TANZANIA

eCooking Market Assessment

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TANZANIA ECOOKING MARKET ASSESSMENT

This study is a publication from the **Modern Energy Cooking Services (MECS) Programme**, and aligns with a 2021 series of publications developed in collaboration with **GIZ/EnDev**. The market assessments offer strategic insight on the current state of electricity access and clean cooking in nine countries across sub-Saharan Africa and South Asia. This document was not made in partnership with **EnDev**, however we acknowledge their influence on the design and methodology.

This study identifies the key opportunities and challenges to the scale up of electric cooking in the coming decade and concludes with a series of recommendations for targeted interventions that could support the development of the eCooking sector.

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.**

Cover photo: Mary Swai, SESCOM, 2021

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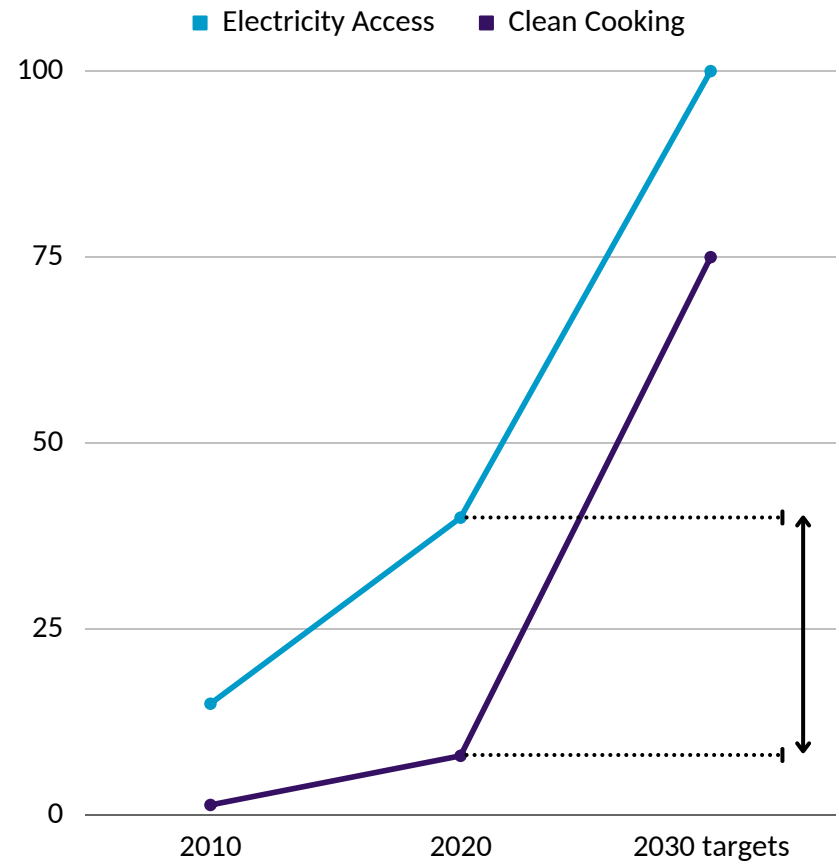
EXECUTIVE SUMMARY

Tanzania has recently made enormous progress on electrification with coverage more than doubling between 2010 and 2020 from 15% to 40% (*World Bank, 2022a*). The government has ambitious plans for electricity access expansion and increased generation capacity, aiming for nearly 6000MW of increased generation by 2026, 65% of which will be from renewable sources (*Ministry of Finance and Planning, 2021*). However, to cook, most of the population still rely on polluting fuels such as firewood and charcoal (approx. 90%). Only 3% of Tanzanians use electricity as their primary cooking fuel (*NBS & REA 2020*). Research on eCooking in Tanzania started in 2018 and feasibility studies show it is cost-effective to cook with electricity compared to other paid-for fuels, compatible to the cuisine, and desirable and convenient for end users. There is a large untapped potential for electric cooking, particularly for key market segments such as urban charcoal users, who are connected to electricity but who do not cook with it, and eCooking will become an increasingly important strategy to stimulate electricity demand as electricity surplus grows.

Since showing feasibility, numerous pilots and activities in Tanzania have focused on strengthening the market system, exploring delivery models, and establishing after-sales support services. The government of Tanzania and the private sector express interest in pursuing eCooking, particularly as neighbouring countries Uganda and Kenya pick up the pace of the transition with National eCooking Strategies under development.

ELECTRICITY ACCESS & CLEAN COOKING ACCESS



32%

now connected to electricity, but primarily cooking with polluting fuels

2030 cooking target (The United Republic of Tanzania Ministry of Energy and Minerals, 2015b) & electricity target (Ministry of Finance and Planning, 2021), 2010 and 2020 electricity data (World Bank, 2022a), 2020 clean cooking data (NBS TZ) and REA, 2020)

ECOOKING GLOBAL MARKET ASSESSMENT VIABILITY SCORE

The MECS 2021 eCooking Global Market Assessment (GMA) draws on the experience of a range of stakeholders to identify the key factors which influence the viability of a scale up of electric cooking and represents this as a weighted score constructed from 37 indicators covering 130 countries in the Global South (*Coley et al., 2021*). As electric cooking relies on a supply of electricity which is provided in a variety of different ways, the GMA provides a score for **national grid, mini-grid and off-grid** (standalone) supported electric cooking as well as a combined overall score indicating the viability of a scale up of electric cooking.

Overall: **37th / 130**

On-grid eCooking: **0.42 – 104th/130**

Mini-grid eCooking: **0.47 – 23rd/130**

Off-grid eCooking: **0.47 – 23rd/130**

Tanzania's score is reflective of its strong mini-grid and off-grid infrastructure, although it is restricted by having low rates of access to electricity. It also has a high proportion of people using commercialized polluting fuels and biomass fuels, demonstrating a need to scale up its transition towards electric cooking as well as an ability to pay for modern fuels. *However, since 2020, regulatory tariff directives, not reflected in this analysis, have affected the stability of the mini-grid and off-grid sector.*

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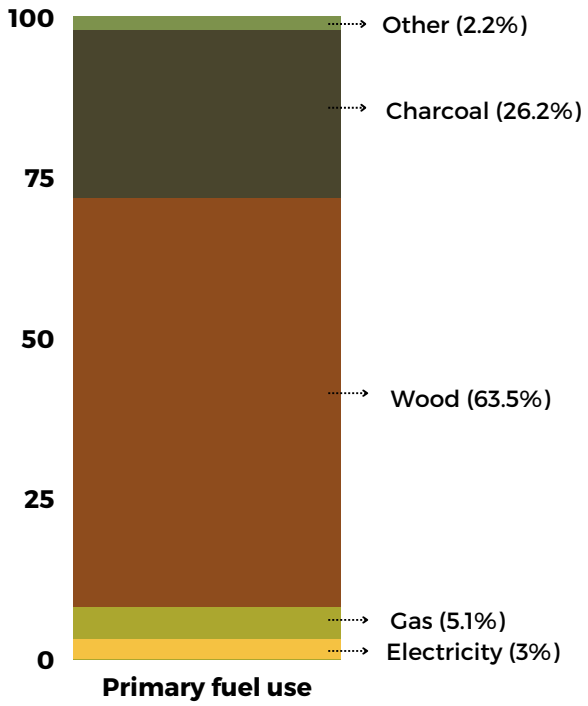
COOKING ENERGY: PRIMARY FUEL USE

