eCook Zambia National Policy & Markets Review

October 2019 Working Paper

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Executive Summary

This report summarises the findings **a review of national policy and the market for clean cooking and electricity in Zambia**, with the aim of informing the development of a battery-supported electric cooking concept, eCook. It is part of a broader programme of work, designed to identify and investigate the opportunities and challenges that await in high impact markets such as Zambia.

This study has confirmed that there is a strong market for eCook products and services in Zambia, however there are a number of regulatory challenges that need to be addressed. Grid electricity is managed by a single state owned company, ZESCO, and generation is almost entirely from hydroelectric sources. In recent years, late rainfall has forced ZESCO to implement load shedding to balance demand with supply. ZESCO now has a Demand Side Management department, who have shown a keen interest in the eCook concept. Zambia has a huge off-grid population and emerging mini-grid and solar markets, primarily focussed on lighting solutions. In rural areas, firewood is the most widely used fuel for cooking, whilst in urban areas, most households fuel stack charcoal and electricity, depending on which foods they are cooking and whether there are blackouts at mealtimes or not. Zambia has seen a range of clean cooking initiatives, the majority focussed on improved biomass stoves. Zambia's most popular stove, the mbaula, is extremely inefficient, as it is entirely constructed from metal, with no insulation to focus the heat onto the pot. However, to date, there have been few clean cooking projects looking at electric cooking, as ZESCO are actively encouraging their users to switch to LPG in an attempt to reduce the loading on the grid and prevent further load shedding.

This research is funded by DfID/UK Aid and Gamos through the Innovate UK Energy Catalyst and the MECS programme.

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This research is funded by DfID/UK Aid and Gamos through the Innovate UK Energy Catalyst and the MECS programme.

1 Introduction

This report presents one part of the detailed in country research carried out to explore the market for eCook in Zambia. In particular, this in country work aims to gain much greater insight into culturally distinct cooking practices and explore how compatible they are with battery-supported electric cooking. The report is rich with detail and is intended to provide decision makers, practitioners and researchers with new knowledge and evidence.

This report presents findings from four focus groups designed to inform the future development of eCook within Zambia. It is one component of a broader study designed to assess the opportunities and challenges that lay ahead for eCook in high impact potential markets, such as Zambia, funded through Innovate UK's Energy Catalyst Round 4 by DfID UK Aid and Gamos Ltd. (https://elstove.com/innovate-reports/). A much deeper analysis of the data collected during this project was supported by the Modern Energy Cooking Services (MECS) programme, which included the writing of this report.

The overall aims of the Innovate project, plus the series of interrelated projects that precede and follow on from it are summarised in in *Appendix A: Problem statement and background to Innovate eCook project*.

1.1 Background

1.1.1 Context of the potential landscape change by eCook

The use of biomass and solid fuels for cooking is the everyday experience of nearly 3 billion people. This pervasive use of solid fuels and traditional cookstoves results in high levels of household air pollution with serious health impacts; extensive daily drudgery required to collect fuels, light and tend fires; and environmental degradation. Where households seek to use 'clean' fuels, they are often hindered by lack of access to affordable and reliable electricity and/or LPG. The enduring problem of biomass cooking is discussed further in *Appendix A: Problem statement and background to Innovate eCook project*, which not only describes the scale of the problem, but also how changes in renewable energy technology and energy storage open up new possibilities for addressing it.

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1.1.2 Introducing 'eCook'

eCook is a potentially transformative battery-supported electric cooking concept designed to offer access to clean cooking and electricity to poorer households (HHs) currently cooking on charcoal or other polluting fuels (Batchelor, 2013, 2015a, 2015b). Enabling affordable electric cooking sourced from renewable energy technologies, could also provide households with sustainable, reliable, modern energy for a variety of other purposes.

A series of initial feasibility studies were funded by DfID UK AID under the PEAKS mechanism (available from https://elstove.com/dfid-uk-aid-reports/). Slade (2015) investigated the technical viability of the proposition, highlighting the need for further work defining the performance of various battery chemistries under high discharge and elevated temperature. Leach & Oduro (2015) constructed an economic model, breaking down PV-eCook into its component parts and tracking key price trends, concluding that by 2020, monthly repayments on PV-eCook were likely to be comparable with the cost of cooking on charcoal. Brown & Sumanik-Leary's (2015), review of behavioural change challenges highlighted two distinct opportunities, which open up very different markets for eCook:

- PV-eCook uses a PV array, charge controller and battery in a comparable configuration to the popular Solar Home System (SHS) and is best matched with rural, off-grid contexts.
- Grid-eCook uses a mains-fed AC charger and battery to create distributed HH storage for unreliable or unbalanced grids and is expected to best meet the needs of people living in urban slums or peri-urban areas at the fringes of the grid (or on a mini-grid) where blackouts are common.

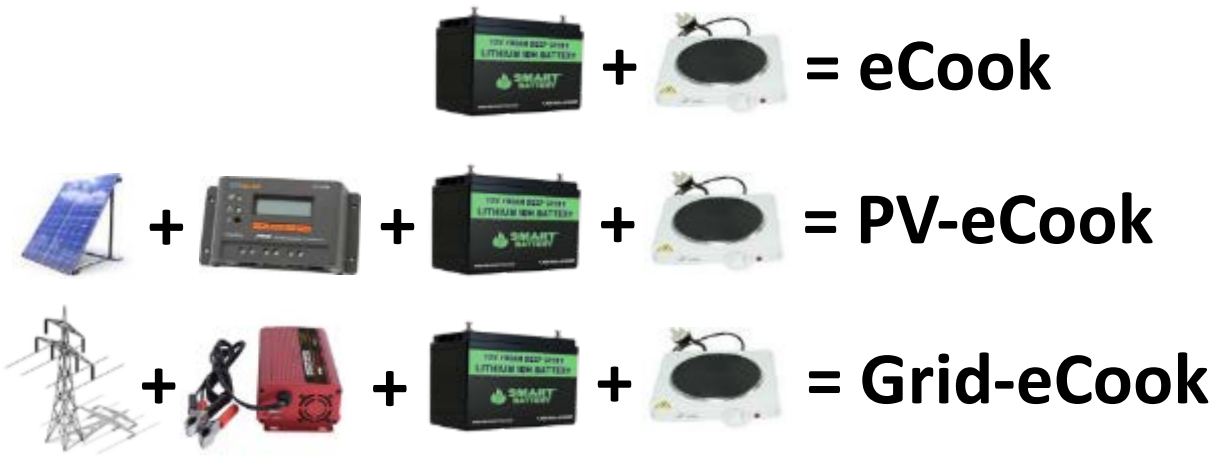

Figure 1: Pictorial definitions of 'eCook' terminology used in this report.

1.1.3 eCook in Zambia

Given the technical and socio-economic feasibility of the systems in the near future, Gamos, Loughborough University and the University of Surrey have sought to identify where to focus initial

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marketing for eCook. Each country has unique market dynamics that must be understood in order to determine which market segments to target are and how best to reach them. Leary et al. (2018) carried out a global market assessment, which revealed Zambia as the third most viable context for PV-eCook, as 10% of the population already cook on electricity and recent load shedding caused a significant number of these users to revert back to charcoal, rapidly accelerating deforestation.

The accompanying reports from the other activities carried out in Zambia can be found at: https://elstove.com/innovate-reports/.

1.2 Aim

The aim of this study was to understand the intersect between 'cooking', which has traditionally meant biomass, in particular improved biomass stoves, and 'energy access', which has tended to focus on electricity and grid access.

The objectives are twofold:

- To review the current regulatory framework in Tanzania and assess which polices are likely to accelerate the uptake of the eCook concept and which may present significant barriers.
- To assess the state of the existing clean cooking and grid/mini-grid/off-grid electrification markets, which may provide the foundation for future eCook products/services.

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2 Methodology

A framework for the policy/markets analysis was developed by Gamos, Loughborough University and the University of Surrey, focussing on the following key areas:

- Clean cooking (health, deforestation, climate change, fuel/stove markets, etc.)
- Electrification (renewable energy, energy-efficiency, grid/mini-grid/off-grid markets etc.)
- Cross-cutting issues (gender, business environment, demographics, etc.)

The elements of the framework were based upon the factors that are most likely to affect the uptake of eCook products/services and the size of key market segments. These factors were first identified by Brown & Sumanik-Leary (2015), then further extended and contextualised by Leary et al. (2018).

Drawing upon their extensive experience in both the Tanzanian clean cooking and electrification sectors, our Tanzanian partners, TaTEDO, prepared a series of responses to the questions posed by the framework, which was supplemented by a literature review. The full framework can be found in Appendix B: Policy/markets review framework.

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3 Results

3.1 Clean cooking

What is the state of the clean cooking sector?

Who are the key government, NGO, research & private sector actors in the clean cooking sphere and what are their roles?

Table 1: Organization/Institution and their roles

ORGAIZATION/INSTITUTION	ROLE
Department of Energy	Policy formulation and implementation
Forestry Department	Policy formulation and implementation
ZESCO	Power generation, transmission and distribution
Rural Electrification Authority (REA)	Infrastructure development and electrification of rural areas
Energy Regulations Board	Regulating the sector and licensing
TDAU	Research and development; technology transfer; sometimes sell ICS
National Institute for Scientific and Industrial Research (NISIR)	Research and development; technology transfer; sometimes sell ICS or parts of e.g. clay lining for ziko stoves
Vitalite	Solar dealers, clean cookstove distributor (set to become a utility)
Muhanya Solar	Solar dealers
Fenix	Solar dealers
ChildFund	Have activities involving clean cookstove installation and promotion
ZENGO	Capacity building for clean cookstove construction/installation and marketing
Emerging Cooking Solutions	Clean cookstove distributors
Lion Alert	Conservationists and clean cookstove promoters
Rasma Engineering	Clean cookstove manufacturer and distributor
Caritas Zambia	Have clean cookstove activities
Action Africa Help- Zambia	Have clean cookstove activities
GreenPop -Livingstone, Zambia	Have clean cookstove activities
Eco-Hazmat Solutions	Clean cookstove manufacture and distribution

What is the national cooking energy mix (i.e. how many people primarily cook with firewood, charcoal, kerosene, LPG & electricity)? How is this changing?

