



# **Prepaid Electricity Model in Zimbabwe: A Cost- Benefit Analysis**

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## **ABSTRACT**

To manage credit risk and improve working capital, many power utility companies have moved consumers from conventional post-payment for electricity to prepayment. Despite the growing use of this prepayment system, the welfare implications of this strategy are unclear and contested. The Zimbabwean utility company, Zimbabwe Electricity Transmission and Distribution Company (ZETDC), introduced prepaid meters in August 2012 and installed over 550,000 prepaid meters by the 31<sup>st</sup> of December 2015. This thesis' objective was to quantitatively assess the societal costs and benefits of introducing prepaid electricity to Zimbabwe, by calculating the net present value of the estimated annual costs and benefits over time. A qualitative analysis was also conducted, based on a consumer survey of 100 consumers who had switched from the post-paid to the prepaid system. The survey captured consumers' perceptions of the prepaid system's costs and benefits. Results of the study showed that both consumers and the utility company have benefited from the prepaid system. The average net benefit per user under the prepaid system was estimated at US\$58.93 per annum. 74% of consumers surveyed confirmed having benefited from the switch to the prepaid system. The main policy recommendation, based on the results of the study, is for ZETDC to continue with its roll out of the prepaid system. However, as the research was limited to the current ZETDC prepaid consumer base of only domestic and small business users, a recommendation for future research would be to evaluate the costs and benefits for larger industrial consumers as well.

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## **GLOSSARY OF TERMS**

DMS	Demand Side Management
MBC	Metering, Billing and Collection
STS	Standard Transfer Specification
USD	United States Dollar – Zimbabwe’s primary currency in the multicurrency regime
ZETDC	Zimbabwe Electricity Transmission and Distribution Company

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## CHAPTER 1: INTRODUCTION

### 1.1 Background

In a bid to manage credit risk and to improve working capital, power utility companies worldwide have switched their consumers from conventional post-paid electricity to prepaid electricity. There has been an on-going debate as to whether this move has produced improvements in net social welfare. Studies such as Tewari and Shah (2003), highlighted the different costs and benefits for the various stakeholders, in different countries. Utility companies across the world, have implemented the prepaid system with different models; which differences affected the balance of stakeholder costs and benefits. Among the variations were, compulsory and optional switching, discounts from nil to different levels of tariff discounts, flat tariffs and rising tariffs, meter equipment costs borne by either the utility or consumer, different types and functionalities of meters, different vending systems with varying levels of robustness, and varying proportions of the prepayment allocated to historical debt. Depending on the prepayment model, the primary stakeholders (the consumers and the utility company) have different costs and benefits, which contribute to the ultimate societal costs and benefits.

In Zimbabwe, the sole distributor of electricity is the Zimbabwe Electricity Transmission and Distribution Company (ZETDC), a 100% subsidiary of the power parastatal, ZESA Holdings.

According to a report by ZETDC presented to the Zimbabwean Cabinet (ZETDC, 2013), prepayment metering technology was first introduced in Zimbabwe around 1994/95 as a pilot project in the two biggest cities, Harare and Bulawayo. In 2009, another pilot, based on the latest Standard Transfer Specification (STS) prepaid metering technology, was conducted again in the two cities. After a successful pilot project, a decision was made to implement the prepaid metering project to other parts of the country. The implementation commenced in August 2012.

The following assumptions and objectives were key tenets underlying the project's adoption:

- To empower and bring about fairness to customers through the system's inherent demand side management (DSM) features and elimination of bills based on estimates.
- To assist ZETDC in resolving challenges with Metering, Billing and Collection (MBC). Debtor days had averaged 200 days on the post-paid system and total domestic debt had

gone up to over US\$200 million. The prepaid system would enable ZETDC to collect money upfront, without any credit control challenges.

- The prepaid system would improve efficiency for both ZETDC and its customers. For ZETDC, it would be through a reduction in operational costs as there would be no/limited requirement for meter reading, credit control, bad debts, postage, disconnection and reconnection of defaulting customers. For customers, it would be through instant feedback on consumption.
- It would offer more flexibility regarding debt recovery and payment methods. The debt would be loaded into the prepaid system and amortised as customers purchase prepaid electricity units.
- ZETDC would enter into smart partnerships with third parties and use third party infrastructure to distribute prepaid electricity units and collect revenue. All this would be done without ZETDC paying upfront and fixed charges for the service, as payments for service rendered will be through commission based on units of electricity sold.

During discussions, ZETDC management indicated that, from an initial target of 579,333 prepaid meters for the first phase, 552,842 had been installed as at 30 November 2015, representing a 95% coverage. 90% of the prepaid installations are for domestic consumers and the balance for small business users. In terms of geographical spread, 32% of the installations are from the Harare Region; 19% from Western Region (i.e. Bulawayo, Matebeleland South and Matebeleland North provinces); 14% from Southern Region (i.e. Midlands and part of Masvingo provinces); 19% from Northern Region (i.e. Mashonaland West, Central and East provinces) and 16% from Eastern Region (i.e. Manicaland and the greater part of Masvingo provinces).

## **1.2 Problem Statement**

Although self-interest was ZETDC's primary motivation, as noted in section 1.1, in introducing the prepaid system, the roll-out of the prepaid system clearly affected consumers as well.

The prepaid system has been implemented in different countries, where results have varied with the models implemented and the circumstances of each country. A recent study in Zambia (Malama, Mudenda, Ng'ombe, Makashini, & Abanda, 2014) has shown more benefits than costs to consumers,

while a study in South Africa has shown prepaid electricity to have more costs than benefits in certain communities (Bond P, 2007). This demonstrates the different impacts a prepayment system can have. It also highlights the need to know if the system has produced greater societal benefits than costs in Zimbabwe.

In Zimbabwe, the prepayment model has been compulsory, the tariff is the same as on the post-paid model, there is no discount given on the tariff for switching to post-paid, credit is bought from different vendors and on certain mobile networks, the meter equipment and installation cost is borne by ZETDC and 40% (increased from an initial 20%) of each purchase is allocated to historical debt service for consumers with debt. This model produces specific types of costs and benefits and as such it will also be important to know if it has produced greater societal benefits than costs in Zimbabwe.

### **1.3 Purpose, justification and significance of the research**

The purpose of this research is to investigate if Zimbabwe's prepaid electricity model has produced net societal benefits.

There have been many studies on the impact of the prepayment system worldwide. Examples include - (South Africa - (Tewari & Shah, 2003); Mozambique - (Baptista, 2013); Argentina – (Casarin & Nicollier, 2010); New Zealand - (O'Sullivan, Viggers, & Howden-Chapman, 2014). In Zimbabwe, although Munhenzva's study (Munhenzva, 2014) was on the prepayment system, the study focused on just improvement in organisational performance by ZETDC, with an emphasis on improved service delivery. Munhenzva's study did not provide an overall cost and benefit analysis and as such justifies a study to investigate if the prepaid electricity model has produced greater societal benefits than costs in Zimbabwe.

The different studies in the other countries discussed above came out with similar and different results because of the different models and circumstances of each country. The varying impacts of the prepaid systems across various communities/countries justify this study in Zimbabwe, which has implemented a unique model and whose circumstances are unique as compared to other countries.

This study will provide empirical evidence on costs and benefits of the prepayment model to both consumers and ZETDC. Energy policy formulation as far as payments systems are concerned has been

based on theoretical frameworks. This study will be able to inform policy based on empirical results, which is a more accurate basis for policy formulation. It will also inform ZETDC on areas of improvement in the current and future prepayment systems and models and thus increase benefits or limit costs for different stakeholders.

#### **1.4 Research Questions, Objectives and Hypothesis**

The study is based on the following research question:

***Research Question:***

Has the prepaid electricity model produced greater societal benefits than costs in Zimbabwe?

For the research question given above, an objective and hypothesis has been formulated as follows:

***Research Objective:***

To determine and evaluate if the societal benefits of the prepaid electricity model are greater than the costs, in Zimbabwe.

***Research Hypothesis:***

H0: Prepaid electricity model has not produced greater societal benefits than costs in Zimbabwe.

H1: Prepaid electricity model has produced greater societal benefits than costs in Zimbabwe.

#### **1.5 Research Assumptions**

The research assumed:

- a) ZETDC and the consumers are the primary stakeholders in the prepaid electricity system and are representative of society.
- b) The assumption is that the sample findings would be reflective of the population.

## **1.6 Research Limitations**

The survey was restricted to Harare residents only due to time and budget limitations. Harare consumers represent 37% of the total number of power consumers and 32% of the total number of consumers on the prepaid system.

## **1.7 Outline of Study**

This thesis is divided into five chapters. Chapter 2 reviews literature; chapter 3 describes the research methodology; chapter 4 analyses the research findings; chapter 5 concludes and makes recommendations for future study.

Chapter 2 focuses on literature review, which includes theoretical and empirical literature. Under empirical literature, review of similar studies in different countries as well as in Zimbabwe is conducted.

Chapter 3 describes the research methodology. This chapter discusses the research approach, strategy, designs and methods used to collect and analyse the data. It also highlights the different data sources.

Chapter 4 covers research findings, analysis and discussion. Research findings are discussed in the context of what other similar studies quoted in literature review found.

Chapter 5 is a discussion of the research conclusions, policy implications and recommendations for future study.

## CHAPTER 2: LITERATURE REVIEW

### 2.1 Introduction

Literature is divided on the merits and welfare implications of demands for prepayment by power utilities. This chapter discusses the areas and roots of agreement and disagreement on these issues. Arguments are supported by empirical evidence from different countries.

### 2.2 Prepaid electricity metering system

Simpsons (1996) defines metering as the process and methods of utilising devices to measure the amount and direction of electrical energy flow; particularly for end-use. The devices make it possible for a power utility to determine the amount of electrical energy a particular customer has consumed.

#### 2.2.1 Prepayment Metering

Casarin and Nicollier (2010) define prepayment systems as the outlay made by a consumer for using goods or services before consumption. It requires the customer to pay for the service before its use. Kettless (2004) defines the prepayment system as a system where a consumer pays for energy before using it. It comprises a system master station (which is a computer that operates and administers the whole system), a vending machine (where consumers buy their electricity) and prepayment energy meters (or dispensers, which dispense the electricity to the consumer). This meter has an interface with the consumer, showing the transfer of credit and the meter/credit status. Casarin and Nicollier (2010), highlight that while credit metering is based on the electricity that has already been used, prepayment metering requires the consumer to pay for electricity before use. Consumers will only be able to use electricity if there is credit in the account, as electricity “self-disconnects” when credit is finished (self-disconnect is a terminology used for disconnections in the prepayment model).

