheet. A data sheet will be prepared monthly and stored in a safe place, including the measurement instrument description, its identification and calibration certificate. The meters will be calibrated once every three years.<br>In case of emergencies, and thus in conditions under which the responsible entity was not able to monitor the electricity generation, the beginning and end of the emergency the resumption of normal operations and details of the emergency should be reported.<br>Representatives of the MRV Cell based in the EPZ office (hereafter denoted as MRVEPZ) collect data from the NEEs. MRVEPZ feeds the data into the Central Monitoring System (CMS) located in the premises of the NIE through the internet enabled MRV system on a monthly basis. |
| **Monitoring frequency:** | Measured – Continuously<br>Recorded – Weekly |

#### *9.1.1.2 Solar PV based lanterns*

The default values, which are fixed ex ante, are provided below.

| Variable | Description | Default Value | Unit |
|---|---|---|---|
| | Lamp Emission factor | 0.023 | $tCO_{2eq}$ per lamp per year |

The data parameters which will be monitored can be seen below.

| | |
|---|---|
| **Data/Parameter:** | $EF_{lamp}$ |
| **Data Unit:** | Number of solar lanterns |
| **Description:** | Number of solar lanterns operating in year y. |
| **Measurement and QC procedures (if any):** | As noted above, all solar lanterns sold under the NAMA are considered to be operational and the date of commissioning of the lanterns sold in month "m" will be the first day of month "m+1".<br>The NEEs operating the EPZs (EPZ-L & EPZ-M) monitor the data. The $MRV_{EPZ}$ collects data from the NEEs and prepares a record on monthly basis. The $MRV_{EPZ}$ feeds the data into the Central Monitoring System (CMS) located in the premises of the NIE through the internet enabled MRV system on a monthly basis. |
| **Monitoring frequency:** | Measured – Continuously<br>Recorded – Monthly |

#### *9.1.1.2 Solar PV based home systems*

As all the electricity generated by the PV home systems will be consumed, only the generation site will be considered, i.e. the average amount of electricity generated by the PV home system, over a defined period of time, needs to be determined. The parameters described below will be determined ex ante.

- **Average electricity output per kWp per year:** The average electricity generated per kWp of solar PV home system will be determined and fixed ex ante. It will based on manufacturers' data or international/ national standards data or data certified by an independent third party. The average electricity output as determined is equal to the electricity generated by PV home system i, supplied to consumer appliances or used for internal home consumption over the time y (EGPV-home,i,y).

The default values that are fixed ex ante are provided below.

| Variable | Description | Default Value | Unit |
|---|---|---|---|
| | Average electricity output per kWp per year | 1,927.20 | kWh per kWp per year |
| $EF_{co2}$ | Fossil fuel emissions default factor. This is fixed ex ante. | 1 | $tCO_2/MWh$ |

During NAMA implementation, the following data are to be monitored and recorded:

| | |
|---|---|
| **Data/Parameter:** | $N_{kWp,y}$ |
| **Data Unit:** | kWp |
| **Description:** | Total kWp of solar PV home system installed in year y. |
| **Measurement and QC procedures (if any):** | As noted above, all solar PV home system sold under the NAMA are considered to be operational and the date of commissioning of the systems sold in month "m" will be the first day of month "m+1".<br>NEEs operating the EPZs (EPZ-L & EPZ-M) monitor the data. The $MRV_{EPZ}$ collects data from the NEEs and prepares a record on monthly basis. MRVEPZ feeds the data into the Central Monitoring System (CMS) located in the premises of the NIE through the internet enabled MRV system on monthly basis. |
| **Monitoring frequency:** | Measured – Continuously<br>Recorded – Monthly |

ICSs for households and commercial activities

The default values that are fixed ex ante are provided in table below.

| Variable | Description | Default Value | Unit |
|---|---|---|---|
| $a$ | "$a$ is the index for the age (in years) of the improved cookstoves that are operating in the year y. | The operating life time of the project device is considered to be four years as confirmed by various manufacturers. So, values of will be either 1,2, 3 or 4 depending on the date of commissioning of the project devices. | Number |

| Variable | Description | Default Value | Unit |
|---|---|---|---|
| $B_{old,i}$ | Annual quantity of woody biomass that would be used in the absence of the NAMA intervention to generate thermal energy equivalent to that provided by the ICS type i, if the ICS operates throughout the year y. | 2 | tons/ device |
| $f_{NRB,y}$ | Fraction of woody biomass saved by the ICS in year y that can be established as non-renewable biomass. | 0.99 | Fraction |
| $NCV_{Biomass}$ | Net calorific value of the non-renewable woody biomass | 0.015 | TJ/ton |
| $EF_{Projected\_fossilfuel}$ | Emissions factor for the fossil fuels projected to be used for substitution of non-renewable woody biomass by similar consumers | 81.6 | $tCO_2/TJ$ |
| $\eta_{old}$ | Efficiency of the baseline (pre-project) cookstoves. | 0.14 | Fraction |
| $\eta_{new,i,a=1}$ | Thermal efficiency of ICS type i | 0.35 | Fraction |
| $\Delta\eta_{i,y}$ | Efficiency de-rating factor of ICSs type i being deployed as part of the NAMA intervention (fraction) in year y. | 0.10 | Fraction |

The data parameters which will be monitored can be seen below.

| | |
|---|---|
| **Data/Parameter:** | $N_{y,i,a}$ |
| **Data Unit:** | Number of ICSs |
| **Description:** | Number of ICSs type i and age $a$ operating in year y. |
| **Measurement and QC procedures (if any):** | Number of ICSs type i and age $a$ operating in year y. As noted in Chapter 4, all ICSs sold under the NAMA are considered to be operational and the date of commissioning of the ICSs sold in month "m" will be the first day of month "m+1".<br><br>NEEs operating the EPZs (EPZ-L & EPZ-M) monitor the data. The representative of the MRV Cell based in the EPZ office (hereafter this official will be denoted as MRVEPZ) collects data from NEEs and prepares a record on monthly basis. MRVEPZ feeds the data into the Central Monitoring System (CMS) located in the premises of NIE through the internet enabled MRV system on monthly basis. |
| **Monitoring frequency:** | Measured – Continuously<br>Recorded – Monthly |