- Zambia's energy sources include; electricity, petroleum, coal, biomass, and renewable energy. Woodfuel, in the form of firewood and charcoal, are widely used for cooking. The proportions of use are shown in the table below:

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Table 2: Share of woodfuel use

Fuel		Proportion (%)
Firewood	Zambia	50.7
	Urban	6
	Rural	84.5
Charcoal	Zambia	32.9
	Urban	59.1
	Rural	13.2

- These are drawn from the Living Conditions Monitoring Survey (LCMS) of 2015, and the Integrated Land Use Assessment (ILUA).
- Statistics for use of other fuels like LPG, biogas, kerosene, etc. for cooking are either very little or non-existent. But it should be noted that these fuels are being used.
- Please refer to this website (http://www.erb.org.zm/reports/consumerPerceptionQualityOfServiceSurveyReport2016.pdf). This is a report by ERB and Central Statistics Office (CSO) of a study conducted in selected districts. It highlights use of different fuels and perceptions from end-users.
- The demand for renewable energies has seen significant growth in the recent years as the market explores alternative sources of energy, with renewable energies proving to be a viable alternative.

Which successful interventions have facilitated transitions to cleaner cooking solutions? Which have failed and why?

- A few successes have been observed with the utilization of the improved cookstoves (ICS). These ICS probably owe their success to the fact that they are still using charcoal and firewood, which are familiar fuels.
- Despite years of campaigns and demonstrations, the ICS are not widely accepted by households. This is because of the high upfront cost of the devices compared to the traditional mbaula; ICS cannot cook all types of food; and other socio-cultural reasons (from various in-country researches).

How many biomass users have adopted improved stoves?

- Exact number is unknown.
- Please refer to the table below of some ICS interventions. This information was gathered for the Barriers project in 2016. There has not been any further research to update this. Note that the number of disseminations/installations is not the same as number adopted.

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Table 3: Commercial ICS intervention in Zambia

Name of project/project developer	Year/duration	Type of cookstove	Project description/Location	Contact
Katete improved cookstove Zambia VCS		Rocket stove	75,000 stoves were disseminated over the period in Katete	The CarbonNeutral Company. London Tel: +44 20 7833 6000 E: info@carbonneutral.com New York Tel: +1-646-367-5800
3Rocks (Icecap)	2010	Bespoke	40,000 stoves were installed over the project period in different rural areas of Zambia	http://www.icecapltd.com/3rocks/
SNV Zambia	2010- 2012	Fixed mud stoves and the pulumusa	Out of the 8200 stoves produced, 6,375 were sold and in use by 2012 in Northern, Muchinga, Lusaka, Central, Luapula and Southern Provinces	Renewable Energy sector Leader. Tel: +211 255 176. Renewable Energy Advisor, SNV Kasama. Tel: +214 222 988
CDM project	2008- 2011	Save80	30,000 stoves were sold in Lusaka Province	Climate Management Ltd, Garden Township, Lusaka.
C-Quest Capital			1,000 stoves were disseminated	http://carbonfinanceforcookstoves.org/connect/profile/1936/
CQC partnership with Community Markets for Conservation (COMACO)	2014	Mud brick rocket stove	60,000 stoves were set to be installed in Luangwa, Eastern province; Lusaka province	http://www.cquestcapital.com/programs/cookstoves-in-zambia-2/

Table 4: ICS Interventions by individuals

Project developer	Name of SME	Year	Type of stove	Project description	Contact
Rashid Phiri	Rasma Engineering	1985-to-date	8types of biomass stoves including the ziko	During the period 2001-2003, about 9,360 domestic stoves were produced and sold. The business is now mostly bespoke, manufacturing biomass stoves for commercial applications such as markets. Customers of these stoves are mainly in Lusaka Province	rashid.phiri@gmail.com
Alfred Mumbi	Enviro- Care International	1999-to-date	Ziko stoves	Have weekly production of 100 stoves. Sales have and are made to regular customers from the SME premises or through retail outlets like P n' P, Shoprite, Spar and during	caregroupzambia@gmail.com

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				exhibitions at public events	
Lazarus Chewe	Dread & Works Enterprise	2003-to-date	Rocket, jiko	Previously had a record monthly production of 350 stoves. They have produced stoves for supply to an already established market that include hospitals and boarding schools. Currently make stoves on demand	chewelazarus@yahoo.com

How and where are improved stoves manufactured?

- Some improved stoves are wholly or certain parts manufactured in Germany, China or South Africa and are then assembled in Zambia. Other stoves are manufactured locally in Zambia.

What are the most popular cooking appliances?

- The electric 4 hotplate cooker is commonly used in households of well to do families. The electric 2 hotplate cooker is common among bachelors and bachelorettes and small families. The most popular appliance that that cuts across the family size or economic status is the traditional mbaula. This appliance is used for preparing long-cooking dishes, water heating and space heating. The fuel (charcoal) is considered cheap. Almost all households in urban areas have one or more of the mbaula.
- Other popular cooking appliances include the microwave, kettle, bread toaster and sandwich maker.

How compatible are the popular electrical appliances with battery-supported electricity?

- The power rating of the electric 2 hotplate cooker, bread toaster, kettle and sandwich maker ranges between 500 and 2000W. The cooking appliances may be compatible with battery-supported electricity, depending on the size and capacity of the battery.

Are there national fossil fuel reserves? If so, how significant are they and how are they exploited?

- Yes, total recoverable coal (in million short Tons) was 11.0 in 2011 (http://zambia.opendataforafrica.org/jvcadog/zambia-energy-profile).
- Coal is now been utilized in power generation at Maamba Collieries Limited (MCL) in Sinazongwe District, Southern Province. The thermal plant has a generation capacity of 300MW. Commissioned in August 2016, it generated about 326MW by the end of 2016. Electricity is generated and sold to Zesco under a long term power purchase agreement (PPA)

What do people cook and how do they cook it?

- Urban areas: People cook chicken and chicken products (village and layers), beef and beef products, vegetables (fresh and dry), pork, fish (fresh and dry), beans, sweet potatoes (and

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irish), kapenta, pumpkins, etc. These foods are either boiled or fried. Vegetables are either boiled (with additions of ground groundnut powder) or fried.

- Rural areas: People cook chicken (village), beef, vegetables, sweet potatoes, beans, fresh fish, kapenta, pumpkins and other garden or wild products. Most foods are boiled or roasted. Foods are smoked (in case of meat) and dried (vegetables) for preservation because there is no electricity for refrigeration. Most of the foods are seasonal. The garden and wild food products are usually consumed after the rainy season because that is harvest time and food is plenty.

How does this vary across the country? Is this changing?

- The preparation methods are likely to change as a result of less time available for cooking and the cash cost attached to cooking fuel[1].

How many people are suffering from acute respiratory illnesses due to cooking on polluting fuels?

- Pneumonia and other respiratory tract infections continue to be the major contribution to ill health among population in Zambia. However, the causes of the pneumonia and respiratory infection have not been fully disaggregated. Most of the ZDHS reports only refer to bacterial and viral causes.
- NGOs that have ICS projects do report that use of their products reduces indoor air pollution but neither statistics have been made available on number of people affected nor the pollution levels investigated. Refer to https://www.carbonneutral.com/images/uploads/projects/Katete_Improved_Cookstoves_Zambia_VCS.pdf

What initiatives have addressed this? How successful have they been?

- ICS that use charcoal or firewood (efficiently), pellets and briquettes are been encouraged and/or promoted. Use of biofuels and biogas are also been encouraged and/or promoted.

How severe is deforestation? What initiatives have addressed this? How successful have they been?

- Deforestation is reported to be occurring at a rate of 250,000 to 300,000 ha/yr (2012 Deforestation Index). Various interventions have been put in place.

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1 http://www.fao.org/fsnforum/sites/default/files/files/90_indigenous_knowledge/summary_89_EN_indigenous_methods.pdf

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- Which policies currently enable or constrain the roll out of cleaner cooking solutions?

Strategies targeted at reducing deforestation that enable or constrain the roll out of cleaner cooking solutions include:

i) Encouraging the use of alternative sources of energy as a way of reducing consumption of charcoal; and
ii) Improving the efficiency and technology of charcoal production and utilization.

Successes have been reported in both rural and urban areas where the clean cooking solutions have been promoted as an alternative rather than the only solution. In rural areas, shortage of fuel has been one of the reasons households have welcomed the ICS.

Are there any specific targets for the quality of clean cooking solutions and the number of people who should gain access to them by a certain date? If so, what policies have been developed to enable this and are there a government budget assigned to it?

- There are currently no standards to ensure quality for ICS (information obtained from ERB and ZABS[2] during Barriers study).
- The Vision 2030 policy aims to reduce the share of people using woodfuel as their primary cooking fuel to 40% by 2030
    - The current use of firewood for cooking is 6% urban and 84.5% rural, while the use of charcoal is 59.1% urban and 13.2% rural (Living Conditions Monitoring Survey (LCMS, 2015), and Integrated Land-Use Assessment (ILUA)).