3% cook primarily with electricity



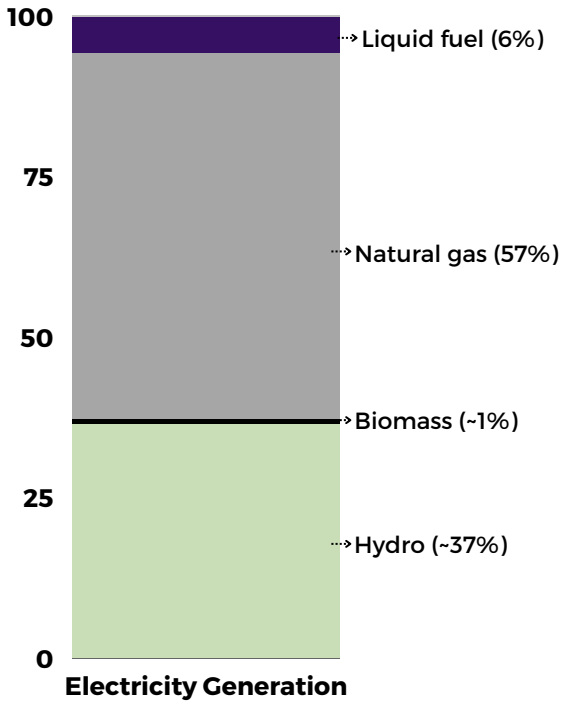
26% cook primarily with **commercialized** polluting fuels (charcoal)

90% cook primarily with polluting fuels

Sources: NBS [Tanzania], REA 2020

ELECTRICITY GENERATION: ON-GRID

37% renewable



30% **surplus** power generation

High reliability **89%** power availability

Sources: Ministry of Energy (2020), Coley et al. (2021)

OFF-GRID

Well-developed mini-grid & off-grid sectors (2020):
nearly **1 million** mini-grid customers, **94** mini-grid developers,
6.4m off-grid lighting/appliance customers

KEY OPPORTUNITIES FOR SCALING ECOOKING

- Access to electricity has more than doubled since 2010 (15% to 40% in 2020, *World Bank, 2022a*)
- EPCs are highly compatible with popular long-cooking dishes such as beans and makande
- Plans to significantly increase electricity generation capacity and a large proportion of this will be renewable energy generation
- Cooking with an EPC is affordable and cost effective compared to LPG, charcoal, and paid firewood, even on minigrids (Inston and Scott, 2022)
- Minister of Energy (Hon. January Makamba), appointed Sept 2021, prioritises clean cooking (Edward, 2022)
- Strong political will to regulate and decrease charcoal production and use
- Solid track-record in government encouraging investment in solar-home system and mini-grid sectors through 2000s and 2010s
- Instability in mini-grid industry caused by low tariff directives in 2020 looks to be reversed in 2022

KEY CHALLENGES FOR SCALING ECOOKING

- LPG perceived as the preferred 'transitional' clean cooking fuel by government and policy-makers, whereas there are key market segments who would benefit from switching straight to eCook.
- Lack of awareness throughout market actors, end users, and decision-makers, about affordability and viability of cooking with EPCs
- Policy therefore focuses more on LPG for cooking futures, missing the opportunity to leverage electricity access gains and investment for clean cooking
- Electricity commonly perceived as 'too expensive for cooking', even though clean fuel stacks (LPG & EPC) often the most cost-effective solution
- No specific electric cooking strategy in policy

POTENTIAL IMPACTS OF SCALED UPTAKE IN MOST VIABLE MARKET SEGMENTS

If 40% of Tanzania's urban, grid-connected charcoal users (6 million people, 1.2 million households) switched to eCooking, the WHO's BAR-HAP tool suggests that:

$220 M/YR NET SOCIAL BENEFIT

2,691 DALYS/YR avoided

1.3 M TONNES/YR CO2 EQ emissions reduced

0.12 M TONNES/YR reduction in unsustainable wood harvest

429 M HRS/YR of women's time saved (344hrs/HH/yr)

530 GWH/YR demand for electricity stimulated

10 MONTHS PAYBACK for eCooking appliances ($80/HH upfront cost, $100/HH/yr savings on fuel energy costs)

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

Photo: SESCOM, 2021

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1. INTRODUCTION

CLEAN COOKING & ELECTRICITY ACCESS IN TANZANIA

Tanzania is a country of 61.5m people, with approximately 22m in urban areas and 39m in rural areas (*World Bank*, *2022b*). The country has made significant strides in increasing electricity access over the last decade, progressing from 15% to 40% in the last ten years, although large disparities exist between urban (73% access) and rural areas (22% access) (*World Bank*, *2022a*).

The government has ambitious energy access targets: the national grid is undergoing rapid expansion and the government aims to increase generation capacity by 5760MW by 2026 from current levels of 1602MW (*Ministry of Finance and Planning*, *2021*). Highest system demand in 2019 was 1120MW (*Ministry of Energy*, *2020*). Julius Nyerere Hydropower Station, scheduled to come online in 2022 and anticipated to add 2000MW of this target, will create a sizeable surplus. The country has ample largely untapped renewable energy sources (geothermal, wind and solar) and large fossil fuel reserves (black coal and gas) available to bolster national grid power generation.

Beyond the national grid, Tanzania has well-developed solar home system (SHS) and mini-grid markets. Tanzania was considered a regional leader in the mini-grid sector, illustrated by an historically adaptive and responsive policy approach that created favourable market conditions and encouraged developers to invest in mini-grids (*Odarno et al.*, *2017*). However, the mini-grid industry suffered a regulatory setback with a tariff directive in 2020 which limited mini-grid tariffs to match those of the national grid, and further uncertainty arose regarding the sector's role in the government's rural electrification strategy and its focus on national grid expansion (*The Mini-Grids Partnership*, *2020*). There is potential for the industry to stabilise again at least from a regulatory perspective in 2022, with recent ministerial announcements that more cost-reflective tariffs are to be allowed again (*Dar24*, *2022*).

The gains in electricity access have not been replicated in the clean cooking sector: new opportunities for eCooking and LPG have emerged over the last few years, yet adoption has been limited. LPG has had low uptake (only around 5.1% of population use it as a primary cooking fuel (*NBS and REA*, *2020*) despite government efforts to promote it, targeted tax and import exemptions and noteworthy private sector investment (e.g. KopaGas). Talks to exploit LNG reserves in South Tanzania have frequently stalled, though in 2022 they resumed and agreements are progressing, with the government aiming to implement this large investment project which will see extraction for export and domestic use (Al Jazeera, 2022). However, uncertainty remains on timelines, size of investment, infrastructure built,

and the balance of export and domestic use of the outputs. Regarding cooking with electricity, the supply chain is under-developed, there is widespread misconception about the expense of eCooking, and only 3% of the population use it as their primary cooking fuel (*NBS and REA, 2020*).

