PREPAYMENT METERING SYSTEMS IN WATER SERVICE DELIVERY: THE CASE OF GHANA

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Abstract

Effective billing and collection systems are a critical component to improving the financial viability of any water service provider. At the heart of this, lies the use of technology in measuring volume of potable water flow. The introduction of prepayment metering technologies in particular, has been proposed as a path to ensuring reliable and effective water billing and collection by water service providers. Prepaid water metering, is based on meters that charge for water consumption and requires consumers to pay before using the service. Such meters are increasingly being utilized by water and sanitation utilities in over 20 African countries.

The objective of this study therefore was to assess the different options or types of prepaid water meters; and make deductions for GWCL to explore whether or not prepayment in water metering can be re-considered as an innovative way of addressing water billing and collection challenges. In addition, the report explicitly reflects the distinct classifications and applications of prepaid water systems to different users, as well as their implications to consumers and utilities. The review draws on an expansive literature and desk reviews on the concept of prepaid water metering, what it entails, and the commonly used prepaid water meters together with their key features.

The research found four distinct categories and classifications of water prepayment systems based on the Token and Standard Transfer Specification (STS) models. Prepaid water meters in these four categories are applicable to individual or residential customers, communal customers without their own connection; institutional or commercial customers; as well as water management devices applicable to both individual and commercial customers. It was indicated, among other things, that deploying the different types of prepaid water meters requires insight into cost-savings and the socio-economic impacts of such technologies. However, this must be done in consultation with key stakeholders within the sector to determine the best possible way forward in deploying such meters. It will also require further research into best practices and effects of the installation of such meters on cost-saving measures of both consumers and the utility.

1. Background

Prepaid water metering system is based on the principle that billing and collection is done in advance before actual consumption. The system requires that, consumers pay for water before consumption through the purchase and use of a prepaid card. Consumers can then draw water by inserting the prepaid card into the meter and drawing water. As service is delivered, the balance is adjusted, and the remaining credit is displayed. Service is automatically terminated if the payment balance is depleted, until the consumer can pay again. Thus a prepaid water meter shuts off its valve when it runs out of credit. Whenever the water meter is recharged, the valves are once again opened to serve water to the customer. The installation of prepaid meters restricts the use of meter readers, extensive billing systems and debt collecting systems thereby reducing the financial risk to a utility.[1]

In a bid to ensure adequate and technologically up-to-date water systems, to help meet the growing demand for water supply in urban/peri-urban areas of Ghana, Ghana Water Company Limited (GWCL) is currently putting in place a number of interventions. Predominantly, these interventions include capacity expansion and system loss reduction projects to improve efficiency in water service delivery.[2] Notwithstanding these interventions, GWCL continues to face challenges in delivering affordable and potable drinking water to consumers. Principal among these challenges are; the escalating cost of delivering safe and affordable water to the rapidly growing urban population, the issue of water losses and non-revenue water in recent times averaging 50 percent, as well as cost recovery.[3]

Cost recovery is a key element for sustainable water supply. Sustainable cost recovery is seen as the need to collect enough revenue from users through a combination of financial sources including user charges (rather than from tariffs alone) to cover the cost of service provided.[4] For a sustainable and realistic cost recovery, then technology with water metering becomes imperative. The introduction of prepayment metering technologies in particular, has been proposed as a path to cost recovery that would simultaneously reduce non-payments and indebtedness.[5]

Given the persistent challenges experienced by GWCL in recovering aspects of its cost of operations, management of GWCL since 2014, has shown increased interest in innovative ways of countering such setbacks. This was done through the introduction of prepaid water meters on a pilot basis, to accurately measure provision of potable water within the Accra-Tema Metropolis of Ghana. According to GWCL, the use of prepaid water meters is expected to address about 50 percent losses in water produced, and also enhance the ease of payments and collection by both consumers and the utility respectively.[6]

Prepaid water metering was developed in South Africa in the 1990s as a solution to water supply and payment challenges in low-income areas.[7] Currently, this technology has advanced, and a growing number of urban service providers in Africa have adopted it as an alternative to conventional (post-paid) water metering. South Africa, Kenya, Zambia, Mozambique, Tanzania, Malawi, Angola, Nigeria, Botswana, Namibia, Swaziland, and Ethiopia are part of over 20 African countries currently using prepaid water meters. The drive towards improved operational

performance, water management, and the need for financially sustainable cost recovery systems have been the main drivers of prepaid water metering projects in most of these countries.[8] Moreover, it has become imperative to adopt water metering to know how much water is available, where it goes, and subsequently how to deal with unaccounted for water.

