Feasibility Study for awareness raising campaign for electric cooking in Rwanda

Working paper

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Energy 4 Impact

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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.

The feasibility study report on awareness raising campaign on electric cooking in Rwanda illustrates the perspectives from institutions, companies, and households towards electric cooking promotion in Rwanda collected through interviews. Interviews consisted of discussions on existing initiatives and programmes on electricity generation and access, clean cooking, and electric appliances' supply chain. This report aims at informing the design of the awareness raising campaign, which, in turn, contributes to achieve behaviour change in the target communities by encouraging the population to adapt new and cleaner ways of cooking through electricity.

Challenges such as low awareness, historic low households' electricity access, high electricity cost, low electricity reliability, weak electric appliances' supply chain, lack of access to finance to both HHs and suppliers, among others, have all been contributed to the low electric cooking adoption in the country. Lack of access to finance, in particular, is negatively affecting clean cooking and electric cooking development. Private companies operating in clean cooking are financially stranded, 35% depend on owners' funds to operate, and are youthful, 70% are less than 3 years in operations, thus still learning in terms of adequate technical capacity to design efficient products for the market.

Nevertheless, recent developments in electricity generation, access, and reliability have given rise to opportunities for electric cooking promotion. Furthermore, regulations have been put in place to ensure both national grid utility and mini grid operators provide a high quality and safe electricity to their customers. Currently, inadequate households' installations with sub standards equipment and voltage drops caused by overcrowded electricity transformers are the main issues in electricity safety. A mechanism to replace all overcrowded transformers by the new and suitable transformers has been activated and responsible institutions are increasing awareness campaigns on the danger of sub-standards equipment use. When using new generation of energy-efficient appliances, various research reports both in Rwanda and in the region, such as the cooking diaries in Rwanda, have also showed that cooking a meal for one person with electricity required the least energy and the least cost eventually, when compared to other cooking fuels such as LPG, charcoal, and wood.

In its efforts to transition from traditional biomass energy cooking to clean and modern energy cooking, in 2017, the government of Rwanda, through Energy Development Corporation Limited, started conducting awareness raising campaigns throughout the country. Designed to educate the public on the dangers of traditional biomass energy cooking and the benefits of clean energy cooking for both health and environment reasons, these campaigns were organized through live talks show and documentaries aired at radio stations, and field mass mobilization of people gathered at marketplaces. To harmonize the awareness raising message, a communication strategy, an awareness strategy, and a community demonstration strategy are being developed through the Rwanda Energy Access and Quality Improvement Project (EAQIP) which aims to increase access to clean cooking Solutions for 500,000 households.

The role of clean cooking companies in these awareness raising campaigns has, however, been found to be minimal, thus, the need for their increased support from government institutions, development partners, and financial institutions to ensure their technical skills, financial strengths, as well as marketing strategies are strong enough to drive electric cooking promotion and adoption.

To maximize the size of the audience, different modes of communication including print media, electronic media, and direct media are required for different target groups.

Demonstration sessions through permanent or mobile labs are proposed to be a powerful tool in raising awareness for electric cooking for their particularity in offering opportunity for practice to local people. Existing infrastructure and programmes both at community level and local institutions such as schools and prisons offer an important advantage for electric cooking benefits dissemination.

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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 findings and recommendations from the Cooking Diaries and Discrete Choice Modelling studies, as well as the Focus Group Discussions; the Feasibility Study for an awareness raising and education campaign for electric cooking as part of a clean cooking (CC) programme strategy and grid expansion (FS) component is one of the research pieces E4I undertook in Rwanda to introduce and raise awareness on clean cookstoves through a programme supported by the Government of Rwanda (GoR).

Through interviews conducted with relevant stakeholders highlighting existing initiatives and programmes on electricity generation and access, clean cooking, and electric appliances' supply chain, this report illustrates the perspectives from institutions, organizations, companies, and households (HHs) towards electric cooking (eCooking) promotion in Rwanda. Coupled with the existing strategies and programme, these perspectives are used to design and propose an awareness raising and education strategy for eCooking in Rwanda.

1.2. Aims of the study

The FS aims at informing the design of the awareness raising campaign, which, in turn, aims to achieve behaviour change in the target communities by encouraging the population to adapt new and cleaner ways of cooking by using electricity in line with the ongoing GoR electricity generation, distribution and access as presented in the Energy Sector Strategic Plan (at least 700,000 new HHs connected to the grid from 2021 to 2024).

Specifically, the objectives of the FS are:

- Explore misconceptions that electricity use for electric cooking is not safe, is very expensive and electricity supply is unreliable
- Highlight disadvantages of traditional means of cooking using firewood and charcoal: increased environmental and economic costs of using firewood and charcoal to the country and individual HHs, amount of time and labour spend in collecting and transporting firewood, health impact of firewood in kitchens and seasonal availability

- Explore how e-cooking may create potential for convergence between Clean Cooking and access to electricity programmes
- Explore electric cookstove supply chain and identify areas for capacity building, access to finance, and other measures to ensure a reliable supply of acceptable quality electric cookstoves and after sale services.

2. Analysis of the state of cooking landscape

2.1. Review of existing awareness raising programme

eCooking sub-sector in Rwanda faces several challenges including historic low HHs' electricity access, high electricity cost, low electricity reliability, weak electric appliances' supply chain, lack of access to finance to 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. All these challenges could explain the low eCooking levels in the country, estimated at 0.19% (Cukic´, et al. 2021).

In addition to HHs' low eCooking awareness observed from previous studies under MECS-E4I project, interviews with electric appliances' suppliers during this feasibility study have shown a great deal of low eCooking awareness among them. In fact, it seemed suppliers did not well-grasp several factors influencing the smooth eCooking adoption such as appliances' energy efficiency, after-sale-services, and financing models.

A recent country-wide survey conducted by the Africa Energy Services Group (AESG) to 1252 respondents, has shown that there is a need for improved awareness campaigns as around 60% of respondents indicated that they were not satisfied with their current cooking technologies. Reasons for this unsatisfaction included the fact that traditional cookstoves produce a lot of smoke, soot and unburnt volatile organic matter that blackens the cooking vessels and the surroundings like the kitchen walls and pollutes the indoor air affecting the family's health adversely; long time to cook and fetch fuel which primarily affects women and children's daily activities; low durability of cookstove; high fuel's cost; risk of explosion accidents, especially for gas users; and difficulty to chop and dry firewood for wood users (AESG 2022).

