Final report

Willingness to pay for improved electricity supply reliability in Zambia

A survey of urban enterprises in Lusaka and Kitwe

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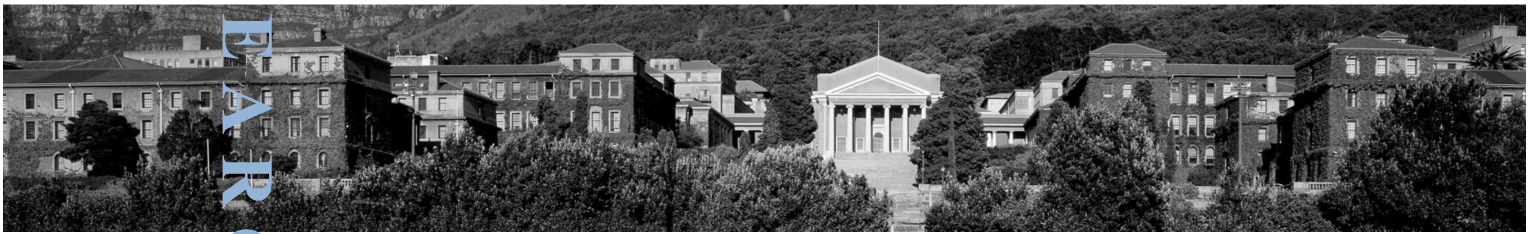

Willingness to pay for improved electricity supply reliability in Zambia

A survey of urban enterprises in Lusaka and Kitwe

BOTHWELL BATIDZIRAI, ALFRED MOYO AND MICHAEL KAPEMBWA

May 2018

Key points

- Zambia experienced electricity supply shortages in recent years negatively impacting businesses and the economy
- There is need to review electricity tariffs to facilitate investment in the sector
- Most businesses are willing to pay (WTP) more for improved electricity supplies
- 50% of enterprises are WTP at least 0.09 ZMW/kWh more for reliable electricity.
- 83% of manufacturing companies are WTP more for secure electricity supplies
- WTP influenced by number of operating hours, annual revenues and tariff category
- WTP not influenced by all other factors (e.g. electricity demand, profitability, electricity bill, etc).
- Public electricity entities not trusted and perceived as inefficient
- There is need for educating consumers on tariff development processes to enable stakeholder buy in for tariff increases.
- Electricity tariff increases need to be implemented in phases to avoid negative impacts on economy.

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Acronyms

AIC	Akaike information criterion
CEC	Copperbelt Energy Corporation
CV	Contingent valuation
ERB	Energy Regulation Board
GDP	gross domestic product
IPP	Independent Power Producer
MMEWD	Ministry of Mines, Energy and Water Development
MYTF	Multi-Year Tariff Framework
PMRC	Policy Monitoring and Research Centre
PSAs	Power Supply Agreements
REA	Rural Electrification Authority
SAPP	Southern African Power Pool
SADC	Southern African Development Community
SME	Small and Medium-Sized Enterprise
USD	United States Dollar
VIF	Variance Inflation Factors
WTP	Willingness to pay
ZESCO	Zambia Electricity Supply Corporation
ZMW	Zambian Kwacha

Units

GWh	Giga-watt-hours
kWh	Kilo-watt hours
kVA	Kilo-Volt-Amperes
MW	Mega-Watts

1. Introduction

1.1 Background and rationale for study

Zambia is a Southern African landlocked country with an estimated population of 16.9 million and a national gross domestic product (GDP) of USD 22 billion (Lucas, 2016). Economically, Zambia is one of the fastest-growing economies in Africa and attained a lower-middle-income status in 2011. Between 2003 and 2013, the average GDP growth rate was 6.3% per annum (Aridas and Pasquali, 2013; World Bank, 2015). However, with a GDP per capita of USD 1361, poverty remains a major challenge, with 60% of the population below the poverty line and 42% in extreme poverty (Lucas, 2016). Zambia's economy came under strain in 2015 and 2016, resulting in a sharp decrease in GDP growth from 4.9% in 2014 to 2.8% in 2015, due to external and domestic factors, including falling commodity prices (especially low copper prices), expensive borrowing on international markets and a weakening currency (World Bank, 2017). This situation was exacerbated by the electricity supply crisis triggered mainly by a drought in the 2014/2015 rainfall season, which caused blackouts of up to eight hours per day (Kesselring, 2017).

Since 2000, electricity demand has increased by 4% per annum, but electricity generation capacity has not kept up with demand. See Figure 1. Zambia's electricity supply is dominated by hydro power generation (about 94% of the generation mix is hydro), so it is extremely vulnerable to changes in rainfall patterns and climate change. Due to drought and subsequent poor rainfall, hydro-power generation was severely reduced in 2015, and this resulted in an estimated power capacity shortfall of about 1000 MW (ERB, 2015a).

These electricity supply problems put severe pressure on the country's economic growth, with commerce and industry suffering substantial losses due to reduced production capacity (many manufacturers claimed to be running at only 30–40% of production capacity during the worst parts of the electricity crisis) (World Bank, 2015). The productive sector also experienced increased input costs due to expensive back-up power and the changing of shifts (Samuel, 2016). As a strategic sector, mines were largely exempted from load-shedding, but were asked to reduce their electricity consumption by 30% in 2015 (Kesselring, 2017; Owen, 2016). The electricity supply crisis was therefore a substantial growth constraint for Zambia.

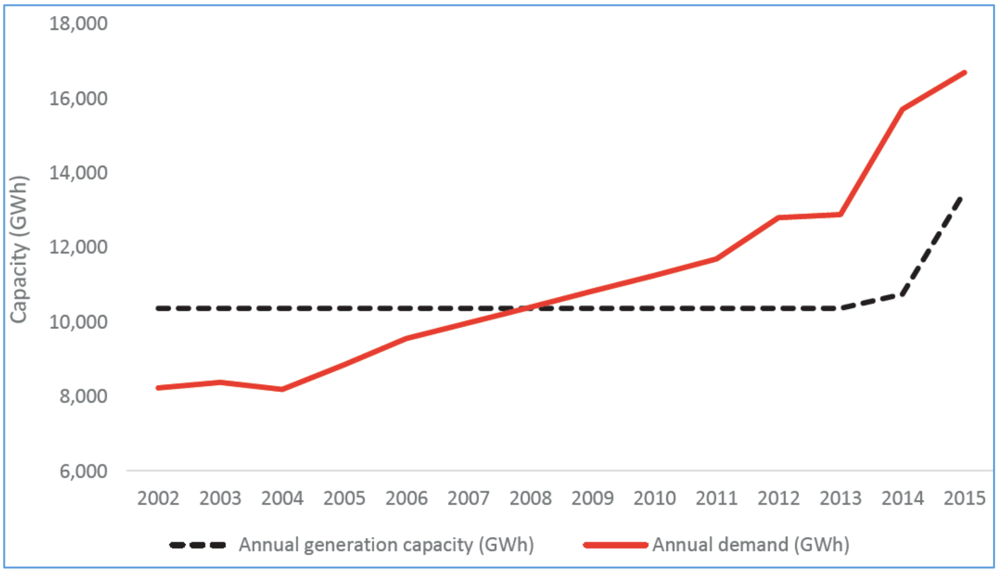


Figure 1: Trends in annual electricity generation and demand

During the worst part of this crisis, the public utility, ZESCO, had to employ emergency measures, such as importing expensive power from the Southern African Power Pool as well as from Aggreko Mozambique (Owen, 2016). Combined with the weakening Zambian currency, the Zambian government needed to provide ZESCO with about USD 340 million to cover emergency power costs in 2016 (World Bank, 2015). For a country already facing economic problems, this was an unsustainable situation, as it took away much-needed financial resources from the productive sector. To avoid similar crises in future, Zambia therefore urgently requires investment in a diversified power sector, including from the private sector – the prospects of which are thin unless the market becomes much more attractive. A key challenge facing the sector is that electricity tariffs have been historically very low and not cost reflective (i.e. the tariffs do not provide an attractive return to power producers), which places further pressure on the fiscus through support of the public utility (as government has to provide direct and indirect subsidies) and this makes it difficult to attract private sector investment in the power sector (Owen, 2016). According to Eberhard et al (2011), tariffs that are not cost reflective are a major barrier to effective and efficient power development projects. Furthermore, the viability of the power industry is affected by the preferential tariffs given to the mining sector (and mining consumes half the electricity supplied in the country (Kesselring, 2017).

Any improvements in the power supply capacity would require substantial funding from both the public utility and private investors to support additional generation capacity as well as maintaining system infrastructure. These investments need to be supported by good tariff regime that ensures return on investment and long-term sector sustainability. Given the historically low tariff regime in Zambia, which depended on a largely amortised hydro-based system, the country needs to revise its electricity tariffs to address the financial health of the sector. However, the level of the tariff increases is a contentious issue, as any increase could have macroeconomic implications through increased cost of goods and services and might affect the viability of businesses and access to energy, especially those in the low-income groups. According to modelling undertaken by PMRC (Zambia), a 75% electricity tariff increase would have huge impacts on the poor, whose real income could be eroded by up to 13%, compared to 6% for the rich (Kabechani, et al 2017). This study therefore attempts to investigate the willingness of business enterprises to pay for reliable electricity supply, thereby allowing for informed, evidence-based decision-making on setting tariffs, taking economic growth impacts into account.

1.2 Objectives of the study

A reliable electricity supply is critical to the Zambian economy. In fact, reliable energy supplies have been identified as an important driving force for economic development in Zambia, and the government has declared its commitment to improving the sector (ERB, 2015; USAID, 2016). However, due to lack of investment, the electricity sector is struggling to keep up with electricity demand and this has placed the already struggling economy under further pressure. Lack of investment is primarily linked to the poor investment climate in the sector, a function of electricity tariffs that are not cost-reflective. In 2015, average electricity tariffs were estimated to be around USD 0.05–0.06 /kWh, while the cost of generation based on new projects is estimated to be over USD 0.12 /kWh (World Bank, 2015; Kotze, 2015).

Thus low tariffs are a stumbling block to sustainable electricity supplies in the long term in Zambia. Tariffs need to be reviewed and revised in consultation with industry and commerce, so that the process of revising them is inclusive of stakeholder views. The objective of this study was, therefore, to explore the willingness to pay (WTP) for reliable electricity supply among electricity consumers in Zambia, and the additional amount business enterprises are able and willing to pay for such a supply. This was done through a WTP survey, applied to commercial and industrial businesses in Zambia (based on the pre-May 2017 tariff level), working with the concepts of WTP and contingent valuation (CV), which are discussed in more detail in the methodology section. The results can be used to inform decision-making on setting prices and on planning in the Zambian electricity sector, on the basis of understanding consumers' constraints, enable the incorporation of determinant variables when establishing suitable and appropriate tariffs in future adjustment processes. The results also provide insights into consumers' perceptions about the quality of current energy services, and this should be used by the electricity utility to improve customer service and other related factors.

In the course of doing this study, there have been some adjustments in electricity tariffs proposed in March 2017 and implemented in May 2017, the period during which the WTP survey was being conducted. Despite this positive development, it is still necessary to explore the market preparedness for such tariff increases and investigate potential implications of increasing electricity tariffs. Since electricity is an important production input in the economy, any adjustments on tariffs will have ripple effects on the cost of goods and services in the country. Hence, there is need to carefully evaluate tariffs to ensure that they are set at feasible levels. If the tariffs are set too high, this could negatively affect businesses; on the other hand, if the tariffs are too low, much needed investment in the sector will not materialise and electricity supply services will not improve.

2. Zambia's electricity sector

2.1 Electricity industry

Despite the availability of diverse indigenous energy resources (SERN, 2012), the electricity supply industry in Zambia is dominated by hydropower generation, which in 2015 accounted for 94% (or 2 269 MW) of the national installed power generation capacity of 2 411 MW. As shown in Figure 2, the balance of 6% is accounted for by diesel (92 MW), heavy fuel oil (50 MW) and solar PV (0.06 MW) capacity (ERB, 2015b). Due to the combination of a long-term lack of investment in power generation capacity, increasing electricity demand and the 2015 drought, Zambia has had to deal with an electricity supply crisis which required extensive load-shedding during much of 2015 and 2016 (Owen, 2016; Engineering Institution of Zambia, 2015). See Annex 3 for load shedding schedules for 2016 and 2017. Electricity demand is expected to continue growing, with a forecast maximum demand of 3 029 MW by 2025, which could translate into a shortfall of 1 179 MW (Chitundu, 2012). While Zambia expects new coal-fired, hydro and renewable energy capacity to be added to the system in the medium term, an expected doubling of copper production capacity means the capacity increases will make little impact to the expected medium - long term capacity shortfall (GIZ, 2016). Mining is the largest consumer of electricity in Zambia, accounting for about 55% of demand (MMEWD, 2014; GIZ, 2016)

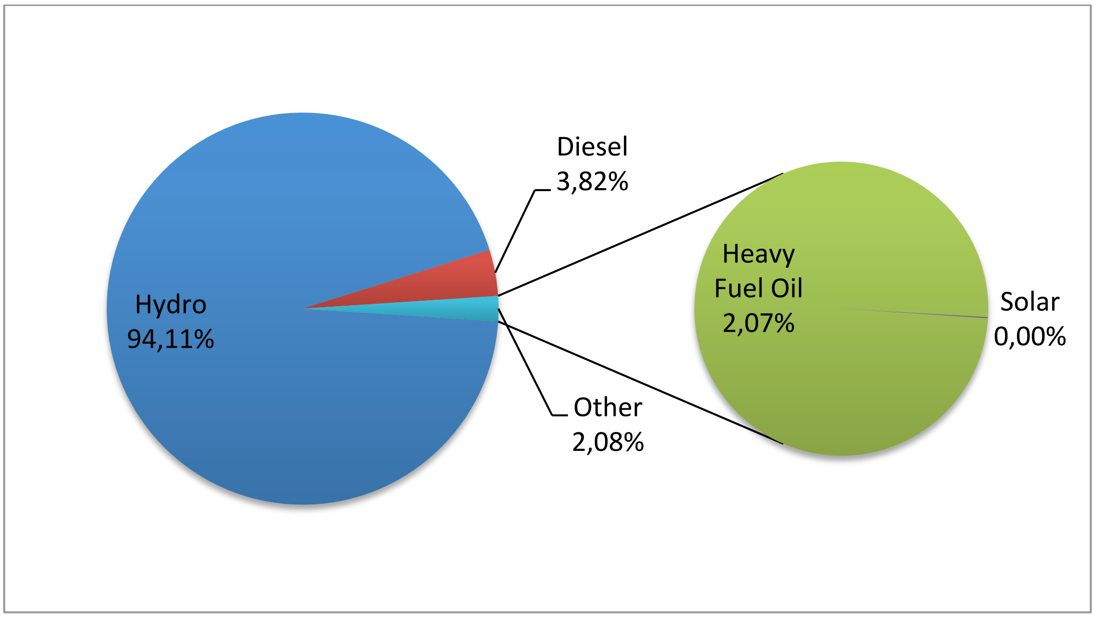


Figure 2: Installed national generation capacity by technology in 2015 (ERB, 2015b)

The Zambian electricity power system is operated as part of the Southern African Power Pool (SAPP), an interconnected power system linking Southern African countries and allowing electricity trading in the region (ZESCO, 2009). This includes import of power from the pool during periods when internal generation capacity fails to meet demand (provided there is surplus capacity in the pool), and also allows countries to sell surplus power to the pool. Zambia traditionally exports more power than it imports. However, in 2015, ZESCO recorded a sharp increase in power imports of 785.2 GWh from 12.8 GWh in 2014 due to the power deficit

(ERB, 2015b). As shown in Table 1, Zambia had to resort to costly emergency power imports to sustain its economy.