Several reasons can be ascribed to why GWCL has been slow, at best, in deploying prepaid water meters nationwide. These may include, among others, controversies over the human right to water – which is life; availability of funds to procure such meters; and the immediate public opposition and reaction after both first and second prepaid water metering piloting attempts were made in 2014 and 2015 respectively.[9] Others have also maintained that water prepaid system will make it too easy for GWCL to cut off supply when consumers cannot afford advance payment, and when credit is exhausted.

Research has however shown that the use of prepaid water meters, which makes use of convenient payment mechanisms (such as mobile money), can help respond to the triple challenges of access, quality, and payment of water services – especially among low-income households.[10] Innovations in prepaid metering such as the use of mobile money pay-as-you-go services is also expected to contribute to the realization of UN Sustainable Development Goal 6, which aims at ensuring the availability and sustainable management of water and sanitation for all by year 2030.[11] Prepaid water metering also holds the promise of remedying low collection rates and inadequate income to meet service expectations.[12] This is because there is no risk of arrears or debt since customers pay in advance for a specified amount of water to be delivered by the utility. There is also the prospect of healthier cash flows and more revenue to the utility to fund wider coverage. Countries such as South Africa, Namibia, Kenya, among others, have observed an improved sector efficiency and performance over the past decade in the use of water prepayment meters.[13]

Regardless of the interest or otherwise in the introduction of water prepayment meters in Ghana, little systematic research has been conducted to understand the opportunities, limits, and implications of the different options that exists for water prepayment systems. It is for this reason that this report discusses a range of options on the types of water prepayment meters that can be considered in the quest to promote improved sector efficiency and cost recovery. In addressing this gap, the report serves as a guide to stakeholders in the water industry on prepayment water metering systems and its implications to both consumers and utilities.

This research piece consists of six sections. The first four sections are critical to the understanding of the background of this research, its objective and significance, as well as the methodology adopted. Section five presents what a successful prepaid water metering system entails, and its implications to users and utilities. The section further identifies and discusses the different options and the commonly used water prepaid meters together with their key features. The final section concludes the study with some recommendations on the adoption and selection of water prepayment meters for the maximum benefit of all stakeholders.

2. Research Objectives

The main objective of this study is to identify and establish a broad understanding of the various types of water prepayment metering systems available. In exploring the subject, we specifically;

a. discuss what prepaid water metering entails;
b. ascertain what unconventional types of prepaid water meters there are; and
c. establish the broad implications of these meters on consumers and utilities with respect to benefits and costs.

3. Research Significance

This study highlights the need to understand holistically, the water prepayment system as well as its distinct applicability to different users. Broad application of water prepaid metering is of major importance in the improvement of efficiency in water usage and payment collection.[14] Hence, in identifying the types of water prepayment systems, the research makes a marked distinction on prepaid metering systems for domestic, communal, and institutional or commercial connections. Each of these have different implications for users, which is significant for a utility's understanding. It is therefore important for a water utility (GWCL) to be able to rationalize the investment in a particular water prepayment system and its opportunity costs, relative to alternative means of improving services.

A sound PURC water tariff policy (which lies at the heart of the Commission's work) is a necessary precondition for the long-term and stable development of water supply. However, development of a sound water tariff policy without the knowledge and measurement (metering) of actual water consumption of GWCL's distinct consumers, would be quite difficult if not impossible. The outcome of this study therefore, will importantly inform the Commission on the need to continuously improve on fair pricing in tariff decisions by considering cost involved in the use of prepaid meters. The Commission would be apprised with the different kinds of prepaid water meters and their implications for consumers; and analyze prepayment meters carefully to provide guidance to GWCL on the basis of decision making on the suitability, reintroduction and management of such meters. The findings of this research will also be useful to government agencies, consultants and NGOs or civil society organizations dealing with any aspect of water metering.

