

REPUBLIC OF RWANDA



MINISTRY OF INFRASTRUCTURE

BIOMASS ENERGY STRATEGY

A sustainable path to clean cooking

2019 - 2030

FOREWORD

The Government of Rwanda recognises the vital role that clean cooking plays in accelerating the country's development through improving health of its citizens and creating economic opportunities. Modernising cooking technologies and practices is at the same time a major contributor to tackling deforestation and contrasting climate change. Despite various initiatives in the biomass subsector taking place over the years, more efforts need to be made at a coordinated level for the Government to meet the targets set for the reduction in the use of inefficient cooking technologies and the rebalancing of demand and supply of wood.

For these goals to be met, the ongoing challenges need to be addressed through business models that are highly context-specific, as the shift of cooking practices ahead are as much of a technological nature as they are of cultural and environmental ones.

The Government developed this strategy with the objective of ensuring that Rwanda's households have access to clean cooking by developing programmes that will facilitate both the end users to access technologies and fully enable private sector participation in the provision of these solutions.

The Government will work with the private sector in implementing this Strategy. Focus will be on developing markets by removing entry barriers and increasing competition within private sector. This approach will lead to reduced costs and improved choice of affordable technologies on the market. Equally important will be the focus that the Government gives to the consumer side by carrying out awareness campaigns and protecting the users by providing robust and enforceable standards.

I would like to take this opportunity to express my gratitude to the Development Partners that have supported the Government in increasing access to clean cooking solutions. Their contribution is of great importance in making our vision a reality.

I would also like to thank all stakeholders and MININFRA staff that contributed to the development of this strategy and look forward to continued support in implementing it.

Thank you

for
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Minister of Infrastructure



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Acronyms and Abbreviations

| ACRONYM | DESCRIPTION |
|-----------|---|
| BAU | Business As Usual |
| BEST | Biomass Energy Strategy |
| DFMP | District Forest Management Plan |
| DFNC | Department of Forestry and Nature Conservation |
| EDCL | Electricity Development Corporation Limited |
| EDPRS | Economic Development and Poverty Reduction Strategy |
| EU | European Union |
| EUCL | Electricity Utility Corporation Limited |
| FONERWA | National Fund for Environment in Rwanda |
| HAP | Household Air Pollution |
| ICS | Improved Cookstove |
| LPG | Liquefied Petroleum Gas |
| MINAGRI | Ministry of Agriculture |
| MINALOC | Ministry of Local Government |
| MINECOFIN | Ministry of Finance and Economic Planning |
| MINEDUC | Ministry of Education |
| MININFRA | Ministry of Infrastructure |
| MOE | Ministry of Environment |
| MOH | Ministry of Health |
| MTF | Multi-Tier Framework |
| NFMP | National Forest Management Plan |
| PSF | Private Sector Federation |
| RCS | Rwanda Correctional Service |
| RDB | Rwanda Development Board |
| RDF | Rwanda Defence Force |
| RNP | Rwanda National Police |
| RSB | Rwanda Standards Board |
| REG | Rwanda Energy Group |
| RURA | Rwanda Utilities Regulation Authority |
| RWFA | Rwanda Water and Forestry Authority |
| SE4ALL | Sustainable Energy For All |
| SFMP | Simplified Forest Management Plan |
| WHO | World Health Organisation |

1 INTRODUCTION

1.1 Problem statement

Biomass is a broad term describing biological material derived from living or recently living organisms. It includes trees, crops, algae, and other plants, as well as agricultural and forest residues. The most widespread forms of biomass energy in Africa are firewood and charcoal, together known as wood fuels.

Worldwide, nearly 3 billion people cook with biomass on traditional inefficient stoves. This practice has particularly harmful effects on health, environment and poverty dynamics.

Firewood collection and charcoal production are worldwide significant contributors to forest degradation and to deforestation respectively. Moreover, the carbon emissions from the wood fires is responsible for an estimated 18% of the global warming process. Moreover, agricultural residues used as cooking fuel are not anymore going back to soil for fertility, leading to a process of soil degradation difficult to reverse.

Families in Rwanda spend up to 6 hours per day collecting firewood and up to a third of their income for their energy needs, exacerbating the cycle of poverty. Nationwide, about 79.9% of households use firewood as their primary cooking fuel, and most of them likely collect it for free, hence spending over 1 hour a day acquiring and preparing fuel collection and preparation (SE4All, MTF). Acquiring and preparing fuel are time-consuming tasks for most households.

According to the latest estimates by WHO, Household Air Pollution (HAP) from traditional Cookstoves leads to over 4.3 million deaths per year worldwide, more than HIV, malaria and tuberculosis combined. Children represent a significant proportion of such deaths. Carbon monoxide and particulates from the fires are responsible for severe respiratory diseases, perinatal mortality, low weight births, cancer, eye illnesses including blindness and cardiovascular diseases. The increasing practice of cooking with agricultural residues in areas where wood is scarce leads to even higher exposure to harmful smokes.

Biomass is the dominant source of energy in Rwanda. According to the United Nations Statistics Division (UNSD)¹, biomass accounted for 87% and 86% of primary energy², in 2014 and 2015, respectively.

¹ www.unstats.un.org; Accessed 23 August 2018

² Primary energy here excludes imports, exports and bunker fuels

Similarly, MININFRA in the Energy Sector Strategic Plan highlights biomass prevalence in the energy consumption as in the below figure.

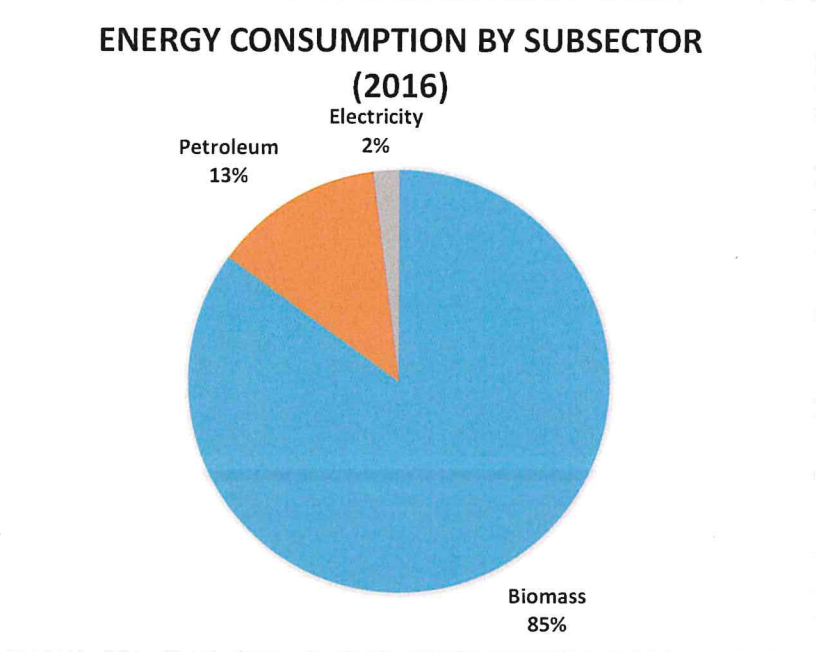


Figure 1 - Contribution to total domestic energy consumption by subsector

From an environmental standpoint, this extensive reliance on biomass for energy – in the form of fuel-wood and charcoal - is no longer sustainable due to consumption being higher than production. Inefficiencies in the production and consumption of biomass for energy exacerbate the problem.

Despite different sustainable options are increasingly being developed for cooking applications, biomass is expected to remain a major source of energy and rural employment. It is therefore important to promote cleaner alternatives to biomass for cooking but also in parallel to promote cleaner , efficient and sustainable use of current biomass resource, including the management of natural forests and tree-plantations.

1.2 Types and penetration of cooking fuels in Rwanda

Firewood is the most common cooking fuel in Rwanda and it is used in various types of woodstoves: 93%³ of rural households utilise firewood as it is considered in most cases still freely available. More than half of the firewood stoves operating nationwide are 3-stones stoves.

³ Rwanda Poverty Profile Report 2016-2017 (EICV 5, NISR)

Approximately 65% of households living in major urban areas like Kigali, Huye, and Rwamagana, use **charcoal** to meet most of their cooking needs, through both traditional and improved Cookstoves. In urban areas, charcoal is the most preferred fuel due to its long-life storage and low-cost transportation, as it is smaller in volume and weight and has higher heat content compared to firewood. Most of the charcoal is produced locally.

In Rwanda, most charcoal (86%) is produced in a rather inefficient way and by use of traditional earth mound kilns with average thermal efficiency of about 12% (air dry kg of charcoal/ air dry kg of wood).⁴

Agricultural residues used to constitute only a small percentage of fuels used by the households, but their use has increased year after year as a substitute due to wood scarcity, particularly among the poorest households of rural semi-arid areas. In Rwanda, the most used agricultural residues at household level are cereals (maize, sorghum, stalks and rachis), wheat and rice straws and husks, tubes like cassava stalks, banana leaves, coffee husks, vegetable wastes (beans, groundnuts, soya, coffee pulps and dried cow dung). Rice husk is used as a fuel mainly for brick firing in the major rice growing areas. Sugar bagasse, coffee husks, rice husks and wheat husks are also used in brick making industries. In urban areas, poor households use sawdust and other end-cuts from wood processing industries without using appropriate cook stoves.

The use of **biogas** as a substitute for firewood and charcoal began in 2007 through the 5-Year National Domestic Biogas Programme (NDBP). Biogas requires the user to have and own enough animal resource and knowledge for domestic animals housekeeping and feeding (including large amounts of water) and for the use of bio-slurry as manure.

Biogas is rarely used as a primary fuel for cooking. Most biogas users often have a main stove, which is either a traditional stove or an improved biomass stove. The high price tag placed for acquisition of the digesters has been a key reason behind the limited uptake, despite the achievement of customer satisfaction once the digester is installed⁵.

