Report

The Limits and Possibilities of Prepaid Water in Urban Africa: Lessons from the Field

Chris Heymans, Kathy Eales and Richard Franceys

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Foreword

On average, cities and towns in Africa are growing at 5 percent per annum—faster than anywhere else in the world. Water service providers face considerable challenges to meet this growing demand, and most lack the resources to do so. The current revenue flows of most also fall far short of requirements to fund investments and run services effectively for these rapidly growing populations.

Meeting the demand, especially in the rapidly expanding unserved poor settlements, requires new thinking and innovation. This is one reason why there has been a surge in interest among sub-Saharan African water service providers in prepaid water systems. Their track record so far has been mixed. Some have not been unable to sustain these systems, but others are delivering results that are sufficiently promising to mitigate potential risks.

Prepaid water remains controversial, however. Proponents see it as a way to improve customer relations, revenue, and access to services; critics complain about technical unreliability, high capital and maintenance costs, and a system they see as penalizing poor customers.

Through this evidence-based study, the Water and Sanitation Program hopes to contribute to the ongoing dialogue in several ways. The present work aims to transcend the existing literature, going beyond technical and technological issues as well as the philosophical issues on the implications of prepaid systems for the right to water. It presents a systematic body of research on the opportunities, limits, costs, and benefits of different experiences of prepaid systems and their equity implications. Moreover, it provides a refreshing emphasis on what customers actually think (especially poor customers).

By offering a tour of real-life cases in eight very different African cities: Kampala, Lusaka, Maputo, Maseru, Mogale City, Nakuru, Nairobi, and Windhoek, this analysis aims to convey that far more is involved than prepaid meters. Service providers need to consider the broader system, from technical challenges such as replacement of parts to the commercial aspects of making payment tokens and vendors accessible to consumers. They have to take on integration of revenue management systems, data systems, and IT, and dramatically improve communication and strengthen accountability to customers *who have already paid* for the service.

The report aims to be both frank and objective in its message that prepaid systems do not offer a miracle cure and that unless utilities do careful assessments and get effective management systems in place, they may well find themselves swapping one set of problems for another. Because the technology is relatively expensive, it does not absolve service providers from sound financial choices and management, such as charging economic tariffs, or policymakers from thinking seriously about how to finance subsidies for the poor. It demands robust regulation beyond the current tendency of regulators to treat it as something experimental and marginal.

Perhaps most powerful of all is the message that prepaid water is ultimately a technology: it is not intrinsically pro- or anti-poor, and it is not a substitute for sound management.

Glenn Pearce-Oroz
Principal Regional Team Leader for Africa
Water and Sanitation Program, The World Bank Group

Executive Summary

Background

This study explores the potential of prepaid meters for serving urban poor communities. It provides urban utilities, oversight agencies, and other stakeholders in Africa with a basis for decision-making on the suitability, introduction, and management of such meters. The need for the assessment emerged from prepaid meters increasingly being utilized by water and sanitation utilities in developing countries, including World Bank clients. The technologies adopted have expanded over this period, but there has been a lack of consolidated data and analysis that capture the service delivery, operational efficiency, and access to services aspects of such systems across utilities and regions systematically.

The review initially aimed to research experiences in six African countries from the perspective of their communities, as well as from water sector bodies, governments, and other investors. The number of case studies was increased to eight with the addition of Windhoek in Namibia and Nakuru in Kenya, as it became apparent that they may offer additional lessons. Windhoek, for example, is one of the prepaid water pioneers in Africa. The study specifically canvased the perspectives of customers, including market research and opinion surveys on people's experience and views of prepaid water in practice. Women and children were well represented in many of these groups.

The analysis aimed to be robustly investigative, deliberately not advocating for prepaid systems in principle, or making firm recommendations, but rather offering balanced analysis and assessment, and considerations to inform policymakers and sector leaders, as well as other stakeholders who may face decisions or challenges on such systems. One of the key conceptual bases that the analysis identified was the need to differentiate between prepaid applications of prepaid system—for standpipes, individual connections, and institutional and commercial customers—each of which have different implications for their users, as well as for cost effectiveness. Utilities must be able to justify the investment in a prepayment system and its opportunity costs specific to the application they choose, and relative to alternative means of improving services.

Key Messages

Prepaid water systems are not a technical magical wand to fix underlying management issues in the delivery of urban water supply. A service provider that falls short on effective management, governance, and sound customer relations is likely to take on far more than it can deal with by resorting to prepaid systems.

The notion of prepayment metering obscures the complementary components of an integrated prepayment system:

- Technically, the system comprises metering, dispensing, and credit-loading components.
- Credit vending is central and requires functional and accessible purchase points that are close to where the customers are, easy to use at flexible hours, and reliable.
- Operationally, the system needs close monitoring and rapid response capability to identify and resolve problems quickly. Regular meter reading is essential to tracking real-time consumption against prepaid sales and flag exceptions, with a database recording meter performance and customer sales and consumption.
- A strong customer focus is essential, driven by a service team geared to respect and respond to customers' service needs, and to act swiftly to remedy faults that affect the supply of water customers have already paid for.

Prepayment can benefit customers, and most seem to like this option. Customers are not primarily interested in the technology. They are looking for good services, reliably delivered at affordable prices. Many customers say they also want more convenient access to credit-loading sites, and a quick response when faults impede the flow of water they have paid for in advance. They like the fact that prepaid systems make it possible for them to manage their accounts more directly, with clear information about where they stand all the time, something that particularly benefits women who manage household budgets. This contrasts with conventional systems that carry the risk of inaccurate and high bills and an unpleasant surprise long after consumption, leaving them in debt. Disconnection from postpaid systems left them reliant on water vendors and other intermediaries who mark up their prices and offer water only at particular times. Prepaid systems may take different forms:

- *Prepaid standpipes* offer more equitable access for people without their own connections. Customers with their own account and credit token can buy water at the utility tariff, without an intermediary's markup and without access being dependent on an intermediary's hours of business. Most said they preferred prepayment, but there were concerns about faulty meters, delayed repairs, too few convenient vending points, and difficulty replacing credit keys.
- *Prepaid individual domestic connections* help manage the risk to customers of consuming more water than they can afford, disconnection, and debt, and the risk to service providers of bad debt. Customers used to a continuous household connection are more sensitive to the inconvenience of supply stoppages when credit is exhausted than those used to fetching and carrying water from shared taps.
- *Prepaid meters on institutional customers* consuming large volumes 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.

Prepaid systems can also assist service providers. For service providers, prepaid systems are a means to meet more customers' service demands, an incentive to extend services to poor people in areas where previously they had no revenue prospects, and a means to improve revenue collection. This offers the prospect of healthier cash flows, more revenue to fund expansion, and more resources to help weather the prevailing reluctance to increase tariffs at all. Cost-effectiveness of prepayment varies significantly across applications. Better collection from large-volume consumers can improve revenue to help subsidize services in low-income areas. But revenue income will meet or exceed prepayment costs only at comparatively high consumption volumes, and the volume of sales required will be determined largely by how cost-reflective the tariff is.

The affordability and financial viability of prepaid water is a major challenge. The benefits of prepaid meters must be balanced with an understanding of the likely increased costs—due to significantly increased capital expenditure on metering devices; recurrent costs such as the cost of vending and ongoing repairs and monitoring; selling more water at subsidized lifeline tariffs rather than full tariffs; etc. The resulting challenge to utility finances has to be planned for, both for an appropriate level of cross-subsidies within the customer base and, quite likely, for subsidies supported by taxation from a wider revenue base. Service providers would be well-advised to assess the cost and revenue effects of introducing prepaid meters carefully, right at the beginning, and to compare these meters' impact to the alternatives. When the utility chooses prepayment as a vehicle for delivering water directly to low-income households at a social tariff, it may also be necessary to consult economic regulators or higher-level decision-makers upfront about how best to recover the costs of this approach.

Prepaid metering should not be seen as a way to avoid high billing and collection inefficiencies. It is difficult to justify financially spending a substantial amount to achieve a relatively small percentage improvement in revenue, when a significant reason that utilities struggle financially is that their tariffs do not adequately reflect their costs. The viability of prepaid systems—like most other aspects of a service provider's business—hinges on the tariff regime. If a service provider, for whatever reason, charges below cost (e.g., through lifeline blocks), it is unclear whether it can find added financial benefit from using a relatively expensive charging mechanism.

Of the three applications, prepaid public standpipes seem most likely to enable water utilities to serve poor households better and offset investment and running costs. This capability is contingent on a distribution network with adequate pressure, the existence of convenient credit purchase points, and a strong customer service component to address faults promptly.

The performance of the technology is still inconsistent. The potential of many prepayment systems is being compromised by unreliable performance, which is inconvenient and frustrating for customers and onerous and costly for utilities. Most utilities and customers complained about meters breaking down, and it would appear that the necessarily skills and spares are not always readily available to deal with faults.

Meters that are initially inexpensive to purchase can prove costly if they fail early and cannot be repaired. If the prepaid industry is to grow, it is important to ensure that meters can be repaired locally and that the supplier can offer good after-sales service and spares.

The Way Forward

This report identifies and discusses key areas in which policy reform, improved regulation, and innovative operational practice could help make the use of prepaid water systems conducive to serving poor people. Key suggestions about the way forward include:

Be clear about the priority: Reaching people without their own connections. Prepaid systems' core potential is in addressing the fact that many urban Africans still do not have their own water connections and remain outside the reach of subsidy regimes. Prepayment does not offer an obvious answer to these challenges, but some of these systems' attributes may provide a tool for addressing them in certain circumstances.

Recognize that prepayment technology is not intrinsically anti-poor. Some critics equate prepaid water with exclusion of the poor from services, without recourse. They fear that prepaid systems make it too easy for service providers to close off water supplies where people cannot afford advance payment, and when credit is exhausted. The technology is a tool of policy, and subordinate to it. Governments, regulators, and service providers should manage the system's deployment, putting in place appropriate policy and regulatory frameworks, and working closely with customers in rolling out the technology.

Recognize that prepayment does not equate to the "commodification" of water. It has been implied that prepaid meters typify the commoditization of water, or even privatization. Significantly, of the eight service providers covered in the case studies, two of the pace setters were neither private nor publicly owned corporate agencies, but municipal water departments concerned with providing services that meet the needs of the people they serve.

Introduce well-targeted social safeguards to secure access to services for the poor. Safeguards to mitigate hardship may address concerns around the possible impacts of prepayment on people's right to water. If it is done well, prepaid technology could also be instrumental in tackling the big policy issues around subsidies and tariffs. This is important, because in many countries general subsidies to existing users mean that unconnected poor people often do not receive the subsidies at all.

Recognize the challenge of prepaid systems to service providers. The tenuous financial basis of prepaid systems, especially their high initial outlay, requires planning for their deployment. Where their primary purpose is to make water available more affordably and equitably to low-income residents, cross-subsidies or external subsidies may be needed to ensure that prepayment does not divert funds from other needs. Service providers would be well-advised to assess the cost and revenue effects of introducing prepaid meters carefully, right at the beginning, and to compare their impact to the alternatives in consultation with economic regulators and higher-level decision-makers.

Think big about the technology. If prepaid water systems are to be applied more widely, some important technological issues must be addressed. There is a general need to improve the robustness and reliability of prepayment systems, in part as a matter for national regulators, but also, if they are to go to scale, a more regional or even global initiative may be required. The most critical game changers are the increasing use of information and communication technologies (ICT) to eliminate cumbersome token usage and link prepaid meters to mobile phones and vendors, and the entry of Standard Transfer System (STS) compliant technology for loading credit and paying for water across a common platform shared with prepaid electricity. STS is also essential to escape the exclusivity of proprietary technologies and promote greater compatibility between different brands through adherence to global specifications. This can be achieved through a combination of regulation and demand from service providers for components that they can combine across brands to get the best mix of price, quality, and innovation.

Summary

Prepaid water is not a miracle cure. It is not obviously cost-effective for the provider; it has not been consistently reliable; and it comes with substantial demands on management. However, many utilities believe that the benefits outweigh the costs. Its growing profile requires that prepaid systems no longer be treated as essentially experimental. Prepaid water needs to be taken far more seriously in water sector policies and regulatory frameworks and in scaled-up technical support to optimize the opportunities they offer and the risks they pose.

NOTE: Full case studies for the eight cities summarized in Appendix B can be accessed online: http://wsp.org/prepaidwater.

I. Introduction

1.1 A Growing Interest in Prepaid Water Meters

Too many people across sub-Saharan Africa still lack access to affordable safe water. In low-income urban areas with few individual connections, residents source their water from a mix of public water points and private water vendors. They often walk far and queue for free water from unsafe wells or streams, or pay water vendors for the same water nearer their homes (Figure 1). Buying treated water from shared standpipes often involves conflict over shared payments, while yard taps and standpipes stand idle when the service provider has disconnected the supply because of nonpayment. The promise of access or improved coverage is eroded when service points are disconnected and where intermediaries inflate the price of treated water.

Service providers, meanwhile, face daunting challenges. One of the most pressing is the difficulty of meeting the ongoing costs of delivering safe, affordable water to rapidly growing urban populations. Although a growing number of people need services, many cannot afford them, and some do not want to pay. The senior managers of service providers often fear political fallout if they raise tariffs to the level required to cover the costs of operations and reasonable capital maintenance.

In response, a growing number of urban service providers in Africa have adopted prepaid water systems since the late 1990s. Prepayment holds the promise of remedying low collection rates and inadequate income to meet service expectations. There is no risk of arrears or debt, because customers pay in advance for a specified amount of water. There is the prospect of healthier cash flows, more revenue to fund wider coverage, and the resources to reverse or preempt a downward spiral that makes tariff increases unlikely, however necessary they might be.

Prepaid water systems are controversial, however. Many of those opposed to prepaid meters say they compromise people's right to water if they cannot afford advance payment and close off water supplies when credit is exhausted, without scope for appeal or negotiation. For some, prepaid meters symbolize the "commodification" of water, and they associate these meters with the exclusion from services of those who cannot pay (see Box 1). Others say the large investment required to run a prepayment system could be better spent elsewhere to expand and upgrade services.

FIGURE 1: MANY RESIDENTS OF AFRICAN CITIES STILL LACK ACCESS TO IMPROVED WATER SOURCES

This rapid assessment explores the potential and the limits of prepaid water meters in serving urban customers, particularly the poor. The issues are complex, and the decision to invest in a prepaid system requires informed judgment and a careful assessment of prepayment as one option to improve revenue and service outcomes. The

BOX 1: WATER USER, CONSUMER, OR CUSTOMER?

Water service providers render a service—treatment and delivery of potable water—that must be paid for. The recipients of that water can be called users, consumers, or customers.

In this report, they are called customers, not because of a desire to commoditize water or emphasize the need for payment, but to emphasize that this is a relationship of reciprocal accountability. Service providers expect payment, and in return customers expect good service. Categorizing them purely as users or consumers suggests a one-way relationship (the service provider provides, the recipient receives), and one-dimensional (the recipient's only role is to use or consume the product, rather than inform the terms of use or the quality of what is offered). The word "customer" is used here to suggest an entitlement to good service and respect from the service provider.

analysis therefore aims to inform decision-making by urban service providers, oversight agencies, and other stakeholders on the suitability, fairness, introduction, and management of prepaid water meters. It investigates the experiences of providers and customers, and the lessons that emerge for others considering prepaid water.

1.2 Methodology

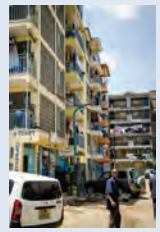
The methodology of this assessment had four elements:

- A review of the available literature to identify research themes and select sites where prepaid water meters have been installed.
- Case studies in eight African cities where prepaid water meters have been in use for some time, mostly five years or more (see the map in Box 2). These sites were selected largely on the basis of their longevity to explore learning over a few years. Thus, some failed projects are not discussed here. For the purposes of this assignment, it seemed more relevant to extract lessons learned from the hard grind of initiatives with a longer history. The case studies describe the difficult issues, processes, stops, and starts as the attempted rollouts unfolded. Field research took place between July 2013 and April 2014, and involved interviews with service provider staff, local authorities, sector regulators, government representatives, nongovernmental organizations (NGOs), funding agencies, customers, and token vendors. These interviews included discussions with service providers and civil society activists known for their skepticism about prepaid water.
- Public surveys and market research to gain the perspectives of customers. Where possible, customers' experience of prepayment was compared to that of other payment options, including postpaid volumetric and nonvolumetric tariffs, and payments to water vendors. With the help of a professional market research team, household surveys and focus group discussions were undertaken in three of the case study cities:
  - 0 Kampala: 388 adults using public standpipes; and eight focus groups with men, women, children, landlords, and water vendors, most using prepaid standpipes.
  - 0 Lusaka: 395 adults with individual prepaid connections; and 11 focus group discussions with men, women, children, tenants and landlords, using standpipes and individual connections, respectively.
  - 0 Mogale City: 397 adults with individual prepaid connections; and eight focus group discussions with men and women from different income strata, including tenants and landlords.
- The customer analysis was triangulated with sales and consumption data from Kampala, Lusaka, Mogale City, and Windhoek. Secondary data was drawn

BOX 2: CASE STUDY SITES

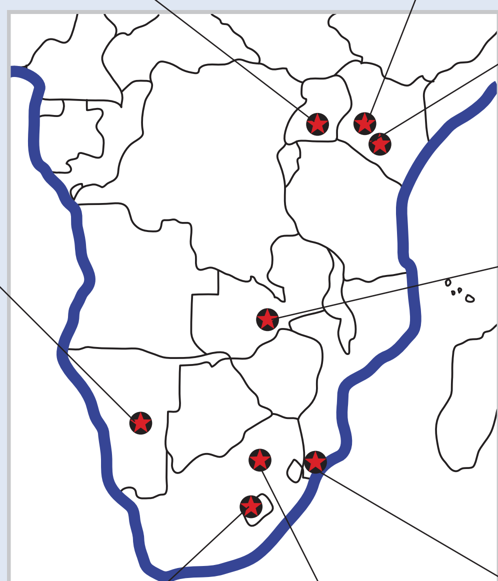
Kampala, Uganda. About 70 percent of the population lives in informal settlements and poor quality housing and relies on communal standpipes, water vendors and public wells. The city's water utility first introduced **prepaid standpipes** in 2007 to improve revenue collection and deliver water directly to users at a social tariff. Currently over 1,600 prepaid standposts serve about 200,000 people, with a further 3,000 planned by 2017. In 2014, the utility introduced **prepaid meters for institutional customers.**

Nakuru, Kenya, is the country's 4th largest urban settlement, with a fast growing population. In poor areas, households who rent rooms in 25–40 room compounds share a single tap controlled by a landlord. In mid-2012 **95 prepaid standpipes** were installed in compounds. Tenants can now access cheaper water, 24/7. Nakuru Water aims to install over a thousand more.

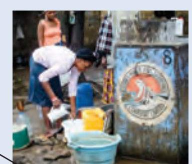


Nairobi, Kenya, has had 620 prepaid meters on **individual connections** in middle and low income housing estates and apartment blocks since 2008. In late 2013, Nairobi Water began installing prepaid standpipes in informal settlements to improve payment levels and reduce the cost of water to those without their own connections.

Windhoek, Namibia, first introduced **prepaid standpipes** in 1998 to supply rapidly growing informal settlements in an arid region The city aims to manage demand and wastage, avoid high water prices rising further and avert conflict at shared water points. About 582 prepaid standpipes serve approximately 80,000 people, with more units being added to serve further people.



Lusaka, Zambia is installing prepaid meters on a large scale—38 **standpipes, over 14,000 individual domestic and 203 institutional connections** in four centers by early 2014. The utility envisages 40,000 by the end of 2015 and a total of over 69,000 by 2018. Sophisticated vending and monitoring systems are being developed to improve services, payments and demand management.



Maputo, Mozambique. Tap attendants take responsibility for selling water from **220 prepaid standpipes;** prepaid metering helps them stay out of debt and avoid disconnection.

Maseru, Lesotho, introduced prepaid meters on **individual** connections from 2008 to improve payments by civil servants. There are now 3,500 prepaid meters on prepaid individual connections, plus 180 **prepaid standpipes** serving tenants in peri-urban settlements.

Mogale City, South Africa, pioneered installation at scale from 1999, with 30,000 **individual prepaid** meters in rich and poor areas by 2002, supported by 6 kls of free basic water to each household. It is currently upgrading and installing **39,000** prepaid meters with a turnkey supply, install, maintain and monitor contract and aims to provide prepaid as the default to all 80,000 metered connections.

from other studies to put the experience of these African cities in a wider perspective. Preliminary findings were discussed (a) case by case with service providers and other stakeholders; (b) in a workshop with senior managers of the service providers covered in the case studies; (c) at the 2014 African Water Association (AfWA) conference in Abidjan; (d) at roundtable discussions in the World Bank; and (e) with regional and national water leadership at the Zimbabwe Water Forum.

1.3 Separating Prepayment Impacts Can Be Difficult

Customers' experiences with prepayment are often shaped by wider changes in their service environment, and isolating what is specific to prepayment can be difficult. Prepaid standpipes, for example, might be introduced as part of a wider service improvement program, and customers may associate prepayment with more water points, shorter queues, closer access, and cleaner water. None of these attributes is intrinsic to prepaid water.

