



# Plan of Action: Rwanda's transition to modern energy cooking

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## Executive summary

This report was commissioned by Loughborough University, the lead implementing partner on the Modern Energy Cooking Services (MECS) programme. It presents recommendations for actions needed to accelerate Rwanda's transition to modern energy cooking, highlighting priority steps for stakeholders at all levels to overcome challenges and gaps in the cooking landscape.

Rwanda's high population density and continued growth rate has put environmental resources and ecological services under strain through unsustainable exploitation. Biomass use for cooking purposes is the leading cause of deforestation. As well as hastening global warming, burning biomass fuels leads to high levels of household air pollution, resulting in a range of respiratory illnesses, cardiovascular conditions, ischemic heart disease, and chronic obstructive pulmonary disease, causing thousands of deaths every year.

To drive down use of biomass for fuel, the government of Rwanda (GoR) has developed several policies, including the national forest policy, energy policy, and biomass strategy, amongst others. This policy framework has resulted in a drop in biomass usage from 79.9% households in 2017 to a projected 42% by 2024. It also establishes a clear pathway towards the popularization of clean and modern energy cooking. In addition to promoting improved cookstoves, pellets and briquette stoves, the government is throwing its weight behind modern energy such as LPG, electricity, and biogas as alternatives to cooking with traditional biomass. LPG received the most pronounced focus from the government as the LPG masterplan sets a national target of 40% of households using LPG by 2024. The prospect of increased volumes of compressed natural gas from Lake Kivu coming online for cooking use has recently raised hopes for reaching medium-term targets.

Although the uptake of electric cooking in Rwanda is still limited (estimated at 0.19% of the population), the developments in electricity generation (from 100 MW to 276 MW), electricity access (from 10% to 75.3%) and reliability over the last decade suggests great potential for its wider rollout. However, various constraints for the customer base, including lack of awareness, limited financing options, limited technical skills and knowledge, as well as gender disparities in purchasing power, dampen the outlook for the modern energy cooking sector.

Regulators could support the modern energy cooking transition in a number of ways, including reducing import tariffs and taxes on electric cooking appliances to allow new efficient appliances to cost-compete on Rwandan market. They could also introduce improved standards and quality control to ensure appliances of higher quality, performance, and durability reach the Rwandan market.

Financial enablers can also support cooking appliance developers to access capital through the introduction of working capital funds, innovation funds, and matching grant schemes, as well as a de-risking funding window. They can also provide technical assistance to modern cooking companies to improve their leadership, technical, sales and marketing skills.

It is also important that further evidence-based research on topics such as the state of the market, value chains, energy cooking demand, cooking behaviours, appliance compatibility with Rwandan dishes, stove feature preferences, and appliance/fuel complementarity, continues to appropriately inform policymakers, the private sector, and consumers.

The implementation of new financing mechanisms to augment the popular ‘cash & carry’ method is critical: financing models such as PAYGO and third-party asset financing enable customers to afford higher prices and more efficient appliances by spreading payments over time with only a reduced upfront payment. Utility-led financing for electric cooking, in particular, is another important model to be explored, although it seems unlikely it will provide a solution for the short- or medium-term considering the current priorities of the national utility as well as the financial challenges facing mini-grid operators.

Despite being the demographic most burdened by cooking-related chores, including collecting wood, purchasing and preparing food and cleaning the dishes, women are significantly less involved in policy and decision-making around clean cooking. There is currently a dearth of women in leadership roles in public institutions or private companies, but given their greater understanding of challenges around cooking, fostering the inclusion of women in such roles can only benefit the transition to modern cooking appliances.

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## 1. Introduction

### 1.1. Background of the study

Energy 4 Impact (E4I) was contracted through Loughborough University, the lead implementing partner for the five-year Modern Energy Cooking Services (MECS) programme, to be the in-country partner for Rwanda. The programme aims to accelerate the global transition from traditional biomass-based cooking to modern energy cooking solutions. Building on the findings and recommendations from the Cooking Diaries, the Discrete Choice Modelling study, the Focus Group Discussions, and the Feasibility Study for an awareness-raising and education campaign for electric cooking, this plan of action for Rwanda's transition to modern energy cooking component is the last of the research pieces E4I has undertaken in Rwanda to highlight existing gaps and relevant solutions within the modern energy cooking landscape.