Table 1: Short term-emergency power supply measures in Zambia (GIZ, 2016)

Source	*Type*	*Capacity (MW)*	*Contract period*	*Price (USD/kWh)*
EDM	Mixed	80–150	Jan 2016- Dec 2017	0.1400
Aggreko	LNG	148	Sep – Dec 2015	0.1886
Aggreko	LNG	40	Jan – Dec 2016	0.1886
Karpowership	HFO	100	Mar 2016 – Dec 2017	0.1673
Eskom	Mixed	50–300	Jan – Dec 2016	0.0600–0.1900

2.2 Energy policy

Energy policy in Zambia is guided by the National Energy Policy of 1994 (ERB, 2015c). The electricity subsector is governed by the Electricity Act of 1995, which regulates the generation, transmission and distribution of electricity. In addition, the Energy Regulation Act of 1995 led to the establishment of the Energy Regulation Board (ERB) to ensure proper coordination and a level playing field in the energy sector (MMEWD, 2014; ERB, 2015c). Furthermore, the Rural Electricity Act was enacted in 2003 to facilitate rural electrification. Electrification in Zambia is low; in 2016, only 25% of the urban population and 3% of the rural population had access to the grid (USAID, 2016). In 2013, the Zambia Grid Code was adopted with the objective of enabling open and non-discriminatory access to the transmission system as well as facilitating liberalisation of the sector (MMEWD, 2014).

2.2.1 Power sector players

Major players in the Zambian power industry include the Ministry of Mines, Energy and Water Development (MMEWD) and state institutions such as the ERB, the Rural Electrification Authority (REA), the public utility ZESCO, and independent power producers such as Copperbelt Energy Corporation, Lunsemfwa Hydropower Company, Zengamina Hydropower Company and Northwest Energy Corporation (see Figure 3). MMEWD is the custodian of the energy sector, including the power subsector, and is responsible for formulating and implementing policy, through the Department of Energy. Within the Ministry of Energy, an Office of Promoting Private Power Investments was set up specifically to coordinate and attract private sector funds into the electricity subsector. The ERB is responsible for regulating operations and pricing of the electricity subsector. The REA is responsible for overseeing rural electrification, operation of grid extension network, as well as managing rural electrification subsidies (SERN, 2012).

2.2.2 Policy on tariffs

Since the 1970s, Zambia had enjoyed surplus electricity capacity and saw no urgent need for new capacity. However, this has now changed, due to increasing demand, the need for increased rural electrification, and the 2015-2016 power deficit (MMEWD, 2014). The Zambian Position Paper on Electricity (2009) made policy recommendations to ensure sufficient power supply in the country. Among them were investments in new power generations using public-private partnerships, a policy to encourage independent power producers and an energy efficiency policy to address demand-side management. It further recommended a migration to cost-reflective tariffs to all consumers including the mines, to be done in a gradual manner, and the diversification of the power mix to reduce the high dependency on hydropower.

Although power generation is mostly from low-cost hydropower (IRENA, 2015), Zambia’s electricity tariffs are still below production costs (Mukanga, 2015), and amongst the lowest in the region, as shown in Figure 4. The production cost of power from large scale grid connected hydro-plants are between USD 0.02 and 0.03 /kWh while that of mini-hydro plants are between USD 0.05 and USD 1 per kWh; and isolated diesel plants are USD 0.35/ kWh. The Government of Zambia basically subsidises electricity tariffs to cover the difference between cost of electricity production and supply and electricity selling prices by paying for the difference between ZESCO revenues and actual costs of supply. According to ZESCO, an average tariff of about USD 0.10 /kWh would be assist in bringing tariffs closer to cost of electricity supply (ZESCO, pers comms, 2017).

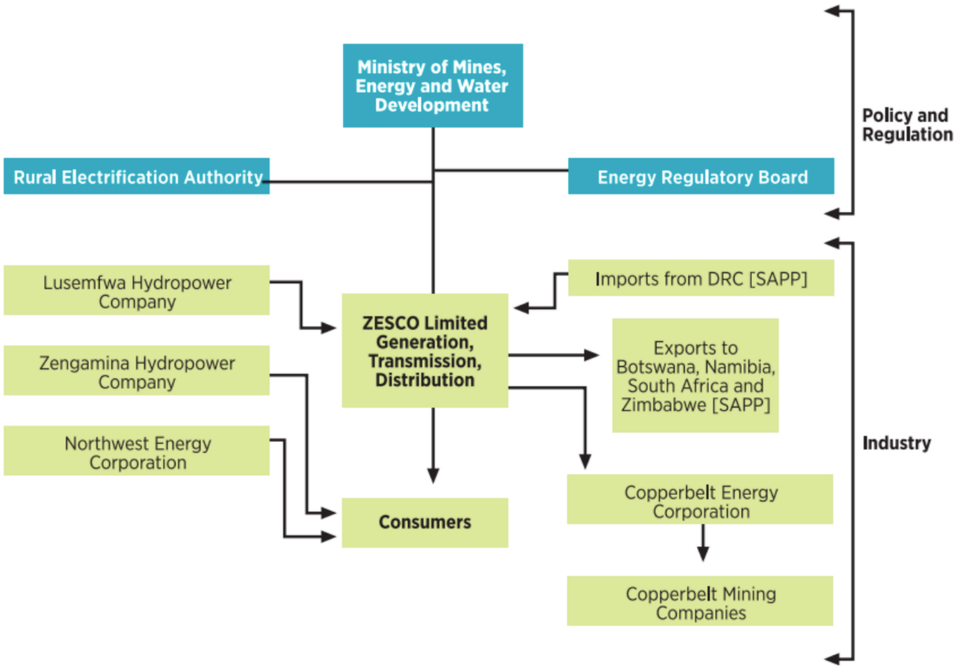


Figure 3: Zambia's power sector players (Singh et al, 2013)

Prior to 2008, the average tariff in Zambia was USD 0.027 /kWh (Singh et al, 2013), which did not reflect the economic cost of producing power. Over the years, this trend has continued and has been a deterrent to private investments in the electricity sector. It was estimated that an investment of USD 6 billion was needed from 2010 to 2015 to attain a generation capacity of 4 500MW sufficient to meet medium-long term power demand in the country (ZESCO, 2009). To raise funds for these investments, there were therefore plans to revise tariffs (ERB, 2015a), but there was a lack of urgency and political commitment to effect these increases. However, the power crisis of 205/16 appears to have propelled government to move swiftly towards cost reflective tariffs due to reduce the economic impact of the power deficit.

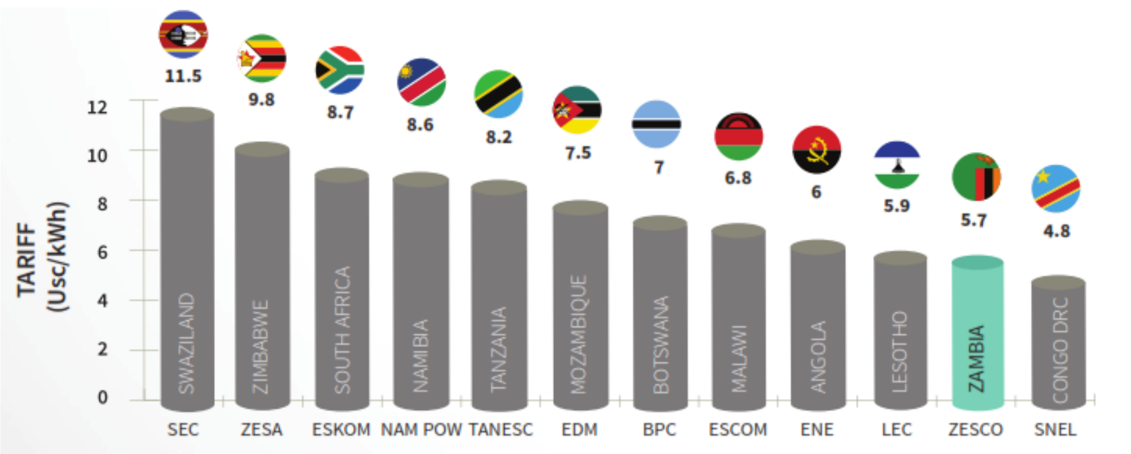


Figure 4: Comparison of electricity tariffs in SADC Region (PMRC Monitoring and Evaluation Division, 2014)

Emergency power imports in 2015/2016 came at a considerable cost to the government. For example, imports from Aggreko were pegged at USD 0.188 /kWh, while Karpower cost USD 0.167 /kWh. Imports from Mozambique were priced at USD 0.076 /kWh and the average SAPP tariff on imports from the day ahead market (DAM) was USD 0.067 /kWh in October 2015. In

2015, emergency power (cost of supply minus tariffs) is estimated to have cost Zambia about USD 44 million. This burden exacerbated by the rapid depreciation of the kwacha in 2015 (World Bank, 2015).

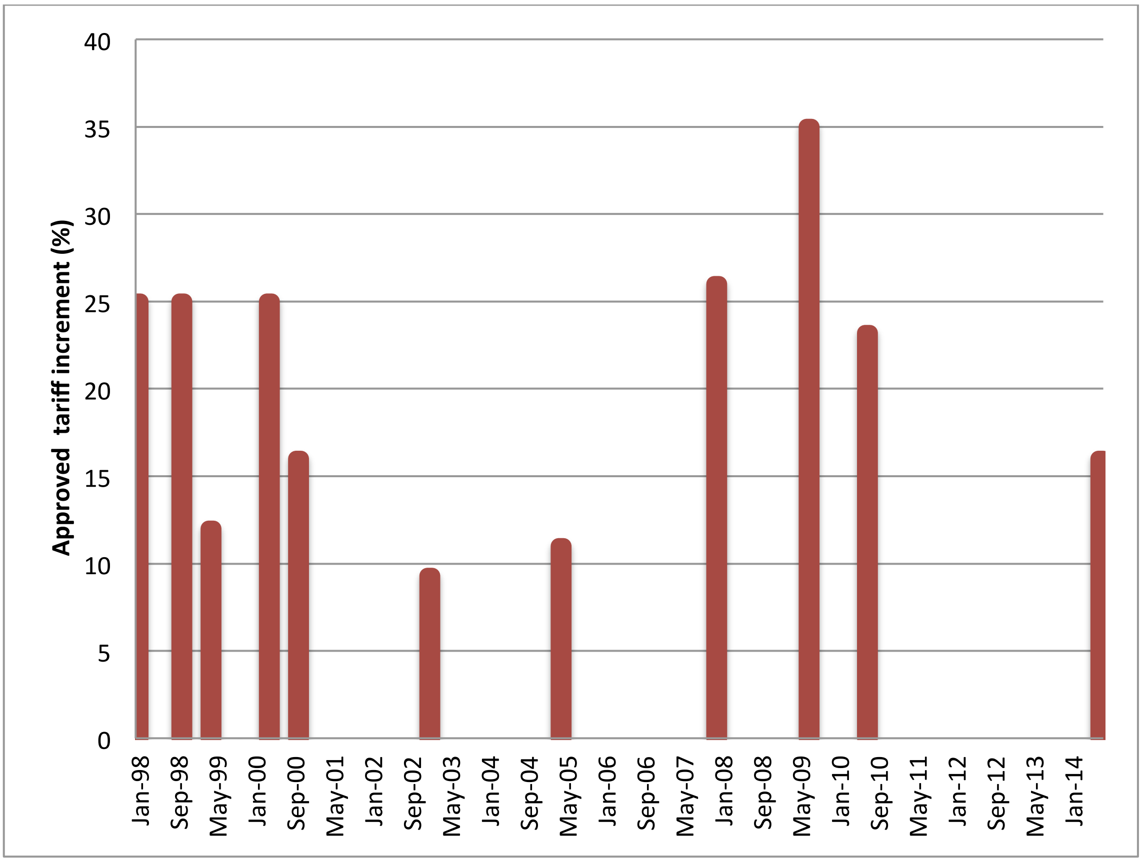
Zambia has a two-tier electricity tariff system. While electricity tariffs are in general regulated and approved by the ERB, mining tariffs have historically been implemented under the so-called “Power Service Agreements” between the mines and government. Most mines in the Copperbelt Province receive their power via the Copperbelt Energy Corporation (CEC) based on the long-term PSAs that run together with Bulk Power Supply Agreements (PSAs) between CEC and ZESCO Limited (World Bank, 2015). These PSAs date back to the mines privatisation process, and were meant to shore up the sector. As a result, mining tariffs have been low and below cost of supply (ZESCO, pers comms, 2017). Due to these historical contracts, ERB does not interfere in these PSAs, except for arbitration. Thus, it is difficult to implement tariff increases for the mines, besides to account for inflation at an annual rate. The ERB does however set tariffs for other consumer categories and provides its consent to ZESCO’s other long-term bulk power agreements (World Bank, 2015). This arrangement has been a source of grief for non-mining consumers who feel the tariff regime is unfair. Greater transparency in mining tariffs relative to the cost of supply could therefore assist in improving the public understanding.

The mining tariffs are also confidential and vary from mine to mine depending on the contracts and PSAs. Apart from differences in the era the contracts were drawn, the differences in PSAs are also due to varying mines sizes and operations (e.g. open-pit, underground, smelters etc.) and power consumption. Also, mines are connected to the grid at high voltage and have to invest in power infrastructure such as substations. Part of these costs are offset by lower tariffs are the utility does not incur distribution costs (ZESCO, per comms, 2017).

The discussion of adjusting electricity tariffs towards costs-reflective levels has been on going for the past decade. Since 2007, ZESCO has made several tariff applications to ERB as shown in Figure 5. The Zambia Position Paper on Electricity (Mukanga, 2009) recommended that mining companies should pay cost-reflective tariffs. Over the period 2007 to 2010, ERB approved average cumulative increases of about 96% for non-mining consumers to ensure financial viability of power supply. These average cumulative increases were much higher for the domestic sector (at 151%), large power (103%), small power (68%) while commercial increases were much lower at 63% (ERB, 2017, 2014). For mining tariffs, ZESCO and CEC agreed to a 35% tariff increase over the same period. However, these tariffs were not inflation linked and remained low in real terms (World Bank, 2015). Over the years, some tariff increments for the mines have resulted in disputes between the mining companies and government (Zambia Mining Magazine, 2014; Mining Technology.Com, 2016; Hill, 2016).

In June 2011, ZESCO and CEC agreed on another 30% tariff increase but this was not applied to other sectors. Some mining customers did not accept these tariff increases and this led to disputes between ZESCO, CEC and these mining companies. ERB engaged the parties in the dispute in July 2013 and this was followed by protracted consultations. Eventually, the BSA tariffs between ZESCO and CEC were increased by 28.8% to USD 0.0684 /kWh in April 2014 while the PSAs tariffs between CEC and its mining customers were increased by an average of 17% in addition to the minimum tariff of USD 0.0684 /kWh. Minimum tariffs for other mines directly supplied by ZESCO were also increased to USD 0.0684 /kWh (ERB, 2014).

As shown in Figure 5, there were no tariff increases for four years from August 2010 to July 2014 despite cumulative inflation of 28%. ZESCO had earlier in 2011 proposed a four-year tariff increase plan and submitted this to the ERB for approval, with the intention of reaching an average tariff of USD 0.13 /kWh in 2015 (IRENA, 2016). However, ERB approved tariff increases on all non-mining consumers in July 2014 - commercial tariffs were increased by 15.4% and residential consumers’ tariffs by 24.6% (World Bank, 2015).



	Jan-98	Oct-98	Apr-99	Oct-99	Apr-00	Oct-00	Jan-03	Apr-05	Dec-07	Jul-09	Jul-10	Jul-14
Average % applied for	30	46	12	15	25	16	16	15	60	66	36	26
Average % approved	25	25	12	0	25	16	9,3	11	26	35	23,2	16

Figure 5: Trends in tariff adjustments

Given the further deteriorating power supply in 2015, government pledged several times to revise electricity tariffs to take the cost of supply into account, but no action was taken by the end of 2015. During the same time, ZESCO applied to the ERB to increase non-mining tariffs from between 167 and 248%, and this was followed by public consultations. At the same time, negotiations for reviewing mining bulk power sales began between ZESCO, CEC and the mining industry to cover the full cost of emergency power imports (World Bank, 2015). ERB approved increases in non-mining tariffs, but this decision was first reversed by government in January 2016 (during the election campaign period), but these tariffs were later implemented in May 2017 (Kesselring, 2017).

Despite consumer resistance, ERB approved a 75% increase in tariffs for ZESCO's retail customers for 2017, which were effected in two phases of 50% from May 2017 and 25% to be effected from September, 2017 (ERB, 2017). These changes (presented in Annex 2) provides for a 'life-line' tariff of USD 0.015 per kWh - aimed at protect low-income residential consumers, but the threshold was increased from 100 kWh to 300 KWh of consumption. The 300 kWh band has been criticised as including many non-poor households as well (World Bank, 2015).

