Final report

Facility level access to electricity and the efficiency of maternal and child health service provision in Zambia

Mashekwa Maboshe
Mundia Kabinga

May 2018

When citing this paper, please use the title and the following reference number:
S-41404-ZMB-1

International Growth Centre

DIRECTED BY LSE University of Oxford

FUNDED BY UKaid from the British people

INTRODUCTION

Access to energy is a critical enabler of healthcare, especially maternal and child health services in low income countries. Health facilities require basic energy for such services as lighting during child delivery, emergency night time care, and refrigeration of essential vaccines and medicines. In most developing countries however, the majority of healthcare facilities lack access to energy. A recent study by Adair-Rohani et al (2013) for example found that only 28% of health facilities in sub-Saharan Africa had reliable access to electricity. In Zambia, the Institute of Health Metrics and Evaluation (IHME) recently found that only 35% of rural health centres had a functional connection to the electricity grid (IHME, 2014).

In recognition of the importance of energy in improving health services, the United Nations' Sustainable Energy for All Initiative (SE4All) designated energy for maternal and child health as a high-impact opportunity (HIO) area. This high-level policy initiative aspires to improve the availability and quality of essential maternal and child health care in developing countries through the scale-up of energy access in health facilities. The initiative is thus crucial, particularly in low-resource countries where the attainment of 100 percent health coverage and universal access to energy by 2030 are top priorities.

While most developing countries, including Zambia are in the process of expanding energy access in health facilities, it is not immediately clear whether and how access to energy impacts health. A recent study by the World Health Organisation (WHO) produced the first framework for linking energy and health in low income countries. The study hypothesized various channels through which access to electricity could impact health outcomes. For instance access to electricity could increase facility working hours, improve staff retention and morale, facilitate refrigeration of medicines and vaccines, or enable staff to attend to night time emergencies. These mechanisms may serve to facilitate the provision of health care, especially among women and children. Due to a lack of any evidence on the impacts of electricity access on health, the study further called for empirical research to understand the various links between energy access and health (WHO, 2014). This paper is a direct response to the call for empirical evidence and focuses on whether access to energy improves the productivity of maternal and child health service provision in Zambia. Assessing productivity effects is particularly important in the context of low-resource and fiscally constrained countries such as Zambia. The results of this study will directly inform ongoing country-level planning for increasing energy access and health services in Zambia and the sub-Saharan Africa region.

INSTITUTIONAL AND POLICY CONTEXT

Zambia operates a multi-tier and –dimensional approach to policy and planning. In this regard, the twin mandates of formulating government policy and long term planning in the health and energy sectors are shared between the Ministries of Health (MoH), Energy and Water Development (MEWD), and more recently, National Development Planning (MNDP). Other government departments, viz-a-vis, the Ministries of Works and Supply (MWS), and Finance (MoF), play an auxiliary role in directing health and energy infrastructure upgrades, and mobilizing and disbursing of funds for the MoH and MEWD, respectively. The MoH provides an equitable healthcare package (GRZ, 2014) that utilizes a decentralized and referral-based system of health services supply. The objective of this system is to provide healthcare services as close to the family as possible, and requires a complex web of infrastructure, staffing, communication, transportation, and cold chain management logistics to supply maternal and child health services in a very sparsely populated country like Zambia (Interview with Assistant Director of Planning at the Ministry of Health, 2016). In terms of health delivery structures, the health services in Zambia are arranged as health posts, health centres, and three tiers of hospitals which, provide progressively specialized treatments (GRZ, 2012:10-11). Health posts are the lowest levels of health care: provide basic first aid as opposed to curative health services, and erected within a 5 kilometre radius of the nearest health centre. There are a little over 307 health posts in Zambia, and these cater for a catchment population of 1,000 to 7,000 people in an urban setting, and about 3,500 people in a rural area (GRZ, 2013). Health centres, comprise of both urban and rural health centres, and provide basic curative health services to 30,000-50,000 people in the urban setting, and 10,000 people in a rural setting. Currently, there are slightly over 409 Urban Health Centres (UHCs) and 1,131 Rural Health Centres in Zambia (GRZ, 2013). First level hospitals are known as district hospitals, 84 in number nationally, provide medical, surgical, obstetric and diagnostic services to a catchment area of 80,000 to 200,000 people (GRZ, 2013:20). Second level hospitals are referred to as provincial or general hospitals, serve a population of about 200,000 to 800,000 people with internal medicine, general surgery, paediatrics, obstetrics and gynaecology, dental, psychiatry, and intensive care services, and are 19 in total. Third level hospitals are called specialist or tertiary hospitals, 6 in number nationwide, cater for a catchment population of approximately 800,000 and above, and offer healthcare services in the sub specializations of internal medicine, surgery, paediatrics, obstetrics, gynaecology, intensive care, psychiatry, training and research (GRZ, 2013: 20).

Similarly, policy implementation within MEWD is undertaken by three semi-autonomous government agencies, namely Energy Regulation Board (ERB), Zambia Electricity Supply Corporation (ZESCO), and Rural Electrification Authority (REA). As a result of this excessively fragmented structure, it is quite challenging to synchronize polices and coordinate plans across this myriad of institutional actors.

The strategic policy focus of the MoH in the Revised Sixth National Development Plan (2014) is raising the availability of human resources for health and infrastructure. To crystallize this, MoH has embarked on programmes to construct 650 additional health posts country-wide, improve and expand 250 existing health centres, and up-grade first and second level hospitals into general and specialist hospitals respectively (GRZ, 2014:121). The strategic targets are to: (i) reduce the maternal mortality rates from 375 deaths per hundred thousand live births to 105 deaths per hundred thousand live births between 2010 and 2017, and (ii) decrease the infant mortality rate from 91 per thousand live births in 2011 to 56 in 2016 (GRZ, 2014). Historically, these two indicators have always performed better in urban than rural areas, presumably due to lack of access to healthcare and facilities in rural Zambia. These relatively lower maternal and child mortality rates in urban versus rural Zambia, also confirm that the issue of high mortality rates can be resolved by increasing access to healthcare and facilities (GRZ, 2006). A key concern with these infrastructure roll-outs is that they do not adequately reflect Zambia's very long-term population estimates and their associated healthcare services requirements. Another key concern is that these current programmes are that they are not properly aligned with the MEWD's electricity infrastructure expansion programmes.