Pellets and **Briquettes** are currently the most advanced biomass-based options being implemented in the latest years in Rwanda. They are produced from by-products of wood processing industries (sawdust or wood shavings) or from forest residues. However, wood is not the only suitable feedstock for pellets fuel: a wide range of biomass materials can be used to manufacture pellets and briquettes, most notably some perennial grasses, e.g., Miscanthus or Switch grass. Raw materials needed to produce pellets and briquettes are

⁴ Source: The Complementary study of the Charcoal Value Chain 2016

⁵ Source: SE4All, 2015

available at a variety of sizes and scales that allow for both small, medium and large-scale manufacturing. Despite these favourable conditions, the uptake of these technologies at present is limited due to the infrastructure investment required for production of these fuels, the requirement of specific stoves to ensure efficiency and the competition with brick makers for the use of raw materials. Woody pellet production, for which forest concessions have to be customised accordingly, is a key solution for replacing charcoal in urban households and providing highly efficient fuel to the wealthier end of rural population. Briquettes made from crops /residues and dried grasses (e.g. marshland) represent a sustainable and efficient alternative for households in areas where wood is very scarce and not accessible but where crop residue/grasses from marshland can represent an accessible and affordable feedstock.

Penetration of **LPG** in Rwanda is still relatively limited, but its availability and adoption are evolving rapidly, demonstrated by the sharp increase of imports in the last few years. LPG is often used in combination with charcoal mainly for meals taking longer to cook (for example beans); the latter is still the principal cooking fuel in urban areas. Through policy interventions and regulation, the penetration of LPG in the urban energy mix will significantly reduce the use of charcoal in urban households.

Currently inadequate supply, primary storage and transport represent bottlenecks to scale-up LPG adoption and discussions are in place between public and private sectors to find solutions. The distribution network is set to be gradually expanded by the largest private actors in the business, which have the means to gather major wholesalers. Efforts are ongoing to create an enabling environment for the penetration of the LPG technology through the design of a proven model for setting up filling centres, cylinder distribution, assisted by an affordable end-user price structure and favourable tax conditions for product and accessories. Standards and norms covering the full supply chain are being developed to assist regulation.

The possibility to use **Methane** in the form of **Compressed Natural Gas (CNG)** from **Lake Kivu** in the medium term as cooking fuel has recently been embraced again, particularly in light of the increased presence of private investors undertaking energy production activities with the lake gas. The amount of methane in place is estimated at about 59 billion cubic meters of which 29 billion cubic meters (29 million TOE)⁶ are believed to be economically recoverable.

Utilization of methane as fuel in the form of compressed natural gas (CNG) for cooking through compression and bottling presents a number of technical and commercial difficulties. An alternative is represented by the transportation and distribution of the gas via pipelines: this option requires very large investments in a widespread distribution and

⁶ Source: RECP - EUEI

reticulation network, coupled with additional high maintenance costs. To mitigate these challenges, a multi-layered strategy for the exploitation of the gas would allow tiered pricing and subsidisation of costs for a variety of different applications and usages, which can include cooking purposes once sufficient demand is established.

Electricity is also being considered as one of the forms of cooking energy that will help Rwanda to reduce the dependence on biomass and increase demand for electricity. So far, electricity as a source of energy for cooking has been extremely uncommon in Rwanda, mainly due to the considerable power requirements of the cooking process and the appliances coupled with the high electricity tariffs in the country.

The type of stove has a significant impact on the amount of fuel required and on the health of the users. A significant proportion of households still resorts to utilising three-stone Cookstoves (the simplest Cookstove, made by placing a pot on three stones, which are positioned around a fire) or other traditional cooking stoves: these are normally fuelled by firewood. The average household uses around 1.8 tonnes of firewood each year to satisfy its cooking needs with low efficient Cookstoves.

A first high-level comparison of Cookstove types is presented in Figure 2:





| Combustion technologies | 3-stone fires | Improved stoves (first generation) | Improved stoves (second generation) | Stoves of high efficiency |
|---------------------------------------|---|---|---|---|
| |  |  |  |  |
| Efficiency | 8 to 12% | 20 to 25% | 25 to 35% | >35% |
| Particulate matter per m ³ | 2,800 ppm | 1,700 ppm | <1,000 ppm | < 250 ppm |
| Energy type | Thermal energy | Thermal energy | Thermal energy, electric energy | Thermal energy, electric energy, chemical energy |
| Conversion type | Combustion | Combustion | Combustion, gasification | Combustion, gasification, liquefaction |

Figure 2 - Classification of Cookstoves by combustion technology and performance (World Bank)

1.3 Policy framework, status and direction of Government interventions

The strategic framework for Rwanda’s energy sector is established in the Energy Sector Strategic Plan (ESSP, 2018-2024) and the Rwanda Energy Policy (REP). These documents

recognize the essential role of clean cooking in accelerating economic development, as well as improving health outcomes and standards of living for people in Rwanda.

Energy policies and strategies interact closely with wider, national policies: high-level national objectives are set by Vision 2050 and NST-1 (2018).

The target set for the biomass energy subsector is to halve the percentage of households that use inefficient traditional technologies for cooking from the baseline value of 83.3% recorded in 2014⁷ to 42% by 2024. This is foreseen to be met through a combination of boosting the adoption of cleaner fuels, technologies and improving efficiency of the existing cooking technologies. Advancing technology means that there is an ever-expanding range of ways for households to access clean cooking, such as: an Improved Biomass Cookstove (ICS); a Liquefied Petroleum Gas (LPG) stove, a biogas stove or an electric stove.

Despite previous policy targets were set to reduce the share of woody biomass in the total energy consumption, little progress has been made concretely and biomass continues to be by far the primary source of cooking energy consumption. The low penetration of improved cooking devices as alternatives to biomass for cooking, such as LPG, biogas or electricity, has contributed significantly to this lack of progress. The use of firewood as the main source of energy for cooking reduced to 79.9%⁸ in 2017 from 83.3% recorded in 2014, but the use of charcoal increased over the same period: an acceleration of the dissemination of more efficient cooking is highly necessary.

Regular modelling updates will demonstrate the impact of different fuel-mix scenarios for cooking. However, it is strived for that a combination of ICS, LPG, efficient biomass (pellets, briquettes, green charcoal, etc.), biogas and electricity will be used to reduce or even replace inefficient use of biomass. Stoves used will be efficient, reducing the cost and negative health impacts on users. The process of urbanisation is expected to contribute to achieving this target, with 35% of Rwandans expected to be living in cities by 2024.

The Government action to modernise the biomass subsector is driven by two parallel efforts:

1. Reducing the demand of biomass for cooking
2. Increasing the supply of wood resources

The design and implementation of this Strategy is undertaken in coordination with the relevant scope within the Forest Sector Strategic Plan for 2018-2024, which falls under the responsibilities of the Ministry of Environment (MOE) of Rwanda.

⁷ Rwanda Poverty Profile Report 2013-2014 (EICV 4, NISR)

⁸ Rwanda Poverty Profile Report 2016-2017 (EICV 5, NISR)

1.4 Challenges to the adoption of clean cooking technologies

Several constraints currently persist on the path to the adoption of cleaner fuels and sustainable use of biomass resources:

- Low general awareness about existing efficient cooking appliances and alternative fuels;
- Inefficient technologies used for production of biomass cooking fuels (charcoal, briquettes). Pellet technology is adequate but still has low production levels;
- Limited production of equipment and components and under-developed markets in biomass energy equipment and services, because of high initial investment cost and lack of financial capacity to cover the initial investment;
- Inadequate financing and monitoring mechanisms, resulting in low uptake of efficient technologies and insufficient scaling-up of production capacity and development of biomass markets;
- Inadequate coordination of efforts among stakeholder institutions in the biomass sub-sector.
- Switching from a mostly no-cost energy source (firewood) to a cost-related energy source requires that the household has a sufficient disposable income to procure the required fuel.

An analysis undertaken by Rwanda Electricity Group (REG) concluded that alternative technologies targeted at reducing the demand for biomass for cooking have not been adopted to a satisfactory extent, due to various challenges which are summarised in Table 1.

| Technology | Challenges to adoption |
|--------------------------------|---|
| Biogas | <ul style="list-style-type: none"> • Limited know-how of operation and maintenance • Inappropriate feeding due to unavailability of feedstock • Limited ability to pay for these systems by end users • Affordability issues • Limited availability of feedstock • Limited capacity of technicians to provide after sales service • Limited access to water • Lack of continuous R&D to adopt digesters to local conditions |
| Liquefied Petroleum Gas | <ul style="list-style-type: none"> • Higher upfront costs for equipment • Limited distribution capacity of companies due to low presence outside Kigali • Limited awareness • All key components and accessories are imported; this has a direct impact on cost • Storage capacity is limited • Limited ability to purchase start-up equipment • No LPG cost regulation |

| Technology | Challenges to adoption |
|--------------------------------|--|
| Pellets and Briquettes | <ul style="list-style-type: none"> • Limited production and awareness • Producers are not identified and not coordinated • Production and business management skills for most producers are limited • There are no production lines that ensure standardised production • Use is limited to users living around the production sites. |
| Charcoal | <ul style="list-style-type: none"> • Most of the producers use inefficient traditional carbonization techniques • Few trainings were provided to producers on modern carbonization techniques • Taxation not harmonized or does not favour the production of green charcoal • Charcoal production not regulated; no framework to guide producers |
| Improved Cookstoves | <ul style="list-style-type: none"> • Limited enforcement of standards/quality control system • Limited awareness of existing standards • Most stoves on the market are not standardized and not tested by an accredited institution • Uptake entirely voluntary, with no enforcement measures in place • Low demand due to limited awareness • Lack of financial support mechanisms to support low income HHs to acquire ICS |
| Electricity for cooking | <ul style="list-style-type: none"> • High energy cost, affordable to only high-income earners • Limited access to electricity • Limited awareness |

Table 1 - Challenges to clean cooking technologies penetration

Manufacturers and distributors of clean cooking products are subject to unfair treatment and competition due to a series of external constraints:

- Cost barriers due to sub-standard equipment being produced in the informal market and illegally produced fuel (particularly charcoal)
- Low financial capacity of households to cover initial investment
- Insufficient awareness on efficient ICS and potential benefits
- Some efficient ICS not taking sufficiently care about local behaviours
- Absence of accredited national testing, certification centres and quality control systems to support the sale on the market of certified Cookstoves.