The AESG report highlights that 95% of active clean cooking companies across the country are privately owned and since 35% of them rely on the owners' funds, their business operations are sensitive to current global economic uncertainty, and it may explain the lack of investment capacity for product diversification to meet diversified consumer market segments. In fact, 70% of these companies are younger than 3 years old, meaning they still are learning in terms of adequate technical capacity to design products that may attract different consumer market segments. Furthermore, they lack the necessary marketing strategy to reach out to different consumer categories, which also relates to the low level of consumer awareness of clean cooking (AESG 2022).

The GoR has embarked on an ambitious journey to transform its energy sector including electricity access, cost, and reliability (MININFRA 2017), as well as development and promotion of the clean cooking sector

(MININFRA 2019). In 2017, the GoR, through EDCL, started conducting awareness raising campaigns throughout the country. This was implemented using two methods. The first was through live talks shows and documentaries aired at radio stations. Here, EDCL's clean cooking specialists would explain the health and environmental benefits of switching to clean cooking technologies to a nation-wide audience. In the second method, EDCL's clean cooking specialists would go to a given field location, mostly at marketplaces or any other place where they could find a crowd such as a venue whereby a social event is occurring and hold a clean cooking mobilization session. To do so, EDCL would invite clean cooking companies, who carried clean cooking appliances to showcase their technologies to the gathered crowd. However, randomly inviting companies, as it turned out, can hinder the promotion of clean cooking technologies. For instance, a company promoting a given cooking fuel type which is not yet available in that region could send a message that the promoted technology is not reliable, in case people get interested and find it unavailable.

Behavior changes related to kitchen and cooking practices such as beans soaking, and other inadequate traditional customs were at the center of these clean cooking awareness campaigns. For instance, it is customary in many parts of the country to hide what is being cooked to any person for whom the meal is not cooked. As a result, HHs place stove in less aerated spaces leading to smokes inhalation problems and increased cooking time. Educational tips such as roles and importance of appliance characteristics were also provided during these awareness events. Nevertheless, during awareness events, EDCL did not usually cover cost perspectives, nor they privilege any clean cooking technologies. The only focus was put on the available support to reduce the environmental and health dangers of traditional cooking technologies. EDCL highlighted that eCooking appliances' suppliers never attended any awareness events. Since COVID-19 outbreak, however, only radio live talk shows and social media events have been used.

To accelerate clean cooking adoption, the GoR in partnership with the World Bank created the Rwanda Energy Access and Quality Improvement Project (EAQIP) aims to increase access to clean cooking solutions for 500,000 HHs. EAQIP's Component 3b of the will set up a clean cooking RBF window to partially subsidize purchases of clean and efficient cooking solutions by eligible HHs (BRD 2021). Through this project, a company has been hired to develop a communication strategy, awareness strategy, and community demonstration strategy. The purpose is to regulate the clean cooking sector and harmonize the awareness raising message, with the local government at the center.

2.2. Misconceptions and barriers to eCooking adoption

2.2.1. Safety

Electricity quality is crucial to the energy sector development agenda as highlighted in the Rwanda grid code (RURA 2012). The Rwanda Utilities Regulatory Authority (RURA) is responsible for determining and setting the Licensee's network performance indices as well as the format in which these are reported. Regulations governing electricity quality published in 2016 (RURA 2016) dictates that the voltage of all networks shall be kept within ±10% of the nominal voltage. For Low Voltage Supply, the Licensee is required to maintain nominal voltage levels at the point of delivery at 230V (±10%) for phase to neutral and at 400V (±10%) for phase to phase, as specified in RS 565-1-2011 standard on electrical wiring of premises. RURA, 2016 continues by stating that each licensee's distribution system shall use reasonable endeavours to maintain system frequency at 50 Hz, subject to the allowable variations of ±1% of the steady voltage level, when these occur repetitively, and of ±3% of the steady voltage level, when these occur frequently, as specified under the Grid Code (RURA 2012). The Licensees are required to limit the unbalanced load drawn by their clients and ensure that their electricity networks do not contribute significantly to voltage unbalance conditions. Regulations accept voltage unbalance level of 3% (RURA 2016).

Regulations in place require the Licensees to minimize electricity supply interruptions and in the case of planned interruptions to ensure that customers are given 10 working days' notice prior to the interruption, and provide the time that the interruption will occur or is planned to occur, the area that will be affected, the reason for the planned interruption(s), the time at which it is anticipated that the supply will be restored, and notification that customers are to treat the supply as live at all times (RURA 2016). Regulations also require licensees to make reasonable efforts to provide a continuous supply of electricity to meet demands and to prepare a load shedding plan with a fair share of available electricity to all customers, in the event that shortages occur due to causes beyond their immediate control.

Customers and HHs are also urged to take whatever precautions they deem appropriate to protect against interruptions of service.

During our interview with the director of generation department in Rwanda Energy Group (REG), the national grid utility, providing electricity to almost 70% of electricity connected HHs (REG 2022a), he reiterated the effort implemented by REG to provide a high quality and safe electricity to its customers. He highlighted that currently the main issue in electricity safety resides in inadequate HHs' connections (installations) with sub standards equipment. He continued stating that, in partnership with RURA, REG is

increasing awareness campaigns on the danger of this practices across the country. Another highlighted issue during the interview is the voltage drop in some neighborhoods caused by overcrowded electricity transformers. The government of Rwanda, through REG, has put in place a mechanism to replace all overcrowded transformers by the new and suitable transformers.

2.2.2. Reliability

The GoR target to significantly improve the reliability of electricity supply for residential and productive users by reducing the average number of interruptions in a year from 265 to 92 by 2024, as well as the total duration of those (MININFRA, 2018). This will be achieved through additional generation capacity and investment in energy infrastructure to meet the country's electrification targets. The main objectives of the ESSP for the improvement of the electricity sector are summarized in Table 1.

Table 1: Summary of Rwanda's objectives for the electricity sector under the ESSP, covering the period 2017/18-2023/24 (World Bank 2020).