#### 9.1.1.5 LPG cooking solutions

The default values under the LPG cooking solution are shown below.

| Variable | Description | Default Value | Unit |
|---|---|---|---|
| $B_{old}$ | Annual quantity of woody biomass that would be used in the absence of the NAMA intervention to generate thermal energy equivalent to that provided by the LPG stove, if the LPG stove operates throughout the year y. | 2 | tons/ device |
| $f_{NRB,y}$ | Fraction of woody biomass saved by the ICS in year y that can be established as non-renewable biomass. | 0.99 | Fraction |
| $NCV_{Biomass}$ | Net calorific value of the non-renewable woody biomass (TJ/ton). | 0.015 | TJ/ton |
| $EF_{Projected\_fossilfuel}$ | Emissions factor for the fossil fuels projected to be used for substitution of non-renewable woody biomass by similar consumers ($tCO_{2eq}$/TJ). | 81.6 | $tCO_{2eq}$/TJ |
| $NCV_{LPG}$ | Net calorific value of LPG (TJ/ton). | 0.0473 | TJ/ton |
| $EF_{LPG}$ | Emissions factor of LPG ($tCO_{2eq}$/TJ). | 63.1 | $tCO_{eq}$/TJ |

The data parameters which will be monitored can be seen below.

| | |
|---|---|
| **Data/Parameter:** | $N_y$ |
| **Data Unit:** | Number of LPG connections |
| **Description:** | Number of LPG connections operating in year y. |
| **Measurement and QC procedures (if any):** | Together the LPG stove and LPG cylinder will be termed the LPG connection. All LPG connections sold under the intervention will be considered to be operational. The "date of first time sale" of the LPG connection will be considered as "date of commissioning" of that LPG connection. The date of commissioning of a LPG connection will be the first day of month "m+1" if the first time sell of that LPG connection is in the month "m".<br>NEEs operating the EPZs (EPZ-L & EPZ-M) monitor the data for LPG connections sold. $MRV_{EPZ}$ collects data from NEEs and prepares a record on a monthly basis. $MRV_{EPZ}$ feeds the data into the Central Monitoring System (CMS) located in the premises of NIE through the internet enabled MRV system on a monthly basis. |
| **Monitoring frequency:** | Measured- Continuously<br>Recorded- Monthly |

| | |
|---|---|
| **Data/Parameter:** | $Q_{cyl,LPG,i}$ |
| **Data Unit:** | Number of LPG cylinders with capacity i (capacity in kg) |
| **Description:** | Number of LPG cylinders of capacity i supplied to each LPG connection (or household) during the year y. |
| **Measurement and QC procedures (if any):** | NEEs operating the EPZs (EPZ-L & EPZ-M) monitor the number of LPG cylinders supplied with their capacity to each LPG connection holder. $MRV_{EPZ}$ collects data from NEEs and prepares a record on a monthly basis. $MRV_{EPZ}$ feeds the data into the Central Monitoring System (CMS) located in the premises of NIE through the internet enabled MRV system on a monthly basis. |
| **Monitoring frequency:** | Measured- Continuously<br>Recorded- Monthly |

### 9.1.2 Sustainable Development

In addition to GHG emissions, the MRV system will monitor the impacts of the NAMA interventions on the identified SD indicators. The measurement process for these indicators is described below:

| | |
|---|---|
| **Data/Parameter:** | $N_{M\&D}$ |
| **Data Unit:** | Number of manufacturing and distribution facilities |
| **Description:** | Number of manufacturing and distribution facilities of RE and CC technologies using energy from EPZs |
| **Measurement and QC procedures (if any):** | The MRV Cell will keep records of the number of manufacturing and distribution facilities operated in the EPZs using energy from the EPZs. |
| **Monitoring frequency:** | The MRV Cell will prepare a record on an annual basis. |

| | |
|---|---|
| **Data/Parameter:** | $N_{CBP,PS}$ |
| **Data Unit:** | Number of people trained |
| **Description:** | Number of people trained from the private sector |
| **Measurement and QC procedures (if any):** | The MRV Cell will keep records on it. Supporting documents such as minutes of discussions, programme reports and attendees lists will be kept for future verification. |
| **Monitoring frequency:** | The MRV Cell will prepare a record on annual basis. |

| | |
|---|---|
| **Data/Parameter:** | $N_{CBP,TS}$ |
| **Data Unit:** | Number of people trained |
| **Description:** | Number of technical staff and workers trained in skills development for the manufacture, distribution and after-sale services of RE and CC technologies |

| | |
|---|---|
| **Measurement and QC procedures (if any):** | The MRV Cell will keep records on it. Supporting documents such as minutes of discussions, programme reports and attendees lists will be kept for future verification. |
| **Monitoring frequency:** | The MRV Cell will prepare a record on an annual basis. |

| | |
|---|---|
| **Data/Parameter:** | $N_{jobs,all}$ |
| **Data Unit:** | Number of jobs |
| **Description:** | Number of jobs and business opportunities created for all |
| **Measurement and QC procedures (if any):** | The Ghana Statistical Service (GSS) will carry out an annual assessment to find out the number of jobs (gender disaggregated) created by the NAMA interventions. The GSS will report these data to the MRV Cell annually. |
| **Monitoring frequency:** | The MRV Cell will prepare a record on an annual basis. |

| | |
|---|---|
| **Data/Parameter:** | $N_{jobs,women}$ |
| **Data Unit:** | Number of jobs |
| **Description:** | Number of jobs and business opportunities created for women |
| **Measurement and QC procedures (if any):** | The Ghana Statistical Services (GSS) will carry out an annual assessment to find out the number of jobs for women created by the NAMA interventions. The GSS will report these data to the MRV Cell annually. |
| **Monitoring frequency:** | The MRV Cell will prepare a record on an annual basis. |