Investment in the cooking sector has historically been directed towards the promotion of improved cookstoves using solid biomass energy sources (firewood and charcoal). Despite these efforts, the majority of the population cook (90%) inefficiently using solid biomass as an energy source (NBS and REA, 2020). This has led to pressure on forests and reducing and regulating demand for charcoal is a high priority for the government, as is tackling deforestation which is a major national issue. The National Charcoal Strategy, due in 2022, seeks to address these issues and will outline alternatives, including eCooking.

The strategy of promoting electric cooking fits well with Tanzania's current status, future plans, and development priorities. It is one means of stimulating demand and generating revenue for the government and national utility in order to avoid falling into an uneconomical electricity surplus, as well as tackling issues around charcoal use, as the urban households that predominantly use charcoal also often have access to electricity. There are potentially transformative opportunities for connected households where energy efficient appliances such as an Electric Pressure Cooker (EPC) can, respectively, be four to six times cheaper than using LPG or charcoal. Modern energy-efficient appliances such as EPCs and rice cookers are able to cook over 90% of a typical weekly menu with time, energy and cost savings for consumers (*see Consumer Demand section*).

2. ENABLING ENVIRONMENT

ECOOKING POLICY OUTLOOK

Until the 2015 National Energy Policy update (*Ministry of Energy and Minerals, 2015a*), which includes eCooking as an alternative modern energy source, there was little policy or regulatory support for eCooking. Since then, eCooking initiatives and policy frameworks that crosscut the electricity access and clean cooking sectors in neighboring countries (such as the National Clean and Electric Cooking strategy documents being developed in Kenya and Uganda) are generating interest from government bodies and ministries, although the policy environment around eCooking remains weak, despite a strong energy access drive. Recent studies and pilot projects carried out by **TaTEDO**, **MECS, A2EI PowerGen, Nexleaf, SESCOM, and others,** are generating evidence around the advantages of eCooking although further research and evidence is required to support scaled uptake and accelerate the change in narrative around eCooking.

There is a need for a strong coordinating body for clean cooking, though there are several potential groups that could grow into this; while the **Clean Cookstoves and Fuels Alliance of Tanzania** (CCFAT) is dormant, **TaTEDO** convened the **Clean Cooking Alliance of Tanzania** (CCAT) in 2021, and **SNV** supported the launch of the **Tanzania Association of Clean Cooking Stakeholders** (TACCS) in 2022.

Key policy stakeholders: *Ministry of Energy, Energy and Water Regulatory Authority (EWURA), Rural Energy Agency (REA), Tanzania Bureau of Standards (TBS), Tanzania Electric Supply Company Ltd (TANESCO)*

TARGETS

ELECTRICITY ACCESS

100% electricity access by 2030 (grid/off-grid)

5780 MW additional generation capacity planned by 2025/26

65% of new generation capacity until 2025 is planned to be renewable (including hydro)

CLEAN COOKING

75% access to modern cooking solutions by 2030

Sources: Ministry of Energy (2020), Ministry of Energy and Minerals, 2015b

RISE SCORES

80	55	60	15
electricity access	clean cooking	renewable energy	energy efficiency

Regulatory Indicators for Sustainable Energy (RISE) scores reflect a snapshot of a country's policies and regulations in the energy sector and designates four pillars of sustainable energy: Energy Access, Energy Efficiency, Renewable Energy, and Clean Cooking. Each pillar is determined from various indicators that are scored on a scale from 0 to 100. These scores provide a picture of the strength of government support for sustainable energy in Tanzania.

KEY NGO PROGRAMMES CREATING THE ENABLING ENVIRONMENT IN WHICH ECOOKING CAN SCALE:

The Modern Cooking Facility for Africa (MCFA) - a financing programme established in 2022 to support the development and scale-up of clean cooking technologies in Africa until 2027, with a focus on Tanzania and five other countries. Nefco manages the facility and the primary donor is the Swedish Development Agency (SIDA), although further funding and funders are sought. Cooking service providers will receive financial support based on eligibility and achieving milestones.

Integrated Approaches to Sustainable Cooking Solutions (2021-2025) - The **EU**, **UNCDF**, **Ministry of Energy and Ministry of Natural Resources and Tourism** – launched December 2021, a 30m EUR programme focused on the policy and market challenges of the cooking energy sector to reduce climate change impact and deforestation in Tanzania. Consists of several components:

- **CookFund initiative**: Accelerated Market Rollout Clean Cooking Solutions in Tanzania 2021-24 – the 17m EUR UNCDF programme will target urban areas by providing financial and technical assistance to support the accelerated market rollout of clean cooking solutions (stoves and fuels). It aims to reach over 640,000 households.
- **3m EUR** is expected to be allocated to UNIDO for continued promotion of bioethanol for cooking.
- **Awareness raising; strengthening enabling environment.**

KEY GOVERNMENT PLANS CREATING THE ENABLING ENVIRONMENT IN WHICH ECOOKING CAN SCALE:

National Five Year Development Plan (FYDP III 2021/2026) (Ministry of Finance and Planning, 2021) – a multisector plan that includes energy sector interventions to develop renewable energy sources for cooking to mitigate climate change and deforestation and promote and develop renewable energy technologies and projects for rural households. Also includes targets for increasing electricity generation capacity, adding 5760MW by 2025/26, 65% of which is planned to be from renewable sources.

National Energy Policy (Ministry of Energy and Minerals, 2015) - the 2003 policy laid the foundation for promoting renewable energy sources and encouraging private sector participation in Tanzania. In 2015, it was superseded by the National Energy Policy 2015 that aimed to attract more private investment and local participation in the Energy Sector, improve efficiency and energy conservation as well as access to modern energy services and increase the share of renewables in the electricity generation mix. It states the intention to enable the switch from wood fuel to modern energy for cooking.

National Charcoal Strategy – expected in 2022, this is expected to regulate the industry and seek to reduce environmental effects of charcoal production on the environment, pointing to alternative modern cooking fuels, including electricity.

Biomass Energy Strategy (BEST) (Camco Clean Energy (Tanzania) Ltd, 2014) – this strategy considered sustainability of the biomass supply chain, efficiency of production and use, and promotion of alternative energy sources to reduce charcoal use.

KEY DRIVERS IN THE ENABLING ENVIRONMENT:

- Commitment to support electric cooking by the Tanzanian Ministry of Energy, as evidenced by recent statements and actions by the Minister of Energy, Hon January Makamba (*Edward, 2022*).
- Ambitious government commitment to electricity access targeting 100% access by 2030 (*Ministry of Energy, 2020*).
- Ambitious government targets for increased generation capacity, with nearly 6000MW additional generation planned by 2026, with 65% of it from renewable sources (*Ministry of Finance and Planning, 2021*).
- This will lead to an electricity surplus and so demand stimulation will be required, as in Kenya and Uganda.
- Decreasing charcoal use is a key current policy focus.

