Uganda

eCooking Market Assessment

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This version is intended for public disclosure

The MECS/EnDev eCooking Market Assessments

This study is one of a series of publications produced jointly by Energising Development (EnDev) and the Modern Energy Cooking Services (MECS) Programme. This series of market assessments offer strategic insight on the current state of electricity access and clean cooking in eight countries across sub-Saharan Africa and South Asia. These studies identify the key opportunities and challenges to the scale up of electric cooking in the coming decade and conclude with a series of recommendations for targeted interventions that could support the development of emerging eCooking sectors. The market assessments are structured according to the MECS transition theory of change (TToC), which consists of three interrelated dimensions: the enabling environment, consumer demand and the supply chain.

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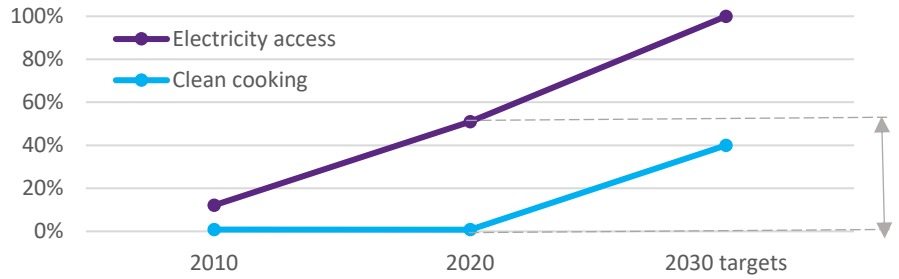
Executive Summary

Despite historically low electrification rates, cooking with electricity is now becoming a viable and scalable option for Uganda. According to the National Electrification Report conducted by the Ministry of Energy and Mineral Development (2020), 24% of households now have access to grid electricity and 27% are off-grid. The total installed generation capacity doubled from 600 MW to 1200 MW between 2010 and 2019. This investment has helped to mitigate against the country's dependency on hydropower, which in 2005 led to significant, drought-induced load shedding and power outages. Uganda today produces an electricity surplus of almost double current demand and is proactively stimulating demand for its predominantly renewable (92%) electricity. 21% of Ugandans use charcoal as their primary cooking fuel, however intensive charcoal production is depleting forests and the population is set to double by 2050. Charcoal users are an attractive market segment to target as they have a guaranteed existing expenditure on a polluting fuel that could be repurposed to electricity units. As a result, the government of Uganda has put in place an array of policies and targets to facilitate the transition away from biomass, including the Draft Energy Policy (2019), which made specific mention of energy-efficient eCooking appliances.

Uganda data snapshot from [MECS eCooking Global Market Assessment]:



50% connected to electricity, but still primarily cooking with polluting fuels

Cooking energy

Primary fuel use:

0% cook primarily with electricity

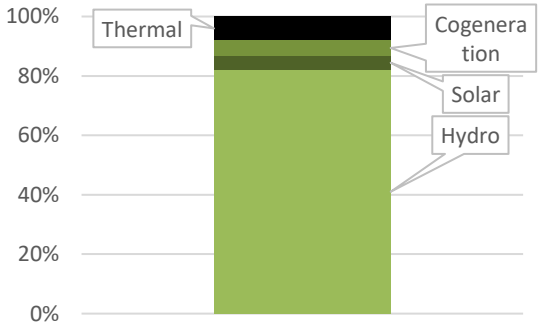
26% cook primarily with **commercialized** polluting fuels (charcoal)

100% cook primarily with polluting fuels (charcoal & firewood)

Electricity generation

On-grid:

92% renewable



76% (520MW) surplus power generation

Increasing reliability: 65% power availability (SAIDI*SAIFI=3,072hrs/yr)

Off-grid:

Rapidly developing mini-grid & off-grid sectors: 0.1m mini-grid customers, 36 mini-grid developers, 5m off-grid lighting/appliance customers

eCooking GMA viability scores/rankings

Overall:	On-grid eCooking:	Mini-grid eCooking:	Off-grid eCooking:
32nd/130	**0.45 – 88th/130**	**0.38 – 39th/130**	**0.48 – 7th/130**

Key opportunities

- Uganda has a sizeable and well-financed SHS sector which may lay the foundations for a future profitable business model for off-grid eCooking solutions.
- Electricity utility Umeme are pro-actively looking at electric cooking as a way of boosting electricity demand.
- Uganda continues to accelerate rapidly with electrification as installed capacity is set to increase substantially from a variety of sources, however this includes the country's first nuclear plants, which are planned to add 2,000 MW of power generation
- The integration of electrification and eCooking in the NDPIII is a significant step forward to eCooking in Uganda.
- Energy efficient appliances are highly compatible with Ugandan cuisine, in particular the EPC, which can drastically reduce energy consumption for the most energy intensive dishes (heavy foods).
- Integration of the East African Community (EAC) has been increasing steadily, suggesting common trade policy relating to the importation of electric cooking appliances.

Key Challenges

- Mini-grid sector at a nascent stage
- Duties on solar products and suitable electrical appliances constrain the off-grid energy market
- Limited lifeline allowance causes affordability issues for some consumers
- Military, state and business elite involvement in charcoal production creates a disincentive for top-down strategies for clean fuel adoption.
- The perception that electricity is too expensive for cooking is deeply embedded in society.

Potential impacts of scaled uptake in most viable market segment

If 40% of Uganda's grid-connected charcoal users (7.8m ppl, 1.7m HHs) switched to eCooking, the WHO's BAR-HAP tool suggests that:

- 6,115 DALYs/yr avoided
- 9.4m tonnes/yr CO2eq emissions reduced
- 1.7m tonnes/yr reduction in unsustainable wood harvest
- 1,041m hrs/yr of women's time saved (593hrs/HH/yr)

- **11 months payback** for eCooking appliances ($70/HH upfront cost, $77/HH/yr savings on fuel energy costs)
- **892 GWh** demand for electricity stimulated

For further detail, please see *Appendix E: Impact of Scaled Uptake*.

Introduction

Clean cooking and electricity access in Uganda

Despite historically low electrification rates, cooking with electricity is now becoming a viable and scalable option for Uganda. 24% of households nationwide have access to grid electricity (Uganda Bureau of Statistics, 2020)[1] and a further 27% use off-grid sources such as solar systems for electricity access. Meanwhile, only 1.4% of households in Uganda use electricity and alternative non-biomass fuels such as LPG as their primary cooking fuel. In urban areas, 4% of households use electricity as their primary cooking fuel (6% in Kampala), and yet 74% of have access to electricity (Uganda Bureau of Statistics, 2021).