4. Scope and Methodology

This research is based solely on a comprehensive desk study and literature review on water prepayment systems. Thus the scope of this study is confined to unconventional water meters, specifically prepaid water meters and does not cover conventional or post-paid water meters. The discussions are robustly intuitive in principle, offering balanced analysis, assessment, and considerations to inform stakeholders on such prepaid water meter systems.

The growing interest from stakeholders in the field of water prepayment systems, has led to a number of reports, articles, and scholarly journals produced by researchers, consultants, and stakeholders in the water sector, that contain valuable empirical evidence that this research draws

from. This research therefore specifically makes links to dispersed literature across issues relating to prepaid water metering systems. This is done in order to signpost key areas related to the subject of the research in order to strengthen the discussions, recommendations, and conclusions.

5. Research Findings

5.1 Successful Operation of Prepaid Water Meters

The World Bank has indicated that, the successful operation of prepaid water meter systems is contingent on having first, an effective vending system that allows customers to buy credit conveniently; and second, an ability to respond rapidly when faults affect the supply of water to customers who have paid in advance.[15] Prepaid water experts have also reinforced that prepaid water systems can be successful if customers or token-holders find it easy to recharge their tokens.[16]

These therefore requires the support of a multidisciplinary team well equipped to negotiate the introduction, siting, and installation of new meters, explain how to load credit, check balances, understand tariffs and charges, replace credit cards and tokens, and mediate possible conflicts that may arise in the use of such meters.

5.2 Implications to Consumers and Utilities in the use of Prepaid Water Meters

While prepaid systems are more expensive to install than conventional metering, this shortfall is outweighed by the convenience of financial control, having real-time visibility into consumption via an app or user interface unit, and being able to identify a leak well in advance of it becoming a financial burden.[17] These enable the consumer to directly pre-budget, monitor and control their own water consumption or expenditure in real-time. Moreover, consumers know exactly how much water they are using and how much it is costing thus the use of water more sparingly.

Prepaid water metering also gives lower-income earners in particular, more financial control since it enables payment in smaller, frequent increments.[18] This helps to prevent debt accumulation which can compound on a post-paid metering arrangement. Users are also able to monitor their usage and credits, which gives them time to buy more before it runs out. Additionally, the built-in processor and shut-off valves of water prepaid meters makes prepaid metering systems suitable for other advanced functions. They can, for instance, be programmed to automatically dispense the free basic allowance of water (lifeline water) or emergency water before requiring credit to operate.[19] This allows users access to some free litres of water or emergency water when the available credit has been depleted (with a warning given to the consumer to recharge the meter credits).[20]

For the water utilities, prepaid water systems are cost-effective solutions to sustainable water management. Aside from their ability to alert the utility of leaks and improved accuracy in consumption measurement, prepaid meters also improve revenue of the utility because of upfront payments for water.[21] The water utility or supplier can also operate efficiently without any confrontation with customers over unpaid bills since water consumption is always prepaid.[22] In

the case of GWCL therefore, water prepayment systems will mean; (i) no need to disconnect customers who do not pay, (ii) no need for meter reading and (iii) no need to send bills; thus a significant reduction in administrative and operational costs. The system also provides improved management information on water use and payment, which substantially reduces the problem of unaccounted for water in water supply processes. These enhances substantial cost recovery. Utilities that have implemented prepaid systems are seeing value from the ability to track usage and stop water flow once a limit has been reached.[23] Since most water prepaid meters are tamper-proof, the utility can curb theft and better manage service delivery in under-served areas.

Box 1: Why Prepaid Water Lags Behind Prepaid Electricity

Successful implementation of prepaid electricity in many African countries is spurring demand for prepaid water. Many customers have experienced the benefits of prepayment for electricity and mobile phones, and it would be logical if their water purchases are done the same way. But prepayment technologies for water lags far behind those for electricity. Three main issues explain this.