The current policy focus of the MEWD is to ensure an adequate and reliable supply of energy at the lowest possible cost (GRZ, 2014:78). To realize this, MEWD has embarked on a review of the energy policy and legal framework, expanding capacity, liberalising transmission access, implementing the Rural Electrification Master Plan, and attaining cost-reflective tariffs. The strategic targets include an increase in rural electrification from 3 percent in 2013 to 8 percent in 2016 (GRZ, 2014:80). Also, the plan aims to increase the percentage of urban households with access to electricity from 25 per cent to 30 percent between 2012 and 2017 (GRZ, 2014). However, very little has been done within these electricity infrastructure expansion programmes to integrate overlapping sustainable development goals (SDG) (Interviews with Director of Strategy and Corporate Affairs at ZESCO and Assistant Director of Energy in the Ministry of Energy, 2016). More specifically, a prioritisation of the electrification of rural health facilities within affordable and clean energy programme goal (SDG #7) could translate into immediate and significant gains in the building of sustainable cities and communities (SDG # 11) and improving maternal and child health and well-being development goals (SDG #3).

Within the MEWD, the ERB undertakes the electricity tariff setting. Although the tariffs have been remarkably low for the last decade, there is increasing pressure to make these tariffs more cost reflective. Unfortunately, social services, such as health, have not been spared from these increments. In 2017, the energy charge per kilowatt hour for social services was a paltry 6 ngwee less than commercial electricity tariff of 0.54 ngwee per kilowatt hour (ERB, 2017). Similarly, the fixed charge for social services is a meagre12.6 ngwee less than commercial fixed monthly charge of 96.41 ngwee (ERB, 2017). These narrow deviations in tariff rates exemplify a detachment of the MoH from the electricity tariff setting process. Prospects for

MoH and health facilities to negotiate a preferential electricity tariff rate exist and should be capitalized on if the country is to broaden and sustain facility-level electricity access.

The national electricity utility, ZESCO, essentially plays two crucially important roles in broadening energy access to health facilities in Zambia. First, the utility acts as custodian of the electricity transmission network, and connects new health infrastructure to the national grid. Second, the utility also collects the rural electrification levy from all electricity consumers on behalf of the Government of the Republic of Zambia and REA. These roles have not been without their challenges. As a result of the increasing political pressures to operate the utility as a commercialised entity, ZESCO now charges MoH commercial rates (approximately US$ 2.5 million in capital contributions for extending the existing electricity grid, establishing a new sub-station, and providing a facility-level electricity connection) for all new rural health facility connections to the national grid (Interview with Director of Strategy and Corporate Services at ZESCO, 2016) which, severely undermines the roll out of new health services, and would-be attainment of the sustainable development goals. However, an opportunity exists for ZESCO to clarify its social and commercial strategy and objectives as a public utility, and purposefully subsidise the MoH’s new connections through integrated infrastructure planning and co-investment. With regard to the collection and remittance of the rural electrification levy, the main challenge is that ZESCO remit these funds to the pooled government account with the Bank of Zambia which, allows for a diversion of these funds. An opportunity therefore exists for the Ministry of Finance to either ring-fence these revenues and remit them to the Rural Electrification Authority (REA) in their entirety or amend the public financial management legislation to allow for ZESCO to remit the rural electrification levy directly to REA.

REA is a semi-autonomous government implementation agency that was established with the sole purpose of broadening and expediting electricity access in rural areas where a little more than 60 percent of Zambia’s population resides (Interviews with REA Staff, 2016). According to the Rural Electrification Authority Strategic Plan (2014), REA seeks to increase the rural electrification rate from 3% to 50% between 2010 and 2030 by expending US$ 50 million annually during this period. REA funds and oversees the implementation of projects that either extend the national grid to rural districts or establish off- grid mini-hydro-, solar-and diesel generator-based electricity solutions to rural health facilities, schools, business and households (Interview with REA Staff, 2016). To achieve its mandate, REA regularly liaises and works very closely with ZESCO, particularly on issues of grid extensions (Interviews with REA Staff, 2016). In other instances, the authority works with local and international contractors to install the off- grid mini-hydro-, solar- and diesel generator -based electricity solutions. However, similar interactions with MoH’s Planning and Infrastructure Departments are lacking, and require cultivation. Although REA evaluates and updates its short-term strategic plans frequently, the most recent evaluation being in 2014, the authority is severely under-resourced. It receives US$ 10 million of its US$ 50 million annual budget allocation at best (Interview with REA Staff, 2016), and as such, risks not realizing the 50% rural electrification target rate by 2030, which, in turn, has the potential to undermine the Sustainable Development Goals (SDGs) of improving electricity access and human well-being in rural Zambia.

METHODS

We employ a mixed methods approach to understand the link between facility level access to electricity and the productivity of maternal and child health services in Zambia. For the quantitative component of this study, we use non-parametric performance measurement techniques and a Tobit regression framework to rank facility efficiencies and evaluate the extent to which factors such as access to electricity impact on these efficiencies, respectively. In parallel, we conducted 17 qualitative semi-structured interviews with senior and mid-level bureaucrats and executives that are actively involved in planning, regulating, and implementing energy and health services in Zambia. The interviews inform the institutional and policy context, and as well as some of the recommendations. The various aspects of the research design are discussed in more detail below.

EFFICIENCY MEASUREMENT USING BASIC DEA

The efficiency scores in this paper will be measured using Data Envelopment Analysis (DEA) - a non-parametric performance measurement technique. The model dates back to the work of Farrell (1957) and Charnes et al (1978). DEA analyses technical efficiency by comparing the ratio of weighted outputs to weighted inputs for each of the decision making units (DMUs), to the ratios of homogeneous DMUs on the "best practice" frontier. DEA does a relative comparison of technical efficiency by assigning an efficiency score of 1 to DMUs with the highest efficiency ratios (DMUs on the frontier) and allocates scores less than 1 to the DMUs that lie below the best practice frontier. A DMU is efficient if it obtains a score of 1 and inefficient if it has a score of less than 1. In assigning the weights to inputs and outputs, DEA maximizes the ratio of outputs to inputs for a given DMU provided that the score attributed to that ratio, in relation to the scores of other DMUs, does not exceed 1. To determine the highest score for *n* DMUs, the relative technical efficiency is estimated (for each DMU with *m* inputs and *s* outputs) by solving the maximization problem below;

$$Max\ h_0 = {\sum_{r=1}^{s} u_r y_{rjo}} \Big/ {\sum_{i=1}^{m} v_i x_{ijo}}$$

Subject to:

$$\sum_{r=1}^{s} u_r y_{rj} \Big/ \sum_{i=1}^{m} v_i x_{ij} <= 1$$

Where h_0 is the efficiency score of the test DMU j_o, and y_{rj} is the amount of output r produced by DMU_j. x_{ij} is the amount of input i used by DMU_j. u_r and v_i are positive weights derived within the DEA optimisation solution. The weights are chosen to maximize each health facility's relative output-input ratio[1].