Through reference to existing literature, expert analysis and interviews with key stakeholders aimed at understanding current initiatives and programmes, this report highlights the main points of action to be taken by the Government of Rwanda (GoR), development partners, donors, private companies in the modern cooking sector, and end-user consumers, in order to transition Rwandan households (HHs) to modern energy cooking.

### 1.2. Aims of the study

Aiming to highlight priority steps for various stakeholders at all levels to overcome challenges and gaps in the cooking landscape, this study will cover the following ground:

- Explore the current status of policy, regulations, supply chain, financing, and human capital within the modern energy cooking landscape in Rwanda.
- Demonstrate the case for modern energy cooking through health, environment and economic benefits while highlighting disadvantages of traditional energy cooking.
- Highlight how regulation, financing innovation, research, and gender mainstreaming could all contribute to the end goal.

## 2. The case for modern energy cooking

Rwanda's population density of 569 people per square km (the second highest population density in Africa) and its annual population growth rate estimated at 2.3% (United Nations 2022) increase the risk of competition for land. This results in the unsustainable exploitation of environmental resources and ecological services, which lead to environmental degradation. The risk to the environment is furthermore increased by the overreliance on biomass for cooking: the majority of Rwandan HHs use wood or charcoal for cooking, which is a leading cause of deforestation. In fact, around 65% of Rwandans live in rural areas (World Bank 2020) and about 83% of the population within those areas use wood as fuel (Cukic', et al. 2021).

Burning biomass fuels leads to high levels of household air pollution (HAP), including the production of particulate matter with a diameter of 2.5 micrometres or less (PM<sub>2.5</sub>) (Okello, et al. 2019), which is known to cause a number of respiratory and cardiovascular illnesses, as well as other diseases including ischemic heart disease, stroke, chronic obstructive pulmonary disease, lung cancer, and diabetes in adults (Kurmi, et al. 2012), acute lower respiratory infection in children (Dherani, et al. 2008), and adverse pregnancy outcomes (Amegah, Quansah and Jaakkola 2014). A report examining these health outcomes globally estimated a total of 3255 deaths and 172,643 DALYs (disability-adjusted life years) to result from PM<sub>2.5</sub> arising from use of polluting fuels in Rwanda in 2020 (IHME 2020). In fact, inefficient combustion of fuels such as wood is responsible for high levels of HAP including PM<sub>2.5</sub> and black carbon (BC) (WHO 2014). The International Global Panel on Climate Change (2022) reported that black carbon is the second most significant contributor to global warming after CO<sub>2</sub>, making it a significant threat to the environment. In fact, more than a quarter of global emissions of BC are estimated to originate from combustion of solid fuels for cooking. In Africa and Asia, where reliance on solid fuels is highly prevalent, such usage has been estimated to contribute 60–80% of total BC emissions (Bond, et al. 2013). For instance, from 2001 to 2019, Rwanda lost 34,500 hectares, 6.9% of its total forest coverage, through unsustainable harvesting of wood for energy which was estimated to generate 8.89 MT of total CO<sub>2</sub> emissions, including HHs and agricultural use (WRI 2020).

Transitioning from these biomass-polluting fuels to modern cooking fuels will have significant public health, environmental, and gender benefits because of reduced personal exposure to HAP, preservation of forests, as well as time savings, particularly for women and girls who normally are responsible for wood collection and cooking (Puzzolo, et al. 2020).

To address these challenges of deforestation and unsustainable use of biomass resources, the GoR developed a National Forest Policy (MINILAF 2018a), first presented in 2004 and revised in 2011 and 2017, as well as a Forest Sector Strategic Plan (MINILAF 2018b). The National Forest Policy includes high-level policy objectives aimed at increasing the capacity of public institutions and private sector actors to manage the country's forest resources more efficiently. The government has also put in place strict tree harvesting regulations; through which only licensed persons are allowed to cut trees, including those from private lands. These measures have helped to reduce deforestation rates in Rwanda, reaching its goal of increasing forest cover to 30% in 2019 and becoming one of only a handful of countries in Africa where the relationship between charcoal consumption and deforestation no longer exists (REG 2021b).