1. Prepaid water meters face physical stresses that do not apply to electricity. There are more moving parts, most subjected to fluctuating pressures and flows, wear, fatigue, and abrasion which increases the likelihood of malfunction. Grit, debris, and air affects prepaid water metering in ways that are not relevant to electricity. Any moisture can cause malfunctioning in the electronic circuitry. Plus, prepaid water meters need their own individual energy source, and finite battery life limits what they can do. Dealing with battery failure and battery replacement is a central part of managing prepaid meters.
2. The electricity sector is much less fragmented than the water sector, and has far greater clout to direct what manufacturers supply. For decades, manufacturers of prepaid electricity equipment that want to serve particular markets have had to conform to standards and specifications that allow utilities to mix and match components, without being locked into a particular proprietary hardware and software system. This has driven competition, with price and quality improvements. Conversely, proprietary systems still dominate the prepaid water market.
3. Prepaid water is often seen as controversial. Payment for the supply of electricity is accepted more widely than payment for water, and access to electricity is not regarded a basic human right. There are no substitutes, such as candles or charcoal, for households that run out of water and cannot buy more. Fear of controversy has deterred some big manufacturing role players from entering this market. Prepaid water systems are now catching up with developments in other sectors. Several suppliers of prepaid water systems now offer nonproprietary options, which permit mix-and-match and allow prepaid water and electricity utilities to share the same vending infrastructure, with big cost savings and benefits for customers.

Source: Heymans, C., Eales, K., and Franceys, R. (2014), The Limits and Possibilities of Prepaid Water in Urban Africa: Lessons from the Field

Experts in prepaid water metering have however recounted the increased cost of installing, operating, and maintaining prepaid meters compared to the conventional ones. For instance, they require the acquisition of additional components in installation, the need for secure housing with tamper protection and stringent requirements for the meter's electrical components.[24] Furthermore, personnel to install these meters require more skills to install, maintain and operate. It has also been noted that these meters require constant inspection and maintenance due to their sophisticated components which can fail and cause problems.[25] As a result, the meters have been said to be expensive to maintain and costly to consumers. In South Africa for example, although the municipal assemblies have been successful in targeting low-income households through water prepayment meters, affordability has been a problem for many.[26] A further disadvantage is that

consumers might be more inclined to tamper with or bypass the meter when their water is shut off, which may cause an increase in apparent losses.[27]

Although prepayment has its own associated problems, research has established that it is highly preferred by residents of informal settlements over the post-paid system.[28] Careful policy considerations should therefore be taken into account on how water prepayment systems should be deployed and implemented.

5.3 Types of Water Prepayment Metering Systems

There are four distinct classifications and applications of water prepayment systems. These are individual or residential prepaid meters; communal prepaid metering standpipes serving customers without their own connection; prepaid meters serving institutional or commercial customers; and the water management devices applicable to both individual and commercial customers. Prepaid water meters in these four categories are based on the Token and Standard Transfer Specification[1] (STS) models. The STS water prepaid meters run on globally accepted standard for prepayment and it is interoperable with different STS compliant vending platforms. Each category and application of prepaid water meter is discussed below.

5.3.1 The Prepaid Domestic/Residential Water Meters

Generally, with the domestic prepaid water meters, customers have their own prepaid meters, and load credit using a tag or smartcard. Each card can only be used on the specific meter for which it is programmed. Users top up credit on the card using a 20-digits token or code which is inputted into the meter. Once the credit is loaded into the meter's memory, customers do not have to use the card each time they draw water, until the credit is used up.

A multi-tier step tariff system monitors the monthly consumption of the consumer, and charges him or her using the appropriate tariff. A monthly consumption profile is generated, which is uploaded to the management system the next time the consumer purchases credit. Prepaid individual or domestic meters help manage the risk of customers consuming more water than they can afford, disconnection and debt, and relieves service providers of the risk of bad debt.[29] The typical domestic prepaid water meters are detailed below.

a. The STS Housing Prepayment Water Meter

This is a Standard Transfer Specification (STS) GPRS remote reading and prepaid water meter (See Figure 1). The meter works with a low power bi-stable latched valve driven by battery that is able to open and shut for 4 million times during battery lifetime. The water meter can transmit data via GPRS to the service provider or vendor. To top-up or recharge the water meter, a consumer must purchase 20 digits' credit token from a vendor and punch in the code using a customer user interface (CIU). The CIU is specifically offered to enter recharge tokens and short codes, and to check information such as low credit warning. Double inside strainers of the meter helps to filter