KEY BARRIERS IN THE ENABLING ENVIRONMENT:

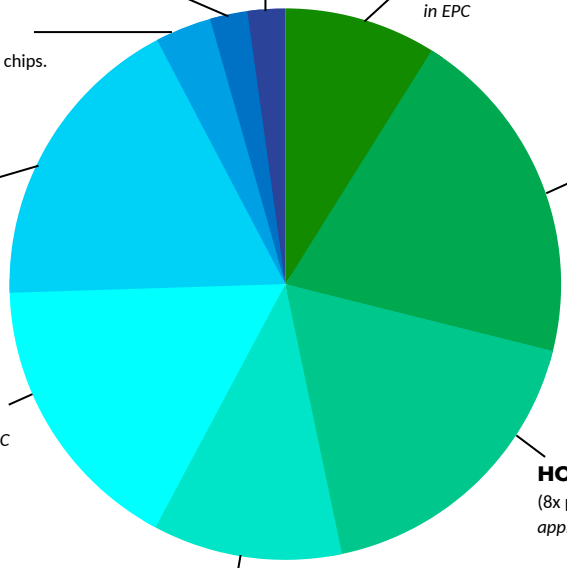
- Lack of awareness throughout market actors, end users, and decision-makers, about affordability and viability of cooking with EPCs.
- Lack of strong national coordinating body to advocate for clean or electric cooking despite promising recent developments with the formation of the Clean Cooking Alliance of Tanzania (CCAT), in 2021, and the Tanzania Association of Clean Cooking Stakeholders (TACCS), in 2022. However, they are yet to reach influential status.
- Clean cooking as yet not adequately integrated into detailed energy access policy.
- Lack of quality standards mean quality of eCooking devices is not controlled.
- Import tax and VAT contribute to high upfront cost of energy efficient eCooking devices.
- Reliability of electricity now high in major cities, but still a challenge at the fringes of the grid (slums, rural areas) and many regions still off-grid.
- LPG has strong regulatory support (though this has not led to a commensurate uptake in use for cooking), but sole pursuance of this strategy for cooking risks locking Tanzania into an increasingly expensive cooking fuel future. A recent agreement may lead to the construction of a facility to extract Tanzania's large reserves of LNG (liquefied natural gas) (*Al Jazeera, 2022*). Part of the gas arriving at the facility in southern Tanzania might also be reserved for the domestic market and the production of cooking fuels (LPG). Pursuing LNG/LPG as the only strategy for clean cooking rather than as a transition fuel could distract from activity to also promote eCooking.

Photo: courtesy of Alex Catherine Nagawa

3. CONSUMER DEMAND

WHAT'S ON THE MENU?

In an average week a typical Tanzanian household will prepare:



FLATBREADS
(1x per week)- e.g. chapati, pancake. *Needs flat pan & even heat - infra-red easiest*

ROASTED/BAKED
(1x per week)- e.g. bread. *Oven at high heat.*

HEAVY FOODS/LONG BOILED DISHES
(4x per week)- e.g.beans, makande. *Big time & energy savings in EPC*

DEEP-FRIED DISHES
(1.5x per week) - e.g. mandazi, chips. *Needs high heat & deep pan.*

QUICK-FRIED DISHES
(8x per week) - e.g. leafy veg, mboga, fried egg. *Require frequent stirring - induction or infra-red easiest*

STEWS/CURRIES
(9x per week) - e.g. green peas, dagga stew, liver sauce *Needs high heat and deep pan.*

BOILED STAPLES
(7x per week) - e.g. rice, sweet potato, boiled veg, pilau, matoke. *Insulated & automated devices (e.g. rice cooker, EPC offer convenience & moderate energy savings.*

HOT DRINKS
(8x per week) - e.g. tea, coffee. *Kettle most convenient, but other appliances needed for Tanzanian chai*

BOILED & STIR STAPLES
(5x per week) - e.g. ugali, porridge. *Staples that require frequent attention/stirring.*

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

POPULAR DISHES: 92% of everyday Tanzanian dishes able to be cooked with an EPC

Ugali – ugali is a maize meal staple dish that is boiled and vigorously stirred. It's easy to cook in an EPC or rice cooker and the non-stick pot is much easier to clean.

Leafy vegetables – usually quickly fried and can also be cooked with an EPC, although people may choose a shallow pan that is easier to stir. Served with many lunch and evening meals.

Beans and Makande – there are many varieties of beans, which are boiled from 30 mins to several hours. Makande is a one pot meal of beans and maize stew boiled for hours, usually served with a tomato and onion sauce. EPCs are the obvious choice in this category, offering big time and energy savings.

Rice and Pilau – simply boiled or steamed rice is a common staple, especially in towns or cities, or rice flavoured with spices and vegetables or meat (pilau).

Stews or curries – stews or curries cooked using vegetables such as matoke, dried fish such as dagaa, or meat such as chicken are common dishes that take around one hour. They are cooked with a shorter frying stage and then a longer boiling or simmering stage. The EPC is well suited to both these processes, with or without pressurizing. Pressurizing will accelerate the process.

Tea – Chai is very easily cooked on an EPC (without pressurizing) although many people will choose to use a sufuria (saucepan) instead, as is traditional.

KEY ENERGY-EFFICIENT APPLIANCES & MARKETING MESSAGES

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

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 long-boiling dishes.

KEY ECOOK DEMAND CREATION PROGRAMMES:

- **The EU's Integrated Approaches to Sustainable Cooking Solutions (2021-2025)** contains awareness raising activities which are expected to be out for tender in 2022.

- **TaTEDO** have been on national TV, radio and continue to carry out in-person awareness raising events in their three Sustainable Energy Support Centers across Tanzania and at trade fairs.

- Projects such as those undertaken by organisations such as **MECS, A2EI, CLASP, SESCOM, TaTEDO, SNV** and **Rift Valley Energy** are creating awareness and familiarity with EPCs among Tanzanian communities.

- **SESCOM**, who import and distribute EPCs from Dar es Salaam, use community networks to grow demand, training sales agents who raise awareness and sell devices to their networks.

- **Jiko Class** from **Nukta Africa Ltd.** (a digital media startup specialising in training courses and R&D of digital and data-driven news and tools) provides online cooking classes for boys and encourages men to contribute and share experiences commonly undertaken by women. The platform suggests energy-saving recipes, utensils and electric devices.

KEY CONSUMER DEMAND DRIVERS:

- Early studies prove the concept of eCooking in Tanzania as viable, affordable and desirable, relative to other commonly used and available fuels (*Batchelor et al., 2019; Inston and Scott, 2022*).
- Rapid urbanization driving broader changes in lifestyle: shifts towards urban areas that have better access to electricity, towards purchasing cooking fuel, and towards a wider range of income generating activities driving demand for time savings.
- Mobile money widely adopted (65% use) (*GSMA, 2021*).
- Over 90% of the everyday Tanzanian menu can be cooked in an EPC, with big time and energy savings on the most energy-intensive dishes (heavy foods), which make up around 10% of the weekly menu.
- Cooking with energy-efficient electric appliances such as an EPC can be much cheaper than popular cooking fuels, yet the high upfront cost of energy-efficient appliances is prohibitive for the low- and middle-income households, that would stand to benefit the most. However high upfront costs can be mitigated by sales on credit, import tax and VAT exemptions, and upcoming innovations such a PAYGO cooking.
- Several trials have been concluded or are ongoing to establish the market for EPCs and how that market can be developed. Results from these trials reveal that EPCs are generally more desirable than biomass cookstoves, especially among charcoal users (*Byrne et al., 2020*).