However, there is a gray area around what can and cannot be credited to prepayment. In some instances—notably Kampala—the proven benefits of prepayment seem to have spurred service providers to provide additional standpipes, because they are now more confident that the intended benefits will be attained. The main driver is not increased income per se but that residents without their own connections can buy water from prepaid standpipes at a social tariff directly from the service provider, without intermediaries capturing the tariff benefit and then charging a markup. The utility in Kampala now receives that income and does not resort to disconnecting shared taps for nonpayment when the local tap attendant does not turn over funds collected from users. Consequently, National Water in Kampala regards prepaid standpipes as a promising technology for improving coverage in low-income areas, and intends to install 3,000 more standpipe meters by 2016, in addition to the current 1,613.

Lusaka Water does not doubt that the introduction of prepaid water is a big reason it can now extend the hours of supply in four urban centers. The introduction of prepaid meters exposed leaks and network problems that required urgent interventions. Major pipe replacements then followed—so although prepaid metering was the trigger and catalyst, the reason for the improved supply is actually the upgraded network. Plus prepaid meters provide an incentive to customers to not neglect leaks—because then their credit will be exhausted and they won't have water. Average water consumption has fallen, because customers with prepaid house connections now pay a volumetric tariff before using any water, and are more conscious of their consumption. They also have a greater incentive to close taps and fix leaks.

1.4 Outline and Structure

Section 2 begins the analysis with a discussion and clarification of some of the key features of prepaid systems. Section 3 reports key findings on customer perspectives, before turning to the operational practicalities of deploying prepayment systems, including the financial challenges. Section 4 draws out key lessons and their implications for policy choices, operational decisions and approaches, and service delivery generally. Section 5 reviews some financial implications of prepaid water metering, and Section 6 reaches some conclusions and suggests a way forward.

II. Prepayment Systems for Water: Key Aspects

2.1 Prepaid Water in a Global Context

A growing number of African water service providers have introduced prepaid water meters (PPMs) since the late 1990s, when the technology first emerged in South Africa (see Box 3). Many more introduced prepaid meters on a pilot basis initially, but moved on to other options because prepayment proved expensive, demanding, and often unreliable. Others persisted and contributed to the evolution of the technology and marked performance improvements.

There have been significant technological advances, particularly beginning in 2011, when the first prepaid water meters were certified for compliance with the global prepayment standard for vending, security, and interoperability. This certification has the potential to free service providers from being locked into proprietary hardware and software systems, and opens the way to mix and match systems across suppliers, potentially offering greater reliability, more competition, more vending options, and lower prices. Chinese, South African, and Turkish manufacturers dominate the production of prepayment systems on global markets.

Today, prepayment water systems are in use in more than 20 African countries, and in locations such as Turkey, parts of the Balkans and Azerbaijan, and Colombia. Their scale of use is ramping up rapidly. The Botswana Water Utilities Corporation, for example, is reported to be planning to install 300,000 prepaid water meters in the near future, beyond the existing small-scale installations. Prepaid meters are attracting widespread interest as service providers seek ways to improve revenue collection to meet the costs of service provision and to minimize water loss and/or water demand. Prepaid meters are a specific permutation of smart meters. There are already signs of convergence in these markets, with

BOX 3: SOUTH AFRICA, PROBABLY THE BIGGEST USER OF PREPAID WATER METERS

Prepaid meters were first developed in South Africa in the mid-1990s, and are used extensively in low-income areas in conjunction with the national policy of free basic water. Nearly all poor households get the first 6 m^3 of water free each month. Prepaid meters are programmed to treat this allocation as the first block in a rising block tariff, with a zero tariff. Capital and operating costs are subsidized heavily by the national government.

Prepaid water is contentious in South Africa. In mid-2006, a coalition of social justice activists challenged the City of Johannesburg and its water utility, in what became known as the *Mazibuko* court case, over the implementation of prepaid water meters in Phiri, Soweto. They argued that they were discriminatory and contradicted the constitutional right of access to water. A High Court judge ruled in their favor, but the Constitutional Court subsequently overturned this decision, saying the meters were neither unfair nor discriminatory, and that the free basic water allocation mitigated hardship for poor households. The Constitutional Court judge drew a clear distinction between disconnection following persistent nonpayment, and the temporary cessation of supply that happens when a prepaid user runs out of credit.

The City of Johannesburg continues to use prepaid meters in Soweto and elsewhere and plans to extend their use more widely. These meters are used widely in other parts of the country, although many municipalities now prefer flow-limiting devices, which supply water up to an agreed threshold, as a more cost-effective and robust alternative.

prepayment being an add-on modular option for some smart meters currently being installed in several African countries.

2.2 What Prepaid Water Entails

It is important to understand two key aspects of prepaid water: first, it is about a prepayment system, not meters alone; and second, the three major applications of prepayment technology have different characteristics, impacts, and challenges.

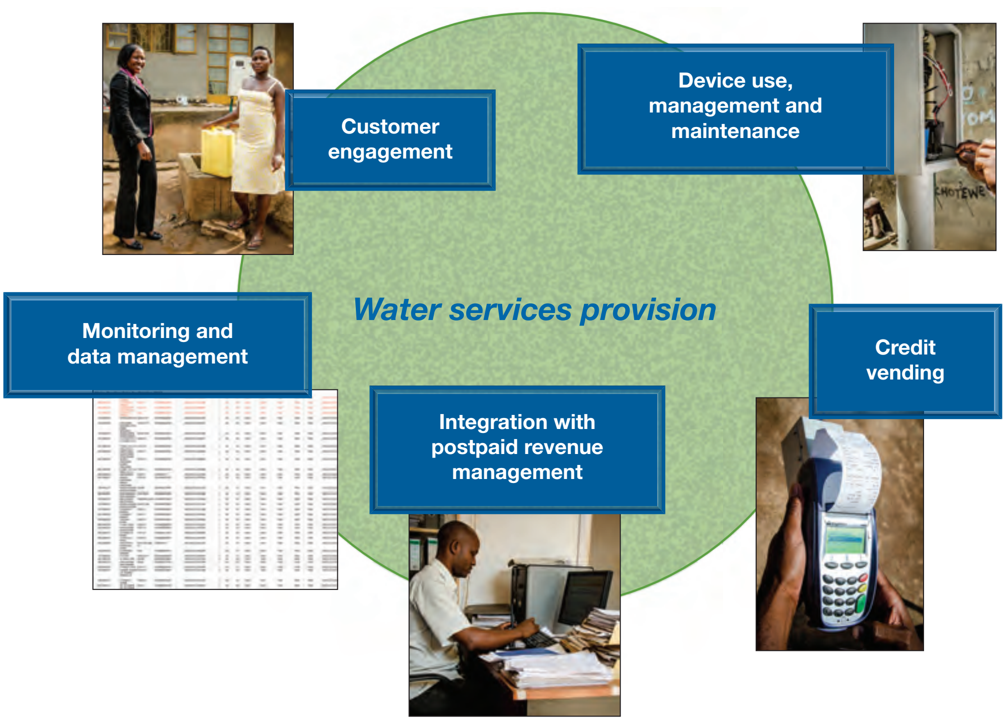
2.2.1 Prepaid Water Is Not about Meters Alone, but about a Prepayment System

Discussion of prepayment *metering* often deflects attention away from the complementary components of an *integrated prepayment system* (see Figure 2).

A prepayment system comprises the prepaid dispensing devices, the technology required to load and transfer credit, a database recording customer purchases and metered consumption, and ongoing engagement with customers (Box 4). A network of credit vendors is needed to sell prepaid credit or "top-ups" to customers (or, increasingly likely in the near future, a mobile phone payment system, also incurring charges). Integration with postpaid revenue management is vital, supported by a database of meters and customers with records of consumption, credit purchases, and performance. This integration is more difficult and costly in terms of investment required (staffing and/or computer billing upgrades) or efficiencies foregone, than is often assumed. Regular monitoring is required to track faults, exceptions, and real-time consumption against prepaid sales. Finally, making meters work and ensuring their acceptability requires ongoing interaction with customers.

A prepayment system differs significantly from conventional systems in that success is contingent on having, first, an effective vending system that allows customers to buy credit

FIGURE 2: COMPONENTS OF A PREPAID SYSTEM



conveniently; and second, an ability to respond rapidly when faults affect the supply of water to customers who have paid in advance. These two legs require the support of a multidisciplinary team equipped to negotiate the introduction, siting, and installation of new meters, explain how to load credit, check balances and understand tariffs and charges, replace credit tokens, and mediate possible conflicts over access to shared facilities.

2.2.2 All Prepaid Applications Are Not the Same

The review found three distinct applications of prepayment systems:

- Shared standpipes serving customers without their own connection
- Individual connections serving residential customers
- Connections serving institutional or commercial customers

BOX 4: HOW PREPAID METERING AND CREDIT LOADING WORKS

Most prepaid water meters use a mechanical water meter, coupled to an electronics module with a credit meter and a water control valve. When water flows, pulses are generated by a probe connected to the mechanical meter. These pulses are converted into credits that are subtracted from the total credits loaded by the customer. The valve closes when credit is exhausted or if there is tampering with the components.

Many prepayment systems use rotating piston and multijet water meters. The accuracy of both meters can be affected by grit, sand, and air; and frequent supply interruptions raise the risk of malfunction. This is a significant vulnerability for prepayment metering systems used in many African cities, where there are aging networks, discontinuous supply, and low pressure fluctuations.

Two alternatives that are better suited to networks with supply interruptions are electromagnetic and ultrasonic meters. These are highly accurate; resilient to pressure changes, air, and grit; and have no moving parts. At current prices—70 percent higher, but falling—they are not a cost-effective option for domestic meters.

Customers load credit bought from designated vendors using a programmed metal key, a smartcard, or a keypad. Dallas keys, or iButtons, are currently the most widely used, and consist of a computer chip mounted in a stainless steel container that looks like a large watch battery. Programmed keys and smartcards allow for a two-way exchange of data. A credit vendor loads credit onto the customer's Dallas key using a point-of-sale device, and uploads consumption data from the customer's prepaid meter for analysis later. This data can be used to track consumption trends and flag exceptions (unusually high or low consumption) or for follow-up. Numerical tokens and keypads are one-way only, and require separate data collection to track consumption.

A growing number of utilities now acknowledge that regular monthly meter reading is essential to collect consumption data to calculate their water balance, reconcile sales, and monitor nonrevenue water (NRW). Some now use automatic meter reading (AMR) systems to collect consumption data from individual meters.

Some utilities now insist that each prepaid device includes a conventional mechanical meter, if necessary, in addition to an electronic meter. If the prepaid unit fails for any reason, the mechanical meter can still be read and supports conventional billing and payment.

FIGURE 3: A PREPAID METER ON A SHARED PUBLIC STAND POST

Each has distinctive features that shape the customer's experience and the cost-effectiveness to the service provider.

The rest of this review focuses mainly on the first two applications, and gives primacy to the perspectives and experiences of the people using them, as well as the service providers who have deployed them. A few initial observations are presented here.

PREPAID PUBLIC STANDPIPES

How they work. 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.

Considerations. Service options for those without their own connection to service provider supply networks are currently fairly limited. They include water kiosks and vendors, who mark up service provider prices to cover their own costs of distribution; access to a yard tap on terms and prices set by a landlord or reseller; unimproved sources, such as springs, wells, or boreholes; and public stand posts (Figure 3), where the cost of the water is shared among a pool of users, but where disconnection is common if the service provider does not receive payment. These options entail higher costs than house connections but lower-income households bear them—queuing, carrying, paying intermediaries' charges, and rarely benefiting from any lifeline tariff system.

This raises the question: Could prepaid water systems on standpipes offer a cheaper service to customers and a better alternative for poor households as a transitional step toward piped services for all?

PREPAID INDIVIDUAL DOMESTIC CONNECTIONS

How they work. Customers have their own prepaid meters, and load credit using a tag, smartcard, or keypad. The tag,

FIGURE 4: A PREPAID METER ON AN INDIVIDUAL DOMESTIC CONNECTION

FIGURE 5: PREPAID METER ON AN INSTITUTIONAL CUSTOMER'S CONNECTION

card, or code can only be used on the specific meter for which it is programmed (Figure 4). Once the credit is loaded into the meter's memory, customers do not have to use the key each time they draw water.

Considerations. Beyond communal standpipes, a growing number of African water service providers are introducing prepaid water systems on individual metered connections to improve payment levels and their overall financial position. This review focuses on the impacts on customers, especially those who are poor. When households progress from communal taps to their own house connections, their water consumption and spending on water typically rise.

Two questions arise. Can prepaid metering help customers better manage the costs of an individual connection, which is more convenient to them but also more expensive? Can the relatively limited increase in revenue collected justify the service provider making such high-cost investments in prepaid metering, particularly where there is often too little water available to sell in the first place?

PREPAID BULK METERS FOR COMMERCIAL AND INSTITUTIONAL CUSTOMERS

How they work. A representative of the customer loads credit using a tag, smartcard, or keypad. The meter is designed for far higher volumes than domestic meters and far greater accuracy, given the volumes (Figure 5).

Considerations. The large volumes of water sold to commercial and institutional customers comprise a significant source of income for water service providers in African cities and towns. However, most experience difficulty with misreading of meters and getting government departments and other institutions (police and army barracks, hospitals, schools, and prisons) to pay their service charges. Late payment of substantial bills squeezes service providers' cash flows and writing off bad debt deprives the service provider of budgeted income, including funding to improve services to the urban poor. The service provider reforms required to serve neglected low-income settlements extend well beyond prepaid metering, but improved collection from large-volume customers is essential to fund the borrowing, cross-subsidies, and stable cash flows required to serve all customers better. This makes prepayment by commercial and institutional customers an attractive option for service providers.

In practice, a critical question is, do governments provide the political backing needed to compel payment upfront, and how best can utilities mitigate the impact on those affected—notably in hospitals, schools, and prisons—when the credit runs out and the water shuts off?

III. What Does Prepayment for Water Mean for Customers?

There are few "typical" customers, beyond broad generalities, and their perspectives on prepaid water are shaped profoundly by their context, needs, and alternatives. This section is concerned primarily with two broad categories of water users in low-income urban settlements: those who have their own water connection, and those who do not. There are substantial differences between them and the benefits and drawbacks of prepayment impact them differently.

This review gathered information on customers' experience of and perspectives on prepayment from different angles: direct observation, discussion with a wide range of informants, household surveys with almost 1,200 prepaying customers across three cities, 27 focus group discussions, and a review of the relevant literature. The findings suggest that very few customers are interested in the technology of water services. What matters most to them are convenience, price, and reliability. Where, on balance, prepayment provides the most benefit, most customers are likely to support it. These findings have important implications for reframing discussion of prepaid water systems.

3.1 How Customers Experience Prepayment

There are marked differences in the experiences and perspectives of customers using prepaid standpipes and prepaid individual connections, respectively. Tables 1 and 2 summarize the key likes and dislikes of people using prepaid standpipes and individual connections, and highlight the distinctiveness of their experience. This grounds broader discussion of how the different prepayment applications affect customers, with common themes (notably disconnection) explored further in a subsequent section.

TABLE 1: PREPAID INDIVIDUAL CONNECTIONS: SOME CUSTOMERS' PERSPECTIVES

Likes	Dislikes
"It's easy to control your budget—you decide how much you want to pay and how long it must last you."	"Water is a need, but money is not always available."
"You can get water with even a small payment. It's better than trying to pay a big bill."	"The water can stop any time if you are not watching how much you have used."
"You use only what you have paid for, so you only use what you can afford."	Inadequate consultation before the prepaid meter was installed
No debt, no disconnection	Inadequate explanation of tariffs and charges
No bills you don't trust and can't pay	Inadequate demonstration of how to use the meter
"You spend less on water because you are more aware and you use less."	"Postpaid gives you more time to find the money."
"You are in charge. You can decide when the water stops, and you can put it on again. No penalty."	Water is more expensive than with a fixed tariff
	Having to travel to purchase credit when you run out
	Some people don't share water anymore
	Slow responses when a fault is reported

TABLE 2: PREPAID STANDPIPES: SOME CUSTOMERS' PERSPECTIVES

Likes	Dislikes
Cheaper water	Paying money but not being able to get water
Being able to afford more water	Meters that don't work, and having to walk further to get water
Being able to budget for water because the price is always the same	Not having money to buy water
Being able to get water whenever you want it	Not enough places to buy credit close by
Being in control, with your own token	Problems buying credit when the vendor is absent, has no credit left to sell, or there is a power outage
Not being disconnected when others don't pay what they owe	Tokens that don't work or get lost or stolen

3.1.1 Prepaid Individual Connections

The default for households with their own formal connections is a continuous supply of water (barring service interruptions), with payment after consumption. The attitudes of people with individual prepaid water connections (Figure 6) are profoundly shaped by how, or whether, they previously paid for water.

Does prepayment represent a loss or a gain? Those who like it often cite their greater ability to monitor their water consumption and the flow of household expenses as a major advantage. It helps them to live within their means, and reduces the risk of running into debt due to unexpectedly high bills.

In areas where people were not previously obliged to pay for water, or where there were previously few sanctions for nonpayment, the introduction of prepaid water meters is frequently experienced as harsh and punitive.

This distinction accounts for much of the opposition to prepaid water meters in Soweto, South Africa, where the collection rate on water bills in the early 2000s remained below 10 percent, long after a boycott of service payments as protest against apartheid in the 1980s had achieved its goals. When prepaid meters were introduced in Soweto in 2004, payment for water was no longer negotiable beyond the free basic water allocation (6 m^3, subsequently raised to 10 m^3 and more for poor families) and there was widespread opposition to prepayment. Similarly, in the low-income township of Jericho in Nairobi, Kenya, where residents rent housing from the city council (Figure 7), customers resisted the shift from not having to pay for water to prepayment. This occurred in a context of limited public engagement, and most meters were bypassed or vandalized within months.

In Lusaka, Zambia, and Mogale City, South Africa, customer reactions to prepaid metering correlate strongly with whether they were previously paying a fixed, nonvolumetric tariff, and whether they now pay more or less. When consumption is modest, customers like to pay only for what they use, rather than a fixed tariff irrespective of consumption. Prepayment is harder for large consumers used to unlimited consumption, and they are likely to spend more than before. As one Lusaka respondent put it, "If you have a small family, prepaid is best. If you have a big family and tenants, the fixed tariff is better."

Prepayment allows customers with their own connection to manage their consumption within limits they can afford, without the risk of arrears, disconnection, or unexpected debt. This is a significant consideration for low-income households moving up from carried water to their own connection or wanting flush toilets. Women often manage household budgets, so this greater certainty

FIGURE 6: PREPAID METERS IN KAGISO, MOGALE CITY, SOUTH AFRICA

FIGURE 7: PREPAID METERS HAVE BEEN IN USE IN JERICHO, A LOW-INCOME COUNCIL HOUSING ESTATE IN NAIROBI, SINCE 2011

benefits them. Some said they prefer postpayment because it gives them more time to raise money to pay for the water they used. Having to pay before consumption can cause hardship for those without money to buy more credit. This critical issue is considered in more depth below.

In surveys and focus groups, those who like prepayment said they felt more in control of their consumption and were no longer anxious about receiving bills they could not pay. Many see prepayment as offering a more transparent and trusted way of being charged for water than erratic bills and estimates.

The gender impacts of prepaid systems seem fairly indirect, and more attributable to improved water supply than specifically to prepaid meters. In many focus groups it was evident that important concerns of women have been addressed because improved and more continuous water supply benefited household hygiene and streamlined budget management because people know what they consume and spend (Figure 8). It has also benefited women and children in making the fetching of water more flexible due to the longer hours of supply, and all have benefitted from access to safer water. One area of perhaps greater specificity has been where women have taken up opportunities as credit vendors, often in addition to their existing roles, in informal and formal small businesses.

Prepayment enables recovery of arrears. Prepayment is used widely (although in none of the cases studied here) for involuntary credit management. Customers who are in arrears or who have been disconnected are connected to a prepaid meter, and a portion of their arrears is deducted from each credit purchase. In the four cities with prepaid individual connections reviewed here, only one—Lusaka—is currently recovering arrears through prepayment, primarily because the others have had prepaid meters long enough for debts from postpaid systems to have been settled. Many Lusaka customers said they felt that a top-sliced deduction of 40 percent for arrears was harsh.

Customers used to a continuous connection are more sensitive to supply stoppages. Customers used to the convenience of a continuous connection at their own homes are more sensitive to the inconvenience of supply stoppages when credit is exhausted than those who fetch and carry water regularly. Many complained that credit vending sites should be located closer to where they lived, and have longer operating hours. Even so, well over 90 percent of those surveyed said they preferred prepayment and would recommend it to others.

FIGURE 8: THE AFFORDABILITY OF PREPAID WATER MAKES SMALLER, MORE FREQUENT LOADS OF LAUNDRY POSSIBLE

Prepayment heightens awareness of consumption and usually results in lower consumption. Most households become more conscious of how they use water and how much they consume. Particularly for those not used to a volumetric tariff, prepayment requires considerable adjustment. A widely echoed comment was, "We know that if we don't close the taps, we will find it finished. We have become very responsible users of water." A majority said they spend less on water with prepayment because they are more conscious of their consumption and regulate it better.