ESSP Objectives	Baseline (2017)	Target (2023/24)
Achieve universal electrification (Tier 1 or more)	40.7 percent (29.7 percent on-grid, 11 percent off-grid)	100 percent (52 percent on-grid, 48 percent off-grid)
Reserve margin	n.a.	15 percent
Average number of interruptions per year	265	92
Average total duration of interruptions per year	44 hours	14 hours
Reduce transmission and distribution network losses	22 percent	15 percent
Expand electricity access to productive users[a]	72.6 percent	2020/21: 100 percent

Over the last years, Rwanda has already made progress on electricity reliability, with the objective to ease doing business and attract investors to the country. The power reliability is often measured by the outage indices based on the duration of each power supply interruption and the frequency of interruption. It is defined as the ability of the power system components to deliver electricity to all points of consumption, in the quantity and with the quality demanded by the consumer (Christie 2012). This reliability is often measured by outage indices based on the duration of the average power supply interruption, through the System Average Duration Index (SAIDI), the frequency of interruption for customers, through the System Average Interruption Frequency Index (SAIFI) and the average time required to restore the service for interrupted customers, through the Customer Average Interruption Duration Index (CAIDI).

Improvements made in Rwanda include the strengthening of transmission and distribution networks stability to ensure a better quality of power supply to customers and stakeholders, and an automated computation system was introduced to consistently monitor outages duration and frequency levels in recognized international network reliability measurements, capturing SAIDI, SAIFI and CAIDI measurements (REG 2021a). For the capital city Kigali, over the period from January 2020 to December 2020, the SAIFI, was 2.49; SAIDI was 1.47; and CAIDI was 10.48 (REG 2021a).

Compared to other regions in East Africa, over the same period (January to December 2020), for Nairobi County in Kenya, SAIFI was 4.5, SAIDI was 11.5, and CAIDI was 2.6 (KPLC 2021b). Although the Uganda Electricity Development Corporation Limited doesn't provide the reliability indices, in 2018, reliability indices were computed as SAIFI at 0.23, SAIDI at 2.99, and CAIDI at 12.7 (Ssemakalu, Edimu and Serugunda 2018).

During the cooking diaries study, cooking process was reported interrupted only 3 times due to power outage (Ntivunwa 2022a)

Furthermore, results from the Discrete Choice Modelling showed that although power outages occurrence, analyzed on a monthly basis, were reported by around 70% of grid connected HHs and 90% of solar mini grid connected HHs (S. D. Ntivunwa 2022b). Figure 1 shows that the grid connected HHs, both urban and peri urban, reported power outage occurrence of once a month in around 60% HHs and twice a month in 27% of HHs. The rural HHs connected to the solar mini grid reported higher power outages frequencies, 3 to 5 times a month reported by 43% HHs, and 20% HHs reported frequencies of more than 5 times a month. Again, with similar trends, Figure 2 shows that power outages usually last less than 30 minutes in 90% of times, for the grid connected HHs, whereas around that same figure, 90%, of solar mini grid connected HHs reported a power outage duration of more than 30 minutes.

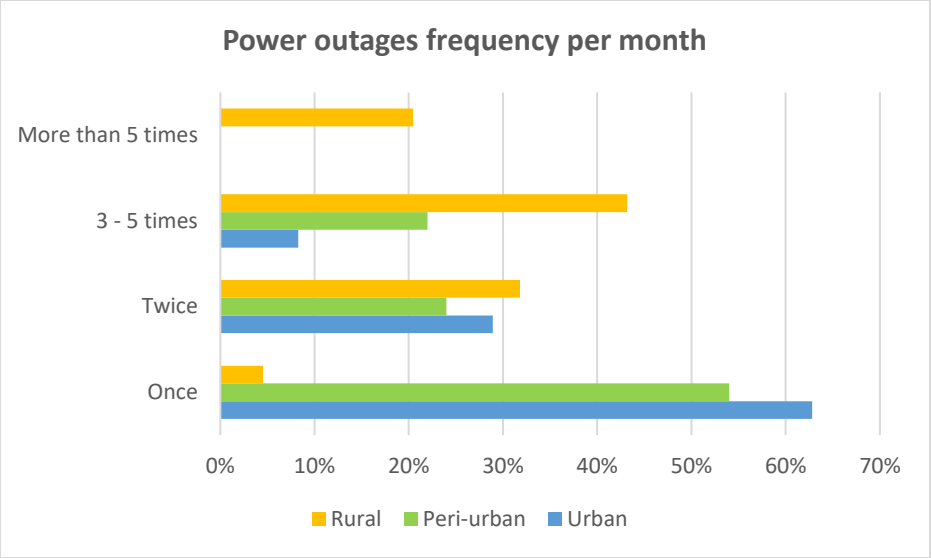

Figure 1: Average frequency of power outages (S. D. Ntivunwa 2022b)

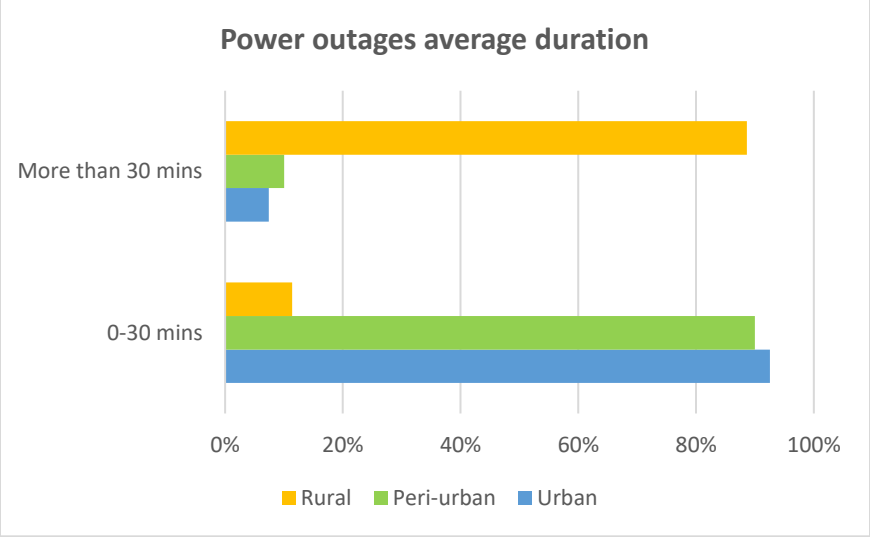

Figure 2: Average duration of power outages (S. D. Ntivunwa 2022b)

2.2.3. Cost

Cooking with electricity is, generally, an unknown practice within rural areas of Rwanda. Nevertheless, eCooking in urban HHs is relatively known, although from hearsay for most of them. Historically, the eCooking appliances found on Rwandan markets consisted of dated, inefficient appliances that would gobble up meter units instantly or leave you with a gigantic bill toward the month's end. Rightly so, this created the perception that eCooking was expensive, particularly in time when existing traditional cooking

fuels were still available for free in many parts of the country (wood) or for low-cost (charcoal). This created the perception, which still exists currently, that the idea of preparing a meal only with electricity is practically ludicrous for HHs to envision.