| | |
|---|---|
| **Data/Parameter:** | $N_{HH,CC}$ |
| **Data Unit:** | Number of households |
| **Description:** | Number of households using clean cooking technologies |
| **Measurement and QC procedures (if any):** | Ghana Statistical Services (GSS) will carry out an annual assessment to find out the number of households using the clean cooking technologies. The GSS will report these data to the MRV Cell annually. |
| **Monitoring frequency:** | The MRV Cell will prepare a record on an annual basis. |

| | |
|---|---|
| **Data/Parameter:** | $N_{HH,RE}$ |
| **Data Unit:** | Number of households |
| **Description:** | Number of households using RE based electricity for lighting and other activity |
| **Measurement and QC procedures (if any):** | The Ghana Statistical Service will carry out an annual assessment to find out the number of households using RE based electricity for lighting and other activities. The GSS will report these data to the MRV Cell annually. |
| **Monitoring frequency:** | The MRV Cell will prepare a record on an annual basis. |

| | |
|---|---|
| **Data/Parameter:** | $N_{OS,NAMA}$ |
| **Data Unit:** | Organizational structure |
| **Description:** | NAMA organizational structure |
| **Measurement and QC procedures (if any):** | NIE along with other key stakeholders including NCA and NAMA TWG will prepare documentation on the overall NAMA organizational structure. |
| **Monitoring frequency:** | The MRV cell will prepare a record on an annual basis. |

| | |
|---|---|
| **Data/Parameter:** | $N_{CBP,OS}$ |
| **Data Unit:** | Number of capacity development programmes |
| **Description:** | Capacity development programme for the NCA, the NIE and the MRV Cell |
| **Measurement and QC procedures (if any):** | The MRV Cell will keep records on it. Supporting documents such as minutes of discussions, programme reports and attendees lists will be kept for future verification. |
| **Monitoring frequency:** | The MRV Cell will prepare a record on an annual basis. |

| | |
|---|---|
| **Data/Parameter:** | $N_{MAC}$ |
| **Data Unit:** | Number of demonstration activities |
| **Description:** | Marketing and awareness raising campaigns including demonstration activities |
| **Measurement and QC procedures (if any):** | The MRV Cell will keep records on it. Supporting documents such as minutes of discussions, programme reports and attendee lists will be kept for future verification. |
| **Monitoring frequency:** | MRV cell will prepare record on annual basis. |

| | |
|---|---|
| **Data/Parameter:** | $N_{MS,NCA}$ |
| **Data Unit:** | Management system |
| **Description:** | Overall operational management system of the NCA |
| **Measurement and QC procedures (if any):** | The NIE along with other key stakeholders including the NCA and the NAMA TWG will prepare documentation on the NCA operational management system. |
| **Monitoring frequency:** | The MRV Cell will prepare a record on an annual basis. |

| | |
|---|---|
| **Data/Parameter:** | $N_{MS,NIE}$ |
| **Data Unit:** | Management system |
| **Description:** | NIE overall operational management system |

| | |
|---|---|
| **Measurement and QC procedures (if any):** | The NIE along with other key stakeholders including The NCA and The NAMA TWG will prepare documentation on the NIE operational management system. |
| **Monitoring frequency:** | The MRV Cell will prepare a record on an annual basis. |

| | |
|---|---|
| **Data/Parameter:** | $N_{MS,NEE}$ |
| **Data Unit:** | Management system |
| **Description:** | NEE overall operational management system |
| **Measurement and QC procedures (if any):** | The NIE along with other key stakeholders including the NCA and the NAMA TWG will prepare documentation on the NEE operational management system. |
| **Monitoring frequency:** | The MRV Cell will prepare a record on an annual basis. |

### 9.1.3 Support

Under the NAMA, financial support is considered as essential and this can be monitored. Financial monitoring involves tracking the resources required and the support received from national contributions and international donor(s). The following financial support will be measured.

| | |
|---|---|
| **Data/Parameter:** | $FS_{international}$ |
| **Data Unit:** | US$ |
| **Description:** | International financial support spent per activity |
| **Measurement and QC procedures (if any):** | All finances disbursed need to be tracked as per the standard governmental tracking procedures. The document NAMAs Investor Guide[12] will provide the guidance to track this support. The Trustee will be responsible for tracking this support. |
| **Monitoring frequency:** | Measured continuously and recorded annually |

| | |
|---|---|
| **Data / Parameter:** | $FS_{national}$ |
| **Data Unit:** | US$ |
| **Description:** | National financial support spent per activity |
| **Measurement and QC procedures (if any):** | All finances disbursed need to be tracked as per the standard governmental tracking procedures. The NAMAs Investor Guide will provide the guidance to track this support. The Trustee will be responsible for tracking this support. |
| **Monitoring frequency:** | Measured continuously and recorded annually |

12 To enable the private sector to access NAMA information, the Environmental Protection Agency, the Ghana Investment Promotion Council and the United Nations Development Programme (UNDP) have developed the *NAMAs Investor Guide*. This document is intended to facilitate private sector participation in NAMAs.

### 9.1.4 Transformational Change

Currently, inefficient and polluting energy processes are deeply entrenched in Ghanaian culture. The NAMA will mark a move away from what has become normal and towards a low carbon economy. Additionally, this NAMA is also expected to have several other social, economic and environmental benefits, thereby making it consistent with Ghana's sustainable development objectives. The NAMA project is considered to be transformational as it will phase out inefficient and ineffective practices and propel the energy sector into RE and modern clean cooking solutions.