The last decade has witnessed a significant increase in electrification in Uganda, with total installed generation capacity doubling from 600 MW to 1200 MW between 2010 and 2019. Electricity in Uganda derives mainly from large scale hydropower (68%) and mini-hydro solutions (16%), with thermal, cogeneration, and grid-connected solar account for the rest (ERA, 2020). Significant investment in generation capacity has helped to mitigate against the country's dependency on hydropower, which in 2005 led to significant, drought-induced load shedding and power outages. In contrast to 2005, when electricity demand was double the supply available, Uganda today produces an electricity surplus of almost double current demand of 680MW (AEPL, 2020) and is proactively seeking ways to boost household demand, i.e. through the use of electricity for cooking.

At present, the vast majority of Ugandan households use either firewood (73%) or charcoal (21%) as their primary cooking fuel (ibid.). Intensive charcoal production is depleting forests and the population is set to double by 2050. As a result, the government of Uganda has put in place an array of policies and targets to facilitate the transition to cooking with clean, modern fuels.

Enabling Environment

eCooking policy outlook: promising policies in place to integrate electrification with clean cooking with the hope of tackling both issues simultaneously.

Key Policy Stakeholders: Electricity Regulation Authority (ERA), Ministry for Energy and Mineral Development (MEMD), African Development Bank (AfDB),

RISE **(Regulatory Indicators for Sustainable Energy) scores:**

74%	72%	54%	19%
Electricity Access	Clean Cooking	Renewable Energy	Energy Efficiency

Targets:

Electricity access
100% electricity access by 2030 (grid/off-grid)
Increase annual electricity consumption from 100 kWh to 1,500 kWh per capita per year consumption by 2030

Clean cooking
40% clean cooking access by 2030

Key government/NGO programmes creating the enabling environment in which eCooking can scale:

- The Energy Development Programme of Uganda's Third National Development Plan (NDPIII)

- MEMD's Charcoal to Power initiative began implementation in July 2021 with the aim of transitioning 500 institutions (and eventually 50,000 households) to electric cooking.
- Umeme hoping to launch a demand stimulation programme around eCooking

Key barriers/drivers in the enabling environment:

Drivers

- The integration of electrification and eCooking in the NDPIII is a significant step forward to eCooking in Uganda.
- Successful economic growth rates, poverty reductions and consequently increased energy access.

Barriers

- Military, state and business elite involvement in charcoal production creates a disincentive for top-down strategies for clean fuel adoption.

For further detail, please see *Appendix B: Enabling Environment*.

Consumer Demand

What's on the menu?

In an average week, a typical Ugandan household might prepare:

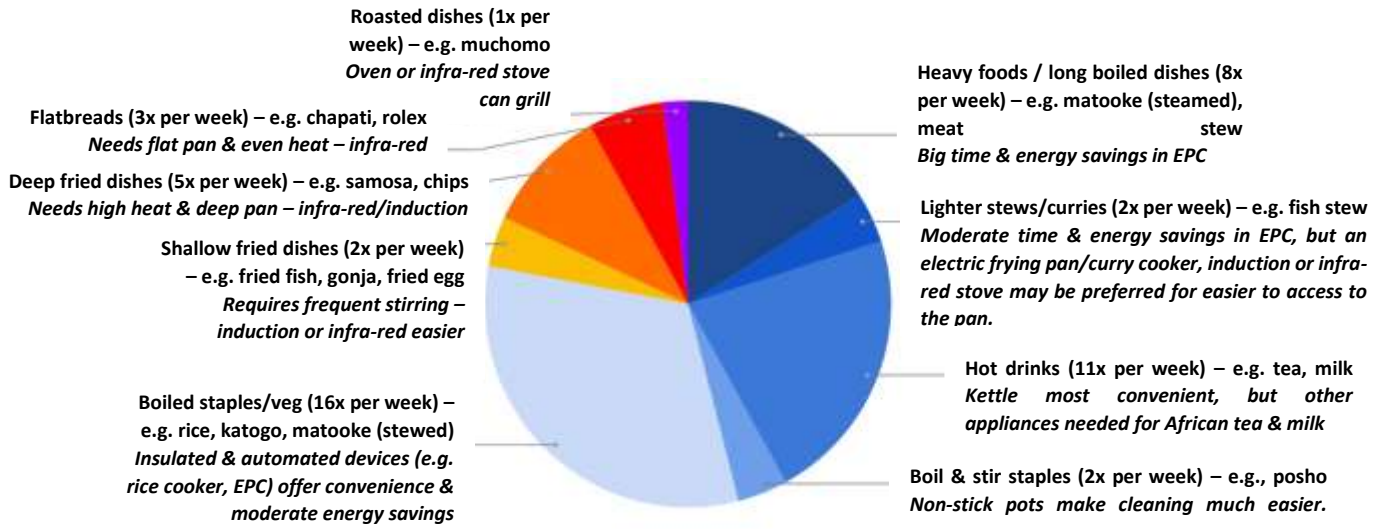


Figure 1: Visualisation of the results of a culinary analysis carried out during this market assessment by asking local team members to map out the dishes that a typical Ugandan household might prepare in an average week and assessing their compatibility with modern energy-efficient appliances.

- A typical Ugandan meal usually pairs a staple food with eriani (relishes).
- The choice of staple foods is seasonally affected based on affordability and availability. Popular staples include emere (maize) or posho (millet), as well as rice, potatoes, cassava or matoke. Most staples are boiled or stewed, meaning that they are well-suited to an EPC (with or without pressurising) or a rice cooker.
- Matooke (banana variety that is usually steamed and mashed) is culturally significant in Uganda particularly in central and western regions. Steamed matooke usually takes several hours to prepare, but this time can be cut in half with an EPC.
- The eriani (relishes) dishes typically consist of groundnut flour, green vegetable or beans, onions, tomatoes and when available, meat/fish stew. These relishes are usually fried and/or boiled. Some require boiling for several hours (e.g. beans), making them well suited to the EPC, however others are fried and require frequent stirring (e.g. green leafy vegetables), so induction/infra-red may be preferred for easier access.

Most viable energy-efficient appliances: **EPCs, rice cookers, induction, infra-red, kettles**

Key marketing messages: **energy-efficient appliances offer substantial time and cost savings and enable multi-tasking. EPCs are the cheapest and most convenient way to cook heavy foods.**

Key demand side barriers/drivers:

Drivers

- Energy efficient appliances are highly compatible with Ugandan cuisine, in particular the EPC, which can drastically reduce energy consumption for the most energy intensive dishes (heavy foods).

- The removal of VAT on LPG in 2020 has made LPG more affordable, which increases the viability of a completely clean fuel stack of LPG and electricity.
- Research conducted by CREEC/MECS showed that participants are willing to continue using the EPC due to the high efficiency of the appliance and participants keeping with budget on their energy consumption.