The ESSP (MININFRA 2017) reflects the ambition to promote a more sustainable management of natural resources which includes a shift away from traditional cooking sources. It defines the target to reduce the number of HHs depending on traditional cooking fuels from 79.9% in 2017 to 42% by 2024 by replacing wood and charcoal with cleaner cooking options. An estimated investment of USD 170m will be needed until 2024 to halve the number of HHs using these traditional cooking technologies (World Bank 2020). These targets are supported by the implementation of the Biomass Energy Strategy (MININFRA 2019), which in addition to improving the sustainable management and supply of biomass resources across the country, aims to reduce the demand for biomass fuels by promoting the switch to modern cooking fuels. Effecting this switch will entail raising customer awareness, strengthening value chains of clean fuels and cooking technologies and improving the coordination and capacity of public institutions in the sector. Through the government updated its Nationally Determined Contributions (NDCs) under the Paris Agreement (Cook, et al. 2020), which includes promoting the use of efficient cookstoves as a mitigation measure, given that cooking-related emissions account for 14% of the GHG emissions from the country's energy sector, Rwanda aims to disseminate modern efficient cookstoves to 80% of the rural population and 50% of the urban population by 2030, with an estimated investment of USD 380 million (Cook, et al. 2020).

The GoR identified several clean and modern energy cooking technologies to replace polluting biomass fuels. LPG tops these technologies and has been selected for urban cities and public institutions (schools, prisons) as priority targets for accelerated rollout. The national LPG masterplan sets the policies and actions required for all relevant stakeholders to achieve the national LPG use target which are set at 40% of the population by 2024 (Cukic', et al. 2021). The prioritization of LPG over other clean technologies

comes from its proven status as a technology with infrastructure that can rapidly be scaled up due to its convenience for transportation, storage, and domestic use (Bruce, Aunan and Rehfuss 2017). LPG safety and regulatory best practices, market and financing models have been successfully and extensively implemented across dozens of countries globally (Thoday, et al. 2018).

Other alternative fuels that can contribute to meeting the overall 42% biomass fuel target include electricity, biogas, and improved high-efficiency biomass cookstoves (pellet and briquette-burning stoves) (MININFRA 2019). Studies such as the cooking diaries in Rwanda by Energy 4 Impact in partnership with MECS (Ntivunwa 2022a) have shown that eCooking is compatible with Rwandan dishes and can in fact be a cheaper option compared to LPG or charcoal, provided modern efficient appliances are used.

A new generation of efficient eCooking appliances is currently available on the market and provide competitive options for cooking energy cost. Although some such as kettles are task-specific and must therefore be used in combination with other appliances to cook a full menu, others such as the Electric Pressure Cooker (EPC) are enabled with mechanisms of insulation, automatic control, and pressurization, are able to cook a full menu by themselves (ESMAP 2020). As Batchelor et al. (2018) state, preventing heat from escaping from the cooking chamber using insulation can enable the same food to be cooked with a fraction of the energy, thus reducing overall energy consumption as well as the cost of cooking.

Furthermore, the strong policy support by the GoR and its key international financial institutions and donors, which resulted in a financing model such as the Clean Cooking RBF scheme funded by the World Bank (BRD 2021), illustrates the excellent potential for Rwanda's clean cooking sector.

### 3. State of access to modern cooking

#### 3.1. eCooking landscape

Although eCooking has been practiced for decades, it is still rarely used in Rwandan HH kitchens. The proportion of HHs using eCooking is estimated at 0.19% (Cukic', et al. 2021) in Rwanda. Several challenges characterize the sector, including historic low HHs' electricity access, high electricity cost, low electricity reliability, weak electric appliances' supply chain, lack of access to finance for both HHs and suppliers, lack of innovative financing models for electric appliances, high cost of electric appliances, HHs' low-income levels, and low levels of eCooking awareness for both HHs and suppliers.

Nevertheless, interestingly the GoR has included electricity in alternative sources of energy for cooking, particularly for the hospitality sector and high-income segments of the population (MININFRA 2019). The recent developments in the country's electricity generation, from 100 MW in 2010 to 276 MW in 2022 (REG 2022a), electricity access, from 10% in 2010 to 75.3% in 2022 (REG 2022b), coupled to the fact that around 60% of HHs are not satisfied with their current cooking technologies (AESG 2022), present an opportunity for eCooking adoption. Furthermore, the inclusion of eCooking appliances within the recent clean cooking results-based-finance (RBF) window by the Development Bank of Rwanda (BRD) (BRD 2021) has been seen as a positive development.