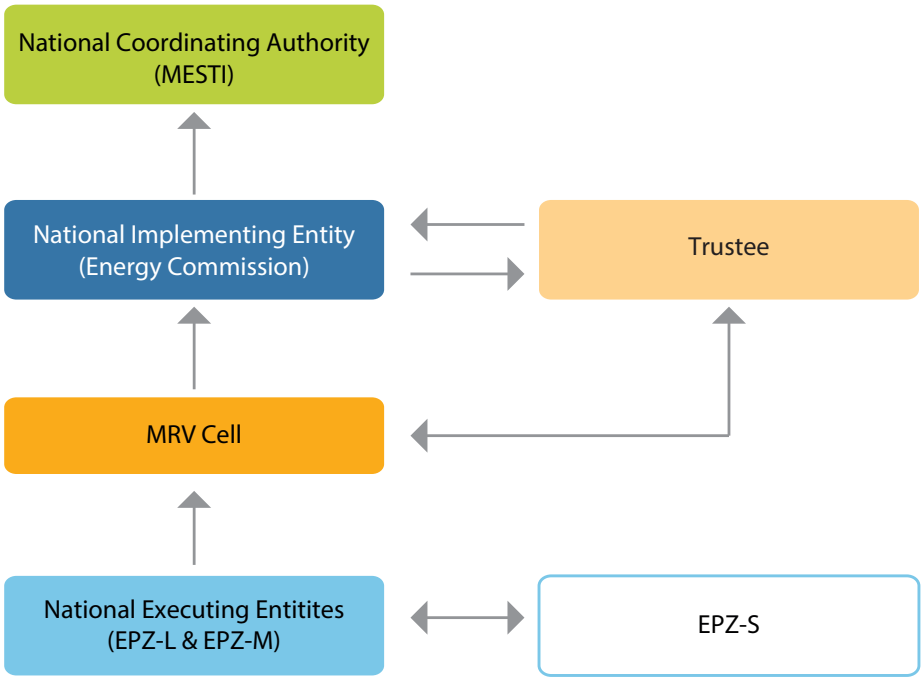
The MRV Cell will be charged with interpreting the data on emissions reduction and sustainable development and using them to discern broader transformative changes e.g. outcomes and impacts of the NAMA. These types of changes cannot be measured annually but will be evaluated twice during the lifetime of the NAMA (see Section 9.3) on the basis of the parameters and indicators described above.

## 9.2 Reporting

### 9.2.1 Process and Plan for Reporting

The data management and reporting system of the MRV structure, at the centre of which sits the MRV Cell, includes the entities shown in Figure 9-2.

**Figure 9-2: Components of the MRV Data Management and Reporting System**



As the large and medium sized EPZs (EPZ-L & EPZ-M) will be the manufacturing and distribution bases for all RE and CC technologies, data collection and data recording will happen only in the eight large and medium sized EPZs through dedicated MRV personnel using data management software, a unique identification system and other relevant information (e.g. contact information on end-users, dates of sale, loan amounts, etc.). Each EPZ-L and EPZ-M will be provided with personnel from the MRV Cell who will be based in the EPZ offices and responsible for data collection from the NEEs. EPZ-Ss are expected to undertake bulk purchases of the RE and CC technologies either from EPZ-L and EPZ-M, and hence are considered as customers in the NAMA MRV system.

As part of the MRV structure, an internet enabled MRV framework along with a Central Monitoring System (CMS) will be established. The geographical spread of the EPZs along with supporting facilities such as internet enabled computers will make the decentralized aggregation of data both desirable and feasible before it is collated in a CMS located in the NIE offices in Accra. The process of data collection and reporting will follow the following sequence (Figure 9-3).

1. NEEs operating in the EPZ-Ls and EPZ-Ms monitor data according to the monitoring plan and ensure they fulfil all requirements such as record keeping and quality control.

2. The official from the MRV Cell based in the EPZ office collects data from the NEEs on the parameters to be monitored and feed them into the CMS on monthly basis.

3. The official from the MRV Cell based in the EPZ office reports the results of the monitoring to the MRV Cell in an annual report. The minimum information to be provided in these reports is listed in Section 9.2.2 on reporting forms.

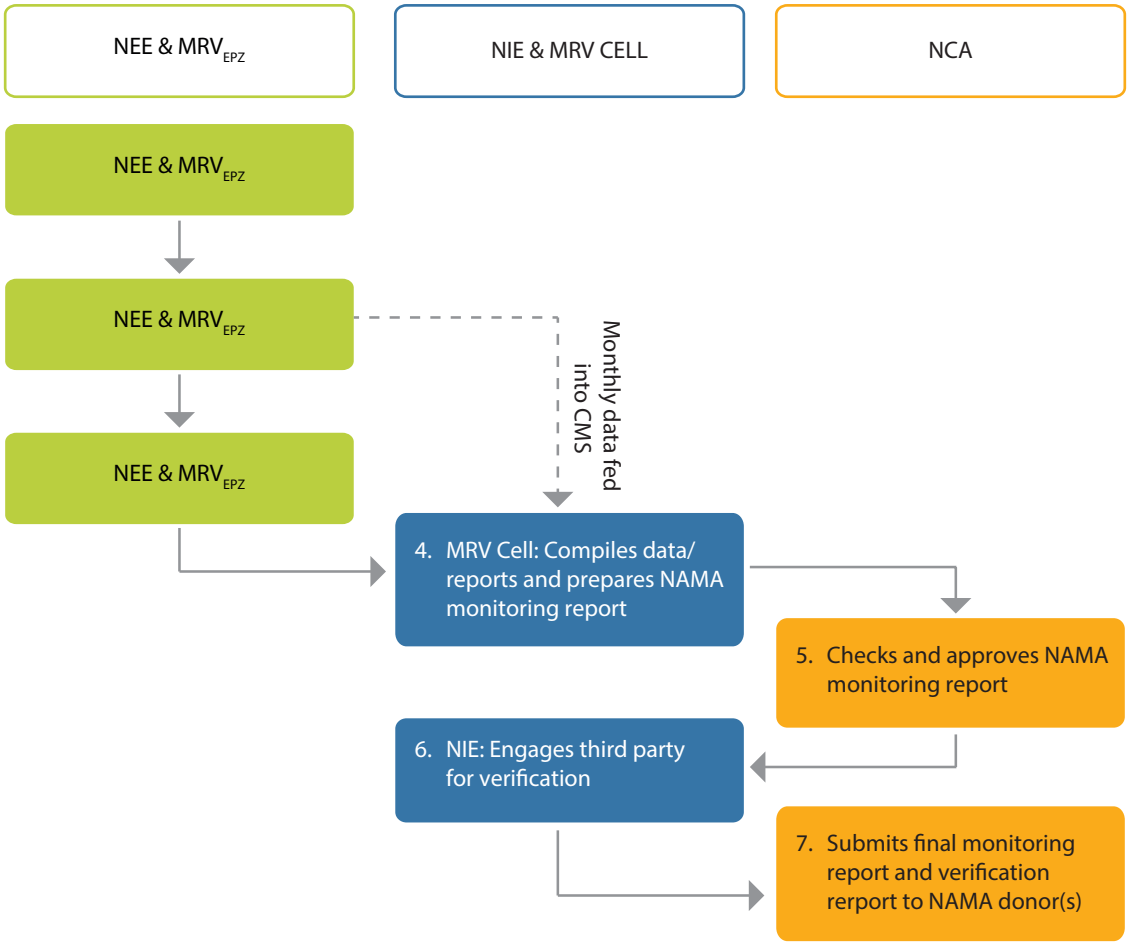
4. The MRV Cell compiles these annual reports along with the monthly data fed into the CMS. It also combines the findings in the reports and summarizes them in an annual NAMA monitoring report. This annual NAMA monitoring report will contain information on GHG emissions reductions, progress on the SD indicators, and the financial performance of those engaged in NAMA activities. The MRV Cell may hire an international consultant for preparation of this annual report. Finally the MRV Cell will submit this report to the NCA for checking and approval.