[1] Standard Transfer Specification is a secure message system for carrying information between a point-of-sale and a meter. It does not specify any physical characteristics of a prepayment meter. It was established in the 1990s in South Africa and is now the most popular prepayment standard in the World.

small particles such as drift, dust, and corrosion of pipe lines or rust to protect the core counter. The STS housing prepaid water meter also has a non-revenue water monitor feature, a tamper proof protection and its valve turns off once tampering is detected. The valve also turns off when credit drops to zero and has a back-flow prevention feature. This meter is currently widely used in South Africa.

b. Keypad Type STS Prepaid Water Meter

This is a standalone keypad prepaid water meter, with an electronic valve controlled water meter built on a 4x3 keypad (see Figure 2 for the keypad type prepaid water meter). The meter operates with STS standard compliant 20 digits' code to handle credit. Customers purchase credit at vending points to get a 20-digits code. They enter this code via keypad on the CIU of the meter to complete the recharge. Customers can check the meter's data, credit status, and historical usage dates from the LCD of the CIU. The meter works with a low power motor driven valve and shuts down for zero credit or when tampered with.

This prepaid meter type supports various payment mediums such as use of credit card, mobile money, and online banking. Alternatively, customers can send SMS or USSD on their cellphones, and a recharge token code is sent back after payment is done. The keypad type prepaid water meter also offers flexible setting for free basic water, emergency credit, low credit warning, has over 10 years' data retention in absence of power, and it is tamper and fraud proof. This type of meter is commonly used in households in Ethiopia and Kenya.

Figure 1: STS Housing Prepaid Water Meter

Source: CalinMeter Co. Ltd

Figure 2: Keypad Prepaid Water Meter

Source: Liaison Technology

c. Split Type STS Prepaid Water Meter

Currently adopted by residential consumers in Malawi and Botswana, this meter type consists of a smart water meter and a separate keypad defined as the CIU, as shown in Figure 3. The meter works with a low power motor driven ball valve of 4 million on/off life span. The overall meter is perfectly water tight and therefore applicable to humid and flooding environments. The meter works with a wireless keypad or CIU which communicates with the meter remotely to recharge and enable its other functions. This design allows the meter to be installed away from customer's

reach and only leave CIU indoors. This is typical of the split metering where meter is placed outside the house, while accompanying electronics are placed inside the house. Customers can toggle up meter's data, credit status, historical usage data by inputting short codes on the CIU.

This prepaid water meter supports mobile money, or any other third party payment systems. Customers do not need to visit a vendor. It operates by sending an SMS or USSD code on their phones with further instructions. The water credit unit token is automatically transferred to the customer's phone. It is also an ideal domestic water meter for tamper prevention with its tamper proof detector. Other key features include a wireless communication range between the meter and CIU, low credit alarm, emergency credit, a non-revenue water monitor, and a back-flow stoppable valve.

Figure 3: Example of a Split Prepaid Water Meter

Source: TagMeter

Figure 4: The Multi-jet STS Prepaid Meter

Source: Calin Meter

d. Multi-jet STS Keypad Prepaid Water Meter

This STS based prepaid water meter is currently the most common in Africa. It complies strictly with the STS encryption rules and also based on the token system including a recharge unit, meter ID, and inputting of a 20-digits token code. An anti-tamper feature triggers its protection mode and automatic shut-off when there is damage, magnetic contact or battery removal on the meter. As such, only authorized field technicians are recommended to restore any tampered meter. The meter also comes with a third payment integration. That is, as the meter is working with token code instead of card or any physical media, the vending process can be wirelessly encrypted and integrated with local mobile payment or any other third party payment systems. This greatly increases revenue collection and cash flow management. Figure 4 shows the multi-jet type of STS prepaid meter.

e. LCD Display STS Compliant Split Prepaid Water Meter

This is an STS compliant prepaid water meter equipped with a motor driven ball valve that shuts off water when the credit runs out. The meter works with a CIU through radio communication. Similar to the Split Keypad Type, the CIU is installed indoor away from the meter. This split design makes the meter immune to any tamper and fraud.