Data collection and processing is generally flawed, with incomplete inputs, insufficient disaggregation of data by customer categories and lack of a centralised and consistent database owned by clearly identified institutions.

2 VISION, OBJECTIVES, TARGETS AND INDICATORS

Vision of the Biomass Energy Strategy

All households, public institutions, private industry operators use efficient and clean energy fuels and cooking devices ranging from alternative cooking solutions like LPG cooking solutions to efficient cooking with biomass from sustainable supply, for socio-economic development and environmental integrity of Rwanda.

Objective of the Biomass Energy Strategy

“To facilitate fuel-switching from traditional biomass energy carriers towards modern biomass energy technologies and cleaner alternative fuels in order to achieve a more sustainable wood fuel balance and to deliver related socio-economic, health and environmental benefits”.

The proposed approach for the reduction of wood fuel demand is articulated according to the principle of **encouraging the shift to the use of non-biomass modern energy** – particularly cooking Gas– and **high efficient biomass technologies**.

In those contexts where this is not practical in the short term, as a first step the approach would be to reduce the demand of unsustainable wood fuel through the adoption of sustainable production, certification of fuels and improved and clean technologies (ICS, kilns).

Specific cross-cutting efforts will concern the reinforcement of capacity building of the stakeholders, but also the promotion of all the new products, technologies and fuels and a strong focus on the educational and awareness aspects.

The support in the financial field will be articulated with the following key investigations:

- Carry out financial assessment of producers and promoters of alternative biomass and non-biomass fuels;
- Carry out incentive needs analysis of producers and promoters;
- Establish working mechanisms between financial institutions and fuel and equipment producers, distributors and end users.

Key targets of the Biomass Energy Strategy

1. Reduce the percentage of households that use inefficient cooking solutions from the baseline value of 79.9% recorded in 2017 to 42% by 2024
2. Wood supply and demand shall be in balance by 2030.

The key indicators to achieve the targets of this Strategy are summarised below:

| Indicators | Baseline values and second-level targets |
|---|--|
| <p>› Percentage of population shifting from use of firewood to modern improved cooking solutions (LPG, Biogas, improved biomass fuels (pellets & briquettes) and Improved high efficient Cookstoves, etc.).</p> | <p>Baseline value 2017: 79.9 %⁹ Target value 2024: 42 % Target value 2030: 0 %</p> |
| <p>› Percentage of Urban Households shifting from cooking with charcoal to alternative improved cooking solutions. (LPG, Biogas, improved biomass fuels (pellets & briquettes) and Improved high efficient Cookstoves, etc.).</p> | <p>Baseline value 2017: 65.1 %¹⁰ Target value 2024: 32% Target value 2030: 1%</p> |
| <p>› Percentage of population using inefficient cooking technologies;</p> | <p>Baseline value 2017: 72.5%¹¹ Target value 2024: 36 % Target value 2030: 20 %</p> |
| <p>› Percentage of public biomass high consuming institutions (e.g. schools, prisons, police and military camps) shifting from traditional woody biomass to clean cooking solutions/Productive use.</p> | <p>Baseline value 2017: NA% Target value 2024: 100 % Target value 2030: 100 %</p> |

⁹ NST-1

¹⁰ EICV5

¹¹ Multi-Tier Framework Survey 2017

| Indicators | | Baseline values and second-level targets |
|---|-------------------|--|
| > Percentage of commercial institutions (Hotels, Restaurants, Tea factories, brick factories) shift from using inefficient wood and charcoal to clean cooking solutions | | Baseline value 2017: NA % Target value 2024: 100 % Target value 2030: 100 % |
| > Increase of exploited tree plantations under Sustainable Forest Management (SFM) | > Private forests | Baseline value 2017 : 3% Target value 2024 : 60% Target value 2030 : 65% |
| | > Public forests | Baseline value 2017 : 21% Target value 2024 : 80% Target value 2030 : 90% |
| > Forest productivity under improved management | | Baseline value 2017 : 10 m ³ /ha/an Target Value 2024 : 11 m ³ /ha/an Target Value 2030 : 12 m ³ /ha/an |
| > Average annual income per ha by producer of wood energy under improved management | | Baseline value 2017 : 8,000 Rwf Target Value 2024 : 12,000 Rwf Target Value 2030 : 15,000 Rwf |
| > Tree density in agroforestry/crop area | | Baseline value 2017 : 25 tree/ha Target Value 2024 : 50 tree/ha Target value 2030 : 75 tree/ha |

3 APPROACH, PROGRAMS AND SOLUTIONS

3.1 Market segmentation and economic considerations

Based on review of recent data, five key market segments have been defined for biomass energy usage for cooking, heating and drying processes in Rwanda, as seen in Table 2 below.

Further to extensive studies, the following technologies have been selected as recommended in principle for each identified market segment in Rwanda. The degree of penetration of each technology will depend on the status of the domestic resources available and how the present market challenges associated with each technology and market segment will be addressed.

| Segment | User Types | Suitable technologies |
|-------------------------------------|--|--|
| 1. Rural Households | Rural consumers who rely mostly on firewood for cooking and heating purposes | Firewood ICS (where wood is more accessible), briquette (from residues, in areas where less wood is available) ICS, Combined Woody pellet ICS and pellets, biogas, and LPG |
| 2. Urban Households | Urban consumers who rely heavily on charcoal for cooking and heating purposes | LPG, electricity, Combined Woody pellet ICS and pellets, ICS that use sustainably sourced wood or Green charcoal |
| 3. Commercial food industry | Hotels, bakeries and restaurants who rely on charcoal and firewood for cooking | LPG, Combined Woody pellet/briquette ICS and pellets/briquette, electricity, ICS that use sustainably sourced wood or Green charcoal |
| 4. Public institutions | Schools, prisons, military, refugee camps relying on charcoal and firewood for cooking purposes | Cooking with Gas, electricity, improved institutional stoves (firewood or Combined Woody pellet ICS and pellets), biogas solutions. |
| 5. Processing and Production sector | Tea factories utilise firewood for tea curing Brick factories utilise firewood for brick making | Gasifiers, cogeneration options including peat and renewable energies |

Table 2 - Identified suitable technologies by customer segment (source: REG)

As Figure 3 shows, households are the undisputed leaders in the share of biomass use. This in itself constitutes an affordability challenge to achieving impact by switching consumption to alternative and cleaner technologies.

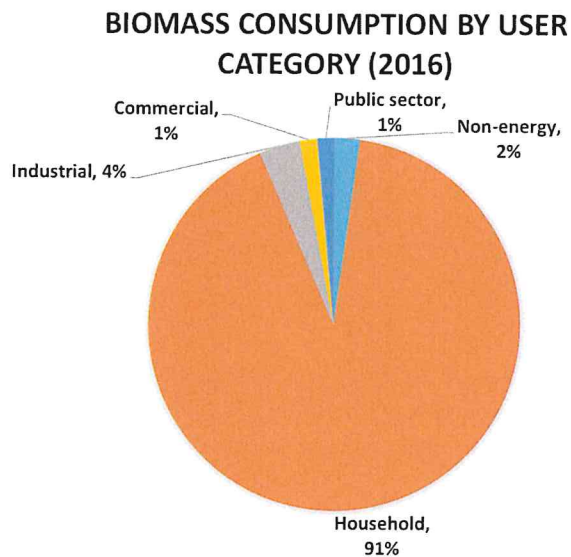


Figure 3 - Biomass consumption shares by user category

LPG and Biogas would be the quickest impact alternatives to counteract massive deforestation to meet the growing energy demand for wood, adverse health and related environmental impacts. Nonetheless, research in cooking with methane gas from Lake Kivu and other wood fuel efficiency utilization mechanisms have to be encouraged given the fact that relying on locally available fuel resources and products will protect the Country from external economic uncertainties, shock and reduce the import-export deficit and not all households will be able to afford the proposed alternatives in the required timeframe.

Many rural households have in general a low incentive to switching away from traditional biomass fuels, such as firewood, as they pay little or nothing for them or simply cannot afford cleaner alternatives. In addition, changing predominant cooking fuel use is a behaviour adjustment that is deeply culturally conditioned. As a result, programs focusing solely on disseminating new technologies without accompanying behavioural change or social marketing campaigns are likely to fail.

Barriers must be overcome to grow the use of alternative technologies. Currently, LPG is imported, with the supply chain acting as a bottleneck, and, like it is the case with electricity, LPG is costly for the vast majority of households, with a recent Multi-Tier Framework survey 2017 showing that it is used by only 0.5% of households. However, pay-as-you-go LPG is increasingly being offered by private companies. This model removes a significant barrier to LPG uptake by removing the requirement to purchase a canister and fuel up front. Customers pay a canister deposit and then use their mobile phone to pre-pay for LPG as they require it. This approach follows the rationale behind the initiatives which have eased the successful expansion of off-grid electricity access seen in recent years.

Similar business models are in place for pellets, with consumers (particularly urban) agreeing to purchase a set number of pellets from a supplier, with a high-efficiency stove provided for no initial cost. To offset the cost of pellets for rural consumers, a scheme consisting of swapping firewood in change for pellets is also being implemented in areas where firewood is collected for free.

Biogas will offer an opportunity to wealthy rural households and farmers, but it will not be able to contribute a significant share to institutional requirements, possibly acting only as a backup/complementary solution to LPG in such instances. The inputs the biogas process needs are significant and research & development efforts will be necessary in order to increase the efficiency of biogas technologies in terms of energy output and ease the operations of the biogas plants.