5. The NCA checks the NAMA monitoring report in accordance with the quality assurance/quality control (QA/QC) process mentioned in the monitoring plan and approves the report.

6. The NIE along with the MRV Cell arranges for an external entity to undertake independent verification of the annual NAMA monitoring report.

7. The final NAMA monitoring report together with the report of the external verifier is submitted to NAMA donor(s) by the NCA.

**Figure 9-3: The Reporting Process[a]**




[a]MRVEPZ=The official from the MRV Cell based in EPZs.

### 9.2.2 Reporting Forms

The MRV Cell is charged with creating reporting form templates. These forms will include at a minimum the following information:

- Details about the technologies (i.e. technology code, unique identification number etc.);
- EPZ contact details;
- Description of the measuring system;
- Data parameters measured;
- The default values applied;
- Calculations of emissions reductions.

The reporting form template will be provided to the NEEs by the MRV Cell. NEEs submit the completed form to the MRV Cell annually.

## 9.3 Verification and Evaluation

The goal of verification is to have an independent third party auditor ensure that the NAMA is operating as planned and that the measuring and reporting system is being implemented as planned. Verification also ensures that emissions reductions and SD benefits are real and measurable.

Auditors should be accredited entities. They can be entities accredited under the CDM or under another accreditation system acceptable to the Government of Ghana and the NAMA donor(s).

Verification should occur every two years. The verification will consist of:

- Desk review of documents;
- Interviews with key stakeholders;
- Site visits to EPZs;
- The drafting of the verification report;
- Provision of feedback on the report by the NIE, the NCA and the Trustee;
- Finalization of the verification report.

The verification boundary will primarily consist of EPZs and the Central Monitoring System. The verification report will contain an assessment of the performance of the NAMA and the extent to which it has contributed to the outcomes set out in the monitoring plan.

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# ANNEXES

## Annex 1: Status of Millennium Development Goal 1

| Targets & Indicators | Baseline | Status | Target (2015) |
|---|---|---|---|
| **Target: Halve the proportion of those in extreme poverty, 1990–2015** | | | |
| Proportion of population below $1.25 (PPP) per day (%) | 51.1 (1991) | 28.6 (2005) | 25.5 |
| Population below national poverty line, total (%) | 31.9 (2005) | 24.2 (2012) | No set target |
| Population below national poverty line, urban (%) | 12.4 (2005) | 10.6 (2012) | No set target |
| Population below national poverty line, rural (%) | 43.7 (2005) | 37.9 (2012) | No set target |
| Purchasing power parities (PPP), national currency per 1993 international dollar | 0.03 (1990) | 0.85 (2012) | No set target |
| Poverty gap ratio | 18.3 (1991) | 9.9 (2005) | 9.15 |
| Share of poorest quintile in national consumption | 6.7 (1991) | 5.2 (2005) | 3.35 |
| Growth rate of GDP per person employed (%) | Not available | Not available | Not available |

| Targets & Indicators | Baseline | Status | Target (2015) |
|---|---|---|---|
| **Target: Achieve full and productive employment and decent work for all, including women and young people** | | | |
| Employment-to-population ratio | 73 (1991) | 52.4 (2010) | No set target |
| Employment-to-population ratio, men (%) | 71.4 (1991) | 54.6 (2010) | No set target |
| Employment-to-population ratio, women (%) | 74.2 (1991) | 50.5 (2010) | No set target |
| Proportion of employed people living below $1.25 (PPP) per day | 47.3 (1991) | 24.8 (2005) | No set target |
| Proportion of own-account and contributing family workers in total employment (%) | 75.4 (2006) | 76.8 (2010) | No set target |
| Proportion of own-account and contributing family workers in total employment, women (%) | 85.4 (2006) | 84.3 (2010) | No set target |
| Proportion of own-account and contributing family workers in total employment, men (%) | 64.8 (2006) | 68.9 (2010) | No set target |
| **Target: Halve between 1990 and 2015, the proportion of people who suffer from Hunger** | | | |
| Children under 5 moderately or severely underweight (%) | 25.8 (1993) | 13.4 (2011) | 12.9 |
| Children under 5 severely underweight (%) | 9.9 (1993) | 2.6 (2011) | 4.95 |

