Basic use of electricity for cooking (Zambia)

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The USAID Zambia Alternatives to Charcoal (A2C) Activity works to reduce urban dependence on charcoal as an energy source in Zambia and catalyze the increased use of low emissions alternative technologies and fuels (ATFs) to reduce charcoal production-driven deforestation and greenhouse gas emissions. The contents of this document do not necessarily reflect the views of USAID or the United States Government.

Background

Electricity is the primary clean cooking solution in Zambia with 16% of households nationally cooking with electricity, increasing to 34% in urban areas and 41% in Lusaka. This is driven by the relatively low cost of electricity (second lowest in the region according to the Energy Regulatory Board) and high connection rates, ranging between 67% in urban areas and 70% in Lusaka specifically[1]. Not only is the fuel readily accessible and reasonably affordable, it is considered not just acceptable, but aspirational. Coupled with high awareness, and accessibility, of electric cooking appliances, covering a range of uses and prices, it is clear to see why it has become such a widely adopted cooking option. However, adoption of electric cooking does fall dramatically as income levels decrease, while at the same time charcoal use is still prevalent, even in high income urban groups, as part of their fuel stack. This is driven by a combination of "load shedding" which impacts accessibility and the perception that electricity is expensive[2].

The government of Zambia is committed to strengthening the technical performance and longer-term sustainability of the national grid, operated by ZESCO, the state-owned utility company. Because the generation mix is 80% hydropower, low rainfall in 2015 and 2016 led to widespread quality of supply problems (power cuts). Generating capacity has since increased and ZESCO claim that these problems have been overcome. Zambian customers once enjoyed some of the lowest tariffs on the continent, but substantial price increases were introduced in 2017 as a step towards cost recovery pricing. These increases seem to have contributed to the widely held perception that electric cooking is expensive.

The government of Zambia have embarked on a policy of reducing the use of electricity for cooking. The urban clean cooking energy scenario of 20-40-20-20 is intended to reduce the proportion of urban households cooking with electricity from 35% to 20%, and to increase the use of LPG from negligible levels to 40% of households (The Republic of Zambia Ministry of Energy, 2019). The reason for reducing electricity use is to alleviate demand on the grid network. Inefficient cooking devices are blamed for high levels of demand, particularly at peak hour (19:00) when most households are cooking dinner.

The government commissioned a Cost of Service Study as part of its efforts to establish cost-reflective tariffs. The report was initially expected to be completed in 2019, however it is now expected to be ready by the end of 2021[3]. ZESCO currently operates a tiered residential tariff structure, meaning that consumers pay less for their electricity if their consumption falls within the Residential 1, or 'lifeline', tariff band (see Table 1).

Table 1 ZESCO tariffs 2021 (Facebook)

	Household consumption (kWh/month)	Unit cost (WMW/kWh)
Residential 1	0-100	0.56[4]
Residential 2	101-300	1.01
Residential 3	> 300	2.31

[1] Living Conditions Monitoring Survey 2015
[2] USAID A2C Consumer Preference Study 2021
[3] https://www.africa-energy.com/article/zescos-debt-balloons-35bn - accessed on 10 November 2021.
[4] This equates to 0.032 USD/kWh (at exchange rates of 17.5 ZMW/USD).

Forthcoming tariff revisions following on from the Cost of Service Study will need to determine the lifeline tier consumption threshold, which requires a determination of what constitutes 'basic' electricity needs. Poorly designed tariffs, if incorrectly judged, can lead to weak conservation outcomes through either encouraging excessive energy usage due to the provision of wide subsidised lifeline bands, or, if too expensive, causing a shift to cheaper "dirtier" power sources such as charcoal[5].