3.2 Performance targets and Tier classification

“Improved” cook-stoves refers to biomass cooking appliances which are energy efficient and emit less Green House Gases (GHG), hence reducing health risks and climate impacts (Stockholm Environment Institute (SEI), 2014).

Performance of a cook stove is characterised by the following key processes:

- 1) Heat-transfer efficiency: how much heat is absorbed by the cooking pot
- 2) Combustion efficiency: quantity of energy and carbon in the fuel that converts to heat and carbon dioxide
- 3) Overall thermal efficiency: how much energy in the fuel is absorbed by the pot

Energy and GHG emission reductions efficiency can only be achieved if fuels and stoves are addressed unanimously. For instance, expected performance efficiency of cook-stoves can only be achieved if fuels undergo complete combustion. While fuel efficiency and emissions reduction efficiency are important factors to consider when selecting a technology, convenience, durability and safety are consumer’s top priority hence equally important (IFC, 2013).

In order to align targets with the revised approach to measuring access, this Strategy references to the Voluntary Performance Targets of the Global Alliance for Clean Cookstoves.

The Clean Cooking Alliance (new name for the Global Alliance for Clean Cook-stoves -GACC) developed an international system for rating stoves based on Voluntary Performance Targets. There are 5 indicators covered by the targets: thermal efficiency, fine particulate matter emissions, carbon monoxide emissions, safety and durability. For each indicator, lab test results are rated along 6 tiers (0: lowest performing to 5: highest performing). Tier 0 represents performance typical of open fires and the simplest Cookstoves.

| Voluntary Performance Targets – Default Values | | | | | |
|--|------------------------|--|---|----------------|--------------------|
| Tier | Thermal Efficiency (%) | Carbon Monoxide Emissions (gram/ mega joule delivered) | Fine Particulate Matter Emissions (milligram/ mega joule delivered) | Safety (score) | Durability (score) |
| 5 | ≥50 | ≤3.0 | ≤5 | ≥95 | <10 |
| 4 | ≥40 | ≤4.4 | ≤62 | ≥86 | <15 |
| 3 | ≥30 | ≤7.2 | ≤218 | ≥77 | <20 |
| 2 | ≥20 | ≤11.5 | ≤481 | ≥68 | <25 |
| 1 | ≥10 | ≤18.3 | ≤1031 | ≥60 | <35 |
| 0 | <10 | >18.3 | >1031 | <60 | >35 |

Table 3 - GACC tier-based Voluntary Performance Targets

The ISO lab testing standard and Voluntary Performance Targets were developed by an ISO technical committee comprised of experts nominated by 45 countries and 8 liaison organizations. They were approved and published in 2018.

The emissions rates that define Tier 5 for fine particulate matter and for carbon monoxide align with the World Health Organization’s Guidelines for indoor air quality with reference to household fuel combustion.

Beyond this purely stove-focused tier system, other elements affect the actual sustainability of cooking practices: the fuel used, the ventilation system, cooking contact time - i.e. how long the main cook spends in the cooking space - and stove stacking practice are the key ones from a technical perspective. In fact, in Rwanda only a quarter of households cook outdoors, and only 15.2% of households that cook indoors use an exhaust system, such as a chimney or hood¹². Improving the ventilation of the cooking space is a key measure to mitigate the detrimental effects of a low-efficiency Cookstove and provide better indoor air quality in general: tackling this specific aspect as well as improving cooking practices that reduce contact time are central components of well-designed awareness campaigns and education programmes. For this reason and in line with the World Bank Multi-Tier Framework findings in the latest Energy Access Diagnostic Report for Rwanda (2017), interventions covering these aspects will be included during implementation of this Strategy.

¹² World Bank, MTF – Energy Access Diagnostic Report for Rwanda, 2017

3.3 Programmes

In order to ensure a comprehensive approach is taken to address what is a particularly complex subsector, this strategy is broken out into five discrete programmes, as detailed below. The programmes are identified considering a supply-demand type of approach and the relationship between types of consumers and appropriate technologies (combining technological and economic elements). Capacity building in key cross-cutting activities will be essential to manage the strategy implementation, hence a separate programme focuses on this component.

Programmes under the Biomass Energy Strategy

1. Increasing supply of woody biomass through improved sustainable management of wood biomass resources and increase of tree density in agroforestry/crop areas
2. Reducing the demand of wood biomass by *institutional consumers* and commercial producers by shifting to alternative fuels, primarily LPG
3. Reducing the consumption of wood by *urban households* through:
 - switching to alternative fuels, primarily LPG
 - replacing traditional charcoal with improved charcoal technologies and woody pellets
 - Dissemination of high efficient wood stoves in peri-urban areas
4. Improving efficiency of biomass usage by *rural households* by:
 - strengthening woody pellets gasifier and briquettes value chains (for households with problems in accessing wood)
 - increasing penetration of high efficiency Improved Cookstoves (ICS) for firewood (for households with easy access to wood)
5. Strengthening coordination and capacity building, monitoring and evaluation, to effectively manage the biomass energy sector.

A significant share of the funding of these programmes will be dedicated to **creating awareness and educating consumers** on the performance and quality levels of the different solutions. These efforts in fact should not just be carried out by business actors as part of marketing: although it is positive to insert an educational element in the sale of the technology, private companies are not usually best placed to carry out grass root awareness work. Dedicated funds will therefore be directed to non-business actors active on the ground at grassroots level and working on wider human, community and family-centred issues, in order to disseminate information and raise awareness in line with the cultural, community and household contexts.

Investments in Research and Development for clean cooking have not been sufficiently prioritised, not only towards research and product development, but also including testing, certification purposes and quality control. This Strategy sets the direction for a prioritisation towards utilising and improving the domestic know-how in the subsector, in order to develop new and sustainable technology solutions locally, to continuously innovate and to provide Rwanda with centres of excellence for testing, certification, quality control and labelling purposes.

Strategic actions that will be taken to facilitate penetration of clean cooking technologies are summarised below.

3.3.1 Promoting LPG in institutions and households in urban areas

Using LPG to meet the cooking energy requirement of households and Institutions is the fastest way to curb the demand for biomass resources. The following actions need to be carried out to increase the usage of LPG in Rwanda;

- Carrying out a market survey to serve as a basis to encourage private sector to invest in LPG business
- Construction of LPG strategic reserves to ensure energy security
- Carrying out promotional, operational and awareness campaigns
- Financing the installation of LPG systems in a selected number of institutions per year.
- Design a mechanism and support programme to encourage all public institutions to switch to LPG for cooking or cooking with high efficient wood stoves
- Release of instructions and guidelines for all restaurants and hotels to replace firewood and charcoal with LPG.
- Training local manufacturers to locally make gas stoves to reduce the cost
- Stipulate agreements with selected financial institutions to provide loans on a low interest rate to institutional and urban household to purchase start-up infrastructure (i.e. Gas cooker, Gas bottle and accessories)
- Disseminating and reinforcing LPG regulations and standards
- Regulation of cooking gas prices as with other petroleum products

3.3.2 Promoting Pellets and Briquettes

Neither deforestation/forest degradation nor Household Air Pollution is automatic and unavoidable results of using biomass fuels. Biomass can also be burned efficiently and cleanly in modern appliances, and this in some cases and contexts may be a more cost-effective solution. In this respect the following actions will be undertaken:

- Training and providing technical support to producers of Pellets, briquettes and of the appropriate stoves;
- Attract private sector to develop pellet and briquette-making factories

- Facilitating factories to access raw materials (e.g. providing forest concessions to pellets makers and providing inventory/mapping of availability of raw material for biomass)
- Carrying out extensive decentralised awareness campaigns
- Promote the use of pellets and pellets stoves in households as a replacement to charcoal and firewood.
- Promote business models that allows people in possession of raw biomass to exchange it with pellets or briquette to support those who do not have monetary resources.

3.3.3 Promoting Improved Cook Stoves

- Supporting ICS producers to cope with market requirements through the existing National Program for Modern Cooking Technologies.
- Setting up a testing centre to certify and ensure quality control of cook stoves for all forms of cooking fuels
- Formulating guidelines to allow for high efficient stoves to be disseminated
- Encourage the production of improved stoves through income tax exemptions and the import of stoves through reduced import duties.
- Setting up quantifiable annual targets for ICS dissemination per districts
- Deploying staff at REG branch level to oversee the implementation of modern cooking technologies programs
- Define and support establishment of financial support & microfinance schemes as well as guarantee mechanisms allowing users to access ICS technologies
- Support the understanding of the benefits of ICS through awareness campaigns

3.3.4 Transitioning to an efficient charcoal value chain

- Analyse existing charcoal production technologies to promote high efficient kilns to support transition towards Green charcoal production
- Training all charcoal producers on green carbonization techniques
- Design financing mechanism
- Harmonizing local taxation of charcoal from tree cutting stage to charcoal transportation
- Developing regulations to limit charcoal production to only green efficient carbonisation techniques using raw material coming from forest under sustainable management, and establish a system for traceability/certification
- Introduce improved packaging to minimize losses during transportation
- Banning individual charcoal producers and promoting certified cooperatives and companies to do carbonization

3.3.5 Electricity

Electricity will be considered among alternative sources of energy for cooking, particularly for the hospitality sector and the wealthiest households.

Rwanda is currently experiencing a significant surplus of energy during off-peak hours of the day, while supply and demand of power get close to each other in the evenings. The possibility of electricity to play a meaningful role as a source of energy for cooking will be investigated further, in light of both the high-power requirements of cooking processes and appliances and the affordability of cooking with electricity. Lower, “smart” electricity tariffs around lunchtime hours may offer an opportunity to absorb the excess baseload energy available in the daytime.

3.4 The issue of wood supply & demand balance and the LEAP modelling approach

The content of this Strategy is mostly based on the interpretation of the Long-range Alternative Energy Planning (LEAP) model data and results, further to exhaustive investigations and discussions.

The LEAP tool is a demand driven modelling software that simulates demand and links it to supply and resource base. The baseline was populated from the latest biomass supply survey “Support Programme to the development of the forestry sector in Rwanda - Phase II of 2015-2016” and the Census Report of 2012.