Is there a national biomass energy or cleaner cooking strategy?

- Yes, biomass energy strategies do exist and are outlined in the National Energy Policy of 2008.

Is charcoal production/transportation/wholesale/retail legal? If so, is it taxed and by how much? If not, how does the sector get around the law?

- Charcoal production, transportation in-country and sale are legal in Zambia. However, due to lack of man-power and other resources, the charcoal production, transportation and taxation are not well monitored (by the Forestry Department) resulting in a lot of leakages.

Are there national targets to reduce the incidence of acute respiratory infections?

- If so, which policies have been developed to enable this and are there a government budget assigned to it?
- Yes, national targets to reduce the incidences of acute respiratory infections are available and have a government budget assigned.

[2] Zambia Bureau of Standards

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- 7NDP[3], Vison 2030, Zambia National Healthy Strategic Plan 2017- 2021

Does cooking contribute towards national targets for nutrition, maternal health, etc.?

- Cooking is not directly linked to attainment of national targets for nutrition, maternal health, etc.

Are there national carbon emissions reductions targets?

- If so, which policies have been developed to enable this and are there a government budget assigned to it? Do they specifically mention cookstoves?
- Yes. The ZNDC[4] has set a target for reduction of carbon emissions of 38,000Gg by 2030. Proposed projects/programmes in the ZNDC have been developed to bankable proposals awaiting finance.
- Yes, implementation of use of clean and efficient cookstoves is among the proposed activities.

Is kerosene or LPG use for cooking encouraged or discouraged by current national policy?

- Yes, the use of kerosene and LPG has been encouraged in the national policy (National Energy Policy, NEP 2008).

Is the retail price of kerosene and LPG fixed? If so, why and to what?

- Petroleum is an imported commodity in Zambia. The retail price of kerosene is therefore fixed by the government. The pricing is based on international oil prices and the exchange rate between the Zambian kwacha and the United States dollar. Kerosene is currently selling at ZMW 7.82.
- The price for LPG is not fixed but is regulated by ERB. In 2016, the ERB approved the regulatory framework on pricing LPG which recommended a light handed regulation by monitoring wholesale and retail prices for both imported and locally sourced LPG (Energy Sector Report, 2016).

3.1.1 Electrification, renewable energy and energy efficiency

3.1.1.1 Grid electrification

What is the state of the national grid?

Who has access and who does not, what are the key generation sources, how efficient is the transmission & distribution infrastructure, how frequent are blackouts/load shedding, does peak time demand exceed supply?

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[3] Seventh National Development Plan

[4] Zambia Nationally Determined Contribution

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- The electricity supply industry in Zambia mainly comprises of a vertically integrated state utility, ZESCO, and an energy service company CEC that purchases power from ZESCO and supplies it to the mines. In addition one independent power producer, Lunsemfwa Hydro Power Company, and some small- scale solar based energy service companies supplying power to some rural areas also participate in the industry[5].
- The ZESCO transmission grid comprises transmission lines and substations at 330 kV, 220 kV, 132 kV and 66 kV voltage levels. The backbone of the grid is built on a robust 330 kV system from the southern part of the country where the major generating stations are located through Lusaka and Central provinces to the Copperbelt.
- Transmission and distribution losses in 2009 were 23%, or approximately 2,407 GWh (https://www.reeep.org/zambia-2012).
- The figure below illustrates the passage of the Zesco grid.

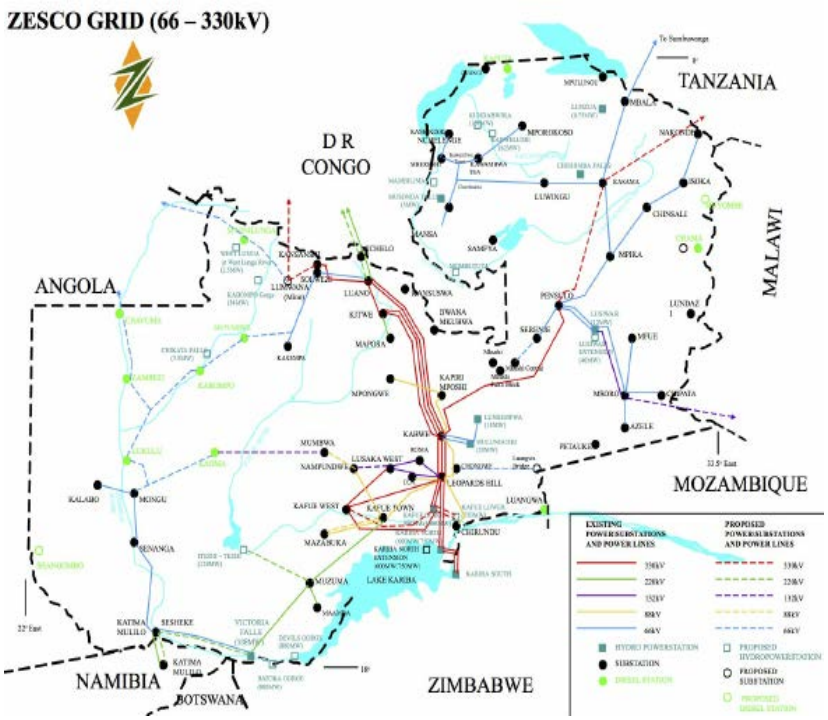

Figure 2: Existing and proposed power stations and transmission lines in the ZESCO grid[6].

[5] http://www.erb.org.zm/content.php?viewpage=eezps

[66] Source of map: Power Instability in Rural Zambia, Case Macha (PDF Download Available). Available from: https://www.researchgate.net/publication/263848421_Power_Instability_in_Rural_Zambia_Case_

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What policies currently enable/inhibit sustainable grid electrification?

- 7NDP- outlines broad strategies and reforms to enhance the supply of electricity for economic development. The objective is to expand and improve electricity generation, transmission and distribution, as well as encouraging the development of small and micro hydro power stations.
- The Electricity Act 2003- which is under review to enable independent power producers (IPPs) to sell power to any consumer other than Zesco Limited.
- (Please refer to https://www.daily-mail.co.zm/what-went-down-in-energy-sector-2017-in-review/. Accessed 14/5/2018)

3.1.1.2 Electricity access

Are there national targets for electricity access? If so, which policies have been developed to enable this and are there a government budget assigned to it?

- Yes, the set targets are from the current 49% to 90% for urban, and from 4% to 51% for rural by 2030 (Vision 2030).
- A government budget has been assigned towards activities for attainment of these targets.

Do the targets specify a service level (hours of availability, maximum power/energy, etc.)?

- No they do not.

What is the connection fee?

- Please refer to this document http://www.erb.org.zm/downloads/finalOtherCharges.pdf

Are subsidies, tax exemptions, utility loans/on-bill financing or micro-loans available to support connection fees for poorer/rural households?

- Subsidies were available under the SE4LL project with support from the World Bank. This allowed households in selected areas to get connected at a fee of ZMW150.

Is there a standard tariff structure for residential customers (e.g. fixed rate, rising block, declining block)?

- Yes there is a standard tariff structure for residential customers. This is divided into R1 (up to 200 kWh, consumption in a month) and R2 (above 200 kWh, consumption in a month) with a fixed monthly charge of ZMW 18.23 for both groups. Refer to ERB website

Is there a cross-subsidised/social/lifeline tariff for poorer households?

Macha?_sg=XBNpSqNdYUuHHRv3fWYUByEV5uTCIXh-sEs_JNzWpnnlxjX6HuC1PtZcbfbHznXoJqn_Bs-yuw [accessed May 15 2018].

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- Please refer to this presentation: https://pubs.naruc.org/pub.cfm?id=538EAF8E-2354-D714-51A6-877DA1707117

Are grid connections pre-paid, post-paid or a mixture of the two?

- Please refer to this presentation: https://pubs.naruc.org/pub.cfm?id=538EAF8E-2354-D714-51A6-877DA1707117

3.1.1.3 Renewable energy

Are there national targets for increasing the proportion of renewable energy? If so, which policies have been developed to enable this and are there a government budget assigned to it?

- Target/goal: To generate 100 MW from solar, 200 MW from small hydro and 100 MW from biomass by 2030. In addition, it is envisaged that 500,000 solar home systems will be disseminated and 350,000 solar water heaters installed.
- Policy and key reform: For the renewable and alternative energy sources, the Government aims to continue putting in place appropriate measures to promote the role of these energy sources in the national energy mix
- The National Energy Policy is the guiding document for this. Yes a government budget has been assigned for this (Refer to the Yellow Book). Activities such as study of the potential for wind and geothermal energy potential are underway.

Is there a feed-in-tariff that is applicable to residential-scale generation?

- Residential-scale generation has been mentioned in the REfiT strategy but implementation has not yet started.

3.1.1.4 Energy efficiency

Are there national targets for energy efficiency? If so, which policies have been developed to enable this and are there a government budget assigned to it?

- Yes there are. The National Energy Policy is the guiding document.
- Target: Promote efficient energy use through energy conservation and substitution.
- Standards for energy efficiency have also been successfully developed.
- The following initiatives/activities at national level are been implemented: phasing out the use of incandescent bulbs in the country (Status: completed); Tax waivers have been introduced on importation of energy efficient equipment (Statutory Instrument 32 & 33 of 20080; introduction of prepaid metering system for public and private buildings; free distribution of Compact Fluorescent Lamps by ZESCO Limited (1million bulbs each year). So far in excess of 94MW realised; Free Energy audits by ZESCO limited; Introduction of low power factor surcharge for large power users (industry, mining, agriculture); and Energy saving awareness campaigns, e.g. commemoration of annual energy Week.