Chisanga (2006) describes the prepayment metering process as follows:

- The consumer buys electricity from a vending station. Vending stations are outlets that have access to the voucher/selling system. In Zimbabwe, they are third parties that receive a commission on sales from ZETDC.

- The consumer upon payment receives a voucher with a certain number of digits to be keyed in into the meter.
- The consumer keys in the code into the meter.
- After keying in the code, the meter updates the credit in the meter and becomes ready for use.

Chisanga (2006) states that electromechanical prepayment meters in general consist of two parts. These are the integrating meter (a standard meter made to operate on the type of circuit concerned) and the prepayment mechanism. The prepayment mechanism is what is subject to considerable variation. The different types of prepayment mechanisms include:

- Fixed charge collector – Hand-Reset type
- Fixed charge collector – Time Switch type
- Flat rate tariff meter
- Two-part tariff – Fixed Rate type
- Two-part tariff – Variable Rate type
- Double tariff, Current Change-over type
- Double tariff, Time Change-over type
- Electrolytic Prepayment Meter

### **2.2.2 Post-paid/Credit Metering**

Chisanga (2006) describes the post-paid/credit metering as the traditional way of metering. A meter, which is installed at the consumer's premises, records the number of units, usually in kilowatt-hours, consumed every time power is switched on. The meter is usually read once a month to determine the number of units that have been consumed and based on that consumption, the consumer is billed and the bill is posted to them. The consumer only pays when the bill has been made and presented to them, creating a gap between the date of consumption and the date payment is required.

Chisanga (2006) recognized the following advantages and disadvantages of post-payment:

**Advantages:**

- It allows the consumer to consume power before using it.
- It enables the consumer to pay at their convenience unless threatened with disconnection.

**Disadvantages:**

- It permits the accumulation of debts that deprive the utility company immediate cash.
- It generates meter-reading expenses such as salaries and fuel for meter readers and other costs related to the delivery of bills.
- It has challenges with wrong meter readings, failure to access the meter box, by-passed meters and inconsistent readings coming from personnel of poor calibre.
- It is labour intensive regarding billing, credit control, disconnections and reconnections, meter reading and delivery of bills.
- It does not encourage consumers to budget their consumption of power, leading to non-payment of bills by many consumers.
- It creates public relations problems arising out of complaints by consumers on what they perceive to be incorrect bills.

It is against the background of disadvantages such as these that the prepaid electricity system was developed.

### **2.3 Development of prepaid electricity metering system**

Kettless (2004) states that the UK has been instrumental in the development of the prepayment system, which has been used there for more than 80 years. It developed several different types of token-based prepayment systems, including coins, magnetic cards and key-based facilities. The different costs and benefits of each particular system result in continuous technological innovation with better systems being produced. According to Tewari and Shah (2003), in Africa, electricity prepayment meters were first introduced in South Africa in the 1980s, to effectively extend electricity supply to low income households. ESKOM, South Africa's power utility company, had faced several challenges with the post-paid system, resulting in high administrative costs due to the absence of postal addresses to which

electricity bills could be sent, as well as the accumulation of debt as low income households could not fully comprehend bills due to high illiteracy rates. Now the prepaid electricity system has spread all over the world, to countries such as Argentina, Australia, Ghana, India, Kenya, Nigeria, Sierra Leone and Turkey (Quayson-Dadzie, 2012).

Chisanga (2006) states the following advantages and disadvantages of prepaid electricity:

**Advantages to the utility company:**

- There is no meter reading because the number of units a consumer buys are determined by how much they pay.
- The system is self-regulating as disconnection happens automatically when credit is used up and reconnection occurs automatically when the unit is recharged.
- There are no bill deliveries and cash flows are improved as money is paid up front.
- There are no accrued debts as the consumer pays before consumption.
- The utility company will be able to recover money owed, as a small proportion of money spent on purchase of vouchers is allocated to debt reduction. On conversion from post-paid to prepaid, the system would have transferred the accumulated debt to the prepaid account. This debt will be reduced at every purchase of electricity until cleared. In the case of Zimbabwe, 40% of prepaid payments by consumers with debt is allocated to debt redemption. This effectively means that for consumers with debt, a unit of electricity is 40% more expensive until the debt is fully redeemed.
- There are no billing problems and billing related queries. Bill estimation challenges, which had become rampant with ZETDC, become a problem of the past.
- It reduces fraud through the use of a plug-in-meter base that gives the consumer no access to the service wire terminations. Meters have anti-tampering provisions whereby the meter cuts off supply when opened or tampered with, preventing disconnected consumers from illegally consuming power.
- There are no reconnections fees as the meter trips when the units have been exhausted and the energising of the meter does not need an officer of the utility to key the voucher number.
- The meter is user friendly since it provides a means to visually gauge consumers' instantaneous consumption. There is a natural tendency to reduce consumption, thus providing a Demand Side Management mechanism.

- There are better customer relations since there are no disconnections done by the utility and the customer only consumes that which has been paid for. The customer can control the power consumption by deciding the amount and time of purchase and deciding on when and how to consume the power. This enables customers to plan their consumption and results in having power whenever it is needed.

**Advantages to the consumer:**

- It eliminates billing problems and queries. A consumer bill is determined by what they can afford as the meter self-disconnects when what they have paid for is exhausted.
- There are no estimations as the consumer pays for what they consume. The consumer does not pay when there is no consumption.
- The consumer does not pay reconnection fees as the meter automatically reconnects when it has been recharged.
- The consumer can control consumption as they can get information on consumption through the machine interface display on the meter. For instance, the consumer can use less power by switching off the geyser and the stove after bathing and cooking.
- There are no regular monthly visits by meter readers to the consumer, as no readings are needed and there are no bills to be delivered.

**Disadvantages:**

- The cost of acquiring the meter is high. On average, a prepayment meter costs as much as three times the cost of a conventional meter and there are also salaries for technical inspectors who go round to inspect them.
- Some meters are faulty. Faults could include not self-disconnecting resulting in consumers using power without paying for it.

**2.4 Other theoretical concepts**

Malama (2014) analyses the prepaid electricity system regarding its performance in three functions: as a mediating tool between energy suppliers and consumers; demand side management of energy, and supply side revenue generation.

He argues that prepaid meters are technological tools that play the role of mediator between energy-producing agents and consumers. In some parts of the world, confrontations between electricity suppliers and consumers are common, as is evidenced by several documented cases in Kenya and other Asian countries. In Kenya, Miyogo et al. (2013), state that the installation of prepayment meters has seen the reduction in conflicts. In the past, the utility company had often needed to hire security services before undertaking disconnections in urban slums, while residents sought the help of criminal gangs to reconnect electricity supply after the utility company and security personnel had left. In such circumstances, the anti-tampering design of prepayment meters reduces conflicts between service-provider and consumer.

Malama (2014) further argues that prepaid meters have played a significant role in demand side management. He states that consumers' ability to monitor the units of electricity being consumed gives them the opportunity to make adjustments that would ensure that available electricity units last longer. The monitoring is done on the in-home display, which provides regular feedback on the amount of energy being used. This ability to control usage is also supported by Tewari and Shah (2003), who stress that self-monitoring of energy usage on prepaid meters enables consumers to economise on energy consumption through turning off high-power electrical appliances such as geysers (water heaters), lighting produced by filament-bulbs, stoves, heaters and pressing irons.

On supply side revenue generation, Miyogo et al. (2013), note that in most countries where prepaid meters have been introduced, revenue collections by the utilities have increased. Malama (2014) highlights the benefit of the redemption of bad debts through the deduction of a proportion of the cost paid at every top-up of electricity to redeem the debts.

Casarin and Nicollier (2010) discuss the perceived costs of the change to the prepaid system. They highlight the manner in which prepaid electricity changes a consumer's budget constraint and so modifies the quantity of electricity he is willing to consume. The change from conventional to prepaid electricity implies that the cost of electricity faced by consumers includes not only the price of electricity itself but also the opportunity cost of reload time and of advanced payment. This change in the price of electricity relative to other consumption goods may result in too little electricity consumption, or even to self-disconnection among poorer groups. Even more, the system may result in a socially inefficient distribution of risk between consumers and the utility, as the latter eliminates the uncertainty in the collection of revenues while the former bears a higher risk of lack of energy and disconnection.

## **2.5 Empirical Literature**

### **2.5.1 South Africa**

Tewari and Shah (2003) assessed the South African prepaid electricity experiment. They performed interviews with both the utility company (ESKOM) and consumers and noted different advantages and disadvantages. Advantages for Eskom included improved cash flows; lower operating costs as it eliminated meter reading, disconnection and reconnection, billing and account posting costs; it was used to recover historical debts; there was no need to access the consumer's property and put employees at risk (especially as South Africa is a crime ridden society) and it eliminated inaccurate readings and the resultant complaints.

However, the disadvantages from interviews with Eskom senior managers included increasing costs of meter maintenance and meter inability to handle large current flows. Tewari and Shah (2003) noted that early research by Eskom indicated significant cost savings by switching to prepaid electricity by abating the cost of billing, meter reading, and meter repairing. Besides, it added to convenience by reducing the risk of security to Eskom employees who had to visit peoples' houses at odd hours. Savings were also expected to be realized in the form of decreased level of pilferage through meter tampering. The introduction of prepaid electricity solved these problems to a great extent. However, new maintenance problems, which were not visualized at the time of initiation of the project, subsequently emerged. These included meter tampering, vendor fraud, and meter failures/replacement. Regarding severity of the problem, the meter failure comes first, vendor fraud is the second most pressing problem, and the last and least severe is meter tampering. However, as a result of the improvements in technology (tamperproof covers) and audits from time to time, electricity thefts have gone down significantly. During the period 1996 - 2001, only 3–4% of meters suffered tampering. The estimated loss of electricity through meter tampering was estimated at R51 million per annum. Tewari and Shah (2003) caution that rising costs of auditing and of the technological improvements required may make the prepayment system cost-ineffective in the long run.

For the consumer, assessment of the experiment revealed that advantages included consumption management, as the consumers would know how much energy is being used and be able to control consumption and thereby control their budget; increased convenience in buying of vouchers/credit; no cost for disconnection/reconnection and no waiting for reconnection. It also enabled consumers to systematically pay back their historic debts.