KEY CONSUMER DEMAND BARRIERS:

- Deep-rooted social-cultural perceptions exist, built over histories of biomass dependency and widely-promoted intermediary technologies such as improved biomass cookstoves.
- Widespread perception that food cooked with electricity doesn't taste the same.
- Limited awareness of the range of the available modern energy-efficient electric cooking appliances and their compatibility with Tanzanian cuisine.
- Widespread perception that electricity is 'too expensive for cooking'.

KEY MARKET SEGMENTS FOR THE ELECTRIC COOKING TRANSITION

- **Urban charcoal users** – The most important market segment for which eCooking is well suited is charcoal users, the majority of which are in urban areas, where around 71% of households depend on charcoal as a primary cooking fuel (*Camco Clean Energy (Tanzania) Ltd*, *2014*). High existing demand is likely to increase unless end users are offered other viable cooking choices, as ongoing rural to urban migration trends are expected to continue, (*Doggart and Meshack*, *2017*). Charcoal has a high price variability, and many policy tools have long been used to attempt to reduce its use, such as two unpopular and short-lived charcoal bans. Despite this, many people consider it the cheapest way to cook. More policy initiatives are expected in the upcoming National Charcoal Strategy. Unlike firewood, charcoal is often purchased and is an existing expenditure that could alternatively be used on electricity units. Many households in Dar es Salaam are grid connected and around 12% of households have electricity in their fuel mix, although few use it as a primary fuel source (*Doggart et al.*, *2020*). The EPC offers a modern alternative that could reduce expenditure on cooking fuel, and the high upfront appliance costs can be mitigated by new business models such as buying on credit and through PAYGO schemes.

- **LPG users** – Another key market segment is LPG users who are mostly in urban centres, who are affluent enough to incorporate LPG into their fuel mix, and who would save money by transitioning most cooking items to EPCs. Imports of LPG to Tanzania have increased significantly, almost doubling between 2016-2018 (*Doggart et al.*, *2020*). It is the second most popular fuel in Dar es Salaam. More LPG cylinders have been introduced, for example a 3kg cylinder making it more affordable for poorer households. Attempts have been made to incentivize LPG use since the National Energy Policy in 2003 and in 2006, gas cylinders were exempted from fuel levies and VAT, though this has not achieved the intended uptake. Increased urbanisation will likely create more demand, although despite tax exemptions it is still more expensive to purchase than charcoal. There is also the added government fiscal burden, as LPG is an imported commodity (although the investment drive for domestic production has restarted in 2022). The expected transition away from charcoal to LPG has not materialized and energy efficient eCooking appliances are cheaper alternatives.

- **Firewood users** – Around 63% of Tanzanians rely on firewood as a primary cooking fuel (*National Bureau of Statistics (NBS) [Tanzania] and Rural Energy Agency*, *2020*). Most firewood users do not pay for their fuel so there is no direct monetary incentive to shift to eCooking or a modern energy fuel that is paid for. This is especially acute in rural areas where 90% of households use firewood as primary cooking fuel, compared to 20% in urban areas (*Camco Clean Energy (Tanzania) Ltd*, *2014*). However, with urbanization and increasing incomes households move away from firewood and it is often substituted for charcoal or additional fuel types in a fuel-stacking pattern. Other factors, such as time and effort spent in collection, and the indirect monetary cost of particularly the time, are potential drivers of behaviour change in this segment.

Photo, SESCOM 2021

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4. SUPPLY CHAIN

KEY ECOOKING APPLIANCE DISTRIBUTORS

SESCOM market and sell an own-brand Global LEAP award winning EPC, adapted for the Tanzanian market (Global LEAP, 2021). Brands such as Electro-Master, KODTEC, Westpoint, Nikai, Russell Hobbs, Kenwood, Singsung and Delsa are imported from UAE, India, Turkey or China and distributed through local retail stores. Those interested in the Tanzanian market are ATEC (PAYGO induction stoves), Group SEB, PowerUP (PAYGO EPCs), Burn (energy efficient cooking appliances), among others.

INNOVATIVE ECOOKING PILOT PROJECTS:

Battery-supported eCooking pilot (2021/22), MECS, TaTEDO – Investigating the compatibility of battery-supported eCooking with households in urban on-grid (AC) and rural off-grid (DC) settings. Also being undertaken in Uganda & Kenya.

Longitudinal eCooking minigrid pilot (2020/21), A2EI, MECS, Nexleaf, PowerGen Renewable Energy (Kweka et al, 2021a) – A study monitoring 100 households connected to solar-hybrid mini-grids in Northern Tanzania using EPCs with smart-meters over 14 months. Analysis found that at national tariffs, EPCs are cheaper than using traditional fuels, and even at mini-grid tariffs of 1USD/kWh, certain foods are still cheaper to cook using an EPC than charcoal (Inston and Scott, 2022). This pilot was ongoing when the low tariff directive was implemented in 2020 and additional analysis captured that EPCs were used 8 times more frequently after the tariff drop. Active users saved nearly 2 hours a day and reduced their use of traditional stoves and associated indoor air pollution by 60% (Kweka et al, 2021b).

Grid connected EPC pilot in Morogoro (2021), SESCOM, Nexleaf, TAFORI – distributed EPCs to 50 households and evaluated EPC use with cooking diaries, data loggers, and feedback surveys on customer experience, while also assessing appliance financing models (SESCOM, Nexleaf and TAFORI, 2021).

Institutional eCooking feasibility (2021), TaTEDO – testing the viability of cooking common Tanzanian food on a 40L EPC, showing it capable of cooking foods typical in schools, catering services and institutions (Aloyce and Ngaya, 2021). In 2022, TaTEDO are beginning a follow-up study in schools around Dar es Salaam.

INNOVATIVE ECOOKING PILOT PROJECTS CONT'D

Minigrid eCooking (2020), CLASP, PowerGen Renewable Energy – an EPC pilot on a PowerGen mini-grid in rural Tanzania, indicating that off-the-shelf EPCs are strongly compatible with microgrids and meet customer needs (Schreiber, Waceke and Blair, 2020).

DC solar-powered cookstoves for food vendors (2020), Loughborough University, Africa Power Ltd – explored DC solar-powered stoves with street vendors, assessing compatibility and desirability (Perrett, 2020).

SHS and solar eCooking technology (2021), Kachione LLC – Malawi-based Kachione LLC have developed a SHS-eCook system that costs only $200 and deliver systems through women's groups. They had a knowledge and skills exchange with The Collaborative in Northern Tanzania, training women to assemble and install SHS-eCook technology.