Barriers

- Low-income households feel pressure to reduce their fuel consumptions with cooking, therefore would often substitute slow-cooked foods for quick foods such as eggs.
- The perception that electricity is too expensive for cooking is deeply embedded in members of society.

Key demand creation programmes:

- Umeme hoping to launch a demand stimulation programme around eCooking

Key market segments

Charcoal users

- 26% of Ugandan households rely on charcoal for their cooking needs, the majority of whom are located in urban areas and are now connected to the national grid.
- Unlike firewood, charcoal is almost always purchased, creating an attractive existing expenditure to convert into electricity units. Despite Uganda still having cheaper charcoal than its neighbours in the region, the price of charcoal has increased. For example, a standard 50kg bag of charcoal has increased from 20,000 to 30,000 shillings (5 to 7 EUR) in Kabale district (western region of Uganda). They can go for more in Kampala and Masaka (southwest of Kampala).
- Charcoal is typically preferred for heavy foods, as it burns slowly and many people still believe it is the cheapest way to cook them. The EPC offers a highly attractive modern alternative that can greatly reduce expenditures on cooking fuel, however the upfront cost is a substantial barrier for many who use charcoal, which can be purchased in small quantities.

Electricity and LPG users

- According to Rhamz International, fuel satisfaction for electricity and LPG respectively in institutional settings is significantly high with **47.2%** claiming satisfaction with electricity and **58.5%** for LPG. Affordability is the main reason for the high uptake.
- However, the rate of uptake in households is low due to high costs, lack of awareness and limited supply of fuels and devices. In the sample produced by Rhamz International, only 16.6% used electricity and less for LPG (13.5%) for some of their cooking needs, however charcoal and fuelwood remained a primary fuel.
- High tariffs and appliance costs mean affluent households gain the benefits of eCooking, particularly adding the fact they have more reliable electricity supply.
- CREEC found that typical Ugandan dishes cooked on an EPC are 2-4 times cheaper than cooking on an electric hotplate.

For further detail, please see *Appendix C: Consumer Demand*.

Supply chain

Key eCooking domestic appliance manufacturers: n/a

Key eCooking appliance distributors: Bamukungu Enterprises Limited, Anisuma Traders Limited, Appliance World Limited, Translink (U) Ltd, Mr. Ronald Musekura

Innovative eCooking pilot projects:

- Pesitho ApS- build solar-powered community kitchen in refugee settlements. Additional funding from the Humanitarian Innovation Fund and ELRHA is allowing the company to expand its PAYC (Pay-as-you-cook) systems and carbon credit schemes.
- Energrow – MECS Electric Cooking Outreach (ECO) project in partnership with Burn Manufacturing aiming to sell EPCs to 200 households using their utility-enabled financing model.
- MEMD- Charcoal to Power initiative; a five-year programme which started in July 2020-aiming to transition 500 institutions to eCooking and other clean fuels including LPG, biofuels and sustainable charcoal.
- ERA- working with UNDP Uganda to transition part of Mulago Hospital from biomass to electric cooking.
- Umeme- Uganda's primary electric utility sought to promote electric cooking to promote overall household consumption and enable affordable electricity tariffs. Piloted EPCs in Kampala and collaborated with EnergGrow, working on consumer finance schemes.
- UpEnergy- developed customised EPC product for the Ugandan market. Pilot Study in collaboration with PowerUp is due to commence October 2021.
- CREEC- preparing to pilot battery-supported grid-connected and solar electric cooking systems in weak-grid and off-grid regions respectively.

Key supply side barriers/drivers

Barriers

- Common External Tariff (CET) makes implementing tariff reductions for electrical appliances just for Uganda difficult.

Drivers

- Integration of the East African Community (EAC) has been increasing steadily, suggesting common trade policy relating to the importation of electric cooking appliances.
- Uganda continues to accelerate rapidly with electrification as installed capacity is set to increase substantially from a variety of sources, including the country's first nuclear plants, which will add 2,000 MW of power generation

Popular appliances in Uganda today:

MECS carried a small-scale appliance availability survey in Uganda, conducted across 9 different online retailers, and analysis of 2019 import data for July-December 2019 on electric cooking devices:

- The category imported in greatest number is the oven/cooker (nearly 1 million units in 6 months), with 27 different models available for sale. The cheapest models available were all above $100 (USD) and the most expensive cost between $300-600.
- Kettles are also imported in large numbers (just over 400,000 in 6 months), with 33 different models available. These sell for between $10-40.

- Hotplates and rice cookers are the next largest category in terms of imports (167k and 140k, respectively). Hotplates are selling at between $15-70.
- Induction stoves have a very small footprint in Uganda with just over 7,000 imported and only two models available across the selected retailers – costing $49.
- Only 2,300 EPCs were imported in the 6-month period in 2019, showing that these represent a very small fraction of the market for electric cooking devices, despite there being over 20 different models available in the retailers we studied. These vary in price from $25-100.
- The main features highlighted in the promotional text were warranties, energy efficiency, durability, control and capacity.
- The data indicates that there is no one dominant importer of electric cooking devices, with the five companies listed above sharing over 70% of the market. Over half (57%, by value) are imported from China.

Table 1: Import volumes and typical retail prices for selected eCooking appliances in Uganda.

Appliance	**Sales volumes (Jul-Dec 2019 import data)**	**Typical retail price (MECS Appliance Availability Survey – Ugandan online retailers)**
Oven/cooker (elec & elec/gas)	930,469	350,000-2,100,000 UGX (100-600 USD)
Hotplate	167,381	50,000-250,000 UGX (15-70 USD)
Rice Cooker	140,226	n/a
Kettle	404,110	35,000-140,0000 UGX (10-40 USD)
Electric Pressure Cooker (EPC)	2,300	90,000-350,000 UGX (25-100 USD)
Induction/infra-red stoves	7,000	180,000 UGX (49 USD)

Relative cost of eCooking vs. popular cooking fuels:

Grid electricity tariffs:

- **Regular (>15kWh/month): 750 UGX/kWh** (0.17 USD/kWh)
- **Lifeline (<15kWh/month): 250 UGX/kWh** (0.07 USD/kWh)
- **Mini-grid tariffs**:

Private sector avg.: n/a

- Figure 1 suggests that cooking all your food with grid electricity is already the cheapest way to cook in Uganda.
- Research by CREEC (2020) shows that:
  - The EPC can save half the time and 60-90% of the cost on dishes with a long boiling stage. Cooking staple foods such as matooke and beans stew, an EPC uses 3x less energy than other popular cooking devices.
  - For vegetables or dishes that generally take a short time (and involve frying), the EPC uses – more or less – the same amount of energy as the other cooking devices. However, comparing with LPG, cooking with an EPC still costs significantly less.
  - Cooking typical Ugandan dishes in an EPC is 2-4 times cheaper than an electric hotplate, which in turn is cheaper than LPG.
  - Since CREEC's study was carried out, VAT on LPG was removed, which has been widely celebrated and has made the fuel more affordable, however, Figure 1, which uses the new LPG prices, shows that electricity is still cheaper.