The rising cost of traditional cooking fuels, following implementation of environmental conservation and related policies, and new developments in the electric cooking appliance market are leading to the realization that cooking with electricity could be a viable option for Rwandan HHs. Various studies' evidence show that current modern energy-efficient appliances are not just a technology of convenience for the wealthy, but also an increasingly affordable cooking method for the common HH, and that the use of energy efficient eCooking appliances can challenge the widespread perception that electricity is too expensive for cooking in developing country contexts.

In fact, the cooking diaries study in Rwanda (Ntivunwa 2022a) showed that when analyzing the per capita energy consumption, which allows us to compare how much energy is required for each heating event for a one-person meal, of different fuel types, eCooking required the least energy. Figure 3 shows that eCooking required 0.76 MJ to cook a meal per person, whilst LPG required 2.83 MJ, and charcoal required 6.4 MJ.

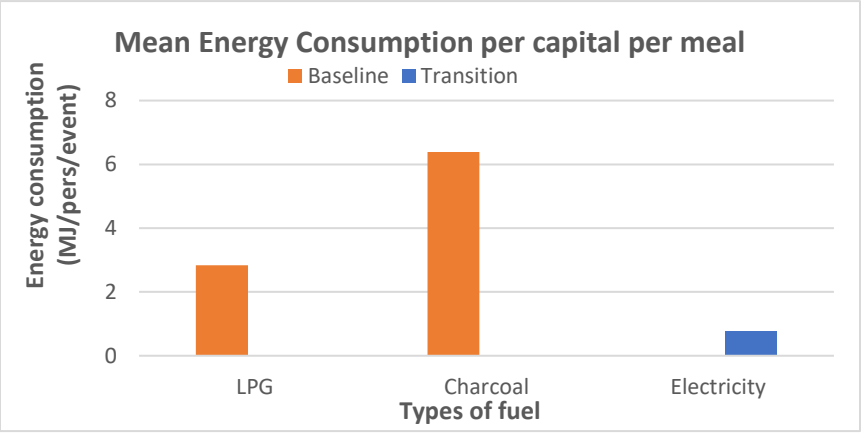

Figure 3: Mean per capita energy consumptions (MJ/person/meal) (Ntivunwa 2022a)

To put the energy consumption results into cost perspective, according to prevailing fuel costs in Kigali City during the study period (Ntivunwa 2022a), eCooking was still the cheapest option at $0.048 (Rwf 48) per person/meal, followed this time by charcoal at $0.069 (Rwf 68), and LPG came next at $0.074 (Rwf 73), as per Figure 4.

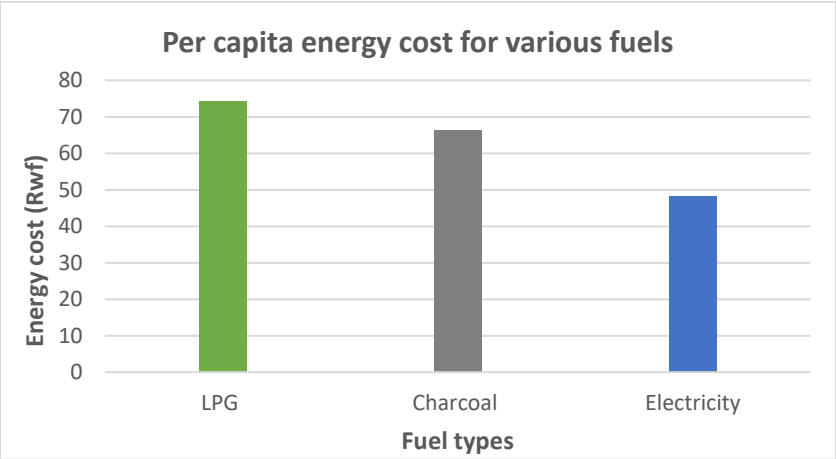

Figure 4: Per capita energy cost per meal for various types of fuels (Ntivunwa 2022a)

Furthermore, the cooking diaries showed that when shifting to higher energy efficient appliance of eCooking (EPC), the mean per capita energy consumption for cooking beans was 10 times less than that of charcoal, and 8 times less than that of charcoal when cooking rice (Figure 5). Preparing porridge on eCooker consumed only three times less than charcoal, although the small reduction could be explained by the fact that porridge was mostly prepared on infrared cookstove which is less energy efficient compared to EPC.

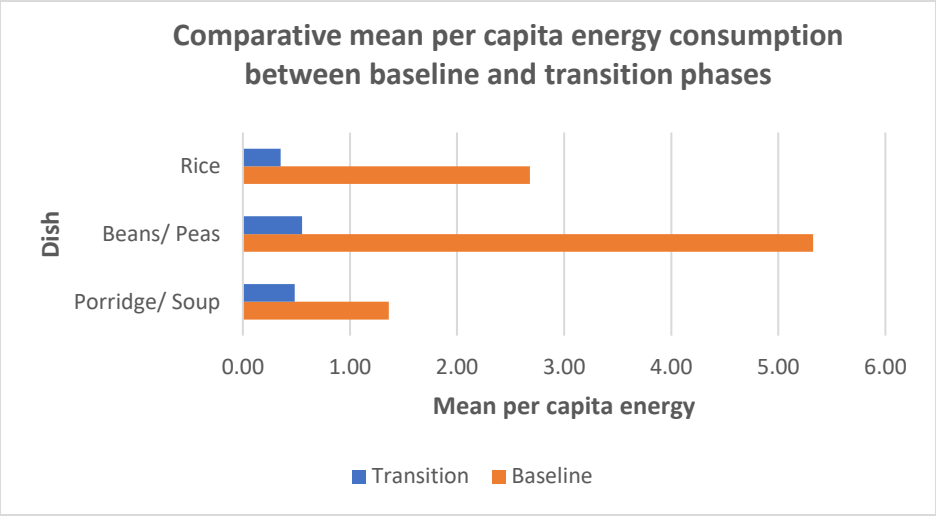

Figure 5: Mean per capita energy consumption of some dishes (Ntivunwa 2022a)

Nevertheless, it's important to highlight that the perception that cooking with electricity is expensive can only be challenged through use of energy-efficiency appliances.