Hydro-minigrid eCooking (2021-), Rift Valley Energy, A2EI – RVE are selling EPCs on credit to customers and A2EI are monitoring the usage for 100 households.

EPC delivery models in rural Morogoro (2022), EnDev/SNV – incorporating EPCs into an existing clean cooking Behaviour Change Communication intervention by equipping high-performing biomass improved cookstove producers with EPC initial stock and marketing support. The aim is to upscale their product offerings to higher tier cook stoves within their existing market presence and customer base.

KEY SUPPLY SIDE DRIVERS:

- Strong supply chains for importation of appliances from UAE, Turkey and China in place, though most importers are not aware of the opportunity of expanding product range into energy-efficient eCooking appliances.
- Demand is beginning to grow for EPCs, which is stimulating the supply chain, as a result of small-scale awareness raising efforts – scaled awareness raising efforts are required to stimulate faster growth.
- Early piloting of innovative consumer financing mechanisms underway to enable low-income households to unlock low-cost cooking with energy-efficient appliances.
- Some market actors have set up after-sales services; for example, TaTEDO and SESCOM have set up 3 distribution centres across Tanzania, trained technicians to repair EPCs, and SESCOM import spare parts. SESCOM, who import into Dar, are starting to receive large orders from other countries in the region - they recently exported hundreds of EPCs to Democratic Republic of Congo (Shuma et al, 2022).

KEY SUPPLY SIDE BARRIERS:

- Lack of quality standards mean some devices brought in are poor quality and risk customer trust.
- Importers and distributers are not aware of the opportunity presented by expanding their range into energy efficient cooking appliances.
- Importers and distributors who are aware require capital to bring in devices at scale in order to get economies of scale in clearing costs and import duty.

POPULAR APPLIANCES IN TANZANIA TODAY:

- In urban areas, where electricity is used for cooking, among the most commonly used appliances are microwave ovens, electric kettles, fabricated coil water heaters, induction stoves, hot plates, mixed LPG and stand-alone electric cookers, and thermal pots (*Byrne et al., 2020*).
- Task-specific appliances such as rice cookers and kettles are popular amongst a wider range of income brackets.
- According to Byrne et al. (2020) *rice cookers are used quite widely in Tanzania in areas connected to the national grid, especially in urban areas. They are commonly given as gifts in weddings and bridal showers. University students use rice cookers to not only cook rice but almost all other meals. As the students are using electricity paid for by the university, they do not face the constraint of paying for energy for cooking* (*Byrne et al., 2020*).
- Induction and infra-red stoves have yet to see substantial uptake.

Appliance	Sales Volume	Typical Retail Price
Hotplate	na	137k – 1.1m TZS (59-503 USD)
Rice cooker	na	44k – 460k TZS (19-201 USD)
Electric Pressure Cooker (EPC)	na	180k – 190k TZS (77-81 USD)
Microwave	na	175k – 750k TZS (75-323 USD)

Table 1: Typical retail prices for selected eCooking appliances in Tanzania (Byrne et al., 2020).

RELATIVE COST OF ECOOKING VS. POPULAR COOKING FUELS:

At the national tariff, cooking with an EPC would be cheaper than using traditional fuels (except collected firewood), and even at mini-grid tariffs it can still be cost effective to cook certain foods with an EPC (*Inston and Scott, 2022*).

GRID ELECTRICITY TARIFFS (2020):

- **LIFELINE**: 100 TZS/KWH (0.04 USD/KWH)
- **REGULAR**: 350 TZS/KWH (0.15 USD/KWH) < 75KWH/MNTH
- **MINI-GRID TARIFFS:** BEFORE 2020 TARIFF DIRECTIVE, TYPICAL EXAMPLE: 1 USD/KWH; AFTER 2020 DIRECTIVE: 100TZS/KWH; 0.04 USD/KWH.

POTENTIAL CHANGE EXPECTED 2022: 1600 TZS/KWH; 0.69 TZS/KWH.

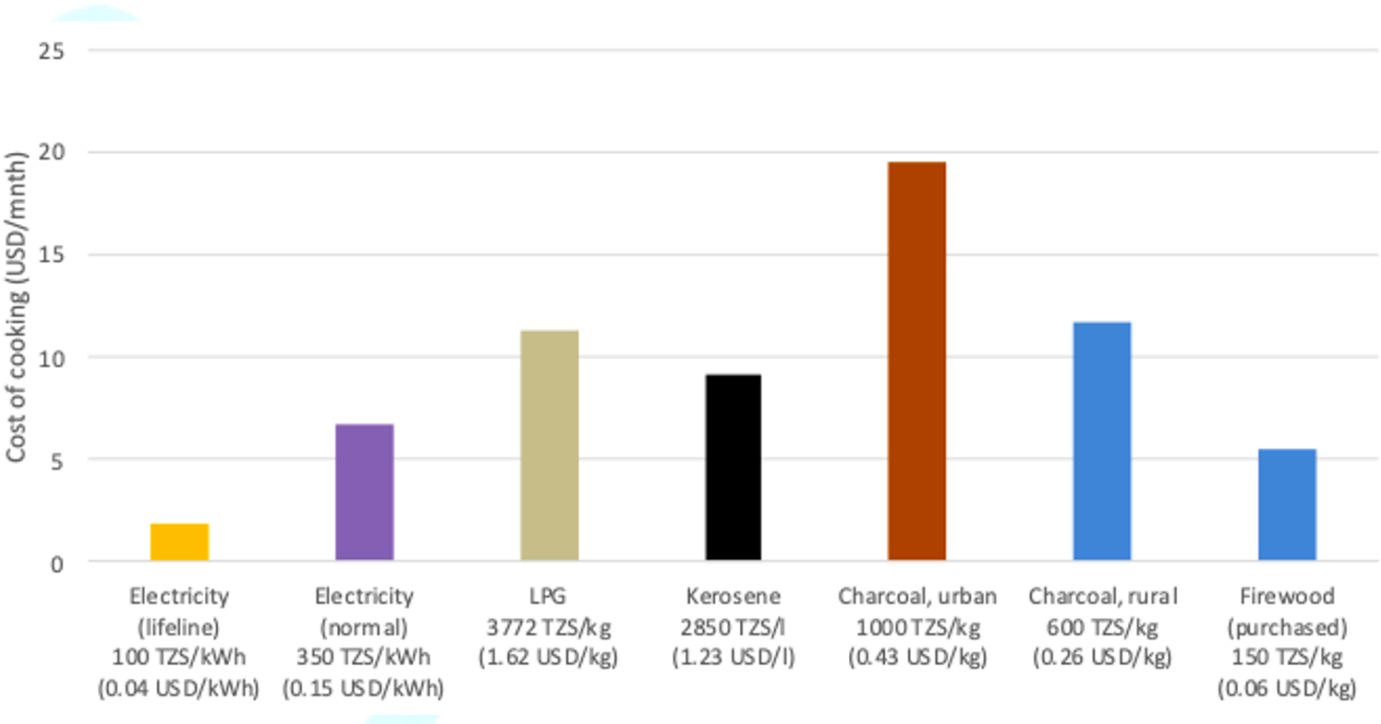

Figure 1: Cost comparison of different cooking fuels based on international averages for cooking energy demand from ESMAP (2020) and local electricity/fuel prices from price surveys conducted April 2022.