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- These initiatives/activities are accounted for in the government budget.

Does the national utility have a demand side management department/s? If so, what is their mandate and what activities have they carried out?

- Yes. The national utility, Zesco has a demand side management unit. Activities of the unit include: managing CFL distribution program; conducting energy audits and consumer awareness on energy usage; promotion of solar water heaters for households, SHS and Solar plants.

Are there time-of-use tariffs?

- Yes. Time of use tariffs are charged for maximum demand clients (industry), MD[7]1 to MD4, and these tariffs were increased by 75% in September 2017 (refer to Ministerial statement by Mr Mabumba).
- Also refer to https://pubs.naruc.org/pub.cfm?id=538EAF8E-2354-D714-51A6-877DA1707117

Are subsidies, tax exemptions, utility loans/on-bill financing or micro-loans available to support consumer purchasing of energy efficient appliances (especially cooking appliances)?

- Yes, tax exemptions are available on energy efficient appliances and equipment being imported but there is no utility loans/on-bill financing or micro-loans to support consumer (end-user) purchase these items.

3.1.1.5 Mini-grid & off-grid systems

What is the state of the mini-grid and off-grid electrification sectors?

How many mini-grids/standalone systems are in operation, what are the key generation sources, who developed/operates them, how many people do they serve, what level of service do they offer, what tariffs do they charge?

- Zengamina Power Limited (750kW): It is a stand-alone micro hydro power plant on the Zambezi River. It is privately owned by the North West Zambia Development Trust (NWZDT).Its base load comprises: residential customers (456 signed-up); Hospital, Mission & Boarding School; Commercial Farm (Irrigation); Cell phone towers; and Crusher and block making machine. ZPL is a generator, distributor and supply company in this area. According to a 2015 report, "current tariff is at US$ c 6.4/kWh. But ZPL prefer the tariff to be around US$ c 10 – 12/ kWh for the project to be successful. There is Government commitment to raise tariffs in the country to around US$ c 10.3/kWh to achieve cost reflectivity and this should help ZPL".

[7] MD is short for maximum demand

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- Mpanta solar mini-grid (60kW): The base load comprises households (450), market place, school, habour depots, churches and rural health centre. Developed by the Rural Electrification Authority (REA) with funding from UNIDO in Samfya District, Luapula. It is managed by the local cooperative. The tariff plan, as of 2015, is as shown in the figure below.
- Muhanya solar mini-grid (30kW): Public-private solar mini-grid implemented by Muhanya solar who won a grant (US$100, 000) under the Off- grid Energy Challenge funded by USADF, in partnership with Power Africa and the U.S.-based company General Electric. Currently, 60 households are connected. The households are charged ZMW5.00 per day. The mini-grid has been developed in Sinda District of Eastern Province. It is a stand-alone project.
- Six mini-grids are earmarked for development and they include four hydro and two solar. These are part of the NAMAs.

Which successful interventions have facilitated uptake of mini-grid and off-grid systems? Which have failed and why?

- There have been a number of funding opportunities for projects/programs to support implementation of mini-grid and off-grid systems. Among them are:
    - African Development Bank is financing renewable energy projects
    - Beyond the grid fund for Zambia (BTGFZ)
    - REA with assistance from UNIDO, the World Bank, etc. has been installing solar panels and SHS in selected places in Zambia. There main target are government clinics/hospitals and staff houses, chiefs palaces, schools and staff houses, offices and business entities.
    - 100 mega watts of solar photo –voltaics (PV) power project at Lusaka South Multi-facility Economic Zone (MFEZ). The project is been implemented through the Scaling Solar Programme spearheaded by Industrial Development Corporation (IDC)8.
    - One initiative that had seen some level of failure is the **Energy Service Companies (ESCOs)** in the Eastern Province of Zambia. Brief background is that government had subsidised the capital cost for rural electrification. Some selected households in Nyimba, Chipata and Lundazi were given 400 Solar PV Home Systems on a loan basis and were expected to pay back on a discounted rate after which, they were to assume ownership of the systems. It was envisaged that the proceeds would be used by government as a revolving fund to procure more solar PV systems which could then

[8] http://www.idc.co.zm/article/zambia-be-net-exporter-energy-18-months-president-lungu

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be distributed to other districts as a way of project expansion and increase in rural electrification rate (MEWD, 2013).

- However after the official withdrawal of support from the Swedish International Development Agency (SIDA) in November 2011, an evaluation of the project by DoE officers revealed that more than 50% of the systems supplied were no longer operational and the ESCOs were almost non-existent on the ground. Despite the ESCOs receiving training in solar home system installation, trouble shooting and maintenance, the number of technicians trained were too few compared to the number of solar systems that they were to work on. This resulted in a major weakness of the ESCOs failure to have a working monitoring system, giving chance to customers to vandalize the systems and even overload them resulting in systems malfunctioning (MEWD 2013).

Which business models have proven to be most scalable?

- Refer to http://www.enea-consulting.com/wp-content/uploads/2016/02/ENEA-Practical-Action-Developing-mini-grids-in-Zambia.pdf

3.1.1.5.1 Business models

Figure 3: Electricity units are often sold at small booths in Zambia, alongside airtime vouchers for mobile phones.

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Figure 4: Charcoal is often sold in small quantities by roadside food vendors. If they were to sell vouchers for just enough units to cook the beans they are selling, the difference in cost between the amount of charcoal and the amount of electricity you need to end up with the same tasty cooked beans would be much clearer.

What policies currently enable/inhibit mini-grid/off-grid electrification?

Are mini-grids legally allowed to operate? If so, can they be privately owned and are they allowed to charge a different tariff to the national grid?

- Yes, mini-grids are allowed to operate and can be privately owned. For example, Zengamina Power Limited (ZPL) in Ikelenge, North Western Province and it is privately owned. They are allowed to charge a different tariff but it has to be approved by the Energy Regulations Board (ERB). Example, refer to http://www.erb.org.zm/press/publications/newsletters/NL-2rd-2008.pdf

Are there national targets for mini-grid/off-grid electrification? If so, which policies have been developed to enable this and are there a government budget assigned to it?

- Yes. 45MW for mini/small hydro by 2019 and 18.15MW of off-grid hydro power by 2030 (refer to NAMAs).
- The National Energy Policy (2008) is the guiding document for mini-grid/off-grid electrification. The REMP provides a blue-print for their development. The Rural Electrification Fund provides part of the resources for renewable energy development projects (from government budget and international funding).

Do the targets specify a service level (hours of availability, maximum power/energy, specific energy services, etc.)?

- Yes. The REMP provides detailed information on the proposed energy sources.

Do subsidies or tax exemptions exist for mini-grids/off-grid systems or key components (solar panels, batteries, controllers, inverters, chargers etc.)?

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- Yes. Tax waivers for importation of energy efficient equipment such as Solar Photovoltaic modules; deep cycle batteries, solar water heaters, energy efficient lights, solar lights and solar pumps used for irrigation are currently in place.

3.2 Cross cutting issues

3.2.1 Electrification/clean cooking crossover

Is there any overlap between the clean cooking and electrification sectors (e.g. SHS suppliers also selling improved cookstoves, energy efficiency programs targeting electric cooking)?

- In a few instances, solar dealers are selling improved cook stoves. For example, Vitalite and emerging cooking solutions are such dealers. But in most cases, solar dealers are just specialized in solar products.

3.2.2 Gender

What role do women and men typically play in society?
Who are the main household decision makers?

- In households with husband and wife, decisions are made together and in other cases husbands have the final say. In female-headed households, the women make all the decisions.

How well educated are women and how does this compare to men? How are these roles changing?

- The Gender Status Report- Zambia 2012- 2014 notes the following:
    - According to the Zambia Demographic Health Survey (ZDHS) 2013-14, 8.4% of women aged 15-49 years compared to 3.7% of men of the same age group had never attended any level of formal Education.
    - More males compared to females were literate, 82.7% and 67.5%, respectively.
    - 48.8% of the total number of women aged 15-49 years were currently employed compared to 72% of men in the same age category.
    - 34.7% of married women with Cash earnings decided how their earnings were used, 49% decided jointly with their husbands, 16% said that their husbands decided how their earnings were used.
    - The men (22.5%) were more likely than women (9.4%) to have sole ownership a house. 30.4% of women owned assets jointly. 58.0% of men and 53.8% of women did not own a house

Have there been any initiatives to empower women? If so, how successful have they been?

- Yes, some initiatives to empower women have been devised. The empowerment of women through promotion of equal access to entrepreneurial opportunities and equity in the ownership of business in key economic sectors among the measures put in place. (Refer to

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the National Gender Policy and the Yellow book for budget allocations to support activities to empower women).

Have any electrification or clean cooking initiatives specifically targeted women as entrepreneurs, as well as end users?

- Electrification or clean cooking initiatives have targeted women particularly as end-users.

Are there national gender equity targets? If so, which policies have been developed to enable this and are there a government budget assigned to it?

- Yes. The National Gender Policy of 2014 is the guiding document. Gender has been mainstreamed into other policy and national development documents (including the 7NDP). The gender related measures have government budget assigned to them.

3.2.3 Business & finance

What are the key contextual factors that enable and constrain the development of new and existing businesses?