A new generation of energy-efficient eCooking appliances is available. Many of these devices are highly efficient at a specific task (for example, kettles for water boiling) and must therefore be combined with other appliances to cook the range of foods that make up a full menu. Induction stoves are gaining in popularity because of their versatility for a wide range of dishes and ability to heat a pot directly through magnetic induction, making the heat source as responsive as gas (Parikh, et al. 2020). EPC, on the other hand, is efficient because of its insulation which keeps the heat in, its pressurization, which makes boiling much faster, and its automation, which turns off the power as soon as it reaches the correct temperature (Batchelor, et al. 2018).

The low eCooking cost through energy-efficient appliances, does not however, remove all barriers as the upfront cost of these appliances remains high. In fact, an EPC costs between $80 and $130 on Rwandan market depending on its size and brand, which is significantly higher compared to charcoal stove, generally costing less than $10. To overcome this challenge, designing and implementation of financing mechanisms is essential. In the case of Rwanda, in partnership with the World Bank, the Government of Rwanda implementing a CLEAN COOKINGRBF (BRD 2021) scheme to enable HHs accessing clean and modern cooking solutions on subsidy. For instance, an EPC (classified in Tier 5) could be subsidized from 45% to 90% of its total cost, depending on the social-economic category (Ubudehe category[1]) of the HHs. For reference, according to the Focus Group Discussions report (Ntivunwa and Mutalindwa 2022), most HHs, both rural and urban, would be willing to purchase these modern cooking solutions if their cost does not surpass $50.

This suggests that the CC-RBF scheme could be a solution to accessing modern cooking solutions in Rwanda.

[1] 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.

Tier Rating1	Stove cost reference RWF	Ubudehe Category	Maximum Percentage Coverage of Cost (%)	Maximum Eligible RBF Amount RWF
Tier 5	70,000-100,000	1	90%	86,000
		2	70%	67,000
		3	45%	43,000
Tier 4	45,000-70,000	1	90%	60,000
		2	70%	47,000
		3	45%	30,000
Tier 3	30,000-45,000	1	90%	38,000
		2	70%	30,000
		3	45%	19,000
Tier 2	20,000-28,000	1	90%	24,000
		2	70%	19,000

Figure 6: Clean cooking stoves subsidy levels[2] (AESG 2022)

[2] USD1 = 1070 RWF

3. Limitations of traditional cooking fuels

Historically, firewood was practically the sole source of cooking energy in Rwanda with the hunting and gathering practices dominating the Rwandan society. With colonization, new fuels such as agricultural residues, charcoal, electricity (from domestic production) and fuel-oil, kerosene, gasoline (imported) started being used in the country, although at a limited rate and only for a handful HHs. In the 1970's charcoal became an important commodity. It was first produced in the South-Eastern area, which was surrounded by a savannah forest of slow growing, densely wooded trees that produce excellent quality charcoal. By the mid 80' most of it were cut and production then shifted to the more densely forested areas of the South and to a lesser extent to the North. While the biomass-based energy supply and demand was booming, the forest areas, particularly natural ones were shrinking rapidly to the point of losing 66% within 40 years from the 60's to around 2010, as highlighted in Figure 7.

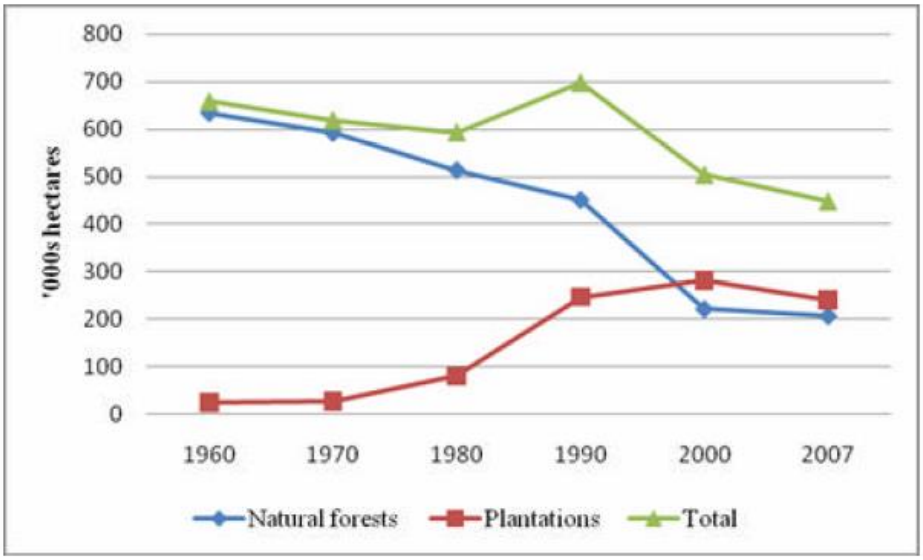

Figure 7: Evolution of forest areas in Rwanda (Marge 2009)

According to Rwanda Biomass Strategy (MININFRA 2019), the reliance on traditional fuels for cooking had continued and as a result limited improvements in health outcomes and deforestation. In rural areas, firewood accounted for 93% of the fuel used for cooking, whilst in urban areas, firewood still represented 26.3% of the cooking fuel used, with charcoal being the most common fuel (65% of total cooking fuel used). This high reliance on biomass for energy consumption in the country, together with the increasing demand due to rapid population growth, resulted in an imbalance between supply and demand of

biomass products. For the case of firewood and charcoal, this annual demand imbalance was estimated at 5,718,000 m3 in 2021 and expected to increase up to 6,591,000 m3 by 2026 (MINIRENA 2017).
Through deforestation, traditional cooking fuels (firewood and charcoal) contribute to the environment degradation. In fact, cooking-related emissions account for 14% of the GHG emissions from the energy sector in Rwanda (Cook, et al. 2020). Burning wood release at once all the CO2 it absorbed over the years while the tree was alive (woodsmokepollution.org 2022). Describing it as renewable since trees can be replanted and eventually reabsorb that emitted carbon would not cut it in our current context as we need to reduce our emissions now, we do not have centuries. Furthermore, wood burning significantly contributes to climate change. In fact, some researchers (familiesforcleanair 2022) report that burning wood create particles called black carbon that are major contributor to climate change. In fact, the International Global Panel on Climate Change reported that black carbon is the second most significant contributor to global warming after CO2.