5. RECOMMENDATIONS FOR INTERVENTIONS

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

		Current status (incl. summary of key opportunities and challenges)	Recommended interventions
Market segments	**On-grid**	Majority of urban population now grid connected, but uptake of eCooking is limited due to low awareness and inadequate supply chain.	Work with TANESCO to pilot promotion of eCooking and delivery of EPCs to their customers, in preparation for when the generation surplus becomes larger. Run far-reaching awareness raising campaigns.
	Mini-grid	Pilots carried out on solar-hybrid MGs with encouraging results. High tariffs were a barrier but reduction due to tariff directive showed large increase in eCooking. More cost-reflective tariffs expected in 2022 which will help stabilise industry.	When cost-effective tariffs are allowed again, work with minigrid companies to support promotion of eCooking and their evolution into distributers of eCooking devices. Work to investigate financing mechanisms, such as working through SACCOs, PAYGO, to bridge affordability gap for low-income users.
	Off-grid(SHS)	MECS pilot of battery-supported SHS eCook is underway in 2022.	Encourage SHS companies to pilot eCooking; lobby government to reduce import tariffs on DC eCooking appliances and battery storage sized for cooking; explore innovative financing mechanisms.
TToc dimensions	**Supply chain**	Product/market fit of EPCs established with early studies. Importer SESCOM has 3 distribution centres across the country with trained technicians who can offer repair services. Sales volumes are low but growing. It is possible to find other brands of EPCs in low quantities and to variable quality in urban markets.	Working capital required for importers to bulk import EPCs - to keep up with demand which will rise with awareness raising, and achieve economies of scale with import and clearing costs. Diversify supply to include EPCs of larger sizes. Work to investigate financing mechanisms, such as working through SACCOs, PAYGO, to bridge affordability gap for low-income users.
	Consumer Demand	Consumer awareness campaigns carried out to raise profile of energy-efficient appliances (in particular EPCs), including news segments, radio, and in-person events; though these have had limited reach thus far, demand is stimulated particularly well at eCooking demos.	Nationwide awareness raising campaigns, involving key stakeholders in the government, using mediums with greater reach – such as national news items, TV and video clips of demonstrations, etc.
	Enabling environment	Strong policy framework for electrification in place and Ministry of Energy Interested in a National eCooking Strategy. Lack of integrated energy planning, eCooking and energy access policy is not interlinked and there is no detailed support for eCooking in policy or strategy documents.	Support Ministry of Energy and other government offices to develop National Strategies relating to clean and eCooking, following in footsteps of Uganda and Kenya. Bring ministries and relevant organisations together at eCooking demonstrations to raise awareness. Advocate for EPC import duty and VAT exemption.

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7. APPENDIX A: 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 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 first part of 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 urban households that are grid connected, but currently cooking primarily with charcoal. While specific data are not available for this demographic, an estimate was made based on the evidence earlier in the report about different categories of users, suggesting approximately 3.1 million households. Consistent with the MECS 40% goal, the scenario models transition of 40% of those, so 1.24 million households. Details are in the first part of the table. BAR-HAP models a ramp-up of transitioning households over the first 5 years to 2025 and then a further 5 years operation.

BAR-HAP has been implemented here using its policy option of a ban on charcoal use, which comes in gradually from 2020 to 2030. This is clearly not a realistic policy and is simply used here to effect the transition wanted for this illustration, with clarity about the impacts and where costs fall; it can be regarded as a proxy for other specific actions used to mobilise a major transition from charcoal to eCooking. 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 $110 in total and to have an average efficiency of 100% (MJ input to MJ useful heat output). This is intended to represent a combination of an EPC (effectively an efficiency of 150%, as it cooks food more quickly and thus needs to deliver a lower level of useful energy: more easily understood as having an energy ratio of about 1 to 15 compared to the energy needed to cook a meal using charcoal: see Scott & Leach, 2022) and an induction hob (efficiency of 75%, or energy ratio of about 1 to 7. eCooking is assumed to save 30% of the typical 2.6 hours cooking per day. Tanzania's grid electricity generation mix is dominated by natural gas (51%) with most of the balance from hydro (32%), and oil (15%) and just over 1% from other renewables. Tanzania has ambitious policy objectives to increase the share of renewables (hydro, wind, solar and geothermal) and reduce the reliance on natural gas. However the analysis here assumes the present generation mix, with electricity-related emission factors to match.

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

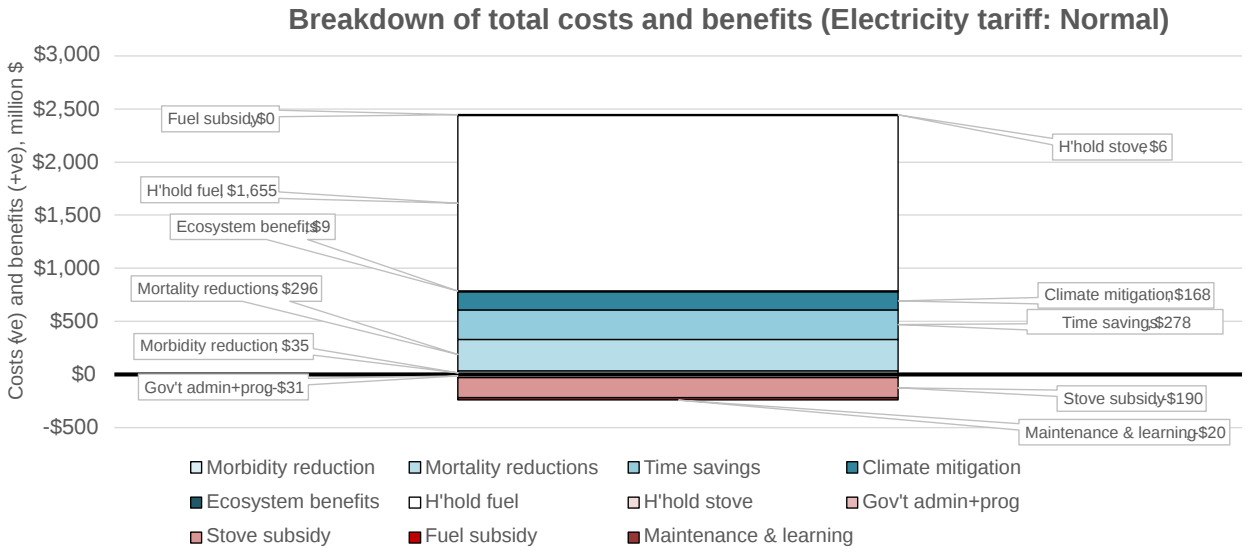
APPENDIX A: IMPACT OF SCALED UPTAKE

Grid connections projections and eCook target		Population (million)	housholds (million)	% grid connected			
Urban population, 2020		21.10	4.35				
Grid connections, 2020		21.10	4.35	100%			
Of which, using charcoal as main fuel		14.98	3.09				
Scenario modelled							
Transition from charcoal to eCooking, 40% of urban grid connected HHs		5.99	1.24				