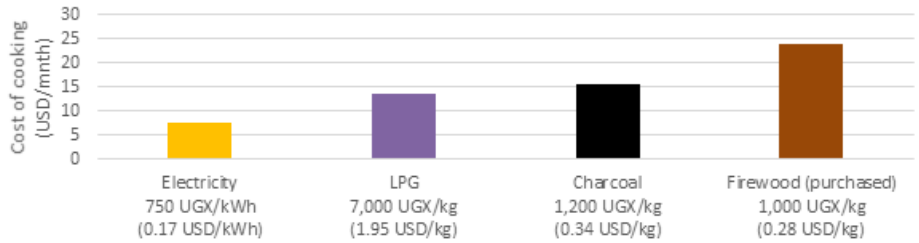


Figure 1: Cost comparison of different cooking fuels based on international averages for cooking energy demand from ESMAP (2020) and local electricity/fuel prices (see Appendix D) .

For further detail, please see *Appendix D: Supply chain & delivery models*.

5 Recommendations for interventions

Table 2: Decision matrix/board highlighting key factors and viability of specific interventions.

		Current status	Recommended interventions
Market segments	**On-grid**	Utility keen to stimulate demand for surplus electricity, but the cost of appliances and electricity are an important barrier.	Support Umeme to develop a cooking with electricity demand stimulation programme, including appliance/service bundling and special tariffs to encourage electric cooking.
	Mini-grid	Incentives for mini-grid developers are lacking, and the sector remains at a nascent stage of development, with a regulatory framework in draft form.	Conduct an electric cooking pilot in rural Uganda, building on MECS pilots in other countries, beginning with food enterprises and expanding to households if/when appropriate
	Off-grid (SHS)	Pesitho piloting SHS eCooking in humanitarian settings.	Support Pesitho to expand SHS piloting outside of the humanitarian space.
TToC dimensions	**Supply chain**	eCooking appliances are expensive to consumers, as they are imported and subject to a range taxes and duties	Support PowerUp (UpEnergy) to reduce appliance costs by accessing carbon finance for eCooking leveraging the new streamlined Gold Standard methodology for eCooking. Develop and deploy an RBF programme for EPCs, similar to the EnDev/CLASP EPC RBF programme in Kenya.
	Consumer demand	Early pilots indicate cultural compatibility of EPCs with local cuisine, but most consumers unaware of this new appliance.	Set up consumer awareness campaigns involving a blend of live cooking demonstrations, TV and social media. For example, MECS featured content on EPCs on Shamba Shape Up in Kenya, which has now expanded into Uganda.
	Enabling environment	There are no specific policy targets for electric cooking, and the policy focus on modern energy remains focused on LPG.	Host regular eCooking policy dialogues with the Ministry of Energy to disseminate research findings and facilitate the development of evidence-based policy for eCooking.

Appendices

Appendix A: Enabling Environment

1.2 Energy Policy

The electricity sector in Uganda is considered one of the most liberalised across sub-Saharan Africa, although a significant degree of centralised authority remains. The sector is regulated by the Electricity Regulatory Authority (ERA), which in turn falls under the Ministry for Energy and Mineral Development (MEMD). Electrification plans are contained within the UEGCL Strategic Plan (2018-2023), the UETCL Grid Development Plan (2018-2040), and the Electricity Connection Policy 2017.

July 2020 saw the release of Uganda's Third National Development Plan (NDPIII), covering the years 2020/21 to 2024/25. The Energy Development Programme of NDPIII seeks to reduce the share of biomass for cooking, increase electricity access and enhance grid reliability. The integration of electrification and clean cooking objectives into a single energy programme is a major step forward for electric cooking in Uganda. Specific aims from the Uganda Draft Energy Policy (MEMD), to be achieved by 2030 (2019 Baseline), are shown in the table below:

Table 1: Uganda Energy Policy Targets

	Indicator	Baseline (2019)	Target (2030)
1	Households with at least one source of clean and modern energy on- and off-grid	50%	100%
2	Rate of grid electricity access	28%	65%
3	Electricity consumption (kWh per capita)	100	1500
4	Population using clean cooking fuels and technologies	<10%	40%
5	Districts involved in decentralization of energy services	17	90%
6	Energy consumption from renewable energy sources	>80%	>95%
7	Integrated Resource Plans developed	0	2

Both the NDPIII and the 2019 draft National Energy Policy (NEP) provide further details about the planned cooking transition in Uganda. The NEP, drafted by the MEMD, makes specific mention of EPCs as a new efficient technology that should be promoted alongside LPG, biogas, and solar cookers.

A clear difference between the NEP (2019) and NDPIII (2020) is a shift away from the promotion of improved biomass cookstoves (ICS). While this does not necessarily signal a shift in thinking, given the two documents are produced by different institutions operating within the fragmented Ugandan energy space, it is important to recognise a mutual commitment to modern energy for cooking, including electricity and LPG. However, in comparison to LPG, electric cooking solutions do not yet receive the same degree of emphasis in these policy documents.

Clean cooking initiatives in Uganda also arise in the context of policies designed to reduce gender inequality. A recently published Gender and Energy Country Brief for Uganda, produced by the AfDB and Energia (2020), notes the potential for clean cooking initiatives to provide a set of gender-responsive actions for the energy sector. Wood fuel collection in urban areas is predominantly carried out by women, while the supply of energy-efficient technologies is itself an initiative that will advantage women. Subsequent initiatives in partnership with the MEMD have focused on increasing women's access to energy-efficient stoves, clean energy more broadly, and finance.

1.3 Energy Governance

Strizke et al (2021) provides an extensive analysis of Uganda's energy governance practices and frameworks. Positive aspects include the independence and transparency of the ERA, as well as recent upgrades to regulatory frameworks (e.g. 2019 draft Uganda Mini-Grid Regulations, 2019 draft Uganda National Energy Policy), which enhance transparency and confidence among potential private investment into the sector. However, despite the electricity sector being relatively liberalised, a centralised decision-making process means that the Ministry and Regulatory Authority maintain greater control over the direction of electrification strategies compared to communities and local authorities. They also note inconsistencies in the allocation of electricity generation licenses, legal disputes over "grid encroachments" that affect the off-grid sector, and an impractical rural electrification master plan.