The USAID funded Alternatives to Charcoal (A2C) activity and the UK Aid-funded Modern Energy Cooking Services (MECS) project would like to make the case for electric cooking to be included as a basic need in this context. Setting the threshold high enough to include basic cooking needs means that grid connected households will have the option to include electricity as part of their clean cooking solutions. This would help stop households switching back to charcoal, which occurred between 2015 and 2018, when tariffs increased and the proportion of households cooking with electricity fell from 16% to 9% nationally[6]. This option is becoming increasingly cost effective as charcoal and fossil fuel prices continue to rise. The diverse and informal nature of the charcoal industry allows it to penetrate to different consumer segments, however without strict regulations, this can result in inequitable price changes which are unfavourable to some consumers. For example, the urban poor, faced with acute cash flow constraints, tend to pay the highest prices for charcoal, buying in small amounts from local vendors. In terms of energy justice, electricity is priced more equitably, as tariffs are applied uniformly. Furthermore, if lifeline tariffs are sufficient to meet electric cooking needs, then this opens valuable opportunities for just, clean energy transitions among the poor.

Although the current policy promotes the use of LPG, both supply and pricing will be subject to uncertainty, therefore it is important to provide consumers with alternative clean cooking options such as electricity. Zambia produces its own LPG from the INDENI refinery. LPG is a by-product of the oil refining process, and at current capacity levels (2018), some LPG is flared off (Mwila et al., 2019), indicating that there is adequate supply to meet increased demand. However, feedstock for the refinery is imported and supplied via pipeline from Tanzania (*ibid*). Landing and transport facilities based in another country constitutes something of a vulnerability. Although Zambia can claim to manufacture its own LPG, imported feedstock also constitutes a foreign currency burden in much the same was as countries facing mounting bills for importing LPG (e.g. in Indonesian fuel subsidies, mostly for LPG, account for 6% of state expenditure (Kuehl et al., 2021)). Furthermore, the refinery has been out of action for all of 2021[7], meaning all LPG is currently being imported as finished product, driving the cost up for consumers, highlighting risks associated with a centralised energy supply.

This paper draws on previous work undertaken by the MECS programme in Zambia to provide an estimate of the amount of electrical cooking energy that should be included as a basic need in determining the lifeline tariff threshold.

Data sources

This paper draws on data generated by two studies under the MECS programme, both of which were conducted as part of activities to understand consumer cooking behaviour specifically in Zambia. Both publications are available on the MECS website:

- eCook Zambia Cooking Diaries

[5] CUTS (2020), 'Targeting Residential Electricity Subsidies in Zambia', CUTS International, Lusaka.
[6] GRZ Gender equality Strategy and Action Plan for the Energy Sector of Zambia (Draft)
[7] https://www.spglobal.com/platts/en/market-insights/latest-news/oil/101221-refinery-news-roundup-some-maintenance-continues-in-africa - accessed 10 November 2021.

- MECS Kitchen Laboratory – Zambia

During the kitchen laboratory study, some of the more common dishes from Zambian cuisine were cooked using different devices using different devices. The purpose of the study was to mimic 'real' kitchen cooking practices to assess the actual energy and cost required to cook these typical dishes. The study made a comparison between two electric devices – a hotplate and an electric pressure cooker.

The Cooking Diaries study was less structured. Twenty participants simply recorded details of how they cook when cooking their normal weekly menus, using their normal fuels. Zambia was an unusual country because some of the participants used electricity as their normal cooking fuel. This was because the electricity tariffs were relatively low. Those participants who cooked mainly with charcoal were then given electric cooking devices (mostly hotplates) and asked to cook as much as possible using electricity.

The Cooking Diaries study gathered data on the dishes cooked, the number of people cooked for, the mix of fuels used, and the amount of fuels used, so it was possible to isolate some information on energy required to cook specific dishes.

Building up daily energy load

Given that most of the cooking in the electricity transition phase of the Cooking Diaries study was done on hotplates, this analysis has focused on cooking with electric hotplates. The consumption figures in Table 2 illustrate the spread of energy required from quick fry dishes (stir fry vegetables) to dishes that need to be boiled for a long time (bean stew).