The benefits to households of being in control of their budget was noted as the prime advantage of this system by Tewari and Shah (2003). Consumers decide how often and in what value they wish to buy the electricity. Should they forget or not be able to pay for their electricity, they will not be physically cut off by Eskom. They will not have to wait to be reconnected and no reconnection fee is paid. They no longer have to understand and pay accounts or bills. However, disadvantages included the ‘hassle’ of buying electricity frequently and the heightened risk of not having power in the house. A significant result of the study shows that it was noted that prepaid meters were not always well-received. Some segments of society were reluctant to implement the system. This reluctance was noted in a number of case studies (McDonald, 2009, Bond P, 2007, Soto et al., 2012). In these areas, homeowners did not see the benefits of the prepaid system outweighing the costs.

Bond (2007) highlighted the resistance of community groups to the prepayment of electricity in Soweto. This resistance was driven by the impact disconnections had to them as a poor community, even when they were on post-paid. Three out of five households experienced cut-offs over the course of the preceding year, of which 86% were due to non-payment. The community understood that with prepaid systems, cut-offs will even be more rampant. Bond’s (2007) survey found that disconnections lead to all manner of health, environmental, social and economic problems. The percentages of respondents confirming the negative impact of disconnections were very high. Among the negative impacts cited were: Food gets spoiled (98%); cannot cook food properly (90%); personal hygiene is negatively affected (88%); spend more money on alternative fuels (84%); children cannot study properly (81%); crime increases in the area (73%) and social costs – it is regarded as degrading for the family to live without electricity (70%). He also suggested that disconnections could pose a health cost, with one indication of electricity denial being the upsurge of tuberculosis (TB) rates and other respiratory illnesses associated with particulates in the smoke from wood, coal and paraffin, which are used as alternative energy.

Tewari and Shah’s (2003) study highlighted the advantages and disadvantages of the prepayment model but did not indicate whether there was specifically an overall cost or benefit to society. Bond (2007) only noted that prepaid electricity may not be seen as a benefit by poorer segments of society.

### **2.5.2 Zambia**

Zambian research on the impact of the prepayment system by Malama et al. (2014) identified key issues relating to behavioural change as a result of the introduction of the prepayment meters, debt recovery, reduction of pilferage, disconnection of consumers and use of alternative energy sources. Qualitative and quantitative data were collected from three household categories affected, i.e. high income (Parklands), medium income (Ndeke) and low income (Kwacha). The results show a general satisfaction with the introduction of prepayment meters right across the three townships. The households indicated that the new system gives them more control over the energy usage and reduces problems with bills that sometimes they were forced to dispute. The respondents also reported satisfaction with the information on the prepayment meter, although some said that they would like to see information on the consumption of different appliances and others said they would like to have a buzzer on the meter that alerts them when their credit is about to run out. There was general agreement also that the introduction of prepayment meters has led to an improvement in their budgeting and many households reported that they ration credit when it is low. Of all the households, 38% reported running out of electricity credit and being disconnected at some point. This problem was predominant in Kwacha and Ndeke and not so much in Parklands. In Ndeke and Kwacha, the main reason given for running out of credit was the lack of money to buy credit, whereas in Parklands it was that they forgot to buy credit. It has also been argued that because of the introduction of prepayment meters, households reduce their consumption. This is however, not the case in Parklands where expenditure has gone up, which has been attributed to the fact that the people there are less stressed about expenditure on electricity. In Parklands consumers spend a low proportion of their income on electricity, as such they are unlikely to change their lifestyles in any significant way because of the introduction of the prepayment meters.

Finally, Malama et al. (2014) noted that 21% of all the respondents reported that they stopped using electricity for cooking and moved to charcoal and firewood. This group has to be differentiated from those that have only limited the use of the appliances such as the cooker and pressing iron (the two appliances deemed to consume a lot of electricity). It has been argued that this could have serious implications for the environment and is an unintended consequence of the introduction of prepayment meters which needs to be further investigated as this could lead to deforestation. However, Malama et al. (2014) recognised that the switch to other alternative sources of energy (charcoal and wood) may work out to be more costly to consumers and society in general. From the survey, he noted that consumers were making decisions to use alternative energy sources from informal information

discussed with neighbours. Malama et al. (2014) recommended the utility company to educate its consumers on how electricity is more energy efficient than other energy sources.

This study highlights that there were more benefits than costs, but was limited to the consumer only and did not include other stakeholders such as the utility company.

### **2.5.3 Botswana**

In Botswana, a study was done on customer perception from switching from a post-paid to a prepaid model (Mburu & Sathyamoorthi, 2014). Mburu and Sathyamoorthi's (2014) findings indicate that the customers have embraced the prepaid system and that they have recognised the benefits of conversion to the prepaid model. A majority of the respondents perceived conversion to be a good move for them. It was seen to bring convenience. Mburu and Sathyamoorthi (2014) reported that the convenience was from the fact that one could budget, buy electricity and send to relatives irrespective of the distance. Access to the voucher purchase points was perceived to be convenient enough. However, Mburu and Sathyamoorthi (2014) reported that there seemed to be no agreement as to whether the conversion had made the cost of electricity higher or lower. The pricing of the vouchers was also perceived not to be uniform from all the vendors and likelihood of the voucher system being offline was noted as a problem. Like Malama et al. (2014), the study focused on consumers only, with the consumers also perceiving benefits from the prepayment model.

### **2.5.4 Mozambique**

In Mozambique, the peri-urban dwellers welcomed the prepaid electricity model since they felt empowered (Baptista, 2013). Baptista (2013) noted that prepaid electricity gave consumers autonomy of electricity use and divisibility of energy purchases, which is in agreement with the other studies above. Baptista (2013) also reported that prepaid meters allowed electricity users to develop a sense of control and 'disciplined autonomy' over their individual lives, unmediated by the uncertain relationship with the utility provider. People became more energy literate in ways facilitated by the practical interactions with the technology of the prepaid meter.

### **2.5.5 Kenya**

In Kenya, Miyogo et al., (2013) carried out a study to determine Kenyan Power's employees and consumers' responses to the transition from post-paid to prepaid electricity bill payment. Miyogo et al., (2013) reported that the findings showed that consumers had embraced the prepaid billing system since the majority registered unwillingness to return to their original billing system. It was also established that the prepaid billing system had brought with it some advantages like reduced power disconnections besides making consumers more careful with their consumption. Besides that, respondents seem not to have noted any change in their payments since they shifted to the prepaid billing system. On the part of management, the study revealed that installation of prepaid meters had greatly improved debt collection.

### **2.5.6 Zimbabwe**

Munhenzva (2014) carried out a study to investigate the relationship between prepayment metering and service performance by ZETDC, according to various criteria of service performance. The study focused on quality of service from ZETDC, and a survey of 500 customers noted that response times to technical faults had not improved. This was despite the thinking that ZETDC staff would have more time to attend to technical faults and service delivery as they were no longer involved in disconnections and reconnections. However, it was noted that prepayment metering is proving to be a good tool for demand side management from a reduction in energy demand levels. The study also realised increased revenue collection to the utility and debt recovery. It was also noted that certain operating costs were also reduced by the introduction of prepayment metering.

Although Munhezva's (2014) study highlighted certain costs and benefits of the prepayment system, the focus was on improvement in organisational performance by ZETDC, specifically service delivery. The study did not provide an overall cost and benefit analysis to society as covered by this study.

### **2.5.7 Cost-benefit analysis**

Casarin and Nicollier (2010) significantly contributed to the debate of prepaid electricity by using a social cost-benefit analysis to assess the adoption of prepaid electricity meters within a local community in Argentina, Carmen de Areco District. The adoption of prepaid meters was voluntary, the consumer would incur the cost of the meter but would be charged a lower tariff. The analysis highlighted how the

role of tariffs, the cost of start-up investment and the socio-economic characteristics of the population affected system performance. Simulation exercises were used to examine the sensitivity of results to change in some distinctive elements of policy implementation. Their research also summarised the results of a survey conducted among local electricity users. Like the other research findings discussed in this chapter, results indicated that prepaid meters led to an increase in welfare. Casarin and Nicollier (2010) reported that the advantages of the system included a reduction of arrears in accounts receivable and reduction in operational and financial costs on the part of the utility company, as well as a better allocation of resources for the consumer. However, survey evidence suggested that the main argument against prepayment related to the possibility of self-disconnection by low income consumers.

Casarin and Nicollier's (2010) study, evaluated the adoption of prepaid meters and the distribution of net welfare changes across consumers, the firm and the government. These were seen through the distribution of profit or loss in the prepaid system over a historical and projected period. The resulting net welfare streams were discounted and summed to yield a net present value for each stakeholder and for society as a whole. They found that the policy led to an increase in overall welfare equivalent to \$a 214,200, or \$a 38 per user. Results differ across groups, as users and the power utility both benefit from the implementation of the system, whereas the government does not.

The analysis was done over a number of years – both historical and projected. Casarin and Nicollier's (2010) reasons for analysing it over a number years was because the increase in social welfare exhibits an evolution over time which is typical of investments with high sunk costs, because the results show that in the first years of implementation the system generated losses owing mostly to the high cost of the technology involved. These results were, however, reversed and more than compensated for when the period of analysis was longer.

In the case of consumers, Casarin and Nicollier's (2010) results indicated that the benefits from lower prices/tariffs and associated taxes exceed the costs associated with the advanced payment of electricity, the time incurred in recharging the meter and the meter cost. In the case of the utility, results indicated that losses of tariff discounts are overturned by the benefits incurred in the reduction of operating and financial costs, highlighting the utility benefiting the most. Finally, the results showed that the government loses, as lower taxes are now being remitted.

The economic model used in the study suggests that the use of prepaid meters leads to a welfare increase, but ignores how consumers evaluate the system. Casarin and Nicollier (2010) noted that the views of consumers were relevant not only because they might be highly correlated with changes in their welfare – and so they might give additional support to the findings of the economic model used – but also because they become a relevant factor behind the success of prepaid systems.

The survey examined the main characteristics of households that switched to prepaid meters and explored their satisfaction with the system. Casarin and Nicollier (2010) reported results that showed that 47% of the 90 users surveyed stated that they had adopted prepaid meters, while the rest indicated they had remained with the conventional system. Results showed that 88% of prepaid meter users were not willing to switch back to the conventional system, whereas 70% of conventional meter users were not willing to switch; only 19% of the latter would consider switching to prepayment. Reasons given for not switching to prepaid included the inconvenience involved in the advance purchase of electricity (not seen as sound practice), the cost of the meter and the fact that tariff discounts are not large enough – given consumption levels – to warrant switching. Reasons given for switching included the possibility of exerting better control of consumption (45% viewed it as an advantage) and that it is cheaper (70% of consumers interested in switching to prepaid meters would do so for reasons associated with the cost of electricity).

