

**PUBLIC UTILITIES
REGULATORY COMMISSION**



REGULATORY BRIEF

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Prepayment Metering
Systems in Water Service
Delivery: Deductions for
Ghana

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Summary of a study conducted by
PURC on Prepayment Metering
Systems in Water Service Delivery

HIGHLIGHTS OF KEY FINDINGS

- **Prepaid water metering systems can be classified into four: residential/domestic prepaid meters; communal prepaid metering standpipes, institutional/commercial prepaid meters; and water management devices.**
- **To operate prepaid water metering systems successfully, there should be an effective vending system that allows customers to buy credit conveniently and easily recharge; and service providers should have the ability to respond rapidly when faults affect the supply of water to customers.**
- **The cost of installing, operating, and maintaining prepaid meters is high compared to conventional meters.**
- **For consumers, although acquisition of prepaid meters is costly, they offer convenience, visibility of real-time consumption to ensure efficient use of water, financial control, and early detection of leakages.**
- **For water utilities, prepaid meter systems are cost-effective solutions to sustainable water management, as they reduce operational costs, improves efficiency and accuracy in consumption measurement and revenue generation.**

Introduction

Ghana Water Company Limited (GWCL) has implemented interventions to ensure adequate and technologically advanced water systems, which will assist the company to meet the growing demand for water supply in urban and peri-urban areas of Ghana. To increase the effectiveness of water delivery services, these interventions mainly involve capacity expansion and system loss reduction initiatives.

However, in spite of the ongoing interventions, GWCL encounters challenges in providing affordable and safe drinking water to the rapidly expanding urban population. Principal among these challenges are water losses, rising cost of water service delivery and the issue of cost recovery. Experts have proposed the introduction of prepayment technologies as a means to recover costs. These experts indicate that prepayment technologies help monitor and minimise water losses, ensure reliable and effective billing, optimise revenue collection and reduce indebtedness.

This regulatory brief is synthesized from the 2019 PURC paper titled 'Prepayment Metering Systems in Water Service Delivery: Deductions for Ghana,' which reviews the literature on water prepaid metering systems primarily to identify and establish a good understanding of the various types of water prepayment metering systems available. Specifically, the paper discusses what prepaid water metering entails; ascertains what unconventional types of prepaid water meters there are; and outlines the implications of these meters to consumers and utilities, considering the costs and benefits.

Following a failed attempt by GWCL to introduce a prepaid metering system in supplying water to its customers in 2014 and 2015, the motivation of the paper is to inform PURC and GWCL on the suitability, reintroduction, and management of prepaid metering system for water service delivery in Ghana. It provides the regulator with a good understanding of the cost involved for both GWCL and consumers and the implication for fair pricing in tariff decisions. Likewise, it informs GWCL of the different options of

prepaid metering systems to consider in its investment decisions should the company decide to reintroduce the prepaid metering system. Other stakeholders such as Non-Governmental Organisations (NGOs) in water and sanitation activities may also find the research work useful for their developmental programs. Key findings of the study are presented in the next section.

Key Findings

Types of Water Prepayment Metering Systems

Prepaid metering systems in water service delivery can be classified into four: residential/domestic prepaid meters; communal prepaid metering standpipes; institutional/commercial prepaid meters; and water management devices. Among these, there are token and Standard Transfer Specification (STS) models. The STS water prepaid meters run on a globally accepted standard for prepayment and is interoperable with different STS compliant vending platforms. Consumers are given a unique tag or smartcard to purchase credit issued in the form of STS 20-digits code and loaded on the meter's memory. This is a common feature for all types of prepaid meters in water service delivery. The meters have a valve, which automatically opens and shuts to control the flow of water based on the availability of credit or tamper detection. The meter shuts off when credit drops to zero or when it has been tampered with.