To provide a systematic framework for tariff setting into the future, the ERB developed the Multi-Year Tariff Framework (MYTF), which included the Multi-Year Tariff Draft Rules and Regulations and the Tariff Determination Methodology in 2016. See Annex 1. This MYTF would provide stability and predictability to tariff determination by presetting tariffs for a longer period and allow for the automatic cost pass through when there is a change in the agreed factors (ERB, 2016). According to the World Bank (2015), electricity tariff increases are a necessary fiscal stabilising strategy as continued long-term subsidies would put huge pressure on the national budget, and may eventually become unaffordable.

3. Methodology

This study employs the concepts of Willingness to Pay (WTP) and Contingent Valuation (CV). The former is the maximum amount of money an individual is willing to give in exchange for a good or service (e.g. electricity) or to avoid something undesirable (e.g. load-shedding) (Champ et al. 2017). Consumers are often willing to pay a higher price for a service than current tariffs in order to receive a good quality and uninterrupted service. They might not be happy to pay the higher tariff, but prefer it to going without the service (Wedgewood & Samson, 2003). CV, on the other hand, is a survey-based economic technique that asks questions to reveal the monetary trade-off that a consumer would make against the value of goods or services. WTP studies are generally used for one of two reasons: to assign a value to a non-commercial or public good, or to inform price-setting for commercial goods/services. In this particular study, the aim is to inform tariff-setting for electricity services in various sectors in Zambia.

3.1 Contingent valuation

CV is one of many methods to determine an individual or business's maximum willingness to pay for an improved service. A CV survey is a useful tool for gathering accurate data on consumers' ability to afford, as well as willingness to pay for, particular service options presented to them. In this study, the aim was to establish the maximum amount of money enterprises were prepared to pay, on top of their current electricity tariff, for the improvement of electricity services such that they would receive an uninterrupted and stable power supply. This was against the backdrop of continuous outages that were affecting business viability and leading to losses and unnecessary expenditure on alternative energy supplies.

3.2 Survey design and implementation approach

3.2.1 Preliminary steps

Interview technique

Interviews were conducted in person, as this allows an interactive discussion where questions that are not clear are clarified, and additional contextual information can be obtained to gain in-depth qualitative data. The survey was designed to facilitate structured and detailed interviews and enable the efficient collection of key datasets, while allowing additional comments to be captured. Tablets were used to record responses on a digital survey form. In a few circumstances, interviews were conducted via telephone or through email and hard copies.

Target group, sample size and geographical coverage

All selected enterprises were located in the urban areas of Lusaka and Kitwe, with a few towns within a 60 km radius of Kitwe. Lusaka and the Copperbelt are the main hubs for entrepreneurial activity in Zambia and most of the businesses are located in these locations. The planned sample size was 210 but the total submitted sample size was 224 – the larger number resulting from the late release of questionnaires from firms that opted to participate by completing hard-copy questionnaires. Of the 224 enterprises, 13 were from Ndola (provincial capital city of Copperbelt province, located 60 km south of Kitwe), 10 were from Chingola (a mining town located 50 km north of Kitwe), 11 from Kitwe, and 190 from Lusaka. The additional urban centres were included as enterprises in those towns were keen to participate in the survey.

Sampling strategies

The sampling strategy was based on cluster sampling, using geographic location of enterprises, accompanied by stratified sampling, to explore various enterprise types, sizes and conditions prevalent in the study areas. The study aimed to capture the WTP of enterprises in the following categories:

- Manufacturing
- Metal processing
- Agribusiness

- Food processing (including milling, beverages)
- Retail/shops
- Hotel/Lodges
- Restaurant
- Logistics (including cold storage)
- Health
- Education
- Others (including media, printing, telecoms)

The contact details of manufacturing companies were largely acquired through the Zambia Association of Manufacturers, with the remainder found through these contacts and referrals. Due to time constraints and unwillingness by different businesses to participate, some sectors were covered more than others. Apart from one company, mines were not included in the survey because (as explained earlier) the mining sector has special PSAs with the government and the tariffs are confidential. Furthermore, mines, as a strategic sector, were exempted from load shedding.

Elicitation method for WTP

The elicitation format used a combination of a single bound dichotomous choice and the so-called 'payment card'. This entailed setting a reference or anchor point – in this case an ideal power supply service was assumed. Respondents were then asked about what they are willing to pay for the anchor point. A follow-up with the payment card[1] then requests the respondent to indicate what the maximum level of tariff increase they are able and willing to pay for the improved service. We selected the payment card as it helps to elicit more representative bids than with a total open bidding format. The payment card (shown in Box 1) as a core part of the elicitation strategy was based on the electricity tariffs approved by the Energy Regulation Board in March 2017. A linear design was applied, with values from 0 ZMW to 1 ZMW. This approach ensured a consistent distribution of values around the approved tariff values. To also anticipate the starting point bias, which implies that the value indicated by the respondent as WTP is influenced by the first value on the payment card, another free choice option was presented.

Also, we noted after the pre-test survey that some respondents did not know their tariffs or link monthly consumption to per unit electricity costs and total monthly bills. As a refinement to the elicitation method, we provided each firm with a small bill calculator, each enumerator had a small spreadsheet (with different worksheets for different tariff categories) to capture some basic monthly parameters and make a quick calculation of the new bill after a chosen level of tariff increase. This way, the respondent could relate to actual bills, which they were familiar with and weigh the impact of the bill increase to overall monthly expenditure.

Box 1: Payment card

0.00 ZMW	0.12 ZMW	0.25 ZMW	0.38 ZMW	0.60 ZMW	0.85 ZMW
0.02 ZMW	0.15 ZMW	0.28 ZMW	0.40 ZMW	0.65 ZMW	0.90 ZMW
0.05 ZMW	0.17 ZMW	0.30 ZMW	0.45 ZMW	0.70 ZMW	1.00 ZMW
0.07 ZMW	0.20 ZMW	0.32 ZMW	0.50 ZMW	0.75 ZMW	>1 ZMW
0.10 ZMW	0.23 ZMW	0.35 ZMW	0.55 ZMW	0.80 ZMW	Other

[1] We did not use a bidding strategy in the second stage, as this would have required a significant amount of pre-testing on location. The payment card also allows for a more representative bid than with a total open format. Also another reason for using this approach is due to the heterogeneous sample with varying tariff rates. It would be difficult to provide different anchoring points and bidding patterns and analyze them as one dataset. With the elicitation of a point estimate it is possible in a second step to do regression analysis on the covariates that influence the WTP allowing further statistical classifications.

3.2.2 Implementation

Questionnaire design

The survey was designed to explore a set of issues that would reveal the nature of business operations; how electricity is used in the business operations; how business operations are affected by outages; perceptions of quality of supply; and factors that affect WTP for improved electricity services. Questions in the survey were mainly closed-ended and dichotomous, designed to be clear and unambiguous. Furthermore, multiple-choice and scaled questions were asked, either giving ranges or using a fixed scale in a consistent way. Open-ended question were avoided except to solicit further comments clarifying chosen responses. The questionnaire was divided into three sections. The first addressed enterprise-related, background and geographical variables. Due to the assumption that companies are more ready to share employee than revenue numbers, the definition of micro, small and medium-sized companies was based on the number of employees, (Table 2).

Table 2: Categorisation of companies by size

Type of enterprise	*Number of employees*
Micro	0–10
Small	10–49
Medium	50–250
Large	> 250

The second part of the questionnaire focused on questions regarding access to electricity, and satisfaction with and perception of the quality of current electricity services. When applying the CV method it is necessary to give the nature and level of service for which respondents are paying for, before asking the respondents about the maximum price they are willing and able to pay (Whittington, 1998). Thus, the questionnaire was designed to include some introductory statements leading to the elicitation for WTP (see Annex 4 for full questionnaire). This introductory statement was used to minimise hypothetical bias, which is the risk that the given WTP of a respondent deviates from his actual WTP. To also anticipate the starting point bias, which implies that the value indicated by the respondent as WTP is influenced by the first value on the payment card, another free choice option was given.

The last part of the questionnaire was designed to elicit the businesses' WTP for improved electricity services based on choices provided on the 'payment card' described above. To reveal and understand the rationale behind the responses, follow up questions were asked based on a Likert scale from 1 (unimportant/strongly disagree) to 10 (very important/strongly agree).

Survey pre-test

After drafting the questionnaire, a pre-test on three companies was conducted in Lusaka, to check consistency and flow of questioning, whether duration is consistent with expected times, and the relevance of questions for eliciting WTP from respondents. It was also used to evaluate any need to adjust the 'draft' payment card. A number of issues which arose during the execution of the pre-test survey were taken into account and incorporated into the final questionnaire design.

Fieldwork design and enumerator training

The survey was conducted using handheld Samsung Galaxy Tablets between April and May 2017. Each enumerator was provided with a tablet preloaded with the survey using the Surveys application. The use of the application enabled data collection to be executed without the need for an internet connection. The survey was designed using LimeSurvey and loaded onto the OfflineSurveys application prior to data collection. A week before the full survey was conducted, enumerators were recruited and underwent three days of training on how to elicit consumer views and especially on how to use the payment card to estimate WTP. They were also trained on the use of Tablets for data capturing, including the functionality of the survey form and OfflineSurvey application.

Survey management
With the use of the LimeSurvey builder, changes to the survey questions or available responses were able to be executed remotely, with the changes reflecting on each tablet instantaneously. Survey responses were recorded on the tablets and the data was downloaded every one-to-three days and consolidated into one large dataset.

3.2.3 Data analysis

Data entry /cleaning/analysis
After data collection, the surveys were checked for completion, coded and entered into a spread sheet. Given the use of LimeSurvey and Offline Survey, the data was downloadable in csv format and reformated in Excel. Discrepancies in the datasets were identified and corrected – e.g. the way certain responses were labeled.

Descriptive statistics
A wide range of descriptive statistics were used in this study to analyse the data collected. A combination of MS Excel and the statistical package Stata was used in the analysis. Statistical analysis was used to determine the mean and median WTP. In addition, descriptive statistics were used to analyse the data on the type of enterprises that participated in the study, such as the sector they operated in and their business viability. We also analysed the electricity use and needs of the enterprises, including their consumption and expenditure. Additionally, the impact of blackouts or load-shedding was considered, as well as the responses of enterprises to these blackouts.

Although the descriptive statistics provided a picture of the characteristics of the enterprises, it could not provide information on the effect of any of the variables on the WTP of enterprises for reliable electricity. Econometric analysis was therefore used to assess the factors that will influence WTP. There are, however, some variables that could not be added to the regression model, due to a limited number of observations in the dataset. For instance, data on annual revenues was obtained from less than half the sample, as most enterprises regard this as sensitive WTP variable was used to analyse if they had any influence on an enterprise's attitude.

Econometric analysis
Several studies have used econometric models to explain the determinants of WTP for reliable electricity. The models have differed across the studies, mostly because of different elicitation methods used to obtain estimates. For instance, Ozbafli and Jenkins (2016) used a mixed logit model to estimate households' WTP for reliable electricity in North Cyprus, while Twerefou (2014) used an ordered probit model in Ghana, and Taale and Kyeremeh (2016) and Carlsson and Martinsson (2007) used tobit models in Ghana and Sweden respectively.

This study used a tobit model, because the data sample had a high number of respondents who indicated that their enterprises were not willing to pay more. Using an ordinary least squares regression model would have given biased and inconsistent estimates of the coefficients on the extent to which various factors influence willingness to pay (Gujarati and Porter, 2009). Using any form of logit or probit model would also not provide output on how the WTP value would be affected by a change in the factors included in the regression. The tobit models addresses both these issues and was therefore the most appropriate. The model used has the general structure used by Taale and Kyeremeh (2016) and is given by the following equations:

$$WTP_i = X_i\beta - \mu_i \qquad \text{if } X_i\beta + \mu_i > 0$$

$$WTP_i = 0 \qquad \text{if } X_i\beta + \mu_i \leq 0 \quad (1)$$

where WTP_i is the dependent variable, which is the willingness to pay more for reliable electricity supply in Zambia, β are the regression coefficients, X_i are the independent variables, and μ_i is the error term.

Details of the variables used in the regression analysis are provided in Table 3. The sample size also limited the number of variables that could be included in the regression model. The independent variables were selected according to which variables were considered most important, and the availability of data on specific factors.

Table 3: Description of variables used in the regression

Variable	*Description*
Dependent WTP	Willingness to pay for reliable/improved electricity supply in Zambia
Independent sectors	Dummy variables: Manufacturing (MF) Financial intermediation, insurance, real estate and business services (FI), Hotels and restaurants (HO), Community, social and personal services (PS), Wholesale and retail (RET) and Other MF is the reference sector.
Operating hours per day	The number of hours the business is operating per day
Years in Business	The number of years a business has been in operation
Profitable business	Dummy variable: 1 if the business is profitable and 0 if it is break-even or making a loss
Average monthly bill (ZMW)	The average amount businesses pay per month for electricity
Electricity consumed (kWh)	The amount of electricity consumed by businesses per month
Business on commercial tariff	Dummy variable: 1 if the business is on a commercial tariff and 0 if it is on any other tariff
Use other sources during outages	Dummy variable: 1 if the business uses other sources during outages and 0 if it does not
Ranking of perceptions of businesses	Dummy variables: (1) Increased profit, competitiveness, and revenues, (2) High tariff good a good option, (3) No trust in government and ZESCO (4) Alternative energy source better Rankings used: not very important, not important, moderate, important, very important. Moderate is the ranking used as the reference

To determine the influence of the various independent variables of factors on the WTP, marginal effects were calculated using the *dtobit* command in Stata. The results of the regression model are provided in section 4.3. Initially, a model (WTP1) that included all the variables in Table 4 was estimated and tested for multicollinearity using variance inflating factors (VIF). According to Gujarati and Porter (2009), multicollinearity exists when there is an exact linear relationship between one or more explanatory variables in a regression, and broadly includes high correlations between explanatory variables. High multicollinearity could result in imprecise estimates of regression coefficients as well as large type II errors, that is, acceptance of the null hypothesis when it should rather be rejected. Multicollinearity can be addressed by dropping one of the highly correlated variables. Since the average monthly bill and electricity consumed in WTP1 had relatively high VIF indicating possible multicollinearity, two additional models were estimated, one without the average monthly bill variable (WTP2) and another without the electricity consumed variable (WTP3). These models were also tested for multicollinearity. The results of these tests are shown in Table 15 and also provided in Appendix 5. The Akaike information criterion (AIC) was then used to compare these three models and the one with the smallest AIC was deemed to perform better than the others.

4. Results

This section present findings and results of the analysis of the survey. It includes results from the analysis, using descriptive statistics that explore and characterise the enterprises that participated in the study as well as results from the regression model that evaluates the factors that influence the businesses' WTP for improved electricity services.

4.1 WTP estimate

The main objective of this study was to establish the level of willingness to pay for improved electricity supplies to businesses in the main economic hubs in Zambia. Therefore, key outcomes were to generate the views and perceptions of electricity consumers towards the principle of paying for improved services, and to provide quantitative insights on the level of additional charges they are able and willing to pay. Table 4 summarises attitude of businesses in Zambia towards paying additional charges for better electricity services. The majority of respondents (67%) indicated that their enterprises would be able and willing to pay more for reliable electricity. However, about a third of the enterprises would not be willing, for various reasons. This includes those businesses that are unable to pay more due to threat of bankruptcy, and those that can afford to pay but don't believe that additional charges would lead to an improvement of the electricity services. Of the total sample of 224 firms, only one respondent did not answer the question.

Table 4: Indication of enterprises willingness to pay for reliable electricity

	No. of enterprises	*Percentage*
No	74	33
Yes	149	67
Total	223	100

Those respondents who were willing to pay higher tariffs were then asked to estimate the additional amount of money in Zambian kwachas (ZMW) that they were willing to pay on top of the electricity tariff that they were currently paying. To enable efficient responses, the payment card described above, with values ranging from 0 to 1 ZMW, was used to elicit the additional electricity charges. Those not willing to pay more were assigned WTP values of 0. These responses were then collated and used to derive the mean and median WTP for all the enterprises, as shown in Table 5.

Table 5: Willingness to pay for reliable electricity estimates

	ZMW
Mean WTP	0.14
Median WTP	0.09
No. of enterprises	213

While the mean would have been the ideal measure for the average value of incremental tariffs that businesses are willing to pay, the outliers and the large number of zeros included in its calculation (representing enterprises that were not willing to pay more) distort the mean. The distribution of WTP is illustrated in Figure 6. The median is, therefore, a better measure of what enterprises are willing to pay. Using the median, it can be concluded that 50% are willing to pay at least ZMW 0.09 per kWh more.