*Source: United Nations Statistics Division, 2015.*

## Annex 2: Status of Millennium Development Goal 7

| Targets & Indicators | Baseline | Status | Target (2015) |
|---|---|---|---|
| **Target: Integrate the principles of sustainable development into country policies and programmes and reverse the loss of environmental resources** | | | |
| No set indicators | | | |
| **Target: Reduce biodiversity loss, achieving, by 2010, a significant reduction in the rate of loss** | | | |
| Proportion of land area covered by forests (%) | 32.7 (1990) | 21.7 (2010) | No set target |

| Targets & Indicators | Baseline | Status | Target (2015) |
|---|---|---|---|
| **Target: Halve by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation** | | | |
| Proportion of population using an improved drinking water source (%) | 56 (1990) | 89 (2015) | 85 |
| Proportion of the population using an improved sanitation facility (%) | 7 (1990) | 15 (2015) | 53 |
| **Target: By 2020, to have achieved a significant improvement in the lives of atleast 100 million slum dwellers** | | | |
| Population with access to secure housing (%) | 65.5 (1990) | 37.9 (2014) | No set target |
| Slum population in urban areas (thousands) | 3571.1 (1990) | 5349.3 (2014) | No set target |

*Source: United Nations Statistics Division, 2015.*

## Annex 3: Status of Millennium Development Goal 8

| Targets & Indicators | Baseline | Status | Target (2015) |
|---|---|---|---|
| **Target: Address the special needs of the least developed countries** | | | |
| Official Development Assistance (ODA) received by Government of Ghana, as a percentage of GDP | 13.2 (2003) | 12.8 (2010) | No set target |
| **Target: Deal comprehensively with the debt problems of developing countries** | | | |
| Public debt as a percentage of GDP | 28.3 (2006) | 39.6 (2010) | No set target |
| Debt servicing as a percentage of exports of goods and services | 36 (1990) | 7.9 (2013) | No set target |
| **Target: In cooperation with the private sector, make available the benefits of new technologies, especially information and communications** | | | |
| Telephone lines per 100 population | 0.30 (1990) | 0.98 (2014) | No set target |
| Cellular subscribers per 100 population | 0 (1990) | 114.82 (2014) | No set target |
| Internet users per 100 population | 0 (1990) | 18.90 (2014) | No set target |

*Source: United Nations Statistics Division, 2015.*

## Annex 4: Financing and Support Instruments for the Cooking and RE Sector

The energy sector in Ghana is supported by following sources of financing.

### The LPG Promotion Programme

As discussed in chapter 2, the Government launched the LPG promotion programme in 1989 to promote the use of LPG as a cooking fuel. The programme targeted households, institutions and small-scale food sellers. As a promotional strategy, 14.5kg and 5kg LPG cylinders were distributed freely to the public and free transportation services were offered. Consumers were required to pay for the cost of the gas only. However, the project was successful mainly in distributing LPG to urban households, while the the rural areas were neglected.

### The LPG Fund

As part of the same programme, a fund called the LPG Fund was also created through a levy on LPG purchases and was used to fund the purchase and maintenance of cylinders, LPG tanks and kitchen equipment for institutions. The LPG Fund was also used to partly finance the construction cost of the Ghana Cylinder Manufacturing Company (GCMC) factory in Accra. The levy was scrapped in February 1998.

### The Unified Petroleum Price Fund (UPPF)

In order to balance the impact of the programme, the Unified Petroleum Price Fund (UPPF) was launched by the Government in 2005 to equalize transport costs. The primary objectives of the programme were to ensure that LPG was available in rural areas and to increase the chances of its adoption for cooking purposes through incentivizing transporters who haul the product to rural and distant locations, outside a radius of 200 km from the refinery. In February 2013 a levy of about US$0.03/litre was imposed on each fuel to fund the UPPF.

### Subsidies

Subsidies were also an integral part of the LPG promotion programme. Subsidy component on LPG in the price build-up was designed for domestic users with Their primary purpose was to help households to satisfy their demand for LPG at an affordable price. According to NPA, the fuel subsidy was in excess of ¢450 million (US$276 million) in 2011. However, in June 2013, the Government removed the subsidy from LPG, petrol and gas oil to help restore fiscal stability after overshooting of its budget deficit target.

Though the programme seems to have raised the number of households using LPG quite dramatically, from 4 per cent in 1998 to 9.5 per cent in 2006 and to 22.3 per cent in by the time of the 2012/13 Ghana Living Standards Survey, factors other than cost led to its abandonment. The subsidies boosted consumption of automotive LPG, causing shortages which were exacerbated by the long shutdown of the Tema Oil Refinery and the fraudulent diversion to urban centres of subsidized supplies intended for the rural areas.

### The Renewable Energy Fund

The Renewable Energy Fund was established in 2014 under the Renewable Energy Act of 2011. The fund is supposed to provide financial support for the promotion, development, sustainable management and utilization of renewable energy sources in the country. To capitalize the fund, the Government has put a levy of US$0.2 per litre on petroleum products. An additional levy of US$0.2 per kWh will be charged on electricity transmitted. However, the fund is still not operational.

### The Climate Investment Fund

In May 2015 Ghana received approval for US$40 million of funding from the UN-supported Climate Investment Fund for the Scaling-up Renewable Energy Program (SREP) investment plan for Ghana. The renewable energy investment plan is structured around four key projects: renewable energy mini grids and stand alone solar PV systems; solar PV-based net metering with storage; utility-scale solar PV/wind power generation; and a technical assistance project (supported by the Sustainable Energy Fund for Africa – SEFA).