- Financing: This is a major factor that enables or constrains development of businesses. This is because of high interest normally charged by the banks making it difficult for individuals to acquire loans. In other cases, the collateral sort by the commercial bank is not in the possession of the individual. Micro-financing institutions could finance all kinds of small businesses but need guarantee keep running.
- Lack of advertising: businesses do not put much effort and to some extent money in to advertising their products and services. Well-advertised products and services have a wider market.
- Consistence: Some businesses are not consistent with operation and supply of products and services. This somewhat discourages the customer.
- After-sale service: Most customers warm up to follow-ups and any after-sale service offered, especially on electrical products. Follow-up which include new technology information or ways to better use an appliance keep the customers and business running.
- Flexible payment scheme: Pay-as-you-go, instalments, etc. systems which allow the customer to 'breath' is most preferred. But these can be damaging to small businesses as income needs to be constantly flowing to keep the business afloat.
- Taxes: It has been noted that most imported products are taxed while local products are not. This is true for ICS. Maybe a fair ground on such products could make the products more competitive.

Are there specific government or market-based financing facilities designed to support developers of mini-grids/off-grid systems and/or manufacturers/retailers of cleaner cookstoves?

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- Yes. The Rural Electrification Fund (REF) managed under the Rural Electrification Authority (REA) does support the development of mini-grids/off-grid systems.
- Manufacturers/retailers of cleaner cookstoves are usually supported by projects funded by the international community.

Are there specific government or market-based financing facilities designed to support consumers of cleaner cookstoves/mini-grids/off-grid systems (e.g. village banking systems, community revolving funds, pay-as-you-go solutions, nationally subsidy programmes)?

- No

How developed is the mobile money industry?

- Mobile money is becoming more popular as a means to transfer money, make payments and also keep money.

Which organisations are using it to allow their customers to make repayments on cleaner cookstoves/mini-grids/off-grid systems?

- Fenix

3.2.4 Demographics

How many people live in urban/rural areas and how is this balance changing?

- The population of Zambia in 2016 was 15, 510 711. Of this, 58.62% was reported to be rural population (World Bank).
- It has been reported that 4% of the rural population have access to electricity (possibly of different forms). We can assume that 8,728 684 are living in rural off-grid areas without any access to electricity (i.e. 9,092 379 minus 4%).

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3.2.5 Climate

What are the monthly average temperatures and how do they vary across the country?

Table 5: Average monthly temperatures for Zambia for the period 1991- 2015[9].

Month	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Temp	23.3	23.5	23.4	22.3	20.5	18.3	17.8	20.4	23.4	25.4	25.1	23.9

Are cookstoves also used for space heating?

- Yes they are, especially while cooking is taking place.

Are batteries likely to be damaged by extreme heat or cold?

- Zambia's climate has been considered favourable and the heat/cold experienced may not cause damage to batteries.

What is the monthly average solar resource and how does it vary across the country?

- The country has an average 2000 - 3000 hours of sunshine per year. Average irradiation is 5.5 kWh/m2/day, with northern areas recording the highest global solar irradiation of 2300 kWh/m2/year.

[9] The dataset from which the table above is derived was produced by Climatic Research Unit of University of East Anglia - http://sdwebx.worldbank.org/climateportal/index.cfm?page=country_historical_climate&ThisCCode=ZMB

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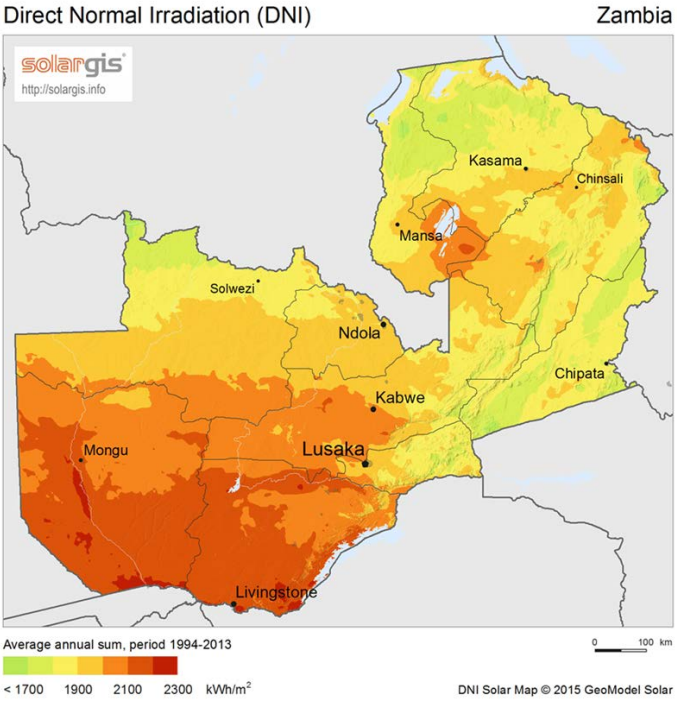

Figure 5: Solar Irradiation in Zambia (kWh/m2).

Are there extended cloudy periods?

- No

Where are the key hydropower resources located?

- The key hydro power resources are located in the southern part of Zambia. These are Kariba dam, Itezhi- tezhi dam, Vitoria Falls and Kafue gorge. There are two main rivers that pass through these hydro power sources, namely Zambezi and Kafue.

What is the potential for micro-hydro powered mini-grids and what are the limitations due to seasonality?

- In the Rural Electrification Master Plan Study, development of micro hydro power plants was considered to be an option to enhance rural electrification in some remote areas in Zambia. According to the estimate of some preceding studies, Zambia has a potential of hydropower generation of more than 6,000 MW and only 1,700MW out of that has been developed so far.
- Information was obtained from District Planners through the Rural Electrification Workshops held in each Provincial centre. There were two main conditions to determine the existence of hydropower potential, namely the certain volume of water flow and the effective elevation gain of waterfall thus the information regarding the existence of waterfall around the un-electrified rural growth centres (RGCs) indicating the possibility of electrification through micro hydropower.

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- The proposed sites in the REMP suggest that North-western, Northern, and Luapula Province may have a lot of Micro-hydropower potential sites.

This research is funded by DfID/UK Aid and Gamos through the Innovate UK Energy Catalyst and the MECS programme.

4 Conclusion

This study has confirmed that there is a strong market for eCook products and services in Zambia, however there are a number of regulatory challenges that need to be addressed. Grid electricity is managed by a single state owned company, ZESCO, and generation is almost entirely from hydroelectric sources. In recent years, late rainfall has forced ZESCO to implement load shedding to balance demand with supply. ZESCO now has a Demand Side Management department, who have shown a keen interest in the eCook concept. Zambia has a huge off-grid population and emerging mini-grid and solar markets, primarily focussed on lighting solutions. In rural areas, firewood is the most widely used fuel for cooking, whilst in urban areas, most households fuel stack charcoal and electricity, depending on which foods they are cooking and whether there are blackouts at mealtimes or not. Zambia has seen a range of clean cooking initiatives, the majority focussed on improved biomass stoves. Zambia's most popular stove, the mbaula, is extremely inefficient, as it is entirely constructed from metal, with no insulation to focus the heat onto the pot. However, to date, there have been few clean cooking projects looking at electric cooking, as ZESCO are actively encouraging their users to switch to LPG in an attempt to reduce the loading on the grid and prevent further load shedding.

The findings from this national policy and markets review will be combined with those from the other activities that have been carried under the eCook Zambia Market Assessment. Together they will build a more complete picture of the opportunities and challenges that await this emerging concept. Further outputs will be available from https://elstove.com/innovate-reports/ and www.mecs.org.uk.

This research is funded by DfID/UK Aid and Gamos through the Innovate UK Energy Catalyst and the MECS programme.

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6 Appendix

6.1 Appendix A: Problem statement and background to Innovate eCook project

6.1.1 Beyond business as usual

The use of biomass and solid fuels for cooking is the everyday experience of nearly 3 Billion people. This pervasive use of solid fuels—including wood, coal, straw, and dung—and traditional cookstoves results in high levels of household air pollution, extensive daily drudgery required to collect fuels, and serious health impacts. It is well known that open fires and primitive stoves are inefficient ways of converting energy into heat for cooking. The average amount of biomass cooking fuel used by a typical family can be as high as two tons per year. Indoor biomass cooking smoke also is associated with a number of diseases, including acute respiratory illnesses, cataracts, heart disease and even cancer. Women and children in particular are exposed to indoor cooking smoke in the form of small particulates up to 20 times higher than the maximum recommended levels of the World Health Organization. It is estimated that smoke from cooking fuels accounts for nearly 4 million premature deaths annually worldwide –more than the deaths from malaria and tuberculosis combined.

While there has been considerable investment in improving the use of energy for cooking, the emphasis so far has been on improving the energy conversion efficiency of biomass. Indeed in a recent overview of the state of the art in Improved Cookstoves (ICS), ESMAP & GACC (2015), World Bank (2014), note that the use of biomass for cooking is likely to continue to dominate through to 2030.

> "Consider, for a moment, the simple act of cooking. Imagine if we could change the way nearly five hundred million families cook their food each day. It could slow climate change, drive gender equality, and reduce poverty. The health benefits would be enormous." ESMAP & GACC (2015)

The main report goes on to say that "The "business-as-usual" scenario for the sector is encouraging but will fall far short of potential." (ibid,) It notes that without major new interventions, over 180 million households globally will gain access to, at least, minimally improved[10] cooking solutions by the end of the decade. However, they state that this business-as-usual scenario will still leave over one-half (57%) of the developing world's population without access to clean cooking in 2020, and 38% without even minimally improved cooking solutions. The report also states that 'cleaner' stoves are barely affecting the health issues, and that only those with forced gasification make a significant

[10] A minimally improved stove does not significantly change the health impacts of kitchen emissions. "For biomass cooking, pending further evidence from the field, significant health benefits are possible only with the highest quality fan gasifier stoves; more moderate health impacts may be realized with natural draft gasifiers and vented intermediate ICS" (ibid)

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improvement to health. Against this backdrop, there is a need for a different approach aimed at accelerating the uptake of truly 'clean' cooking.