The Prepaid Domestic/Residential Water Meters

The residential meters have a multi-tier step tariff system which monitors the monthly consumption and charges using the appropriate tariff. A monthly consumption profile is generated and uploaded to the management system when a consumer purchases credit. The valve for some of the residential meters can open and shut 4 million times during the lifetime of the battery with which the meter operates. There are double inside strainers to filter small particles and protect the core counter. Seven types of prepaid residential water meters are

identified. They are the STS Housing Prepaid Water Meter, Keypad Type STS Prepaid Water Meter, Split Type STS Prepaid Water Meter, Multi-jet STS Keypad Prepaid Water Meter, LCD Display STS Compliant Split Prepaid Water Meter, Smart RFID Card Prepaid Water Meter and the Wireless Remote Control STS Prepaid Water Meter. They differ based on the availability or nature or location of some functional features. These features include keypad, tamper prevention, Consumer Interface Unit (CIU), different payment systems, wireless or GPRS communication between the meter, CIU, vendor and service provider as well as provisions for free basic water, lifeline water, and emergency water, non-revenue water (NRW) monitor and data retention. Based on the type, credit purchases can be made with cash, bank card or mobile money at vending points, through mobile (app or USSD) or online to obtain a standard compliant STS 20-digits code. The code is entered via keypad or the CIU of the meter to complete the recharge. Customers are able to check their meter data, credit status, consumption and historical use on the CIU, which makes it possible for users to monitor and manage their consumption and exercise financial control.

Communal Prepaid Water Metering Model

A typical example of a communal prepaid meter is the prepaid standpipe shared by 20 to 50 households. The meter is set on a standpipe. It comes with a sensor and each household is given a unique smart card which is used to purchase credit and also touch the sensor to dispense water. As in the case of residential meters, the monthly consumption of a consumer is monitored by a multi-tier tariff system which applies the appropriate tariff to charge the consumer. The meter box has an LCD display to provide consumers with information on credit balance, amount of water dispensed, tariff level, and rate. It also has an alarm to alert a low battery status. Compared to others, prepaid standpipes have the greatest potential to support more equitable access to water for people without direct water connections in their homes. They enable service providers to sell water directly to consumers without intermediaries and price mark-ups. For this reason, it has

been empirically established that prepaid standpipes are relatively cheaper for consumers than conventional standpipes. Furthermore, because there are no sales attendants at the pipe stands to regulate access, prepaid standpipes are conveniently accessible at any time. The credit tokens are also programmed to be usable at any prepaid standpipe anywhere in the community and at any time. This gives flexibility to consumers. However, unlike the case of residential prepaid meters, consumers do not benefit from the lifeline tariff system and also have to queue and carry water over distances. This makes communal prepaid standpipes more costly, compared to residential prepared meters.

Prepaid Bulk Meters for Commercial/ Institutional Customers

Bulk prepayment meters are designed to sell large volumes of water with greater accuracy to commercial and institutional consumers. The most common bulk prepaid water meters are the STS Bulk Prepaid Meter and the Woltmann Prepaid Bulk Water Meter. They are developed based on volume calculation and billing functions, and generally with no direct contact with water to ensure clear reading and easy maintenance. They have a real-time clock, real-time volume calculation, and monthly billing data. The meters can record all events that happen during their lifetime. A maximum of 10 years' monthly consumption data can be recorded and requested. The STS type has a friendly period management function to calculate water used during holidays and off-duty periods. Bulk prepaid meters, like other types of prepaid meters, are recharged with a 20-digit token after purchasing a credit using tag or smartcard. The meter comes with an alarm to alert users when credit is near exhaustion. When the credit runs out, an overdraft function is activated; customers can decide to recharge the credit immediately or continue to consume the water and recharge when the overdraft runs out. To prevent tampering, the bulk prepaid meters also have anti-tamper magnetic field protection which automatically closes the valve to stop the flow of water when there is interference.