Rising block tariffs can cause discontent. In the cases studied here, prepaid customers pay the same tariff or less than postpaid customers, and all pay a rising block tariff.

Prepaying customers are, however, much more aware of what they pay and what they get for what they pay. Most buy more than once a month. They are keenly aware of the impact of rising block tariffs within a monthly billing cycle, yet few understand why the same amount of money might buy different amounts of water. "The cost per unit is not consistent," said a woman from Lusaka. "You find that today you buy for K100 and they give you this number of units. When you go next time, they give you less for the same K100." Zambia's regulator recommends a uniform tariff for prepayment, not a rising block tariff, so customers know in advance how much water they can buy with a particular sum of money, without the amount being determined by the volume they have already consumed that month.

3.1.2 Prepaid Standpipes

Households without their own connections fetch and carry water from a variety of sources: standpipes, neighbors, a landlord's tap, kiosks, water vendors, or various unimproved sources such as wells or springs. They make their own arrangements to ensure continuity of supply, for example, keeping one or more containers of water in reserve (Box 5).

BOX 5: NAKURU, KENYA: CHEAPER WATER FOR TENANTS, WHENEVER THEY WANT IT

In Nakuru, northwest of Nairobi, 95 prepaid standpipes have been installed in high-density housing compounds. There is generally one tap serving a compound of 25 to 40 households; and in compounds without prepaid meters, the landlord controls access closely to limit the risk of a high utility bill. It is not unusual to find the single tap in a compound locked except for a few hours a day, three or four days a week. Even then, many compound taps are disconnected because the landlord has not paid the bill, although tenants generally pay rent of about 1,300 KSH a month (US$15.00), which includes about 300 KSH for water. Tenants' main alternative is to buy from a water vendor, at a cost of 6 to 10 Kenyan shillings per 20 liter jerrycan (US$0.067 to US$0.11). The nearest water kiosks are some distance away and although they sell water relatively cheaply for 2 KSH per jerrycan, the water is only available when the kiosk operator is working.

Some tenants and landlords were resistant when Nakuru Water first proposed installing prepaid meters in 2012. Some tenants objected to having to pay for water, not realizing that they were already paying their landlord for little, if any, water. Some landlords were concerned they would lose their income stream from selling water. Once the prepaid standpipes were installed, compound residents had access 24/7 for just 1.2 KSH (US$0.01) per jerrycan. Tenants had a far better service for a fraction of the price they had paid previously, and landlords found they could rent their rooms more readily, often for a better price, with minimal conflict over water and no risk of disconnection.

Since prepaid stand posts were introduced, tenants living in Nakuru housing compounds have gained access to far cheaper water, at any time of day.

Payment arrangements cover a wide spectrum. They range from no payment for water from unimproved or unauthorized sources, to payments before consumption to tap attendants, kiosks, and water vendors. In some cases, there is also payment after consumption from shared standpipes, neighbors, or vendors who provide a regular delivery service. For most people without their own connection, prepayment for water is nothing new.

Prepaid standpipes impact customers in more diverse, complex, and potentially positive ways than prepaid individual connections, and merit closer consideration.

Cheaper water any time, because prepaid standpipes bypass intermediaries. Prepaid standpipes enable service providers to sell water directly to customers with their own prepayment tokens, without tap or kiosk attendants or other intermediaries adding a markup or capturing lifeline tariff benefits for themselves (Box 6). This marks a significant difference from what happens in many low-income settlements, where there are too few standpipes and service providers pass on the costs of local distribution and payment collection to vendors, who recover these costs from their customers by charging several times the service provider's tariff (Figure 9). With prepaid standpipes, service providers carry the cost of collecting payment, and recover it across their wider customer base (just as they recover the cost of bad debt across all customers).

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 advance for people who leave home early or return late. It also distributes collection times more evenly throughout the day, which eases queuing times, especially for women and children who have primary responsibility for fetching water.

BOX 6: WINDHOEK, NAMIBIA: LESS CONFLICT, FAIRER PAYMENT WITH PREPAID STANDPIPES

In Windhoek, Namibia, prepaid standpipes have reduced conflict around shared payment and disconnection. The cost of safeguarding adequate water in this semi-desert terrain is high, and water tariffs average close to US$2.00 per m^3 for domestic users. In informal settlements where residents share a conventional connection or standpipe, the onus is on users to agree how to collect payment to cover their shared water bill. If the full bill is not paid, the water may be disconnected, and so the poor frequently subsidize the nonpaying poor. This often leads to conflict, particularly where those living close to the standpipe are perceived to be using more water than those who must fetch and carry from further away.

With prepaid standpipes, this source of conflict falls away, and residents are not penalized by disconnection if others do not pay. They pay US$0.04 per jerrycan, which works out at about half of what it costs those who share a bill. The City Council faces strong demand from residents for more prepaid meters in informal settlements.

Drawing water from a prepaid standpipe, Okuryangava, Windhoek

FIGURE 9: A WATER VENDOR USES HIS BICYCLE TO DELIVER WATER CONTAINERS FILLED AT A WATER KIOSK IN KATEMBWO, NAKURU

The credit tokens are programmed to be usable at any prepaid standpipe, at any time of night or day. "Wherever you go as long as you have your key, you can just put it inside," said one user. "It does not have any specific time."

Subsidies reach their intended beneficiaries directly. As in Nakuru, prepaid standpipes in Kampala and Nairobi have resulted in a sharp drop in what people without their own connections pay for water. Customers now get more water for less money, because they receive the benefit of a lifeline tariff directly. The cost of a jerrycan of water from a prepaid standpipe in City Carton, Nairobi, is half a Kenyan shilling (less than US$0.01), compared to 2 to 5 shillings from a water vendor or kiosk. In Kampala, a 20-liter jerrycan costs just under 25 Ugandan shillings (US$0.01) from a prepaid standpipe. This works out to be 55 percent of the cost from a house connection, substantially less than the 200 to 500 Ugandan shillings and more that water vendors and resellers charge.

Among those surveyed, virtually all prepaid customers said they now spend less on water, and most now use more water because it was much more affordable. From discussions in focus groups, it was evident that lower water costs have reduced stresses for women who depend on their husbands or partners to provide money for food and water, as they can now afford to buy more of the water they need without having to compromise on food.

Consistent pricing and more control over expenditure. A frequent theme in focus group discussions in Kampala was that customers like knowing what they will pay per jerrycan, and feeling more in control of what they spend on water. Water vendors' prices vary by season and often by time of day but prepaid water prices are consistent and residents can stick to a budget. One resident said, "Those token meters are good. It's not going to give me a hard time, like with those taps. I earn very little, so it helps me if I know I have recharged with 2,000 shillings (US$0.79), then I can budget for the month."

Customers without their own connections have the benefit of their own service provider account. With a credit key or smartcard issued to each individual customer, a prepayment system enables people with no prospect of having a connection of their own to have their own independent account and relationship with the service provider as full customers. One immediate benefit for standpipe users is that they are responsible only for paying for their own consumption, and are not impacted by added costs or disconnection if others do not pay.

Advance payment means the water supply stops when the credit is finished. An obvious disadvantage of prepaid meters is that the water supply stops when the credit runs out. Surprisingly few interviewees raised this as a concern, perhaps because they are accustomed to paying for water before they use it and have well-established coping mechanisms for when they cannot buy water. They said they generally shared water with a neighbor or used someone else's token until they had cash and could repay what they had used, or they fetched water from a well. The critical importance of mitigating affordability constraints is discussed further below.

Faulty meters can cause the whole water point to dysfunction, and lengthen queues elsewhere. The reliability of prepaid meters varies widely by type, and so do service providers' response times when faults are reported. Customer responses reflect this, with some very satisfied with their experience with prepaid standpipes, and others bitterly unhappy. "Me, I do not like the prepaid meter, because I may pay, only to go to the machine and find it is faulty or the water fails to flow," said one Kampala customer. "So I prefer using first, then paying what I have to pay." Others benefit from meter faults: "Those machines jam a lot, and we end up getting a lot of free water when it spills over."

When prepaid standpipes do not deliver water, customers have to fetch and carry further from alternative water points (Figure 10). This occurs in Lusaka, where rapid growth in the peri-urban areas has put the city's existing public standpipes under acute pressure. Low water pressure and interrupted supply compounds reliability problems with some of the prepaid standpipes. When they fail, the queues at the alternative standpipes grow even longer.

FIGURE 10: PREPAID METERS ARE POPULAR WITH CHILDREN

Many children are enthusiastic users of prepaid meters because they are easy to use, plentiful (reducing queuing time) and conveniently located (reducing walking distance)

Physical tokens are expensive to buy and replace, and raise the cost of services. Users of nearly all prepaid standpipes currently need to use a physical credit token (iButton, smartcard, or credit key) to get water from a prepaid standpipe. Physical tokens get lost, damaged, or stolen, and cost customers upward of US$12 to replace. (The service providers in this review subsidize or issue the first token per customer free.) The option of a numerical token and keypad exists, but has not yet been implemented at scale.

Prepaid standpipe users had much more to say than those with their own prepaid connection about credit tokens getting lost, stolen, or damaged, because they use the token every time they fill a container at a multi-user meter. Without a working credit key of their own, they have to rely on others to get water and might pay more. Conversely, those with a prepaid house connection typically use their credit keys only two or three times a month when they go to buy credit and load it on to their own prepaid meter, and evidently have fewer problems with their credit keys.

The intermediary problem can persist if there are too few credit keys. If customers do not know where to go to get a replacement, or cannot afford one, they revert to relying on an intermediary for water, and may have to pay extra. Conversely, the combination of an undersupply of credit keys in some parts of Kampala and shared appreciation of cheap water has led to increased solidarity—and pride in this solidarity—among some residents who share keys or supply water to each other at no extra cost.

Rent-seeking gatekeepers can take ownership of prepaid standpipes. Prepaid meters are no less prone to "capture" than any other valuable resource. In Kampala, some landlords deny prepaid customers access to "their" meters unless they pay a premium, despite the agreement they sign with National Water that commits them to allow any customer access to the meter installed on or adjacent to their property. Some landlords insist on selling the water themselves, marking it up to 100 shillings per jerrycan. "Some insist that you buy from them, even if you have your own token," said one tenant. Another said, "Landlords take charge and chase away those they don't like. If you are on poor terms with your landlord, they won't let you get water from that prepaid meter."

3.1.3 Two Cross-Cutting Issues

Customers' ability to take advantage of the benefits of prepayment presupposes that the prepaid meters function properly, and that customers can buy credit relatively easily.

Unreliable meters invite vandalism, bypassing, and tampering. Customers who have paid in advance for their water have a legitimate expectation that it will be available and that any faults will be repaired swiftly. Some types of prepaid meters are more reliable than others, and service providers vary in their ability to respond quickly to call-outs and resolve them, for reasons explored in the next section. All were aware that slow response times and limited monitoring invite vandalism or bypassing. Some prepaid users were quite candid about colluding with service provider staff and others to get free water. Prepaid meters, especially on individual connections, are not difficult to bypass or tamper with, for example, by puncturing the valve. If customers believe they can get away with it, some will try.

Credit purchase is not always easy. Inconvenient credit purchase is one of the most significant areas of customer dissatisfaction: vendors need to be located centrally, and open after hours and on weekends. In five of the study sites, there were three or fewer places where customers could go to recharge credit, and these were open only during regular office hours. Customers had to plan their purchases and consumption to ensure they had enough water to get through evenings and weekends. They complained of having to spend money on transport to get to a vending site, and many said they wanted to be able to buy credit using their mobile phones, like they do for prepaid electricity.

3.2 Does Prepayment Compromise Customers' Rights?

Prepaid standpipes are not a panacea to the challenges of serving low-income settlements. The technology is expensive, still maturing, and prone to faults, and there is still much to be done to offer customers a dependable and convenient service. In particular, better safeguards are needed to mitigate inconvenience when people run out of credit, and hardship when people cannot pay. But it is not necessarily helpful to dismiss prepaid water as a technology that intrinsically violates human rights, as some critics do.

There is substantial critical literature concerned with the commodification of water and the impacts of an emphasis on cost recovery on poor households. For some, prepaid water meters exemplify neo-liberal thinking, and are seen as compromising basic human rights by making access to water contingent on advance payment. Prepaid meters are seen by many as being punitive to the poor, because the poorest households have generally been targeted for prepayment and are most negatively affected by the need to pay in advance for all water.

In areas where customers have their own connection, service providers implementing prepayment are increasingly targeting the nonpoor—middle- and upper-income households and large institutional users (Figure 11). Prepaid meters are expensive and it makes little financial sense to install costly devices where the revenue collected per meter is low.

FIGURE 11: TARGETING AFFLUENT HOUSEHOLDS TO AVOID STIGMA

Since 1999, affluent households in Mogale City, South Africa, have been targeted for prepaid metering to avoid the "poor-only" stigma of prepayment

Most low-income prepaid customers surveyed for this review were mainly positive about prepayment, despite its drawbacks. A key benefit for standpipe users is cheaper water (through direct access to utility tariffs, often at lifeline levels) and more autonomy. For those with a prepaid connection, better risk management is a big advantage: they cannot run up bills they cannot afford or get disconnected for nonpayment.

Disconnection of postpaying low-income households for nonpayment is widespread. Service providers in seven of the eight cities reviewed here disconnect their postpayment customers for arrears beyond a certain threshold. (The exception is Mogale City, South Africa, where access to water is a constitutional right, and poor households, defined very broadly, get at least 6 m^3 of free water per month. Here, the flow of water can only be restricted, not stopped.) In Kampala, 84 percent of prepaid standpipe users surveyed said they had experienced disconnection of taps they relied on, whether a neighbor's tap or a public standpipe. In Lusaka, 36 percent of those with their own connections had been disconnected. "You get a bill you can't pay, and then you're disconnected, and still you owe them," said one Lusaka woman, who was emphatic that the benefits of prepayment far outweighed its downsides.

Few prepaid users surveyed for this review seemed to perceive the supply shutdown that happens when they run out of credit as a disconnection. They simply run out of credit and need to buy more. This is not just a semantic distinction. It goes to the heart of a difference that surfaced repeatedly in focus group discussions: Prepaid users feel they are more in control of their consumption and expenditure (see Box 7). Users with their own connection say they are no longer at the receiving end of bills they do not trust and cannot pay, and they are not punished for nonpayment. They feel that they have more control over their spending on water.

> For me [prepaid meters] are OK, because I don't have the Council coming and disconnecting the water. I use what I buy. If I buy for K20 and it runs out, it is me that will go and buy again. With postpaid, when you are

BOX 7: URBAN LEGENDS ABOUT PREPAID WATER METERS

Only the poor have prepaid water meters.
Zambia's President uses a prepaid water meter, one of four installed at the State House in Lusaka. Water utilities in Zambia, Uganda, and Malawi have introduced prepaid water meters for institutional customers (government buildings and police and army barracks), who are often their biggest debtors. Prepaid water systems have been installed in high-income housing estates since 1999 in South Africa and elsewhere. Several cities (Lusaka, Mogale City, Johannesburg, and others) aim to make prepaid metering the default on all metered connections. Conversely, in Mzuzu, Malawi, the utility plans to target all areas except low-income settlements, to avoid any possible hardship and because the costs outweigh the benefits.

Prepaid meters solve cost recovery problems.
The cost-recovery potential of prepaid meters is not as straightforward as many of their protagonists assume. Prepaid meters bring their own set of problems: the high cost of installation; the fact that meters can develop faults that deliver free water or can be bypassed or vandalized when monitoring and follow-up action are neglected, which opens the way for high NRW losses; technical shortcomings, including inaccurate readings when water pressure is variable; and so on. In addition, the opportunity cost of big investments is high, as the real working life of prepaid meters is only about 5–7 years, compared to the estimated 15 to 20 years for conventional meters.

People using prepaid meters spend more and consume less.
Households in Lusaka and Mogale City with prepaid house connections tend to be more conscious of their water consumption and use less, and consequently spend less on water. In Kampala, most households using prepaid public standpipes say they spend less and use more because water from standpipes is substantially cheaper than from third-party sellers. This review found no evidence that prepaid users pay a higher tariff than other utility customers. The costs of prepaid metering are spread across the total customer base, just as the costs of credit management and bad debt are borne by all customers.

> disconnected, they close the meter. It will be up to you to follow them to come and reopen after you have paid. But with prepaid, if water runs out you buy and put yourself back on. [Lusaka resident]

Some criticize prepaid meters for making access to water contingent on upfront payment. In most parts of most cities, where people rely on water vendors, kiosks, and neighbors who resell, they often already pay for water before they use it and they are familiar with the consequences of not having cash to buy water, and the vast majority have coping strategies—for example, they borrow cash or water from neighbors, reciprocally. In focus groups, users with their own connection who had previously had the option of "use now, pay later" were most likely to find prepayment inconvenient or compromising. They were used to a continuous flow and postpayment, rather than discrete advance purchases, and felt keenly the inconvenience of having to fetch water in a container. "The disadvantage with prepaid is that your dignity suffers when you have to go and borrow some water," said one man from Mogale City. "You carry a bucket up and down, and people see you. They will say, 'He doesn't have the money to buy water.'"

A defining feature of prepayment is that the water supply stops when the credit is exhausted. Service providers need to give considerably more attention to measures that minimize the inconvenience and potential hardship this can cause. These include tariff subsidies, including a possible zero tariffs for a lifeline amount, and a reserve allowance loaded onto a customer's credit token or meter, like a reserve tank on a motorcycle that a customer must activate deliberately. Some make allowances for credit running out when vendor top-up options are unavailable (overnight, for example). There is also a form of overdraft facility that allows customers to access water in an emergency, with the option of repayment being waived on appeal (see Box 18 on Mzuzu, Malawi). Underpinning all of these, the service provider must be prepared to respond rapidly when faults are reported to keep water outages to a minimum.

3.3 Summary

Prepayment systems have the potential to offer customers some significant benefits: for standpipe users, access to lifeline tariffs, more autonomy, and their own account with the service provider; for those with a prepaid connection, better risk management and more control over consumption are big advantages. Most low-income prepaid customers surveyed for this review were mainly positive about prepayment, despite its drawbacks. They flagged three broad areas warranting closer attention:

- Improved technical performance and reliability
- More convenient vending
- Better safeguards against inconvenience and hardship

The next section looks at improving the overall management of prepayment.

IV. Prepaid Water in Practice

The evidence from this review suggests that most domestic customers actively prefer the benefits that prepayment confers over postpayment. To secure and sustain such benefits, a service provider must be able to manage the operational challenges that a prepayment system presents, and the prepayment system must be cost-effective. This section explores what it takes to introduce and run a prepayment system so it delivers the benefits envisaged.

4.1 Why Service Providers Opt for Prepaid Water: Key Drivers

Many service providers believe that prepaid water meters can help them address some of the service challenges they face: limited funding to serve rapidly growing settlements, demand for water outpacing the available supply, aging networks, high nonrevenue water (NRW), poor payment levels, and so on (see Box 8). As section 5.3 points out,

BOX 8: SOME REASONS SERVICE PROVIDERS GIVE FOR INTRODUCING PREPAYMENT

Improve revenue

- Raise payment levels, improve cash flows, and avoid arrears and bad debt: Prepaid meters make payment unavoidable (unless customers bypass or tamper with their meters).
- Maximize collection: Stop staff from colluding with customers to alter their credit records, delete debt, understate meter readings, and so on.

Manage water demand

- Promote greater water conservation and reduced wastage: Prepayment raises awareness of consumption, and incentivizes customers to close taps and repair leaks on their properties.

Improve equity

- Sell water more equitably to poor customers using standpipes by cutting out intermediaries and supplying water at the same tariff or less than the provider charges customers with their own connections.
- Extend access beyond the hours that water vendors and tap attendants work.

Reduce the cost of doing business

- Reduce billing queries: Estimates, human error, and disputed bills can annoy customers, create extra work for utility staff and delay payment.
- Avoid disconnections, which are unpleasant both for customers and the staff who execute them.
- Streamline revenue administration: Reduce the number of staff required for meter reading, issuing bills, responding to billing queries, following up arrears, and disconnecting supplies; redeploy some of them to tracking leaks and following up anomalies revealed through analyzing purchase and consumption data.

Respond to explicit customer demand

- Give water users the benefits they currently enjoy with prepaid electricity, such as more control over consumption, more credible metering, no questionable bills, no debt or arrears, and various top-up options.
- Enable customers to pay only for the water they consume, rather than sharing bills and subsidizing nonpayment by others.

those who support prepaid approaches believe that the financial costs of the systems are in many ways outweighed by the benefits they can deliver for customers (see Box 21).

Their governments expect prepayment systems to be commercially viable and self-funding. Some are even expected to serve as "cash cows" for other sectors. Yet many of those same governments prefer to hold down tariffs at subeconomic levels, and offer meager subsidies, if they offer subsidies at all. Prepayment holds the promise of a remedy for low collection rates. Customers pay in advance for a specified amount of water from a shared or individual connection. There is no risk of arrears or debt, and, for the service provider, there is the prospect of healthier cash flows, more revenue to fund upgrades and wider coverage, and the resources to reverse or preempt the kind of downward spiral that makes tariff increases unlikely, however necessary they might be.