It is also important to recognise that a clean cooking transition is not just dependent on creating an enabling environment for electric cooking; transition is also related to the long-term viability of the biomass sector. A political economy perspective, when applied to Uganda's charcoal industry, reveals that there is significant military, state and business elite involvement in charcoal production, creating a disincentive for top-down strategies for widespread clean fuel adoption. The charcoal industry is made up of both small-scale household production as well as extractive industrial production, and the geographical reach of charcoal traders has expanded significantly across much of Uganda. For instance, the end of civil war in Northern Uganda in 2006 led to the return of households to an area that had become overgrown by trees, creating a useful and profitable supply of wood and charcoal to urban areas in the region. Since South Sudanese independence in 2011, this supply has also served the Kampala charcoal market, as export trucks returning from South Sudan to Kampala have stocked up on charcoal from the North (ibid.). These deeply embedded charcoal supply chains have political and economic logics that may present a barrier to the realisation of the full potential of electric cooking in Uganda.

However, a number of districts across the country have banned charcoal production (e.g., West Nile, Karamoja and Acholi), and it has been reported that the enforcement of these by-laws in certain cases has reduced commercial charcoal production. Deforestation is most severe on privately-owned land in Uganda, which is said to have the second highest rate of deforestation globally: natural forest cover fell from 24% in 1990 to 12% in 2015 (Ministry of Water and Environment, 2017). 654kg of wood, equivalent to 15 five-year trees, is needed annually and per person to meet existing levels of biomass consumption. While charcoal is cheaper in Uganda than in some neighbouring countries, its price is said to have increased by 30% since 2017 (Haysom et al, 2021).

1.4 Macroeconomic Context

Uganda is generally seen as a favourable environment for foreign direct investment (DFI), and the Uganda shilling (UGX) has proved stable against the US dollar. According to the World Bank (2021), the major challenges to 'doing business' in Uganda relate to starting a business and access to electricity. With regards to electricity access, the World Bank also note improvements in the "monitoring and regulation of power outages" and a reduction in "delays for new electricity connections", pre-pandemic.

Uganda has long been touted as an economic success story in East Africa, following high and prolonged economic growth rates, poverty reductions, and increased energy access. However, there is evidence that economic gains have been more modest in recent years, and poverty has risen between 2013-17 explained in part by limited industrialisation and rapid population growth. 75% of the workforce work are in the informal economy (Balloon Ventures, 2018), which limits government revenue and the prospects of public sector-led development. External debt repayments have jumped from 2.5% of government revenue (2007-17 average) to an average of 12% between 2018 and 2020 (Jubilee Debt Campaign, 2020). Today, Uganda remains an agriculture-based economy, with the majority of the population living in rural areas. The Ugandan government has renewed its efforts to bring about structural transformation, as evidenced in the National Industrial Policy (2020), which includes a focus on environmentally sustainable industrialisation and technologies.

Appendix B: Consumer Demand

Local Cuisine

Ugandan cuisine is largely plant-based, with most meals consisting of a) *emere* - a staple food such as maize or millet porridge (posho), rice, potatoes, cassava or matoke, and b) *eriani* - dishes (or relishes) often made with onion, tomato, and groundnut flour, combined with green vegetables or beans (CREEC, 2020). Meat and fish are popular but often too expensive to be cooked and eaten regularly.

Matooke is synonymous with Ugandan food culture especially in the central and western regions; matooke is a banana variety that is steamed and mashed. The choice of staple food appears to vary according to seasonal variations that affect the relative affordability and availability of matooke, posho and others. For instance, households increase their consumption of posho when matooke is too expensive. However, the end of school holidays push up the price of posho, which can lead to a reduction in the number of meals consumed per day (ibid.). On average, households in Kampala consume 2.4 meals per day, which includes 4 hours of preparation time (ibid.).

Based on research carried out for MECS, CREEC have reported a number of important regional differences in food consumption and cooking habits:

> "Cooking practices and types of foods regularly consumed vary from one region to another depending on factors like climate and land cover as well as by ecological zone and ethnic group. Households in Central and Western Uganda heavily rely on matooke and sweet potatoes as their staple food. In the Northern parts of the country, the primary food crops include ground cassava millet, sorghum, and simsim (sesame). A wide variety of dry beans are produced predominantly in the Western and Northern regions. Beans are cooked and served as a compliment ("sauce") to other staples.
>
> The other notable change is the emergence of new foods like 'Rolex' and 'tv chicken', or a mix of traditional foods with new ways of food preparation such as 'fried cassava'. Rolex is a rolled chapatti filled with egg omelette and vegetables such as cabbage while TV chicken is chicken roasted in a make-shift rotisserie oven that to the locals, resembles a television and served with salad and fries. These new trends include an element of convenience, time and cost-saving as well as the emergence of new tastes and food styles."

Lower-income households are often under pressure to reduce the use of already expensive cooking fuel. It is common for slow-cooked foods to be substituted for quick-cook foods (e.g., porridge made of cassava rather than maize), or for slow simmering techniques to be replaced by a shorter boil (e.g. for matooke) (CREEC, 2020). Mukwaya (2016) has also shown that some households deploy the dangerous technique of adding paracetamol to beans, which is said to speed up the cooking time and save on cooking fuel expenses. A large survey in rural

areas of Uganda show a common preference for cooking devices that minimise smoke, heat food rapidly, and can cook large quantities (Nsamba et al, 2021).

Fuel Preferences and Costs

Charcoal is cheaper in Uganda in comparison to other countries in the region. However, recent reporting suggests that the standard 50kg sack of charcoal has increased from 20,000 to 30,000 shillings (5 to 7 EUR) in Kabale district (western region, 400 km from Kampala), and those sacks can sell for between 50,000 and 70,000 shillings (12 to 17 EUR) in Kampala and Masaka, a market and commercial hub for surrounding coffee-growing areas, located southwest of Kampala (The Independent, 2021). Firewood for household consumption is estimated to be 1000 shillings/kg (national average) and ranging from 2000 shillings/kg in Kampala down to 300 shillings/kg in the Northern Region. Briquettes are said to cost 700 shillings/kg across the different regions of Uganda (ibid.).

LPG is relatively expensive compared to neighbouring countries, but the removal of VAT on LPG in 2020 has been widely celebrated and has made the fuel more affordable. The refill price of a 12kg cylinder costs approximately 83,500 UGX, down from a cost of between 110,000 and 130,000 UGX. This compares to a cost of 72,000 UGX in Kenya, 42,000 UGX in Tanzania, and 52,000 UGX in Rwanda (New Vision, 2020).