The Water Management Device (WMD)

Water Management Devices (WMD) are devices programmed to allocate water daily to domestic and institutional consumers. They provide accurate data on water flow and consumption levels. They enable two-way communication, configuration as well as the option for STS-approved prepaid water supply. They enable the delivery of free basic water, Automated Meter Reading (AMR), emergency and lifeline water, and leak and tamper detection. Meter readings are by radio signal or the global system for mobile communications (GSM) to a drive-by or walk-by collector, or through a fixed network. A WMD switches on at a fixed time each morning and generally restricts a household or institution to a set amount of daily water allocation. It switches off when the daily water quota is used up and resets the next morning. The device can however be configured to dispense water at two scheduled times daily. It can also dispense between 10 to 50,000 litres of water. Customer can request for a higher allocation other than the nationally agreed allocation. Consumers cannot use water more than their daily limit in a day unless a prepayment is used to purchase extra litres of water when the daily quota is used up. In this case, the daily quota will be suspended until the extra litres have been consumed. If a consumer uses less water than the daily allocated amount, the remaining amount will be carried forward to the next day. WMD allows consumers a free basic monthly allowance of water before shutting off automatically. The system gives water access to poor families and at the same time tackle the problem of unpaid bills. It has been noted to be cost-effective. Uniquely, it can be effectively used to control water supply and demand. With WMD, consumers can budget their daily or monthly consumption through prepayment and capped daily and/or monthly allowance. Consumers can also be linked to a fixed (flat rate) tariff to provide them with the option to voluntarily limit consumption according to their budget. WMDs are widely used in South Africa to regulate water consumption in low-income and poor households.

Successful Operation of Prepaid Water Metering System

To operate prepaid water meter systems successfully, first, there should be an effective vending system that allows customers to buy credit conveniently and easily recharge. Secondly, service providers should have the ability to respond rapidly when faults affect the supply of water to customers. The customer needs no frustration. Convenience

drives acceptance and determines demand. It is one of the advantages of a prepaid metering system that conventional meters do not have. The easier it is to purchase and recharge credit at home or nearby payment points, without wasting time and resources, the more convenient it is. The ability to purchase credit through mobile, online and vendors with mobile money, bank card or cash provide convenience to customers. Frustration and dissatisfaction are created among consumers if they cannot successfully load the credit purchased.

FACTORS TO CONSIDER WHEN SELECTING A PREPAID 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

Implications of Prepaid Water Meters for Consumers and Utilities

The Cost of Installation, operation, and maintenance

The cost of installing, operating, and maintaining prepaid meters is high compared to conventional meters. For instance, installation requires acquisition of additional items such as secure housing

with tamper protection, which increases the cost of installation. In contrast to electricity prepaid meters, standardisation in water prepaid meters is less and therefore make the cost of water prepaid meters higher. Standardization in technology enables a mix of meter components from different vendors without being locked to a particular technology. It reduces the cost of technology adoption. Although standardisation in water prepaid metering systems has improved over the years, it is still lagging. As a result, the electrical components of the prepaid

meters have stringent requirements which makes them more costly. Apart from standardisation, the high level of technology involved require a high skill level for installation, maintenance, and operation. Personnel training is required, increasing the cost. Also, contrary to electricity prepaid meters, water prepaid meters are exposed to physical stress through the pressure of flow and harm from grit which causes, fatigue, wear, abrasion, and malfunction. Routine inspection and maintenance are needed for fault prevention. Thus, water prepaid meters are expensive for utilities to roll out and costly for consumers to acquire.

Benefits, Consumer Perspective

On the side of consumers, although it costs more to acquire prepaid meters compared to conventional meters, the benefits of using prepaid meters outweigh that of conventional meters. Prepaid meters offer convenience, visibility of real-time consumption, financial control, and early detection of leakages. Users can recharge their credit at the comfort of their homes regardless of time. They can purchase credit for longer or shorter intervals, looking at their income stream. Because consumers can directly monitor their water consumption and cost on an app or CIU in real time, it makes it possible for them to economically manage the usage of water to meet their budget. The flexible nature of payment and consumption management on a prepaid metering system gives low-income earners additional room for greater financial control in ways suitable to their economic circumstances. Without the ability to pay monthly bills as done on post-paid metering system or load one-time credit to cover a month or more on a prepaid metering system, low-income earners can make smaller but frequent credit purchases. This helps to prevent debt accumulation and disconnection in the usage of water, a phenomenon associated with post-paid meters. Moreover, the ability to programme prepaid meters to automatically dispense the free basic allowance of water, lifeline water, or emergency water before purchasing credit is beneficial to poor households. It is therefore not surprising that residents of informal settlement, as one research have

revealed, highly prefer prepaid meters over post-paid meters.