The results of the LEAP modelling efforts indicate that under current trends, wood stocks will be depleted in the medium term. Interventions will be needed to bridge this supply gap, which should be seen as a key trigger to reduce the use of firewood for cooking.

Figure 4 below shows how the imbalance between supply and demand is particularly concerning in the proximities of larger towns and in Northwestern Rwanda (REMA). This geographical difference is an important factor, as during implementation phase regional differences will be considered, especially between consumption and production centres. Sparsely populated, forested areas with extensive wood and charcoal production may require different measures than urban consumption areas. Uptake of technologies may be more likely in one region than the other, because of economic factors, level of economic activity or cooking habits. Therefore, some interventions may be targeted at certain regions only, or may be piloted in defined areas.

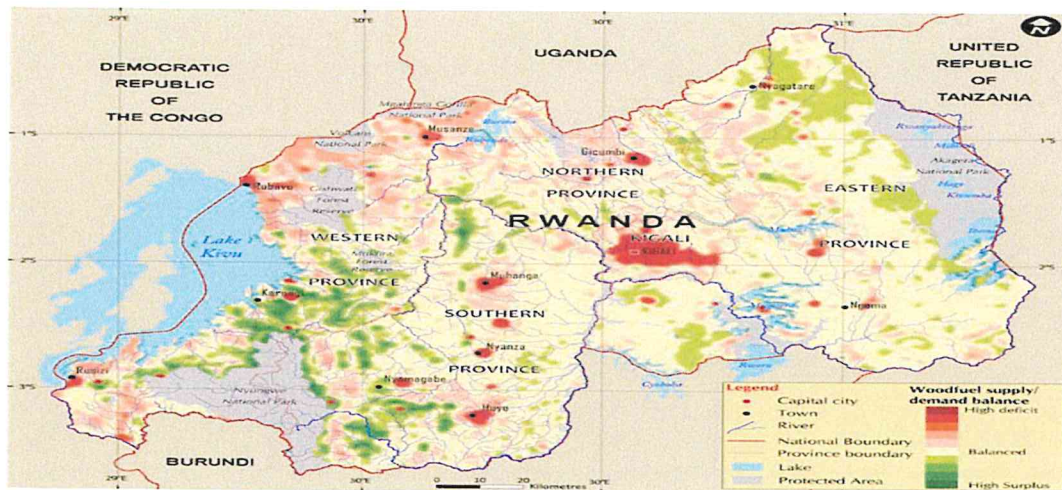


Figure 4 - Domestic map of wood fuel supply-demand balance (source: REMA)

The development of this Strategy is premised on the projection that a “business-as-usual” (“BAU”) approach will result in an increased deficit of woody biomass amounting to 11 559 tonnes of wood equivalent (TWE) per annum, by 2030. This is associated with a demand and supply of 12 119 TWE and 560 TWE per annum, respectively, by 2030.

An alternative scenario – the “BEST” scenario - which seeks to create a sustainable balance between the consumption and production of woody biomass, envisages a surplus of 1,576 TWE by 2030, based on supply and demand of 5,485 TWE per annum and 3,908 TWE per annum, respectively, by 2030.

Further analysis will be performed during implementation to improve the accuracy of projections and model the impact of interventions.

Both supply-side and demand-side interventions are required to reach a sustainable balance between the production and consumption of biomass for energy. As illustrated in Figure 5, the greater impact to wood fuel rebalancing is achieved by reducing the projected demand: in fact, if all demand side solutions proposed are implemented, the total demand would decrease from 7,980,890 tons of wood in 2018 to 3,908,960 tons in 2030, i.e. A reduction of 51%.¹³

¹³ LEAP modelling

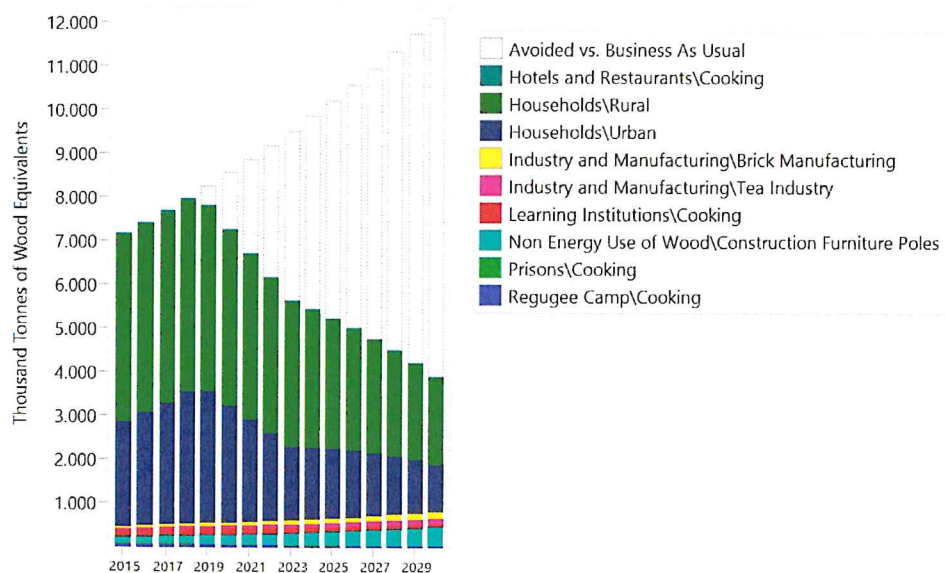


Figure 5 - Reduction of wood fuel demand by customer category from BAU to BEST scenarios (source: Exergia study)

Implementation of both supply and demand-side solutions are informed by short-term and long-term action plans, which cover the periods 2018 to 2024 and 2018 to 2030, respectively.

Any biomass supply-demand model is always under revision and improvement, as more reliable data may become available. Updates will be also needed to reflect the on-going results of the planned activities in the Strategy, therefore a monitoring system will be put in place to follow the developments and take corrective actions if needed.

To cover all aspects of the Strategy implementation progress, other surveys are needed to feed the LEAP model, as shown in Annex 2 – Data requirements and planned surveys **Error! Reference source not found.** In this regard, a national survey on biomass energy use should be planned and executed every 5 years.

Besides gathering data on the present situation, knowing existing trends is crucial to understand the problems and identify key interventions. Interventions should be designed accordingly in order to maintain the balance. Important trends to be analysed on the demand-side are:

- Population growth;
- Urbanisation rates;
- Trends towards switching between energy sources;
- Pricing changes of biomass energy and other cooking fuels.

Following the publication of the results of the new comprehensive EICV5 integrated households living conditions survey in Rwanda (to replace EICV4 2013/2014) the LEAP model and this Strategy will be updated.

3.5 Solutions to address the wood biomass demand-supply imbalance

The comparison of annual wood growth and demand is shown in Table 4 below. In 2018, the deficit between supply and annual demand for wood is calculated as 6,587,000 tons. In the “do nothing” case, the demand will increase from 7,175,000 tons in 2018 to 12,119,000 tons in 2030, and the negative balance will increase by 4,801,000 tons in 2018 to 11,559,000 tons in 2030, i.e. An increase of 73%.

| BAU scenario (2018-2030) | | | |
|---------------------------------------|---------------|---------------|----------------|
| | 2018 | 2024 | 2030 |
| Total Demand (1,000 tons/year) | -7,981 | -9,861 | -12,119 |
| Total Growth (1,000 tons/year) | 1,393 | 416 | 560 |
| Balance | -6,587 | -9,441 | -11,559 |

Table 4 - Balance of wood demand and supply growth in BAU scenario

The Strategy is based on the following specific complementary proposed solutions:

| |
|---|
| <p>Key Solutions to reduce woody biomass demand to 4-5 million tons per year in 2030</p> <ol style="list-style-type: none"> 1. Replace traditional charcoal with improved certified charcoal and green charcoal options; 2. Replace charcoal and 3-stones firewood with woody pellets burnt by high efficient (Thermal efficiency > 50%) gasifier stove; 3. Replace charcoal and 3-stone firewood with high efficient (> 30%) wood stoves; 4. Replace charcoal and firewood with LPG in urban HHs; 5. Replace charcoal and firewood with electric stoves; 6. Replace 3-stones firewood with biogas for HHs with livestock that can produce sufficient feedstock to power the system; 7. Replace 3-stones firewood with combined high efficient briquette stoves and biomass briquettes solution |
|---|

Key Solutions to *increase supply of biomass* to 4-5 million tons per year in 2030

8. Large investment in afforestation of non-forested land;
9. Conversion of poorly managed forests into high productivity forests under sustainable forest management;
10. Increase tree density in crops land through agroforestry promotion;
11. Increase forest productivity through seed genetic improvement. privileging energy-intensive species

The LEAP results of the above solutions in terms of rebalancing wood demand and supply in 2024 and 2030 are shown in Table 5 below, highlighting a net positive balance of 1,575, 000 tons of wood in 2030. By implementing all the eleven solutions detailed, the wood supply would increase from 2,374,000 tons in 2018 to 5,484,000 tons in 2030 and the balance with the demand would break even in 2026.

| BEST scenario (2018-2030) | | | |
|---------------------------------------|---------------|---------------|--------------|
| | 2018 | 2024 | 2030 |
| Total Demand (1,000 tons/year) | -7,175 | -5,456 | -3,908 |
| Total Growth (1,000 tons/year) | 2,374 | 3,296 | 5,484 |
| Balance | -4,801 | -2,159 | 1,575 |

Table 5 - Balance of wood supply and demand in BEST scenario

4 DRIVING PRINCIPLES

Moving large numbers of households and large consumers from firewood and charcoal onto biogas, pellets, LPG and other technologies will require the expansion of and improvements of these supply chains. This will include developing local production and import routes, building storage/collection and processing points around the country and linking these to rural households. The Government includes these elements in the context of this Strategy and is working with private companies to assess capacity and needs and will ensure appropriate support is in place.