The main disadvantage reported by one third of users referred to the possibility of disconnection. The risk of disconnection did not seem to be too much of a problem. Results indicated that 45% of prepayment users reported having been disconnected at least once during the last year. The data also show that 62% of users that were disconnected, the lack of energy lasted less than seven hours; in 80% of the cases, disconnection occurred due to user neglect. The opposite situation occurs, however, in the case of disconnections over periods longer than seven hours, the main cause was the lack of money to reload the meter.

In their conclusion, Casarin and Nicollier (2010) warned that even if the results of their analysis pointed out to an overall benefit to society, the social impact of the prepayment system partially depends on the particular socio-economic characteristics of the consumers. Further studies remain to be conducted in the future on the extension of this analysis to different locations. This recommendation for further studies in different locations motivated this study in Zimbabwe.

## CHAPTER 3: RESEARCH METHODOLOGY

### 3.1 Introduction

This chapter describes the research methodology used in this study, the research approach and strategy, research design, research instruments used, sampling, data and the data analysis.

### 3.2 Research approach and strategy

We examine the adoption of prepaid electricity using social cost and benefit analysis techniques. This approach was adopted by Casarin and Nicollier (2010) in assessing social costs and benefits of adopting prepaid electricity in a local district in Argentina, Carmen de Areco District. Casarin and Nicollier (2010) adopted this approach from Jones et al. (1990), and Galal et al. (1994) and Newbery and Pollit (1997) who applied it to examine privatization policies. As used by Casarin and Nicollier (2010), the method compares the performance of the electricity distribution system in the local district after the adoption of prepaid meters with what that performance would have been had prepayment meters not been adopted. The differences in welfare in the two scenarios form the welfare gains or losses that form the benefits or costs of prepaid electricity. For the purpose of this study, the basic notion behind this partial cost-benefit analysis is simple: the prepaid electricity model will have produced greater societal benefits than costs in Zimbabwe if the welfare gains are more than the losses.

The cost and benefit analysis has both *quantitative* and *qualitative* dimensions. On the quantitative dimension, according to Casarin and Nicollier (2010), the model requires an appreciation of the difference between two results: the social value of the system under the prepayment system and its social value if that innovation had not been adopted. This social value can be expressed in monetary terms.

For application in the Zimbabwean case, the net effect on social welfare can thus be estimated by adding up the net welfare changes of the consumer and the utility company in monetary terms. Like Casarin and Nicollier (2010), these changes can all be expressed as  $\Delta W = \Delta C + \Delta \pi$ , where  $\Delta W$  represents the total net social welfare change,  $\Delta C$  the changes in consumers' welfare and  $\Delta \pi$  the changes in the utility company's profits. The aggregated results for the consumer and utility company leads to a final monetary outcome for society. Unlike Casarin and Nicollier (2010), this study does not look at the

government, as the utility company in Zimbabwe is not a private entity but already a government agency.

On the qualitative approach, the analysis aims to achieve a comparison between the non-monetary or unquantifiable cost and the benefits of the prepaid system. These qualitative factors mainly relate to consumers' perceptions which are critical in determining whether society views the prepaid system as beneficial or not. Although the approach is qualitative, the analysis employed will allow consumers' perceptions to be ranked and determine if there is an overall cost or benefit from the prepaid system.

### **3.3 Research design**

The research design was based on a survey. The survey included a self-administered consumer questionnaire and face to face interviews with ZETDC management. According to Hofstee (2006), surveys can be a good way of finding out people's opinions, desires and attitudes. This makes surveys such a powerful tool when such information is required. They can also be used to elicit purely factual information. For the purpose of this study, interviews with ZETDC management provided factual information on the functionality, performance, costs and benefits of the prepaid system. Consumer questionnaires were also used to obtain factual information on the impact of the prepaid system to them, as well as their perceptions regarding the system's costs and benefits.

### **3.4 Research instruments**

#### **3.4.1 Questionnaires**

A questionnaire was used to collect data from the prepaid electricity consumer, which was used for both the quantitative and qualitative cost and benefit analysis. This instrument was chosen as it allows more data volume (i.e. they can be sent to more people) which raises confidence levels in the sample. Questionnaires are easy to analyse and turn into quantitative results. However, Hofstee (2006) highlights that they have the disadvantage of not allowing the researcher to interact with respondent and probe for any clarification. 130 questionnaires were distributed and only 125 were collected. The first 100 responses were used for the analysis.

A combination of open (which respondents answer in their words) and closed questions was used. According to Hofstee (2006), open questions allow for the collection of as much information as possible in respondents' words, providing deeper insight into the research topic. However, the disadvantage is that there is no opportunity to get clarification when needed and final analysis and data presentation is difficult. Closed questions, according to Hofstee (2006), offer respondents the same options/possible alternative answers. Closed questions are beneficial as they allow easy comparison of results and analysis. They are simple to answer, although they have the weakness of providing predetermined responses instead of the respondent's own words. To benefit from the advantages of closed questions highlighted above, the questionnaire used in this study had 86% closed questions against 14% open questions.

After careful preparation of questions and editing to avoid ambiguity and clutter, the validity of the questionnaire was ensured through pretesting.

### **3.4.2 Interviews**

To obtain data from the utility company, in-person interviews with management/officers of ZETDC were conducted. The interviews had a combination of structured and open ended questions to allow the gathering of as much information as possible on the cost and benefits to ZETDC. Interviews were done with the Project Manager – Prepaid Electricity and the Accountant. Munhenzva (2014) had warned that, while interviews have the advantage of allowing for clarification directly between interviewer and interviewee, they are time consuming and exposed to interviewee-interviewer bias.

The interviews with ZETDC were primarily focused on getting factual (positive rather than normative) information on the impact of the prepaid system as opposed to perceptions which reduced the risk of bias. Responses were supported by evidence from independent company reports.

### **3.5 Sampling**

According to Saunders et al. (2009), probability sampling (or representative sampling) is an associated feature of survey-based research strategies where inferences about a population are drawn from a sample to answer a research question.

Currently, there are 552,842 prepayment consumers in Zimbabwe. Yamane's simplified formula was used to calculate the sample size for the study. It is defined as:

$$n = \frac{N}{1 + N(e)^2}$$

n: sample size

N: total population

e: the precision

$$n = \frac{552\,842}{1 + 552\,842(0.1)^2}$$

n= 100

A sample size of 100 was considered appropriate based on a 95% confidence level and a 10% confidence interval.

The capital city, Harare, accounts for 32% (ZETDC, 2015) of the installed prepaid meters in Zimbabwe. The city was considered appropriate to represent the country as it had the most significant number of prepaid consumers covering both low and high income groups. 75%<sup>1</sup> of the meters in Harare have been installed in the high density suburbs, where levels of bad debt on power bills had typically been greatest (middle density has been classified under high density). As such, 75% of the sample came from households living in high density suburbs representing the low income earners, whilst 25% came from households in the low density, representing the high income earners. The researcher used simple random sampling to identify participants in the survey.

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<sup>1</sup> Source: ZETDC Management

### 3.6 Data analysis

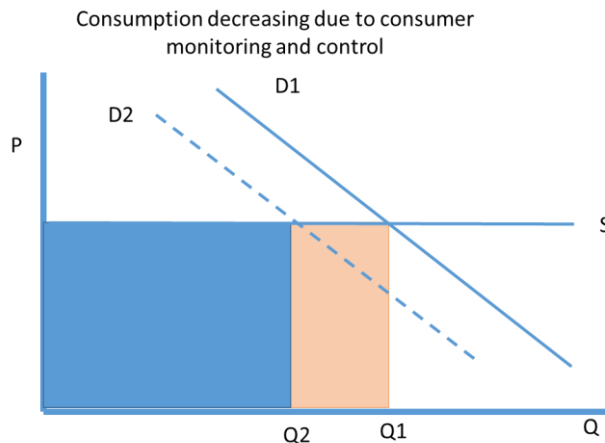
#### 3.6.1 Quantitative approach

The model compares the annual cash flow benefits against the cash flow costs for both the consumers and the utility. The net cash flows for the consumers and the utility are calculated separately over a historical and projected period. These net cash flows are then discounted to come up with a net present value of the net cash flow, which will represent either the consumers' or the utility's net welfare. This welfare can be calculated per user by dividing the consumers' and the utility's welfare by the number of consumers on the prepaid meter system.

As costs and benefits are determined by the specific prepayment systems a country implements, information on the costs and benefits for Zimbabwe came from the consumer questionnaires and ZETDC management interviews and reports. The following factors were included in the model:

#### Consumer welfare:

1. Benefit of a decreased bill to the consumer - average amount of decrease per annum (+ *benefit*)



Graph 1: Impact of prepaid system on energy consumption

The graph above illustrates the impact of the prepaid system on a consumer's consumption. Consumption decreases due to increased monitoring and control by the consumer on energy use. This monitoring and control reduces wastage of energy, resulting in the decrease being a benefit to the consumer.

2. Cost of a self-disconnection to a consumer - average hours disconnected per annum X tariff (- *cost*)

After obtaining the above information, an average (mean) net welfare position per consumer was calculated.

**ZETDC welfare:**

For ZETDC, a lot of benefits were quantified, including increased cash collections (improved working capital); recovery of historical bad debts and decreased running and finance costs. Regarding costs, the following were quantified - meter acquisition and installation costs; equipment repair and maintenance costs; vendor commission and other incremental operating costs.

- Increased cash collections as 100% of electricity is sold on a cash basis (+ *benefits*).
- Benefit of recovery of previously unrecoverable historical bad debt. This amount is now being recovered, as 40% (initially 20%) of actual power sales to existing consumers with debt is allocated towards debt reduction (+ *benefits*).
- Reduced finance cost due to lower working capital borrowings - this is determined by calculating the difference in the finance costs between the prepaid and post-paid system. During the post-paid system, consumer debt was accumulating. As a result, the utility company would borrow an equivalent of the amounts owed by consumers to fund working capital and thus increase finance costs. With the prepaid system, there is no accumulation of debt, with the historical consumer debt decreasing from current debt repayments. The debt not accumulating results in lower or no working capital borrowings and thus a reduction in the finance cost (+ *benefits*).
- Benefit of the reduction in running costs - the annual savings from discontinuance of the post-paid system (e.g. cost associated with meter readings, dispatch of correspondence/bills, collection costs, disconnection and reconnection costs) (+ *benefit*).
- Cost of vendor commission and other operating costs (- *cost*).
- Cost of prepayment meter and related equipment - the total cost of acquisition of the new meters and equipment and the associated annual finance cost (- *cost*).