In addition to environmental issues, the overexploitation of biomass, in particular firewood and charcoal, contributes to health threats through HH air pollution (HAP). In fact, HAP from solid fuel use is the fourth leading risk factor for morbidity and mortality in Rwanda, and respiratory infection the leading cause of life lost (IHME, 2021). It is estimated that more than 7,383 premature deaths in Rwanda are attributable to HAP annually, with total welfare losses of USD 674 million per year (World Bank and IHME, 2016). Seventy-six per cent of HHs spend at least 7 hours per week acquiring fuel on average, either by collecting or purchasing it and preparing the fuel for their stoves, with a disproportionate burden on HHs using firewood. Women and girls also disproportionately bear the burden of fuel collection and cooking-related activities. As a result, women and children are more susceptible to HAP and associated adverse health effects, and chores relating to cooking take a considerable amount of their time, which otherwise could have been used for other productive areas such as education or employment (World Bank 2020).

To address the challenge 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 Biomass Energy Strategy translates these high-level objectives into specific targets to be achieved by 2024 and 2030 (MININFRA 2019). The GoR is also aiming at diversifying away from traditional wood fuel to look at other forms of biomass such as papyrus, rice

and coffee husks, as well as biogas, which benefits from the 'One cow per poor family' scheme. 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 does no longer exist (REG 2021b).

The ESSP (MININFRA 2017) reflects the ambition to promote a more sustainable management of natural resources and the shift away from traditional cooking sources, with 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 clean 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 in the country, aims to reduce the demand for biomass fuels by promoting the switch to modern cooking fuels. This includes raising customer awareness, the strengthening of value chains of clean fuels and cooking technologies and the strengthening of the coordination and capacity of public institutions in the sector. Table 2 indicates the main targets for 2024 and 2030 outlined in the Biomass Energy Strategy for the reduction in biomass dependence for cooking.

Additionally, in May 2020, 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 energy sector in Rwanda. With that aim, Rwanda NDC's mitigation measures include the dissemination of 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).

Table 2: Key indicators of the Biomass Energy Strategy on the reduction of biomass dependence for cooking, p.11 (MININFRA, 2019b).

Indicators	Baseline values and second-level targets
› 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 %[9] Target value 2024: 42 % Target value 2030: 0 %
› 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.).	Baseline value 2017: 65.1 %[10] Target value 2024: 32% Target value 2030: 1%
› Percentage of population using inefficient cooking technologies;	Baseline value 2017: 72.5% [11] Target value 2024: 36 % Target value 2030: 20 %
› 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.	Baseline value 2017: NA% Target value 2024: 100 % Target value 2030: 100 %
› 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 %

4. eCooking as a potential convergence between clean cooking and access to electricity programmes

In Rwanda, HHs' access to electricity has seen a rapid rise in the last decade, rising from around 300,000 HHs in 2012 up to 2 million HHs in 2022 (REG 2022b). To achieve its target of universal electrification by 2024, the GoR has adopted the approach of diversifying electricity sources, since it would take time to reach all HHs through only on grid connections. Currently, more than 640 thousand HHs are connected to off-grid solutions which include inter-alia standalone solar home systems and mini-grids (REG 2022b).

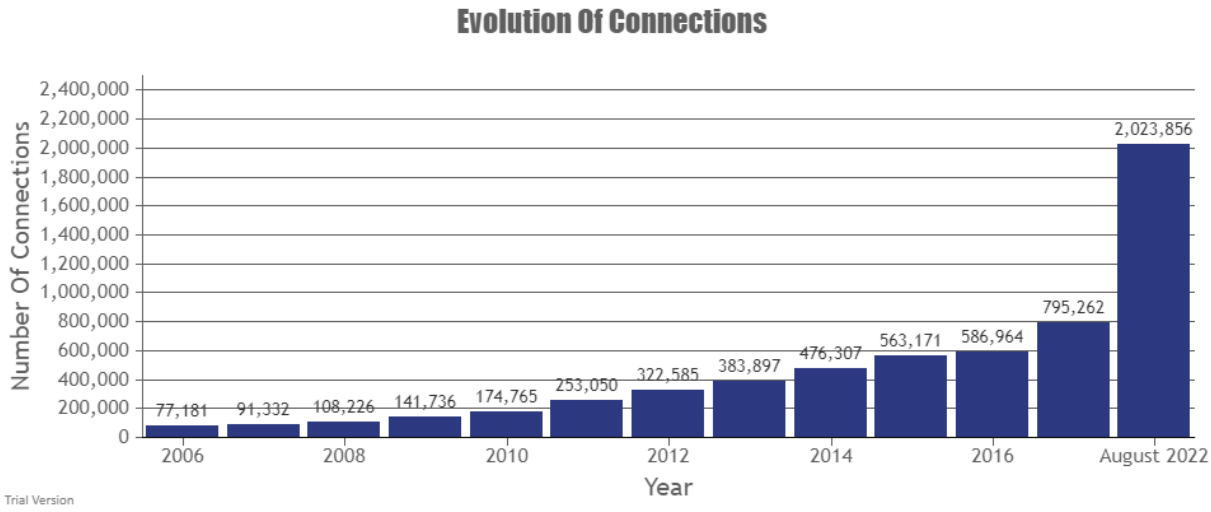

Figure 8: Evolution of HHs' electricity connections in Rwanda (REG, 2022b)

Although the HHs' electricity access is rapidly rising, the HHs' use of electricity is still limited mostly to lighting. According to REG's Director of generation and production department, not even all connected HHs use it for lighting. Some HHs can spend months without using electricity at all, although they are connected, and the reason is mainly low-income levels in relation to the cost of electricity. He also highlighted that the majority of HHs only use basic electric appliances, although the grid electricity can sustain high load appliances. This is in line with the (NISR 2017) report which stated that most of the grid connected HHs (83%) only use the basic appliances that can be simply powered by a small solar lighting system such as Radio and Mobile phone. The report continues stating that 12% of the HHs own mid-level appliances such as TV and Computer while only 4% use cooking appliances.

The low adoption of eCooker in Rwanda runs deeper and can be explained by the historical low HHs' electricity access. In fact, from the 1937 when the national utility was established, and 1957 when the first

power plant was built in Rwanda, to the year 2000, only 46000 HHs had access to electricity, and in 2009, the number was only 6% of Rwandan HHs (REG 2022b).