The financing and implementation of this Strategy will be in fact undertaken in partnership with the private sector, where competition will help drive down costs and improve options for customers and aftersales services. This builds upon the growing private sector interest in clean cooking technologies in Rwanda and across Africa and the entry made in this market from traditional off-grid electrification players.

The Government role in a sustainable, commercial dissemination approach will continue to be facilitating a competition-based development of markets for affordable products. In order to maximize impact, Government resources will be used in a targeted fashion to: i) help

provide a basic level of support to afford improved technologies to those with the lowest income; ii) reduce the risks perceived by the private sector in providing systems on finance through the establishment of a risk mitigation facility; and iii) provide social goods such as education, information dissemination and standards to raise awareness and protect consumers, as well as to support the penetration of private sector initiatives.

Specific regional features affecting the dissemination of and needed support to specific technologies will be captured in further refining policy actions and instruments, particularly referring to differences in the availability of wood.

World Bank sources (2017) indicate that ineffective or perverse incentives have been noted to be common in regulations governing solid fuel production and improved biomass Cookstoves. To contrast this, the Government will progressively set minimum performance requirements so that existing players and new entrants will be pushed to innovate to meet the market demand. Channelling of Government funds will prioritise promotion and awareness campaigns and research & development efforts. While new technologies will be supported through policies and regulations to be able to penetrate the market, special attention will be given to the design of any necessary subsidy scheme for technology components for the poorest households so that this is time-limited, rule-bound and transparent, hence not causing unnecessary distortion of the market.

Further options to overcome the cost barrier for the consumer will include the facilitation of end-user financing through support of microfinance mechanisms, or leasing arrangements with stove producers. Particularly, allowing a stove to be paid for in instalments is identified as an effective way to increase households' ability to pay for an improved biomass stove without resorting to upfront cost subsidies. Offering a six-month payment plan was especially effective in increasing willingness to pay among rural households.

Pay-As-You-Cook and fuel-based models are encouraged as they lead to multiple benefits towards scalability, ultimately generating more interest from investors. In fact, these models:

- Improve affordability
- Improve margins through recurring revenue streams
- Provide greater insight into customer usage features and patterns

ICSs are a promising solution for a large percentage of households in Tier 0, which use a three-stone or traditional stove. To access these appliances, more than half of respondents to a SE4All-led MTF survey indicate they are willing to pay for an ICS at the price of 3,000 Rwandan francs, and three-quarters are willing to pay for one at a discounted price of 1,000 Rwandan francs. The survey also showed that willingness to pay was higher for urban households and for households that spend more on fuel.

Principles driving the Biomass Energy Strategy

- 1) The Government will set minimum performance requirements so that existing players and new entrants will be pushed to innovate.
- 2) Government will take a value chain approach to the mainstreaming of cleaner solutions to cooking needs, including production, infrastructure, storage and logistic elements
- 3) The financing and implementation of this Strategy will be undertaken in partnership with the private sector, to drive down costs and widen options for the consumers
- 4) Education and awareness campaigns, as well as research and development efforts, will be prioritised in the allocation of Government funds
- 5) Government resources directly supporting dissemination of technology will be used in a targeted fashion, as a last resort to allow the poorest households to access the most appropriate technology while minimising distortion of the market

4.1 Considerations and approach to the gender component

Gender mainstreaming in infrastructure sector is a pathway to poverty reduction and job creation. The Government recognises the importance of gender – focused interventions in infrastructure through the formulation of an Infrastructure Gender Mainstreaming Strategy 2017/2018 – 2021/2022 and the allocation of a dedicated budget.

The most significant gender issue observed relates to the time women and girls spend collecting firewood and plants residues and the time they are exposed to indoor pollution. Time spent for collection of fuel affects the time women could use for other purposes, including income generation. Absence from class especially for girls at school age is another consequence resulting from the time used for firewood collection. As regarding domestic pollution, women are mostly affected by diseases associated with the smoke from the firewood as they are the most exposed to emissions while preparing the food for families.

The strategy process aims at enlisting a variety of stakeholders in developing a consensus around a biomass energy strategy, in a participatory manner: government, the private sector and civil society, including women’s organizations and groups, given women’s key roles in the biomass supply and demand system.

Female-headed households account for 26% of rural households and 23.9% of urban households. In line with the fact that women are the main cook in 78% of households, they also suffer more from health issues associated with indoor air pollution. Women are often active in stove production, charcoal trading, agricultural processing and commercial and institutional cooking.

More female-headed households (57.7%) than male-headed households (51.8%) use a three-stone stove as their primary stove: this reflects the lower purchasing power of women compared to men. Yet women alone make the decision for 85.6% of clean fuel stove purchases. Nationwide, more female household members (49.7%) than male household members (40.3%) make the decision to purchase appliances. This could reflect stronger decision-making power for women in higher income households.

Because female household members spend more time collecting and preparing cooking fuels and spend more time in the cooking space, they would benefit most from switching to modern clean technologies. Cookstove-related campaigns and dissemination efforts will be therefore tailored to both a male and female audience. Special attention will be given to creating greater access to finance and opportunities for female households. Gender-targeted subsidies for improved Cookstoves are foreseen to significantly improve women’s access to such appliances.

5 IMPLEMENTATION PLAN

5.1 Institutional Framework

Biomass energy is a complex, cross-cutting subsector which involves several institutions, both Government and non-Government ones, central and local. These institutions play different roles, from regulatory and supervisory, to implementation and support. This complexity, and the subsector's diverse resource base, frequently associate to unclear allocation of responsibility, duplication of roles and gaps in action and decision making

It is therefore imperative that institutional mandates and responsibilities align with legal and legislative frameworks governing their respective sectors.

| Government | Private sector | Civil society and international community |
|---|--|---|
| <ul style="list-style-type: none"> - Ministries - Districts - Agencies - Universities and research institutions | <ul style="list-style-type: none"> - Energy companies - Agribusiness players - Wood fuel transporters, producers and traders - LPG distributors - Stove producers - Timber industry - Farmers - Forestry companies and private concessionaires | <ul style="list-style-type: none"> - NGOs - Development Partners - Consumers |

Table 6 - Key stakeholders by category

Table 7. Stakeholder's roles and responsibilities.

| Roles and responsibilities of Government | Roles and responsibilities of Private Sector | Roles and responsibilities of Development Partners |
|--|---|---|
| <ul style="list-style-type: none"> - Form and empower a dedicated Committee to drive the implementation of the Strategy - Monitor and evaluate strategy implementation - Establish a policy and regulatory framework that will enable the transformation of the biomass sector and boost adoption of clean cooking solutions - Facilitate access to clean cooking proportionally to those households with the lowest incomes; - De-risk investment by the private sector through the provision of a risk-mitigation facility; - Establish the enablers for the market to expand including the development of an institutional and regulatory framework and increased consumer awareness; - Promote awareness campaigns and disseminate information; - Enforce performance and quality standards; - Provide fiscal incentives to transition, as well as disincentives to remain on charcoal and firewood - Integrate cooking energy in Research & Development efforts | <ul style="list-style-type: none"> - Invest and attract investment and expertise in the clean cooking sector (Private Sector Federation to coordinate) - Compete for ensuring quality and economic supply of alternative fuels to biomass - Produce and sell Improved Cookstoves that respond to the policy directions of the Government, whether based on biomass or not and respond to cooking needs and habits of the Rwandan population - Provide only certified Improved Cookstoves through an appropriate and agreed internationally recognized standard - Commit to a minimum service and warranty period for units; - Report quarterly on sales and other relevant information. - Engage in afforestation and agroforestry efforts - Maximise job creation for Rwandans across the value chains | <ul style="list-style-type: none"> - Contribute to financing the programmes - Support programmes planning - Providing guarantees and risk mitigation instruments - Support on educational and awareness campaigns (considering NGOs for their implementation) - Provide technical assistance |

The responsibilities for the coordination of the strategy and the monitoring and evaluation of its implementation lie with MININFRA.

REG is appointed as the leading organisation responsible for the implementation of the strategy.

To maximise the effectiveness of the implementation process, a Steering Committee will be established. The Steering Committee will be composed by representatives of the key stakeholders and will meet monthly.

A summary of envisaged roles and responsibilities for each Government institution is illustrated in the following table:

| Institution | Responsibilities |
|--|---|
| Ministry of Infrastructures (MININFRA) | <ul style="list-style-type: none"> - Inter-sectoral lead and coordination of the Strategy implementation plan - Close monitoring of activities for reduction of demand of wood biomass - Funding mobilisation - Balance fuel prices and incentivising clean fuels - Revise building codes to integrate LPG features - In collaboration with MOE, restructure the regulation on charcoal value chain in transitioning to green charcoal, including certification, traceability and taxation systems |
| Ministry of Environment (MOE) | <ul style="list-style-type: none"> - Design policy instruments, implement Forest Management Plans and supply-side interventions - Support linkages between professional forest investors and small-holders/cooperatives - Manage concessions and forest management contracting while supporting clean cooking solutions in use of wood residues - Coordinate research efforts and implementation of genetic improvement solutions for increasing tree productivity - Build the capacity of forest sector institutions and actors - Support agroforestry tree planting in crops areas in collaboration with RAB - Support and regulate production of efficient "green " charcoal" |
| MINAGRI/RAB | <ul style="list-style-type: none"> - Support integration and increase of tree density in crops area through adoption of agroforestry technics - Where sufficiently available, support good management, collection and use of crop residue for briquette production - Support Dissemination of Biogas |
| Ministry of Health (MoH) | <ul style="list-style-type: none"> - Awareness raising, impact monitoring and development of emission benchmarks for Household Air Pollution (HAP). |
| Ministry of Education (MINEDUC) | <ul style="list-style-type: none"> - Support Research and Development in Alternative cooking technologies - Awareness raising through education campaigns - Introducing cooking energy issues into formal education. |

