

# Troubled Tariffs

## Revisiting Water Pricing for Affordable and Sustainable Water Services

Luis A. Andrés, Gustavo Saltiel, Smita Misra, George Joseph, Camilo Lombana Cordoba,  
Michael Thibert, and Crystal Fenwick





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This publication received the support of the Global Water Security & Sanitation Partnership (GWSP). GWSP is a multidonor trust fund administered by the World Bank's Water Global Practice and supported by the Australian Department of Foreign Affairs and Trade, Austria's Federal Ministry of Finance, the Bill & Melinda Gates Foundation, Denmark's Ministry of Foreign Affairs, the Netherlands' Ministry of Foreign Affairs, the Swedish International Development Cooperation Agency, Switzerland's State Secretariat for Economic Affairs, the Swiss Agency for Development and Cooperation, and the U.S. Agency for International Development.

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Please cite the work as follows: Andrés, Luis A., Gustavo Saltiel, Smita Misra, George Joseph, Camilo Lombana Cordoba, Michael Thibert, and Crystal Fenwick. 2021. “Troubled Tariffs: Revisiting Water Pricing for Affordable and Sustainable Water Services.” World Bank, Washington, DC.

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## Acknowledgments

This report was prepared by a World Bank team led by Luis Andrés (Lead Economist) and comprising Gustavo Saliel (Lead Water Supply and Sanitation Specialist), Smita Misra (Lead Water Supply and Sanitation Specialist), George Joseph (Senior Economist), Camilo Lombana Cordoba (Senior Water Supply and Sanitation Specialist), Michael Thibert (Consultant), and Crystal Fenwick (Consultant) of the Water Global Practice (GP).

The report draws on background papers, case studies, and additional contributions prepared by Economic Consulting Associates (Peter Robinson, Nick Haralambopoulos, Richard Bramley, Tatiana Tumenggung, Richard Holcroft, David Storey, Alex Schmid, Andrew Tipping, and Ester Vespasiani), German Sember, Laura Abramovsky, Ignacio Hanesman, and Gonzalo Espiñeira.

Peer review was conducted by Charles Delfieux (Senior Water Supply and Sanitation Specialist), Fan Zhang (Senior Economist), Bill Kingdom (Consultant), Diego Polania (Executive Director, Comisión de Regulación de Agua Potable y Saneamiento Básico, Colombia), and Alain Locussol (Consultant).

Insightful and helpful advice and comments were received from Martin Gambrill (Lead Water Supply

and Sanitation Specialist), Joel Kolker (Lead Water Supply and Sanitation Specialist), Yogita Mumssen (Practice Manager), Aude-Sophie Rodella (Senior Economist), Alexander Danilenko (Senior Water Supply and Sanitation Specialist), and Stephane Dahan (Senior Water Supply and Sanitation Specialist). The team also received constructive advice from the following external reviewers: Rui Cunha Marques (Universidade de Lisboa), David Fuente (University of South Carolina), Samuel Huston (USAID), and Rolfe Eberhard. Finally, the report has benefited greatly from strategic guidance and general direction provided by the management of the Water GP including Jennifer Sara (Global Director), Richard Damania (Chief Economist, Sustainable Development Practice Group), Soma Ghosh Moulik (Practice Manager), and Maria Angelica Sotomayor (Practice Manager). Alona Daniuk and Isabel Junior provided administrative support. Editorial services were provided by Fayre Makeig.

This work was made possible by the financial contribution of the Global Water Security & Sanitation Partnership (GWSP), <http://www.worldbank.org/en/programs/global-water-security-sanitation-partnership>.



**Tariffs are essential—but not the only pathway—to recovering costs, addressing affordability, and managing water conservation. To maximize their potential, they must be well designed, complemented by appropriate instruments, adequately regulated, and understood by customers.**



Designing effective tariffs is a function of economic efficiency and requires a detailed understanding of costs



Tariff design demands a holistic approach that carefully considers competing policy objectives



Tariff complements can be used to effectively address affordability and improve services



Regulation is an effective tool for increasing efficiency and ensuring good governance



Resistance to tariff reform is reduced by strong political leadership, improved service quality, and increased stakeholder engagement





## Executive Summary

Few resources on Earth are as important and as poorly managed as water. Its price rarely reflects its economic value or the costs of treatment and distribution. Low water prices have resulted in inefficient use and reduced provision and expansion of services, particularly for the poor, making the sector less attractive to investors and inflicting high costs upon the economy, society, and environment.

In 2010, the United Nations recognized safe and clean drinking water and sanitation as a human right (UN 2010). At the time, the Millennium Development Goals (MDGs) were focused on halving the number of people living without access to improved water supply and sanitation (WSS) services by 2015. The United Nations then adopted the Sustainable Development Goals (SDGs) in the fall of 2015, raising global ambitions further with the new targets of achieving “universal and equitable access to safe and affordable drinking water” and “adequate and equitable sanitation and hygiene for all” by 2030. These declarations and targets have directed much-needed attention to the plight of billions of people who still lack access to safely managed water supply and sanitation (WHO 2017) and bolstered arguments in favor of subsidization, as efforts to charge the full economic costs needed to sustain services have been seen as exclusionary.

Water and sanitation services are funded through a mixture of revenues from the so-called three Ts: tariffs, taxes, and transfers (OECD 2009). The full economic cost of water may be defined as the total costs of producing, treating, and distributing water, including the depreciation and rate of return of

capital assets. There is little consensus on optimal tariff design, particularly given that water is classified as both an economic good (which favors recovering all costs through tariffs) and a human right (which favors subsidization by the government).