Even though improved cooking solutions are expected to reach an increasing proportion of the poor, the absolute numbers of people without access to even 'cleaner' energy, let alone 'clean' energy, will increase due to population growth. The new Sustainable Development Goal 7 calls for the world to "ensure access to affordable, reliable, sustainable and modern energy for all". Modern energy (electricity or LPG) would indeed be 'clean' energy for cooking, with virtually no kitchen emissions (other than those from the pot). However, in the past, modern energy has tended to mean access to electricity (mainly light) and cooking was often left off the agenda for sustainable energy for all.

Even in relation to electricity access, key papers emphasise the need for a step change in investment finance, a change from 'business as usual'. IEG World Bank Group (2015) note that 22 countries in the Africa Region have less than 25 percent access, and of those, 7 have less than 10 percent access. Their tone is pessimistic in line with much of the recent literature on access to modern energy, albeit in contrast to the stated SDG7. They discuss how population growth is likely to outstrip new supplies and they argue that "unless there is a big break from recent trends the population without electricity access in Sub-Saharan Africa is projected to increase by 58 percent, from 591 million in 2010 to 935 million in 2030." They lament that about 40% of Sub-Saharan Africa's population is under 14 years old and conclude that if the current level of investment in access continues, yet another generation of children will be denied the benefits of modern service delivery facilitated by the provision of electricity (IEG World Bank Group, 2015).

> "Achieving universal access within 15 years for the low-access countries (those with under 50 percent coverage) requires a quantum leap from their present pace of 1.6 million connections per year to 14.6 million per year until 2030." (ibid)

Once again, the language is a call for a something other than business as usual. The World Bank conceives of this as a step change in investment. It estimates that the investment needed to really address global electricity access targets would be about $37 billion per year, including erasing generation deficits and additional electrical infrastructure to meet demand from economic growth. "By comparison, in recent years, low-access countries received an average of $3.6 billion per year for their electricity sectors from public and private sources" (ibid). The document calls for the Bank Group's energy practice to adopt a new and transformative strategy to help country clients orchestrate a national, sustained, sector-level engagement for universal access.

In the following paragraphs, we explore how increasing access to electricity could include the use of solar electric cooking systems, meeting the needs of both supplying electricity and clean cooking to a number of households in developing countries with sufficient income.

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6.1.2 Building on previous research

Gamos first noted the trends in PV and battery prices in May 2013. We asked ourselves the question, is it now cost effective to cook with solar photovoltaics? The answer in 2013 was 'no', but the trends suggested that by 2020 the answer would be yes. We published a concept note and started to present the idea to industry and government. Considerable interest was shown but uncertainty about the cost model held back significant support. Gamos has since used its own funds to undertake many of the activities, as well as IP protection (a defensive patent application has been made for the battery/cooker combination) with the intention is to make all learning and technology developed in this project open access, and awareness raising amongst the electrification and clean cooking communities (e.g. creation of the infographic shown in Figure 6 to communicate the concept quickly to busy research and policy actors).

Gamos has made a number of strategic alliances, in particular with the University of Surrey (the Centre for Environmental Strategy) and Loughborough University Department of Geography and seat of the Low Carbon Energy for Development Network). In October 2015, DFID commissioned these actors to explore assumptions surrounding solar electric cooking[11] (Batchelor, 2015b; Brown and Sumanik-Leary, 2015; Leach and Oduro, 2015; Slade, 2015). The commission arose from discussions between consortium members, DFID, and a number of other entities with an interest in technological options for cleaner cooking e.g. Shell Foundation and the Global Alliance for Clean Cookstoves.

Drawing on evidence from the literature, the papers show that the concept is technically feasible and could increase household access to a clean and reliable modern source of energy. Using a bespoke economic model, the Leach and Oduro paper also confirm that by 2020 a solar based cooking system could be comparable in terms of monthly repayments to the most common alternative fuels, charcoal and LPG. Drawing on published and grey literatures, many variables were considered (e.g. cooking energy needs, technology performance, component costs). There is uncertainty in many of the parameter values, including in the assumptions about future cost reductions for PV and batteries, but the cost ranges for the solar system and for the alternatives overlap considerably. The model includes both a conservative 5% discount rate representing government and donor involvement, and a 25% discount rate representing a private sector led initiative with a viable return. In both cases, the solar system shows cost effectiveness in 2020.

[11] The project has been commissioned through the PEAKS framework agreement held by DAI Europe Ltd.

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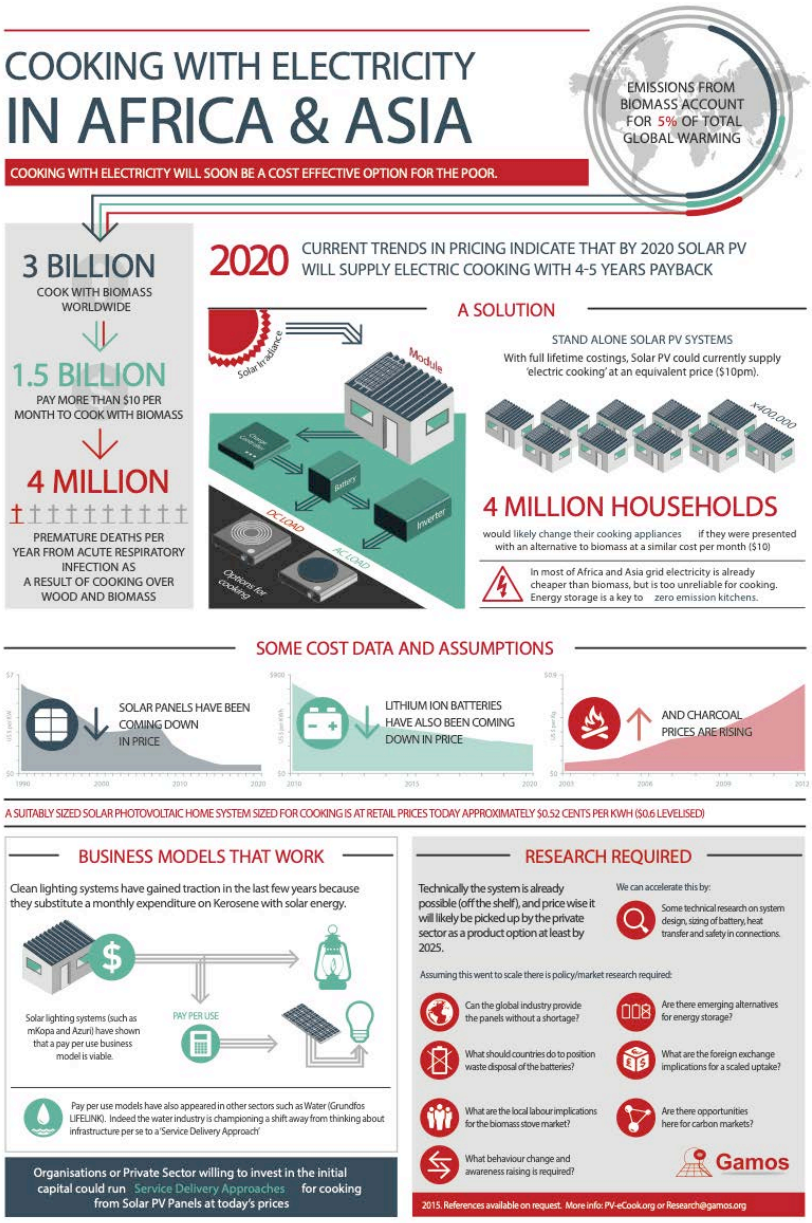

Figure 6 Infographic summarising the concept in order to lobby research and policy actors.

The Brown and Sumanik-Leary paper in the series examines the lessons learned from four transitions – the uptake of electric cooking in South Africa, the roll out of Improved Cookstoves (ICS), the use of LPG and the uptake of Solar Home Systems (SHS). They present many behavioural concerns, none of which preclude the proposition as such, but all of which suggest that any action to create a scaled use of solar electric cooking would need in depth market analysis; products that are modular and paired with locally appropriate appliances; the creation of new, or upgrading of existing, service networks; consumer awareness raising; and room for participatory development of the products and associated equipment.

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A synthesis paper summarising the above concludes by emphasising that the proposition is not a single product – it is a new genre of action and is potentially transformative. Whether solar energy is utilised within household systems or as part of a mini, micro or nano grid, linking descending solar PV and battery costs with the role of cooking in African households (and the Global South more broadly) creates a significant potential contribution to SDG7. Cooking is a major expenditure of 500 million households. It is a major consumer of time and health. Where households pay for their fuelwood and charcoal (approximately 300 Million) this is a significant cash expense. Solar electric cooking holds the potential to turn this (fuelwood and charcoal) cash into investment in modern energy. This "consumer expenditure" is of an order of magnitude more than current investment in modern energy in Africa and to harness it might fulfil the calls for a step change in investment in electrical infrastructure.