| Institution | Responsibilities |
|---|---|
| Ministry of Local Government (MINALOC) | <ul style="list-style-type: none"> - Integrate clean cooking interventions in existing social programmes, resettlement programmes and run awareness campaigns - Set and monitor dissemination targets at a district level |
| Ministry of Finance and Economic Planning (MINECOFIN) | <ul style="list-style-type: none"> - Setting taxation, approving subsidies and reducing import duties on relevant items. - Provision of finance for clean cooking access for the vulnerable - Approval of guarantees and other risk mitigation instruments. |
| Rwanda Development Board (RDB) | <ul style="list-style-type: none"> - Encouraging investment in the clean cooking sector (including LPG stocks) and provide incentives to investors |
| REG / EDCL | <p>Leading the implementation phase, including:</p> <ul style="list-style-type: none"> - Coordinate implementation of all composing initiatives and sub-programs - Monitoring progress towards set targets - Monitoring vendor performance (including sales volumes) - Leading the dissemination of information |
| Rwanda Standards Board (RSB) | <ul style="list-style-type: none"> - Setting and enforcing quality standards - Certification of products and vendors |
| RURA | <ul style="list-style-type: none"> - Monitoring prices and the level of competition in the market - Setting and enforcing regulations |
| FONERWA | <ul style="list-style-type: none"> - Coordination and mobilization of donor funds - Accessing international finance - Channelling funds to appropriate programmes |
| Commercial Banks & SACCOs, | <ul style="list-style-type: none"> - Provide loans to the private companies / financial institutions/end users - Manage risk-mitigation facility |

| Institution | Responsibilities |
|--|--|
| DISTRICTS | <ul style="list-style-type: none"> - Support in the dissemination of information - Support in monitoring vendor performance and product quality standards - Help to enforce payment - Coordination and tracking Ubudehe scheme and implementation - Management of possible theft insurance - provision of tree cutting permit while sensitizing and incentivizing woodlot owners on the improved practices of tree plantation, maintenance and cutting |
| Institutional users (i.e. RDF, RNP, RCS, MINEDUC/SCHOOLS etc.) | <ul style="list-style-type: none"> - Invest in LPG infrastructure and bulk purchase at competitive prices |

Table 8 - Key responsibilities by Government institution

The associated Short Term (ST) and Long-Term (LT) budget figures are summarised in Table 9:

| Strategic Objective | Programs | Short Term Budget 2018 - 2024 ('000 USD) | Long Term Budget 2024-2030 ('000 USD) ¹⁴ |
|---|--|--|---|
| Objective 1 Increase supply of woody biomass through Improved sustainable management of wood biomass resources and agroforestry promotion | Program 1 Increasing supply of woody biomass | 201 992 | 70,306 |
| Objective 2 Reduce the consumption of wood for charcoal making by improving the efficiency of charcoal value chain | Program 2 Reducing the demand of wood biomass by institutional consumers | 332 856 | 110,813 |
| | Program 3 Reducing the consumption of wood by urban households | | |
| | Objective 3 Reduce the demand of wood biomass by shifting to efficient clean cooking stove and alternative fuels | | |
| Objective 4 Strengthen coordination, capacity building, monitoring and evaluation, to effectively manage the biomass energy sector | Program 5 Strengthening coordination and capacity building, monitoring and evaluation | 2 085 | 1,390 |
| Total Budget | | 536 933 | 182,509 |
| 10% contingency | | 53 693 | 18,251 |
| Grand Total Budget | | 590,626 | 200,759 |

Table 9 - Budget breakdown by objective (source: Exergia study)

¹⁴ Exchange rates as 1 USD = 0.875 EUR

5.2 Financing the Programmes

Acceleration of market growth can only be realised through adequate financing (World Bank, 2014). Financing needs are particularly high in clean cooking for two main reasons: the upfront purchase of clean cooking equipment presents an affordability challenge to most households, which adds to the monthly fuel expenditures, and secondly the businesses operating in the sector are often unable to attract finance for development, marketing and distribution. Serving low-income households also generally yields low returns.

The Strategy Action Plan will be financed by the Government of Rwanda and the Development Partners, which will be mobilized for the purpose of co-financing. The associated Action Plan will be also supported by international Technical Assistance where necessary.

A specific support will concern the reinforcement of capacity building of the stakeholders, but also the promotion of all the new products, technologies and fuels, especially by providing grants and loans for the development of new products and financing educational and awareness campaigns on the ground.

While the programmes will initially mostly require funding from Government and its development partners, they are expected to catalyse a sustainable private-sector-led market for clean cooking energy provision. Once these companies have proven the market's viability, they will be able to take on a greater share of the investment risk. This will allow for more limited Government interventions going forward, alleviating the fiscal burden. Public-Private Partnership options will be explored, in particular for the development and management of critical infrastructure necessary to the penetration of cleaner fuels.

Local Savings and Credit Cooperatives (SACCOs) and banks will also become increasingly protagonist of the financing process: to enable this effectively, strong capacity building interventions will be undertaken towards these actors, along with the direct involvement of the national financing sector in selected Government and donor-funded initiatives.

At a later stage of implementation, co-financing could come from the taxation system and possibly from a carbon trading mechanism.

In addition, the private sector which is expected to play a lead role in implementing this strategy will provide the commercial equity and debt to support their investments in the sector.

Common challenges to all cooking fuel forms and cooking technologies is that there are few investors and the initiatives are not well coordinated. There are scattered innovations that need to be promoted and financed to reach the required quality and quantity to satisfy the market. The recently launched Sustainable Energy for All (SE4All) Investment Prospectus helps filling this gap.

5.3 The SE4All Investment Prospectus and the opportunities for the biomass subsector

In the context of a wider regional intervention the SE4ALL through the Investment Prospectus (IP) for Rwanda provides prospective multi-lateral development banks, development and commercial finance institutions, impact investors, grant funders and development partners (including for technical assistance) an overview of the investment requirements related to Rwanda's progress towards meeting national energy-sector objectives.

The reduction of inefficient use of woody biomass to meet the cooking energy requirements by 2024 is set as one of the top two priority areas for intervention by the Prospectus.

The implementation process of this Strategy represents several investment opportunities across the biomass energy value-chain, for example:

- **Supply-side initiatives**

- Concessions that enable capable private sector companies to implement afforestation and sustainable forest management programmes
- Involvement of smallholder farmers in improving the sustainable supply of woody biomass
- Regulatory support and incentives for the introduction of improved certified charcoal and green charcoal solutions
- Promotion of biomass pellets and briquettes

- **Demand-side measures**

- Introduction of efficient clean Cookstoves
- Diversification from biomass through the development of LPG value-chains, preliminary targeting institutional & productive consumers and urban areas
- Promoting the sustainable supply of biogas to rural households.

The current proposed investment requirements calculated as per the Prospectus are presented in Table :

| Description | Investment requirements (2018-2024) (USD M) | investment requirements (2024-2030) (USD M) |
|--|--|--|
| LPG equipment and infrastructure | 70 | 93 |
| Strategic and commercial LPG stocks | 31 | 41 |
| High-efficiency Clean Cookstoves Programme | 81 | 135 |
| Sustainable forest management | 58 | 96 |
| Total (USD M) | 240 | 365 |

Table 10 - Investment requirements

Different LPG price scenarios will be developed to assess potential limits to affordability for consumers and attractiveness for investors. The potential to produce compressed natural gas (CNG) from local methane resources will be further explored, while in parallel the Government will strengthen efforts to increase the efficiency and sustainability of biomass value-chains.

5.4 Communication Plan

Communicating this strategy with key partners is critical to ensuring smooth implementation. Stakeholders such as Government institutions, civil society, development partners, NGO's and the public at large must be aware of the Strategy and its benefits, and the challenges that may be met during its implementation.

The Communication Plan is expected to be prepared and implemented by MININFRA and will involve conducting regular meetings with the subsector stakeholders as well as holding press conferences and talk shows at different media houses and road shows. The Plan will tailor rationale and justifications, differentiate approaches and identify the most appropriate communication channels for each target group. Emphasis will be given to structuring an effective media campaign, considering mainstreaming through both video and audio channels and the production of a short film.

Annex 1 – Action Plan

| Programmes | Objectives | Indicators | Baseline Value | Short Term Targets (2024) | Long Term Targets (2030) | Activities | Responsible Institutions |
|---|---|--|---------------------------------------|---------------------------|--------------------------|---|--------------------------|
| Program 1 Increase Supply of Woody Biomass | Objective 1. Increase supply of woody biomass through improved sustainable management of wood biomass resources | Increase of exploited tree plantations under Sustainable Forest Management (SFM) | Private forests under SFM in 2017: 3% | 60% | 65% | A.1.1. Design of DFMP and related public Forest Management Unit. Integration of data and plan in user friendly database software to ease implementation by stakeholders | MOE |
| | | | | | | A.1.2. Capacity building and on-the job training of Districts, DFNC and private partners in DFMP/SFMP design and implementation | MOE |
| | | | Public forests under SFM in 2017: 21% | 80% | 90% | A.1.3. Support public forest cover mapping and conflict case resolution to speed up concession process | MOE |
| | | | | | | A.1.4. Support processes of contracting of public Forest Management Units to professional private operators investing in wood product value chain. | MOE |

| Programmes | Objectives | Indicators | Baseline Value | Short Term Targets (2024) | Long Term Targets (2030) | Activities | Responsible Institutions |
|------------|------------|------------|--|---------------------------|--------------------------|--|--------------------------|
| | | | Tree Density in Agroforestry Areas Baseline Value 2017: 25Trees/ha | 50 Trees/ha | 75Trees/ha | Implementing quick conversion of old exhausted forest into new productive plantation while ensuring high efficient transformation of any wood biomass residue into wood energy products | MOE |
| | | | Forest productivity under improved management Baseline value 2017: 10 m3/ha/yr. | 11 m3/ha/yr. | 12 m3/ha/yr. | A.1.5. Support small-holder private owners in gathering their land into Cooperatives' private FMUs, in conversion of their poor forest or cropland into productive plantation and in managing it under SFMPs | MOE & MINALOC |
| | | | | | | A.1.6. Increase of tree density in crops land by supporting agroforestry through FFS groups | MOE, RAB, & MINALOC |
| | | | | | | A.1.7. Support improved participatory management through local Vigilance Committee of road / river / lake-side plantations | (MINALOC) |
| | | | | | | A.1.8. Increase tree productivity through genetic improvement of tree reproductive material | MOE |