Although current eCooking use rate is still very low, varieties of eCookers are present on market shelves across Kigali city and other cities. However, commercial distributors and retailer networks is the only existing distribution model of eCookers in Rwanda. The lack of aftersales services and little awareness of their benefits are believed to be the main hinders of eCooking adoption. Encouragingly, there is a growing interest from private companies in manufacturing EPCs in Rwanda, which would considerably reduce most of the barriers to adoption of eCooking.

#### 3.2. Cooking gas landscape

To achieve the GoR's target of 40% of the population using LPG in 2024, a plan that considers three action options has been proposed (MININFRA 2017):

- Develop new policies to improve LPG access and direct public institutions to transition to LPG from biomass use and implement the Branded Cylinder Recirculation Model (BCRM) plan.
- Mobilize industry and financial sector to expand LPG cylinder inventories and distribution networks.

- Require urban residential and institutional users to switch to LPG and prohibit biomass supply and use for cooking in the urban markets through awareness campaigns.

However, Rwanda relies on imported LPG from other countries as it has no domestic production. Retail distribution is done through service stations, independent distributors, and supermarkets in an assortment of cylinder sizes ranging from 3 kg to 50 kg for HHs, whilst tanks from 500 kg to 5000 kgs are available for big institutions (EPD 2022).

Rwandans are shifting from charcoal to LPG as the source of cooking energy and as a result LPG imports have increased 14 times from 2014 to 2021 (REMA 2021). It is estimated that 5.6% of HHs in Rwanda use LPG as their primary cooking energy (Cukic', et al. 2021). This fast LPG adoption is also affirmed by the Energy Private Developers association (EPD), although it acknowledges that its penetration has not yet reached a satisfactory level to see an impact on the reduction of biomass use (EPD 2022). For EPD, progress is demonstrated by the increase in private companies involved in LPG distribution.

The possibility of using methane gas as cooking fuel in the form of Compressed Natural Gas (CNG) from Lake Kivu has recently turned into reality with the launch of the USD 400M production plant at the Kivu Lake shores in Karongi by Gasmeth Energy Ltd (Africa-Energy 2022). The amount of methane in place is estimated at about 60 billion cubic meters (29 million tons oil equivalent) and believed to be economically recoverable (REMA 2021). It is estimated that the project could serve up to 400,000 HHs (Africa-Energy 2022).

The use of biogas technology has been promoted as an alternative solution to alleviate poverty and as a suitable renewable energy, with a potential market estimated at 150,000 HHs, which will serve to decrease the consumption of wood fuels and reduce indoor air pollution (REMA 2021). Various energy related policies in Rwanda such as the Economic Development and Poverty Reduction Strategy and the Energy Sector Strategic Plan (MININFRA 2017) have included biogas as one of the sustainable solutions to reduce reliance on wood-based fuel.

In 2008, the GoR launched its National Domestic Biogas Programme, targeting the introduction of biogas digesters in all schools (estimated at around 600), large health centres, and institutions with canteens and HHs (Rincón, et al. 2021). Through this institutional biogas program, 86 Institutional biogas digesters were constructed in secondary schools and prisons, and 10,200 domestic biogas digesters have been installed in HHs (EPD 2022). However, the biogas rollout seems to have regressed countrywide and the

sustainability of biogas systems remain a challenge for their wider adoption, mainly due to the high upfront investment required, access to the necessary levels of human or animal waste, lack of familiarity with biogas technology, minimal institutional capacity, inadequate suppliers and maintenance personnel, and an inadequate marketing and awareness campaign (Mukeshimana, et al. 2021).

### 3.3. Cooking appliances' financing

One of the main challenges in accessing modern energy cooking technologies is financing. To achieve its 2030 targets of disseminating modern efficient cookstoves to 80% of the rural population and 50% of the urban population, it is estimated that Rwanda will need a USD 380 million investment (Cook, et al. 2020). Although a number of HHs would be able to afford modern energy cooking appliances, the majority of Rwandan HHs would struggle to pay the upfront cost which is usually 10 to 30 times higher than traditional stoves. It is believed, as per MECS & E4I (2021), that any successful clean cooking business model depends on the price of the clean cooking hardware, the operating costs (mainly the price of fuel) and end-user financing. For instance, an EPC costs between USD 80 and USD 130 on Rwandan market depending on its size and brand, LPG products which are often sold in bundles, with the upfront cost of 6 Kg cylinder including a burner costing around USD 40, a 12 kg cylinder including a 2-burner stove around USD 82, a 15 kg cylinder with a two burner stoves around USD 92, and a 20 kg cylinder with a two-burner stove cost around USD 120. Biogas also, despite the subsidy scheme, requires high investment ranging from USD 300 to USD 500. All these modern fuels' upfront costs are significantly higher compared to charcoal or wood stoves, generally costing less than \$10.