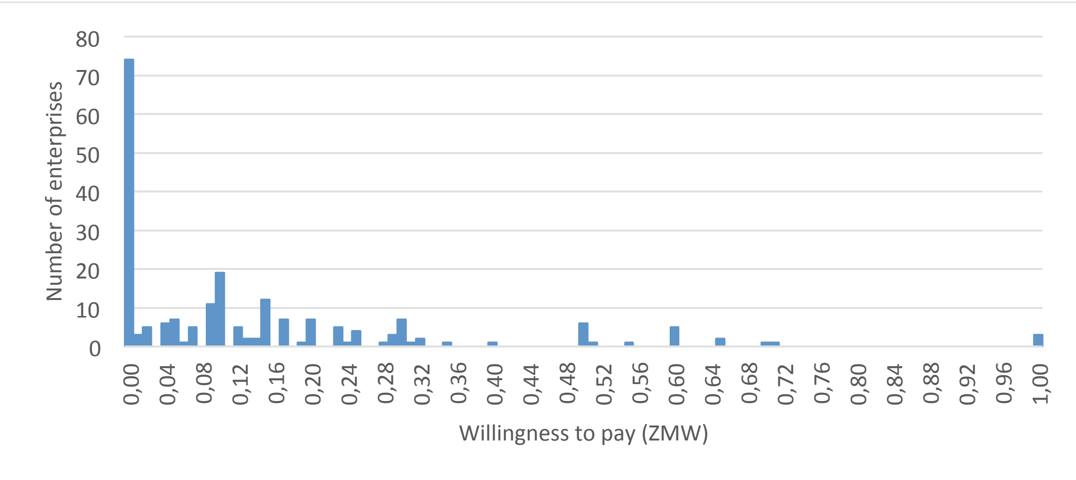


Figure 6: Distribution of firms by willingness to pay

About a third of enterprises have zero WTP, thus pulling the median value closer to zero. The distribution of WTP does not suggest the presence of any social desirability bias or experimenter demand effects, as only a few respondents provided a slightly positive WTP value.

Comparison of the approved tariff increments in 2017 (which were increased by an average of 75% between May 2017 and September 2017) with the WTP from this study, shows that the implemented tariff increases were generally more than what most firms are willing to pay. As shown in Figure 7, only about 25% of the firms are willing to pay more than a 75% increase in electricity tariffs. This figure includes only those firms that have WTP. About a third of the firms are willing to pay tariff increases of between 25-50%. However, since the tariff increases were staggered with an initial increase of 50% in May 2017 and a further increase of 25% in September 2017, the majority of firms would have found the tariff increases within acceptable bounds. About 41% of the firms expressed WTP for tariff increases of more than 50%.

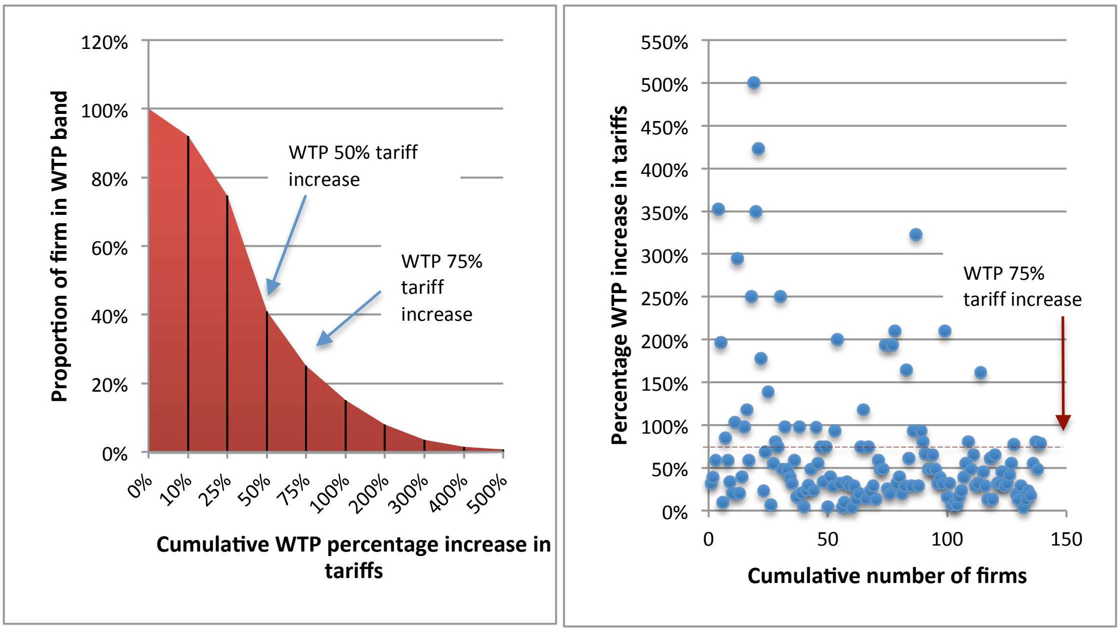


Figure 7: Distribution of firms by (WTP) percentage increase in tariffs

Enterprises that were not willing to pay more were asked to give reasons. As shown in Table 6, most firms were not willing because the tariff they were currently paying was above cost (about 20% of businesses), or they did not believe doing so would improve electricity supply (about 18%). These two factors show that most consumers in Zambia (about 40%) generally believe that the national utility is inefficient and passes on unnecessary costs. It also shows that consumers do not understand the tariff build-up formula, have no faith in the tariff consultation process, and generally distrust the state-run entities that deliver electricity services.

Table 6: Reasons for not willing to pay more for reliable electricity supply

Reason	*No. of enterprises*	*Percentage*
Cannot afford to pay (threat of bankruptcy)	26	11.6
Do not believe they would get improved supply	40	17.9
Demand is already met from self-generation	5	2.2
Can meet additional demand from self-generation at a lower cost	4	1.8
Tariff above cost	44	19.6
Tariff above other countries	6	2.7

Another 3% of the businesses believed that their tariffs were higher than in neighbouring countries – which is an ill-informed position, as Zambia has traditionally had the lowest tariffs in the region. All these reasons indicate lack of awareness on the part of consumers and lack of a proper communication of electricity tariff policy and processes on the part of the authorities. A significant number of enterprises (about 12%) were unable to pay more for their electricity as their businesses were struggling, whether or not they would be otherwise willing. About 4% of enterprises would rather rely on their own gen-sets or alternative energy than pay higher public electricity tariffs. About 50% of this group believe their private gen-sets can deliver energy services at lower costs than the publicly provided electricity. However, in reality, private small-scale gen-sets have higher unit energy production costs than public electricity (due to economies of scale) and this shows lack of awareness of electricity and energy production costs. This group also considers energy security as critical to their businesses and would rather invest in a self-managed system than pay more for better public services (which they cannot control). Again, trust of the public system of electricity delivery is at the core of this unwillingness to pay.

4.2 Survey results - descriptive statistics

The following sub-sections present some of the key survey results, using descriptive statistics to analyse the nature of businesses that were included in the study, their energy use patterns and expenditure, perceptions about electricity services, impact of electricity outages, and several other factors that influence the consumers' WTP for improved electricity services. In addition, basic correlations are included in this section for some variables and the enterprises' WTP for variables that were not included in the econometric analysis.

4.2.1 Classification of the enterprises

The sample consisted of 224 enterprises in different sectors and operating at different scales, as shown in Figure 8, but only 219 respondents were able to provide complete information on the classification of the business. As described above, enterprises were categorised into different types (micro, small, medium and large), based on the number of employees. The study sample consisted mostly of micro and small enterprises (93%). About 56% of the enterprises were micro-enterprises and about 37% were small. Only 2% were classified as large. However, some businesses (particularly the larger ones) indicated that the number of employees fluctuated due to seasonal workers intake.

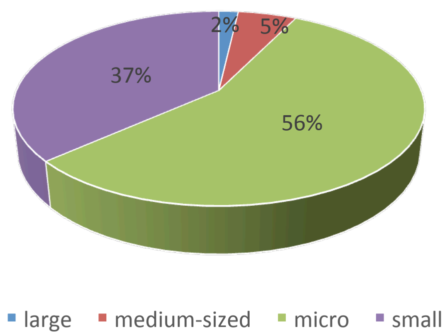


Figure 8: Distribution of enterprises by size of business

Apart from size of business, information on the economic sector of the enterprises was also collected. The sectoral classification shown in Table 7 was applied to allow the identification of a few broad economic classes. The 'Other' sectoral category combined some key economic sectors (including agriculture, forestry, mining/quarrying, construction, telecommunications, logistics and transport) which could not analysed separately due to the small number of enterprises in those sectors.

Table 7: Classification of sectors

Description	*Abbrev. /code*
Financial intermediation, insurance, real estate and business services	FI
Hotels and restaurants,	HO
Manufacturing (incl. automotive engineering workshops)	MF
Personal services (incl. Community, social and personal services sector which included education, health, recreation and, cultural and supporting services, media print and entertainment, laundry, hairdressing, beauty treatment, funeral)	PS
Wholesale and retail	RET
Other (incl. Agriculture, forestry, and related services, Mining/Quarrying, construction, telecommunications, logistics and transport)	Other

Figure 9 shows that a large number of the enterprises in the survey sample (38%) were in the personal services (PS) sector, including a variety of small-scale community, social and personal services. This was followed by the retail sector (RET) at 24%, financial services companies (13%), manufacturing companies (11%) and hotels and restaurants (9%). The 'Other' sector had the smallest share (5%), including diverse enterprises from mining, construction to agriculture and logistics.

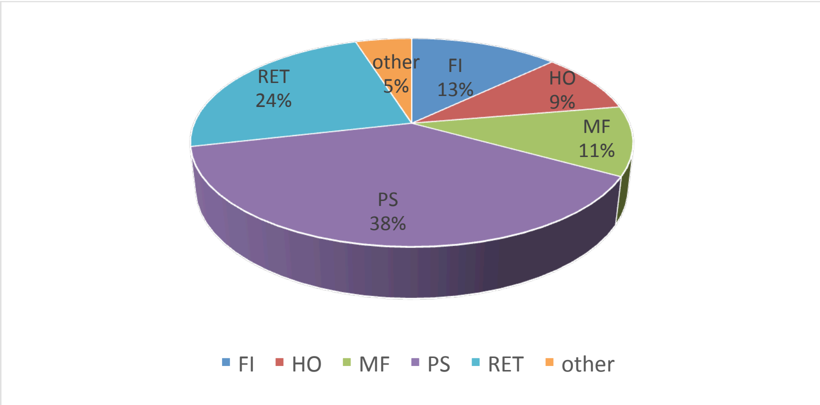


Figure 9: Distribution of enterprises by sector

Given this sectoral classification, potential linkages between the different sectors and WTP were explored, in order to check whether specific sectors and business activities are more sensitive to power outages and as a result are willing to pay more, and if there are any peculiarities that influence the position of similar type of business operations on WTP. As shown in Figure 10, generally, more enterprises are willing to pay more for reliable electricity across all the sectors, although the relative proportion of firms varies for the different sectors. Manufacturing has the highest proportion of firms willing to pay more (83%), followed by financial services (72%). About two thirds of 'Hotels and restaurants' and the 'Retail' sector are willing to pay more. Personal services and 'Other' sectors have relatively lower WTP, at 62% and 55% respectively. The 'Other' sector includes various sectors, and closer analysis of composition of the enterprises in the 'other' sector (in terms of their operations, annual revenues and size) did not provide any insights or consistent pattern as to why this group has the smallest differences in WTP.

It is to be expected that there are more companies in the manufacturing sector willing to pay more for reliable electricity services since production facilities are very sensitive to power outages. Hotels and restaurants are also fairly sensitive to outages as they depend on meeting high customer service expectations, especially the tourist clientèle in a competitive market. Similarly, the financial services sector's IT-based systems rely on electricity, and it may not always be possible to provide back-up gensets due to the location of the offices. In the econometric model (see section 4.3), a dummy variable for the sectors was included, as indicated in Table 3. Section 4.3 also provides further analysis from the regression model and insights into the differences between enterprises in the manufacturing sector (used here as the reference) and the other sectors.

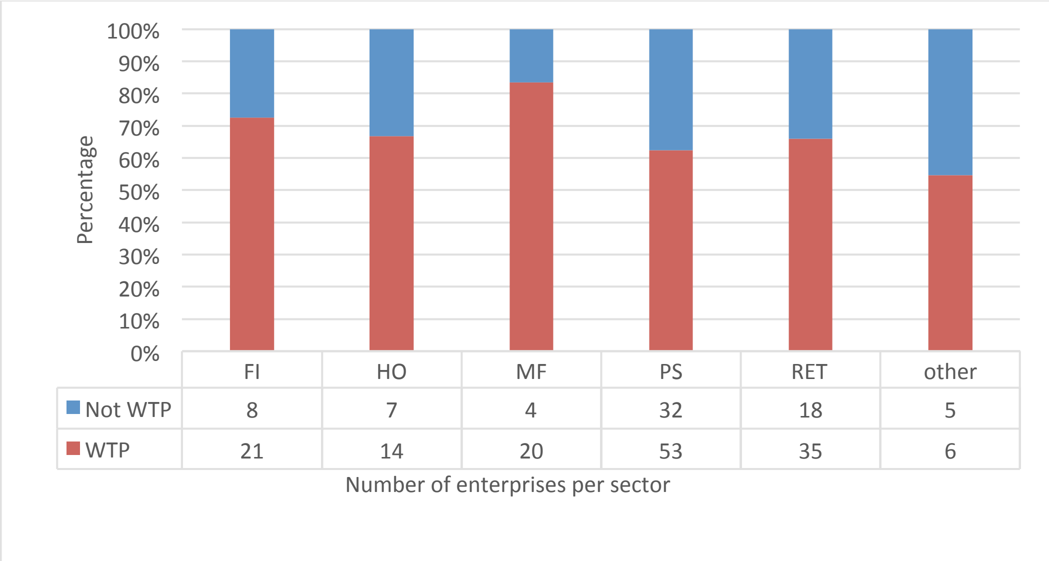


Figure 10: Comparison of willingness to pay by sector

4.2.2 Years in business

The ‘number of years an enterprise has been in operation’ was also included in the econometric model to establish if this factor influences the firms’ willingness to pay more for reliable electricity. About 25% of the enterprises in the sample have been in business for more than ten years, while another 30% have operated for six to ten years. This means that some 55% have been operating for at least six years and are thus fairly well established. However, the sample also included some start-ups, as about 9% of the enterprises had been in operation for one year or less. This group included mainly firms in the PS sector. The remaining 36% have been in operation for two to five years.

4.2.3 Annual revenue

Data on incomes is typically difficult to obtain in surveys as it is sensitive information. We managed to get annual revenue data from less than half of our sample (109 out of 224 enterprises). However, it is likely that even this data is not reliable as companies are not keen to divulge their real earnings (for various reasons). As shown in Table 8, 50% of the enterprises had annual revenues of ZMW 700 000 (about USD 68 500) or less. The enterprise with the lowest annual revenue was earning ZMW 10 000 (about USD 1 000) and the one with the highest annual revenue had ZMW 31.7 billion. About 14% had annual revenues of more than ZMW 10 million.

Table 8: Annual revenue of enterprises

Percentiles	*Annual Revenue (ZMW)*
1%	11 000
25%	300 000
50%	700 000
75%	1 500 000
99%	500 000 000
No. of enterprises	109
Average annual revenue	ZMW 303 million

Given the limited data on annual revenues, they were not included in the regression model and it was not possible to test if WTP more was influenced by an enterprise's earnings. However, the WTP for enterprises in the different revenue bands was compared, as shown in Figure 11 (i.e. those below the median annual revenue of ZMW 700 000 and those that were equal or above the median revenue). There is no distinct difference in the WTP positions of the two groups. In both groups, more enterprises were willing to pay extra compared to those that were not. In relative terms, however, a marginally higher proportion of enterprises with annual revenues above ZMW 700 000 were willing to pay more than those with revenues below the median (75% compared to 70%). This could support the notion that enterprises with higher revenues or income can afford to pay more, hence their higher willingness to pay. However, the differences are too marginal to allow making that categorical conclusion.