| Programmes | Objectives | Indicators | Baseline Value | Short Term Targets (2024) | Long Term Targets (2030) | Activities | Responsible Institutions |
|---|---|---|---|---------------------------|--------------------------|--|--------------------------|
| | | | Average annual income per hectare (ha) by producer of wood energy under improved management Baseline value 2017: 8,000 Rwf | 12,000 Rwf | 15,000 Rwf | A.1.9. Support linkages between professional forest investors and small-holder forest growers / agroforestry FFS cooperatives, in establishment of type of "farming contract" and provision of technical / financial support | MOE |
| Program 2 Reducing the demand of wood biomass by institutional and Commercial consumers | Objective 2 Reduce the consumption of wood for charcoal making by improving the efficiency of charcoal value chain | Percentage of Charcoal on the market produced using Improved High Efficient Kilns | TBC | TBC | 100% | A.2.1. Develop regulations to prohibit and phase out use of traditional charcoal production and shift to alternative solutions as well as green charcoal | MININFRA |

| Programmes | Objectives | Indicators | Baseline Value | Short Term Targets (2024) | Long Term Targets (2030) | Activities | Responsible Institutions |
|------------|------------|--|--|---------------------------|--------------------------|--|--------------------------|
| | | Percentage of population shifting from use of firewood to modern improved cooking solutions (LPG, Biogas, improved biomass fuels (pellets & briquettes) and Improved high efficient Cookstoves, etc.). | Baseline value 2017: 79.9 % ^[1] | 42% | 0% | A. 2.2. Establishment of the legal framework allowing/encouraging the shift from traditional charcoal (to be forbidden in next years) to Improved Certified Charcoal and enforcing quota of production only for District having the capacity of supply | MOE |
| | | Percentage of Urban Households shifting from cooking with charcoal to | Baseline value 2017: 65.1 % ^[2] | 32% | 1% | A.2.3. Establishment of different taxation system easing the shift from traditional charcoal (to be highly taxed) to Improved Certified Charcoal or other alternative energy | MOE & RRA |

| Programmes | Objectives | Indicators | Baseline Value | Short Term Targets (2024) | Long Term Targets (2030) | Activities | Responsible Institutions |
|---|--|--|--------------------------------|---------------------------|--------------------------|---|--------------------------|
| | | alternative improved cooking solutions. (LPG, Biogas, improved biomass fuels (pellets & briquettes) and Improved high efficient Cookstoves, etc.). | | | | A.2.4. Support Organization of charcoal makers into certified Cooperatives authorized to produce Improved Certified Charcoal using only raw material coming from forest under Simplified Forest Management Plan | RSB, RWFA & RCA |
| | | | | | | A.2.5. Awareness Raising, Promotion, Training of charcoal makers in use of improved kilns (such as "casamancaise") | REG, MININFRA & MOE |
| | | Percentage of population shifting from using low efficient cooking technologies to alternative or high efficient | Baseline value 2017: 72.5% [3] | 36% | 20% | A.2.6. Support establishment of Improved Certified Charcoal traceability system | RSB |
| | | | | | | A.3.1. Forbid charcoal in institutions. Using Price regulation | MININFRA |
| Program 3 Reducing the consumption of | Objective 3 Reduce the demand of wood biomass by shifting to efficient clean cooking | | | | | A.3.2. Replace charcoal and 3-stone firewood stove by woody pellet using highly efficient gasifier stove (>50% efficiency), firstly in urban areas and | MININFRA |

| Programmes | Objectives | Indicators | Baseline Value | Short Term Targets (2024) | Long Term Targets (2030) | Activities | Responsible Institutions |
|--------------------------|-----------------------------|--|----------------|---------------------------|--------------------------|--|--------------------------|
| wood by urban households | stove and alternative fuels | cooking soln; Percentage of commercial institutions (Hotels, Restaurants, Tea factories, brick factories) shift from using inefficient wood and charcoal to clean cooking solutions | NA% | 100 % | 100% | secondly in rural areas where wood resources are scarce | |
| | | | | | | A.3.3. Replace low efficient wood stove and 3-stone by highly efficient wood stove (>30% efficiency), firstly in rural households having potential access to wood (MININFRA) | MININFRA |
| | | | | | | A.3.4. Replace charcoal and firewood by LPG, firstly in urban areas and thereafter in rural areas | MININFRA |
| | | | | | | A.3.5. Replace charcoal and firewood stoves by electric stoves | MININFRA |
| | | | | | | A.3.6. Replace 3-stone firewood stove by biogas for HH with more than 2 cows | MININFRA |
| | | | | | | A.3.7. Assess the market on new biomass fuel products (e.g. briquettes, pellets, wood chips) to valorise biomass residues including charcoal, saw dust, coffee / rice husks, cassava | MOE & MINAGRI |

| Programmes | Objectives | Indicators | Baseline Value | Short Term Targets (2024) | Long Term Targets (2030) | Activities | Responsible Institutions |
|---------------------|------------|--|----------------|---------------------------|--------------------------|---|-------------------------------------|
| by rural households | | Percentage of public biomass high consuming institutions (e.g. schools, prisons, police and military camps) shifting from traditional woody biomass to clean cooking solutions or productive use | 23% | 100 % | 100% | industry residues and marshland grasses) | |
| | | | | | | A.3.8. Elaborate and implement quality standards and control mechanisms for new products and their processing lines | RSB |
| | | | | | | A.3.9. Train cooperatives and companies on processing biomass and agricultural residues into biomass fuels | MOE & MINAGRI |
| | | | | | | A.3.10. Provide grants and loans for development of new products | MOE, DPs and FINANCIAL INSTITUTIONS |
| | | | | | | A.3.11. Monitoring of biomass briquette stove equipment dissemination and fuel wood saving measurements | REG & RSB |

| Programmes | Objectives | Indicators | Baseline Value | Short Term Targets (2024) | Long Term Targets (2030) | Activities | Responsible Institutions |
|--|---|--|--|---|---|---|--------------------------|
| Program 5 Strengthening coordination and capacity building, monitoring and evaluation | 4 Objective Strengthen coordination, capacity building, monitoring and evaluation to effectively manage the biomass energy sector and support transition to Alternative Clean Cooking Solutions | Annual Nationwide Awareness Campaigns | TBD | TBD | TBD | A.4.1. Awareness campaigns to drive behavioural change and attract investment in the biomass subsector | MININFRA |
| | | No of People trained in SFM | TBD | TBD | TBD | A.4.2. Re-enforce the existing FMES/DFMP/LEAP database, and required regular surveys and systems on monitoring of wood energy supply and demand, intra and inter district flows, as planning and decision support tools | MININFRA, MOE & MINALOC |
| | | No of Businesses Manage by Women and Youth | TBD | TBD | TBD | A.4.3. Support gender equality and gender mainstreaming in actions related to BEST | MININFRA & MIGEPROF |
| | | Bi-Annual Surveys carried out to update LEAP Model | Baseline value 2017: 1 Survey carried out (MTF Survey) | 3 Surveys carried out. At least every 2 years 1 survey carried out. | 6 Surveys carried out. At least every 2 years 1 survey carried out. | A.4.4. Coordinate and promote the implementation of a monitoring and assessment system for the activities of the Action Plan | MININFRA |

Annex 2 – Data requirements and planned surveys

| Required data | Proposed surveys |
|---|---|
| Demand Side | |
| Real consumption of final unit energy (MJ/capita/year) for cooking per type of HH and per type of institution (boarding school, prison, refugee camp, policy/military camp) | <p>Survey 1: National HH surveys on cooking fuel energy and technologies (including use of biomass crops waste/dry grasses, etc.)</p> <p>Survey 2: National surveys on cooking fuel energy and technologies in Institutions (boarding school, prison, refugee camp, policy/military camp)</p> |
| Accurate penetration (% sharing) of type of fuel (including biomass crops waste, dry grasses, etc.) and cooking technology (ICS) per type of HH and per type of institution | |
| Real calorific efficiency (%) and real consumption of energy fuel (Kg-litre/capita/year) per type of ICS/fuel and per type of HH/institution | |
| Real current cost (RWF/capita/year) for cooking per type of ICS/fuel and per type of HH/institution | |
| Limiting/level factors, socio-economic and cultural constraints and opportunities of each cooking solutions per type of HH/institution | |
| Modalities and constraint of access of HH/institution to energy fuels for cooking | |
| Consumption (m3/capita/year) of service wood per type of HH | |

| Supply Side | |
|--|---|
| Real current productivity (m ³ /ha/year) per type of forest (private institution, small holder, public, crop/agroforestry lands, per region) | Survey 3: Forest productivity measurement in permanent sample plots (established in 2015 + additional) |
| Updated Forest cover (ha) per type of forest land type | Ongoing by RWFA |
| Real Efficiency (air dry Kg charcoal/air dry kg wood) of traditional and improved charcoal making process | Survey 4: National surveys on charcoal making processes |
| Current average % sharing of traditional/improved charcoal | |
| Total production (kg/year) of biomass crops residue and of dry grasses/leaves/tree branches, and % sharing of use of this biomass (energy, soil fertility, animal feeding, etc...) | Survey 5: Biomass crops residues production and use |
| Prices, access and flux of firewood and service woods per District | Survey 6: Firewood and service wood value chain analysis |
| Current organisation and trends of firewood and service wood value chain | |
| Feasibility study on pellet production and rationality of pellet use (comparison between energy needed to produce and transport the pellets and energy saved by using them) | |
| Prices, access and flux of timber products in Rwanda | Survey 7: Timber value chain study (ongoing with support of GIZ/CIFOR) |
| Current organisation and trends of timber products value chain | |