DEA solves the problem by finding the highest score of each DMU given the weights assigned to inputs and outputs. The standard DEA above is the constant returns to scale (CSR) technology. Other alternative specifications include the flexible DEA model by Banker et al (1984) which takes into account variable returns-to-scale technology. DEA

[1] Refer to Marshall and Flessa (2011) for more details on the 2 step DEA model

models can also be defined by different orientations to reflect the direction of optimisation. In some DMU's, the quantity of inputs may be fixed with organisations tasked to produce as much output as possible. This is the output-oriented approach. If the levels of output are however fixed and organisations are tasked to reach that output using minimal inputs, then input-oriented DEA is the appropriate model in such a case.

In this paper, we assumed an output oriented model with variable returns to scale. The choice of the output oriented model was guided by the fact that most public health facilities in Zambia are likely to have more flexibility in controlling outputs than inputs. Facility managers for example could have greater discretion and control over the number of community outreach visits that the facility undertakes but less control over the number of medical personnel or equipment allocated to a given facility. Typically, decisions about clinic inputs are made at the district and central government levels. Furthermore, we chose variables returns over constant returns to scale to allow for flexibility in the scale of operation of various health facilities.

DEA models have the following strengths: i) DEA does not impose assumptions of any functional form in the relationship between inputs and outputs; ii) DEA can be used to both identify and quantify the efficiency gap of inefficient facilities; iii) the technique allows the analysis of multiple inputs and multiple outputs. Despite these advantages, DEA is particularly sensitive to outliers and measurement errors. Second, DEA may over-estimate efficiency scores if the number of input factors in the model is high. In spite of the shortcomings, DEA remains one of the most appropriate technical tools currently available for measuring efficiency in health services (Marschall and Fless, 2011).

TWO-STAGE DEA ANALYSIS

Once the facility level efficiency scores are estimated, a regression model to explain the determinants of efficiency is estimated at the second stage. While ordinary least squares

(OLS) could be used to obtain estimates of the determinants of efficiency, it is generally agreed that OLS could lead to biased estimates due to the censoring of the DEA scores. Several authors have interpreted the DEA score *(θ)* as a censored outcome, limited to the 0-1 range. The appropriate model to run that corrects the inherit bias in OLS is the Tobit model. For a given facility,*k*, the tobit model can be defined as;

$$\theta_k^* = \beta X_k + \varepsilon_k$$

$$\theta_k = \begin{cases} \theta_k^* \; if \; \theta`_k^* > 0 \\ 0 \; otherwise \end{cases}$$

Where $\theta_k^*$is an unobserved latent variable and $\theta_k$is the DEA score. X_k is a row vector of observation –specific variables that affect its efficiency. The vector of parameters β represent the coefficients to be estimated. Simar and Wilson (2007) have however argued that since the DEA estimator gives relative scores, efficiency estimates at the frontier are highly likely to be correlated with those of the other observations, in addition, environmental variables could also be correlated with input and output variables. These problems could lead to complex order serial correlation and render standard regression inference invalid at the second stage. Simar and Wilson (2007) therefore recommend a second-stage regression based on bootstrap methods. However, other scholars such as Ramalho et al (2010) and McDonald (2009) argue that standard econometric techniques such as logit, probit or truncated tobit models could be used for second stage estimation. Moreover, Alfonso and Aubyn (2011) have shown that tobit and bootstrap algorithms yield very similar results. Given that the methodological debates are still ongoing without a clear consensus, we use the truncated tobit model in this paper to estimate the second- stage DEA model.

DATA

This study uses the Access, Bottlenecks, Costs and Equity (ABCE) survey – a nationally representative sample of health facilities in Zambia. The survey was conducted by the IHME and the University of Zambia in 2012 and included both public and private health facilities across various levels of care. A two-step stratified random sampling process was used to achieve a nationally representative sample. The first step involved creating a sampling frame of districts based on selected geographic performance indicators such as average household wealth, population density and coverage of skilled birth attendants. From that sampling frame, 21 districts were randomly selected while Lusaka, the capital city, was automatically included due to size and importance to Zambia's health service provision.

The second sampling step involved sampling facilities from each selected district across a range of health care platforms in Zambia. In the IHME ABCE survey, "platform" refers to the channel through which health services are provided. The full sample of health facilities included various types of hospitals, clinics, health posts as well as dentists and pharmacies. The health facilities were selected from the 2010 Ministry of Health list of health facilities. The final sample for Zambia included 188 facilities. Health centres made up 63% of the sample, while 19% of the sample were hospitals. Health posts, pharmacies and dental clinics made up about 9%, 7% and 2% of the final sample respectively. Further details about sampling and sample descriptions can be found in IHME (2014)

In this study, we focus on health centres and health post: the main channels through which primary health services such as maternal and child health services are provided to the general population. Facilities such as dental clinics and pharmacies and drug stores are clearly not suitable for inclusion in the study and are therefore excluded. Hospitals are also excluded due to their specialised nature in services provision, and fundamentally different nature of health production.

To measure the efficiency of maternal and child health services, we follow traditional practice and use only a tightly defined set of inputs for the basic DEA model. Using a high number of inputs could over-state the efficiency of health facilities. Based on the available input set, we selected the number of medical personnel, the number of beds, expenditure on medicines and pharmaceuticals and number of laboratory tests performed as the main inputs for the first stage DEA model. Medical staff comprises the number of nurses, doctors, clinical officers and other medical staff reported at the facility. The number of medical personnel is undoubtedly a key input in the provision of maternal and child health services. Maternal and child health services are usually provided by nurses and clinical offices in most health centres and health posts in Zambia. However, due to staffing challenges, especially in rural areas, it is not uncommon to find community health workers and environmental health technicians providing primary healthcare. Non-medical personnel such as cleaners have not been considered as a key labour input in the provision of maternal or child health services and are therefore not included. We use the number of beds at a facility as a proxy for capital inputs. Studies such as Marshall and Flessa (2011) have used facility floor size (area in meters squared) to proxy for capital. They have argued that bed capacity may not be appropriate because hospitalisation only occurs in emergencies and for short time intervals. While Marshall and Flessa's (2011) argument is valid, bed capacity is also a good proxy for capital inputs because health planners at district and national levels match facility inputs to local community health demand. Therefore facilities with larger bed size are also likely to have more medical staff, more medical equipment and pharmaceutical and likely to serve larger catchment areas. Given that floor size was not physically measured during the survey and that values are missing for 20% of the facilities in the sample, we chose to use bed capacity as a proxy for capital inputs. The choice of bed capacity is also in line with the majority of the papers in the literature who also included number of beds as a DEA input variable[2]. This study also includes expenditure on medicines and pharmaceuticals as a DEA input variable.