Some service providers see prepaid standpipes as their best option for providing more equitable services in low-income areas, but acknowledge that revenue income will not meet the costs unless cross-subsidies are in place.

Another set of drivers is the buzz and prestige associated with technological advances, such as smart metering and advanced metering infrastructures, as well as the increasing prevalence of prepaid systems for electricity and mobile phones. Upfront payment for services is a widely adopted practice. Despite political controversy about using prepaid systems for water—with access enshrined as a basic right in some constitutions and international declarations—there is growing demand from customers for the benefits they believe prepayment offers (see Box 9).

4.2 Most Service Providers Underestimate What Prepayment Entails

4.2.1 Managing Prepayment Is More Demanding than Conventional Meters and Billing

All of the service providers reviewed found that they had underestimated what it takes to run an effective prepayment system sustainably, and just how much maintenance, support, and monitoring it requires. Managing prepayment is more demanding than conventional meters and billing, with interdependent electronic, mechanical, and software components to manage, and more to go wrong.

Beyond the daily challenges of maintaining a reliable supply of safe water, a prepayment system has interdependent electronic, mechanical, and software components to manage and maintain at each connection site and vending point. It requires a network of credit vendors selling prepaid water that must be equipped, serviced, and managed. A credit transfer device is needed—either a physical token or smartcard, (which can get lost, stolen, or broken) or a numerical credit key, printed on paper or sent by mobile phone, and entered via a keypad that must communicate reliably with the device. Most importantly, at the heart of prepayment are customers whose trust in the new system must be earned and sustained. A fault on a prepaid meter can shut down the supply of water that customers have already paid for, or provide free water. Regular monitoring and data collection is essential to track performance and consumption.

Most service providers said they had focused on the potential to optimize collection and minimize debt, without taking into account the degree of back-office integration necessary. Especially challenging has been the additional maintenance required, and the importance of equipping staff to engage effectively with customers around prepayment. Managers found themselves exchanging one set of challenges (around payment) for another, with which they were less familiar (Figure 12).

This may be a particular challenge for small-town municipalities and the small private providers they often contract. The experience of a pilot project in Koboku, northern Uganda, from 2011 showed that small towns relying on private operators may struggle to implement and sustain a prepaid water system. In particular, Koboku's small operator struggled with procurement and cash flow requirements needed to source stock and spares, and was dependent on external technical support, travelling from another country, to set up the management system and address faults.

BOX 9: 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 now want to manage their water purchases in the same way. But prepayment technologies for water lag far behind those for electricity. Three main issues explain this.

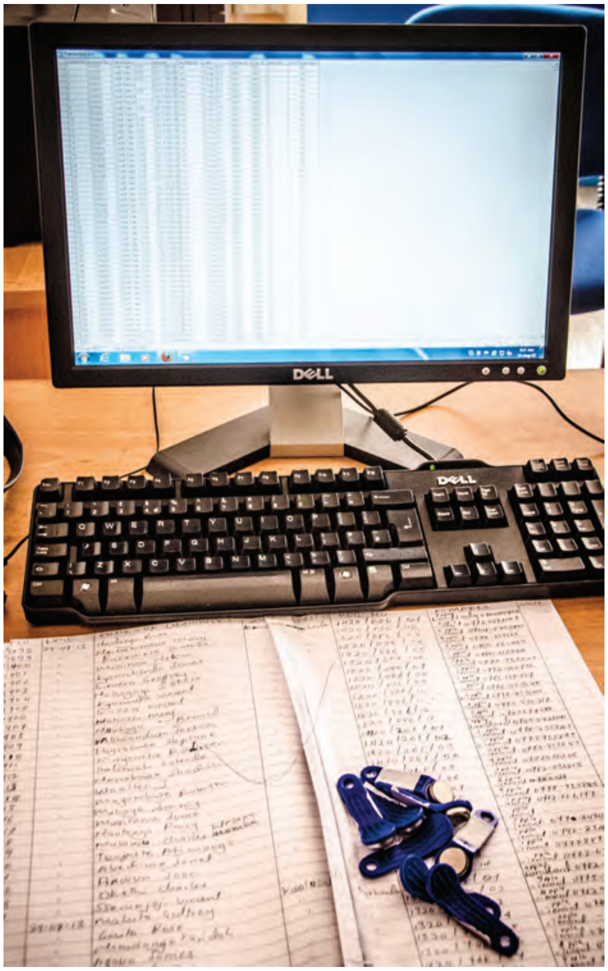
- Prepaid water meters face physical stresses that do not apply to electricity. There are more moving parts, most subjected to fluctuating pressures and flows, and wear, fatigue, and abrasion increase the likelihood of malfunction. Grit, debris, and air affect water metering in ways that are not relevant 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. All of these issues make prepaid water a less reliable technology than prepaid electricity.
- The electricity sector is much less fragmented than the water sector, and has far greater clout to direct what manufacturers supply. For more than two 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.
- 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. The real breakthrough will be when nonmechanical water meters become more affordable, because this will lessen prepaid water meters' vulnerability to debris in the network.

Adapting to prepayment requires a significant shift in the way service providers organize their operations. Customers who have paid in advance for water have a right to expect a prompt response in case of a service problem. Yet few service providers have revised their operational management systems to support quick response times and speedy resolution of likely problems. Lusaka Water is an exception, as it is aiming to make prepayment the default across the city. For this purpose, it established a dedicated prepayment department, which has led the development of streamlined operating procedures to speed-up call-outs and accelerate resolution of queries.

Developing an integrated post- and prepayment revenue management system can be challenging. Service providers' revenue management systems are configured for postpayment, where the relationship between consumption and sales is straightforward. With prepayment, consumption

FIGURE 12: MANAGERS OF PREPAYMENT SYSTEMS OFTEN FACE AN UNFAMILIAR SET OF CHALLENGES



follows sales. Credit might be used over more than a month, and the relationship between credit purchased and volume sold may be affected by the impact of a rising block tariff (if used over one month, it buys less water than if the same amount of credit was used over two months or more). Regular meter reading is needed to track real-time consumption and calculate water balances and NRW accurately (Box 10).

Effective operational management of prepayment may need more staff, not less. Several heads of service providers said they anticipated human resources savings from prepaid meters—primarily because they will need fewer meter readers and billing and credit-management staff. The overall staff numbers required might not be fewer, if a reduction in billing and credit-management staff is offset by additional customer engagement and technical support staff. This may be the case particularly in areas served by communal water points. Beyond interacting with local administrations and leaders, community liaison staff is kept busy building acceptance and understanding of prepayment, and helping to deal with software errors and token faults. Vending management entails a range of new relationships and support needs, with special effort required to support integration of prepayment with the existing revenue management function. Meter readers are redeployed from meter reading for billing to meter reading for monitoring, because consumption data must be collected to track NRW. Finally, because more can go wrong with prepaid meters, additional technical staff may be required to respond quickly to faults.

BOX 10: PREPAYMENT DOES NOT GUARANTEE LOWER NONREVENUE WATER

Prepayment metering can improve or worsen NRW, depending on how well the system is managed. Volumetric tariffs and more accurate metering will reduce NRW, and prepayment cuts out a range of administrative losses arising from data capture errors, wrong tariff codes, and incorrect addresses for billing. NRW will increase where reduced consumption raises water pressure and the leakage ratio, and where faults, tampering, and bypassing provide free water.

When a service provider signs up prepaid customers who use a shared tap and issues them an iButton or smartcard, it signs up a substantial number of new customers with whom it has a direct service relationship, even though the number of connected water points barely changes. This calls for a reassessment of staffing ratios, service norms, and desirable indicators to assess the effectiveness of service provision, in contexts beyond postpaid individual connections.

4.2.2 Prepayment Raises Expectations: A Customer Focus Remains Imperative

Improved payment levels are about more than the technology of payment and collection. Technical approaches that assume that customers will accept prepayment with minimal consultation or engagement may invite bypassing and vandalism, and will fail to address the underlying reasons for poor payment.

Nearly all African water service providers face a tough dilemma. Without improved collection rates, they will struggle to fund service improvements, but without service improvements, customers have little incentive to pay promptly. Opting for prepayment meters to resolve low collection rates before attending to service deficiencies is likely to prove contentious.

"Customer care remains key," said a Mogale City technician. "If you put [PPMs] in and forget about them, you can forget about your money too." If anything, prepayment requires even greater interaction with customers: building acceptance for paying for water among people who have not previously paid; developing trust in prepayment; negotiating installation; explaining charges and issuing tokens; showing customers how to use the prepaid meter; and following through with regular monitoring, maintenance, and interaction. In addition, the introduction of prepaid meters on communal meters offers service providers the opportunity to establish direct relationships for the first time with a vast new base of customers who were previously served, often poorly, through intermediaries.

The way prepayment meters are introduced is decisive. Some managers argue that available funds are better spent maximizing the extension of services to new areas, rather than on interacting with people who are already serviced. Yet the value of vast investment in physical infrastructure can be compromised if customers feel they were consulted inadequately before installation, do not understand the tariffs and charges, or are not confident using the meter.

Proactive communication is essential for helping customers understand the reasons for the service provider's change in payment strategy and how it may impact them. When individual prepaid meters replace aging conventional meters, education programs need to alert customers that their metered consumption may be higher than they are used to, because the older meters may have been under-reading. Equally, large households on fixed tariffs may pay more when paying a volumetric tariff, especially if there are unnoticed leaks. House-to-house visits and local public meetings are essential to develop a direct engagement with the customer (Figure 13); media campaigns and publicity are not likely to be enough. In Kampala, the value of augmenting the National Water team with social science expertise has been demonstrated through enhancing the organization's understanding of its customers' needs and those of specific subgroups, notably women and children, and its capability to engage with them.

FIGURE 13: ONGOING INTERACTION WITH CUSTOMERS IS ESSENTIAL

4.2.3 Demand Management: A Different Business Case for Prepayment

Prepaid meters on individual connections promote greater awareness of consumption and waste than conventional meters, because the relationship between payment and consumption is more direct. Customers say they no longer leave taps running and notice leaks sooner, and have an immediate incentive to attend to repairs because they can see their credit drain rapidly if they do not.

For customers, lower consumption translates to lower spending on water. For service providers, lower consumption means less revenue for the service provider, while fixed overhead costs remain the same. Leak repairs on large institutional customers (notably big government housing estates or army barracks) can reduce consumption by two thirds.

But reduced consumption also means more water in the network, higher pressure, and potentially higher leakage and NRW. In Kafue, Zambia, reduced consumption and higher water pressure raised the leakage ratio to the extent that Lusaka Water was obliged to halt the installation of prepaid meters and allocate resources to repair and replace sections of the network. Once the upgraded network was repaired, at significant cost, the combination of reduced consumption and fewer leaks meant that the hours of supply increased from less than 15 hours to a continuous 24/7. Lusaka Water has moved from a significant supply deficit in Kafue to having sufficient water to extend coverage to new areas, with lower NRW.

In Mogale City, South Africa, water officials found that the business case for saving water was very different from that for recovering the cost of supply. Mogale City moved from low payment of a fixed tariff irrespective of consumption, to prepaid metering with a volumetric tariff. The gains with prepayment were substantial, but not primarily from revenue collection. Purchases by low-income customers beyond the free basic allocation were modest. The real benefit was lower NRW and lower bulk water purchases. Average monthly household consumption dropped by nearly two thirds, from more than 29.9 m^3 to 11.2 m^3 over 21 months from early 2006, as part of a focused demand management intervention that tracked 677 households new to prepayment and a metered tariff. Significant energy savings accrued from pumping lower volumes of water (Olivier and Fouche 2007).

4.3 Three Core Challenges

4.3.1 Improved Technical Performance and Reliability

Prepaid water metering can support service improvements by improving revenue collection to extend coverage, increase connections, and fund improvements, and through better demand management that can make more water available to raise pressure, extend supply hours, or serve other areas. But it can worsen access to water where the technology is unreliable and response times are inadequate.

Prepayment technologies are improving, but even the best systems are more vulnerable to faults and failure than conventional metering systems. They are more complicated, and have higher maintenance costs and a shorter average life cycle (seven years is generally the outer limit, which is half that of conventional meters). Batteries fail, valve diaphragms and seals wear, moisture disrupts the circuitry, and communication errors between the credit token reader and meter can affect supply. A common cause of faults is worn seals or diaphragms that cause the valve to lock, cutting off the supply entirely, or stay open so that water flows continuously.

Prepaid metering can magnify the impact of network deficiencies. A critical vulnerability is that mechanical meters are prone to errors caused by air and grit in the water network. This fault is common across all metering applications, but the impacts are more serious in a prepaid meter. Air in the system after a supply interruption can spin the counters and erode credit, and grit can jam the meter. Low water pressure can shut down water meters; irrespective of whether customers have credit remaining (see Box 11). Most meters require a minimum pressure of 1 bar (a head of water of 10 m) to register flow and read accurately, although some can be set to cope with pressure as low as 0.2 bar. But water pressure is likely to increase when prepaying customers reduce their consumption, and with that, leaks and NRW may rise.

The performance and reliability of prepaid meters vary markedly. Water managers in the eight case study cities have had experience with 10 makes of prepaid meters between them (see, for example, Box 12). One manufacturer

BOX 11: PREPAID METERS DO NOT COPE WELL WITH WATER SUPPLY INTERRUPTIONS

Twenty-four/seven water supply should be considered a minimum requirement when installing prepaid meters, because air and grit can get sucked into the network after a supply interruption and cause the prepaid meter to malfunction. Grit can jam the valve open (free water) or closed (no water), and air can spin the counters in the mechanical meter and exhaust the remaining credit without supplying any water. This vulnerability makes prepaid metering an unsuitable choice for cities with regular supply interruptions that may be looking to prepayment to improve collection rates.

Water utilities are learning to focus their prepaid meter installations in areas with 24/7 supply and water pressures levels that the meters can tolerate. In areas where service interruptions are likely, the service provider may have to pursue other technologies, or budget extra to upgrade the network, street by street. Without this, service quality for customers will deteriorate and prepayment metering will be associated with more frequent supply interruptions. But service interruptions contribute to low payment rates. “If you don’t sort out your network, you’ll never get decent collection rates,” said one technical manager.

Bypassed prepaid standpipe meters because of low water pressure in Kanyama, Lusaka. The utility has now installed a conventional meter and tap ahead of each prepaid standpipe, and tap attendants sell the water per container for cash, bypassing the disabled prepaid device.

currently dominates the market for prepaid standpipes, but there is more competition among suppliers of individual meters. One recent entrant in particular shows promise of much improved reliability where the supply is 24/7 and the pressure relatively constant.

Some brands perform comparatively well, while others are notorious. Among the worst performers, one service provider said 20 percent of installed units failed in the first six months; another described this type as “just an expensive tap,” and removed them all within 18 months.

Pricing varies significantly, but all service providers who bought on the basis of the lowest price have been disappointed. Inexpensive devices can prove costly when they fail within a year or two and when reparability, access

BOX 12: TOO COLD FOR COMFORT: WINTER CHALLENGES FOR PREPAID METERS IN MASERU

Lesotho is known as the mountain kingdom, and has very cold weather in winter. This raises the maintenance load significantly for WASCO staff when the prepaid meters ice up inside and shut down. In the cold months, there are up to 60 call-outs a day in subzero temperatures, against a total of about 3 500 prepaid meters. Learning from these experiences, WASCO technical staff prepares refurbished meters in advance to swap in and out within five minutes to minimize the inconvenience to customers. The utility bears the full cost of all maintenance.

In 2011, the utility introduced 300 meters of a different type that were designed to cope with subzero temperatures. Programming the software on the new meters to meet WASCO's needs presented challenges that could not be resolved. WASCO wanted to be able to track whether customers were buying credit each month, as a way of identifying possible tampering or bypasses, but instead the meters cut-off supply entirely if no credit was bought within a 30-day period. This inconvenienced customers and created extra work for utility staff. After 18 months they were all removed, and replaced with more of the frost-sensitive type. Mounting the meter units inside a robust plastic container below ground has reduced their vulnerability to low temperatures.

Although the managing director believes that prepaid meters help improve revenue collection, and that customers really want prepaid meters because they feel in control and can manage their consumption in line with what they pay upfront, there are also concerns in senior management that prepaid meters remain unreliable and require high maintenance, particularly in winter.

to spares, and aftercare is poor. The realistic working life of the device before replacement is a critical cost consideration, particularly with proprietary systems that do not allow service providers to mix and match components. Price alone is not an indicator of performance, as even some mid-range meters have proved unreliable, unrepairable, and poorly supported.

Two trends are evident among suppliers of prepaid meters: a growing number of suppliers are entering the market with the aim of competing on price, while more sophisticated high-end models that aim for robust reliability are being developed. If the performance of prepaid meters improves and demand increases, perhaps large production runs and scale economies will allow the benefits of more reliable technologies to be shared more widely at lower prices.

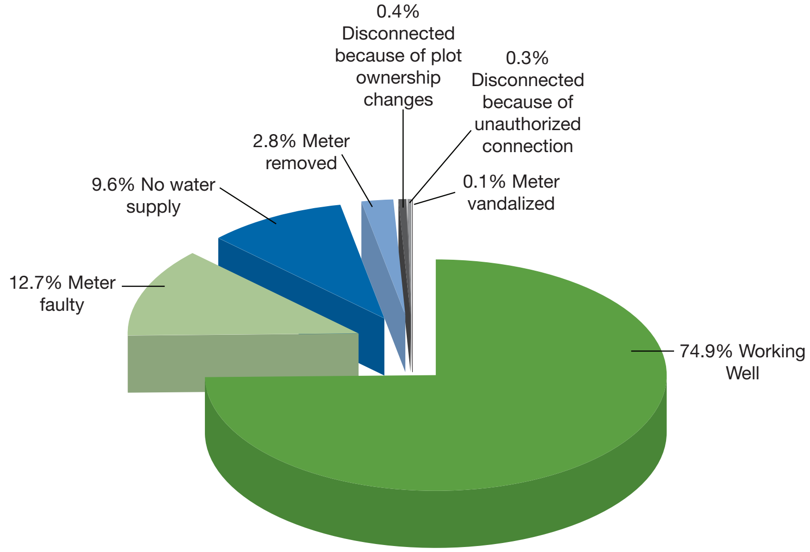
Limited record-keeping constrains management's awareness of the high maintenance burden. Most service providers do not keep detailed records of prepaid meter call-outs and repair costs, and can only give anecdotal accounts of call-outs, service failures, and maintenance requirements. This constrains sober assessment and awareness by service providers, beyond maintenance units, of what it takes to keep prepaid meters working.

Analysis of the data that service providers do collect gives some indication of performance. Box 13 provides two useful snapshots of the performance of prepaid standpipes. Both use the same make of prepaid meter that is used widely on standpipes.

These findings flag the importance of service providers developing the capability in-house to respond swiftly to call-outs and undertake repairs themselves, rather than paying suppliers or their agents. Yet every technical team interviewed said they were under-resourced: They needed additional personnel, more vehicles, and the budget and procurement support to carry a larger inventory of spares.

BOX 13: SOME PERFORMANCE DATA ON PREPAID STANDPIPES

FIGURE 14: STATUS OF 1,223 METERS IN FEBRUARY 2014

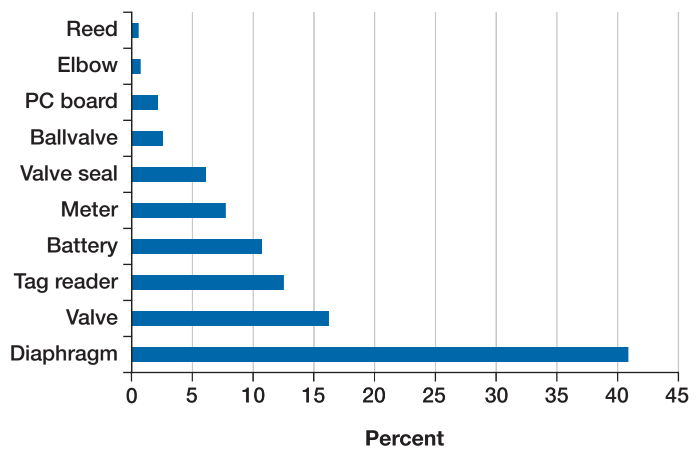


Source: Data provided by NWSC

In Kampala, National Water reads every standpipe meter monthly and records basic performance data. Figure 14 shows the status of 1,223 prepaid standpipes on the day they were visited in February 2014. Three quarters (74.9 percent) were working well on the day their meters were read in February 2014.

Technical faults with the prepaid meter accounted for half the number not delivering water; more general service problems explained the lack of water at the remaining 12.4 percent of sites. Performance was markedly worse at meters that were more than three years old, with almost half not working. Average consumption per meter from a sample of 455 for which data was available over a six-month period was 34.6 m^3 per month.