- Cost of annual maintenance and repair/replacement of prepayment meters and related equipment (- *cost*)

The net present value of the cash flows was divided by the number of consumers on the prepaid system to obtain the utility welfare per consumer.

The overall societal cost or benefit was determined by summing the consumer and the utility welfare per consumer. Both the utility and the consumer welfare have been expressed per consumer as the utility company is a government entity to which costs or benefits will eventually accrue to the consumers who are the taxpayers and citizens of the country.

These are the significant costs and benefits for the quantitative cost-benefit analysis. The rest will be analysed under the qualitative analysis, due to the limitation on quantifying certain costs or benefits in monetary terms.

### **3.6.2 Qualitative approach**

As the quantitative cost-benefit analysis does not capture other qualitative costs and benefits, a qualitative approach was adopted to complement it.

A questionnaire was circulated to randomly selected households in the different income groups. The questionnaire included both open and closed ended questions on different costs and benefits of using prepaid meters. Additionally, the questionnaire aimed to capture consumers' perceptions. On a section of the questions, respondents highlighted whether they strongly agreed, agreed, were indifferent/not sure, disagreed or strongly disagreed with statements related to the costs and benefits of the prepaid system. The Likert scale was used to assist in quantifying the significance of each benefit and cost, by giving a value to each type of response. This allocation of a value allowed the determination of an overall net cost and benefit position. A software package for statistical analysis, SPSS Statistics, was used in analysing the responses.

The qualitative approach has been limited to consumers as most costs and benefits for the utility company have been captured in the quantitative approach.

Both the quantitative and qualitative approach allowed the researcher to determine if the prepaid system has produced greater societal benefits than costs.

## **CHAPTER 4: RESEARCH FINDINGS, ANALYSIS AND DISCUSSION**

### **4.1 Introduction**

This chapter discusses the quantitative estimates of costs and the benefits affecting consumers and the utility, as well as the qualitative survey of consumers' perceptions. It provides the basis for the study's conclusions and recommendations.

### **4.2 Quantitative results**

A quantitative analysis was conducted to determine the cost and benefit of the prepaid system to both the consumer and the utility, as well as the overall society. This analysis was based on calculating the net present value of the annual cash flows, with benefits represented by positive cash flows and costs represented by negative cash flows.

The table below shows the summarised cash flows split into two periods. The first covering the historical period 2012 to 2015 and the second covering the projected period 2016 to 2027. For presentation purposes, the periods have been summarised into these two periods but the analysis was carried out on annual cash flows. The analysis is over a period of 15 years as the prepaid meters have a 15 year life span. A real discount rate of 15% was used in line with the utility's average borrowing rate, which is also the average borrowing rate on the market. Zimbabwe is unusual because it is using the United States Dollar as its main currency. As such, inflation rates are very low and at times negative, resulting in the nominal and real interest rate being the same.

A real discount rate of 15% might seem high to non-Zimbabweans, but it reflects local market rates. It is important to stress that, although Zimbabwe uses the United States Dollar as a currency, its interest rates reflect local levels of risk. Since nominal rates in excess of 15% are common despite the country having recently experienced price deflation, a real rate of 15% seems realistic.

Data used in calculating the historical and projected cash flows was obtained from both interviews with ZETDC management and results of the consumer survey. This data was not inflation adjusted as a real rate was used to discount it. Both prices and interest rates were real, resulting in the use of real cash flows and real discount rates.

Table 1: Quantitative cost-benefit analysis

PREPAID SYSTEM COST-BENEFIT ANALYSIS	Historical 2012 to 2015 Yr 0 to Yr 3	Projected 2016 to 2027 Yr 4 to Yr 15	Total 2012 to 2027 Yr 0 to Yr 15
<i>Figures in USD</i>			
<b>CONSUMER</b>			
1 Decreased expenditure	101 958 591	583 251 950	685 210 541
2 Cost of self disconnections	-1 542 508	-8 951 623	-10 494 132
<b>Subtotal</b>	<b>100 416 083</b>	<b>574 300 326</b>	<b>674 716 409</b>
<i>Net Present Value (cash flows from 2013)</i>	244 016 195		
<i>Average prepaid users</i>	527 178		
<i>Benefit per user over the period</i>	463		
<i>Benefit per user per annum</i>	30.86		
<b>UTILITY</b>			
1 Increased collections	22 004 647	126 115 847	148 120 494
2 Recovery of historical debt	93 873 967	125 002 823	218 876 789
3 Reduced finance cost due to lower working capital borrowings	68 783 168	660 932 324	729 715 491
4 Running costs benefit:			
Billing costs	1 898 347	10 879 931	12 778 277
Disconnection and reconnection costs	1 487 391	8 524 634	10 012 025
5 Operating expenditure:			
Vendor commission	-21 808 698	-163 973 558	-185 782 256
Internal labour	-6 293 786	-23 714 940	-30 008 726
6 Capital expenditure:			
Meter units	-65 051 691	-1 138 200	-66 189 892
Vendor systems	-1 600 000	-	-1 600 000
Accelerated life testing	-1 500 000	-	-1 500 000
Other capex	-1 057 272	-943 319	-2 000 591
Replacement of faulty meters	-	-1 784 566	-1 784 566
7 Financing cost	-4 000 000	-	-4 000 000
<b>Subtotal</b>	<b>86 736 072</b>	<b>739 900 974</b>	<b>826 637 046</b>
<i>Net Present Value (cash flows from 2012)</i>	253 777 537		
<i>Average prepaid users</i>	527 178		
<i>Benefit per user over the period</i>	481		
<i>Benefit per user per annum</i>	32.09		
<b>SOCIETY</b>			
<b>GRAND TOTAL</b>	<b>187 152 155</b>	<b>1 314 201 300</b>	<b>1 501 353 455</b>
<i>Net Present Value (cash flows from 2012)</i>	465 965 533		
<i>Average prepaid users</i>	527 178		
<i>Benefit per user over the period</i>	884		
<i>Benefit per user per annum</i>	58.93		

Source: ZETDC Management, Consumer Survey

The results show that consumers have an overall net present value of US\$244m, with the benefit per user, per annum of US\$30.86. The user benefits greatly from decreased expenditure due to the ability to monitor and control electricity usage.

The results for the utility show an overall net present value of US\$254m, with the benefit per user, per annum of US\$32.09. The utility benefits significantly from recovered historical debt as well as reduced finance cost due to lower working capital borrowings. If the prepaid system had not been implemented, the consumer debt of US\$219m as at 31 December 2012, would have been accumulating. This debt accumulation would increase annual finance charges as the utility would need to borrow funds equivalent to the consumer debt to fund working capital requirements. As noted in the table, the costs of meter units and other capital expenditure, as well as operating costs such as vendor commissions, are outweighed by the benefits of the prepaid system.

Overall, the society benefits with a net present value of US\$466m. The benefit per user, per annum is US\$58.93. The overall benefit, which includes the benefit accruing to the consumer and the utility company, has all been expressed as a benefit per user, as the utility company is a government entity to which benefits will still accrue to consumers who are also taxpayers and citizens of the country. This benefit is an estimated 8% of an average household's total spending on electricity per annum of US\$773<sup>2</sup> (monthly average of US\$64). The monthly average of US\$64 (US\$45 for low income consumers and US\$122 for high income) may be considered high as most consumers are still paying an additional 40% for debt redemption. These results are in line with the results of Casarin and Nicollier's (2010) study of a local community in Argentina, which showed an overall benefit to society equivalent to \$a 214,200, or \$a 38 per user. In both cases, the consumer and utility benefited from the implementation of the prepaid system.

### **4.3 Qualitative results**

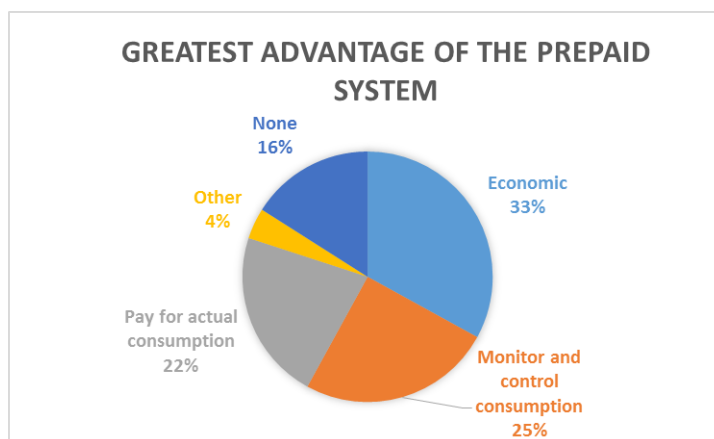
A questionnaire to capture consumer's perceptions was conducted. Results were obtained and analysed from 100 users who had switched from the post-paid to the prepaid system.

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<sup>2</sup> Source: Consumer Survey

### 4.3.1 Advantages of the prepaid system

Chart 1: Greatest advantage of the prepaid system



Source: Consumer survey

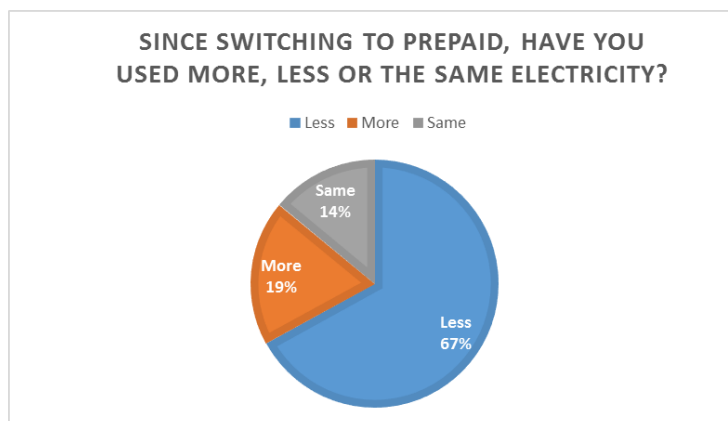
33% of the respondents confirmed that the greatest advantage of the prepaid system was that it was economic as their expenditure on electricity decreased by circa 30%. 25% confirmed the ability to monitor and control consumption as their greatest benefit, while 22% saw the paying for actual consumption instead of estimates as their greatest advantage. These results were in line with studies by Tewari and Shah (2003) (South Africa); Malama et al. (2014) (Zambia) and Baptista (2013) (Mozambique) in which advantages such as monitoring and control of consumption were noted as prime benefits.

The decrease in electricity expenditure reported by respondents is due to the decrease in usage, as there was no tariff discount on switching. A further analysis on electricity usage is noted below.