In urban areas in particular, households are acutely aware of the problems that come with an over-reliance on charcoal, but the perception that electricity is too expensive is also deeply entrenched. Since the government removed subsidies on electricity in 2012, the cost of electricity per unit has been on the rise. Consumers currently pay 750 UGX per unit (£0.15 or $0.17/kWh. Although, households enjoy a lower rate (lifeline tariffs), the scheme only applies to the first 15 units/month, one of the lowest lifeline thresholds in the region (In Kenya the lifeline tariff threshold is at 100 kWh/month, in Ethiopia 50 kWh/month and in Tanzania 75 kWh/month). However, energy-efficient appliances already available in the market can help overcome this specific barrier. Research by CREEC (2020) shows that cooking typical Ugandan dishes in an EPC is 2-4 times cheaper than cooking on an electric hotplate, which in turn is cheaper than cooking using an LPG stove.

There is also the widespread view that electricity is unreliable, and many seem concerned by the prospect of relying on electricity for daily activities such as cooking. Significant power shortages in the 2000s have had a pronounced and prolonged impact on public confidence and way of life, and this is still felt today in spite of significant improvements in reliability and access. Survey-based research in 2019 suggests that confidence in the reliability of electricity has been increasing over the last decade, with far more households satisfied with their provision (58%) than those that are dissatisfied (40%) (Kakumba, 2021).

Cooking Devices

Flat-bottomed pots and pans of various sizes, which can be used on biomass stoves, LPG stoves, and some low-efficiency electrical appliances are commonplace in Uganda (Diehl et al, 2018). CREEC research confirms that fuel stacking is widely practiced in Kampala. It is common for LPG and electricity to act as secondary fuels to charcoal, and the relative advantages and disadvantages of these fuels can be generalised in the following way:

- LPG is often the preferred cooking fuel, but its high costs limits usage
- Charcoal is convenient and cheap, but not otherwise desirable
- Electricity is clean but expensive and not always reliable.

Ongoing research by CREEC/MECS reveals that households involved in pilot research projects sustain their use of electric pressure cookers over time, owing to the fact that the high efficiency of the appliances allows households to cook with electricity and still remain within their budgets for energy consumption. Anecdotal evidence from this research also reveals that cooking with an EPC saves time and provides much-needed convenience to Ugandan cooks, and particularly mothers. Participants note an interest among friends and colleagues in EPCs, and the participants themselves have significantly reduced their charcoal use, which tends to be needed for specific dishes (e.g., smoked meat) or when visitors are being catered for. EPCs appear to be an excellent fit for Ugandan cuisine as they can make cooking easier, given their efficiency with boiling and ability to fry food when required. Drawbacks of an EPC include relatively small pot sizes, high up-front costs, and difficulties cooking flatbreads.

The feedback from participating households has highlighted that the various inconveniences associated with charcoal (smoke, dirt, lighting, etc.) act as constraints to when and how households cook, clearly showing that households find the idea of 'cooking whenever and from wherever' a key advantage of electricity. In contrast to using EPCs, individuals have expressed concern about the danger of cooking with LPG and the risk of children crawling toward and touching hot charcoal.

Market Segmentation

Rhamz International (2020) noted that the adoption of clean fuels for cooking is a very recent phenomenon, as many households and institutions have historically had little choice beyond using charcoal and/or firewood. However, their research involving 237 institutions and 552 households across Uganda suggests that both electricity and LPG have been adopted by institutions so effectively that the percentage using these fuels (69% and 62% respectively) has now surpassed the proportion using charcoal (61%). It appears as though the affordability of the fuels is the main factor in explaining uptake among institutions. Their research also suggests that 47.2% of institutional users of electricity for cooking were satisfied with the fuel, which ranks electricity third behind biogas (100%) and LPG (58.5%). Fuel satisfaction for charcoal and firewood institutional users was lower, at 24.4% and 33.3% respectively.

Due to prohibitive costs, a lack of awareness and potentially limited supply, the rate of uptake has been much more modest among households. Within their sample of urban households, 16.6% use electricity and 13.5% use LPG for at least some of their cooking needs, but the vast majority of these households rely on charcoal and firewood as their primary fuels.

Due to weak supply chains and limited appliance availability, it can be expected that the uptake of electric cooking will be concentrated in urban, on-grid areas, as opposed to rural, off-grid or mini-grid areas. High tariffs and high appliance costs mean that it is largely affluent households that have benefited from electric cooking to date. It is also this market segment that are more likely to have more reliable electricity supplies. LPG also involves significant costs, in terms of the stoves themselves, refills, and the cost of cooking per meal. It may be expected, therefore, that the relative use of electricity and LPG as non-primary cooking fuels may be driven by the quality of electricity supply. It is also expected that the use of charcoal and firewood as primary cooking fuels will continue in the short- and medium-term, as long as biomass options remain a relatively affordable and accessible cooking fuel option, and no additional efforts are made to lower the cost of modern energy alternatives. The removal of VAT for LPG is expected to encourage uptake among a greater segment of the population, and a reduction in electricity tariffs could have a significant effect for the use of electric cooking appliances.

Appendix C: Supply chain & delivery models

Clean Cooking Initiatives

Ongoing MECS research suggests that the clean cooking agenda in Uganda today has shifted towards electric cooking, as evidenced by the five-year **Charcoal to Power** initiative that began implementation in July 2021 with the aim of transitioning 500 institutions (and eventually 50,000 households) to electric cooking. Led by the MEMD, this initiative hopes to encourage the uptake of electricity for cooking, but also includes a wide range of cooking fuels including LPG, biofuels, and sustainable charcoal. On social mediav, the ERA explained that only 30% of the cost of electric cooking appliances would be paid by the target population. ERA is already working with UNDP Uganda to transition part of Mulago Hospital from biomass to electric cooking.

Umeme is Uganda's primary electric utility and has proactively sought to promote electric cooking in order to boost household consumption and enable more affordable electricity tariffs in the future. Umeme has developed plans in conjunction with the MECS Programme to pilot electric pressure cookers (EPCs) in Kampala, and has also partnered with asset financing company EnerGrow, working on consumer finance schemes for electric appliances. Umeme has also played a pivotal role in accelerating rural electrification in Uganda, working in partnership with REA to connect 142,000 new customers through a subsidisation programme (Electricity Connections Policy), funded by the government, World Bank and other international organisations (Twesigye, 2019).

Kenya-based **BURN Manufacturing** has a range of improved cookstoves that it sells through Ugandan distributors. At an early stage, BURN recognised the need for an energy-efficient electric cooking solution and developed the ECOA, an EPC customised for Kenyan cuisine. BURN is an awardee of the MECS programme's Electric Cooking Outreach (ECO) Challenge Fund, and have engaged 200 households in Uganda in a cooking diaries study and a sales testing pilot. This pilot is operating through two distribution centres, in Nyenje and Kampala. BURN is partnering with EnerGrow and Umeme in order to, respectively, develop consumer financing solutions and understand the implications of electric cooking on household energy consumption.