### Licensing in the Renewable Energy Sector

Under Renewable Energy Act 2011, the Energy Commission of Ghana has defined the following activities that require licensing:

- production and supply of electricity, biofuel, firewood and charcoal;
- bulk transportation of biofuel, firewood and charcoal;
- bulk storage of renewable energy products including biofuel, firewood and charcoal;
- distribution, sale and marketing of renewable energy products;
- export and re-export of renewable energy products;
- import of renewable energy products; and
- installation and maintenance of renewable energy facilities (solar, wind, biogas, biofuel and small hydro).

## Annex 5: Proposed Policy Actions under Ghana's INDC

The INDC Policy actions and their respective programme of actions relevant with respect to this NAMA study have been indicated in the table below.

| INDC Policy Actions | Programme of Action | Supporting national Policy & Measures | Status | Investment Needs (US$ million) | Sustainable development benefits |
|---|---|---|---|---|---|
| Scale up renewable energy penetration by 10 per cent by 20304 | Establish solar 55 mini grids with an average capacity of 100 kW each.<br>Scale-up the 200,000 solar home systems for lighting in urban and selected non-electrified rural households. | National Energy Policy<br>National Renewable Energy Act (Act 832).<br>Set up feed-in-tariff for Renewable Energy technologies.<br>Establishment of National Renewable Energy Fund<br>Design Renewable Energy Purchase Obligation.<br>Net metering scheme for households | Conditional | 2,2145 | Job creation opportunities through installation and maintenance of about 127.5 million man hours.<br>Reduced consumption of fossil fuel consumption for power generation.<br>Increased electricity access to rural communities and contributed to realize energy security.<br>The electricity demand saving of about 200 MW |
| Promote clean rural households lighting | Increase solar lantern replacement in rural non-electrified households to 2 million. | Sustainable Energy Action Plan<br>National Bio-energy strategy<br>Phasing out fossil fuel subsidies | Conditional | 300 | Avoided GH¢74 million subsidy on kerosene annually.<br>Kerosene savings to the nation of 60,000 litres, 150,000 litres and 390,000 litres. |
| Expand the adoption of market-based cleaner cooking solutions | Scale-up adoption of LPG use from 5.5 per cent to 50 per cent in peri-urban and rural households up to 2030.<br>Scale-up access and adoption of 2 million efficient cookstoves up to 2030 | Sustainable Energy Action Plan<br>National Natural Gas Master Plan<br>National LPG Programme | Conditional | 0.6<br>50 | 39,500 hectares of woodland are saved from degradation.<br>Reduction in indoor pollution resulting from woodfuel usage<br>Reduction in smoke related respiratory and eye diseases<br>Reduction in household cooking fuel expenditure<br>Job creation through the manufacture and sale of the efficient stoves |

*Source: Republic of Ghana, 2015.*

## Annex 6: SD indicators for Intervention 1

| Domain | Indicator | Selected (Yes/No) | Identified impacts | Explanation of chosen indicator | Effect on Indicator |
|---|---|---|---|---|---|
| Environment | Climate change adaptation and mitigation | Yes | Reduce GHG emissions | This intervention will reduce consumption of fossil fuels in electricity generation through the manufacture of CC & RE technologies, and thus GHG emissions are reduced. | Positive |
| Social | Livelihood of poor, poverty alleviation, peace | Yes | Quality of Life | This intervention promotes income generation through the manufacture and sale of CC and RE technologies. This also encourages local communities to become involve in income generation activities. | Positive |
| | Affordability of electricity | Yes | Provide affordable electricity | Implementation of this intervention will provide electricity to the manufacturing and distribution facilities of RE and CC technologies along with other income generating activities in a sustainable and affordable way. | Positive |
| Growth and Development | Access to clean and sustainable energy | Yes | Enhance access to clean and sustainable energy | Access to clean energy such as solar PV based electricity generation is very limited in Ghana. The intervention will provide access to solar PV based electricity for manufacturing and distribution facilities along with other income generating activities. | Positive |
| | Empowerment of women | Yes | Jobs for women | Women will be involved in the manufacture and distribution of CC and RE technologies along with other income generating activities. | Positive |
| | Access to sustainable technology | Yes | Provide access to sustainable technology for electricity | Access to RE based electricity such as solar PV based electricity is very limited in Ghana, particularly in rural areas. The NAMA will provide access to these technologies through the manufacturing and distribution facilities in the EPZs along with other income generating activities. | Positive |
| | Energy security | Yes | Improve energy security | The NAMA will improve energy security in the country by conserving fossil fuels. | Positive |

| Domain | Indicator | Selected (Yes/No) | Identified impacts | Explanation of chosen indicator | Effect on Indicator |
|---|---|---|---|---|---|
| Growth and Development | Capacity-building | Yes | Increase skills and capacity | Under this intervention, capacities will be developed in the manufacture, distribution and use of clean cooking and RE technologies. In manufacturing capacities, in the form of technical skills, will be developed, while in distribution, capacities will be developed in the care and maintenance of the technologies. | Positive |
| Economic | Income generation/ expenditure reduction/Balance of payments | Yes | Reduce energy import bill | Implementation of this intervention will promote savings in fossil fuel, thus reducing national expenditure on energy. | Positive |
| | Job Creation (number of men and women employed) | Yes | Jobs creation | The implementation of the NAMA will require the use of several local/ national entities for: RE supply and installation, EPZ operating mini grids, surveys, awareness raising, marketing, accounting etc. | Positive |
| Institutional | Policy and planning | Yes | Professional dialogue | The implementation of the NAMA will require a proper organizational structure and management system for the entities involved, i.e. NIE, NEE, NCA | Positive |
| | Laws and regulation | Yes | Enhance proper operation management | The NIE will have to establish an operations management system, including manuals, process description and NEE reporting procedures, so as to ensure proper implementation and monitoring of the interventions. | Positive |