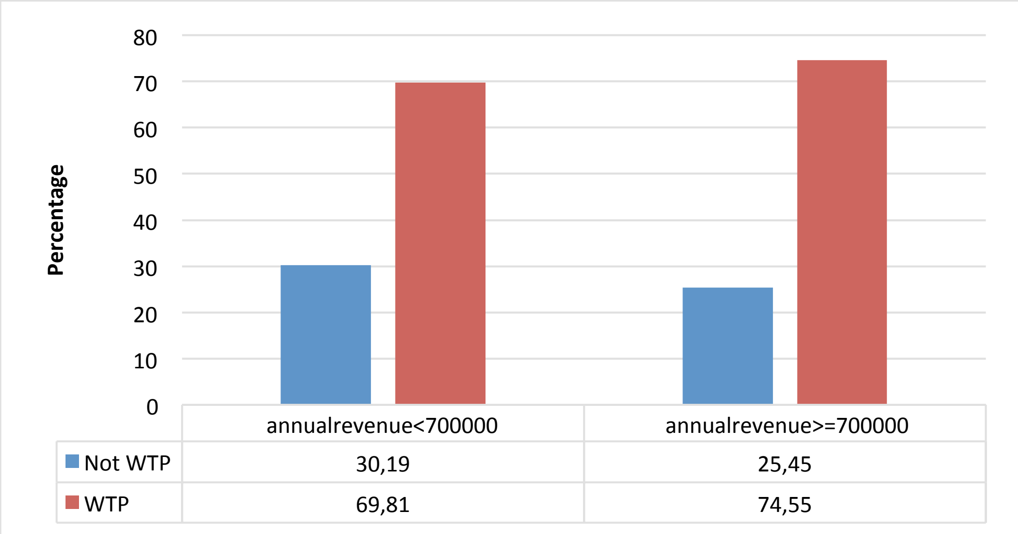


Figure 11: Comparison of annual revenues and willingness to pay

4.2.4 Business viability

The financial state of a business affects its ability to pay for various inputs, including energy services. An evaluation of the financial state of the enterprises is shown in Table 9. About two-thirds of the sample were making a profit and therefore, in theory, would be able to absorb increases in input costs. Of the remaining third, 28% were breaking even while 6% were making a loss. Although this group may be willing to pay additional electricity charges, it could potentially have an adverse impact on their viability. However, most of the companies making losses indicated that they are willing to pay more. This includes some big companies that have loan repayments. To assess whether profitability of enterprises could influence its WTP, we included a dummy variable in the regression model (Table 15).

Table 9: Business viability

	No. of enterprises	*Percentage*
Loss	12	5.5
Break even	60	27.7
Profit	145	66.8
Total	217	100

4.2.5 Electricity use and needs of enterprises

Operating hours per day

As shown in Figure 12, most of the enterprises operate for eight or nine hours per day. Cross-tabulation of the operating hours per day and the sectors of the enterprises revealed that most of the enterprises that operated for eight or nine hours are in the FI, PS and RET sectors. Only 3.6% of the enterprises operate for less than eight hours per day – these are mainly retail shops and a few personal services companies. About 36% of the enterprises operate between eight and 24 hours and the remaining 10% operate for 24 hours per day (mostly hotels and restaurants). The number of operating hours per day is expected to influence the enterprises' WTP. This variable was therefore included in the regression model and is discussed in more detail in section 4.3.

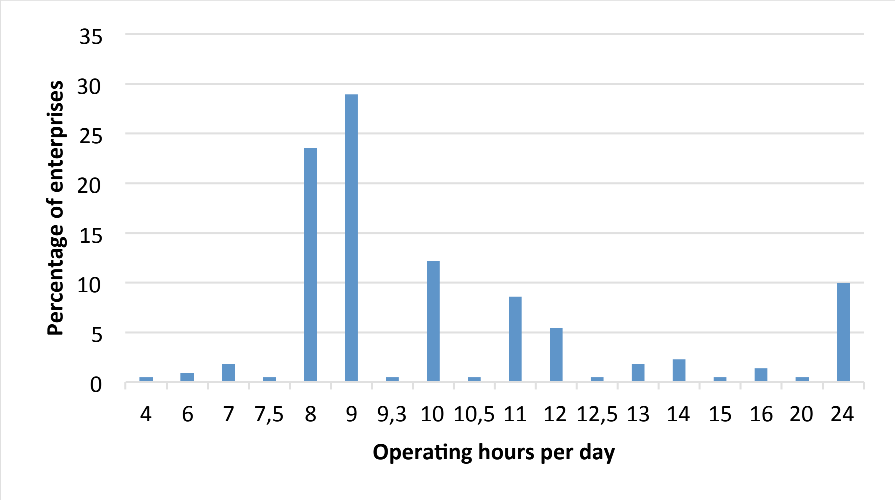


Figure 12: Distribution of enterprises by number of operating hours per day

Electricity consumption

Electricity consumption ranged from 30 to 255 000 kWh per month. As shown in Table 10, half of the enterprises consumed up to 755 kWh of electricity per month. Two enterprises that were in the 99th percentile consumed at least 100 000 kWh of electricity per month. One of these enterprises was a large manufacturing company with about 400 employees, using electricity for lighting, heating, cooling as well as production. It was willing to pay as much as ZMW 0.32 more for reliable electricity supply. The other company was a medium-sized hotel which operated for 24 hours a day and throughout the year, using electricity for lighting, heating, cooling, laundry and cooking. It indicated that it was willing to pay more for reliable electricity supply, but did not say how much more. Electricity consumption per month was included as an independent variable in the econometric model to determine if it influences businesses' willingness to pay.

Table 10: Electricity consumption per month

Percentiles	*Electricity consumed (kWh)*
1%	30
25%	343
50%	755
75%	2 695
99%	54 000
Average electricity consumption	4 850

Energy services required

Lighting is the most common use of electricity in the sampled businesses, as shown in Table 11, with every firm listing lighting as a key electricity function. Heating and cooling are also common electricity applications, in 82% and 66% of the companies respectively. About a third of the companies use electricity for production.

Electricity was required least for various 'other' applications in 65 firms – including powering computers and other IT equipment as well as TVs and radios for entertainment. The data shows that electricity was mainly used for lighting and cooling in the FI, HO, PS and RET sectors, but for the MF sector, the main uses were lighting and production.

Table 11: Electricity services required by enterprises

Energy service	*No. of enterprises*
Lighting	223
Heating	147
Production	72
Cooling	182
Other	65

We also investigated the potential links between the electricity services that enterprises required and their willingness to pay more. As shown in Figure 13, there is no distinct difference in WTP for the different energy services (ranging from 63% to 78%). What is counter-intuitive is that those companies using electricity for production have the lowest proportion that are willing to pay more for it. On the other hand, the 'other' electricity applications have the highest proportion of businesses that are willing to pay more (78%). This is probably due to the lack of alternatives for these energy services.

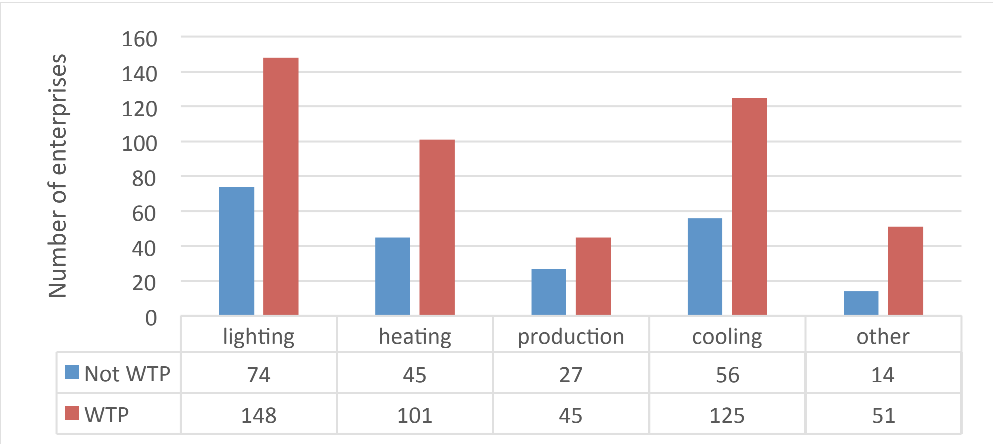


Figure 13: Comparison of required electricity services and willingness to pay

4.2.6 Tariffs and expenditure on electricity

Figure 14 shows the distribution of enterprises by tariff category. About 67% were on a commercial tariff and 26% on the Metered Residential tariff.

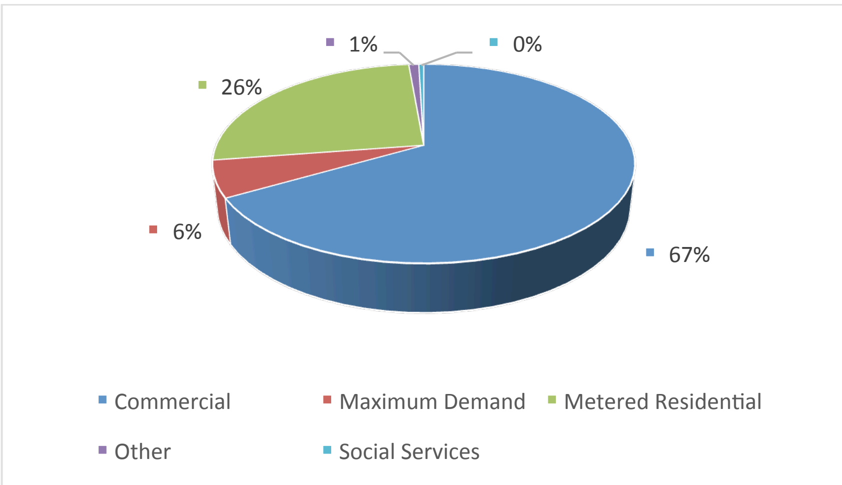


Figure 14: Distribution of enterprises by tariff category

A small number (6%) of larger businesses were on Maximum demand while about 1% were on other tariff categories. Most of the enterprises (71%) paid an electricity tariff of ZMW 0.31/kWh (USD 0.03/kWh), 22% paid ZMW 0.51/kWh (USD 0.05/kWh) and only 7% paid ZMW 0.2/kWh (USD 0.02/kWh) or less. Details of the tariffs paid by interviewed firms are presented in Table 12 and while the more general tariffs are given in Annex 2.

Table 12: Tariffs paid by enterprises per month

Tariff per month (ZMW/kWh)	*No. of enterprises*	*Percentage*
0.12	1	0.5
0.13	1	0.5
0.15	4	1.8
0.17	4	1.8
0.18	1	0.5
0.2	5	2.3
0.31	153	70.5
0.51	48	22.1
Total	217	100

Cross-tabulation of the data on the monthly tariff and the tariff type confirmed that the commercial tariff was ZMW 0.31/kWh and the (third tier) Metered Residential tariff was ZMW 0.51 /kWh. Thus, businesses that were on the domestic tariff (and especially those that consume more than 560 kWh per month) were actually paying a higher amount per kWh than those on commercial tariffs and this is probably due to lack of knowledge on the appropriate tariff to apply for (although some areas may not qualify for commercial tariffs due to zoning).

Since the current tariff on which enterprises are on is expected to influence the willingness to pay, this factor was further analysed using the regression model, by including a dummy variable for whether an enterprise is paying a commercial tariff or not. This is further discussed in section 4.3.

Apart from the tariff category and rates, the average monthly electricity bills were also explored, to check if the absolute energy bill also has an impact on the firms' WTP. From the data, the average monthly bill ranged from ZMW 50 to ZMW 28 000. Although this range is quite wide, only four enterprises had an average monthly bill of ZMW 10 000 or more. As indicated in Table 13, 50% of the enterprises had an average bill of ZMW 400 or less.

Table 13: Average monthly electricity bill of enterprises

Percentiles	*Average monthly electricity bill (ZMW)*
1%	70
25%	200
50%	400
75%	1 000
99%	13 000
No. of enterprises	*213*

The enterprises monthly electricity bill was also included in the econometric model as an independent variable as there could potentially influence their willingness to pay more, and this is also discussed further in section 4.3.

4.2.7 Electricity supply quality and interruptions

To elicit views from the businesses on the quality of electricity services, several questions were posed, including the impact that electricity supply interruptions were having on their enterprises. At least a third of the respondents indicated that they experienced some form of poor quality electricity supply through either poor voltage profile or fluctuations. About 40% confirmed that they experienced flickering lights, while 34% experienced brown lights. Flickering and brown lights are an indication of poor quality electricity; in the form of voltage fluctuations and voltage drop respectively. In addition, about 44% of the enterprises experienced some dips or surges in voltage, ranging from one to 60 weekly. However, only 16% of these had 20 or more surges or dips per week. These observations show that electricity supply quality has been poor, and needs to be addressed.

Respondents were also asked about their experiences of electricity supply interruptions. Most of the enterprises (65%) indicated that they had six or seven outages per week. Only 1% had more than seven per week. About 83% indicated that the interruptions were unacceptable, with 44% of these finding them highly unacceptable. Only 17% of the enterprises found the interruptions acceptable. Figure 15 compares enterprises' WTP against the number of electricity interruptions they faced per week.

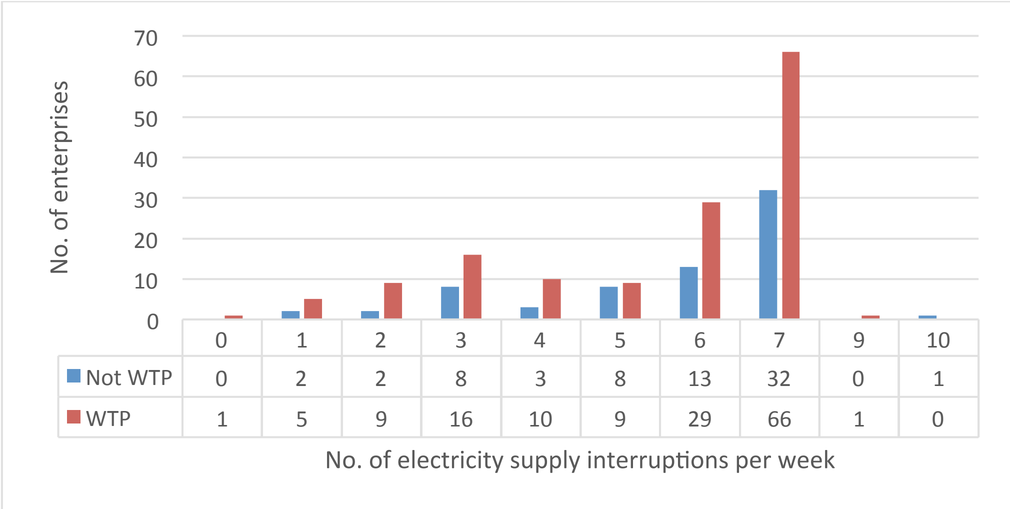


Figure 15: Comparison of electricity outage incidences and WTP

Although there is generally a higher proportion of enterprises willing to pay more for reliable electricity per each category of outages per week, there seems to be no distinct pattern in the distribution of WTP with more outages. There is, however, a general upward trend, implying that enterprises that faced more electricity supply interruptions were likely to be more willing to pay for electricity. There are some outliers, as shown in Figure 15; the enterprise that had the highest number of the interruptions per week was not willing to pay more for reliable electricity. Closer inspection of the data revealed that this enterprise was a medium-sized hotel which used a generator during power outages. The use of the generator cost ZMW 192 000 per annum. The hotel indicated that electricity prices were high and it was not willing to pay more because tariffs were above costs.

Table 14: Duration after which outages becomes a significant problem

Duration of outage	*No. of enterprises*	*Percent*
Up to 1 minute	109	48.7
Up to 1 hour	39	17.4
1-6 hours	31	13.8
7-12 hours	40	17.9
More than 12 hours	5	2.2
Total	224	100

Furthermore, the firms were also asked to indicate when the duration of the outage became a significant problem for their business operations. As shown in Table 14, about 49% indicated that outages of up to one minute were a problem. A further 17% said up to an hour. Only 2%

indicated that outages that were longer than 12 hours were a problem. Although, it could be expected that outages that last longer would cause more problems, this observation shows the level of intolerance for outages to business operations. It clearly shows that even momentary glitches are a huge inconvenience to businesses, as they can imply damage to equipment or need to reset equipment, and in some cases loss of production material. The longer outages may include those that are planned, when businesses are able to arrange alternatives.