For DEA outputs, we specified two separate sets. Maternal health services included the following outputs; i) number of family planning visits; ii) number of antenatal visits; iii) number of obstetric care visits and; iv) number of live deliveries reported at a facility. Child health services on the other hand included; i) the number of immunisations performed at a facility; ii) the number of live deliveries and; iii) the number of paediatric visits. Table 1 below summaries the DEA input and output variable definitions.

TABLE 1: Input and Output Definitions

Variable	Definition	Unit of Measurement
INPUTS		
X1	Nurses	Number of staff
X2	Clinical officers & other medical staff	Number of staff
X3	Beds (including emergency, paediatric + other types of beds)	Number of beds
X4	Expenditure on medicines and pharmaceuticals	Expenditure in 1000's of kwacha
Outputs – Maternal services		

[2]Studies such as Di Giorgo et al (2015), Jehu-Appiah (2014) and have used bed capacity as a proxy for capital inputs.

Y1	Family planning	Total number of outpatient visits
Y2	Ante-natal care	Total number of outpatient visits
Y3	Obstetric care	Total number of outpatient visits
Y4	Births	Total number of live deliveries
Outputs – Child services		
Z1	Immunisations	Total number of immunisations performed
Z2	Births	Total number of live deliveries
Z3	Paediatric care	Total number of outpatient visits

To account for potential variation in service quality, we performed quality adjustment for each output variable. Following the approach in Di Giorgio et al (2015), a quality adjustment factor was calculated by firstly determining whether, for a given output, a prescribed set of pharmaceutical supplies and medical equipment where available and functional at a given facility. We then summed the total of the binary responses and divided by the highest quality values found within the sample for a given outcome. The resulting quality adjustment factor was then applied to the corresponding outcome measure in the survey. The inclusion of a given indicator was informed by clinical guidelines and physician recommendations as well as whether the indicator was captured in the IHME survey. In this paper, we broadly follow the indicators available in Di Giorgio et al, (2015) with slight modifications. Table A1 in the appendix shows the quality indicators used for each maternal and child health outcome.

Table 2 on the next page presents summary statistics of the DEA model variables. The resource endowment and service provision levels vary markedly across facilities as can be seen by the wide range and high standard deviations. The variance in health centres and health posts staff levels is likely a reflection of the staffing challenges seen in the Zambian health sector, particular in rural areas where lack of infrastructure and amenities led to poor staff recruitment and retention. Although most facilities in the sample had beds, a sizeable 16% of the sample of health facilities did not have at least a bed. While health centres and health posts may not be expected to provide inpatient care services, beds (at least 1 bed) are important especially in rural areas where transport systems and referral services are poor. Moreover, beds could also be used for patient observation and have at times been used for emergencies deliveries and care. Medical and pharmaceutical expenditures range widely as well – reflecting the varying facility sizes and numbers of patients seen.

Similar to facility resource endowment, service provision varies quite widely across the health centres and health posts. On average however, family planning and antenatal activities constitute a larger share of health service provision for women and mothers while immunisations and paediatric visits constitute the majority of child health services provided.

Table 2: Summary Statistics of input and output variables

	N	Mean	Std.Dev.	Min	Max
Inputs:					
Nurses	103	4.0	5.4	0	24
Clinical & other staff	103	9.9	15	0	78
Beds	103	9.5	11	0	62
Medical &pharmaceutical expenditure	103	46820	59586	844	382648
Outputs:					
Family planning visits	103	562	790	0	5193
Antenatal visits	103	540	778	0	3646
Obstetric visits	103	160	469	0	3655
Number of births	103	119	212	0	1178
Immunisations	103	1042	3267	0	21137
Paediatric visits	103	2995	3753	0	19372

The variables in this section were used as inputs and outputs to calculate the DEA efficiency scores.

QUALITATIVE DATA

As mentioned in part previously, the qualitative data in this paper was derived from 17 semi-structured and in-depth interviews with Directors, Senior Managers, Specialists and Analysts in the Ministries of Health, Energy, and Works and Supplies, Energy Regulation Board (ERB), Rural Electrification Authority (REA), and Zambia Electricity Supply Corporation (ZESCO). See Appendices B and C for a detailed list of respondents and interview questionnaire, respectively. Each interview was approximately forty-five minutes to an hour in length, and was captured in audio format. The audio recordings from the interviews were each analytically reviewed, and subsequently, synthesised into the policy context and recommendations subsections. A further set of consultation on the quantitative findings was undertaken with 5 health economists and sector policy experts based at the University of Zambia (UNZA) and Zambia Institute for Policy Analysis and Research (ZIPAR) (see Appendix B), and their suggestions were also integrated into the policy context and recommendations subsections.

RESULTS

Technical Efficiency

The technical efficiency scores were calculated separately for maternal and child health service provision. The estimates obtained by the application of the VRS output oriented DEA models are summarised in Table 3 below.