## Annex 7: SD indicators for Intervention 2

| Domain | Indicator | Selected (Yes/No) | Identified impacts | Explanation of chosen indicator | Effect on Indicator |
|---|---|---|---|---|---|
| Environment | Air pollution/ quality | Yes | Improve household air quality | This intervention promotes use of energy efficient, superior performance improved cookstoves, which promotes reduced use of firewood and charcoal and hence lowers emissions of soot and other pollutants in the air. | Positive |
| | Biodiversity and Ecosystem balance | Yes | Reduce deforestation | Intervention will reduce the use of non-renewable biomass, which is a major reason for deforestation in the country, thereby preserving ecosystem integrity. | Positive |
| | Climate change adaptation and mitigation | Yes | Reduce GHG emissions | Implementation of this intervention will reduce consumption of non-renewable biomass and fossil fuel, and thus GHG emissions are reduced. | Positive |
| Social | Health | Yes | Improve health of women and children | Smoke from conventional cookstoves causes a number of diseases, including respiratory illness and even cancer, among women and children exposed to it. Reduction of smoke will reduce the risk of such cases from happening. | Positive |
| | Livelihood of poor, poverty alleviation, peace | Yes | Quality of life | Implementation of this intervention will save the time that women of the house spend every day in collecting fuel wood from far flung places. Besides, it will reduce the medical needs of women and children. The NAMA will also improve light conditions, allowing children to study at home, which has a significant impact on improving children's education in rural families and their future employability. | Positive |
| | Time savings/time availability due to project | Yes | Improve productivity and promote economic diversification | NAMA saves time that women of the house spend every day in collecting fuel wood from far flung places, thus providing them with the opportunity to engage in other economic activities. | Positive |

| Domain | Indicator | Selected (Yes/No) | Identified impacts | Explanation of chosen indicator | Effect on Indicator |
|---|---|---|---|---|---|
| Growth and Development | Access to clean and sustainable energy | Yes | Enhance access to clean and sustainable energy | Access to clean energy such as ICSs for cooking and RE technologies for lighting is very limited in Ghana. The NAMA will provide access to ICSs, LPG cookstoves and RE technologies for households. | Positive |
| | Education | Yes | Provide educational opportunities to children | Children have more time to go to school as they can be released from collecting fuel wood. | Positive |
| | Empowerment of women | Yes | Jobs for women | With better health, women will be physically able to do other things, take up new ventures or engage in other income-generating activities. | Positive |
| | Access to sustainable technology | Yes | Provide access to sustainable technology for cooking | Access to modern energy technology for cooking & lighting such as ICS, LPG cookstoves and solar lanterns is very limited in Ghana, particularly in rural areas. The NAMA will provide access to these technologies for both rural and urban households. | Positive |
| | Energy security | Yes | Improve energy security | The NAMA will improve energy security in the country by conserving woodfuel. | Positive |
| Economic | Income generation/ expenditure reduction/ balance of payments | Yes | Reduce energy import bill | NAMA will promote savings in woodfuel and thereby requirement for fossil fuels, thereby allowing national expenditure on energy to be reduced. | Positive |
| | Job creation (number of men and women employed) | Yes | Jobs creation | Added manufacturing capacities and the sale of clean cooking and RE technologies will create jobs and provide business opportunities for both the rural and urban poor. | Positive |

## Annex 8: NAMA Measures and Interventions

| | Objectives, Interventions and Measures |
|---|---|
| **1.** | **Objective 1 – Enable the private sector to participate in the manufacture and distribution of clean energy technologies in Ghana.** |
| 1.1. | This intervention is to support the establishment and operation of 28 EPZs across Ghana |
| 1.1.1 | This activity focuses on the building of awareness and know-how within the private sector for the business model for EPZs, which includes setting up of solar PV power plants and manufacturing and distribution facilities. |
| 1.1.2 | To support qualified businesses that meet the defined eligibility criteria to sign an appropriate PPP agreement with the National Implementing Entity and provide training in the various enabling mechanisms, including quality standards, business models etc. |
| 1.1.3 | This activity is to support the private partners in the PPP agreement in the procurement of a solar PV Power plant, and the design and establishment of the EPZs including facilitating the required approval processes for the acquisition of land, technology, equipment etc. |
| 1.1.4 | This activity is to support the private partners by training them in the operation and maintenance of PV power plants and provide training for the workforce within the EPZs |
| 1.2. | This institutional measure is to establish a Public Private Partnership (PPP) mechanism for the operation of the EPZ business model |
| 1.2.1 | This activity is to provide institutional knowhow for the procurement and operation of the various clean energy technologies under PPP agreements under the NAMA, to prepare the PPP frameworks (incl. regulation, standards, structure, draft agreements, and tender frameworks), and finally to give support to those seeking access to finance. |
| 1.3. | This financial measure is to support the private sector entities applying for grants and loans. |
| 1.3.1 | This activity is to make two-year grants available for the procurement, installation, operation and maintenance for the solar PV power plants to be located in the EPZs. |
| 1.3.2 | This activity is to make loans accessible to private sector entities investing in each of the three business models |
| **2.** | **Objective 2 – Create an enabling market environment that encourages distribution of the clean energy technologies to the end-users supported by an appropriate financing model.** |
| 2.1 | This institutional measure is to undertake a detailed Techno-Commercial Analysis. |
| 2.2.1 | This activity is to undertake a detailed consultancy to study how specific local conditions affect demand for technology, annual distribution potential by location, costs and other factors that will affect NAMA outcomes, and on the basis of that study, to prepare an implementation plan for formal approval by the Government and to be made available to donors for financing. |
| 2.2 | This financial measure is to establish and operate the NAMA Financing Facility (loans and grants). |
| 2.2.1 | This activity starts with determining the source(s) of capital for the different financial instruments (grants, guarantees and/or subordinate debt), structuring the operational by-laws and evaluation mechanisms under which the financial instruments will function, including eligibility criteria and risk mitigation strategies, and a programme evaluation mechanism, after which the financial instruments, both short- and long-term, can be activated. |
| 2.2.2 | This activity will deal with the selection and capacity-building of the national commercial bank(s), which will operate the the financing facility |



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