Costing (costs are -ve, benefits are +ve)	Assumes electricity tariff: Normal for all customers			$/yr	$/yr per household transitioning	$M total for 10yrs	$total per household
Total present value (ie net social benefits of the transition)				**220,515,275**	**177**	**2,205**	**1769**
Total costs of transition, government+private				**141,943,958**	**114**	**1,419**	**1139**
Private cost to housholds: total				164,000,469	**132**	1,640	1316
Stove				*552,500*	**0**	6	4
Fuel				*165,458,022*	**133**	1,655	1328
Maintenance				*-2,010,052*	**-2**	-20	-16
Costs to government: total				-22,056,512	**-18**	-221	-177
Stove				*-18,992,190*	**-15**	-190	-152
Fuel				*0*	**0**		
Admin+Programme				*-3,064,322*	**-2**	-31	-25
Health, Time, and Environmental Benefits: total		Physical: change/yr	Physical: % of national cooking total	**78,571,317**	**63**	**786**	**630**
Health impacts total: DALYs avoided	DALYs	2,691		33,022,755	**26**	330	265
Mortality reduction	*YLL*	*1,392*	0.2%	*29,555,736*	**24**	*296*	237
Mortality reduction	*Lives*	*120*	0.4%				
Morbidity reduction	*YLD*	*1,300*	0.7%	*3,467,019*	**3**	*35*	28
Morbidity reduction	*Cases*	*6,654*	0.7%				
Time savings	Hours	429,242,860	6.5%	27,773,000	**22**	278	223
Time savings per adopting household	*Hours/HH*	*344*					
Electricity use	*MWh*	*531,467*					
CO2-eq reduction (CO2,CH4,N2O)	Tonnes	1,332,319	8.4%	16,834,042	**14**	168	135
Unsustainable wood harvest reduction	Tonnes	137,334	5.8%	941,520	**1**	9	8

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 $180 per household for equipment and programme costs, it would save households 8 times that in reduced energy bills over the ten years of the programme: electricity tariffs are relatively low, and charcoal prices are high. Furthermore, health benefits would include 120 lives saved per year and avoid serious health impacts for a further 6600 people annually. Some 5% of current national unsustainable wood harvesting would be avoided. These impacts may seem modest but this scenario is targeting only 10% of the national population. The transition from charcoal to electric cooking would also make a significant reduction in greenhouse gas emissions, even with the analysis using the current mix, with 50% natural gas.

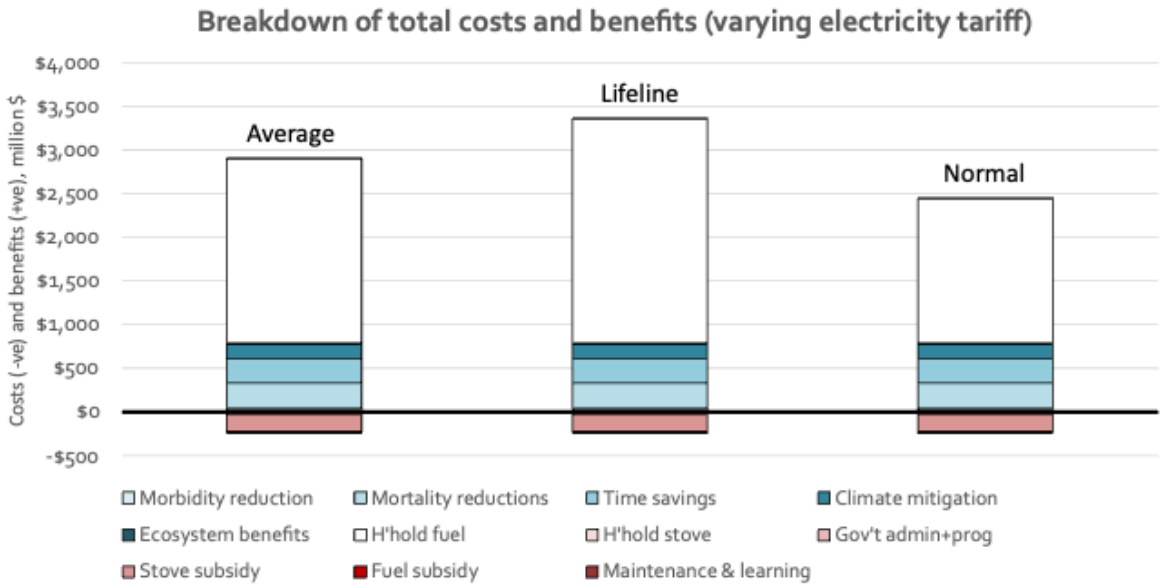


APPENDIX A: IMPACT OF SCALED UPTAKE

The chart summarises the various physical and financial impacts of the transition in monetary terms. Overall, the impacts result in a very substantial net social benefit to society. The largest element of cost is from the purchase of modern stoves by government. The social benefits from avoided time spent cooking are significant, reflecting mainly time savings using an EPC, and the opportunity cost for peoples' time, as used in BAR-HAP. However this saving is not as large as for some countries: it is assumed here that average cooking time before transition is 2.6 hours/day, which is lower than suggested for some others. Health benefits are also considerable, mainly associated with the lives saved.

By far the largest benefit though comes from reduced energy costs to households. It is unclear what tariff the large number of households transitioning to electric cooking would pay. As shown earlier in the report, the normal tariff is 15 UScents/kWh, but the Lifeline tariff of 4 UScents could be sufficient for lower-income households without very large non-cooking electricity use to undertake their cooking. The table and chart above show the results of a conservative assumption that all transitioning households pay the normal tariff. Charcoal prices were assumed to be $0.43/kg, and even with electricity tariffs at $0.15/kWh, combined with cooking energy savings from use of more efficient electric devices this leads households to save around $11 per month.

The chart shows the influence of the assumption about the tariff paid. The right hand column shows the case above, with all households paying the full 'normal' tariff of 15 UScents/kWh (fuel saving per HH $11/month). These savings could lead to a simple payback time of just 10 months if households were oaying for the electric cooking equipment themselves. The middle column shows the larger savings to be made if all households could cook within the Lifeline tariff (fuel saving per HH $17/month). The left hand column shows the overall benefits if half the households were paying each tariff, equivalent to everyone paying an average tariff of 9.5 UScents/kWh (fuel saving per HH $14/month).



This is an impact analysis for one simple scenario for just one particular, but significant, segment (urban, grid connected charcoal users) of Tanzania's population. The scenario has very significant net social benefit overall, based on the WHO's physical impact and impact monetisation methodologies, even with current electricity mix with majority fossil fuels, and even if cooking is done at the full electricity tariff.