As end-user financing, a clean cooking (CC)-RBF subsidy scheme (BRD 2021) is being implemented by the GoR to reduce the burden of the high upfront cost of most of the modern cooking appliances. In fact, modern energy cooking solutions (eCooking, LPG, and ethanol stoves) are subsidized at 45% for Ubudehe 3, at 70% for Ubudehe 2, and at 90% for Ubudehe 1 category<sup>1</sup>. This CC-RBF scheme could be the solution to end-user financing considering findings of the Focus Group Discussions report (Ntivunwa and Mutalindwa 2022) which suggest that, both rural and urban, would be willing to purchase modern energy cooking solutions if their cost does not surpass \$50.

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<sup>1</sup> Ubudehe categories refer to the economic life standing of households and are utilized as a planning tool or baseline by national policy makers, policy implementers, and researchers.

Other forms of financing such as instalment payments in the form of PAYGo are emerging, particularly for clean cooking solutions such as ICS using charcoal and/or wood, pellet stoves, implemented by BioMasters Ltd and EcoGreen Ltd, as well as EPCs, implemented by Electrocook Ltd. Usually, for EPC, pellets' stoves, as well as ICS, payment is scheduled into 3 instalments. However, for LPG stoves, this approach has not started yet.

The majority of modern cooking appliances are currently sold for cash. Although it is well-established that access to consumer credit and financing solutions is crucial to improve the access of low-income groups to modern energy cooking solution, it is also essential to support market growth for the higher value products.

Lack of financing is also an issue when it comes to CC technologies' developers and suppliers. There are, however, signs of profitability and product attractiveness in the CC sector as indicated by the continuing increase of private companies entering the CC market. A study by AESG (2022) showed that among 32 companies registered into the CC-RBF scheme, 95% are privately owned by individuals whilst 5% are NGOs, and that 70% of those companies have been in business for more than 3 years. The study also showed that the business proprietors contributed 34% of the initial investment with 64% from external funding. This implies that the owners were ready to take the risk, which indicates that they are confident in their business growth and survival. In addition, the fact that 50% of that external funding comes from FIs highlights the creditworthiness of the borrowers from this sector. Nevertheless, more financing for developers and suppliers is needed as highlighted by the fact that machinery consumes 42% of the company expenditures, leaving less resources for working capital which impacts on production volume and profitability (AESG 2022). Limited financing of developers also makes them vulnerable to unpredicted turbulence from global supply chain fluctuations as 70% of the raw materials (sheet metal, steel, batteries, solar panels, etc.) are imported. Furthermore, the limited financing of developers and suppliers is the cause of reported knowledge gaps by staff in key areas such as management, technical, sales, and marketing, all affecting daily company operations. In fact, 64% of CC companies reported having staff knowledge gaps in those areas at a 50% level (AESG 2022).

### 3.4. Bringing cooking appliances to consumers

Currently, there exists no manufacturing plant in Rwanda for eCooking, LPG, or any other modern cooking appliances. All merchandised appliances are imported, usually from China, although some are brought in

from other places. The common import route for these appliances is through maritime cargo to Dar Es Salaam or Mombasa ports, from where they are shipped through trucks to warehouse and stores in Kigali city. Another rare route is through the cargo airplanes to Kigali warehouses. Commercial distributors and retailer networks are the only existing distribution model of modern cooking appliances in Rwanda, and the lack of awareness about energy efficiency among local retailers might negatively impact on adoption.