Comparative analysis of the enterprises' WTP compared with (when) the duration of the outages becoming a significant problem was made, as shown in Figure 16. Generally, a higher proportion of businesses were willing to pay more, irrespective of when the interruption became a challenge to their businesses. In relative terms, 80% of the businesses that had problems with outages that last more than 12 hours were willing to pay more. This was followed by the under one minute category (at 69%), seven to twelve hours (65%), up to one hour (64%) and, lastly, one to six hours (63%).

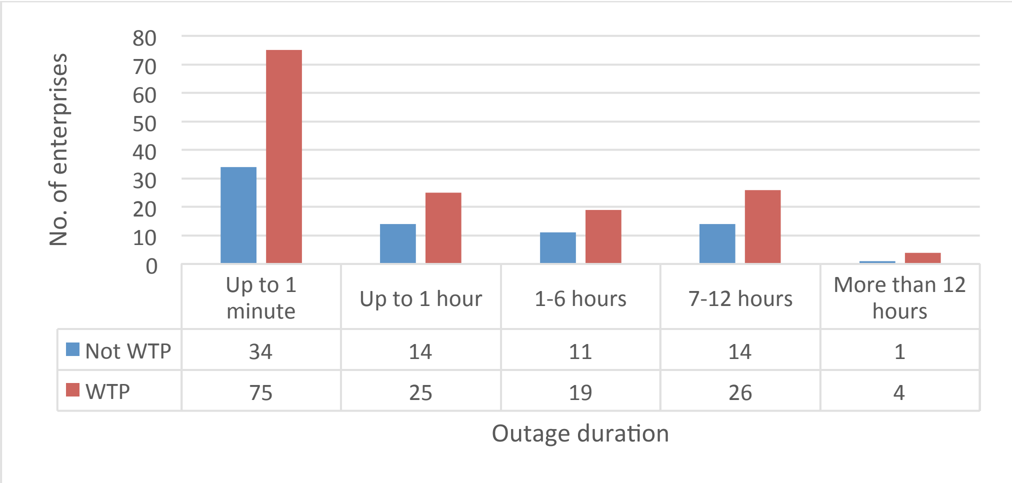


Figure 16: Comparison of outage duration and willingness to pay

4.2.8 Use of alternative energy sources

To deal with electricity outages and allow continuity in business operations, most enterprises resorted to various measures including using alternative energy sources. About 71% of the firms indicated that they used alternative energy sources during blackouts. Figure 17 shows the use of alternative energy sources during outages by sector. Hotels and restaurants had the largest share, because this sector is very sensitive to customer inconvenience. Wholesale and retail had the smallest share, although, 50% of retail shops used alternative energy during blackouts. Most of the enterprises indicated that they used back-up diesel or petrol generators during outages. Other resources included solar power, paraffin lamps, and charcoal.

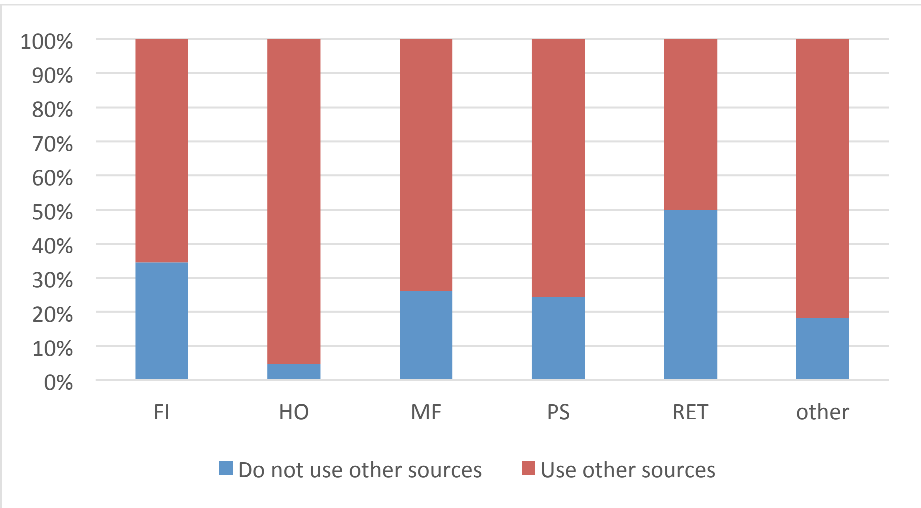


Figure 17: Share of enterprises using alternative energy by sector

Using alternative energy sources is a common strategy in many African countries where electricity supplies are unreliable. Although these back-up energy supplies are usually more costly per unit of energy produced, companies are more concerned about continuity in business operations and meeting the expectations of their clientèle. Thus, the use of alternative energy potentially influences the enterprises' willingness to pay more for reliable electricity. A dummy variable was therefore used in the regression model to investigate the potential effect.

4.3 Econometric analysis

The tobit model was used to estimate the effect of various factors on the willingness of enterprises in Zambia to pay more for reliable electricity. The marginal effects of the three models that were estimated are presented in Table 15.

Table 15: Results from the tobit model

	Model		
Variable	*WTP 1*	*WTP2*	*WTP3*
Sectors			
Financial intermediation, insurance, real estate and business services	-0.0471	-0.0493	-0.0549
Hotels and restaurants	-0.0944**	-0.0944**	-0.0987**
Community, social and personal services	-0.0463	-0.0475	-0.0519
Wholesale and retail	-0.0493	-0.0494	-0.0507
Other	-0.0579	-0.0739	-0.0637
Operating hours per day	-0.0054*	-0.0054*	-0.0044
Years in business	-0.0004	-0.0004	-0.0003
Profitable business	-0.0181	-0.0217	-0.0176
Average monthly bill (ZMW)	0.0000	-	0.0000*
Electricity consumed (kWh)	0.0000	0.0000**	
Business on commercial tariff	-0.1177***	-0.1142***	-0.1209***
Use other energy sources during outages	0.0041	0.0025	0.0038
Increased profit, competitiveness and revenues			
Not very important	-0.0716	-0.0668	-0.0736
Not important	0.3279***	0.3281***	0.3208***
Important	0.0548	0.0617	0.0526
Very important	0.0616*	0.0615*	0.0573
High tariff a good option			
Not very important	-0.0660**	-0.0710**	-0.0697**
Not important	-0.0233	-0.0234	-0.0285
Important	0.0432	0.0397	0.0363
Very important	0.1856***	0.1820***	0.1845***
No trust in government and ZESCO			
Not very important	-0.0434	-0.0436	-0.0471
Not important	0.0241	0.0212	0.0154
Important	-0.0475	-0.0514*	-0.0498
Very important	-0.0318	-0.0323	-0.0346
Alternative energy source better			
Not very important	0.0570*	0.0570*	0.0567*
Not important	0.0568	0.0592	0.0563
Important	0.0015	-0.0104	0.0070
Very important	0.0917	0.0933*	0.0976*

	Model		
Variable	*WTP 1*	*WTP2*	*WTP3*
Number of businesses	171	173	172
Left-censored observations	54	55	54
Uncensored observations	117	18	118
AIC	46,7847	44,3869	44,4784

*** 1% level of significance; ** 5% level of significance; * 10% level of significance
Note: Left-censored observations refers to those that had zero WTP

The variance inflating factors (VIF) for the average monthly bill and electricity consumed variables in the WTP1 model were much higher than those of the other explanatory variables (see Appendix 6). This suggests that this model could suffer from multicollinearity. The VIFs are much lower for the same variables in the WTP2 and WTP3 models, implying that multicollinearity is not a problem. Although the marginal effects of all three models are quite similar, the average monthly bill and electricity consumed were found to be statistically insignificant in WTP1 but significant in the WTP2 and WTP3. This seems to indicate that the WTP1 model has a type II error due to multicollinearity.

The models were compared, and best model was deemed to be the one with the smallest AIC. The results in Table 16 indicate that this would be the WTP2 model. The results from the WTP2 model are discussed in more detail below.

In considering the impact of the various sectors on WTP, manufacturing was selected as a reference, as most enterprises in that sector (about 83%) expressed willingness to pay more for reliable electricity services. From Table 15, the WTP2 model results show that only enterprises in the hotels and restaurants sector had a WTP that was significantly lower than that of the manufacturing sector – by about 9%. As shown in Figure 17, hotels and restaurants had the largest share of enterprises that used alternative sources of energy during outages. This could explain why they were not willing to pay as much as those in the manufacturing sector.

The number of hours an enterprise operated per day also had a significant effect on the WTP. WTP2 model results show that an increase in operating hours by one hour would lead to a decrease in willingness to pay of ZMW 0.01 for the average enterprise, all things being constant. A possible explanation for this could be that enterprises that were open for longer could postpone activities that required electricity, while those open for a few hours did not have that flexibility. Also, some enterprises that were open for longer, e.g. hotels and restaurants (which operated continuously), used alternative sources of energy during outages and thus are less willing to pay.

Also, the tariff category had a significant impact on the WTP. Enterprises on a commercial tariff were 12% less willing to pay for reliable electricity services than those on other tariffs. This could be because commercial tariffs are lower than the metered residential tariffs, as discussed earlier (residential 3rd tier tariff is more expensive than commercial).

Several factors were found to not influence the WTP. Although electricity consumed per month appeared to be statistically significant in the WTP2 model, the marginal effect was 0, implying that it would not have an effect on WTP. The number of years an enterprise had been in business, its profitability, average electricity bill, the amount of electricity consumed, and whether it used an alternative source during outages were all statistically insignificant. The conclusion, therefore, was that these variables did not influence the willingness to pay more for reliable electricity in Zambia.

Dummy variables on respondents' perceptions of how the enterprises could benefit from improved electricity supply, whether high tariffs would be good, their trust in government and ZESCO, and whether alternatives were better, were included in the regression model. Those with moderate perceptions on each of these variables were used as the reference.

Results of the WTP2 model in Table 15 show that those who rated the statement that 'their company would be able to increase profitability, competitiveness and revenue in the case of uninterrupted, secure power supply' as very important were willing to pay 6.2% more than those that gave a moderate rating. While the results also indicate that some of the respondents that rated the same statement as not important have a positive and significant value, these made up only 8.1% of the sample, hence those results are not reliable.

Respondents were also asked to rate the statement that higher tariffs would be a good option to contribute to and support a stable and reliable grid managed by ZESCO. Those who rated this statement as 'not very important' were willing to pay 7.1% less than those that gave a moderate rating, while those that rated it as very important were willing to pay 18% more.

The survey also sought to establish how trust in the government and ZESCO's abilities would affect the willingness to pay of enterprises. Respondents were asked to rate the statement 'I do not trust the institutional and technical capabilities of the government/ZESCO to implement a reliable system through a higher tariff paid by firms'. Enterprises indicating this statement as important were less willing to pay to by 5.0%, compared to those that gave the statement a moderate rating.

In addition to the dummy variable that captured whether enterprises used alternative energy sources during outages, respondents were asked if they felt that their company was better off in terms of additional costs with their current alternatives for energy. Those enterprises that rated this statement as not very important (representing 56% of the sample) were willing to pay 5.7% more for reliable electricity than those with the moderate rating. This could be due to the higher costs associated with using alternatives, hence they were not really considered a permanent or long-term option for these enterprises, which were mostly micro or small in size. At the same time, enterprises that rated this statement as very important were willing to pay 9% more than those who provided a moderate rating. However, these constituted a small fraction of the sample (6%), so this result should be taken with caution.

4.4 Discussion on methodology

Various techniques are used to evaluate the willingness to pay for goods and services. For energy projects in developing countries these techniques include travel cost methods, hedonic pricing methods, averting expenditure methods, production loss methods, captive generation methods and contingent valuation (Devicienti, et al 2004). All these methods of valuing goods and services have strengths and weaknesses (Geleto, 2011). In this study we employed CV as it is one of the most widely used valuing techniques. Despite its wide use it also suffers from a lot of weaknesses, but such weaknesses can be minimised by proper design and implementation of the survey (Kerr, 2001). Some of the problems of CV relate to the elicitation system used in a particular CV study. There are various elicitation methods including 'open ended questions', 'closed ended single bounded dichotomous choice', 'double bounded dichotomous choice', 'payment card', and 'iterative bidding games'. Recently, the dichotomous choice approach has gained a high level of popularity, as it is usually considered incentive compatible and free of starting point bias, but it comes at the cost of efficiency (i.e. provides little information) (Kerr, 2001). Thus approaches (such as payment card) that obtain more information from each respondent can be much cheaper to apply because fewer survey responses are necessary to obtain any pre-determined level of accuracy. The payment card offers one method for increasing efficiency over dichotomous choice, however it may also introduce a number of biases. The payment card avoids the need to produce a single starting point, and provides the respondent with a context for determining their WTP (Heinzen and Bridges, 2008). However, given the range of values presented, the payment card can introduce an alternative framing effect known as range bias or anchoring bias (i.e. the maximum and/or minimum price could influence the WTP) (Geleto, 2011). After some considerable evaluation of the different elicitation techniques, the study team decided to employ a combined payment card and the single bound referendum to address both the starting point bias and anchoring bias.

Despite the careful selection of an elicitation method, there are other issues that may introduce distortions. These issues can only be minimised by careful survey design and implementation. For instance, the responses on valuation depend on information about the service and its provision (e.g. insights on how tariffs are formulated, appreciation of electricity units and understanding the bill structure). Our pre-test survey established that some firms had no clue what their tariff was; neither did they have data on their monthly consumption or ability to relate an increase in unit electricity cost to monthly bills. Thus valuation on issues that respondents are unfamiliar with could be regarded as arbitrary and not useful for decision making. Apart from providing a good explanation of the service being valued, it may also help to give sufficient time for the respondent to collect sufficient information (e.g. by discussion with others) and give well thought value for the service. However, given the time and other resource constraints, it is not always possible to allow an elaborate interview process.

It has also been suggested that the payment card design may influence the WTP, i.e. the number of divisions, or cells, on the payment card is a potential source of bias. According to Kerr (2001), increasing the number of cells on a payment card is theoretically expected to increase efficiency except in those cases where respondents find it more difficult to answer the contingent valuation question because of the increased number of payment card cells. However, such increases in efficiency may only be realised if respondents are well-informed and have certain preferences. Narrowing the interval size may increase the difficulty of answering the question because of the apparent increased visual complexity. In practice Kerr (2001) study found that the card design had little influence on the valuation process.

Also responses may depend on the enumerator and how they present the questions or explains the good/service being valued. In this study, the firms were expected to indicate their WTP to pay for an ideal electricity supply service, and although the enumerator was trained to provide a description of this ideal service, the understanding and value of an improved electricity supply could be interpreted in different ways – and this would affect the WTP.

Despite inherent and potential weaknesses, CV provides one of the best approaches to determining the willingness to pay for improved energy services. According to Devicienti, et al (2004), CV has been employed in several developing countries to value electricity and the cost of unserved energy, both of which are important for investment planning and tariff-setting. This is due to the difficulties in arriving at acceptable and fair restructuring of tariffs in developing markets that are characterised by administered prices, a high level of cross subsidisation, low recovery of revenues, and strong political influence.

5. Policy implications

Judging by observations of the surveyed businesses, electricity supply quality in Zambia has been poor, and a long term strategy is required to ensure sustainability of the power sector, accompanied by improved electricity services and followed by efficient economic productive activities. At least a third of the respondents indicated that they experienced some form of poor quality electricity supply through either poor voltage profile or fluctuations. Also, most of the firms were experiencing at least six electricity supply interruptions per week. About 83% indicated that the interruptions were unacceptable, with 44% of these affirming that they were highly unacceptable. Also, the results show that businesses have a high level of intolerance for outages: even momentary glitches are a huge inconvenience to businesses as they can imply damage to equipment or a need to reset equipment, and in some cases loss of production material. Although the impact of poor electricity services could not be derived from the survey data, it is highly likely that most company operations have been adversely affected, with negative impacts on their viability.

Other reports on the impacts on electricity outages on businesses in Zambia (e.g. ERB, 2017), confirm these assertions. The ERB study established that load shedding in 2015 led to adverse disruptions in the operations of most small enterprises (SMEs) in major urban centres surveyed. Most SMEs had inadequate response strategies and resorted to reducing their work outputs resulting in reduced turnover whilst incurring additional costs such as idle labour and overtime. The study established that, as a result of load shedding, about 30% of SMEs reported damaged equipment and spent about ZMW 3 754 390 (about USD 375,000) in the restarting of operations in 2015 alone. Overall, losses amounting to about ZMW 623 871 515 (~ USD 62.4 million) were incurred as a result of load shedding by SMEs translating into USD 0.95 /kWhlos (kilowatt hour lost).