FIGURE 15: ANALYSIS OF PREPAID METER FAULTS ON WINDHOEK STANDPIPES REQUIRING REPLACEMENT PARTS OVER A 10-MONTH PERIOD, 2012–2013



Source: Data provided by Windhoek City Council

Windhoek City Council files records of all call-outs but does not collate or analyze the data. Call-outs are most commonly the result of customers reporting that they cannot get the water they have paid for. About 20 percent of calls report water running nonstop from the meter. Records from a 10-month period in 2012–2013 show 1,135 call-outs from 582 meters (Figure 15). Most prepaid standpipes are three years old or newer. This represents just over two call-outs per meter per year, in a context of 24/7 water supply and adequate water pressure.

The most common problems were software errors, valve faults, and low battery power. Two thirds of call-outs required replacement of parts; of those, 63 percent involved the valve—a seal, a diaphragm, or the entire latch valve. Replacement of the parts shown in the graph cost the city just less than US$30,000. Per meter, this averages nearly 10 percent per year of the US$550 purchase price of each standpipe device. In addition, Windhoek replaces the batteries proactively every 18 months, and more frequently where individual batteries fail before this. Each battery costs about US$42. In areas of dense settlement and intensive use, batteries may fail after as little as three months.

FIGURE 16: COLLINS OUMA, A SELF-TAUGHT METER REPAIRMAN IN NAKURU, KENYA, REPAIRS A LEAKING SEAL WITH A MAKESHIFT PLASTIC GASKET

Reparability and ready availability of spares is critical for optimizing turnaround times. Some types of prepaid meters cannot be repaired locally because of how the components are assembled and they have to be returned to the supplier (Figure 16). Service provider staff in Kampala, Maseru, Nakuru, and Windhoek has built up the skill and experience to repair their meters themselves. All use the same type of prepaid meter, and its reparability is an important reason why many service providers prefer it. But difficulties in sourcing spares and delays in delivering them can mean that shared water points designed to serve more than a hundred people may stand unusable for months, and put pressure on other water points. Where meters are not reparable, service providers routinely swap out faulty meters on individual connections and replace them with new meters, or install an unmetered "straight-through" connection that supplies free water, or revert to a conventional meter.

Regular monitoring is essential to track real-time consumption. Meter reading is just as important for prepaid meters as for regular meters, because service providers need consumption data to monitor demand and NRW. Equally, faults, bypassing, and tampering can result in high NRW losses (see Box 14). Customers are likely to report faulty meters that do not dispense water. Users of prepaid meters on communal standpipes are as likely to report "no water" as water that flows continuously, where it inconveniences them. But customers with their own connections might not notice and are less likely to report meters that dispense water for free.

Data collected using automatic meter reading (AMR) can help flag free water swiftly, but AMR is seldom cost-effective for low-volume consumption. Regular proactive visual inspection remains essential, even with AMR, to spot ground disturbance and evidence of pierced valves.

BOX 14: REGULAR MONITORING IS ESSENTIAL TO MINIMIZE NONREVENUE WATER

In 2012, Mogale City municipality commissioned a performance audit of 10,000 prepaid meters—nearly a third of the total—after adverse comments by the Auditor General about high NRW figures in its annual financial statements. The results were sobering. Eight years after installation, more than 90 percent of the meters were found to be faulty. The vast majority was delivering free water, either because the valves were jammed open, or because customers had bypassed or tampered with them. These findings prompted a far-reaching change in strategy, with a new emphasis on regular monitoring and swift follow-up on exceptions.

Tampering (left) and bypassing (right) have fallen sharply in Mogale City since the municipality appointed a service provider to do regular visual monitoring, meter reading, and exception reporting.

Few service providers are using the data capabilities of prepaid systems to track consumption trends and respond to exceptions. With some exceptions, service providers are not yet fully exploiting the data capabilities they have invested in. In their defense, most are using fairly dated proprietary software that is slow, unwieldy, and inflexible once it has been configured. It is also expensive, which is a deterrent to regular upgrades and customization.

Two exceptions are Mogale City and Lusaka. Mogale City has service providers doing visual inspections and a combination of manual and automatic meter reading to collect data, analyze it, follow up on exceptions, and do maintenance across a growing proportion of the city's 35,000 prepaid meters, and report on their findings to the municipality finance and water department (see Box 15). The data is useful for tracking seasonal consumption trends, calculating water balances, identifying households consuming more water than they buy or bypassing their meters, and so on. Another is Lusaka Water, which is collecting data fortnightly with drive-by automatic meter reading to pick up faults and problems early on in its new prepayment systems.

One supplier suggests that the costs of prepaid systems could be lowered, and the overall management could be streamlined, if service providers kept their data demands simpler, and used the data available to them already. According to him, "Service providers are demanding more and more bells and whistles on their systems which they never use."

BOX 15: TURNKEY MANAGEMENT CONTRACTS OFFER A ONE-STOP SHOP OPTION, AT A PRICE


A committee member fills his container.

Athi River, Kenya: One manufacturer has developed a standalone prepaid system for a shared water point outside of the utility supply area, with a full-service contract. It has a solar-powered borehole and solar-powered prepaid water dispenser that provides water to customers at the same price as local water vendors, but more reliably. Forty of these systems have been have been installed in East Africa since 2008, and the approach seems to be working well. The capital and installation cost is very high, but the system is robust and supported by a prompt and efficient back-up team. The system is monitored constantly via an Internet link, and a maintenance crew is dispatched in response to automated alerts. Users say supply interruptions are rare.

A local community-based organization (the "Ten Sisters and Fifteen Brothers Self Help Group") manages the system day to day, and receives the balance of funds once costs are covered; the CBO's main source of income is from selling water at a markup to customers who do not have their own credit token. The CBO employs an attendant and security guard.

Customers top-up their credit using their mobile phones, and receive a token number by mobile phone. They enter this number and top-up their Dallas key on the dispenser itself. The mobile phone operator charges no fee for this service, as it benefits by locking customers into its network. The phone company pays the service provider, which deducts its service fees and pays the balance to the CBO.

In 2014 the manufacturer will introduce a new prepayment system and service package that is priced more competitively.

Mogale City, South Africa: The municipal water department first adopted prepaid water in 1998, and after trying different permutations of in-house and external installation and management, has now opted for a full turnkey contract to supply, install, maintain, and monitor 39,000 prepaid meters. It first piloted this approach by replacing aging prepaid meters in a 1,026-unit installation at an upmarket housing estate. It quadrupled sales in the first month with the new meters, and sales now average more than three times what they were because of regular visual monitoring and firm action against those who bypass or tamper with their meters.

This approach was then scaled up to cover 4,600 units. A new expanded contract will serve 39,000 meters, with a drive-by automatic meter reading component. Some visual inspection will be retained to remind customers that bypassing and tampering will be noted.

4.3.2. Improve the Convenience to Customers of Credit Top-Ups

For a management system that is premised on advance payment, a surprising finding is how inadequate most credit vending arrangements are. Most service provider's planning emphasizes physical installation of prepaid meter units and their associated reticulation and plumbing, not the development of a wide network of conveniently located credit vendors (Figure 17).

Easy credit purchase is one of the most critical success factors for a prepayment system. Making payment easy, pleasant, and convenient for customers is one of the most basic requirements for raising payment levels, yet this is one of the weakest links in the prepayment service cycle.

The comparatively high perceived cost of vending infrastructure limits the number of top-up sites. A point of sales device on its own can cost as much as US$2,000, with the vending software a further US$15,000 or more.

Service providers are usually cautious about the number of credit-loading devices they purchase initially, while they are still piloting prepayment or trialing a particular make, and are often slow to expand later. Most prepaid water systems use proprietary hardware and software, and service providers may find themselves locked into a technology that is relatively inflexible and expensive to maintain and change. Service providers that are unhappy with the performance of their systems are often reluctant to invest in additional vending sites. They might then move on to try another make of prepaid meter in a new area, and set up a new proprietary vending system to serve new customers there, leaving their existing customers no better off, and with no prospect of improved credit-loading options. Customers expressed great frustration with the inconvenience and cost of travelling to distant top-up points.

Where water service providers stipulate that their suppliers must comply with the nonproprietary Standard Transfer System (STS) specifications developed for prepaid electricity (see Box 16), there is scope to reduce the cost of vending infrastructure substantially and offer customers the convenience they want. STS is an open standard

FIGURE 17: IN KAMPALA, NATIONAL WATER SELLS CREDIT THROUGH A NETWORK OF 23 SMALL BUSINESSES

Vendors purchase credit in bulk from NWSC and sell it to customers, using a point of sales machine that loads credit onto the customer's credit token. The credit vendors earn 10 percent commission on sales. This vendor's main business is a clothes and dress-making boutique, where she earns about US$150/month selling water credit.

BOX 16: STANDARD TRANSFER SYSTEM: A GAME CHANGER FOR PREPAID WATER?

South Africa's national electricity supplier, Eskom, led the development of prepaid electricity, and was large enough to require meter manufacturers to conform to common standards and design protocols. Proprietary hardware and software benefits its suppliers by locking customers into exclusive products. Eskom turned this around, and from 1993 required the suppliers of prepayment systems to design for compatibility.

The initial focus was on developing security and encryption capabilities for numerical prepayment credit tokens, so that third parties, such as supermarkets, could sell prepaid electricity credit on commission. This would give customers the convenience of a wide range of pay points for buying prepaid electricity, and allow the electricity service provider to stay focused on its core business. A number of specialist vending management companies have subsequently emerged to handle bulk credit sales and cash handling, and to provide support for a large number of vendors. Those third-party vendors sell prepaid electricity primarily to increase foot traffic to their own businesses, in return for a small commission of about 3 percent.

This encryption standard was called the Standard Transfer System (STS). The specifications were subsequently expanded to define the requirements for interoperability, allowing service providers to mix and match compatible components from different suppliers. This had the effect of spurring competition in addition to price and quality improvements in prepaid electricity metering.

In 2007, STS was adopted by the Geneva-based International Electrotechnical Commission as the international specification for vending and credit token encryption for prepaid service providers, and now straddles electricity, water, and gas. It is used in 84 countries with about 130 suppliers certified as compliant. The latest specification, released in May 2014, is contained in IEC 62055-41 and is available on the Internet.

More and more water service providers are asking for STS compliance, and suppliers are under pressure to offer compliant meters. By mid-2014, three manufacturers serving the water sector have been certified as STS compliant, and this number is expected to rise rapidly. This signals the start of a big shake-up in the prepaid water market.

Key benefits of STS compliance include:

- **Compatibility.** The common specification allows service providers to mix and match components, and opens the way for greater competition around price and quality.
- **A common vending platform.** A common platform allows the service provider to share the cost of providing vending infrastructure with others already in the market. A water service provider will be able to sell prepaid water credit from the same places and devices that sell prepaid electricity and even mobile phone "air time." The comparatively high cost of proprietary vending devices has been a key constraint on providing more vending sites.
- **Customer convenience.** STS compliance gives customers the option of buying prepaid water from more places, 24/7, by mobile phone or over the Internet.

A credit purchase receipt, showing the 20-digit numerical token that defines encryption protocols for credit transfer, and decoding protocols for prepaid meters so that the credit data is interpreted correctly and the meter functions as required. STS-compliant prepayment systems allow water service providers to piggyback on vending systems set up for prepaid electricity, and means prepaid water credit can be sold by a wider range of retailers or via mobile phones and the Internet 24/7. STS-compliant credit tokens can be loaded using smartcards, Dallas keys, or with a keypad using a 20-digit code delivered by SMS or on paper. Two of the case study cities (Mogale City and Lusaka) are currently introducing STS-compliant systems.

The increasing use of ICT in Africa may help make prepaid systems more effective, eliminating cumbersome token usage and vendors. Mobile phones are an obvious vehicle for loading credit and paying for water. Most poor families have a mobile phone, and the vending infrastructure for "air time" is extensive and well developed. At least two manufacturers of prepaid standpipes currently support credit recharge via SMS, but the credit still needs to be loaded onto a physical token, and their proprietary systems are not widely used. Many current vending challenges could be resolved using an STS-compliant SMS-based system capable of supporting multiple users at a standpipe that does not require a physical token. The challenge is to develop a system that is robust enough to withstand intensive use outdoors in all weather.

4.3.3. Provide Better Safeguards against Inconvenience and Hardship for Customers

Water is both a human right and a commodity. Both characteristics need to be taken into account to safeguard sustainable access to water for all. Prepayment offers many benefits, but better safeguards are needed to buffer customers against inconvenience and hardship when their water supply runs out. This section has already flagged the need for quick response times to remedy inevitable technology faults, and more convenient vending options to make top-ups easier. But what happens when credit runs out and all vendors are closed, or the user has no cash to buy credit?

Mitigate inconvenience with a reserve supply of credit. Prepaid meters on individual connections can be programmed to hold a specified amount of credit in reserve. Customers can access this reserve if they run out of credit after hours, or at any time. A portion of their next credit purchase is allocated to top-up their reserve. Box 17 describes how this is implemented in Mzuzu, Malawi.

Mitigate hardship with an emergency supply of water. In several cities where the prepaid meters have been programmed to support it, customers can activate an emergency supply of water (usually three or four cubic meters) beyond any remaining credit or reserve. This amounts to a form of water overdraft, and the deficit is returned to zero at the next credit purchase, or later by arrangement.

Preempt hardship with special measures to ensure households are not denied access to prepaid water because they cannot afford to pay. Prepaid metering provides a precise, effective mechanism for targeting subsidies to poor and vulnerable households. The subsidy can be accessed in different ways, depending on how it is targeted:

- Service level targeting, for example, a lifeline tariff for all customers using a prepaid standpipe.
- Spatial targeting, for example, a lifeline tariff or other measures for all households living within a defined area.
- Individual targeting in cases of special need, as a standalone support measure or in addition to benefits provided through service level or spatial targeting.

The subsidy mechanism can be programmed on the prepaid meter itself, with the option of providing additional measures or concessions through a customer's individual credit token. This allows measures that target the intended beneficiaries even if they do not have a connection of their own. This represents a significant advance on subsidies that are at risk of capture by intermediaries, without the benefits being passed on.

BOX 17: COMMUNITY ENGAGEMENT AND CUSTOMER SAFEGUARDS IN MZUZU, MALAWI

In Mzuzu, Northern Malawi, the Northern Region Water Board (NRWB) is introducing prepaid meters in low- and medium-density settlements, and for institutional and some commercial customers. It is not targeting high-density settlements or areas served by standpipes, because the costs of installation exceed the likely income and because it wants to avoid any possible hardship to low-income families.

NRWB's approach was informed by close interaction from 2008 with service providers using prepaid meters in Lesotho, Uganda, Zambia, and South Africa. As part of its due diligence, the company seconded three members of staff to work in two utilities to learn more about the practical management of prepayment. Among others, its application of two lessons from these exchanges seems particularly pertinent. The first lesson concerned the importance of not imposing prepayment, but rather engaging with customers through letters, house visits, and public meetings, and offering prepayment as a choice. Another lesson was the need for safeguards to minimize inconvenience or hardship. Implementation began in early 2013.

In Mzuzu, prepaying customers can avoid running out of water afterhours or on weekends when credit top-up facilities are closed by accessing a programmed reserve. Their prepaid meter stores a certain number of purchased units (usually 3 m^3) in reserve, where they remain available for use when the regular credit runs out. Customers can activate this reserve at any time and access enough water to supply them for a few days while they make arrangements to buy more credit.

If this reserve is exhausted, there is an emergency "fire mode." If activated, customers can access an emergency supply even when there is no remaining credit. This "overdraft" is paid off the next time the customer buys credit. NRWB says there have been cases where this emergency credit has been accessed in cases of hardship, and where it has waived payment or made special arrangements for the amount to be paid off over time.

NRWB is open to negotiation in special cases, and has supplied water on credit to both domestic and institutional customers, where the customer negotiates payment by an agreed date. This has proved important for some institutional customers as it provides an uninterrupted supply for when the available credit is exhausted, before the next round of monthly funding by Treasury.

Most of the service providers in this review provide a lifeline tariff to customers using prepaid standpipes, and a rising block tariff for those with an individual connection; the first block set at social tariff. The benefits of a simple, fixed, predictable tariff that is easier for customers to understand than a rising block tariff need to be weighed against the relief that a rising block tariff can offer poor customers. South African municipalities take the principle of a rising block tariff further by providing the first 6 m^3 free to poor households each month, with the cost funded by taxpayers through the national government (Box 18). Prepaid meters make the administration of this benefit relatively straightforward.

4.4 Summary

Water services are replete with examples of good service delivery technologies that are marred by unhappy customers and conflicts between users. Yet the evidence suggests that the converse is true for prepaid water metering: Most customers are comparatively happy with prepaid water

BOX 18: "FREE-PAY" METERING IN MOGALE CITY, SOUTH AFRICA

Mogale City provides the first 6 m^3 of water monthly to all its domestic customers for free. The free basic allocation is allocated automatically on the first day of each month, and prepaid meters in that municipality are programmed to treat the first 6 m^3 as the first increment of a rising block tariff, with the tariff set at zero. Analysis of consumption data from a sample of 4,500 prepaid customers in Mogale City shows that roughly half of those living in Kagiso, a low-income township, are able to keep their consumption within the 6 m^3 threshold, and pay nothing at all for their water. Municipal billing data shows that average consumption of postpaid customers in Kagiso is markedly higher, averaging about 20 m^3 per month.

meters, but the technology still lags behind what reliable service delivery requires. The contexts in which they are used calls for particular resilience.

Service providers need to gear up to manage their prepayment systems more comprehensively, with a greater emphasis on monitoring and maintenance. The challenge to manufacturers is to raise their game by offering more reliable products that can cope with the operating environments in which they are used.

There are also several enabling environment issues to address, such as social safeguards to ensure that poor people do not get excluded from services. In many African countries and cities this remains a challenge. South Africa's Free Basic Water facility may provide one way to deal with the challenge, but it may not be affordable to many institutions. Yet, this type of contextual response will prove critical as prepayment unfolds. On its own, the technology cannot resolve many of the major issues that face water services in African cities and towns. Its adoption must be matched by appropriate institutional reform and action, business planning that considers different options, and careful scrutiny and redress of the seemingly perennial underpricing of water. The next section of the report turns to the latter issue.

Reference

Olivier, F. and E. Fourie. 2007. "Prepayment Water Meter as a Revenue Enhancement Tool." Paper presented by Francois Olivier at the annual conference on Metering, Billing and CRM Africa, Cape Town, South Africa, May 16. http://www.metering.com/prepayment-water-meter-as-a-revenue-enhancement-tool.

V. Is Prepaid Water Cost-Effective?

The financial costs of the three applications of prepaid metering are substantial, and for many service providers they may prove prohibitive. This requires serious consideration, because service providers need to decide whether they can justify using scarce financial resources for such an expensive revenue collection mechanism rather than on other pressing needs, such as additional bulk water delivery.

Considering the benefits that prepayment could deliver, it would be unwise to advise service providers blankly against exploring this option. Nonetheless, given the strategic decisions required, service providers considering prepayment would be well advised to address the costs and revenue effects of introducing prepaid meters from the start in their business planning. They may also find it useful to weigh prepayment against alternative means of achieving similar benefits—for example, by improving billing management, strengthening interaction with customers, and managing tap attendants differently.

This section discusses some of the key financial issues around prepayment. It starts with a review of some basic costs, before a more strategic analysis of the wider implications for service delivery finances, including tariffs.

5.1 Basic Costs in Perspective

When discussing costs with service providers, the review team was told on several occasions that "prepaid meters cost about four times more than a conventional meter." This is based on the typical cost of a prepaid metering device for an individual domestic connection, about US$210, compared to typical conventional mechanical meter, about US$50. A brief review of the typical costs of a prepayment system shows that the full cost is considerably more.

Based on prices quoted by suppliers and figures provided by service providers in the different case study cities, the price of a prepaid meter for an individual domestic connection ranges from about US$100 for a basic device with questionable longevity, to about US$180 to 270 for a more robust device with a lifespan of about seven years. The cost of the same device can vary considerably from supplier to supplier. The most commonly used prepaid stand post device costs between US$540 and 616, excluding the cost of the concrete apron.

Beyond the device are all of the other components of the prepayment system that must be purchased upfront: management hardware and software, vending hardware and software, point of sales devices (US$800 to 2,200, depending on type), and credit tokens at US$10 each and more. The costs mount swiftly once staff training, integration with the postpayment system, and a basic inventory of spares are added in.

Figures 18 and 19 give an indicative breakdown of the cost of two prepayment systems, costed in 2013. Figure 18, based on information provided by the senior manager of the utility concerned, shows the utility's expenditure on a large pilot installation. Figure 19 summarizes costs from a 2013 tender submission.

Figure 18 shows a breakdown of costs for a prepayment system for 1,246 meters totaling US$476,500. This includes about 1,100 domestic meters with 15-mm gauge, at a cost of US$223 each, including their plastic casing. The rest were bulk meters for institutional and commercial customers, with meter gauges ranging from 15 mm to 100 mm, and costs varying by size. The cost of vending hardware in this example includes smartcards.

Figure 19 shows a substantially bigger installation of 20,000 domestic meters, with a total cost of US$5,702,362. The cost per meter, including installation but excluding system costs, was US$285. Credit tokens cost US$9.84 each.

Management hardware and software costs were similar at the two sites. Figure 19 shows that nonmeter costs are a small proportion of the total cost in a large installation. One implication of these charts is that the cost of vending infrastructure is a small proportion of the total cost. Limiting the number of point of sales devices is therefore false economy relative to the cost of dissatisfied customers.