Consumers buy 20 digits' credit token from a vendor and input it into the CIU to top up credit to the meter. Information like token acceptance and rejection, credit status, historical usage data can be displayed on the LCD of the CIU. The meter's attribute is reinforced with its wireless communication, allowing the meter to communicate with CIU or a head-end server from a visual distance up to 1 mile. It also has over 10-years data retention in absence of power, with reduced operational and inventory cost. This type of water prepaid meter is currently deployed in Angola.

f. The Smart RFID Card Prepaid Water Meter

This is an STS compliant, RFID Card type electronic valve controlled prepayment water meter. It is an ideal domestic water meter for revenue collection and consumer management, and has proven to be reliable and cost-effective.

Figure 5: Smart RF Card Prepaid

Source: Global Sources

Its main features include a serial port or USB port card reader, a real time clock, and a pre-programmable low credit warning. Other features include a rechargeable smart RFID card, a flexible tariff and debt collection setting, as well as a non-return valve preventing back-flow.

g. Wireless Remote Control STS Prepaid Water Meter

As the name suggests, this type of prepaid meter operates with a user interface unit and wireless communication with the meter for up to 300 meters. Thus installation becomes easy and wireless with no extra cost. Customers can check the meter's data, credit, and records with the user interface unit in home use. The meter comes with a hydraulically operating ball valve built in the water meter and driven by low power usage motor. The valve shuts off when credit is exhausted and restores after top-up of credit. This meter owns rigorous anti-tamper function. That is the valve automatically goes off when there is magnetic scrambling, damage or battery loss. The water meters are also installed centrally in a meter box, which can also prevent the meter from being stolen or tampered with. Furthermore, it has a built-in strainer which prevents water with grit particle, while its non-return valve avoids the backflow of water.

Similar to the other prepaid meters discussed, users can recharge this water meter by inputting a 20-digits token code acquired from a vendor. Consumers can enter a short code to check the total

water consumption. The recharge tokens can be bought from a vendor or through mobile money. The battery, which is replaceable, has a maximum lifespan of 6 years. Its vending software can also integrate with a mobile payment platform. This type of water prepaid meter is common in Mozambique and Congo.

5.3.2 Communal Prepaid Water Metering Model

In this model, water meters are activated using tokens that are bought from the water service provider. The tokens are uploaded with credit at designated pay-points or vendors and water users can draw water up to the amount credited in the token.[30] An example of a communal prepaid meter is a prepaid standpipe. Typically, 20 to 50 households share a standpipe and they all have their own credit tag, key, or smartcard that they press against a sensor on the dispenser each time they draw water.[31] For this type of prepaid meters, there are no slots to insert a card. Because several consumers use the same standpipe, the electronics are programmed such that they can accept several credit or user tags.[32] A multi-tier tariff system monitors the monthly consumption of the consumer and charges him using the appropriate tariff. The common types of prepaid standpipes are shown in Figure 6.

A monthly consumption profile is generated for consumers, which is also uploaded to the management system the next time the consumer purchases credit, aiding consumer water management. An LCD display on the meter boxes also provide the consumer with additional useful information such as credit remaining, amount of water dispensed, tariff level and rate, plus alarms such as low battery.

Prepaid standpipes have the greatest potential to support more equitable access for people without their own connection.[33] They enable service providers to sell water directly to customers with their own prepayment tokens, without intermediaries adding a mark-up or capturing the benefit for themselves. Empirical evidence has established that prepaid meters on communal standpipes are relatively cheaper than conventional standpipes, as they require no tap attendant and can easily be relocated to provide services elsewhere.[34]

Figure 6: Types of Prepaid Standpipes

Source: TagMeter[35]

With prepaid standpipes, service providers incur the cost of collecting payment, and recover it across their wider customer base. Prepaid standpipes allow customers to get water whenever it suits them, outside the limits set by landlords and well beyond the hours when vendors and tap attendants work. This is a major advancement for people who leave home early or return late. The credit tokens are also programmed to be usable at any prepaid standpipe, at any time of night or day.

This metering system is however relatively costly when compared to domestic connections as it is mostly patronized by lower-income households who queue, carry the water, and rarely benefit from any lifeline tariff system.[36] Communal prepaid standpipes are widely used in South Africa, Kenya, Namibia, and Uganda.