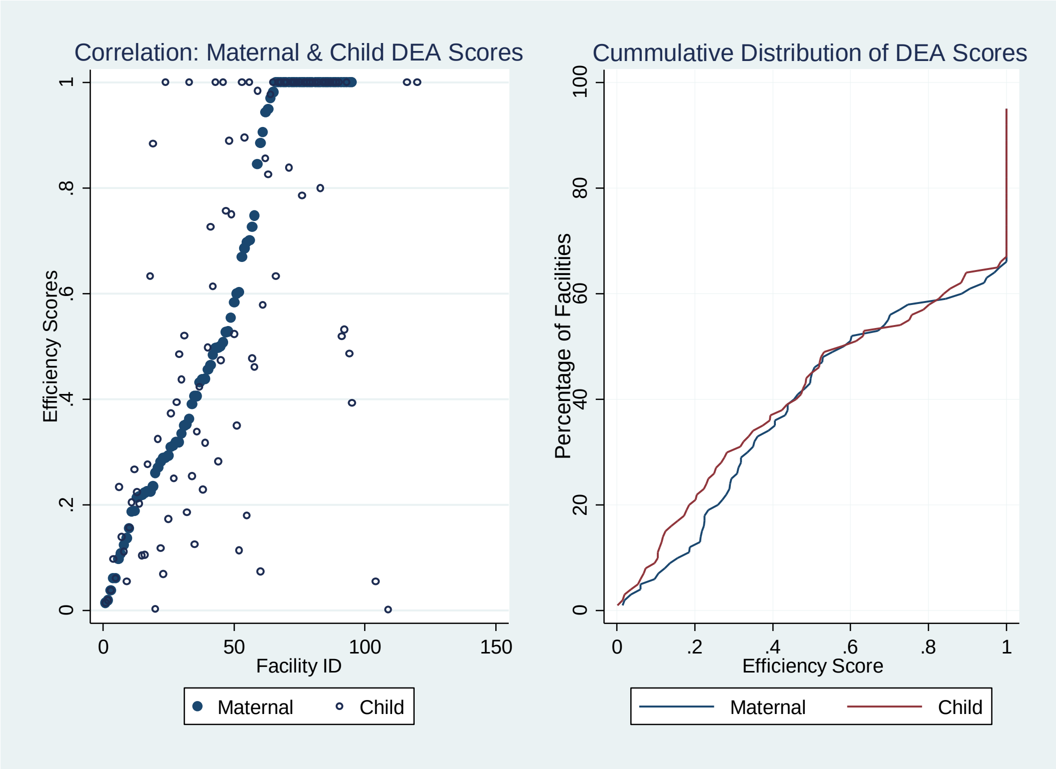
Table 3: DEA Efficiency Summary Scores

Statistic	Maternal	Child
Mean Efficiency Score	0.60	0.58
Median Efficiency Score	0.53	0.52
Standard Deviation	0.34	0.37
25th Percentile	0.29	0.22
75th Percentile	1.00	1.00
Lowest Efficiency Score	0.015	0.0017
Mean Efficiency Score - Urban location	0.71	0.70
Mean Efficiency Score - Rural location	0.55	0.52
Mean Efficiency Score - Publicly owned	0.62	0.59
Mean Efficiency Score - Privately owned	0.31	0.42
Mean Efficiency Score - Electricity	0.61	0.55
Mean Efficiency Score - No Electricity	0.60	0.61

The average efficiency score for maternal health services is 0.60, with a standard deviation of 0.34. This indicates quite a large variation in efficiency scores. Indeed as can be seen, the estimates range from the least efficient score of 0.015 to the highest score of 1. By construction, the most efficient facilities will have a score of 1. A score of 1 indicates that a health facility forms the best practice frontier, producing the highest level of maternal (or child) health services for any given level of inputs. Only about 32% of the health facilities in the sample are efficient, implying that the majority of the health facilities are not operating at technically efficient levels. The average efficiency score for the inefficient facilities is about 42%. This implies that collectively, inefficient the health centres and health posts in Zambia have the potential to increase their maternal health service provision by nearly 60% using the same level of medical staff, medical equipment and facility budgets that they currently use.

Table 3 also presents efficiency scores for child services. The average child efficiency score is 0.58 with scores ranging from virtually 0 to 1. About 31% of the facilities in the sample are technically efficient in providing child health services. Like we found for maternal services, levels of child health service provision efficiency are still quite low in Zambia. The average score of 38% among facilities before the frontier indicates that child health services could be expanded by roughly two-thirds if resources were used optimally.

The summary statistics discussed above suggest that the distributions of maternal and child health service efficiency are quite similar. This is likely due to the fact that mothers and their children both visit the same facilities particularly in rural areas where health care alternative are limited. Moreover, there is also a considerable overlap between inputs used for maternal and child health service provision. Therefore, facilities that may be efficient in providing maternal services are also likely efficient in the provision of child health services. Indeed, an inspection of the efficiency scores shows that 72% of the health facilities that were 100% efficient in the provision of maternal services were also fully efficient in providing child health services. The overall similarities in distributions in maternal and child health efficiency scores are illustrated in the first graph in Figure 1 below.



As can be seen in the first graph in Figure 1 above, the efficiency of maternal and child health scores are quite closely correlated. The Pearson correlation coefficient of 0.75 (statistically significant at the 1% level) confirms the strong positive linear relationship between maternal and child efficiency scores in facilities. The second graph presents the cumulative distributions of the maternal and child health provision efficiency scores. The distributions show that on average, there is a relatively higher proportion of facilities with poorer child health efficiency outcome compared to maternal health outcomes in the bottom half of the distribution. In the top half, maternal and child efficiency scores are more tightly correlated.

For each of the first stage DEA model outcomes, we compared how the average DEA efficiency scores differed by location, ownership and electrification status. As can be seen in the bottom half of Table 3, the efficiency of both maternal and child health service provision seems much higher in urban compared to rural areas. The average efficiency score for urban located facilities is 0.71, compared to only 0.55 for facilities located in rural areas. The non-parametric Mann-Whitney test confirms that urban based facilities have higher mean maternal efficiency scores than rural based health centres and health posts (p=0.028). This finding could be driven by the fact that urban areas are more densely populated and therefore likely to have higher health demand on average. The bivariate comparison of efficiency in child health service provision between urban and rural based facilities also yields similar findings –that urban based facilities are more efficient.

Bivariate comparisons further show that public health facilities have statistically significant higher maternal efficiency score than private ones. This finding is not surprising, given that primary health care services in Zambia are largely free in public facilities but quite unaffordable for the less well-off Zambians in private facilities. Therefore, for any given clinic input set, public clinics are more likely to record higher primary care visits than their private facilities especially among the poor in Zambia. We do not find a statistically significant difference in child health efficiency between public and private clinics. This result is however likely due to low sample size of private facilities offering child primary care services (i.e. 8 private clinics compared to 91 public facilities). Finally, we tested whether access to reliable electricity is in any way statistically significantly related to better efficiency scores. For both the maternal and child DEA efficiency scores, we do not find any statistically significant difference between availability of reliable electricity and efficiency outcomes. We explore and discuss the relationship between electricity and efficiency in maternal and child health provision in greater detail in a multivariate context below.

MULTIVARIATE REGRESSION

Based on the technical efficiency scores estimated from the one-step DEA models, we estimated the second stage regression using tobit models. The main determinants of efficiency considered in this paper are location of facility, population density, facility ownership, distance to nearest referral center as well as proxies for local clinic management quality such as hosting of administrative meetings and personnel training. These factors are similar to what other papers such as Di Giorgio et al (2015), Masiye (2007) and Marshall and Flessa (2011) and others have considered as covariates of facility level efficiency. Importantly, we also include a variable that measures whether a facility had electricity or not. In particular, the IHME survey had a question on the number of days in the last week that the health facility had no electricity available for at least 2 hours. We defined electricity as reliable if the facility did not report any black outs during the past week. In other words, we only considered electricity connections as reliable if supply was nearly continuous in the past week. At the time of the survey around 2011/2012, daily electricity blackouts like those seen in 2015/2016 were not commonly experienced. This measure is therefore likely to accurately measure reliability of access to electricity. Using this measure, 29% of the facilities had uninterrupted access to electricity in the last week.

Table 4 below presents the summary statistics for the facility-level variables used in the second stage regression.