FIGURE 18: INSTALLATION COST BREAKDOWN FOR A 1,246-UNIT PREPAYMENT SYSTEM FOR INDIVIDUAL CONNECTIONS, 2013

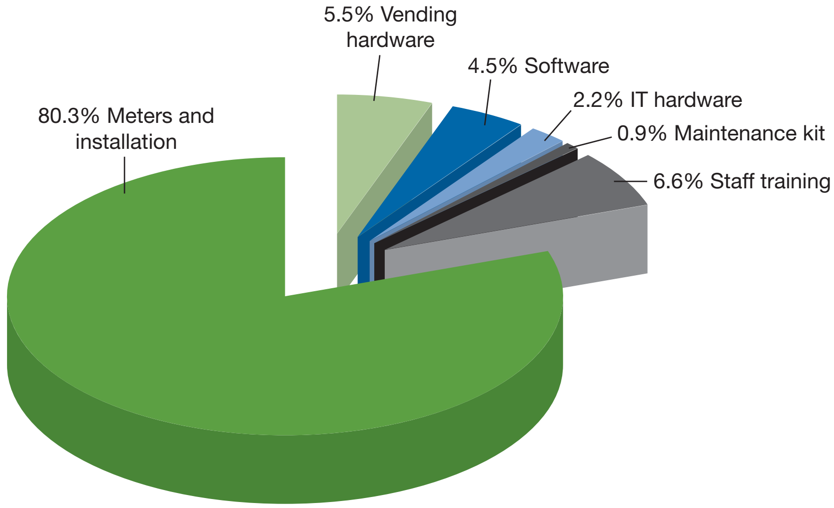
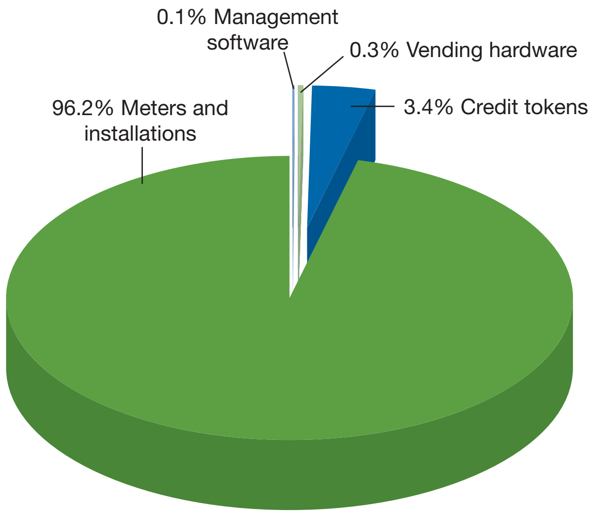


FIGURE 19: INSTALLATION COST BREAKDOWN FOR A 20,000-UNIT PREPAYMENT SYSTEM FOR INDIVIDUAL CONNECTIONS, 2013



These high costs flag the need to consider the realistic working life of the prepayment devices. Prepaid meters that fail and need replacement within the first year or two are not uncommon, and add considerably to system costs. Even the best systems currently available have a realistic life of about seven years.

Most installations to date have had significant funding support. Most installations to date were funded with substantial external support, and service providers have not had to fund the full capital project or cost of capital themselves. More and more are now using commercial or concessionary loans from private banks or international finance agencies. South Africa is an exception in providing substantial grant funding to support the cost of providing water services, including prepaid metering, in low-income settlements. At least 70 percent of the capital cost of prepayment systems in Mogale City, for example, is funded by the national fiscus.

Most service providers do not require a contribution from customers to the installation cost. With one exception, customers have not been required to contribute directly to the cost of the prepaid water meters in any of the cities reviewed (see Table 3). Lusaka customers with individual connections are charged a monthly rent of 8 Kwacha (US$1.22) per meter, which is the same amount charged to customers with conventional meters.

TABLE 3: SUMMARY OF TARIFF APPROACHES FOR PREPAID METERING IN THE EIGHT CASE STUDY CITIES

City	Tariff approach for prepaid meters
Kampala	The prepaid standpipe tariff is by far the lowest utility tariff
Lusaka	Prepaid standpipe users are charged a tariff roughly equivalent to individual customers, taking into account the additional monthly meter rent charged to those with their own meters. The tariff for prepaid and postpaid customers with their own metered connections is the same.
Maputo	Only tap attendants have a smartcard for the prepaid standpipe or ablution block tap. The utility charges them a special vendors' tariff, and they are allowed to charge a substantial regulated markup when selling to their customers.
Maseru	The prepaid stand post tariff is the lowest utility tariff. Customers with individual prepaid or conventional meters pay the same rising block tariff.
Mogale City	Prepaid and postpaid users pay the same rising block tariff. All get the first 6 m^3 free.
Nairobi	Prepaid meter tariffs are less than those for conventional meters, and the prepaid standpipe tariff is the lowest.
Nakuru	Customers pay slightly more than the regular tariff for individual customers, but less than the wholesale kiosk tariff.
Windhoek	Prepaid standpipe users are charged a fixed tariff that is lower than the tariff for individual connections up to 3.8 m^3 but pay as much or more than those with their own piped connection beyond that because of the way standing charges are calculated.

Most service providers are absorbing the higher capital and operating costs of prepaid meters into their general expenses. Prepaying customers are generally tariffed at the same volumetric rate or less than those who pay after consumption.

Several service providers have struggled to find an equitable tariff formula for customers with their own prepaid meter that ensures parity with the regular standing charge plus consumption tariff approach for customers with conventional meters. Difficulties in programming the software of some meters to accommodate a rising block tariff compounds this, and Lusaka and Nairobi's utilities are considering a fixed tariff.

5.2 Cost Effectiveness Varies across the Three Applications

Although the costs and benefits of prepayment systems need to be considered in a wider economic and social context that is not only confined to the financial aspects, it is necessary to look at some of the key financial issues in their own right. This is important not only to address obvious costs such as those discussed in this report, but also because recovery of real costs may require significant tariff adjustments. This would require approval from the relevant authorities or economic regulator.

The indicative financial model (Box 19) considers the likely costs and benefits of prepaid metering in different scenarios, and compares them with conventional meters.

BOX 19: NOTES ON THE FINANCIAL MODEL

This financial model's analysis is based on the costs of a generic fictitious service provider. It uses realistic generic data on costs, tariffs, and consumption for different categories of customers. Its purpose is to assess the financial consequences of using an expensive technology to sell different volumes of water at low water tariffs. It places no economic value on the preference that customers expressed for prepaid meters in household surveys and focus groups. Nor does it account for the economic cost of local water vendors' earnings being "exported" to foreign manufacturers.

Using a simple regulatory accounting approach, the model considers capital and operating expenditures, likely capital maintenance expenditures and a notional cost of capital. This approach has the same components as present value or internal rate of return analysis, but constructs the model in a way that is more comparable to consumer and service provider expenditures and accounting patterns. It looks at the costs incurred by consumers through different approaches as well as by the service provider, both for household prepaid meters and through stand posts.

The model uses averages. The model is indicative, populated with information that reflects averages of information from service providers during the fieldwork stage. The purpose has been to gain insights into likely overall costs and financial benefits, rather than assess the impact on a specific service provider based on any specific manufacturer's costs. It allows for an average mix of 6,000 household and 300 stand pipe prepaid meters, which offers economies of scale in management, software, and maintenance support. Prepaid systems are presumed to deliver 100 percent bill collection efficiency compared to 80 percent for postpaid meters. The model allows for cash flow benefits from earlier tariff payments and reduced supply-side leakage, reported when consumers monitor flow more carefully.

It was not possible to determine any indicative costs of reconfiguring service provider billing, banking, and accounting procedures to make best use of electronic prepaid billing systems. An overly generous assumption of zero cost was used for this.

The model tests different sensitivities. The sensitivity of the indicative results has been investigated by considering "best evidence" assumptions for the stand post service, bracketed by "challenging" or "optimistic" assumptions for consumption, meter cost, and meter life. Costs and consumption for individual domestic prepaid meter connections were investigated, using a range of consumption levels linked to broad income. Costs and volumes typical for large institutional/commercial customers were also modelled. These findings were compared with conventional metering approaches, using an assumption of 25 percent NRW and 80 percent bill collection efficiencies.

The findings are indicative. The model uses a broad brush approach, and aims to give a sense of the implications of this technology and its possible role in conventional service provider operations. Each service provider is different, of course, with varying cost structures related to bulk water, NRW, and cost reflectively of tariffs. These differences at the service provider level may affect the validity of the findings presented here.

Prepayment shows a net revenue loss across most applications. The financial analysis found that a typical service provider in sub-Saharan Africa would make a net revenue loss on all prepaid metering approaches at present tariffs, except for large institutional/commercial consumers (Box 20).

Using the same assumptions, conventional postpaid metered households and vendor-run stand posts make a small but positive margin, even allowing for reduced bill collection efficiency for stand posts compared to domestic connections. This is primarily because of higher sales income. Customers with their own postpaid connections typically use more water than those with prepaid meters, and tap attendants and vendors do not buy water at a lifeline tariff.

The findings indicate that prepaid meters on individual connections are not cost-effective, except at high average household consumption levels. Prepayment for large institutional customers, conversely, is very cost-effective.

The high cost of prepaid metering rules it out as a cost-effective remedy for billing and collection inefficiencies, except at high consumption volumes. The investment and maintenance costs are high, and much higher than current tariffs are designed to accommodate. This does not mean that prepaid meters are necessarily a wrong choice, but that their cost and revenue implications must be investigated and managed.

A key underlying issue is the pricing of water. The viability of prepaid systems (like most other aspects of a service provider's business) hinges on the tariff regime. If a service provider, for whatever reason, charges below cost (for example, through lifeline blocks), the added financial benefit to be gained from using a relatively expensive charging mechanism is an open question. The modeling results indicate high sensitivity to the underlying price charged for water. The average tariff charged by the service providers reviewed here is US$ 0.66 per m^3. The findings are influenced particularly by the lifeline tariff, which averages US$ 0.27 per m^3, using the data provided to this study.

The results are equally sensitive to the size of the lifeline block, modeled here at 5 m^3 per month), relative to the likely bulk water cost (assumed as US$0.25 per m^3 based on analysis of one service provider's bulk water cost).

Tables 4 and 5 summarize the findings of the model. The values used are well-founded, but indicative only. Their details can be debated, but the larger point is clear: Prepayment for water is an expensive approach, and only cost-effective at high consumption volumes.

Table 5 assesses costs for standpipes, with three scenarios for prepaid standpipes differentiated mainly by the cost of the prepaid meter.

The model shows that prepaid standpipes are more cost-effective than prepayment for individual connections with low or moderate consumption, because they aggregate the consumption of multiple households. But it also indicates that the combination of an expensive technology and lifeline tariffs may yield negative revenues from prepaid standpipes where tariffs and sales volumes are low.

With a one-third increase in tariff above the present average of US$ 0.66 per m^3, prepaid meters are viable for high- and middle-income consumers, institutional users, and stand post users, but not for low-income households with individual connections, who are likely to be accessing water at the lifeline tariff. The findings suggest that the cost of the prepaid system is presently too high to be supported financially through the sale of a low-priced product.

Costs absorbed across all consumers deliver a substantial benefit to people otherwise dependent on intermediaries. The model takes into account the significant finding that the additional cost of prepaid meters for standpipe customers is absorbed into the general costs of the service provider. This enables the lowest-income consumers to access water

BOX 20: PREPAYMENT FOR INSTITUTIONAL CUSTOMERS CONSUMING LARGE VOLUMES HELPS MANAGE DEMAND AND RISK, AND IS COST-EFFECTIVE

Large institutional consumers (police and army barracks, prisons, hospitals, schools, and government housing estates) are often the biggest payment defaulters, and erratic payments and bad debt affect service provider cash flows profoundly. Ministries of Finance routinely allocate funds for water to each ministry, department, or entity, but the funds are often diverted to other purposes. The ministry then allocates additional funds to settle some portion of the bill, while arrears continue to mount.

With the backing of their respective finance ministries, from 2013 service providers in Malawi, Uganda, and Zambia began introducing prepayment for institutional customers. In Zambia, installation of prepaid meters began at the president's residence.

Prepayment provides institutional customers with a strong incentive to manage consumption better and fix leaks, and offers the service provider smoother cash flows without the risk of bad debt. The combination of high-volume consumption, low transaction costs relative to purchases, and tariffs that are more likely to be cost-reflective, yields attractive revenue flows. Improved income through prepayment for large volume customers can help fund service improvements and subsidies in low-income areas, including, potentially, subsidies for low-income households using prepaid technologies.

Implementation has raised a number of unanticipated challenges. In Lusaka, for example, low water pressure initially compromised the performance of some prepaid meters, but once those leaks were repaired, consumption at some sites fell by two thirds; this, in turn, increased network pressure and resulted in a higher network leakage ratio.

Long-term neglect of maintenance at many sites has given rise to extensive internal leaks, such that even large purchases of prepaid credit can be exhausted within days. This problem is particularly evident at army and police barracks, college residences, and apartment blocks, and flags unresolved questions about where exactly responsibility lies for the cost of repairs.

Prepayment for schools and prisons is particularly controversial if it jeopardizes the continuity of water supply. At issue is that those who suffer the consequences of cut-offs are seldom those responsible for payment. Service providers in Lusaka and Mzuzu now make provision for special short-term credit advances for large prepaid customers, including schools, to safeguard continuity of supply.

TABLE 4: INDICATIVE ASSESSMENT OF COSTS AND REVENUE INCOME AT DIFFERENT LEVELS OF CONSUMPTION ON PIPED CONNECTIONS WITH CONVENTIONAL AND PREPAID METERS

Individual Domestic and Institutional Connections					
		Piped Distribution with Individual Prepaid Meters			
	Piped Distribution with Conventional Meters	Institutional	High-Income HHs	Middle-Income HHs	Low-Income HHs
Annual water consumption (m^3)	164.5	1,825	246.4	147.8	78.8
	Results with Average Tariff = US$0.66 per m^3	Lifeline Tariff = US$0.27 m^3			
Total annual costs to consumer per household or connection	US$133.8	US$1,297.3	US$177.9	US$112.9	US$73.1
Net annual revenue to utility per household or institution	US$2.3	US$393.7	US$1.2	US$26.9	US$42.7
	Results with Average Tariff = US$0.99 m^3	Lifeline Tariff = US$0.41 m^3			
Total annual costs to consumer per household or connection	US$176.3	US$1,922.9	US$247.5	US$150.0	US$90.3
Net annual revenue to utility per household or institution	US$27.1	US$878.6	US$52.8	US$1.8	US$29.3

TABLE 5: INDICATIVE ASSESSMENT OF COSTS AND REVENUE INCOME, COMPARING PREPAID STANDPIPES WITH CONVENTIONAL STANDPIPES AND VENDORS

Shared Standpipe Serving 35 Households				
		Prepaid Meter on Shared Standpipe		
	Standpipe Pay on Use/Individual Private Vendor/Operators/Suppliers	Optimistic Assumptions	Best Evidence Assumptions	Challenging Assumptions
Annual water consumption (m^3)	41.1 113 l/hh/d	49.3 135 l/hh/d	54.3 150 l/hh/d	49.3 135 l/hh/d
	Results with Lifeline Tariff = US$0.27 m^3			
Total annual costs to consumer per household	US$111.9	US$19.1	US$20.6	US$19.1
Net annual revenue to utility per household	US$3.3	US$6.1	US$9.2	US$11.9
	Results with Lifeline Tariff = US$0.41 m^3			
Total annual costs to consumer per household	US$156.6	US$25.8	US$28	US$25.8
Net annual revenue to utility per household	US$11.4	US$–0.6	US$–3.1	US$–6.4

at the lifeline tariff, rather than buying water at a vendor's markup. This is a significant benefit to those consumers. On average, the costs for postpaid metered standpipes are transferred directly to the lowest-income consumers through increased user charges (over and above standard rates). The analysis indicates that the use of prepaid meters might be beneficial to such consumers by a factor of six. This would mean that low-income customers could reduce their water costs by as much as 80 percent.

A move to prepaid communal supplies affects service provider revenue flows in different ways. Service provider business managers need to be aware that a move to prepaid communal supplies has four likely effects on revenue flows:

- More water is likely to be sold at subsidized lifeline rates (as opposed to the typical average rates when vendors have to pay for much of their consumption above the lifeline block).
- Vending costs will be absorbed by the service provider rather than through the private vendor passing them on directly to the customer.
- There could be an additional charge to revenue of between 5 and 10 percent for vending costs and commission.
- If service providers have been absorbing vendor costs, it is likely that "robot" vendors (prepaid water meters) will be more expensive than human vendors until the technology improves and becomes more robust and cheaper.

Greater cost-effectiveness would require a combination of a reduction in meter costs and an increase in tariffs. The results are not particularly sensitive to meter cost or meter life or to software or electronic vending charges. The key driver of cost-effectiveness is the tariff, which was not designed to accommodate the real costs of prepayment. In this model, a tariff increase of one third, off a low base, would require only a 10 percent reduction in meter cost with a 15 percent increase in effective meter life for prepaid meters to become financially viable for middle-income households as well. Alternatively, a 10 percent tariff increase would require a 35 percent reduction in meter cost and a 35 percent increase in effective life.

Expensive meters of any sort add to the base cost of already financially challenged service providers. A particular challenge of prepaid meters is their short effective life as compared with conventional meters. One implication is that service providers will face the challenge of renewing their prepaid meters much sooner than with conventional meters. Sourcing additional funds for replacement after a relatively short interval may prove onerous, particularly for those who funded the initial installation with generous external support.

Involve economic regulators or tariff approvers in planning early on. Managers are advised to be aware of these costs, and to ensure they are minimized to the extent possible. Managers should also be certain that the benefits derived in their particular situation do justify the added expenditure and its opportunity costs. Involvement of economic regulators or tariff approvers should be involved at an early stage so that the evident societal benefits of prepaid meters are understood and accepted and the resulting costs recognized and provided for through sound business planning.

5.3 Beyond the Finances: Broader Economic and Societal Considerations

Service providers and their financers, as well as customers, could benefit markedly from systematic economic cost-benefit assessments whenever they consider prepayment options, but there are also other potential impacts. Although a detailed quantitative analysis of the economic costs and benefits of prepaid water is beyond the scope of this study, consideration of economic costs and benefits brought to the fore interesting examples of potential elements to keep in mind (see Box 21).

At prepaid stand posts, potential demand-side benefits include:

Cheaper water than from intermediaries. Buying water directly from the service provider at the same tariff (or less) as those with their own water connection offers a way out of the excessive surcharges typical of intermediaries like vendors or tap attendants. As cited earlier, in Kampala for instance, water from a prepaid standpipe costs at least a fifth, and often a twentieth, of what it costs from water vendors and resellers.

BOX 21: WHY ARE SERVICE PROVIDERS PURSUING PREPAYMENT IF RETURNS ARE LIMITED AND COSTS HIGH?

A combination of hope and optimism, and a cost-benefit assessment that goes beyond finance—rather than robust examination of key cost, service, and performance indicators—seems to drive service providers in pursuing prepayment. “We believe there are more benefits than disadvantages,” said one utility head. “If we don’t take this bold leap, nothing is going to change. With prepaid meters, there is a prospect of getting into an upward performance spiral.”

The costs and benefits are not viewed as purely financial. All service providers analyzed said they had underestimated what prepayment would take, and all acknowledge that it is expensive. Most appeared committed to making their prepayment systems work, because they believed it was in the best interests of customers, directly and indirectly, and because their customers demanded it. When discussing the human rights dimensions of prepaid metering, one utility CEO said, “Which is the worse evil—to allow the utility to collapse, or to enable it to survive and meet the challenges?”

Co-funding softens the impact of high costs. Kampala, Windhoek, and Mogale City received significant external contributions for capital investment, and Mogale City receives significant operating subsidies from national government. This reduces the costs they must recover directly through prepayment.

Phased implementation means that costs are staggered over time and ease the squeeze. Among the eight services providers reviewed here, three phases of engagement with prepaid metering are evident:

- **Start-up.** Lusaka, Kampala, and Maputo began small-scale pilots in 2007–2008, and Lusaka and Kampala are scaling up. Maputo’s utility is in no rush to follow them, as it has been disappointed in the performance of its meters and has other funding priorities.
- **Scale-up.** Nairobi and Nakuru are much more recent adopters, and both are keen to scale up prepaid standpipes, but not prepaid individual connections.
- **Consolidation.** Only three—Windhoek, Mogale City and Maseru‘s WASCO—can be said to be in a consolidation phase after a decade of experience. WASCO is ambivalent about continuing with prepayment. Instead it is exploring a demand management device that limits flow within a preset cap, and has the option of prepayment as an add-on module. Windhoek and Mogale City service providers view prepayment as their best available option for providing services that poor households can afford, and for optimizing collection.

Revenue from prepayment is often a relatively small component of overall income. Apart from Mogale City, revenue collected through prepayment is still a small proportion of overall income among the cases studied, and the extent of under-recovery from low-volume customers might not be apparent. Conversely, prepayment for institutional customers was introduced in 2013 in Lusaka and Mzuzu, and in 2014 in Kampala. This takes prepayment in a new direction, with conspicuous revenue benefits, provided that the necessary political support can be mobilized.