5.3.3 Prepaid Bulk Meters for Commercial and Institutional Customers

The large volumes of water sold to commercial and institutional customers comprise a significant source of revenue for water service providers. These bulk prepayment meters are designed for far higher volumes than domestic meters and far greater accuracy, given the volumes. The most common bulk prepaid water meters are the STS Bulk Prepaid Meter and the Woltmann Prepaid Bulk Water Meter. These meters are developed on the basis of volume calculation, billing functions, and generally with no direct contact with water to ensure clear reading and easy maintenance.

They have real-time clock, real-time volume calculation and monthly billing data. The STS type for instance is designed with a friendly period management function to calculate water used during holidays and off-duty periods. Similar to the other prepaid water meters discussed, a 20-digit token is acquired after purchasing water to recharge the meter using the customer card. A representative of the institution loads credit using a tag, smartcard, or keypad.

Figure 7: STS Bulk Prepaid Meter

Figure 8: Woltmann Prepaid Bulk Water Meter

Source: Laison Tech

The meters have an alarm buzzer which beeps and closes the valve once to remind customers that the water is about to be used up. Valve can be switched on for continuous use of water until the credit balance runs out. Whenever the credit runs out, and an overdraft function is activated, customers can use their cards to open up the valve for continuous use of water until the overdraft consumed credit runs out. The meters can record all the events that happened during the lifetime of the water meter. They store monthly consumption data and a maximum of 10 years' monthly consumption data can be recorded and requested. Their valves close automatically when magnetic interference happens.

Prepaid meters on institutional customers consuming large volumes of water help manage demand and debt risk. The combination of high-volume consumption, low transaction costs relative to purchases, and cost-reflective tariffs facilitate improved revenue flows, which can be used to support cross-subsidization to poor customers.[37] This makes prepayment by commercial and institutional customers an attractive option for service providers.

5.3.4 The Water Management Device (WMD)

Water Management Devices (WMD) are programmed to provide a daily allocation of water for both domestic and institutional consumers. They provide accurate data on water flow and water consumption levels, and can be programmed to control water use at both the household and institutional level. WMD's enable two-way communication, configuration, as well as the option for STS-approved prepaid water supply. This smart meter is then able to provide free basic water, automated meter reading (AMR), emergency and lifeline water, leak and tamper detection. Water management devices are widely distributed in South Africa as a way to regulate water consumption in low-income and poor households who do not have the means to meet their actual needs.[38] The system gives water access to poor families while, at the same time, tackling the problem of unpaid bills that put water providers in difficulty. Figure 9 shows an example of the WMD meter.

Figure 9: Water Management Device

The WMD meter switches on at a fixed time each morning. It has been noted to be cost effective and generally restricts a household or institution's water to 350 litres a day.[39] The meter can however be configured to dispense between 10,000 – 50,000 litres of water, at two scheduled times daily. It switches off when the consumer has used its daily water quota. It resets the next morning to release the daily amount. A consumer will not be able to use more water than their daily limit in one day. However, extra litres of water can be purchased with prepayment when the daily quota is met.[40] The suspension of water will then be deactivated until the prepaid litres have been consumed. If consumers use less than their quota in a day, the amount not used will be carried over to the next day. In terms of lifeline water, the meter allows consumers a free basic monthly allowance of 6,000 litres of water before shutting off automatically.[41]

With WMD, consumers can budget their daily or monthly consumption through prepayment and/or a capped daily and/or monthly allowance. Consumers therefore, cannot over use or over spend if they are on flow limitations or prepaid options. It is also useful for water suppliers who wish to reduce overall water consumption due to lack of water supply or increased demand.[42] WMD can also be linked to a fixed (flat rate) tariff to provide consumers with the option to voluntarily limit consumption according to their budget. WMDs enable meter readings by radio signal or the global system for mobile communications (GSM) to a drive-by or walk-by collector, or through a fixed network.