Table 4: Summary Statistics of Second-Stage Control Variables

Variable	N	Mean	Std.Dev.	Min	Max
Reliable Electricity	103	0.3	0.5	0	1
Rural	103	0.6	0.5	0	1
Population catchment	100	13330	18886	300	133628
Public	103	0.9	0.3	0	1
Administrative meetings	103	0.8	0.4	0	1
Time to referral centre (minutes)	87	50	62	3	420
Holds training sessions	103	0.3	0.5	0	1

A priori, we expect that facilities with access to reliable energy will have higher efficiency scores. As suggested by the WHO (2014), such facilities are likely to have better motivated health workers and higher staff retention rates; and also likely to operate for longer hours than those without reliable energy. We therefore expect that access to reliable electricity will be correlated with better maternal and child health services. We also expect that facilities located in urban areas will have higher efficiency outcomes compared to those in rural areas due to the relatively higher population density and health demand in urban areas. Furthermore, as found in Jehu-Appiah et al (2014), we expect that government owned facilities will be more efficient than privately owned ones because health services in public facilities are largely freely provided to patients. We also expect that facilities with better quality management, as captured by whether regular administrative meetings are held, or whether training courses are held, will be more efficient. Finally, we included a measure of distance to nearest referral facilities, as a proxy of proximity to alternative health facilities. We expect that facilities that are farther away from referral facilities will have higher health demand rates and likely higher efficiency. Table 5 below presents the second-stage tobit regression results.

Table 5: Second-Stage Regression Results

VARIABLES	Maternal Model	Child Model

Reliable Electricity	0.044	-0.109
	(0.112)	(0.109)
Rural Location	-0.310**	-0.348***
	(0.138)	(0.130)
Log of Population density	0.078	0.084
	(0.073)	(0.062)
Public Ownership	0.475**	0.341*
	(0.224)	(0.195)
Facility holds administrative meetings	0.077	-0.095
	(0.138)	(0.137)
Time to referral centre (minutes)	0.002**	0.002**
	(0.001)	(0.001)
Facility holds training courses	0.100	0.206*
	(0.113)	(0.113)
Constant	-0.500	-0.268
	(0.760)	(0.614)
Observations	78	81

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Based on the multivariate regression model, we find that facilities located in rural areas have lower maternal and child health service efficiency, and the results are significant at the 5% level. We also find that efficiency of maternal health service provision is positively associated with public facility ownership. This relationship however is not robust in the case of child service provision. Furthermore, as expected, we find that facilities located far away from their referral centres are likely to have higher efficiency than those located nearer to their referral centres. Local administrative capacity, and reliable electricity connection are not significant determinants of efficiency in our model.

With reference to electricity, we find that access does not on average lead to better health service efficiency in our sample[3]. While this finding may be surprising at first, there are at least 2 reasons that could explain the outcome based on our collaborative interviews with the experts. First, we note that the basic maternal and child health service package does not directly require any energy intensive inputs (such as energy reliant medical diagnostic devices). Second, most maternal and child health services such as routine family planning or

[3] The results remain insignificant even after accounting for interactions effects between electricity and local or public ownership.

antenatal check-ups may not directly require the availability of energy services; although certain immunisations and some medicines may require basic energy for cold chain management. In that context, facilities without refrigeration services may have inherent operational constraints resulting in lower efficiency outcomes. Our findings however show that at least for primary health care (maternal and child health), the differential impact of electricity on efficiency outcomes is immaterial. Most maternal and child services such as family planning and immunisations can be administered with little or no electricity. Where the refrigeration of medicines and vaccines is essential, expert interviews indicated that facilities without functional electric refrigerators had various workarounds in place such as referring patients to nearby bigger centres with functional refrigeration systems, or having in place alternative cold chain management interventions such as kerosene or solar fridges. To corroborate the evidence on whether health facilities without electricity have some form of alternative cold chain management system, we use the IHME 2011/2011 Zambian health facility survey and explore evidence of alternative refrigeration systems for clinics and health posts without election connections. Table 6 summarises the patterns of cold chain systems by facility electrification status.

Table 6: Refrigerator Types by Facility Electrification Status

	Type of Refrigerator				
Does Facility has a functional electricity connection?	Electric	Gas	Kerosene	Solar	Total
0. No	1	1	8	11	21
%age	5%	5%	38%	52%	100%
1. Yes	29	2	5	4	40
%age	73%	5%	13%	10%	100%
Total	30	3	13	15	61
%age	49%	5%	21%	25%	100%

Source: 2011/2012 IHME Zambia Facility level survey dataset

Table 6 shows that nearly all the health facilities without a functional electricity connection have either a kerosene or solar powered refrigeration system in place. These results corroborate the expert interviews and provide preliminary evidence to support the view that even without functional electricity connections, primary health facilities have refrigeration workaround systems in place which help ensure certain types of basic maternal and child health services are still provided.

Third, we find the suggested role of electricity in extending operating hours seems an unlikely channel through which electricity could impact the efficiency of basic maternal and child health service provision especially in Zambia. According to the Ministry of Health (expert interviews), facility operating hours in Zambia are quite fixed in practice and policy and therefore unlikely to change on the basis of whether or not a facility has access to reliable electricity or not.

CONCLUSION

This study finds that the impact of facility level access to electricity on the efficiency of maternal and child service provision at the basic healthcare level in Zambia is negligible. While the WHO (2014) postulates that access to electricity may improve facility provision of health services via channels such as availability of refrigeration, facilitation of longer working hours and better staff motivation and retention, the results in this paper show no direct impact of electricity on basic maternal and child health service efficiency. We note that these findings may only be valid for basic maternal and child health services and not valid for the other more energy intensive primary health care services or for more specialised and larger facilities such as hospitals. There are a number of plausible factors that could explain these findings. Largely, the current primary health package for maternal and child health in Zambia is quite basic, with little or no use of energy dependent technologies or energy-intensive inputs. For refrigeration services for maternal and child vaccines and medicines, we find that facilities without access to reliable electricity typically have alternative cold chain management systems in place to mitigate any adverse impacts of lack of access to reliable electricity. Furthermore, the suggested role of electricity in extending operating hours seems an unlikely channel through which electricity could impact the efficiency of basic maternal and child health service provision especially in Zambia. Facility operating hours in Zambia are fixed by health authorities and therefore unlikely to change on the basis of whether or not a facility has access to reliable electricity.

This study has some limitations. Due to data constraints we were unable to conduct any analysis of the relationship between energy access and maternal and child health provision at the district, provincial and tertiary hospital levels where electricity access is likely significantly correlated with specialised maternal and child health services. We recommend that future research assesses the impacts of electricity access on energy dependent maternal and child health services at higher platforms such as district, general and tertiary hospitals. Future study could also consider the role of electricity in the efficiency of specialised mother and child health services such as diagnostics, internal medicine, obstetrics and gynaecology, general surgery, and intensive care. Given the small sample size in this study, we therefore recommend replication of this study using a large sample size.