In Kampala’s case, improved collection from high-volume institutional customers will offset poor cost-recovery from prepaid standpipes. National Water’s managers say they know prepaid standpipes are not cost-effective in financial terms, but they believe they offer an important vehicle for providing more equitable services to the urban poor, and have the means to recover any shortfall elsewhere.

Access to lifeline tariffs. As direct customers of the service provider, the users of public stand posts can access lifeline tariffs in line with the service provider's tariff structure. In parts of Nairobi, for example, access to the service provider's lifeline tariff means spending between 20 and 50 percent less than on water from a water vendor or kiosk.

More productive time. With access to water whenever it suits them at unattended prepaid standpipes, customers have shorter queuing times and more time for productive purposes and possible income generation.

Social benefits. There is a range of potentially positive social impacts for people once they switch to prepaid systems at public stand posts. This includes women being able to avoid possible harassment by male vendors at stand posts, and being able to collect water when other members of the household return from work and can assist at home. Children—often tasked to fetch and carry water—may benefit from increased hours of supply due to prepaid standpipes because it means they waste less time in queues, miss less school, and have more time for recreational activities. The experience in Windhoek shows that tensions within a community may also be mitigated when residents are no longer penalized by disconnection if others do not pay, as often happens when payment occurs after the water had been used.

Across prepaid standpipes and individual connections, prepaid meters assist households in cash management. The focus group discussions in three cities reiterated the fact that customers feel more in control of what they spend on water with prepaid metering. They can monitor and adjust their consumption, budget more accurately, and do not have to fear unexpectedly excessive bills after they have used the water. This effect is even stronger when service providers offer reserve allowances, such as in Mzuzu, Malawi, where the prepaid meters hold a certain quantity of purchased units in reserve, or allow emergency supplies when regular credit runs out.

For customers with prepaid meters on household or institutional connections, prepaid meters preempt the risk of debt shocks from bills they cannot pay. They are not liable for payment for more water than they have already bought, and potential losses from unnoticed leaks are capped by what they have paid already.

Heightened awareness of the costs of consumption usually results in reduced consumption. Customers say they no longer leave taps running, they notice leaks sooner, and they have stronger incentives to attend to repairs because they can see their credit drain if they do not get the leakages fixed. Less waste means more water in the network to provide longer hours of supply and potentially service new areas.

In the case of institutional customers, the combination of high-volume consumption, low transaction costs relative to purchases, and cost-reflective tariffs facilitate improved revenue flows for the service provider, which open opportunities for cross-subsidization of poor customers.

It would be inaccurate to suggest that these putative benefits apply equally and consistently wherever prepaid water is used.

No transaction costs can be mitigated fully by prepaid technology. Prepaid standpipes, like all shared water delivery points, may still incur costs due to time lost while queuing, or when carrying water. Even at their most functional, prepaid stand posts cannot completely undo those costs to communities and households.

The high frequency of technical faults adds further risk. Valve failures especially can cause continuous, costly flows, which local residents cannot stop. The benefits mentioned previously may therefore apply to many communities and customers, but the customer analysis demonstrates the frustration and costs that follow interrupted services.

Substantial opportunity costs. By subsidizing prepaid users, service providers divert resources from somewhere else. This could mean less is available for direct funding for connections that cost less than prepaid ones, or for customers that have not been connected before at all. In such cases, the benefits of an investment in an expensive technology such as prepaid systems may not be justifiable.

Exporting jobs. It can be argued that prepayment leads to exporting jobs to a distant country that manufacturers and supplies prepaid meters, eroding the benefits of water vendor incomes within the local economy (Figure 20). However, given that water vendors' incomes are funded mostly by the poorest users through overly high payments, the negative impact may not be very significant overall. Although there have been cases of vendors losing income when prepaid meters were introduced, the poorest households have benefitted though reduced spending on water and lower transaction costs due to flexible and longer hours of supply as well as not having to deal with intermediaries.

FIGURE 20: WHEN PREPAID STANDPIPES ARE INTRODUCED, WATER VENDORS OFTEN EXPERIENCE DECREASED REVENUE.

After watching revenue drop by 50 percent, many water vendors in Kampala now encourage business by offering lower prices and home delivery to regular customers

5.4 Summary

The core message of the financial analysis is that prepaid metering on its own cannot resolve a service provider's financial woes. It may even make things worse, at least in the short to medium term. It may help improve revenue and also meet customers' needs for all the reasons discussed earlier, but it should not be viewed automatically as a cost-effective way to resolve high billing and collection inefficiencies except for large volume customers.

Using data from the case study cities, the results of financial modeling suggest that a substantial investment in a prepayment system to achieve a relatively small percentage improvement in revenue collection is difficult to justify in purely financial terms, except when the volume of sales per metering unit is comparatively high. It makes little financial sense to spend vast amounts of money on a technology that can affect improvement in revenue on the margins, while the underlying pricing of water remains unattended. Although prepayment is an interesting innovation with potential for application under some conditions, it is unlikely to provide a long-term answer to subeconomic pricing of water.

The evidence indicates that prepayment is potentially best suited to poor households with volatile incomes, because people can pay in line with what they can afford and also access social tariffs. Safeguards to minimize inconvenience when people run out of credit and hardship for those who cannot prepay can mitigate the downsides of prepayment while offering positive benefits to the urban poor.

Prepaid public standpipes have the highest financial potential to be cost-effective, provided that the distribution network is capable of supporting 24/7 supply, a network of credit vendors exists to provide convenient credit purchase points, and an effective service provider customer service team can address faults and queries promptly.

Prepayment for medium and high-volume residential customers with their own connections can make financial sense for the service provider if tariffs reflect costs. The low volumes typically consumed by poor households do not generate sufficient revenue to offset the high capital, operating, and maintenance costs of a prepayment system for individual house connections.

Prepayment for institutional and commercial customers consuming large water volumes meets this requirement, and is highly cost-effective. Improved revenue here can help subsidize services in low-income areas. Prepayment for institutional customers in particular offers service providers significant benefits in terms of improved cash flows and reduced bad debts from large customers who are often slow to pay.

Introducing prepayment for commercial customers with poor payment records also has merit, but service providers are wary of introducing prepayment as the default for all commercial customers. Their consumption may decline, and reduce revenue to the service provider, even though the water demand benefits may be attractive.

VI. The Way Forward: Can Prepaid Systems Be Made to Serve the Poor?

How, if at all, can prepaid systems become an instrument to improve access and quality of water services to poor people in African cities and towns?

We phrase the question in this manner because many urban Africans still do not have their own water connections, and mostly remain outside the reach of whatever subsidy regimes are in place. Prepayment does not offer an obvious answer to these challenges, but the evidence presented earlier shows that some attributes of prepayment may offer a tool for addressing some of them in certain circumstances. Despite many challenges, prepaid systems are evolving; they are being offered by a growing range of suppliers; and a growing number of service providers have already deployed them or are considering them as an instrument for broadening access.

It makes sense then to explore how the risks of prepayment can best be mitigated, and its potential contributions optimized. This section identifies and discusses a few key areas in which policy reform, improved regulation, and innovative operational practice could help make the use of prepaid water systems conducive to serving poor people.

6.1 Be Clear about the Priority: Reaching People without Their Own Connections

Although all three prepaid applications have some relevance to the poor, the greatest need for a transformative system is in increasing access to water for people who have no connection at all. Service providers across the continent—and in developing countries globally—continue to find it difficult to reach them through subsidies. In practice, most subsidy regimes reach those with an individual connection, which excludes the significant proportion of the urban poor who rely on public or shared service points. Their payment is usually intermediated by vendors who must be recompensed for their time—a cost that service providers have generally assumed to be the responsibility of those direct customers.

Among the limited delivery options currently available, prepayment on stand posts has perhaps the greatest potential to support more equitable access (without time restrictions and including access to any lifeline tariffs) for people without their own connection. Public standpipes in general—post- or prepaid—offer a means of serving people who do not have their own connections, but the incentives for utilities to introduce and maintain such facilities are weak when people do not pay or when there is a disproportionate challenge in ensuring vendor payment of utility bills. The equity impact may also get distorted when some customers pay and others do not, leaving the poor to subsidize others who are poor or face disconnection, and when intermediaries control access and add surcharges on shared access points. If service providers cut off supplies to standpipes where payment levels have been low (or the vendor has not passed on customer payments), those who pay get penalized for others' nonpayment. This is a common cause of resentment and conflict in poor areas. Prepaid systems offer a potential means to ensure fairer payment. The technology supports targeted provision of social tariffs, allowing for a certain volume of water to be charged at a concessionary rate or (as in South Africa) a zero tariff.

6.2 Recognize That Prepayment Technology Is Not Intrinsically Anti-Poor

Some critics equate prepaid water with exclusion of the poor from services, without recourse. They maintain that prepaid systems make it too easy for service providers to cut supply when people cannot afford advance payment, and when credit is exhausted.

These are risks indeed, but the earlier analysis has shown that neither the benefits nor the potential risks of prepaid technology are inevitable, and they are often contingent on factors beyond the technology itself. The technology is a tool of policy, and subordinate to it. How it is deployed can be managed by governments, regulators, and service providers by putting in place appropriate policy and regulatory frameworks, and working closely with customers in rolling out the technology, as with any other technology.

Despite the high costs of implementing prepaid systems, services can be made affordable to customers through, for example, targeted subsidies. This can be done through national programs targeted at poor people, such as South Africa's Free Basic Services policy, but also in the way local service providers approach the goal of universal service access. Mogale City, for example, has used a combination of public education and technology to give people the tools to monitor and manage their own consumption. As a result, around 50 percent of its prepaying customers in the relatively poor area of Kagiso manage their consumption to stay within the 6 m^3 free basic water allowance per connection per month, which is subsidized by the central government. Several African utilities have measures that allow customers to reach a limited level of "water overdraft," without their supply stopping when their credit runs out. There is nothing inevitable about prepaid systems disadvantaging poor people.

That said, there is a real risk that if national governments and regulators do not provide firm guidance and support, many service providers in African cities and towns will not be able to provide the necessary social safety nets. Changes in technology cannot alone improve the sector. It depends on whether the relevant institutions develop policies and mechanisms to ensure that the poor are targeted through subsidies, and can access services that stay functional.

6.3 Prepayment Does Not Equate to the Commodification of Water

A concern for some is that prepaid water meters exemplify the commodification of water, or even privatization. Of course, it is possible that a private sector provider may opt for a prepaid system, but there is no inevitable association. In fact, of the eight service providers covered in our case studies, two of the most committed pace setters (Mogale City and Windhoek) have been neither private nor publicly owned corporate agencies, but municipal water departments.

In adopting prepayment to make the service more viable through improved revenue collection, both Mogale City and Windhoek have been further motivated by a commitment to improving service delivery to poor customers in particular. Both have persisted, weathering poorly performing systems, because they believe they are the best option available for meeting the service needs of the people they serve. Mogale officials believe prepayment helps people avoid debt and even remain within their free basic allocation and pay nothing for water. Windhoek has worked hard to provide an alternative to stand post conflicts that arise from sharing stand post bills. In Kampala, Nairobi, and elsewhere, public water utilities believe prepayment offers the possibility of greater equity to those without the prospect of their own connection, and provide subsidies to ensure cheaper water, better access, and more autonomy.

6.4 Introduce Targeted Social Safeguards to Secure Access to Services for the Poor

Safeguards to mitigate hardship may address concerns around the possible impacts of prepayment on people's right to water. If successful, prepaid technology could also be instrumental in tackling the big policy issues around subsides and tariffs. This is an important issue, because in many countries, "universal" subsidies mean that unconnected poor people do not receive any subsidy at all.

Again, however, the technology cannot achieve this change in isolation. It can at most assist in applying improved policies and fiscal rules that require service providers to recover the full costs of service provision from consumers who can afford to pay, while supporting the poor through explicit subsidies. Prepayment for institutional customers may contribute to achieving this.

6.5 Recognize the Cost Challenges of Prepaid Systems to Service Providers

Whatever the benefits of prepaid meters, both to customers and through enhanced billing and collection by service providers, they must be balanced with an understanding of likely increased costs.

Service providers face not only significantly increased capital expenditure on meters but also must incorporate the higher recurrent costs into their overall revenue base. Whereas previously the cost of vending has, by default, been passed on directly to the lowest-income consumers, the utility now absorbs the equivalent of those vending costs itself. The cost of this vending function through a "robot" (prepaid meter) will likely be higher for the service provider than through a human vendor. Similarly, the cost of a network of credit vendors to manage the token top-up process, taking 5–10 percent commission in some of the case studies, is an additional charge to revenue.

Service providers face the challenge of recovering the costs of selling more water at subsidized lifeline tariffs. Previously vendor-managed stand posts, and single connections to compound housing, had caused such customers to pay at a higher tariff band.

Overall, because of increased awareness of costs and greater attention paid to leakage and waste, prepaid meters may lead to lower overall consumption of water. This has to be beneficial in the long term, not least for energy savings. In the short term, the utility has to try to recover higher costs, typically 80–90 percent fixed, from a lower overall volume of consumption while a significant proportion of their consumers are now accessing higher subsidies.

The resulting challenge to utility finances has to be planned for, both for an appropriate level of cross-subsidies within the customer base and, quite likely, for subsidies supported by taxation from a wider revenue base

An inherent weakness in rising block tariff systems might be made more apparent through the use of prepaid systems. The weakness is that if too many people use them, or are tempted to restrict their demand to stay within the lifeline block, overall revenue for the utility will be insufficient. It is not possible to cross-subsidize a high proportion of the customer base. External support may be necessary.

Some believe that the critical condition for effective cross-subsidization lies in ensuring that the average tariff, paid by the majority of customers, is set to ensure the financial sustainability of the provider, whereas the range of tariffs increase progressively as levels of water consumption increase. There is an opposing view, articulated by the Zambian regulator, that stepped tariffs are not transparent for prepaying customers and are not understood. Ultimately, prepaid systems only function effectively if the wider systems for costing, management, and prevention of water losses are in place.

6.6 Get Regulators to Take Prepayment More Seriously

Issues impacting a utility's revenue base must be addressed by the economic regulator, with provision to rebalance tariffs and subsidies as necessary. Until now, most water regulators have shied away from prepayment. They seem to regard it as an experimental technology, outside the mainstream of service delivery or the tariff-setting mandates of regulatory agencies. Among the case studies covered in this assessment, only in Zambia has the national regulator (NWASCO) begun to analyze prepayment carefully and provide guidance to water service providers. NWASCO is concerned that utilities may be attracted by the allure of a new technology before considering its service requirements, impacts, and costs fully. Other regulators have barely engaged with prepayment.

Yet if prepaid water is to contribute effectively to the public objectives of improved service delivery access, regulators must give it closer attention. A number of areas stand out for such attention:

- **Cost-effectiveness overall.** It may be necessary to ensure that prepaid systems do not destabilize service delivery by absorbing scarce resources for limited gain.
- **Standards for technology.** The performance reliability issues raised earlier indicate an urgent need for improved regulation of prepaid service norms and standards. Service provider managers are the target of aggressive marketing by suppliers, and there is no formal guidance on the criteria and approaches for choosing between them. National standards authorities should specify standards relevant to local conditions and require compliance. This could be enhanced at a global level by building on progress in developing standards for the use of STS technology in prepaid systems and for technical standards for prepaid water systems more generally. The incentives for attaining compliance to such standards seems to be an area for particular consideration, where lessons from the

International Finance Corporation (IFC) supported *Lighting Africa* initiative may be instructive. These lessons include providing concessions on the import duty of compliant devices and making information on compliance publicly accessible (see Box 22).

- **Opportunity cost of deploying prepaid technology.** Regulation could help direct service providers' priorities, and help them weigh the trade-offs between prepayment and more immediate challenges such as network upgrades.

BOX 22: LESSONS FROM SETTING STANDARDS FOR SOLAR LIGHTING

There are currently no standards covering the overall performance or reliability of prepaid water meters. Existing national and international standards for prepaid meters focus primarily on metrology (the accuracy of metering) and STS (the credit transfer protocols that support compatibility across different suppliers of vending and prepaid metering components).

The experience of developing and incentivizing standards for solar lighting components may be relevant for prepaid meters. *Lighting Africa,* a joint initiative of the World Bank Group's International Finance Corporation (IFC) and the International Bank for Reconstruction and Development, has been working since 2007 to improve access to affordable solar lighting products for home users in sub-Saharan Africa, by accelerating the development of markets for good quality products.

The *Lighting Africa* team found that the influx into Africa of poor quality lighting products represented a key market threat that risked eroding confidence among consumers. In response, they worked closely with suppliers, stakeholder institutions, and sector industries to formulate standards for solar lighting products and provide incentives to manufacturers to meet minimum specifications.

The resulting minimum quality standards served as the foundation for the global International Electro-technical Commission (IEC) technical specification. The quality standards set a baseline level of quality, durability, and truth-in-advertising to protect consumers. Suppliers wanting to participate in *Lighting Global* support programs and their incentive schemes must comply as a minimum requirement.

Conformance is evaluated based on results from laboratory testing at an approved third-party test center using randomly procured samples. The certificate is valid for two years. *Lighting Africa* reports that the certification process is driving competition. Suppliers now try to maintain their competitive edge by exceeding the minimum requirements while keeping prices competitive. The Ethiopian Government was one of the first to use the standard to differentiate between different quality products, and it introduced a waiver on import duties for products that conformed to the specifications.

Although dealing with a different innovation, service providers and regulators in the water sector with an interest in prepaid water meters could apply some of the lessons from this initiative. They could, for example, consider forming a working group to formulate which specifications they want their prepaid meters to conform to, to meet minimum quality and performance requirements. As such an initiative grows, it could become a platform for knowledge exchange and dialogue with suppliers generally, but also broaden to include other partners, such as financiers, strengthening their reach and impact to address the current absence of clear quality standards and benchmarks.

- **Convenient credit purchase.** At a time when mobile technology is opening many commercial opportunities in many sectors, regulatory guidance to promote STS compliance and mobile technologies in prepaid systems could help enable far more accessible and customer-friendly vending options (see section 6.7).
- **Safeguards to minimize inconvenience and hardship.** Prepayment should not be punitive. A minimum raft of safeguards should be available to reduce the potential for inconvenience or hardship to customers. Sound regulatory guidance could assist in developing recourse options where they are inadequate or neglected, with a process of appeal for special concessions or subsidies, and penalties when these are ignored.

It is probably necessary to assist regulators to acquire and develop the knowledge required for this new role. This may be a role for development partners and public sector and other training institutes to look into, together with the regulators and other interested parties.

6.7 Think Big about the Technology

If prepaid water systems are to be used more widely, technological issues demand attention.

First, the incidence of faults remains unacceptably high. Improving the robustness and reliability of prepayment systems is a priority for both service providers and manufacturers.

Second, the prevalence of proprietary technologies is a major concern. These technologies lock utilities into systems that are incompatible with any others, limit development, and make credit top-ups more costly and inconvenient to customers. Both utilities and regulators should be more assertive in demanding greater compatibility and compliance with globally accepted standards and specifications, such as IEC 62055-41 for STS compliance.

Third, the increasing use of ICT in Africa may help make prepaid systems more effective by offering wider vending options. Most poor families have mobile phones, and there is surely scope to use this technology, not proprietary credit tokens, to make credit top-ups easier and more convenient. A mobile phone-based system for buying and loading credit would be a game changer if it freed utilities and households from dependence on physical credit tokens that are comparatively expensive and can be damaged or lost. Phone-based top-ups linked to open standard vending technologies would offer customers 24/7 convenience, without the utility needing to set up and manage its own network of credit vendors. Regulators and service providers should demand greater cooperation between manufacturers and service providers to advance vending technologies and give customers the convenience and choices they expect.

6.8. Shift the Focus from Metering to Service Delivery and Governance

Prepayment for water is an entry point for wider reforms in public service provision. It places greater accountability on the service provider, and demands a fresh look at what serving a customer actually means and requires and how that can be operationalized. The technology involves more than metering. More significantly, prepayment goes well beyond technology. In fact, a service provider that falls short on effective management, governance, and sound customer relations is likely to take on far more than it can deal with by resorting to prepaid systems.

The starting point is for the service provider to redefine its relationship with the users of its services. Although it should be intrinsic to the mandate and obligations of a public service provider to offer its customers respect and good service, the fact that users have already paid for the service adds immediacy to that demand. If customers do not receive water, a breakdown of the relationship between service provider and customers is likely.

A dedicated customer service team is needed to build trust in and understanding of the new technology and to ensure communication, advice, follow up, and robust technical support.

6.9 Summary

The analysis here shows that prepaid water is not a miracle cure for the revenue challenges of urban water service providers. It has the potential to deliver significant benefits, but is not obviously cost-effective for the provider, has not been consistently reliable, and comes with substantial demands on management. Its growing profile requires, however, that prepaid systems are no longer treated as essentially experimental. As Box 23 highlights, there is much more analysis, dialogue, and technical work to be done to enable service providers, their clients, and potential financiers to make informed judgments about prepaid systems, mitigate the risks they pose, and optimize the opportunities they offer. And they should be taken far more seriously in water sector policies and regulatory frameworks.