Unlike the Kitchen Laboratory study, each meal recorded in the Cooking Diaries study was cooked for a different number of people. Therefore, specific energy consumption figures were calculated as means of making figures comparable (expressed as MJ/person/heating event). Meals cooked in the Kitchen Laboratory study were estimated to feed 3 people, so figures in Table 2 have been divided by three to give the specific figures in Table 3. The table shows that, for this limited number of dishes, there is a high degree of consistency in the energy consumption figures derived from the two, quite independent and different studies. This validates the consumption data generated by the Cooking Diaries study.

Table 2 Energy consumption to cook typical dishes on a hotplate (Kitchen Lab study)

Dish	Energy consumption (kWh)
Nshima	0.36
Bean stew	2.47
Chicken stew	0.33
Porridge	0.52
Vegetable (rape)	0.11

Table 3 Comparison of per capita energy consumption results from the two studies

Kitchen Lab		**Cooking diaries** (medians)		
Dish name	kWh/person	Dish name	MJ/person	kWh/person
Nshima	0.12	Nshima	0.47	0.13
Chicken stew	0.11	Meat/chicken/fish stew	0.38	0.11
Vegetable (rape)	0.04	Veg dish (leaves/pods/fruits)	0.23	0.06

At the next level up from individual dishes, the Cooking Diaries study extracts the electricity consumption for each meal – breakfast, lunch, and dinner. But how often are each of these meals cooked in a day? Participants were asked to record details for all meals prepared, so the ratio of meals recorded reflects how often each meal was prepared. It can be seen from Table 4 that dinners were the most commonly prepared meal. Based on the assumption that dinners were prepared every day, estimates of the average energy required to cook less frequently prepared meals (breakfast and lunch) have been based on these ratios. The total daily per capita energy consumption, including diversification of meals prepared, has been estimated at 0.23 kWh/person/day.

Table 4 Estimated contribution of each meal to total daily energy consumption (medians)

	Breakfast	Lunch	Dinner	Total
Energy consumption (MJ/pers/event)	0.08	0.4	0.45	
Mix of records	23.2%	30.4%	37.7%	91.3%
Relative proportion of meals	62%	81%	100%	
Adjusted energy consumption (MJ/pers/event)	0.05	0.32	0.45	0.82 (0.23 kWh/pers)

The Cooking Diaries study also extracted the total daily energy consumption among households that transitioned to cooking with electricity: 5.9 MJ/day (median) or 1.64 kWh/day. N.B. this is based on days in which only a single fuel was used. However, the mean number of people cooked for in these events was relatively high at 7.9 persons; this gives a per capita consumption of 0.21 kWh/person/day. There is, therefore, a good degree of consistency between the daily consumption data and the estimate built up from meal level data (Table 4).

Estimating basic cooking requirements

When considering the monthly amount of energy required to cook using electricity (compatible with lifeline tariff structures), several factors need to be considered:

- **Household size**. The small number of participants in the Cooking Diaries are by no means representative of the demographic of ZESCO consumers, so the number of people cooked for should be ignored, which is why the analysis has focused on per capita consumptions up to this point. Larger households will require more electricity for cooking, so the lifeline policy will need to consider what size of households the tariff will cover. Rural households tend to be larger than urban households (Figure 1); average household sizes are 4.7 for urban and 5.2 for rural households (Zambia Statistics Agency et al., 2019). If the tariff were based on a household size of 5, then this would not be enough to meet the cooking needs of over 40% of rural households (see Figure 1). For the purpose of this paper, cooking demands have been based on a household size of 8, which would reduce the number of inadequately covered rural households to approximately 10%.