Benefits, Perspective of Utility Companies

For water utilities, prepaid meters systems are cost-effective solutions to sustainable water management. It reduces operational costs and improves efficiency. The metering system has advanced management information on water use and payment and alert of leakages to help curb water losses in the supply processes. It improves accuracy in consumption measurement and revenue generation. Revenue generation also improves due to upfront payment by consumers. Utility companies no longer have to employ labour and spend to read meters, print and distribute bills, disconnect defaulting customers and recover revenue from debtors, reducing administrative costs. Security concerns of employees which occur through confrontations with customers during meter reading, disconnection, and debt recovery outings are done with. The prepaid meters are tamper-proof to help curb theft. It effectively reduces administrative and operational costs.

Policy Implications

The following are policy lessons from the study. First, it is worthy to note that the acceptance and success of prepaid water metering depend on how well the system is managed after implementation. It goes beyond the simple installation of new technology. Thus, before reintroduction, GWCL should be well prepared to effectively manage the system, considering customer service, routine meter inspection, and maintenance of the meters and pipes. Well-trained and motivated technical staff are required to ensure that the meters are fault free, leaks are detected and resolved and the system operates efficiently. Similarly, well-trained and dedicated customer services are required at call centres and local offices to ensure continuous contact, advice, support, and follow-ups in addressing customer concerns about credit purchases and loading, payment system challenges and

refund, billing, and reported faults. Phone and appropriate social media platforms when used should be able to deliver a prompt solution to customers at their convenience. Failure to ensure efficiency in operation and management with sound customer relations could erode desired consumer benefits such as convenience and financial control and make the system ineffective in achieving the desired outcome.

Also, water prepayment systems have unique features which government and GWCL can capitalise on to successfully introduce water prepayment systems without denying poor households access to water. The provision of free basic or lifeline water enabled through the multi-tier tariff system of the prepaid meters ensure that poor households who cannot afford to purchase water at the regular tariff rates can still have access to free or lifeline water. The provision of emergency water ensures that households are not immediately denied access to water when they are out of credit; they will still have access to water while they prepare to recharge their credit. While some CSOs oppose the introduction of a water prepayment system in Ghana on grounds of human rights on access to water, the technological provisions in the water prepayment system deflate their arguments. The poor can still have access to water under the water prepayment system. The right number of litres of water can be designated as free or subsidised to meet the daily needs of every poor household.

Additionally, GWCL must recover its cost to operate sustainably. As a result, the provision for free basic water or subsidised lifeline water should be understood as a welfare system, the cost of which must be borne by the government. In this case, the government will be required to make budgetary transfers to GWCL to cover the cost of free basic water and subsidised lifeline water. Alternatively, a progressive tariff can be built into a multi-tariff structure to make provision for cross-subsidisation and ensure that the total cost of water delivery is fully recovered from the tariffs. In this scenario, free basic water and subsidies on lifeline water will be recovered from the tariffs of customers who consume more water. It must be noted that the

prepayment technology cannot compensate for a defective tariff structure that fails to fully recover the cost. While technology gives room to design policy and regulatory frameworks to meet the needs of consumers, PURC will be required to implement the right tariffs to realise the objective of cost recovery if the water prepayment system is introduced.

Though a rollout of a water prepaid metering system is beneficial to the needs of both utilities and consumers, we learned that the cost of installing, operating, and maintaining water prepaid meters is high compared to the conventional one. Affordability and cost-effectiveness for utilities and consumers could be in doubt. To allay the fears of the consumers, GWCL can appraise the investment, juxtaposing cost to revenue, relate the outcome to alternatives, and share the results with the general public. PURC can conduct simulations on tariffs to predict the most likely outcome of tariffs that takes free water beneficiaries and lifeline customers into consideration to show the financial viability of a prepaid metering system.