The most popular payment method known to Rwandan HHs is the “cash & carry” method. By paying 100% upfront, the consumer avoids financing costs (interests, commission, etc.) and the selling company improves its cashflow, reduces the need for working capital, also saving it from consumer credit risk assessment and eventual debt recovery processes. All these have made the method popular over the years up to now, although some argue that it is much more compatible with low price appliances than the higher end. In fact, the method becomes less efficient when it comes to high price appliances as many consumers can no longer afford them, and companies lose on the size of their target market. In addition, the popularity of this method might rely on the fact that, as highlighted during the Focus Group Discussions (Ntivunwa and Mutalindwa 2022), a number of Rwandan HHs, particularly from rural areas, prefer an upfront payment of the total price.

“Layaway savings” method is proposed by some retailers and supermarkets as a way of payment, particularly for high price cooking appliances such as electric or gas ovens, as it allows them to build cashflow, attract quality clients, and easy to administer. However, it attracts very little interest from consumers as the idea of locking away your funds for long periods before accessing the appliance put off many potential customers.

## 4. Action points for the transition

### 4.1. Regulate and enable the transition

- Advocate for reduced import tariffs and taxes on electric cooking appliances to allow internationally recognized efficient appliances on Rwandan market. In fact, high quality appliances, due to their improved energy efficiency, are likely to cost-compete with traditional cooking technologies.
- Advocate for improved standards and quality control to ensure appliances of higher quality, performance, and durability reach the Rwandan market. In fact, in 2002, the GoR created Rwanda Standards Board (RSB) to provide affordable standardization, metrology, quality testing and certification services for sustainable socio-economic development. Cookstove quality testing is one of its mandates, done through a cookstove testing laboratory. This laboratory, equipped with Real-Time Laboratory Emission Monitoring System designed in accordance with ISO 19867, tests stoves for fuel performance and has the capability to conduct tests on biomass household cookstoves on a laboratory test bench or customer premises. It is capable of testing biomass fuel calorific energy value determination using bomb calorimeter, biomass fuel conditioning, stove thermal efficiency, stoves emission (CO, CO<sub>2</sub> and PM<sub>2.5</sub>), stove safety and durability, stove dimensions and marking inspection, solid biomass fuel calorific value, solid biomass fuel moisture content, as well as solid biomass fuel ash content (RSB 2022).

However, one of the main challenges with their capabilities is that it currently only tests ICS, meaning that appliances such as imported EPC and other eCookers only need to show the standards certification from the country of manufacturing. This leads to uncertainty around standards in regards to these appliances as fraudulent certification may arise, resulting in substandard appliances flooding Rwandan market.

To solve this issue, development partners could advocate for RSB to coordinate information sharing with appliance suppliers on trusted standards certifications and their control procedures to only allow quality appliances on the local market.

- Increase modern energy cooking appliances developers and suppliers' access to capital which will help them increase production capacity, strengthen their financial position, enhance the quality of their appliances, produce on a larger scale and at a cheaper cost, innovate around quality improvements, and reach a wider range of the population. This can be done through a working capital fund, an innovation fund, or a matching grant scheme.

- Build capacity of modern energy cooking appliances developers through technical assistance provided by consulting companies to increase the ability of organizations to pitch their ventures for funding. The TA can also include basic business skills to help them learn how to write company plans that are investor-ready and paint the true financial picture.
- Enhance the role that FIs play in the design and implementation of cookstove programs. This can be achieved through:
  - ✓ Developing a strategy to encourage FIs to offer lower-interest loans for projects including modern energy cooking solutions.
  - ✓ Mitigating risk for FIs by improving knowledge of the modern energy cooking sector players, through their historic track record.
  - ✓ Raise more capital to encourage lending in the modern energy cooking sector.
- Improve understanding of how carbon finance might help Rwanda's modern energy cooking companies gain long-term financial support and possibly lower the cost of technology for consumers. This can be done by educating the sector players and assisting companies in understanding how to unlock carbon financing.
- Advocate for youth engagement in the clean cooking industry while establishing a de-risking funding window to provide support to FIs lending to youth and the general public.

#### 4.2. Conducting research for a data driven transition

It is imperative to conduct evidence-based research to appropriately inform policy and decision makers, private sector, and consumers of alternative cooking technologies. It has been elaborated that cooking is embedded in cultural habits and experiences, hence for the transition to occur successfully, evidence around the compatibility between popular kitchen practices and modern cooking appliances must be produced. Research on market assessment and value chain analysis, stakeholder mapping, cooking diaries studies to understand how people cook, the amount of energy required, and HHs' favourite dishes is still emerging. However, the research conducted so far is on a small-scale and there is a need for a more detailed understanding of:

- Comparative energy needs and demand of modern energy cooking against traditional cooking fuels and translate that data into monetary expenditure.
- Factors influencing Rwandans to purchase a given cooking appliance, what appliances' characteristics are they looking for. Research all over the world have established that the appliance cost, power,

durability, portability, ability to allow the user to multitask, smoke emissions, among others, can influence consumers to purchase a given appliance. Such data would in turn inform the private sector to develop products and services tailored to their target customers.