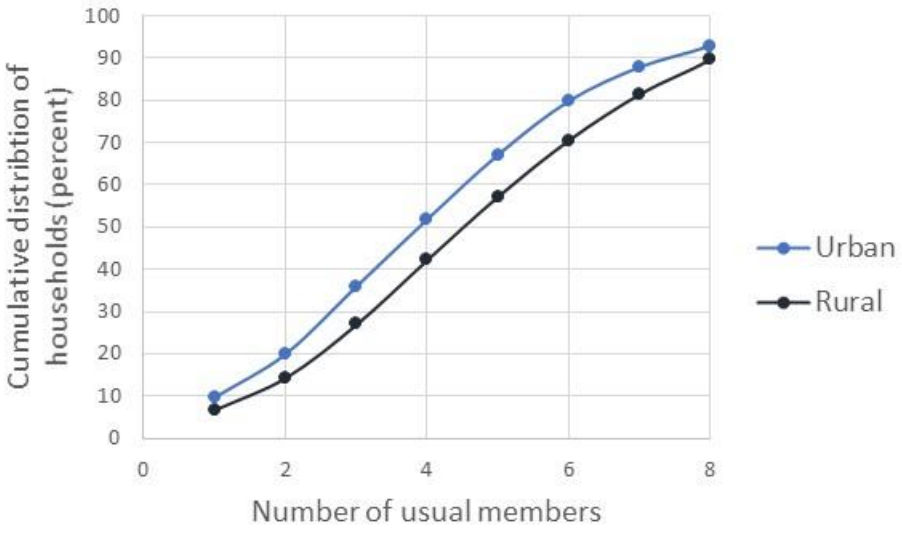

Figure 1 Cumulative distribution of households by household size (Zambia Statistics Agency et al., 2019)

- **Proportion of days when meals are cooked**. The analysis of daily energy consumption up to this point has considered only days on which electricity was used for cooking. In practice, people don't cook every day, so some diversification can be introduced. An adjusted energy consumption figure can be estimated from data on the proportion of days in which each type of meal was prepared (from the Cooking diaries study) – see Table 5.

Table 5 Estimated contribution of each meal to total diversified daily energy consumption (medians)

	Breakfast	Lunch	Dinner	Total
Energy consumption (MJ/pers/event)	0.08	0.4	0.45	
Proportion of days with heating event	44.4%	61.6%	78.8%	
Adjusted energy consumption (MJ/pers/event)	0.04	0.25	0.35	0.64 (0.18 kWh/pers)

The reasons why people do not cook every day are not clear, but are expected to revolve around eating out (e.g. street vendors, fast foods, restaurants), and social engagements (e.g. visiting family and friends). It is likely that these issues are more likely to be enjoyed by urban and middle-class households (like the participants in the Cooking Diaries study). For the purposes of a lifeline tariff that is inclusive of rural and lower income households, it is argued that no diversification should be included.

- **Type of electrical cooking devices used**. As described earlier, the analysis has focused on cooking with electrical hotplates. These are cheap, portable devices that could be installed into Cooking Diaries participants' kitchens with minimal disruption. In 2017, 42% of households had access to electricity, and 47% used electric stoves for cooking, often stacked with charcoal (Luzi et al., 2019). Although this Multi-Tier Framework (MTF) report does not detail the type of electric stove used, evidence from the Cooking Diaries study suggests these are mostly large, combination cookers (hob and oven). The Cooking Diaries study included a cohort of participants that cooked with electricity before the study, who are likely to exhibit similar cooking practices to other Zambian households cooking with electricity. Data from the Cooking Diaries study suggests that these users consume approximately three times as much electricity as the households that transitioned from charcoal. There, is, therefore,

a case to be made for the lifeline tariff to accommodate this higher level of demand. However, the Cooking Diaries study speculated that such high consumption levels were partly due to inefficient cooking practices linked to low tariffs (little incentive to cook economically). If correct, then it would be hard to argue that profligate electricity use should be covered by a 'basic' cooking demand.

On this basis, the electricity required to meet the cooking demands of a household of 8 is estimated to be 55 kWh/month (30 days, based on 0.23 kWh/person/day). This would account for over half of the current lifeline tariff allowance of 100 kWh (Table 1). It has been estimated that 50 – 75 kWh would be enough for subsistence use such as basic lighting, basic water heating using a kettle, and operating a radio or TV for a typical low-income household[8]. Therefore, a future revision of the lifeline tariff in Zambia could be set at around 125 kWh per month to meet all 'basic needs', including electric cooking on an entry level appliance, such as a hotplate. Higher tariff prices for subsequent tariff bands should help to encourage more wealthy consumers to conserve electricity by switching to more efficient appliances, such as electric pressure cookers.

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