POLICY RECOMMENDATIONS

Based on the findings of this paper and the broader stakeholder interviews and general principles of good policy implementation, the following recommendation were made on how health sector electrification policies and programmes could positively impact maternal and child health provision in Zambia:

i) In the short term, government through the Ministry of Health (MoH) should continue to ensure that adequate and functional cold chain management systems are available especially in rural and remote facilities to mitigate the problem of lack of electricity in ensuring basic maternal and child health provision.

ii) We propose that government seriously consider collecting longitudinal panel statistics at the nexus of the health and energy sectors. Perhaps the Ministries of Health and Energy in collaboration with the Central Statistics Office (CSO) and Department of Economics at the University of Zambia could develop a facility-level statistical dashboard which they can use to track both health and electricity outcomes in relation to the SDGs and over time. This would probably entail complementing the MoH's National Health Accounts (NHA) with a Geographic Information System (GIS) mapping of all health facilities in Zambia, and including longitudinal data on the energy-dependent infrastructure, and maternal and child health statistics in the facility's catchment area.

iii) In the medium to long term, government through the Ministries of Health, Energy and Works and Supply, must equip the health care system with modern, efficient and energy dependent technology for efficient management of maternal and child health case. This is in line with the SDGs' vision of modern and energy-dependent maternal and child health provision by 2030.

iv) Government must ensure better coordination in policies and plans at the nexus of health and energy sector development. At the policy level, the Ministries of Health, Energy and Water Development, National Development Planning and Finance should establish inter-ministerial committees that meet regularly, plan and evaluate policies, and co-implement health and energy infrastructure programmes. At the operational level, there is needs to set up an inter-organizational planning team with representatives drawn from the strategy and corporate planning departments at Zambia Electricity Supply Corporations, Rural Electrification Authority (REA) and Energy Regulation Board (ERB) that regularly engages with the inter-ministerial planning committee, and collaboratively implements the organizational health and energy infrastructure strategic plans.

v) We recommend that MEWD be adequately financed and capacitated to undertake regular evaluations of electricity sector masterplan implementation, and develop regular short- and medium- term strategic plans. We also recommend that MEWD proactively emulates MoH by synchronizing its plans with the ever shifting global policy developments. MEWD should incorporate the Sustainable Development Goals (SDGs) of affordable and clean energy, sustainable cities and communities, and good health and well-being into its current and future sector plans and policies. Similarly, we recommend that ERB and ZESCO update their strategic and implementation plans to include the SDGs. Perhaps the ERB strategy can be made to focus on developing a concessional and health-sector specific electricity tariff that bolsters both facility-level electricity access and maternal and child health outcomes. Likewise, ZESCO would do well to broaden its strategic focus areas to include maternal and child health outcomes and thereby, work towards optimizing the cost of extending the national electricity grid to health facilities.

vi) We further suggest that the Ministry of Health (MoH) actively engage Zambia Electricity Supply Corporation (ZESCO) in the preliminary planning phases of annual grid extensions so as to harmonize implementation plans and save on financing grid extensions to a single health facility at full commercial price. These savings must then be used to finance multiple rural health grid connections and infrastructure developments, and quality improvements in maternal and child health service.

vii) We also recommend the Ministry of Health (MoH) to actively engage Energy Regulation Board (ERB) on the social electricity tariff determination. The ERB and MoH should take optimal advantage for the Cost of Service Study on ZESCO that is nearing completion, and annual financial statements from health facility to determine the optimal social electricity tariff for Zambia. Further, the MoH should also facilitate a platform for rural district hospitals management teams to negotiate and secure a relatively more flexible electricity tariff from ERB and ZESCO.

viii) Finally we also recommend that the Ministry of Finance (MoF) both scales-up and honours its annual obligations to REA given the authority's immense and proven potential to improve electricity access to rural health and education facilities in Zambia. We further recommend that the Ministry of Finance ring-fence rural electrification levy collections and remit these to REA in their entirety, or legislate that ZESCO should remit the rural electrification levy to REA directly without being posted into a pooled government account.

REFERENCES

Adair-Rohani, H., Zukor, K., Bonjour, S., Wilburn, S., Kuesel, A.C., Hebert, R. and Fletcher, E.R., 2013. Limited electricity access in health facilities of sub-Saharan Africa: a systematic review of data on electricity access, sources, and reliability. *Global Health, Science and Practice*, *1*(2), p.249.

Afonso, A. and St. Aubyn, M., 2011. Assessing health efficiency across countries with a two-step and bootstrap analysis. *Applied Economics Letters*, *18*(15), pp.1427-1430.

Akazili, J., Adjuik, M., Jehu-Appiah, C. and Zere, E., 2008. Using data envelopment analysis to measure the extent of technical efficiency of public health centres in Ghana. *BMC international health and human rights*, *8*(1), p.11.

Chowdhury, H. and Zelenyuk, V., 2016. Performance of hospital services in Ontario: DEA with truncated regression approach. *Omega*, *63*, pp.111-122.

Di Giorgio, L., Moses, M.W., Fullman, N., Wollum, A., Conner, R.O., Achan, J., Achoki, T., Bannon, K.A., Burstein, R., Dansereau, E. and DeCenso, B., 2016. The potential to expand antiretroviral therapy by improving health facility efficiency: evidence from Kenya, Uganda, and Zambia. *BMC medicine*, *14*(1), p.108.

ERB. 2017. Revision of the Electricity Tariffs: May 2017.May 2017. Lusaka: Energy Regulation Board.

Government of the Republic of Zambia (GRZ). 2014. Revised Sixth National Development Plan: 2013-2016. Lusaka: Ministry of Finance.

GRZ. 2013. The 2012 List of Health Facilities in Zambia: Preliminary Report – Version 15. April 2013. Lusaka: Ministry of Health.

GRZ. 2012. National Health Policy: A Nation of Healthy Productive People. August 2012. Lusaka: Ministry of Health.

GRZ. 2006. Vision 2030: A Prosperous Middle-Income Nation by 2030. December 2006. Lusaka: Government Printers.

Jehu-Appiah, C., Sekidde, S., Adjuik, M., Akazili, J., Almeida, S.D., Nyonator, F., Baltussen, R., Asbu, E.Z. and Kirigia, J.M., 2014. Ownership and technical efficiency of hospitals: evidence from Ghana using data envelopment analysis. *Cost Effectiveness and Resource Allocation*, *12*(1), p.9.

Marschall, P. and Flessa, S., 2011. Efficiency of primary care in rural Burkina Faso. A two-stage DEA analysis. *Health economics review*, *1*(1), p.5.

Masiye, F., 2007. Investigating health system performance: an application of data envelopment analysis to Zambian hospitals. *BMC Health services research*, *7*(1), p.58.

McDonald, J., 2009. Using least squares and tobit in second stage DEA efficiency analyses. *European Journal of Operational Research*, *197*(2), pp.792-798.