- Appliance and fuel complementarity. The few already released research publications indicate an important fuel stacking habit in Rwandan HHs. Evidence on which appliances/fuels complement one another best would provide an indication on which appliances to promote for a given target base.
- Cooking behaviors within Rwandan kitchens. Data on household cooking schedules (how many times do they usually cook per day, do they prefer cooking from fresh or reheating food), preferred cooking processes (boiling, frying, grilling, etc.), pre-cooking treatment of food such as been soaking could provide initial information on appliance's compatibility with Rwandan cuisine.

In addition to HHs' kitchens, the research should also be conducted in kitchen laboratory settings.

There are a few uncertainties around the impact of mass eCooking adoption on the general integrity of the system, whether for the national grid or mini-grids, hence the necessity of conducting research to model the increased load and revenue due to mass eCooking uptake against the potential cost of infrastructure upgrades that may be required. Further research could examine methods that could define load profile by modifying customer behaviours, such as variable tariff structures (for instance, off-peak tariffs) or smart appliances that can be managed by the grid operator.

### 4.3. Financing the transition

For the transition to flourish, new financing innovations must be put in place, for both end-users and modern cooking appliances developers and suppliers. They may include the following:

#### 4.3.1. PAYGO

The PAYGO technology is important since it removes the upfront price challenge of the cooking appliances, by allowing end-users to pay a small deposit (or none depending on the agreement), followed by affordable instalments over time. This can be done for end-users (the B2C model), but also be applicable to intermediaries (the B2B model).

Development partners should encourage the development of PAYGO solutions for modern cooking in Rwanda now that a variety of appliances (EPCs, induction stoves, LPG stoves, ethanol stoves, biodigesters, etc.) have been tested and operated under PAYGO by various clean cooking companies in the region. Smart meters, which are frequently used for PAYGO, can give consumption data that is essential for

reporting on impact metrics and for impact payments, such as carbon credits and other results-based financing schemes, in addition to making payment collection easier. To develop technical solutions for various appliances and optimize business models, further study and testing is required. Here, development partners play an important role through pilots funding.

The PAYGO technology variants that allow end-users to purchase small fuel amounts would likely be successful (particularly for LPG users) in light of the findings of the Ntivunwa and Mutalindwa (2022) report on focus group discussions in which many HHs stated that refilling the whole LPG cylinder is quite often a financial burden to them and would find it better to pay for smaller amounts.

#### 4.3.2. Asset financing

Asset financing and/or third-party financing is an important source of financing to end-users as it enables them to afford higher price and more efficient appliances by spreading payments over time while simultaneously building their credit trustworthiness with the lending institution. This will eventually enable consumers to access loans for their further endeavours. Furthermore, for countries such as Rwanda where appliances' developers and suppliers still struggle financially, the asset financing approach would benefit companies too as they are not exposed to end-users' credit risks and do not have to get involved into administering loans.

Donors and development partners have an important role to play in making this approach successful by supporting lending institutions through credit risk sharing practices such as collateral provision.

A soon-to-be implemented Financial Inclusion for Clean Cooking project of Mercy Corps, funded by Jersey Overseas Aid, is an example of donor support for end-user (particularly women) financial inclusion through building creditworthiness while de-risking the credit for the lending institution, and simultaneously developing the modern energy cooking market through developers' and suppliers' healthy cashflow.

#### 4.3.3. Utility-led financing

Utility-led financing, particularly for eCooking, is an important tool to reduce the appliances' upfront cost barrier and increase appliance uptake as the utility already has an existing client base.