During the interview, REG's Director of generation and production indicated that eCooking promotion in Rwanda is possible, as far as grid reliability and capacity is concerned. He, nevertheless, highlighted that although the current installed generation capacity is at 305 MW, a significant part of it is not necessarily available at the same time. Examples provided were for instance the difficult production of electricity from peats and solar power plants in rainy season, and the significant reduction in production capacity of hydro-power plants. The subsequent result is the electricity demand, currently at 186 MW at peak hours, being very close to the available production, thus no electricity surplus. This situation would obviously not lead to push of mass eCooking adoption, however, he indicated that there are several ongoing generation projects which would result in around 60 MW of electricity surplus.

Discussing about the smart tariff policy (cooking tariff), the Director of generation and production indicated that eCooking promotion should probably be based on HHs level, depending on their income levels. He highlighted the existing efforts of GoR in subsidizing the electricity where currently the first 15 kWh, which have been reported sufficient to cover monthly lighting needs for small HHs, are priced at Rwf 89 (8 cents) per kWh. He added that country-wide research on cooking energy demand would be required to quantify the equivalent electricity needed to satisfy the cooking needs of Rwandan HHs, which would be provide basis for further consultations on electricity cooking tariff policy.

5. eCooking appliances supply chain

Although current eCooking share contribution to clean cooking technologies in Rwanda is still very low, varieties of eCooking appliances (eCookers) are present within Kigali city markets' shelves. However, commercial distributors and retailer networks is the only existing distribution model of eCookers in Rwanda.

Currently, there exists no manufacturing plant for eCookers in the country. All merchandised eCookers are imported, usually from China, although some are brought in from South Africa and the United States of America. Most of these eCookers sold locally by supermarkets and shops are purchased from overseas wholesalers and authorized distributors, although a new local distributor dedicated to electric pressure cooker (EPC), Electrocook ltd, imports them from a specific Chinese manufacturer on commission.

The common import route for these eCookers 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.

The current commercial and retailer distribution model would hardly lead to mass eCooking adoption, particularly considering the lack of energy efficiency awareness among the local retailers. In fact, during the Key Informant interviews conducted with several local retailers, it was noticed that they were not aware of the relationship between appliance's energy efficiency and adoption pattern, thus the decision on which eCookers to import comes down to the product cost. As a result, the market is flooded by relatively low-cost low-energy efficient eCookers. To local retailers, eCookers were just like any other products in the shop.

Furthermore, the lack of after-sale-services by the local retailers is a significant bottleneck on eCooking penetration. For instance, eCookers quality, which is a pre-requisite for winning over a target market, is only guaranteed by the manufacturers or their representative, who, as it has been found, are not always faithful. eCookers quality assurance should be enforced and safeguarded for their sustainable penetration. The crucial need for the after-sale-services could be clearly highlighted by what happened with EPCs used during the cooking diaries study in Rwanda. In fact, among 25 EPCs initially supplied by Burn Manufacturing ltd, only 2 were operational after a year. Although Burn manufacturing ltd replaced the first 5 pieces, it was not enough and there clearly was a need of their presence on the ground to sort out the technical issues.

The case of Electrocook Ltd, however, could bring about changes. In fact, Electrocook took more than a year of testing the robustness of various EPCs models, their compatibility with popular Rwandan dishes, eventually producing a Kinyarwanda manual guide on how to operate, preserve, and cook those dishes in

EPC, before bringing them on the market. Electrocook also trained a pool of local technicians on functioning and repairing of those EPC, for future technical support.

Lack of financing models by retailers is another shortcoming aspect that hinders uptake for eCookers. In fact, high energy efficient eCookers (including EPC) prices range from $85 to $120, which are high in relation to the estimated $93 HH's average monthly income in Rwanda (NISR 2022). Electrocook has introduced a financing model whereby an EPC can be paid for in 3 installments for same price as an upfront cash payment. This has yield tangible results as they have sold more than 120 pieces in around 5 months. Implementation of the GoR project funded by the World Bank to increase clean cooking adoption, under which several eCookers retailers and distributors are registering, will eventually facilitate eCooking development in the long run.

Table 3: Some of the eCooking appliances available on Kigali city market

Product type	**Brand**	**Model**	**Power (W)**	**Volume (litre)**	**Retail shop**	**Location**	**Price (£)**
Electric Pressure Cooker	Electrocook	MY-CJ0001	1000	6	Electrocook Ltd	Local-physical (Kigali)	77.24
	Instant Pot	DUO	1000	6	Kamica Ltd	Local-physical (Kigali)	65.04
	Maier	MR-4848	1000	6	Simba supermarket Ltd	Local-physical (Kigali)	103.66
	Maier	MR-4646	1000	6	Metrotech Ltd	Local-physical (Kigali)	239.84

	Sonifer	SF-4009	1000	6	HH & Fashion Ltd	Local-physical (Kigali)	73.17
	Ewant		1400	10	Ayaat Trading Ltd	Local-physical (Kigali)	69.11
	Ecoa		1200	8	Burn manufacturing Ltd	Nairobi- for Import	93.50
Hot plate	Sanford	SF5014IPT	2500	N/A	Metrotech Ltd	Local-physical (Kigali)	36.59
	Saachi	NL-HP-6209	2500	N/A	Shema shop Ltd	Local-physical (Kigali)	36.59
	JEC	CP-5831	1500	N/A	Skyworth Ltd	Local-physical (Kigali)	40.65
	Infrared cooker	HS-247	2000	N/A	Universal Tech Ltd	Local-physical (Kigali)	77.24

6. Awareness raising strategy

Awareness raising on clean cooking has been conducted in Rwanda and the campaigns are attributed to NGOs and development partners such as SNV, and other institutions such as REG, however the involvement of clean cooking companies has been less.

Assessing the awareness raising gap on targeted groups of people is very vital in setting up a plan to identify the best strategy to raise awareness. Understanding who will be reached, and by which kind of information is key. Therefore, different target groups require different modes of communication in order to maximize the size of the audience. This also gives an understanding of knowledge, experience and perceptions people have about eCooking technologies in Rwanda.

Some of the most preferred platforms used to raise awareness on clean cooking in Rwanda are social gathering, community meetings, media platforms such as TVs and Radios. Most of the key messages that have been communicated around clean cooking via these platforms are,

- Economic benefits of clean cooking
- Health benefits of clean cooking
- Social and environmental benefits
- Available and affordable products.

6.1. Market barriers

A number of barriers and behaviors exist to consumer adoption of eCooking appliances and some of these barriers include:

- High cost of technology
- Lack of fuel choice
- Lack of information
- Convenience
- Fashion shifts: Electric ovens are becoming more popular
- Usability issues.