UpEnergy, based in Kampala, has also re-orientated its operations towards electric cooking, and through a period of EPC product testing have developed a customised product for the Ugandan market. In partnership with Power Up, a product development company hosted by UpEnergy, a pilot study is due to commence in October 2021, involving 500-600 units. Plans are in place for the initiative to expand to induction stoves in year two. The initiative is also hoping to develop a carbon asset specifically for electric pressure cookers, that can lower the inventory costs to retailers and suppliers in Uganda and potentially in neighbouring countries.

In 2019/20 the MECS programme funded a project in Bidibidi refugee settlement in Northern Uganda. Danish company **Pesitho ApS** monitored the emissions and wellbeing impact of their solar powered electric cookstove (ECOCA), 50 units of which had been deployed in the local community. Since the end of the project, Pesitho ApS have continued their operations with refugee communities in rural Uganda, building a solar-powered community kitchen and establishing a local cooperative for the sales and assemblage of their cooking devices. Additional funding from the Humanitarian Innovation Fund and Elrha is allowing the company to expand its activities relating to pay-as-you-cook systems, carbon credit schemes and expand the geographical reach of the enterprise.

These initiatives show that an extensive uptake of electric cooking in Uganda will most likely rely on imported products, and programmable devices such as EPCs can be customised for the local market.

Appliance Availability

MECS activities in Uganda have included a small-scale appliance availability survey, conducted across 9 different online retailers, and analysis of 2019 import data on electric cooking devices. The key findings are as follows:

- The category imported in greatest number is the oven/cooker (nearly 1 million units in 6 months), with 27 different models available for sale. The cheapest models available were all above $100 (USD) and the most expensive cost between $300-600.
- Kettles are also imported in large numbers (just over 400,000 in 6 months), with 33 different models available. These sell for between $10-40.
- Hotplates and rice cookers are the next largest category in terms of imports (167k and 140k, respectively). Hotplates are selling at between $15-70.
- Induction stoves have a very small footprint in Uganda with just over 7,000 imported and only two models available across the selected retailers – costing $49.
- It appears that only 2,300 Electric Pressure Cookers were imported in the 6-month period in 2019, showing that these represent a very small fraction of the market for electric cooking devices, despite there being over 20 different models available in the retailers we studied. These vary in price from $25-100.
- The main features highlighted in the promotional text were warranties, energy efficiency, durability, control and capacity.
- The data indicates that there is no one dominant importer of electric cooking devices, with five companies (BAMUKUNGU ENTERPRISES LIMITED, ANISUMA TRADERS LIMITED, APPLIANCE WORLD LIMITED, TRANSLINK (U) LTD, Mr. RONALD MUSEKURA) sharing over 70% of the market. Over half (57%, by value) are imported from China.

Regional Integration

Regional integration of the East African Community (EAC - Uganda, Tanzania, Kenya, Rwanda, Burundi, South Sudan) has been increasing steadily. Other EAC countries account for 40% of Ugandan exports in 2018, rising from 10% in 2005 (Manwaring, 2021). As stated above, regional cooperation makes unilateral trade policy decisions impossible without going through the official exemptions process. However, electric cooking is gaining traction in much of the region, particularly Kenya and Tanzania. This suggests that a common trade policy relating to the importation of electric cooking appliances may be viable in the future.

A key feature of the EAC's Custom Union is the Common External Tariff (CET), which is designed to promote free trade within the community. The CET has three tariff points: 0% on capital goods; 10% on intermediary goods; and 25% on final goods. Regarding imports of small domestic appliances within the categories HS851650 (microwaves) and HS51660 (other ovens, cookers, cooking plates, etc), the middle rate of 10% is applied in all EAC countries. The tiered system is designed to minimise the cost of industry inputs for Uganda-based firms, and protect domestic products from global competition. Small domestic appliances are also subject to 18% VAT, 6% Withholding Tax, and a 1.5% Infrastructure Levy.

As with most customs unions, exemption schemes exist for EAC countries to apply unilateral deviations from the CET rates. Research has shown that Uganda (as well as Tanzania and Kenya) tend to seek rate increases for additional external protection, and particularly in the last few years. While the presence of the CET makes tariff reductions for electrical appliances difficult to implement in East Africa, exemption schemes offer a possible way forward.

Electricity Generation

As Uganda continues along a path of rapid electrification, installed capacity is set to increase substantially from a variety of sources. The Karuma (600MW) and Achwa (49MW) dams are expected to take total capacity to over 2000 MW this year. Uganda's Vision 2040 outlines a plan for a substantial investment in nuclear power, totalling 24,000 MW, more than ten times the capacity expected at the end of the year. In May 2021, it was announced that the country's first nuclear plants will be built in Buyende and Nakasongola districts, adding 2,000 MW to Uganda's power generation.

Vision 2040 shows that investments in nuclear, thermal, geothermal, solar, and hydropower aim to industrialise the Ugandan economy and ensure the population's rapidly increasing demand for electricity will continue to be met. The east and north east of Uganda have the highest potential for solar generation, given the regions' high irradiation levels. Uganda's oil reserves are yet to be utilised, but extraction is planned by 2025, creating the potential for domestic LPG production and increased electricity generation. However, a great deal of uncertainty remains given previous challenges and a changing financial environment, as global finance tends towards clean and renewable energy.

eWaste Regulations

Uganda is currently developing an eWaste management policy, and eWaste guidelines were issues in 2016. In June 2021, Uganda's first National e-Waste Management Centre was established to tackle the country's increasing e-Waste problem, which is projected to reach 4500 tonnes per year in 2022. Waste and e-Waste management regulations derive from the Ministry of Information and Communications Technology and the National Environment Management Authority (NEMA).

Appendix D: Impact of Scaled Uptake

This section explores the likely costs and benefits for one simple illustrative scenario of scale-up of eCooking in selected key segments.

The World Health Organisation (WHO) revised "Benefits of Action to Reduce Household Air Pollution" (BAR-HAP) tool[2] has been applied to quantify the expected financial costs, health and environmental benefits of the scale-up.