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6.1.3 Summary of related projects

A series of inter-related projects have led to and will follow on from the research presented in this report:

- Gamos Ltd.'s early conceptual work on eCook (Batchelor, 2013).
  - The key **CONCEPT NOTE** can be found here.
  - An early infographic and a 2018 infographic can be found here.
- Initial technical, economic and behavioural feasibility studies on eCook commissioned by DfID (UK Aid) through the CEIL-PEAKS Evidence on Demand service and implemented by Gamos Ltd., Loughborough University and University of Surrey.
  - The key **FINAL REPORTS** can be found here.
- Conceptual development, stakeholder engagement & prototyping in Kenya & Bangladesh during the "*Low cost energy-efficient products for the bottom of the pyramid*" project from the USES programme funded by DfID (UK Aid), EPSRC & DECC (now part of BEIS) & implemented by University of Sussex, Gamos Ltd., ACTS (Kenya), ITT & UIU (Bangladesh).
  - The key **PRELIMINARY RESULTS** (Q1 2019) can be found here.
- A series of global & local market assessments in Myanmar, Zambia and Tanzania under the "*eCook - a transformational household solar battery-electric cooker for poverty alleviation*" project funded by DfID (UK Aid) & Gamos Ltd. through Innovate UK's Energy Catalyst Round 4, implemented by Loughborough University, University of Surrey, Gamos Ltd., REAM (Myanmar), CEEEZ (Zambia) & TaTEDO (Tanzania).
  - The key **PRELIMINARY RESULTS** (Q1 2019) can be found here.
- At time of publication (Q1 2019), a new DfID (UK Aid) funded research programme '*Modern Energy Cooking Services*' (MECS) lead by Prof. Ed Brown at Loughborough University is just beginning and will take forward these ideas & collaborations.

This data and material have been funded by UK AID from the UK government; however, the views expressed do not necessarily reflect the UK government's official policies.

6.1.4 About the Modern Energy Cooking Services (MECS) Programme.

Sparking a cooking revolution: catalysing Africa's transition to clean electric/gas cooking.

www.mecs.org.uk | mecs@lboro.ac.uk

Modern Energy Cooking Services (MECS) is a five-year research and innovation programme funded by UK Aid (DFID). MECS hopes to leverage investment in renewable energies (both grid and off-grid) to address the clean cooking challenge by integrating modern energy cooking services into the planning for access to affordable, reliable and sustainable electricity.

Existing strategies are struggling to solve the problem of unsustainable, unhealthy but enduring cooking practices which place a particular burden on women. After decades of investments in improving biomass cooking, focused largely on increasing the efficiency of biomass use in domestic stoves, the technologies developed are said to have had limited impact on development outcomes. The Modern Energy Cooking Services (MECS) programme aims to break out of this "business-as-usual" cycle by investigating how to rapidly accelerate a transition from biomass to genuinely 'clean' cooking (i.e. with electricity or gas).

Worldwide, nearly three billion people rely on traditional solid fuels (such as wood or coal) and technologies for cooking and heating[12]. This has severe implications for health, gender relations, economic livelihoods, environmental quality and global and local climates. According to the World Health Organization (WHO), household air pollution from cooking with traditional solid fuels causes to 3.8 million premature deaths every year – more than HIV, malaria and tuberculosis combined[13]. Women and children are disproportionally affected by health impacts, and bear much of the burden of collecting firewood or other traditional fuels.

Greenhouse gas emissions from non-renewable wood fuels alone total a gigaton of CO_2e per year (1.9-2.3% of global emissions)[14]. The short-lived climate pollutant black carbon, which results from incomplete combustion, is estimated to contribute the equivalent of 25 to 50 percent of carbon dioxide warming globally – residential solid fuel burning accounts for up to 25 percent of global black

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[12] http://www.who.int/indoorair/health_impacts/he_database/en/

[13] https://www.who.int/en/news-room/fact-sheets/detail/household-air-pollution-and-health https://www.who.int/gho/hiv/epidemic_status/deaths_text/en/, https://www.who.int/en/news-room/fact-sheets/detail/malaria, https://www.who.int/en/news-room/fact-sheets/detail/tuberculosis

[14] Nature Climate Change 5, 266–272 (2015) doi:10.1038/nclimate2491

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carbon emissions[15]. Up to 34% of woodfuel harvested is unsustainable, contributing to climate change and local forest degradation. In addition, approximately 275 million people live in woodfuel depletion 'hotspots' – concentrated in South Asia and East Africa – where most demand is unsustainable[16].

Africa's cities are growing – another Nigeria will be added to the continent's total urban population by 2025[17] which is set to double in size over the next 25 years, reaching 1 billion people by 2040. Within urban and peri-urban locations, much of Sub Saharan Africa continues to use purchased traditional biomass and kerosene for their cooking. Liquid Petroleum Gas (LPG) has achieved some penetration within urban conurbations, however, the supply chain is often weak resulting in strategies of fuel stacking with traditional fuels. Even where electricity is used for lighting and other amenities, it is rarely used for cooking (with the exception of South Africa). The same is true for parts of Asia and Latin America. Global commitments to rapidly increasing access to reliable and quality modern energy need to much more explicitly include cooking services or else household and localized pollution will continue to significantly erode the well-being of communities.

Where traditional biomass fuels are used, either collected in rural areas or purchased in peri urban and urban conurbations, they are a significant economic burden on households either in the form of time or expenditure. The McKinsey Global Institute outlines that much of women's unpaid work hours are spent on fuel collection and cooking[18]. The report shows that if the global gender gap embodied in such activities were to be closed, as much as $28 trillion, or 26 percent, could be added to the global annual GDP in 2025. Access to modern energy services for cooking could redress some of this imbalance by releasing women's time into the labour market.

To address this global issue and increase access to clean cooking services on a large scale, investment needs are estimated to be at least US$4.4 billion annually[19]. Despite some improvements in recent

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[15] http://cleancookstoves.org/impact-areas/environment/

[16] Nature Climate Change 5, 266–272 (2015) doi:10.1038/nclimate2491

[17] https://openknowledge.worldbank.org/handle/10986/25896

[18] McKinsey Global Institute. *The Power of Parity: How Advancing Women's Equality can add $12 Trillion to Global Growth*; McKinsey Global Institute: New York, NY, USA, 2015.

[19] The SE4ALL Global Tracking Report shows that the investment needed for universal access to modern cooking (not including heating) by 2030 is about $4.4 billion annually. In 2012 investment was in cooking was just $0.1 billion. Progress toward Sustainable Energy: Global Tracking Report 2015, World Bank.

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years, this cross-cutting sector continues to struggle to reach scale and remains the least likely SE4All target to be achieved by 2030[20], hindering the achievement of the UN's Sustainable Development Goal (SDG) 7 on access to affordable, reliable, sustainable and modern energy for all.

Against this backdrop, MECS draws on the UK's world-leading universities and innovators with the aim of sparking a revolution in this sector. A key driver is the cost trajectories that show that cooking with (clean, renewable) electricity has the potential to reach a price point of affordability with associated reliability and sustainability within a few years, which will open completely new possibilities and markets. Beyond the technologies, by engaging with the World Bank (ESMAP), MECS will also identify and generate evidence on other drivers for transition including understanding and optimisation of multi-fuel use (fuel stacking); cooking demand and behaviour change; and establishing the evidence base to support policy enabling environments that can underpin a pathway to scale and support well understood markets and enterprises.

The five year programme combines creating a stronger evidence base for transitions to modern energy cooking services in DFID priority countries with socio-economic technological innovations that will drive the transition forward. It is managed as an integrated whole, however the programme is contracted via two complementary workstream arrangements as follows:

- An Accountable Grant with Loughborough University (LU) as leader of the UK University Partnership.
- An amendment to the existing Administrative Arrangement underlying DFID's contribution to the ESMAP Trust Fund managed by the World Bank.

The intended outcome of MECS is a market-ready range of innovations (technology and business models) which lead to improved choice of affordable and reliable modern energy cooking services for consumers. Figure 7 shows how the key components of the programme fit together. We will seek to have the MECS principles adopted in the SDG 7.1 global tracking framework and hope that participating countries will incorporate modern energy cooking services in energy policies and planning.

[20] The 2017 SE4All Global Tracking Framework Report laments that, "Relative to electricity, only a small handful of countries are showing encouraging progress on access to clean cooking, most notably Indonesia, as well as Peru and Vietnam."