6.2. Engagement and Identification stakeholders/partners

For the awareness raising to be successful, it is recommended to engage different players, and these may include local authorities, donors, retailers, clean cooking companies, regulators, FIs and local technicians.

These stakeholders can significantly influence the behavioral change towards eCooking in Rwanda as well as facilitating community mobilization. The Table 4 below highlights key actors that can be involved in awareness raising and their role.

Table 4: Awareness raising actors

Key stakeholders	**Role**
Governmental and administrative stakeholders	Creating an enabling environment for Clean cooking companies, public and private funding for clean cooking
Non-Government Organizations	Grant Financing Economic and social opportunities Capacity building opportunities for clean cooking companies
Local leaders/authorities	Community mobilization and ensuring project buy-in
clean cooking companies/Manufacturers	Act as key players in the transition of clean cooking solutions
Men and Women (HH heads)	Responsible for Buying fuels and stoves
Local technicians	Operation and maintenance of stoves/technical support
Financial Institutions	Access to finance and opportunity to work with clean cooking companies and consumer financing
Retailers	Supply of eCooking appliances most of the which are imported
Donors	Donors to contribute to financing consumer studies, local outreach programmes

6.3. Existing opportunities for awareness raising for eCooking in Rwanda

With the increased access to the grid in Rwanda, connected households present an opportunity for eCooking use. Therefore, incorporating eCooking technologies into the awareness raising plan as an alternative solution is vital.

Key message on use of eCooking focusing on faster cooking and cleaner space would have a competitive advantage compared to other non-clean fuels. Other key messages that can be prioritized are the economic benefits of e-cooking and the health benefits of e-cooking.

Access to e-cooking appliances also is hindered by the high cost of fuels and stoves, safety, and health concerns, however this presents an opportunity to be incorporated into the campaign to deliver a fully packaged message to the people that will influence the adoption of eCooking.

6.4. Framework of the awareness raising strategy

While planning for eCooking, an awareness raising communications strategy should include the following steps:

1) Definition of the problem,

2) Analysis of the situation (including a detailed analysis in public relations),

3) Determination of the "end targets" / Goals (the most important stage of the planning process),

4) Description of the aim,

5) Description of the target group(s),

6) Communication tools and selection of the communication techniques: the way, how messages are transferred to the public with minimum charge and time,

7) Preparation of the campaign implementation and evaluation

6.5. Potential platform or avenues for awareness raising for eCooking

In order to disseminate key messages on e-cooking the awareness raising strategy should take into consideration the following as shown in the Figure 9.

Figure 9: Potential avenues for eCooking's awareness raising

6.5.1. Demonstration sessions

One of the main challenges in clean cooking adoption is lack of information on benefits and alternatives of clean fuels. Unlocking this challenge requires changing the mindset of the communities. Therefore, the involvement of the communities and cooks in the demonstration of these technologies (cooking practices) is important to provide a hand on benefits. This challenge can be approached by setting up:

A. Demonstration Labs

Demonstration labs equipped with all eCooking and even other clean cooking technologies (fuels and stoves of LPG, ethanol, pellets, ICS either of firewood or charcoal) could be installed permanently or semi-permanently in Districts. The purpose of these labs would be to serve as information center on the benefits of clean cooking, demonstration sites on new technologies, and cooking practices. This can be visited by suppliers, cooks, institutions, and people within the communities where they can witness or have a practical experience of technologies. This can be implemented in partnership with REG and local government. This proposed infrastructure aligns with the ongoing world bank & Government project to support clean cooking companies to access RBF facility to address the issue of financing.

B. Community based demonstration lab:

Across the country there is a local government program around village kitchen which addresses the issue of malnutrition and teaches communities how to prepare a balanced diet. This can be leveraged on to introduce energy cooking practice where eCooking can be applicable. Normally the communities use mostly firewood and sometimes charcoal. Setting up a community kitchen in communities that runs on eCooking appliances would also demonstrate the economies of scale that can be achieved by sharing cooking between households, reducing fuel consumption, and enhancing energy efficiency. For this to be effective, cultural acceptance of such a solution needs to be taken into consideration and integrated into the awareness raising plan. In addition, this will be a demonstration site on clean fuels and benefits but on a small scale compared to the proposed domo on a provincial level.

These demonstration sites would also convey messages to the communities related to health, financing, costs, environment, and safety.

C. Institutional cooking (schools)

There is an existing program of school feeding in government and private schools in Rwanda that provide meals to pupils and students. Most of these schools still use firewood for cooking. All existing ongoing

programs on clean cooking solution are focusing on HHs level, leaving out institutions and yet they are among the largest consumers of firewood. A mobile kitchen for raising awareness on eCooking in schools which could be used for 1 week in particular schools and move around various schools and other institutions like prisons, industries could be a practical tool.

6.5.2. eCooking tariff

The introduction of the eCooking tariff would also discourage the use of firewood and encourage the eCooking uptake in Rwanda. This strategy has not been introduced in Rwanda and there is a great need to advocate for this policy among relevant key stakeholders such as REG to put in place a specific tariff for eCooking.

6.5.3. Support required to make eCooking awareness raising effective.

In order to ensure an effective awareness raising campaign, there is a need to support both end-users and clean cooking companies. End-users require additional support by lowering the cost of eCooking products. This implies that affordability of eCooking solutions is one of the major barriers that hinder their adoption. Thus, clean cooking companies should have a business model that works for communities such Pay As You Cook. It is also important to have additional financing for private companies to reach the last mile and offer after-sale support services. In the awareness raising plan on eCooking the element of affordability should also be considered as well as advocacy for the subsidization and incentivization of eCooking appliances.

7. Conclusion

Despite the current low awareness of eCooking across the country, the fragile supply chain, the lack of access to finance and financing models, for both end-users and suppliers, eCooking still presents opportunities for growth, particularly through implementation of improved awareness raising campaigns, tailored to each target customer group.

Government institutions and its decision makers would, however, need to understand and include eCooking into priority programmes promoted across the country. Development partners would also need to enhance their technical and financial support to clean cooking companies involved in eCooking to enable them to participate in existing and conduct their own awareness campaigns. Furthermore, financial institutions need to support end-users, and in particular eCooking suppliers to enable them to develop a much more sustainable supply chain. Finally, eCooking suppliers are encouraged to take advantage of the existing infrastructure, programmes, and evidence-based research to promote and educate their customers and the general public on the economic, health, and environmental benefits of eCooking.

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