### 4.3.2 Electricity usage

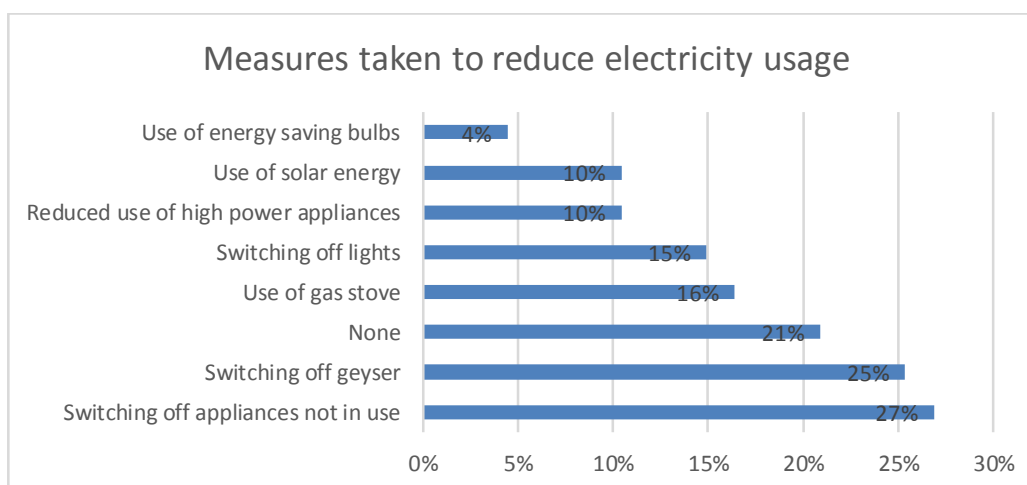
One of the main benefits generally sighted for prepaid electricity is the demand side management. Prepaid meters allow consumers to monitor and control their use of electricity. From the survey, 67% confirmed to be using less electricity since switching, while 29% are using more and 14% have maintained. This reduction in electricity usage matches information reported by ZETDC management. The primary measures taken by those who have reduced utilisation is switching off appliances and geysers when not in use.

Chart 2: Electricity usage



Source: Consumer survey

Chart 3: Measures taken to reduce electricity usage

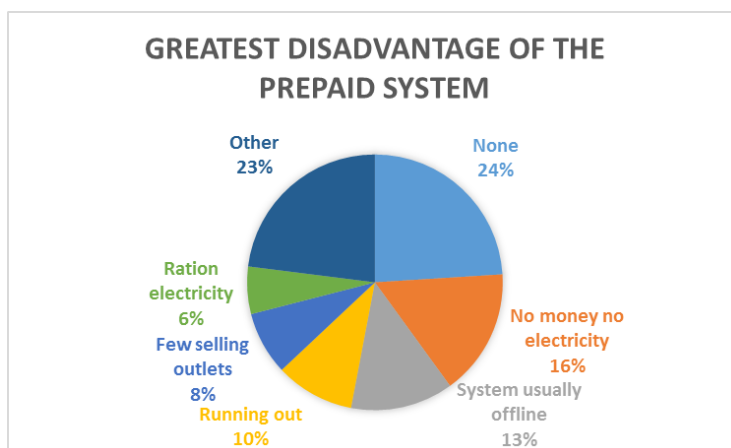


Source: Consumer survey

Measures taken of switching off appliances and geysers when not in use is considered beneficial to society, especially in this period where the demand of electricity outweighs the supply. These measures allow the saved power to be directed to consumers who are in need of it and thus reducing incidences of load shedding.

### 4.3.3 Disadvantages of the prepaid system

Chart 4: Greatest disadvantage of the prepaid system



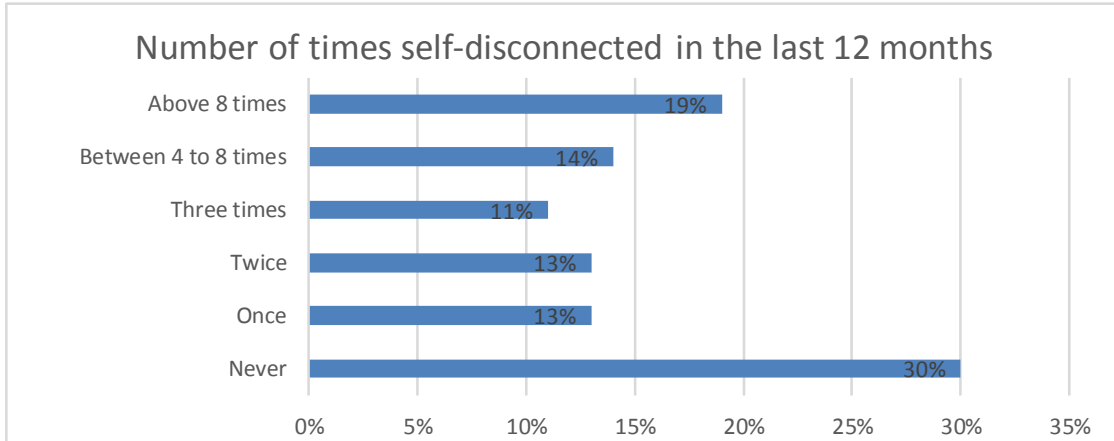
Source: Consumer survey

The main disadvantage of the prepaid system reported by 16% of the respondents is that if one has no money/credit, they have no electricity. This is based on the prepaid system's functionality of self-disconnecting when credit runs out. Unlike post-paid, in which one can have electricity while owing the utility, the prepaid system self-disconnects if no payment has been made. The system being offline certain times was also seen as the greatest disadvantage by 13% of the respondents. Interestingly 24%, being the highest proportion of respondents, did not report any disadvantages with the prepaid system. This 24% compares to only 16% who did not report any advantages of the prepaid system, which can be viewed as an indicator that respondents considered the prepaid system to be more of an advantage than a disadvantage.

### 4.3.4 Self-disconnections

Further analysis was conducted on self-disconnections as they were regarded as a major disadvantage. 30% of the respondents confirmed not to have been self-disconnected within the last 12 months, while 13% have been disconnected once, 13% twice, 11% three times, 14% between four to eight times and 19% above eight times. It is interesting to note that those respondents disconnected more than eight times were the most significant at 19%, confirming that self-disconnections are common. On further analysis, it was noted that 84% of the respondents who were disconnected for more than eight times were from the high density areas where lower income consumers reside.

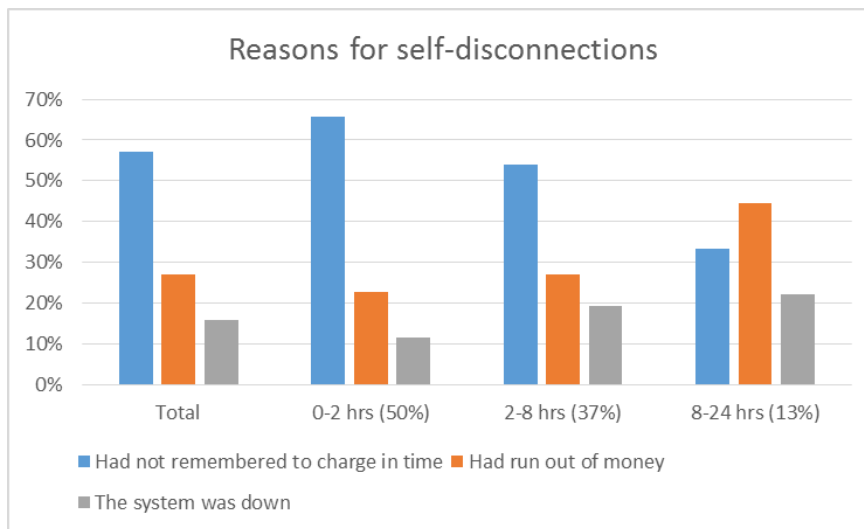
Chart 5: Number of times self-disconnected in the last 12 months



Source: Consumer survey

Of the respondents that were disconnected, 50% confirmed being disconnected between 0 - 2 hours, 37% between 2 – 8 hours and 13% between 8 – 24 hours.

Chart 6: Reasons for self-disconnections



Source: Consumer survey

For those disconnected between 0 – 8 hours, the main reason was that they had not remembered to charge in time. However, for those disconnected between 8 – 24 hours, the main reason was that they

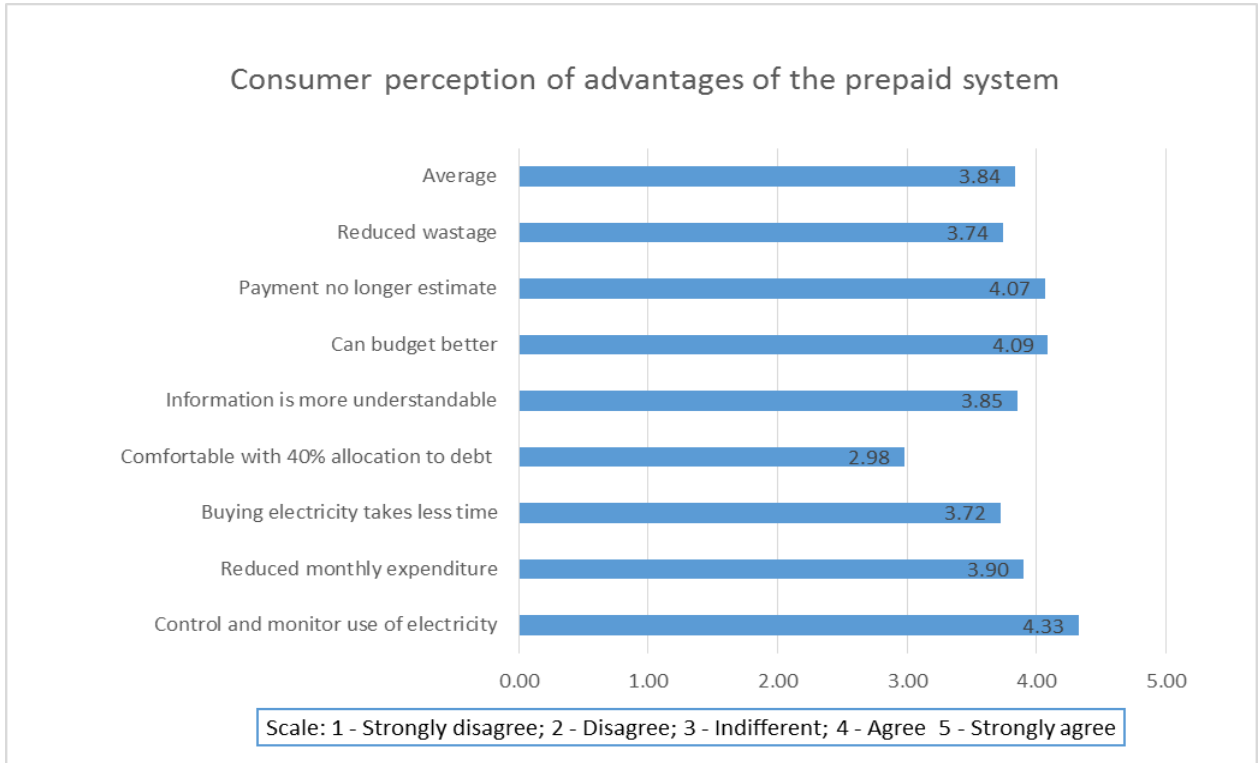
had run out of money. On further analysis, 90% of those who responded to have run out of money across the time periods were from the high density.