BOX 23: AGENDA FOR FURTHER WORK ON PREPAID SYSTEMS

The emergence of prepaid options has opened a new set of opportunities (as well as risks) for water service providers. In moving forward, service providers may benefit from applied information, guidance, and advice on a series of issues.

Develop standards for prepaid systems and incentivize compliance. The performance reliability issues pose one of the greatest challenges to the relevance of prepaid water systems. National standards authorities should be core participants in any dialogue and should ensure that standards are appropriate in each local context. This could be strengthened at global level with the support of development partners and potential investors, and should aim to engage suppliers of prepaid devices.

As demonstrated in the brief dialogues that informed the development of this study, there is a considerable appetite among service providers for knowledge exchange and joint efforts to understand and discuss issues, options, and practices.

Develop indicative frameworks for deciding whether to use prepaid systems. The decision-support tool presented in Appendix B is indicative of the kind of questions to ask and the decisions that may be required. Answering each question adequately requires considerable analysis, based on credible data, relevant to each situation.

Improve the financial assessment of prepaid options. Cost-benefit assessments prior to the introduction of prepaid systems are often inadequately robust even though the high costs of prepaid devices pose one of the greatest risks associated with their deployment. Service providers will benefit greatly from more robust cost modelling and business planning methods and enhanced skills to undertake assessments.

Develop more robust economic analyses. Related to the financial assessment is a need for more in-depth assessment of the economic costs and benefits of prepaid water. This fell outside the scope of this particular study, but as governments and service providers consider their options in the future, an important area for due diligence will be stronger economic analysis that assesses prepaid water in a wider societal context.

Develop tools and capacity support for monitoring and managing the performance of prepaid services. All the service providers consulted say that they underestimated what managing a prepayment system entailed. There seems to be a need for particular assistance in conceptualizing and deploying performance management systems. Generic guides and toolkits have marked limitations; context-specific practical master classes and direct technical assistance may prove more useful.

Selected Bibliography

Anti Privatisation Forum (APF) and Coalition Against Water Privatisation (CAWP). 2007. *Lessons from the War against Prepaid Water Meters: The Struggle against Silent Disconnections Continues*. http://apf.org.za/IMG/pdf/Final_PPM_Research_Report_-_102006-2.pdf.

Appelblad-Fredby, Jenny, and David Nilsson. 2012. "From 'All for Some' to 'Some for All'? A Historical Geography of Pro-poor Water Provision in Kampala." *Journal of Eastern African Studies* 7 (1): 40–57.

Beckedorf, Anne-Sophie. 2012. "Denying Access to Water? Moral Values and Commercialization Policies in Khartoum Governmental Water Management." Working Paper. Geowissenschaften. http://opus4.kobv.de/opus4-ubbayreuth/frontdoor/index/index/docId/899.

Beckedorf, Anne-Sophie. 2012. *Political Waters: Governmental Water Management and Neoliberal Reforms in Khartoum/Sudan*. Berlin: Lit Verlag.

Berg, Stanford, and Silver Mugisha. 2009. "Pro-poor Water Service Strategies in Developing Countries: Promoting Justice in Uganda's Urban Project." *Water Policy* 12 (4): 589–601.

Bond, Patrick. 2008. "The Case of Johannesburg Water: What Really Happened at the Prepayment 'Parish Pump.'" *Law Democracy and Development* 12 (1): 1–28.

Bond, Patrick, and Jackie Dugard. 2008. "Water, Human Rights and Social Conflict: South African Experiences." *Law, Social Justice & Global Development Journal (LGD)* 1. http://www2.warwick.ac.uk/fac/soc/law/elj/lgd/2008_1/bond_dugard.

Carion, L., M. Hasse, J. Jakperuk, and B. Pallier. 2012. "Smart Metering and Smart Payment: The Global Potential." Global Water Policy and Management Project, Cranfield, UK: Cranfield University.

Coalition Against Water Privatisation (CAWP) and Anti Privatisation Forum (APF). 2004. Nothing for Mahala. The Forced Installation of Prepaid Water Meters in Stretford Extension 4, Orange Farm, Johannesburg, South Africa. Research report 16. Durban: Centre for Civil Society.

Dugard, Jackie. 2007. "A Pro-poor Critique of Prepayment Water Meters in South Africa: The Phiri Story." *Critical Health Perspectives* 2. http://www.phmovement.org/sites/www.phmovement.org/files/CHP%202007%20No2%20Water%20Rights1.pdf.

Dugard, Jackie. 2008. "Rights, Regulation and Resistance: The Phiri Water Campaign." *South African Journal on Human Rights* 24 (3): 593–611.

Dugard, Jackie. 2008. "The Phiri Water Case (Mazibuko and Others v City of Johannesburg and Others): Can Human Rights Traverse the Commercialization of Water in South Africa?" http://www.nottingham.ac.uk/shared/shared_cssgj/Documents/smp_papers/Dugard.pdf.

Dugard, Jackie. 2010. "Can Human Rights Transcend the Commercialization of Water in South Africa? Soweto's Legal Fight for an Equitable Water Policy." *Review of Radical Political Economics* 42 (2): 175–194.

Dugard, Jackie. 2010. "Civic Action and the Legal Mobilisation: The Phiri Water Meters Case." In *Mobilising Social Justice in South Africa: Perspectives from Researchers and Practitioners*, edited by Jeff Handmaker and Remko Berkhout, 71-99. The Hague: ISS and Hivos.

Dugard, Jackie, and Sandra Liebenberg. 2009. "Muddying the Waters: The Supreme Court of Appeal's Judgement in the Mazibuko Case." *Economic and Social Rights Review* 10 (2): 11–17.

Foster, W. 2008. "Water Wars Move to Cape." *Mail & Guardian.* May 12. http://mg.co.za/article/2008-05-12-water-wars-move-to-cape.

Gerlach, Esther, and Richard Franceys. 2010. "'Standpipes and Beyond'—A Universal Water Service Dynamic." *Journal of International Development* 22 (4): 455–469.

Kumwenda, M. K. 2006. *Pre-paid Water Metering: Social Experiences and Lessons Learned from Klipheuwel Pilot*

Project, South Africa. M. Phil dissertation, University of the Western Cape.

Laport-Vergnes, Alice. 2010. *Prepaid Water Meters in Low Income Areas, NWSC, Uganda*. MSc dissertation. Cranfield, UK: Cranfield University.

Lopez Rivera, D. M. 2013. "Flows of Water, Flows of Capital. Neoliberalization and Inequality in Medellin's Urban Waterscape. Research Network on Interdependent Inequalities in Latin America." Working Paper 38. http://www.desigualdades.net/Resources/Working_Paper/38_WP_Lopez_Online.pdf.

Macdonell, Andrew. 2001. "Cost Recovery at Any Cost?" *Proceedings of the 27th WEDC Conf.* Zambia, 34–37. http://wedc.lboro.ac.uk/resources/conference/27/Macdonell.pdf

Mara, Duncan, and Graeme Alabaster. 2008. "A New Paradigm for Low-Cost Urban Water Supplies in Sanitation in Developing Countries." *Water Policy* 10 (2): 119–129.

Marah, L., M. O'Donovan, K. Finlayson, and D. Boberg. 2004. "Institutional and Socio-economic Review of the Use/Application of Electronic Prepayment Water Meter Technology in the Provision of Water Supply Services to Urban and Peri-urban Areas." Water Research Commission Report 1206/1/04.

Marvin, S., H. Chappells, and S. Guy. 1999. "Pathways of Smart Metering Development: Shaping Environmental Innovation." *Computers, Environment and Urban Systems* 23 (2): 109–226.

Mayr, Anna Kristina. Undated. "Pay as You Drink: Pre-paid Meters for Water Supply in Uganda." http://www.afriwater.org/urban-water-management/113-pay-as-you-drink-pre-paid-meters-for-water-supply-in-uganda-2.

McKinley, D. 2008. "Water Struggles from Johannesburg and Beyond." http://www.anarkismo.net/newswire.php?story_id=9168.

Mugisha, Silver, and Tatiana Boisova. 2010. "Balancing Coverage and Financial Sustainability in Pro-poor Water Service Initiatives: A Case of a Uganda Project." *The Engineering Economist* 55 (4): 305–327.

Naidoo, P. 2008. "Eroding the Commons: Prepaid Water Meters in Phiri, Soweto." *Public Citizen*. http://www.citizen.org/cmep/article_redirect.cfm?ID=11991.

Saes, L. 2012. *Prepaid Water in Namibia: The Impact of Prepaid Household Water Meters on the Inhabitants and the Municipality of Otjiwarongo*. MSc dissertation. Einhoven, The Netherlands: Einhoven University of Technology.

Tewari, D.D., and Tushaar Shah, 2003. "An assessment of South African prepaid electricity experiment, lessons learned, and their policy implications for developing countries." *Energy Policy* 31 (2003) 911–927.

Thompson, L., T. Masiya, and P. Tsolekile de Wet. 2013. "User Perceptions and Levels of Satisfaction of Water Management Devices in Cape Town and eThekwini." WRC Report No 2089/1/13.

Van Herwijnen, M. 2012. *Prepaid Water in Namibia: Understanding the Ongoing Transition*. MSc dissertation. Einhoven, The Netherlands: Einhoven University of Technology.

Vela VKE Consulting Engineers. 2012. "Investigation of Prepaid Water Meters for Woodland Hills, Bloemfontein." Technical Report. http://woodlandhillsblog.co.za/wp-content/uploads/2012/03/Vela-VKE-Technica-Report-for-Woodlands-on-water-meters-24-02-2012.pdf.

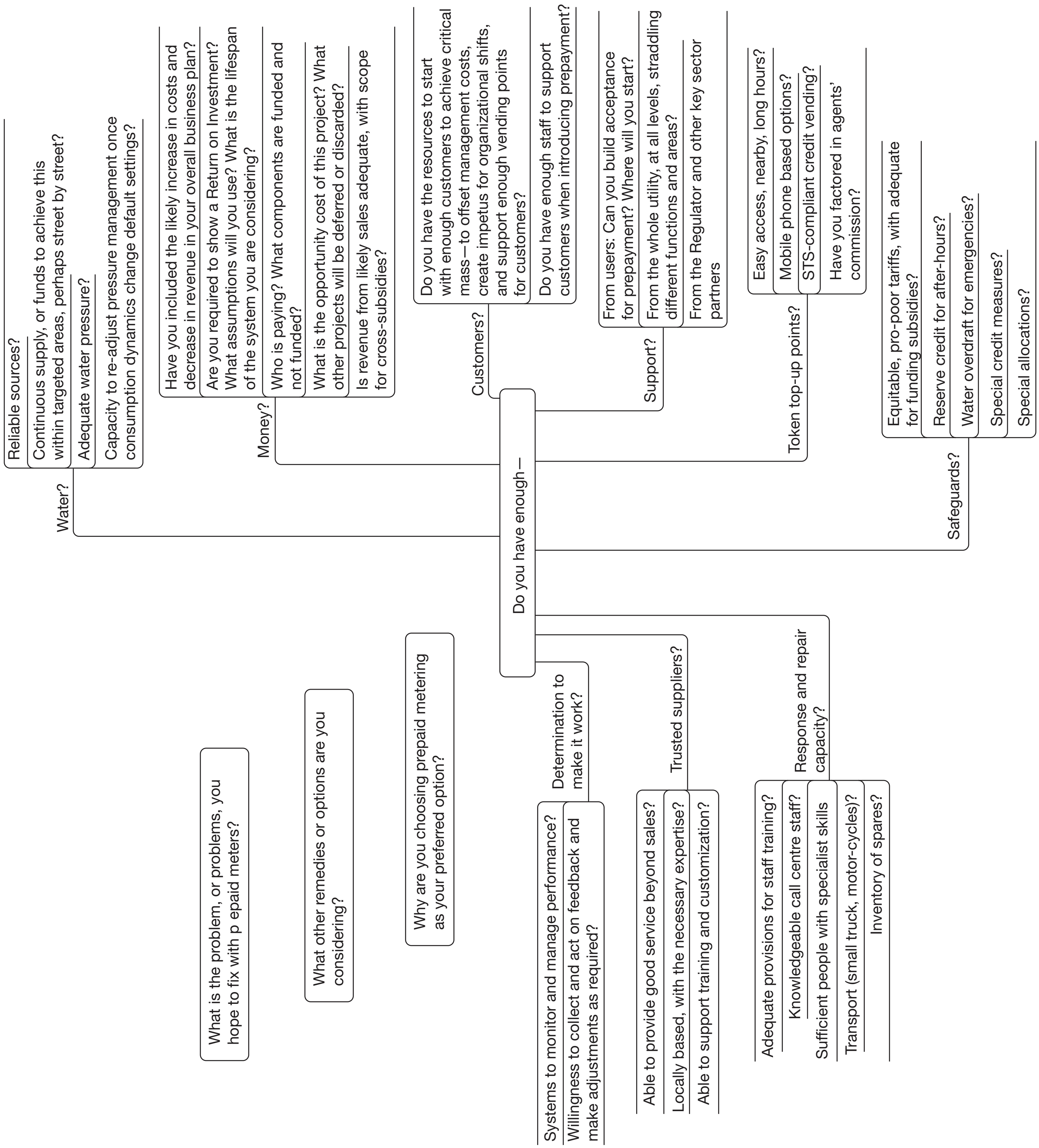
von Schnitzler, A. 2008. "Citizenship Prepaid: Water, Calculability, and Techno-Politics in South Africa." *Journal of Southern African Studies* 34 (4): 899–917.

Water and Sanitation Program. 2009. "Setting Up Pro-poor Units to Improve Service Delivery. Lessons from Water Utilities in Kenya, Tanzania, Uganda and Zambia." Field Note. Washington, DC: World Bank. http://www.wsp.org/sites/wsp.org/files/publications/service_delivery_field_note.pdf.

Woodland Hills Board of Trustees. 2012. Document fragment explaining the decision to replace Teqnova meters with Utility Systems meters. http://whe.beta.scibit.com/wp-content/uploads/2012/02/Replacement-of-Water-Meters-Process-Followed.pdf.

World Bank. 2013. *Do Pro-poor Policies Increase Water Coverage? An Analysis of Service Delivery in Kampala's Informal Settlements*. Washington, DC: World Bank. http://www.wsp.org/sites/wsp.org/files/publications/Kampala-Service-Delivery-Analysis-Water-PPP.pdf.

Appendix A: Decision-Support Tool When Considering a Prepaid Water System



Appendix B: Overview of the Case Studies

NOTE: Full case studies for the eight cities summarized in this overview can be accessed online: http://wsp.org/prepaidwater.

APPENDIX B: OVERVIEW OF THE CASE STUDIES

City	Why Prepaid Meters?	Application of Prepaid Meters	Number Installed	People Served	Highlights & Problems	Lessons
Kampala, Uganda	Provide cheap water 24/7 at a constant price without markups by intermediaries Provide water at a social tariff directly to those without their own connection	Public stand posts in low-income slums and informal settlements Institutional customers from mid-2014	1,613	170,000	Strong emphasis on dialogue and interaction with low-income customers through a dedicated propoor unit that drives prepayment installations, maintenance, and ongoing support. Worked with local development structures to gain the support and cooperation of landlords—sited meters on their land. Landlord benefits from less conflict over water with tenants, and easier renting. Number of prepaid standpipes doubled in 2013 to meet an output-based aid deadline. Now issued credit tokens to 29,500 households.	Provide enough accessible vending sites to minimize inconvenience to customers wanting to top-up credit. Make replacement of credit tokens easy or those who lose theirs will revert to reliance on intermediaries. Useful to use social scientists for community engagement. Because prepaid standpipes resolve payment to the utility, the utility is more willing to install additional water points, so prepaid meters can enable closer, more convenient access and shorter queuing times.

City	Why Prepaid Meters?	Application of Prepaid Meters	Number Installed	People Served	Highlights & Problems	Lessons
Lusaka, Zambia	Improve payment levels to turn around rising debt and poor cash flows and fund service improvements in the rapidly growing city	Public stand posts, individual connections, and large institutional customers	More than 14,000, including 200 institutional customers	More than 50,000	Zambia's president was one of the first to receive a prepaid meter, to show endorsement from the top. More conscious consumption with prepaid meters means lower water bills, and more water to extend hours of supply and serve other areas. Prepaid meters for institutions is helping utility cash flows, but long-standing leaks may need expensive repairs with uncertainty about who will fund this. National regulator is developing guidelines to guide prepayment.	Interrupted supplies and low water pressure increase prepaid meter faults and water outages and increase the maintenance and repair. Upgrade the network to support 24/7 supply before installing prepaid meters. Build understanding of tariffs and charges, and prepare customers previously paying a fixed tariff for possibly higher costs with a volumetric tariff.
Maputo, Mozambique	Improve payment to the utility by tap attendants collecting payments from shared water points	Public standpipes and communal sanitation blocks	220	30,000	Tap attendants supply water from public standpipes and communal sanitation blocks, and sell at the regulated vendors' tariff. Water is no cheaper for customers, but the tap attendant is protected from running up bills they cannot pay, and the utility receives full payment.	Inexpensive meters can prove costly if they fail soon and can only be replaced, not repaired. Ensure that support and spares are readily available. If the prepaid meter works, prepayment has the potential to safeguard the continuity of water supplies at standpipes run by tap attendants, by ensuring that the tap is not cut off if the utility does not receive payment.

APPENDIX B: CONTINUED

City	Why Prepaid Meters?	Application of Prepaid Meters	Number Installed	People Served	Highlights & Problems	Lessons
Maseru, Lesotho	Improve payment levels and help customers avoid getting into debt Reduce billing queries related to meter-reading errors and estimates	Individual connections in middle-income areas Public standpipes in peri-urban areas	3,500 180	15,000 11,000	Ten years after first introducing prepaid meters, WASCO management is unresolved about whether to continue with prepayment. Customers like the benefits prepaid meters offer, but the utility says the cost and the maintenance burden is high. It is now exploring flow-limiting devices, with a preset upper limit and automatic meter reading as a possible alternative to manage demand and the risk of bad debt.	Ensure that the prepaid meter can cope with local operating conditions. Many of Maseru's meters freeze up in subzero winter temperatures and malfunction, and add to the maintenance load of utility staff.
Mogale City, South Africa	Change consumption behavior and improve payment levels after two decades of politically motivated service payment boycotts Help poor customers stay out of debt	Individuals in low-, middle-, and upper-income areas	35,000	160,000	All customers get the first 6 kls free each month. Prepaid meters help poor households manage their consumption, with half in a low-income area managing to stay within their free allocation and pay nothing for water at all. Early adopter of prepaid, from 1999. Now busy with its third major installation of meters, after a 2012 audit revealed that more than 90 percent of 8-year-old meters were supplying free water because of faults and bypasses.	Prepaid meters can shift customer behaviour, improve demand management, and help poor households avoid debt, but they are expensive and require high maintenance. Revenue generated from low-income sales is not enough to cover the costs of prepayment, without big capital and operating subsidies. Regular monitoring with exception reporting and rapid follow-up is essential. Bypasses and tampering are likely without ongoing visual monitoring.

City	Why Prepaid Meters?	Application of Prepaid Meters	Number Installed	People Served	Highlights & Problems	Lessons
Nairobi, Kenya	Improve demand management given acute supply shortages Improve payment levels and reduce staff costs Provide better access to cheaper water in informal settlements	Individual connections in low- and middle-income areas Now beginning with prepaid standpipes in informal areas	650	2,500	The utility underestimated what prepayment entails and was not adequately prepared with integrated management, adequate monitoring, and maintenance capacity or vending sites. Prepayment cannot resolve low payment levels without better service quality, closer interaction with customers, and convenient payment options.	Build acceptance of the need for payment and improve service quality before introducing prepaid meters in areas with low payment levels, to avoid vandalism and bypasses. Provide enough vending sites to make credit top-up easy for customers. Ensure that after sales support and spares are available to avoid having to replace meters that are not reparable.
Nakuru, Kenya	Provide tenants with affordable access to an improved supply of water 24/7 Funding partners wanted to pilot the introduction of prepaid standpipes in Kenya	Public standpipes	95	12,000	Targeted housing compounds where 20–40 households shared a single tap with restricted access. Prepaid standpipes supply water 24/7, far cheaper than any other option available. The meters require intensive maintenance, with 6–9 callouts a day. A local resident has learned how to repair the meters and provides on-the-spot support.	Careful preparation and building acceptance among tenants and landlords is essential. Local residents can play a key role in maintaining prepaid standpipes. The more users per standpipe, the more cost-effective the installation, but queuing times grow longer.
Windhoek, Namibia	Minimize conflict over shared bills for shared public taps Improve payments and minimize water wastage in an arid area with expensive water	Public standpipes	582	60,000	An early pioneer, since 1998. Persevered with various types of standpipe meters to improve services to residents of informal settlements, because it sees them as the best available option to meet its needs. Now has in-house repair capacity and aims for a one-hour turnaround when faults are reported.	A slow and cautious approach is appropriate when innovating with an unproven technology and without funding support. A quick response and rapid repair is essential–delays in restoring a supply that users have already paid for invites vandalism.

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