The scenario modelled is chosen to reflect the MECS programme's suggested "40, 60, by 2030" goals: a target of 40% for all households connected to grid or off-grid electricity in Low and Middle Income Countries to be using it for cooking by 2030, and a target of 60% of households utilising modern energy for cooking to be utilising energy generated from low carbon sources by 2030 (low carbon interpreted here to include electricity coming from relatively low carbon fuel mix, and excluding fossil-derived LPG). For this illustrative analysis of costs and benefits, the focus is just on the existing 4.3m grid connected households (19.5m people) that are using charcoal for cooking, and not already using any form of MECS. Whilst more households are expected to connect to this existing grid by 2030[3], and grid expansion can be expected, the current scenario is kept to the existing households whose fuel use is known. Reflecting the MECS 40% goal, the scenario assumes 40% of households transition to eCook (so 1.7m) by 2030; BAR-HAP models this with a ramp-up of transitioning households over the first 5 years to 2025 and then a further 5 years operation. Details are in the first part of the table below.

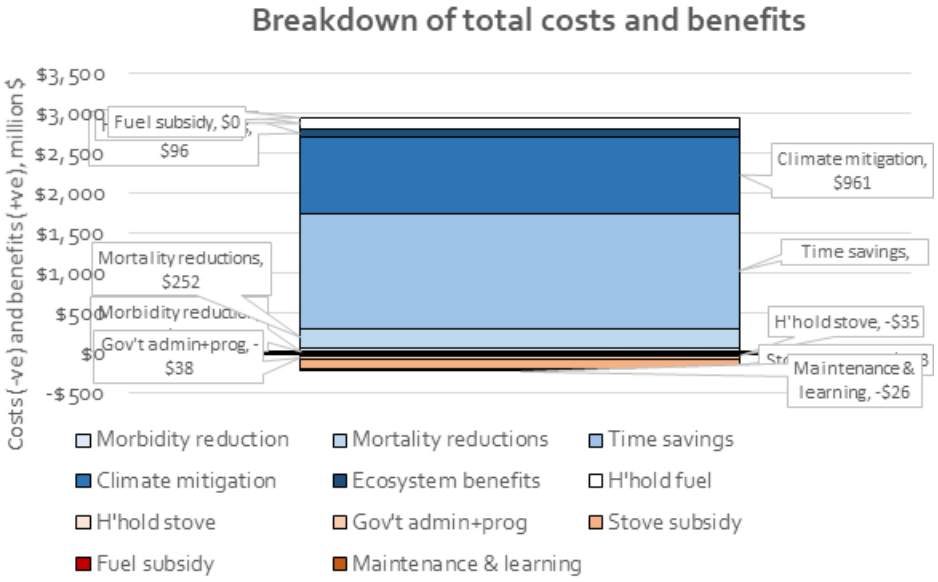
BAR-HAP has been implemented here using its policy option of a ban on charcoal use, which comes in gradually from 2020 to 2030. However the assumption is that transitioning households are fuel stacking, with 20% of cooking still delivered using charcoal. The full costs of the new MECS devices have been assumed

to be paid for by the Government, as a convenient simplification for this illustration. Other policy options that could have been modelled would see a different distribution of stove and fuel costs and savings between parties. eCook devices are assumed to cost $80 and to have an average efficiency of 75% (MJ input to MJ useful heat output). eCooking is assumed to save 30% of the typical 4 hours cooking per day. Uganda's grid electricity generation mix comprises 82% hydro, 6% oil and 12% other renewables.

The lower part of the table shows the outputs of BAR-HAP for the modelled scenario. The chart shows the structure of costs and benefits.

Grid connections projections and eCook target		Population	households	% grid connected			
National population, 2020		45,500,000	10,034,542				
Grid connections, 2020		19,500,000	4,300,518	43%			
Scenario modelled		Population	households	% of grid connected			
MECS "40%" target for eCooking by those connected		7,800,000	1,720,207	40%			
Other MECS		0	0	0%			
Not transitioning (the remainder)		11,700,000	2,580,311	60%			
Costing (costs are -ve, benefits are +ve)				$/yr	$/yr per household transitioning	$M total	$total per household
Total present value (ie net social benefits of the transition)				271,521,603	155	2,715	1547
Total costs of transition, government+private				-8,620,846	-5	-86	-49
Private cost to housholds: total				7,481,904	4	75	43
Stove				-3,526,516	-2	-35	-20
Fuel				13,574,386	8	136	77
Maintenance				-2,565,966	-1	-26	-15
Costs to government: total				-16,102,749	-9	-161	-92
Stove				-12,342,806	-7	-123	-70
Fuel				0	0		
Admin+Programme				-3,759,943	-2	-38	-21
Health, Time, and Environmental Benefits: total		Physical: change/yr	Physical: % of national cooking total	280,142,448	160	2,801	1596
Health impacts total: DALYs avoided	DALYs	6,115		30,912,351	18	309	176
Mortality reduction	*YLL*	*3,394*	0.4%	*25,218,759*	14	*252*	144
Mortality reduction	*Lives*	*287*	1.2%				
Morbidity reduction	*YLD*	*2,721*	2.3%	*5,693,592*	3	*57*	32
Morbidity reduction	*Cases*	*13,370*	2.1%				
Time savings	Hours	1,041,207,489	10.8%	143,539,069	82	1,435	818
Time savings per adopting household	*Hours/HH*	*593*					
Electricity use	*MWh*	892,000					
CO2-eq reduction (CO2,CH4,N2O)	Tonnes	9,396,228	25.9%	96,123,519	55	961	548
Unsustainable wood harvest reduction	Tonnes	1,723,666	11.8%	9,567,510	5	96	55
Note: costs are discounted across programme period.							
Totals are Net Present values; costs/year are NPV divided by the ten years of the programme							

The table shows that while this transition would cost government some $90 per household for equipment and programme costs, it would save households $77 in reduced energy bills. Overall the transition would have a small net cost for the direct financial costs faced by private and public sectors together. However, the economic valuations of health and environmental benefits are much larger. More than 280 lives would be saved per year; some 11% of current unsustainable wood harvesting would be avoided and greenhouse gas emissions from the national cooking sector would be reduced by more than 25%. The overall social benefit-cost is strongly positive.



The chart summaries the various physical and financial impacts of the transition in monetary terms. Uganda's electricity mix is currently >90% renewable and hence the greenhouse gas emission benefits of switch from charcoal to electricity are large. However the social benefits from avoided time spent cooking are even larger, reflecting mainly time savings using an EPC, and the opportunity cost for peoples' time, as used in BAR-HAP. The reduced fuel costs to households shows a small positive benefit, resulting from use of more efficient stoves, despite a perception in Uganda that the $0.17/kWh electricity tariff makes electricity too expensive for cooking. The largest element of cost is for the purchase of modern stoves by government; households are assumed to benefit further by avoiding the need to pay for their traditional charcoal stoves.

This is an impact analysis for one simple scenario for just one particular segment (grid connected charcoal users) of Uganda's population. However it demonstrates very significant net benefits that could be achieved, based on the WHO's physical impact and impact monetisation methodologies.