Through implementation of strategies such as On-bill financing (OBF) (appliances are financed on the balance sheet of the utility and the repayments collected through the utility bill), On-bill repayment (OBR) (appliances are financed by a third party and the repayments are collected through the utility bill), or co-

marketing and data-sharing (the finance and the billing for the devices are done by a third-party, but the utility provides data and other support related to their customers for credit scoring and marketing purposes), eCooking developers/suppliers could benefit from a large pool of customers with historic data for payment risk assessment, and the utility could increase its electricity sales. However, based on the interview with Rwanda Energy Group (REG), the national grid utility, the utility-led financing is unlikely to be implemented in short or mid-term, as REG is hardly meeting the current demand, which is projected to significantly increase in the next decade, thus the current focus on increasing their available production. Nevertheless, REG's research and development department has started to explore various initiatives to increase future electricity sales and eCooking is one of them. Development partners should take utility-led financing discussions up with REG as it is projected to serve 70% of Rwandan HHs when the universal electrification target of 2024 is achieved.

Furthermore, utility-led financing discussions should be taken up with mini grid developers as a productive use component. Donor support to mini-grid developers would be crucial as their tariffs are generally higher than the national grid which significantly impacts the cost-competitiveness of the most energy-efficient appliances in relation to the traditional cooking fuels. In addition, mini grid developers are often strapped for funds and would tend to avoid OBF and OBR to not put their customers under more financial strain through on-bill payments for appliances.

#### 4.4. Enhancing gender roles for the transition

Cooking and all other related chores, in Rwandan HHs, has traditionally been a task for women and young girls. From wood collection or fuel purchasing, cooking water fetching, food purchasing, food preparation, food serving, to utensils cleaning, are all usually executed by women. As the demographic most affected by cooking-related challenges, women have a better understanding of those challenges and so sufficiently motivated enough to find solutions to them, and also passionately deliver those solutions countrywide. To do so, they must be given a significant role in policy and decision making, either in public or private entities, private companies' ownership, leadership, technical as well as sales and marketing positions. However, women participation in CC companies' ownership is still very low, at 10%, among registered Rwandan companies (AESG 2022). Deeper analysis of the AESG (2022) report shows that higher levels of women in leadership are found in local subsidiaries of regional companies and in board composition, going up to 70%. These levels fall significantly down when it comes to small local companies run by sole proprietorship (AESG 2022). It seems levels of participation by women are only high when there is a direct support or they are working in tandem with men. Women participation in sales and marketing, and other

part time jobs was higher than that of technical roles. Women were found to comprise 27% of the overall staff composition of registered CC companies.

Based on the above-described figures, the GoR with its development partners must work on the need for advocacy for enhanced participation of women in CC decisions and companies' operations at all levels.

These can be achieved through:

- Incentivizing companies to implement gender inclusive approaches, cutting across all their operations levels, including women inclusion in their aftersales and repair operations.
- Promote women inclusion into less technological production of CC solutions such as low tiers (1,2, or 3) products to support market development. This can be done through provision of technical and leadership trainings to women, particularly rural ones.
- Advocate to and support CC companies to implement initiatives targeting women and women's associations to access consumer financing, allowing them to massively adopt CC and modern cooking solutions.

## 5. Conclusion

Rwanda has developed several policies to support and enable the CC and modern energy cooking transition. In fact, allocating CC development and promotion responsibilities in the same implementing institution as electricity development can only act to the advantage of eCooking promotion. Although Rwandan HHS' access to modern energy cooking solutions, particularly eCooking, is still very low, various existing policies in energy, forestry, health, and climate change could facilitate the maturation of the sector with the assistance of development support programmes.

However, access to capital, adequate skills and knowledge are still lacking to propel the manufacturing of modern energy cooking appliances. The supply chain is limited and would need to shift its attention to products that offer aftersales services and also widen distribution methods from solely commercial distributors and retailer networks to include deployment through service providers and utilities for bulk distribution. The lack of options within consumer financing is the biggest limiting factor when it comes to the mass adoption of modern cooking appliances. Investment and donor funding for various innovative models such as PAYGO, asset financing, RBF, amongst others, would help turn the tide. Continued research is also needed to provide the evidence-based data which would enable leaders, both in the public and private sectors, to make informed decisions. Education and awareness campaigns, on both energy and cost efficiency, as well as the health benefits of modern energy cooking solutions, are also expected to play a major role in shaping the transition, should the strategies be sufficiently aligned with the priority needs of consumers. Finally, regulators will need to play an important role in ensuring that appliances, both imported and locally produced, meet national and international quality standards, to ensure sustainable sector development.

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