Box 2: Factors to consider when selecting a prepayment water metering system

a. Application of the meter and need for metering
b. Acceptance by political representation and the beneficiary community or users
c. Robustness, performance and reliability
d. Functionality, especially around tariff structures and the dispensing of free basic water
e. Approvals provided by standards setting bodies
f. Cost
g. Expected service life of the meters
h. Experience in similar areas or countries
i. Managerial and technical capacity to operate and maintain the system once installed

Source: Van Zyl JE (2011), Introduction to Integrated Water Meter Management 1st Ed. Water Research Commission, Johannesburg, South Africa

6. Recommendations and Conclusions

The introduction of prepayment technologies has been proposed as a path to cost recovery that would simultaneously reduce non-payment and indebtedness to water utilities. Prepaid water meters have been identified by water experts and scholars as the innovation in prepayment technologies that will meet that end. This study therefore discussed prepaid water metering systems which holds the potential to improve quality of water service delivery and enhance the financial performance of water service providers.

The success and acceptance of prepaid water meters will however be a function of how well the system is managed after installation. It is therefore important that a prepaid metering system is managed well because technological systems demand attention. This will require dedicated technical staff to ensure the system and meters operate efficiently. More significantly, prepayment systems go beyond technology and metering because of the limited face-to-face contact between service providers and consumers. Therefore, a dedicated customer service team is also needed to understand the new technology and ensure constant communication, advice, support and follow-ups that will address customer concerns. Failure to adhere to strict operational efficiency and management of the system, with sound customer relations could erode the ideals and objectives sought in the implementation of any water prepaid metering project.

The distinct categories and applications of water prepayment meters to different users raises some interesting inferences. For instance, in low-income areas or communities where water is supplied via communal standpipes, installing a prepaid water meter to the standpipe may be an attractive option which can significantly reduce wastage despite the teeming number of users consuming the service at a time. It would also allow for accessibility at any point in time without the services of a vendor who will open and close the services at specific times. Another advantage is that, it would reduce pilfering and corrupt behaviors at the standpipe joints, given that physical contact with money would be effectively cut out of the chain. For middle to high-income areas or residents, there is the likelihood of a reduction in revenues from these consumer section as a result of continuous monitoring of their consumption patterns and habits leading to more conservative use. In this regard therefore, careful consideration must be given to such areas in terms of realigning the system especially in areas where either a flat rate system or conventional metering system is in place. However, for security purposes and the inaccessible nature of some residential facilities especially in gated communities in Ghana, it would be ideal to install smart prepaid meters, which would enable GWCL pick readings of a customer's consumption outside his or her property with or without the customer's availability.

The Standard Transfer Specifications (STS) mentioned in the findings of this report indicates the need for water prepaid services to follow global acceptable standards. Therefore, PURC must carefully consider and specify standards relevant to local socio-economic conditions (in the event GWCL re-pilots water prepaid meters). Such regulatory guidance in the promotion of STS compliance in prepaid systems should also enable accessible and customer-friendly vending options. The economic regulator of the sector should also advice and direct GWCL's priorities, by weighing the tradeoffs between prepayments, post-paid, and any immediate challenges in terms of quality of water service delivery. This must be done in consultation with GWCL.

Regardless of the type of prepaid water meter to deploy, a backlash from the public is anticipated when the system is perceived by potential consumers as being forced on them – as happened in the first two pilot attempts in Ghana. It is therefore recommended that before any future projects in this regard are undertaken, there must be consistent public awareness programs, which are geared towards educating the public on the benefits of such meters. This should be done so as to reduce any anticipated resistance and to get the buy–in of consumers and other stakeholders before installing such prepaid meters. It is recommended that such pre-paid water meters should initially be installed on demand from individual consumers or institutions, while steps are concurrently taken to make the system more appealing to other consumers. Additionally, different communication platforms and sufficient space should be made available for consumers to contribute towards the deployment strategy. In this way, consumers' readiness for such meters can be increased and similarly allow for better and swift adaptation to a change in their water demand.

At the policy level, deploying different types of prepaid water meters requires insight into cost-savings and the socio-economic impacts of such technologies to be employed as part of urban water provision strategy. This must be done in consultation with key stakeholders within the sector to determine the best possible way forward in deploying such meters. This will thus require further research into best practices and effects of the installation of such meters on cost-saving measures for both consumers and the utility.

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