This analysis confirms that lower income groups experience more self-disconnections and running out of money to recharge is a significant reason for the self-disconnections. These results on self-disconnections are in line with the findings by Malama et al. (2014) (Zambia) and Casarin and Nicollier (2010) (Argentina). Malama et al. (2014) noted that 38% of the respondents reported running out of electricity credit and being disconnected at some point. This problem was more predominant in the lower income groups with the main reason being lack of money to buy electricity. The main reason for self-disconnections reported by the high income groups was that they had just forgotten to buy credit. Casarin and Nicollier (2010) reports that the main disadvantage reported by one third of users referred to the possibility of disconnections. Results indicated that 45% of prepayment users report having been disconnected at least once during the last year. For disconnection over periods shorter than 7 hours, disconnection occurred due to user neglect, while for periods greater than 7 hours, the main cause was the lack of money to reload the meter.

#### **4.3.5 Likert scale: analysis of consumer perception**

Consumers were requested to respond to a series of questions aimed at measuring the significance of selected advantages and disadvantages of the prepaid system. This was done in the form of a Likert scale, where 1 meant strongly disagree and 5 meant strongly agree with a given statement.

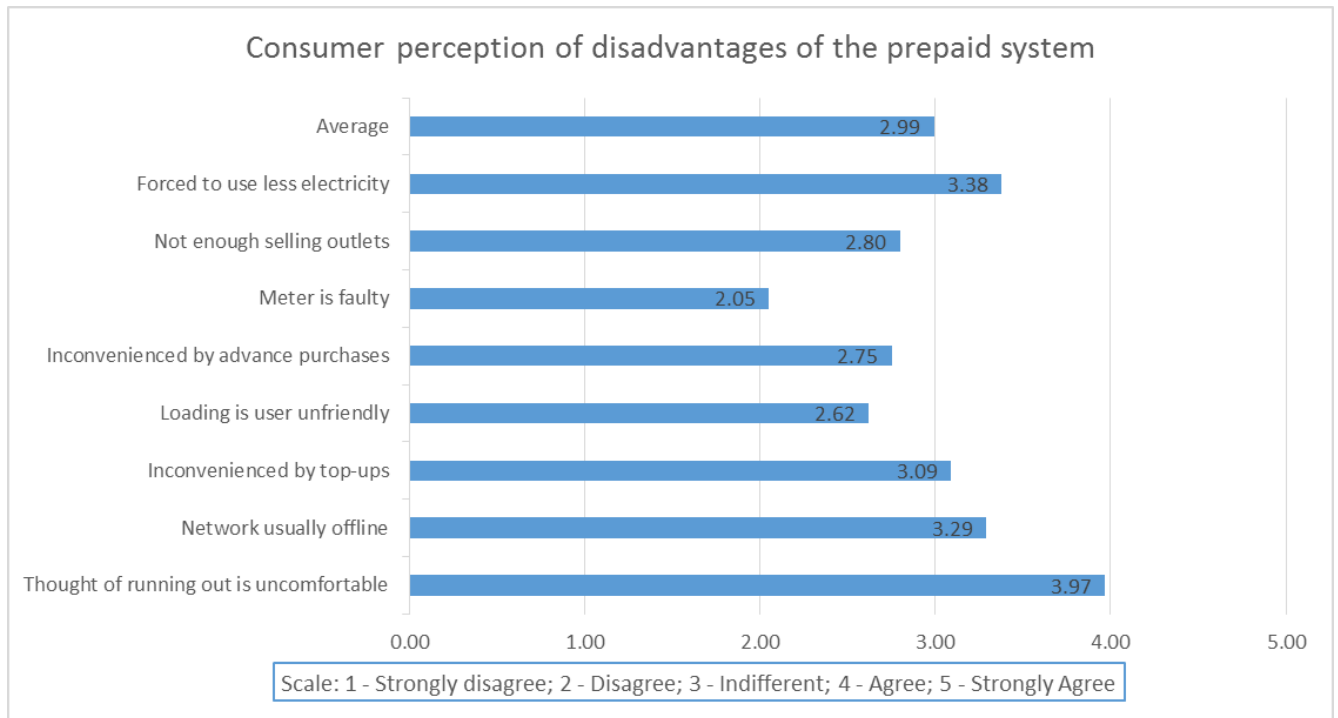
*Chart 7: Consumer perception of advantages of the prepaid system*



*Source: Consumer survey*

Consumers agreed with the advantages, with an average score of 3.84. 7 out of 8 of the advantages had scores between 3.72 and 4.33, confirming agreement, while only one was largely indifferent, although skewed towards disagreement, with a score of 2.98. In terms of ranking, ability to control and monitor use of electricity had the highest score (4.33), while 40% of payment being allocated to historical debt had the lowest score (2.98). The results show that consumers generally agreed with the advantages noted.

Chart 8: Consumer perception of disadvantages of the prepaid system



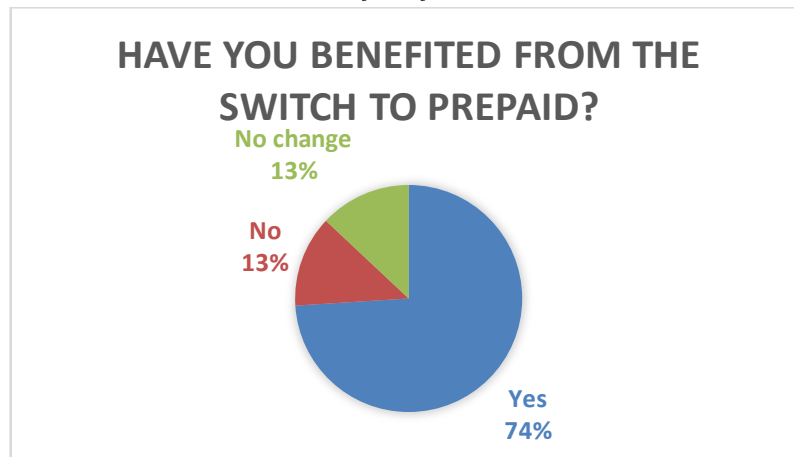
Source: Consumer survey

Consumers were indifferent on the disadvantages, although skewed towards disagreement, with an average score of 2.99. 4 of the disadvantages had scores below 3, confirming disagreement, whilst the remaining 4 had scores above 3, confirming agreement. Respondents did not agree to the meter being faulty but agreed to the thought of running out/being self-disconnected making them uncomfortable. The rest of the disadvantages were in the indifference range, with an equal number skewed towards disagreement with those skewed towards agreement. The results show that consumers neither agreed nor disagreed with the disadvantages.

Overall, the Likert scale analysis shows that consumers agreed with the advantages, at an average score of 3.84, while being indifferent about the disadvantages, at an average score of only 2.99. This confirms that consumers view the prepaid system to have produced more advantages than disadvantages.

#### 4.3.6 Benefit or cost of prepaid system

Chart 9: Benefited from the switch?



On concluding the survey, consumers were asked to respond to whether they have benefited or not from the switch to the prepaid system. 74% confirmed having benefited from the switch, while 13% had no change and another 13% did not benefit at all.

#### 4.4 Conclusion

Both the quantitative and qualitative analysis had results that showed that both consumers and the utility company, ZETDC, have benefited from the prepaid system. The overall societal benefit per user under the prepaid system was quantified to be US\$58.93 per annum. The consumer survey showed 74% of interviewees claiming to have benefited from the switch to the prepaid system. These results were supported by the Likert scale analysis in which consumers generally agreed to the advantages, but were indifferent on the disadvantages. These findings are largely consistent with the findings of other studies discussed in the literature review section.

## **CHAPTER 5: RESEARCH CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE RESEARCH**

### **5.1 Introduction**

This chapter presents the research conclusions, policy implications and recommendations for future research.

### **5.2 Research conclusions**

This research investigated the net benefits of the move to prepaid electricity in Zimbabwe. Variations in the impacts of the prepaid systems across communities and countries justified a Zimbabwean study, since both the model implemented and the county's circumstances were unique.

This study provides empirical evidence on costs and benefits of the prepayment model to both consumers and ZETDC. The study applied both a quantitative and a qualitative analysis. Under the quantitative analysis, a net present value benefit of US\$58.93 per user, per annum was noted. The consumer had a benefit of US\$30.86, while the utility had a benefit of US\$32.09 per user, per annum. These results are consistent with the results of Casarin and Nicollier (2010) who also noted an overall societal benefit for a local district in Argentina, Carmen de Areco District.

The qualitative approach captured consumer's perceptions of the costs and benefits of switching to the prepaid system through a consumer survey. The results of the study noted that 74% of the respondents benefited from the switch to the prepaid system. These results were supported by the Likert scale analysis in which consumers generally agreed to the advantages, but were indifferent on the disadvantages. The consumer's perceptions noted from the study were largely consistent with perceptions noted from similar studies in Zambia, Botswana, Mozambique, South Africa, Kenya and Argentina discussed in the literature review section. Although the results of the different countries were consistent in highlighting an overall benefit, it was interesting to note that self-disconnections, which were noted as one of the main disadvantages of the system in Zimbabwe, were also the main disadvantage in Zambia, South Africa and Argentina, especially amongst the poor.

Overall, the study found that the prepaid system has produced greater societal benefits than costs in Zimbabwe.

### **5.3 Policy implications and recommendations**

As the prepayment system is being applied in phases in Zimbabwe, with existing installations covering some domestic and small business, it is recommended that the prepayment system be implemented in full to include all other consumers. This is expected to bring benefits to both the consumers and the utility. Currently, ZETDC is only recovering just over US\$200m from the current domestic and small business consumers.<sup>3</sup> If the prepayment system is extended to all other consumers, including the big industrial consumers, the utility may be able to recover the circa US\$1bn<sup>4</sup> consumers owe it. This cash recovery would go a long way in benefiting both the utility and the consumer.