Ramalho, E.A., Ramalho, J.J. and Henriques, P.D., 2010. Fractional regression models for second stage DEA efficiency analyses. *Journal of Productivity Analysis*, *34*(3), pp.239-255.

Simar, L. and Wilson, P.W., 2007. Estimation and inference in two-stage, semi-parametric models of production processes. *Journal of econometrics*,*136*(1), pp.31-64.

World Health Organization, 2014. *Access to modern energy services for health facilities in resource-constrained settings: a review of status, significance, challenges and measurement*. World Health Organization.

United Nations. 2015. World Population Prospects: The 2015 Revision, Key Findings and Advance Tables. United Nations Department of Economic and Social Affairs Population Division Working Paper No. ESA/P/WP241.

APPENDIX A: Output-specific health facility indicators for quality-adjustment

Table A. Structural quality indicators, by output type.

Quality indicator group		**Indicators**
Births	Pharmaceuticals	ACTs, gentamicin, iron supplements, antenatal steroids, oxytonics (e.g., oxytocin, misprostol), analgesics, BP-lowering drugs
	Medical supplies and diagnostics	Incubator, vital signs monitor, ultrasound, suction machine, oxygen system/cylinder, hemocytometer, wheelchair, BP apparatus, refrigerator for vaccines or medicines, sterilization equipment (electric autoclave; dry heat sterilizer; sterilizer stove), electronic balance, adult bag-valve-mask, transport incubator, stethoscope, cauterizer, examination table (proxy for labor table)
Antenatal/Obstetric visits	Pharmaceuticals	Iron supplements, antenatal steroids, Fansidar/SP, tetanus vaccine
	Medical supplies and diagnostics	Ultrasound, BP apparatus, hemocytometer
Family planning visits	Pharmaceuticals	Availability of IUD, contraceptive injections, contraceptive implants, emergency contraceptives, condoms, oral contraceptives
	Medical supplies and diagnostics	Examination table, hemocytometer, BP apparatus, refrigerator for vaccines or medication, electronic balance, stethoscope
Immunizations and pediatric visits	Pharmaceuticals	oral antibiotics for pneumonia, oral antibiotics for dysentery, ORS, measles vaccine, BCG vaccine, OPV, DPT vaccine, Hibvaccine, hepatitis B vaccine, pentavalent vaccine, yellow fever vaccine, tetanus vaccine, deworming, aspirin, analgesics
	Medical supplies and diagnostics	Examination table, hemocytometer, BP apparatus, refrigerator for vaccines or medication, electronic balance, stethoscope

Note: *(1) ACTs = artemisinin-based combination therapies; BP = blood pressure;CBC = complete blood count; CSF = cerebrospinal fluid; CT = computerized tomography;DPT = diphtheria-pertussis-tetanus*; *ECG = electrocardiogram; Hib =* Haemophilusinfluenzae*type b*; *IUD = intrauterine device; IV = intravenous; OPV = oral polio vaccine*; *ORS = oral rehydration salts; SP = sulphadoxine/pyrimethamine*.

(2)Tabled and most indicators adapted from Di Giorgio et al(2015).

APPENDIX B: List of Interview Respondents

Table B. Interview Respondents by Organization and Designation

Name	Organization	Designation
Dr. Caroline Phiri	Ministry of Health	Director – Mother and Child Health
Mr. Patrick Banda	Ministry of Health	Assistant Director – Planning
Ms. Kakulubelwa Caroline Mulalelo	Ministry of Health	Chief Infrastructure Planner
Mr. Arnold Simwaba	Ministry of Energy	Assistant Director - Energy
Mr. William Masocha	Ministry of Energy	Energy Officer
Mr. Besty Phiri	Zambia Electricity Supply Corporation (ZESCO)	Director – Strategy & Corporate Services
Mr. Clive Khan	Ministry of Works and Supply	Chief Engineer
Mr. Benny Kangwa Bwalya	Energy Regulation Board	Financial Analyst – Electricity
Mrs. Naomi Nachalwe Sidono	Rural Electrification Authority (REA)	Acting Corporate Affairs Manager
Ms. Leah Banda	Rural Electrification Authority (REA)	Senior Engineer - Infrastructure Planning
Mr. Andrew Chilala	Rural Electrification Authority (REA)	Acting Monitoring & Evaluation Specialist
Mr. Eugene Chandi	Rural Electrification Authority (REA)	Assistant Monitoring & Evaluation Officer
A/Prof. Felix Masiye	University of Zambia (UNZA)	Dean and Associate Professor of Health Economics and Health Policy
Dr. Chrispin Mphuka	University of Zambia (UNZA)	Head, Department of Economics, UNZA.
Dr. Dale Mudenda	University of Zambia	Senior Lecturer in Health Economics

	(UNZA)	(Former Consultant to MOH on National Health Accounts)
Mr Bonah Chita	University of Zambia (UNZA)	Health Economics and Policy Expert (Former Director in the Central Board of Health and Lecturer - Health Economics)
Mr. Caesar Cheelo	Zambia Institute for Policy Analysis and Research (ZIPAR)	Senior Research Fellow and Health Policy Expert (Former Lecturer in Health Economics and MOH on National Health Account)

Appendix C: Interview Protocol

Interview Questions

1. **Context and specific infrastructure development plans**

Do you have any specific energy or health infrastructure development plans?

Of what duration are they?

*Short term *Medium term *Long term

Where are we with regard to implementing these plans?

What challenges are you experiencing in terms of implementing these plans?

If the Ministry could do anything differently, what would this be?

2. **Sector Integration**

How do you integrate other stakeholders and sectors in these plans?

*Do you have planned meetings or not?

*If so how regular are these engagements?

*Are these engagements with other ministries – held co-jointly?

What specific links are there between energy plans and health plans?

*What in particular?

*How has this worked?

3. **Notable Policy Shifts**

Considering that your Ministry [organization] is responsible for determining the policy direction in the Health[Energy], have there been any notable shifts or changes in policy/strategy since you have been with [name of the organization]?

*If so what may these be?

*How did this come about?

*How have these played out?

*What are the main implications of these changes?

What impact did these have on material and child health provision [electrification strategy]?

*Is this an important consideration?

*Are there any specific documents you would recommend we review to get a better understanding you previous and new policies/strategies?

The International Growth Centre (IGC) aims to promote sustainable growth in developing countries by providing demand-led policy advice based on frontier research.

Find out more about
our work on our website
www.theigc.org

For media or communications
enquiries, please contact
mail@theigc.org

Subscribe to our newsletter
and topic updates
www.theigc.org/newsletter

Follow us on Twitter
@the_igc

Contact us
International Growth Centre,
London School of Economic
and Political Science,
Houghton Street,
London WC2A 2AE

International Growth Centre

DIRECTED BY

FUNDED BY

Designed by soapbox.co.uk