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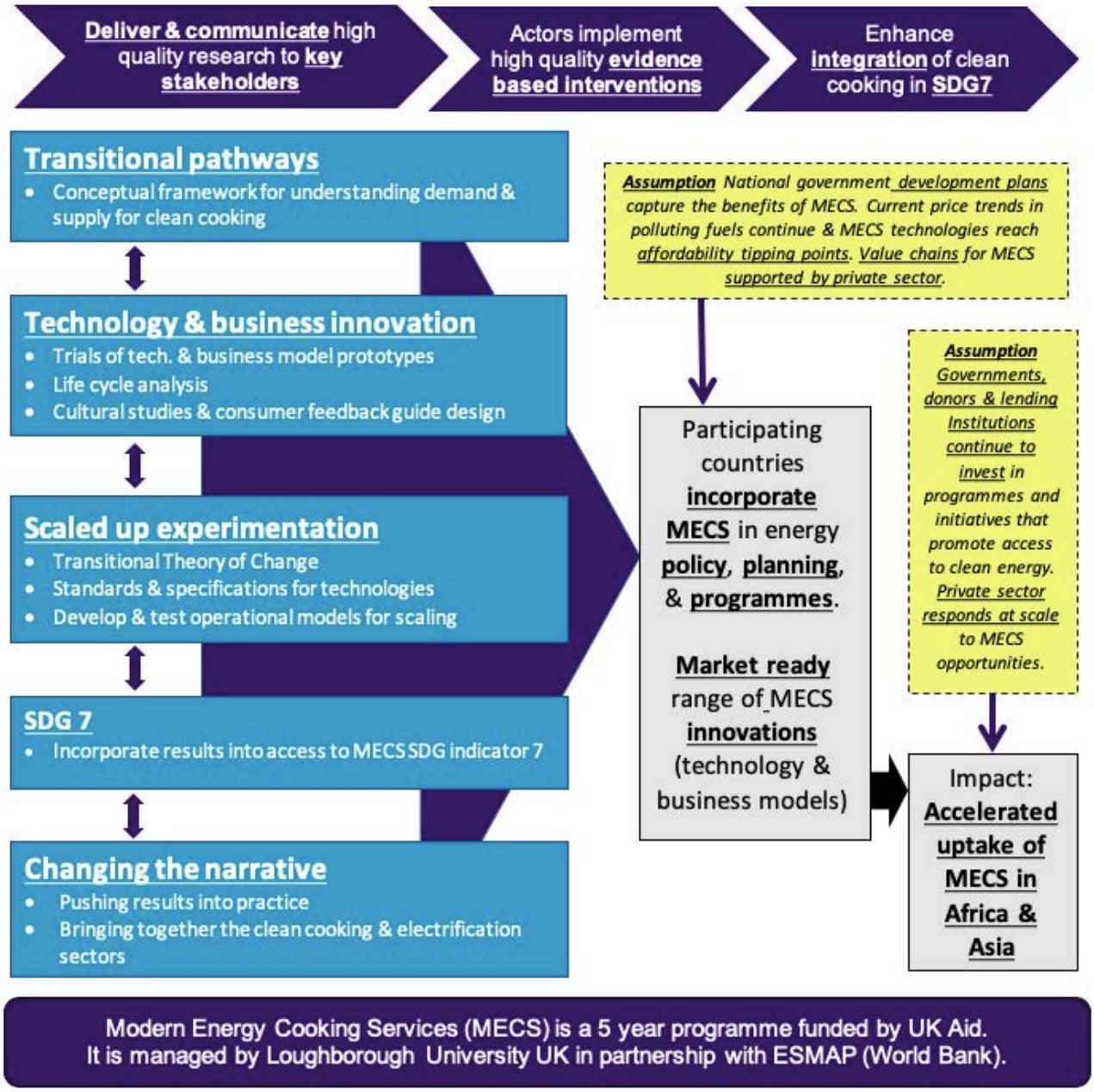

Figure 7: Overview of the MECS programme.

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6.2 Appendix B: Policy/markets review framework

For all factors, what is their current status and what is the likely future direction?

How do trends vary across the country, particularly from urban to rural areas?

6.2.1 Clean cooking

What is the state of the clean cooking sector?

- Who are the key government, NGO, research & private sector actors in the clean cooking sphere and what are their roles?
- What is the national cooking energy mix (i.e. how many people primarily cook with firewood, charcoal, kerosene, LPG & electricity)?
    - How is this changing?
        - Which successful interventions have facilitated transitions to cleaner cooking solutions? Which have failed and why?
        - How many biomass users have adopted improved stoves?
        - How and where are improved stoves manufactured?
    - What are the most popular cooking appliances?
        - How compatible are the popular electrical appliances with battery-supported electricity?
    - Are there national fossil fuel reserves? If so, how significant are they and how are they exploited?
- What do people cook and how do they cook it?
    - How does this vary across the country?
    - Is this changing?
- How many people are suffering from acute respiratory illnesses due to cooking on polluting fuels?
    - What initiatives have addressed this? How successful have they been?
- How severe is deforestation?
    - What initiatives have addressed this? How successful have they been?

Which policies currently enable or constrain the roll out of cleaner cooking solutions?

- Are there any specific targets for the quality of clean cooking solutions and the number of people who should gain access to them by a certain date?
    - If so, what policies have been developed to enable this and is there a government budget assigned to it?
- Is there a national biomass energy or cleaner cooking strategy?
    - Is charcoal production/transportation/wholesale/retail legal? If so, is it taxed and by how much? If not, how does the sector get around the law?
- Are there national targets to reduce the incidence of acute respiratory infections?
    - If so, which policies have been developed to enable this and is there a government budget assigned to it?
    - Does cooking contribute towards national targets for nutrition, maternal health, etc.?
- Are there national carbon emissions reductions targets?
    - If so, which policies have been developed to enable this and is there a government budget assigned to it? Do they specifically mention cookstoves?
- Is kerosene or LPG use for cooking encouraged or discouraged by current national policy?

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- Is the retail price of kerosene and LPG fixed? If so, why and to what?

6.2.2 Electrification, renewable energy and energy efficiency

6.2.2.1 Grid electrification

What is the state of the national grid?

- Who has access and who does not, what are the key generation sources, how efficient is the transmission & distribution infrastructure, how frequent are blackouts/load shedding, does peak time demand exceed supply?
- Is there a single state-owned electrical utility or is there competition from the private sector?

What policies currently enable/inhibit sustainable grid electrification?

- Electricity access
  - Are there national targets for electricity access?
    - If so, which policies have been developed to enable this and is there a government budget assigned to it?
    - Do the targets specify a service level (hours of availability, maximum power/energy, etc.)?
  - What is the connection fee?
    - Are subsidies, tax exemptions, utility loans/on-bill financing or micro-loans available to support connection fees for poorer/rural households?
  - Is there a standard tariff structure for residential customers (e.g. fixed rate, rising block, declining block)?
    - Is there a cross-subsidised/social/lifeline tariff for poorer households?
    - Are grid connections pre-paid, post-paid or a mixture of the two?
- Renewable energy
  - What is the current energy mix for the national grid?
  - Are there national targets for increasing the proportion of renewable energy?
    - If so, which policies have been developed to enable this and is there a government budget assigned to it?
  - Is there a feed-in-tariff that is applicable to residential-scale generation?
- Energy efficiency
  - Are there national targets for energy efficiency?
    - If so, which policies have been developed to enable this and is there a government budget assigned to it?
  - Do/es the national utility/ies have a demand side management department/s? If so, what is their mandate and what activities have they carried out?
  - Are there time of use tariffs?
  - Are subsidies, tax exemptions, utility loans/on-bill financing or micro-loans available to support consumer purchasing of energy efficient appliances (especially cooking appliances)?

6.2.2.1.1 Mini-grid & off-grid systems

What is the state of the mini-grid and off-grid electrification sectors?

- How many mini-grids/standalone systems are in operation, what are the key generation sources, who developed/operates them, how many people do they serve, what level of service do they offer, what tariffs do they charge?

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- Which successful interventions have facilitated uptake of mini-grid and off-grid systems? Which have failed and why?
    - Which business models have proven to be most scalable?

What policies currently enable/inhibit mini-grid/off-grid electrification?

- Are mini-grids legally allowed to operate? If so, can they be privately owned and are they allowed to charge a different tariff to the national grid?
- Are there national targets for mini-grid/off-grid electrification?
    - If so, which policies have been developed to enable this and is there a government budget assigned to it?
    - Do the targets specify a service level (hours of availability, maximum power/energy, specific energy services, etc.)?
    - Do subsidies or tax exemptions exist for mini-grids/off-grid systems or key components (solar panels, batteries, controllers, inverters, chargers etc.)?

6.2.2.2 Cross cutting issues

- Electrification/clean cooking crossover
    - Is there any overlap between the clean cooking and electrification sectors (e.g. SHS suppliers also selling improved cookstoves, energy efficiency programs targeting electric cooking)?
- Gender
    - What role do women and men typically play in society?
        - Who are the main household decision makers?
        - How well educated are women and how does this compare to men?
        - How are these roles changing?
    - Have there been any initiatives to empower women? If so, how successful have they been?
        - Have any electrification or clean cooking initiatives specifically targeted women as entrepreneurs, as well as end users?
    - Are there national gender equity targets?
        - If so, which policies have been developed to enable this and is there a government budget assigned to it?
- Business & finance
    - What are the key contextual factors that enable and constrain the development of new and existing businesses?
    - Are there specific government or market-based financing facilities designed to support developers of mini-grids/off-grid systems and/or manufacturers/retailers of cleaner cookstoves?
    - Are there specific government or market-based financing facilities designed to support consumers of cleaner cookstoves/mini-grids/off-grid systems (e.g. village banking systems, community revolving funds, pay-as-you-go solutions, nationally subsidy programmes)?
    - How developed is the mobile money industry?
        - Which organisations are using it to allow their customers to make repayments on cleaner cookstoves/mini-grids/off-grid systems?
    - What interest rate would a) private sector and b) utility actors would use when developing their business models?
    - International trade and domestic manufacturing
        - How strong are local manufacturing industries?

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        - How established are supply chains for importing equipment from China?
            - How much extra does it cost and how long does it take to import $10, $100, $1000, $10,000 or $100,000 of solar panels and batteries from China (including shipping and/or road transport, import duties and VAT)?
- Demographics
    - How many people live in urban/rural areas and how is this balance changing?
        - How many people live in urban slums and rural grid connected areas?
        - How many people live in rural off-grid areas?
- Climate
    - What are the monthly average temperatures and how do they vary across the country?
        - Are cookstoves also used for space heating?
        - Are batteries likely to be damaged by extreme heat or cold?
    - What is the monthly average solar resource and how does it vary across the country?
        - Are there extended cloudy periods?
    - Where are the key hydropower resources located?
        - What is the potential for micro-hydro powered mini-grids and what are the limitations due to seasonality?

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