As control and monitoring of electricity use were one of the main advantages noted by consumers, new technology such as smart metering should also be considered for future phases, as it further enhances demand side management.

Prepayment technology should also be considered for other services such as water, as this may also benefit both the consumer and water companies. However, as prepayment technology is advancing, measures should be put in place to safeguard worsening the standard of living of poor/low-income groups in the community from self-disconnections.

Although these are not major drawbacks, certain consumers noted the inadequate number of voucher selling outlets and the likelihood of the voucher system being offline, as disadvantages. ZETDC could rectify both deficiencies.

### **5.4 Recommendations for future research**

The study still provides opportunities for future in-depth research on the costs and benefits of the prepaid system.

- The current study was conducted on the current prepaid consumers who are primarily domestic and small businesses consumers. ZETDC is still to roll out the prepaid systems to the large industrial consumers. As this is a different type of consumer from the current prepaid

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<sup>3</sup> Source: ZETDC Management

<sup>4</sup> Source: ZETDC Management

domestic/small business consumer, a study would need to be conducted to see the impact of the prepaid system on large industrial consumers.

- The new smart metering technology also provides an opportunity for future research as the costs and benefits may be different from the existing prepayment system.
- The prepayment technology is now being applied in other services such as water in Zimbabwe. A study can be conducted to determine if the same cost and benefits noted in prepaid electricity apply to prepaid water.

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## **APPENDICES**

## Appendix 1: Anonymous prepaid electricity customer survey

FULL COLOUR THINKING



### ANONYMOUS PREPAID ELECTRICITY CUSTOMER SURVEY

NOTE: ONLY PEOPLE WHO HAVE SWITCHED FROM THE POST PAID TO THE PREPAID ELECTRICITY SYSTEM MAY PARTICIPATE IN THIS SURVEY.

I am a student at the University of Cape Town - Graduate School of Business, pursuing a Masters in Development Finance. I am conducting a research on the electricity prepaid system. I would appreciate it, if you would answer the following questions to help me assess the effectiveness of the system.

This research has been approved by the Commerce Faculty Ethics in Research Committee. Your participation in this research is voluntary. You can choose to withdraw from the research at any time. The questionnaire will take approximately 8 minutes to complete.

The information you will provide will be treated with strict confidence and used for academic purposes only. You will not be requested to supply any identifiable information, ensuring anonymity of your responses.

Thank you.

**Shingirai Mujaji**

MCOM Development Finance

FULL COLOUR THINKING



Fill in or tick your responses. If you prefer not to answer, you can leave the question blank.

**SECTION A**

**1 In which suburb do you live?**

**2 Do you share your meter with other families/households?** YES  NO

**3 Before using prepaid electricity meters, were you using post-paid?** YES  NO

**4 Since you switched from paying at the end of the month to prepaid, have you been using more, less or the same amount of electricity?**

Same  More  Less

**5 If less, what measures have you taken that have resulted in a lower monthly usage?**

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**6 How much do you now spend per month on electricity?**  (estimate)

**7 When you were on post-paid, how much did you spend per month on electricity?**  (estimate)

**8 In the past 12 months, how many times have you run out of electricity in your prepaid meter?**

- |                |                          |                                |                          |
|----------------|--------------------------|--------------------------------|--------------------------|
| a) Never       | <input type="checkbox"/> | e) Between four to eight times | <input type="checkbox"/> |
| b) Once        | <input type="checkbox"/> | f) Above eight times           | <input type="checkbox"/> |
| c) Twice       | <input type="checkbox"/> | g) Other (specify)             | <input type="checkbox"/> |
| d) Three times | <input type="checkbox"/> |                                |                          |

**9 On average, when you ran out of electricity, how long did it take before you recharged?**

- |                 |                          |                    |                          |
|-----------------|--------------------------|--------------------|--------------------------|
| a) 1 - 2 hours  | <input type="checkbox"/> | d) 16 - 24 hours   | <input type="checkbox"/> |
| b) 2 - 8 hours  | <input type="checkbox"/> | e) Other (specify) | <input type="checkbox"/> |
| c) 8 - 16 hours | <input type="checkbox"/> | f) N/A             | <input type="checkbox"/> |

**10 In instances where your electricity ran out, what was the reason?**

- |   |                          |                    |                          |
|---|--------------------------|--------------------|--------------------------|
| a) Had not remembered to recharge in time | <input type="checkbox"/> | d) Other (specify) | <input type="checkbox"/> |
| b) Had run out of money                   | <input type="checkbox"/> | e) N/A             | <input type="checkbox"/> |
| c) The system was down                    | <input type="checkbox"/> |                    |                          |

**11 What has been the greatest ADVANTAGE of the prepaid system to you?**

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**12 What has been the greatest DISADVANTAGE of the prepaid system to you?**

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**SECTION B**

**1 I can now monitor and control my use of electricity.**

Strongly agree  Agree  Not sure/Indifferent  Disagree  Strongly Disagree

**2 The thought of having my electricity run out with the prepaid system, makes me uncomfortable**

Strongly agree  Agree  Not sure/Indifferent  Disagree  Strongly Disagree

**3 It has helped me reduce my monthly electricity expenditure.**

Strongly agree  Agree  Not sure/Indifferent  Disagree  Strongly Disagree

**4 The ZESA network is usually unavailable/is offline when I go to buy electricity.**

Strongly agree  Agree  Not sure/Indifferent  Disagree  Strongly Disagree

**5 It takes less time to buy electricity at a selling agent than it used to take to pay my bill at ZESA.**

Strongly agree  Agree  Not sure/Indifferent  Disagree  Strongly Disagree

**6 I am inconvenienced/bothered by the need to always top-up my electricity during the month.**

Strongly agree  Agree  Not sure/Indifferent  Disagree  Strongly Disagree

**7 I am comfortable with 40% of my payments being allocated to clear my historical debt.**

Strongly agree  Agree  Not sure/Indifferent  Disagree  Strongly Disagree

**8 Loading electricity is not user friendly - it is complicated and takes time.**

Strongly agree  Agree  Not sure/Indifferent  Disagree  Strongly Disagree

**9 The prepaid meter gives me more understandable information than I used to get from a ZESA statement.**

Strongly agree  Agree  Not sure/Indifferent  Disagree  Strongly Disagree

**10 I am inconvenienced by doing advance purchases of electricity.**

Strongly agree  Agree  Not sure/Indifferent  Disagree  Strongly Disagree

**11 I can now budget better as I can predict my electricity expenses.**

Strongly agree  Agree  Not sure/Indifferent  Disagree  Strongly Disagree

**12 My meter is faulty and is giving me problems.**

Strongly agree  Agree  Not sure/Indifferent  Disagree  Strongly Disagree

**13 There are not enough electricity voucher selling agents or outlets.**

Strongly agree  Agree  Not sure/Indifferent  Disagree  Strongly Disagree

**14 I now pay for electricity that I will use and no longer pay based on estimates (no more dispute on bills).**

Strongly agree  Agree  Not sure/Indifferent  Disagree  Strongly Disagree

**15 The prepayment system has forced me to use less electricity than I would like.**

Strongly agree  Agree  Not sure/Indifferent  Disagree  Strongly Disagree

**16 It has helped me reduce the amount of electricity I waste.**

Strongly agree  Agree  Not sure/Indifferent  Disagree  Strongly Disagree

**17 Overall, I have benefited from the switch to the prepaid electricity system?**

Yes  No  No change/Indifferent

## **Appendix 2: ZETDC management interview questions**

1. Is there a tariff discount or difference in price between post-paid and prepaid?
2. May you provide a breakdown of the installations from project inception to end of 2015?
3. Is it possible to get a breakdown of the installation per suburb or per density (high and low)?
4. What level of sales/collections are you generating monthly from the prepaid meters and how much are you recovering as payment towards the historical consumer debt?
5. What is the vendor/selling agent commission?
6. What other operating costs are involved in running the prepayment system?
7. What is the cost of equipment and installation of a prepaid meter to ZETDC?
8. What other capital expenditure items have been incurred to implement the system?
9. What is your weighted average finance cost?
10. What is the useful life of a prepaid and post-paid meter?
11. What is your current annual maintenance cost (per meter or in total)?
12. a) Of the prepaid meters installed, what % has been faulty?
  - b) Who bears repair costs?
  - c) Who bears replacement costs?
  - d) How much is your annual repair/replacement cost?

13. What are the running costs savings that you have made? (E.g. cost associated with meter readings, dispatch of correspondence/bills, collection costs, invoice claims and disconnecting services).
  
14. a) What was the historical debt balance of consumers that were moved to the prepaid system?  
b) If there was no prepaid system, how much do you think would have been irrecoverable?  
c) How much are you now recovering monthly?  
d) What is the amount of current consumption that would have needed to be written off as bad debt in the future (as a % of sales), if the prepaid meter had not been implemented?
  
15. Is there data that shows the average consumption before and after the implementation of the prepaid system?

### Appendix 3: ZETDC research approval letter



## ZIMBABWE ELECTRICITY TRANSMISSION & DISTRIBUTION COMPANY

HEAD OFFICE  
ELECTRICITY CENTRE,  
25 SAMORA MACHEL AVENUE,  
HARARE  
P.O. BOX 377, HARARE  
TELEPHONE: 774491/9, 774508/35  
FAX: 774542/3, 758356

OUR REF: .....JCM/ecom  
YOUR REF: .....

WHEN CALLING WITH REFERENCE  
TO THIS LETTER PLEASE ASK FOR

Mr J Chinembiri  
.....

29 May 2015

**Commerce Research Committee**  
Faculty of Commerce  
University of Cape Town  
Rondebosch  
Cape Town  
South Africa

Dear Sir/Madam

#### APPROVAL TO CONDUCT INTERVIEWS FOR RESEARCH PURPOSES AT THE ZIMBABWE ELECTRICITY TRANSMISSION AND DISTRIBUTION COMPANY (ZETDC)

This is to confirm that Shingirai Mujaji, who is studying for a Masters in Development Finance at the University of Cape Town – Graduate School of Business, has been given permission to conduct interviews for research purposes with ZETDC management and staff. These interviews are for the purposes of obtaining information for a research on the prepaid electricity model. We understand that all responses will be confidential and used for the purposes of this research only.

Yours faithfully,

Eng. J. M. Chinembiri  
**MANAGING DIRECTOR**