The evidence of high demand for prepaid meters among residents of poor communities favours the introduction of prepaid meters. However, for reasons of context specificity and hindsight from the first prepaid introduction attempt, this evidence should not be generalised to Ghana. It will be good for specific studies to be conducted to know the level of demand for water prepaid meters among poor households in Ghana. If supportive evidence is found, the study will reveal the appropriate strategy to implement the water prepaid metering system in Ghana – whether to implement the metering system based on demand, user group, a total rollout, or other. Evidence of high demand in poor communities or among poor households will specifically indicate that the prepaid system can be implemented on-demand basis. It may also suggest that the intervention can be rolled out with little or no hindrance from the public.

Regardless of the evidence of high demand for prepaid meters among residents of poor communities and the availability of

technological mechanisms to implement a prepaid metering system without denying the poor access to water, GWCL is still required to effectively engage stakeholders. Every medium must be used to communicate the problems of the current system as well as the costs and benefits of the prepayment system. Engaging the various classes of people in our social structure equally will reveal the various concerns, which when addressed will ensure support for the intervention. A transparent process should be encouraged upfront. Efforts must be made to listen to and address the concerns of other stakeholders like government and CSOs, recognising that they are sponsored entities with active force. Price signals coming from full cost recovery and subsidies influence the popularity of a ruling government. GWCL should also recognise the political economy situation involved and ensure appropriate engagement. That said, there past GWCL lessons on water prepayment systems to learn from. There is also the opportunity to learn from the experience of the Electricity Company of Ghana on the introduction of prepaid metering systems, looking at the challenges, cost, benefits, and standardisation issues involved.

Furthermore, the distinct categorisation and application of water prepayment meters are suitable for the Ghanaian context. Residential homes with GWCL water connections can be provided with residential prepaid meters. Beneficiaries will be able to monitor their consumption patterns, control water use, and spend economically on water. For households who do not have direct GWCL water connection and instead depend on water from communal standpipes, prepaid meters can be installed on community standpipes. This will remove intermediaries (sale persons attending to community pipes), remove price markups and make water more affordable, reduce wastage of water at the dispensing point, and also stops revenue losses that occur because of poor accountability. For high-volume consumers, rolling out a commercial prepaid metering system for them will promote the efficiency of GWCL.

It will minimise water theft and leakages and prevent debt. It will also encourage productivity among commercial customers since they will no longer queue to pay bills and follow up on bills and disconnections. For communities with problems of frequent water shortage, WMDs can be applied to effectively ration water to both households and institutional users. Moreover, the security and accessibility problems associated with post-paid meters, occurring through meter reading, bill distribution, disconnection, and debt recovery can be mitigated with a prepaid metering system since the latter does not require field personnel to perform the said functions.

PURC will have to establish some priorities for GWCL specifically on standardisation and payment systems if the intervention is to be implemented. Standardisation reduces cost and promotes advanced technology in prepaid water metering systems. STS compliance should be established to enable accessible and customer-friendly vending options. There is also the need to prioritise models that can link up payment systems (mobile payments or vendors) directly with meters aside the use of tokens. Token usage makes payment cumbersome.

Finally, although a major benefit of a prepaid metering system is derived from the ability of the consumer to monitor their consumption patterns, control water uses, and spend economically on water, this actually depends on behavioural change - how well consumers are able to control their behaviour towards the use of water. In a critical time when all look to prevent water scarcity, the consciousness of personal financial management can lead to sustainable water management. Nevertheless, not every individual is able to control his or her behaviour and change his or her consumption pattern. Awareness creation is still needed to help develop a positive attitude toward the use of water. Education is needed to encourage the use of water-efficient appliances, such as dual flush toilets, water-efficient washing machines, and to reduce the level of water consumption and expenditures.

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