The World Bank study (World Bank, 2015) also noted various adverse impacts on the Zambian economy including reduced output and redundancies across businesses, increased costs of production. In addition, there were various social and environmental impacts of the power crisis including poor quality health care and education. Increased use of firewood and charcoal also leads to an increase in land degradation. Another study (Sing'andu, 2009) established that ZESCO's power rationing in Lusaka district eventually led to a decline in firm productivity and consequently reduced business income because SMEs are unable to meet customer demand.

Given that SMEs contribute significantly to the Zambian economy through employment creation, taxes and income (according to Nuwagaba (2015), SMEs employed 18% of the labour force of which 47% are women in Zambia), it is therefore important to ensure that electricity (as one of the key inputs in production) is supplied in sufficient amounts and quality to support business operations. Such improved electricity supplies would require long term power system improvements supported by national policies and strategies. Growth of the Zambian economy should be supported by growth in energy supply to ensure sustainability of businesses. According to Kesserling (2017), the expansion of mining activities in the early 2000s (without additional power generation capacity) possibly contributed to the 2015/2016 electricity crisis. Also studies done in the 1990s forecasted that demand would exceed supply around 2007, but no action was taken to increase power generation capacity. Although the 2015/2016 electricity crisis was much more pronounced and severe, Zambia had been experiencing power rationing since 2006 (Kabechani, 2017; Yamba pers comms, 2017). In addition, it is important for Zambia to diversify its power generation mix to avoid vulnerability to weather related capacity shortfalls. Due to the ElNino phenomenon, hydro-based power generation will always be affected periodically. Modelling of different hydrology conditions done in 2015 showed that even in a wet (above average rainfall) scenario, the impact of the 2015 drought would affect power shortages to at least 2018 (World Bank, 2015).

Analysis of the survey results has shown that the majority of companies are willing to pay more for improved and reliable electricity supplies in Zambia. This includes companies that are currently having financial difficulties and making losses. Those that are unwilling to pay additional electricity charges argue that the current tariffs were too high, or that any tariff increases was not going to make a difference as utility inefficiencies would absorb the additional revenue meant for system improvements. Only 12% of the enterprises are unable to afford additional tariff increases, and this shows there is scope for increasing tariffs in the remaining 88%. Only a small number of businesses prefer to use their own private gen-sets than to pay additional electricity charges.

5.1 Lack of trust in public electricity entities

These observations have several policy implications. First, they show that most consumers in Zambia generally believe that the national utility is inefficient and passes on unnecessary costs. Indeed, stakeholders wanted confirmation of cost of supply via a 'cost of service' study before any tariff increases can be effected. The World Bank report (World Bank, 2015) also argued that although increases in tariffs to cost reflective levels are necessary, this was not sufficient to increase private investment in electricity generation in Zambia. This is because there are many other challenges that hinder investment such as improve sector planning and procurement processes. Independent power producers are also offered attractive tariffs by ZESCO (as the main offtaker and public grid operator), but ZESCO sells the electricity at a loss to final consumers – which is unsustainable as the funding gap has to be plugged by government (Owen, 2016; Yamba pers comms, 2017). According to Owen (2016), it is important to have more transparency in the power industry, including transparency on tariff breakdown, trends in generation costs and revenue collection by ZESCO and other IPPs. The failure to collect revenue (and other non technical losses) and infrastructure related technical losses are typically challenging areas for African utilities. ERB monitors ZESCO's performance through so-called Key performance indicators (KPI) such as quality of supply, system losses and metering of customers- and these KPI are factored into tariff reviews. ZESCO has improved its technical losses from high distribution losses of up to 32% in 2009 to 10% in 2016 (ZESCO, 2009; ERB, 2016). Such improvements are not necessarily in the public domain, as shown by the negative perception to ZESCO performance.

It is therefore important that ZESCO continues to improve system-efficiencies, targeting non-technical losses and revenue collection, as well as streamlining their institutional and organisational operations. Second, the results show that consumers do not understand the tariff build-up formula, have no faith in the tariff consultation process, and generally distrust the state-run entities that deliver electricity services. Despite the fact that Zambia has traditionally had the lowest tariffs in the region, due to its hydropower endowment, some firms believed that their tariffs were higher than in neighbouring countries. The relevant authorities such as ERB, ZESCO and DoE could work together to educate consumers on the tariff development process, as these observations indicate lack of awareness on the part of consumers and lack of a proper communication of electricity tariff policy and processes on the part of the authorities. The 'Cost of service' study should also be part of the package of material which the national authorities should use to show to consumers the true cost of delivering electricity, including the long-run cost of investing in new power facilities. An inclusive and transparent consultative process that includes key stakeholder representatives should be instituted to take into account different stakeholder interests and the long-term sustainability of the sector into account.

5.2 Need for awareness and education

Lack of awareness of energy costing is also exhibited by some enterprises, which believe that private gen-sets can deliver energy services at lower costs than the publicly provided electricity. Typically economies of scale favour large-scale energy production, and private small-scale gen-sets have higher unit energy production costs. However, the underlying issue is probably energy security rather than unit energy costs, especially for sensitive businesses like hotels. This shows that, even for those that are unwilling to pay more for better electricity services, in reality they are spending even much more to be energy-secure. That is, these firms are willing to pay more for reliable power supplies if they are given assurance that power would be available when needed. Again, trust of the public system of electricity delivery is at the core of this unwillingness to pay – the fact that they are not willing to pay for the same assurance means they do not trust higher tariffs will make a difference. Education of such consumers, combined with sustained engagement, would help to gain support for electricity tariff increases.

There are few distinct patterns and trends that can be used as a basis for formulating tariff policies targeting either specific sectors or tariff categories. Generally, business activities that are more sensitive to power outages are also willing to pay more for electricity. It is therefore to be expected that there are more companies in the manufacturing and hotel sectors that are willing to pay more for reliable electricity services. As expected, manufacturing has the highest proportion of firms that are willing to pay more. Unlike mining, which is considered strategic at a national level and therefore mostly exempt from load shedding, other productive sectors are adversely affected by outages. To avoid loss of business, companies such as hotels and restaurants use alternative energy sources, incurring higher costs in the process. Although using alternative energy sources is a common strategy in many African countries where electricity supplies are unreliable, it is a costly way of doing business. According to ERB, electricity tariffs are set for each consumer category according to the cost imposed on the electricity system by each sector. However, given that the country only conducted a cost of service study in 2017, it appears that stakeholders were genuinely concerned that any electricity tariffs would not be based on actual costs of supply but used to cover up financial black holes in the utility system.

There is also no distinct difference in the WTP for small or large business, nor is there any evident pattern on WTP for financially viable companies and those that are struggling. The expectation is that larger enterprises with higher revenues streams can afford to pay more, and have higher WTP. Although, the large more profitable businesses have a marginally higher WTP, even small struggling companies making losses are also willing to pay more for improved electricity services. An apparent anomaly in the tariff structure is the much higher tariff rate for the domestic sector compared to the commercial and maximum demand tariffs. Typically, the domestic sector tariffs are much lower than commercial tariffs, unless a consumer exceeds the lower tariff bands. The businesses that are on the domestic tariff are actually supposed to be on commercial tariffs and this is probably due to lack of knowledge on the appropriate tariff to apply for. To address this would require rationalising the tariff structure, allowing businesses to make well-informed tariff choices, and setting tariffs on the basis of consumer category and not location. As discussed below, some special consumer categories can be on negotiated tariffs that take into account the nature of their operations. This is particularly important for maximum-demand consumers who get penalised for peaking and those consumers that operate continuously, and take advantage of cheaper time-of-use tariffs.

5.3 Improved tariff formula

The current tariff determination process may benefit from a more transparent formulation, in which costs of supply are clearly defined and utility input costs are automatically adjusted to prevailing economic fundamentals. ERB’s Multi-Year Tariff Framework (MYTF) is a good starting point as it allows for an automatic cost pass through. Such an automatic tariff-adjustment formula becomes an objective tool for the tariff-setting process and might get better stakeholder support. It would show the utility cost variables and the consumer price index as well as account for movements in the kwacha exchange rate. However, such tariff formulas may need to be tailored for special consumer groups whose operations are incompatible with the standard tariffs. This may include special tariffs linked to commodity-prices on the global market to assist consumers during commodity price fluctuations, and these could be denominated in US dollars to hedge against depreciation of the kwacha.

ERB needs to set up consumer advisory committees to allow consultations between the public electricity bodies and consumer representatives. These committees would be used as a platform to educate the consumer group segments on the cost structure of electricity tariffs as well as the concept of the levelised cost of electricity linked to new power systems investment. The consumer representatives are, in turn, expected to educate their members on the tariff formula to get broader buy-in.

To roll out tariff increments would require sensitivity to business operations and broader macro-economic impacts. Sudden increases in important production inputs such as electricity could have negative impact on the price of goods and services. Businesses could also collapse as a result of higher inputs costs and lower demand for products, and this would have far-reaching negative feedback into the national economy. Thus a phased approach to tariff increases would be recommended, taking into account the sensitivities of different consumer groups.

5.4 Improved operational efficiency

Apart from increasing tariffs, there is need for visible improvements in efficiency in the public electricity institutional operations. Stakeholders interviewed during the survey indicated that increasing tariffs was not a panacea that would end power supply problems. Although increasing tariffs would enable the utility to improve its revenue and financial health to allow for investment in infrastructure (and lowering the burden on government), stakeholders were concerned that the electricity sector had been poorly managed for a long time and the system incurred substantial losses which needed to be also addressed. However, ZESCO have indicated that they have reduced losses from a high of 30% a decade ago, to 10%. Opening up the sector to the private sector and having an inclusive public grid was also recommended as a potential solution to lack of capacity and bringing in much needed funding into the sector. ZESCO argues, on the other hand, that independent power producers will only put further strain on their balance sheet, as ZESCO has to act as off-takers and sell at low tariff. In the long term, ZESCO estimates that an average tariff of USD 0.1 per kWh would be ideal, although currently IPP projects are around USD 0.11 per kWh. These tariffs have been considered too high by consumer groups.

6. Conclusions

The recent drought in Zambia led to severe electricity supply shortages in the hydro power dominated system and consumers experienced poor quality electricity supply with negative impacts on business operations. There is therefore a need to address the long term electricity supply in the country to avoid recurrence of the 2015/2016 electricity crisis as this could adversely affect national economic growth. Part of the solution appears to be diversification of the energy mix supported by a cost reflective tariff regime and accompanied by improved public sector performance to facilitate investment and efficiency in the sector. This study assessed the willingness to pay for improved electricity services by businesses in Lusaka and Kitwe and the key findings are summarised below:

- About 50% of the enterprises are willing to pay at least ZMW 0.09 per kWh more for reliable electricity supply in Zambia.
- Of those firms that were not willing to pay more, most of them argued that the tariff they were currently paying was already too high and they also did not believe doing so would improve electricity supply
- A higher proportion of enterprises that had higher annual revenues (above the median amount of ZMW 700 000) were willing to pay more than those with lower revenues.
- The manufacturing sector had the highest percentage of companies (83%) that were willing to pay more for secure electricity supplies. 'Hotels and restaurants' had a significantly lower willingness to pay compared to other sectors and this could be due to the use of stand by generators.
- An increase in operating hours would lead to a decrease in willingness to pay, since businesses that operate continuously also consume more, and thus are concerned about higher electricity bills.
- Enterprises on a commercial tariff were less willing to pay more than those that were on other tariffs
- Various other factors had no influence on the WTP by firms – i.e. electricity consumption, the number of years an enterprise had been business, its profitability, average electricity bill, and the use of alternative energy sources were found not to influence the willingness to pay more for reliable electricity in Zambia.

Generally, the businesses are not aware of the tariff determination process and have no trust in the public electricity delivery entities. There is a perception that the public utility is very inefficient and improvements would also need to be made in operational management and infrastructure if tariff increases are to result in significant electricity supply improvements. There is therefore a need to provide a transparent cost of electricity supply system, which could include a revised tariff formula that accounts for movements of macro economic fundamentals and linked to global markets for special consumer groups. There is also need for educating consumer groups and bringing awareness on tariff development processes to enable stakeholder buy in and support for tariff increases. Ultimately, any electricity tariff increases must be implemented in stages over several years to avoid suffocating industry and allowing businesses to adjust gradually to higher input costs.

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Annexes

Annex 1: Electricity tariff determination

Revenue requirement method
In determining the electricity tariff, the Energy Regulation Board (ERB) uses the revenue requirement (RR) method which is a service approach otherwise known as the rate of return (RoR). In RoR method, the revenues of regulated utilities have to cover their operating and maintenance expenses, taxes and depreciation. Utilities also have to ensure a fair rate of return on assets utilized for generating, transmission, distribution and supply of electricity (ERB, 2015a).

The generic formula of RR is:

$RR = O + D + T + (r*B)$

Where: *RR = Revenue requirement*

0 = Allowed operating and maintenance expenses

D = Allowed depreciation expenses associated with the rate base

T = Corporation tax

r = Allowed rate of return (benchmarked; currently benchmarked at 6% real)

B = Rate base (or regulatory asset base)

ERB reviews and verifies all the parameters of the revenue requirements in the Utility's tariff application before arriving at a tariff. The average tariff determination for each customer category is shown below (ERB, 2015a):

$T_f = RR/E$

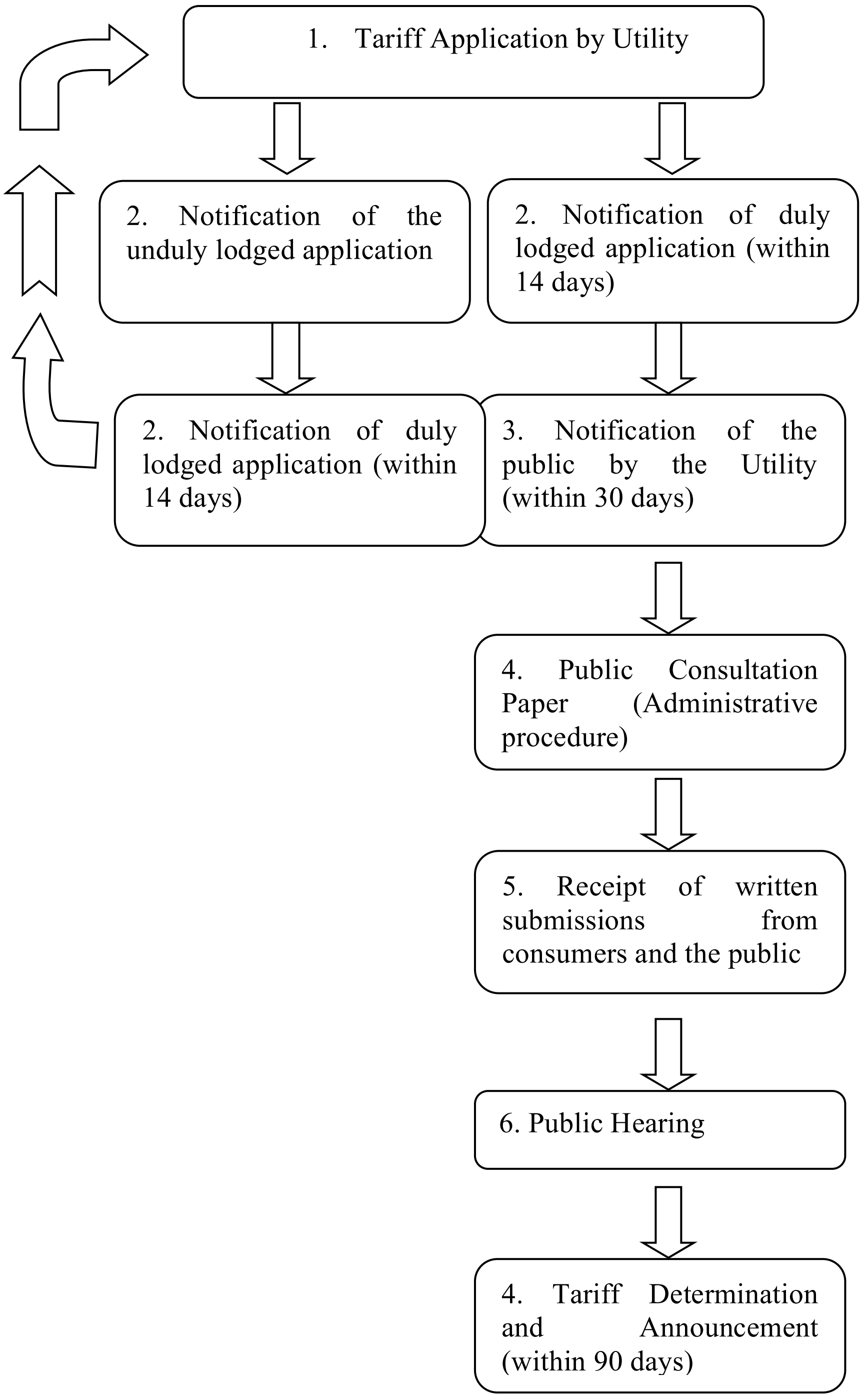
Where:

T_f = *Average tariff per customer category*

RR = Utility's revenue requirement attributed to a customer category

E = energy demand in kilowatt hours

Energy Regulation Board Tariff Application and Procedure



Source: ERB (2015)

Annex 2: Electricity tariffs approved in December 2015

Category	**Consumption**	**Unit**	**Tariffs**		
			Previous	Approved	
			ZMW	ZMW	USD
Residential	Consumption up to 100kWh	Energy Charge/kWh	0.15	0.15	0.15
	Consumption from 101 to 300kWh	Energy Charge/kWh	0.31	0.15	0.15
	Consumption above 300kWh	Energy Charge/kWh	0.51	0.77	0.89
		Fixed Monthly Charge	18.23	27.35	31.90
Commercial Tariffs (capacity 15kVA)	Commercial	Energy Charge/kWh	0.31	0.88	0.09
		Fixed Monthly Charge	55.09	156.47	16.08
Maximum Demand Tariffs	MD1- Capacity between 16 - 300 kVA	MD charge/kVA/Month	13.97	48.05	4.93
		Energy charge /kWh	0.20	0.70	0.07
		Fixed Monthly Charge	136.82	470.65	48.37
		Off-peak MD charge/ kVA/Month	6.98	24.03	2.47
		Off-peak energy charge/kWh	0.15	0.52	0.05
		Peak MD charge/kVA/ Month	17.46	60.06	6.17
		Peak Energy Charge/kWh	0.25	0.87	0.08
	MD2- Capacity 301 to 2,000 kVA	MD charge/kVA/Month	26.13	89.9	9.16
		Energy charge /kWh	0.17	0.58	0.05
		Fixed Monthly Charge	273.62	941.25	95.75
		Off-peak MD charge/kVA/ Month	13.07	44.95	4.61
		Off-peak energy charge/kWh	0.13	0.43	0.04
		Peak MD charge/kVA/ Month	32.67	112.37	11.53
		Peak Energy Charge/kWh	0.21	0.72	0.07
	MD3- Capacity 2,001 to 7,500 kVA	MD charge/kVA/Month	41.75	115.23	11.84
		Energy charge /kWh	0.14	0.38	0.03
		Fixed Monthly Charge	579.74	1,600.10	164.44
		Off-peak MD charge/kVA/ Month	20.87	57.61	5.92
		Off-peak energy charge/kWh	0.1	0.28	0.02
		Peak MD charge/kVA/ Month	52.19	144.04	14.80
		Peak Energy charge/kWh	0.17	0.47	0.04
Maximum Demand Tariffs	MD4-Capacity above 7500 kVA	Peak Energy Charge/kWh	0.21	0.72	0.07
		MD charge/kVA/Month	41.98	115.87	11.90
		Energy charge /kWh	0.12	0.32	0.03
		Fixed Monthly Charge	1,159.50	3,200.22	328.90
		Off-peak MD charge/kVA/Month	20.99	57.93	5.95
		Off-peak energy charge/kWh	0.09	0.24	0.02
		Peak MD charge/kVA/ Month	52.48	144.83	14.88
		Peak Energy Charge/kWh	0.14	0.4	0.04

Source: (ERB, 2015b)

Note: Conversion rate of Zambian Kwacha to US Dollar is: 1 USD = 9.73 ZMW (XE Currency Converter, 2017)

Annex 3: Load shedding for 2016 and 2017

Year	**2017**		
Region	Residential average load shedding (hours)	Commercial/ industrial average load shedding (hours)	Notes
Lusaka Division	4	4	Commercial load shedding mostly done between 17:00-21:00 hrs.
Copperbelt Division	4	5	Commercial load shedding mostly done between 18:00-22:00 hrs.
Northern Division	6	7	Commercial load shedding mostly done between 22:00 and 05:00 hrs.
Southern Division	4	4	
Year	**2016**		
Region	Residential average load shedding (hours)	Commercial/industrial average load shedding (hours)	Notes
Lusaka Division	6	6	Commercial load shedding mostly done between 01:00 -06:00 hrs.
Copperbelt Division	6	6	
Northern Division	6	6	
Southern Division	6	6	

Source: ZESCO (2017)

Annex 4: Survey questionnaire

Currently, the electricity supply in Lusaka faces a number of problems in terms of reliability and stability. The tariff you pay for the electricity you consume includes: grid supply, as well as any damage due to voltage fluctuations and interruptions to supply. You may also pay for standby generation in cases of interruptions, which can be far more expensive per kWh than grid supply

To improve electricity supply and enhance grid reliability, the utility (ZESCO) needs to invest in for example new power plants and maintenance of the existing electricity network. To cover these investment costs the electricity tariffs paid by consumers and companies will have to increase in order to be cost reflective. Increased payments will result in:

Reliable, uninterrupted regular 24 hour electricity supplies to firms Obtain good quality electricity supplies – i.e. no flickering or dimming of light, no low voltages and machines will not burn due to high current The power bills are accurate and easy to understand

Section A: Basic business information

A1. **Date and Time (DD/MM/YYYY) (HH:MM)**

A2. **Company Name**

A3. **Company Location**

A4. **Enumerator Name**

A5. **Name of Respondent**

A6. **Position of Respondent**

Manager, accoutant, salesperson etc

A7. Type of Business

- Multinational ☐
- Local ☐
- Microenterprise ☐

A8. Sector/Type of enterprise

- Manufacturing ☐
- Mining ☐
- Metal processing ☐
- Agribusiness ☐
- Food processing (incl Milling, Beverages) ☐
- Retail/shops ☐
- Hotel/Lodges ☐
- Restaurant ☐
- Logistics (incl Cold storage) ☐
- Health ☐
- Education ☐
- Others (incl media, printing, telecoms) ☐

A9. Describe what the business does

A10. Operating hours per day/week

A11. Years in Business (Exact number of years/year of establishment)

A12. Number of employees ***(give a range if exact numbers are not known)***

A13. Annual revenue ***(Give a range if exact numbers are not known)***

A14. Viability of Buisiness

Would you say your business is struggling or doing well? Are you making profit of losses currently?

Non-operational – not taking on business ☐

Operational – but with losses ☐

Operational – break even ☐

A15. Ownership of premises

Owned by company ☐

Rented by company ☐

Other arrangement ☐

A16. What electricity services are required?

Lighting ☐

Heating ☐

Production ☐

Cooling ☐

Other ☐

A17. List of key equipment required

A18. List of equipment required

What kinds of equipment do you predict you will acquire or wish to acquire to expand your business?

Section B: Access to electricity

Level of service recieved

B1. What is you average monthly electricity consumption? (kWh)

If they do not know please note

B2. What electricity tariff is your business on?

- Metered residential ☐
- Commercial ☐
- Social services ☐
- Maximum demand ☐
- Other - please note ☐

B3. **Is your electricity connection shared with another firm/account?**

If yes - how is this shared?

If yes -

Yes ☐

No ☐

B4. **What is your company's own monthly electricity consumption from this shared bill?**

B5. **How much do you pay per kWh for your electricity?**

Section C: Quality of supply

C1. **Over the last year, how many outages do you have per day/week/month/year?**

C2. **How long do these outages usually last?**

Less than a minute ☐

Several minutes ☐

One hour ☐

8 hours ☐

12-24 hours ☐

more than 24 hours ☐

Variable and unpredictable ☐

C3. **Do you experience seasonal differences in frequency of outages?**

Yes ☐

No ☐

Don't know ☐

C4. Do you expereince:

- [ ] Flickering lights
- [ ] Brown Lights
- [ ] Other

Other

C5. How many times do you experience surges or dips in voltage in a day/week/month?

C6. After what time does an outage create a significant problem for the operation of your business?

Take note of what problem this causes

- [ ] Less than a minute
- [ ] One hour
- [ ] 8 hours
- [ ] 12-24 hours

C7. Have there been improvements in power supply quality over the last 6 months? If yes explain.

- [ ] Yes
- [ ] No

Section D: Satisfaction with service

D1. **What do you think of the quality of electricity supply?**

A good supply has no interruption, stable voltage etc.

- Very good ☐
- Good ☐
- Satisfactory ☐
- Very poor ☐

D2. **I think that in general the number of electricity supply interruptions on my firm is**

- Highly unacceptable ☐
- Unacceptable ☐
- Acceptable ☐

D3. **Do you know when an outage will occur?**

Prior notification allows companies to schedule activities in line with outage and preparation fo rht eoutage depends on business

- Always know times of power outages ☐
- Sometimes know about power outages ☐
- No, power goes without prior notice ☐

D4. **What measures do you take when you prepare for outages?**

- Switch off appliances ☐
- Switch on alternatives ☐
- Close business ☐
- Other ☐

Other

D5. **Do you use any other form of energy during these outages?**

If yes, specify

- Yes ☐

D6. **Are there any expenses incurred for these outages?**

- [ ] Yes - using the alternative
- [ ] Yes - loss of business and revenue
- [ ] Yes - loss of productivity
- [ ] No
- [ ] Other

Other

D7. **Have you tried to quantify these losses/cost incurred due to outages? If yes, can you quantify how much you spend in response to outages and losses incurred.**

- [ ] Yes
- [ ] No

Section E: Costs and Billing

E1. **What is your average monthly electricity bill? (Zambian Kwacha)**

Average over the last 12 months

E2. **Roughly, what percentage of your monthly expenses are spent on electricity?**

E3. **If you own a generator, do you know how much the energy costs are in ZMK/kWH?**

- [ ] Yes
- [ ] No
- [ ] Don't own generator

Section F: Billing Accuracy

F1. **Do you read and understand your electricity bill?**

Yes ☐
No ☐

F2. **Is your bill based on yout meter reading or is it estimated?**

Meter reading ☐
Estimated ☐
Don't know ☐

F3. **Do you think you are paying more than the electricity units you consume?**

Yes ☐
No ☐

F4. **I think that the price of our electricity is:**

Very low ☐
Low ☐
Moderate ☐
High ☐
Very High ☐

Section G: Current electricity service and attitudes to the electricity system

G1. **My confidence in our electricity authority is:**

Very Low ☐
Low ☐
Moderate ☐
High ☐
Very High ☐

G2. **Our power supply has improved in the last year. Do you:**

- Strongly Agree ☐
- Neutral ☐
- Disagree ☐
- Strongly Disagree ☐

G3. **What challenges or problems do you face due to poor electricity supplies?**

- Loss of data ☐
- Damage to equipment ☐
- Damage to product/s ☐
- Loss of business ☐
- Resetting electrical devices ☐
- Losing access to electronics ☐
- Losing heat or A/C ☐
- Losing stock/product ☐
- Losing ability to cook ☐
- Losing lighting ☐
- Having to move out ☐
- Other ☐

G4. **Which of these challenges id the single most important problem caused by the outages?**

- Loss of data ☐
- Damage to equipment ☐
- Damage to product/s ☐
- Loss of business ☐
- Resetting electrical devices ☐
- Losing access to electronics ☐
- Losing heat or A/C ☐
- Losing stock/product ☐
- Losing ability to cook ☐
- Losing lighting ☐

Having to move out ☐

Other ☐

G5. **Do you think your business would improve if electricity services were to improve?**

Yes ☐

No ☐

G6. **Wha aspects of your business would improve if electricity services improve?**

Expansion of business ☐

Better service ☐

More revenue ☐

Improved viability ☐

Other ☐

Section H: Willingness to Pay

H1. ***Currently, the electricity supply in Lusaka faces a number of problems in terms of reliability and stability. The tariff you pay for the electricity you consume includes: electricity supply, as well as any damage due to voltage fluctuations and interruptions to supply. You may also pay for standby generation in cases of interruptions, which can be far more expensive per kWh than grid supply***

To improve electricity supply and enhance grid reliability, the utility (ZESCO) needs to invest in for example new power plants and maintenance of the existing electricity network. To cover these investment costs the electricity tariffs paid by consumers and companies will have to increase in order to be cost reflective. Increased payments will result in:

Reliable, uninterrupted regular 24 hour electricity supplies to firms Obtain good quality electricity supplies – i.e. no flickering or dimming of light, no low voltages and machines will not burn due to high current The power bills are accurate and easy to understand

We want to find out how much improved and better service by ZESCO is worth to you.

Would you in principle be interested to pay an additional fee per kWh for electricity to receive improved/reliable electricity supply?

Yes ☐

No ☐

H2. **I would like to know what the development of the electricity grid in order to provide more reliable and stable services is worth to you. Please consider the chosen amount as a top-up on your current basic electricity tariff per kWh.**

When you consider the additional fee, please take into account:

Your companies budget for operational expenses. The kwh tariff your company pays will increase with the additional fee Possible alternatives for electricity supply. You are currently paying {INSERTANS:975714X2X30} per kwh

Record willingness to pay amount selected from paycard

H3. **Please, could you give the reason(s) why you are not willing to pay more for the improved electricity supply**

- Cannot afford to pay (threat of bankruptcy) ☐
- Do not believe they would get improved supply ☐
- Demand is already met from self-generation ☐
- Can meet additional demand from self-generation at lower cost ☐
- Believe the current tariff is already above the cost of grid supply to industry ☐
- Believe the current tariff is above the industrial tariff in other states ☐
- Other (please specify) ☐

H4. **I will now mention different statements. Please rate on a scale from 1 (not important) to 10 (very important) of how relevant each statement was for you by deciding for the above chosen amount.**

	1	2	3	4	5	6	7	8	9	10
The introduction of new investment in the electricity sector in this country has a good chance of improving the electricity supply.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
This new investment may improve the electricity supply, but it will take so long to produce benefits that it is not worth much to me.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

	1	2	3	4	5	6	7	8	9	10
I believe that my company is able to increase profitability, competitiveness and revenues in case of an uninterrupted, secure power supply.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
I think higher tariffs are a good option in order to contribute to and support a stable and reliable grid managed by ZESCO.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
I just do not believe improved electricity supplies can be achieved in this country.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
I do not trust the institutional and technical capabilities of the government/ZESCO to implement a reliable system through a higher tariff paid by firms.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Through the increase of tariffs, I expect a positive development regarding a reliable electricity grid.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
I feel that paying a higher tariff will not change the reliability of the grid.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
I feel that my company is better off in terms of additional costs with current alternatives to overcome unreliable electricity supply.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Annex 5: Test for multicollinearity

	Variance Inflating Factors		
Variable	**WTP 1**	**WTP2**	**WTP3**
Financial intermediation, insurance, real estate and business services	2.16	2.08	2,08
Hotels and restaurants	2.52	2.49	2,5
Community, social and personal services	3.06	3.06	3,03
Wholesale and retail	2.77	2.80	2.77
Other	1.81	1.75	1,78
Operating hours per day	2.02	1.96	1,9
Years in Business	1.43	1.43	1,41
Profitable business	1.23	1.21	1,24
Average monthly bill (ZMW)	6.47	-	1,35
Electricity consumed (kwh)	6.98	1.46	-
Business on commercial tariff	1.39	1.36	1,4
Use other sources during outages	1.33	1.31	1,33
Not very important	1.65	1.63	1,69
Not important	1.29	1.29	1,29
Important	2.52	2.52	2,52
Very important	2.68	2.71	2,68
Not very important	2.16	2.09	2,11
Not important	1.71	1.68	1,68
Important	1.78	1.71	1,73
Very important	1.73	1.70	1,76
Not very important	1.45	1.48	1,44
Not important	1.60	1.50	1,56
Important	1.56	1.56	1,56
Very important	1.72	1.72	1,71
Not very important	2.22	2.25	2,23
Not important	1.97	1.96	1,97
Important	1.50	1.52	1,49
Very important	1.54	1.54	1,53

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