A 2019 flagship report of the World Bank’s Water Global Practice, “Doing More with Less: Smarter Subsidies for Water Supply and Sanitation” (World Bank 2019), explored the question of how scarce public resources can be used most effectively to achieve universal service delivery. That report provided guidance to policy makers on how to design smarter subsidies to attain policy goals.

This report builds upon that one, and provides policy makers with the information needed to design better tariffs to further the economic efficiency, affordability, and environmental sustainability of water supply services. Through a layered and comprehensive analysis of the most prevalent tariff structures, it provides policy makers with specific guidance on pricing water supply services in response to the sector’s often-competing goals.

WSS services are intrinsically linked. In member countries of the Organisation for Economic Co-operation and Development, and large cities in middle-income countries (such as Brazil, Chile, and South Africa), services are often provided by a single provider. However, in urban areas in low-income countries, most households rely on on-site sanitation services, which have different financing, management, and regulatory challenges than do networked services. Similarly, rural WSS services present distinct challenges. Given these differences,





this report focuses specifically on residential water consumption tariffs in urban areas.

This document comprises a synthesis of 15 unique research papers (listed in appendix A) that, combined, articulate a step-by-step thought process for designing effective tariffs with a view to achieving SDG 6 (figure ES.1).

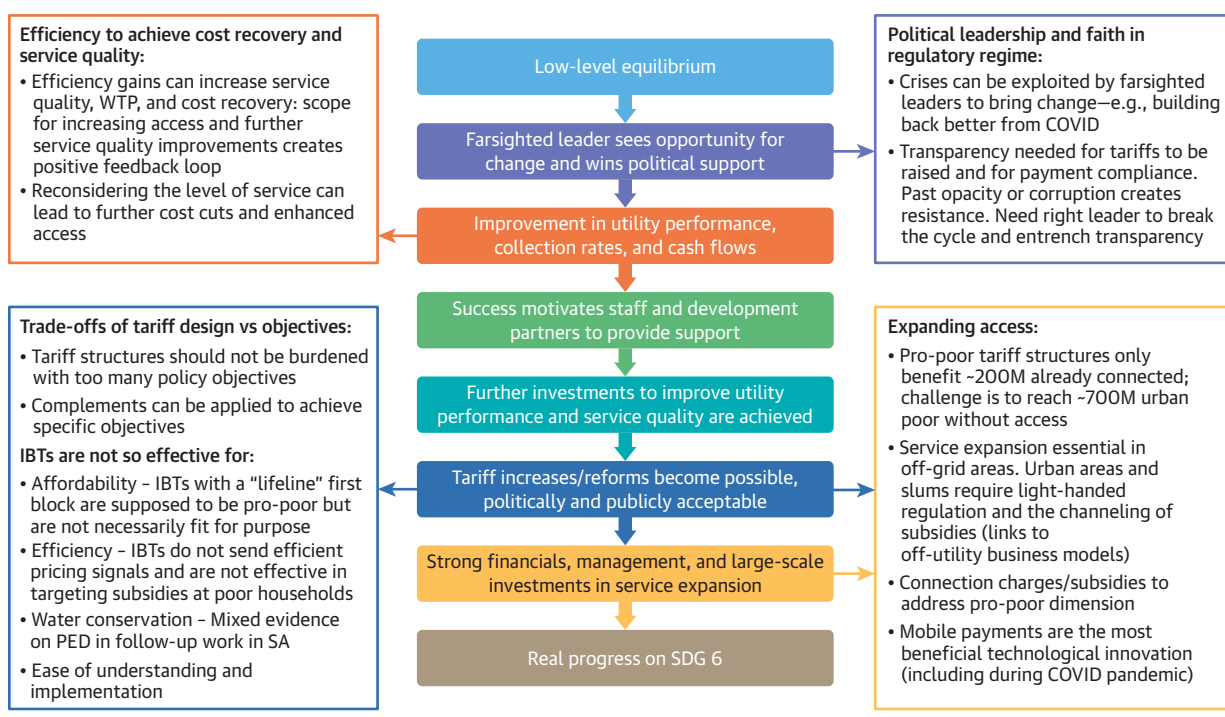
The results of this global study on tariffs can be summarized in the following five key messages.

### Key Message 1. Designing Effective Tariffs is a Function of Economic Efficiency and Requires a Detailed Understanding of Costs

Improving economic efficiency is critical to designing effective tariffs and can reduce reliance on

revenues collected through taxes or transfers. This is especially important during times of crisis, such as the COVID-19 pandemic and post-pandemic recovery period, when subsidies are likely to be directed elsewhere, inadvertently affecting initiatives designed to achieve the SDGs. Total economic costs can be defined as capital costs (including financing), the costs of operating and maintaining water supply systems, and externalities (such as environmental costs). The failure to recover any one of these costs has distinct, adverse consequences. Accordingly, correctly identifying and quantifying costs are fundamental to the tariff design process. Using a backward-looking approach to calculate average costs focuses heavily on expenses incurred and,

**FIGURE ES.1. Leveraging Leadership to Increase Efficiencies and Effect Lasting Change in the WSS Sector**



Source: Original compilation.

Note: IBT = increasing block tariff; M = million; PED = price elasticity of demand; SA = South Africa; SDG = Sustainable Development Goal; WSS = water supply and sanitation; WTP = willingness to pay.



because of its simplicity, is by far the most common approach. There are, however, sound arguments for a more forward-looking approach that explicitly recognizes invested asset value and the decline in the useful life of capital assets.

Total economic costs can be further divided into efficient and inefficient costs. Inefficient costs include costs associated with high system losses and an overstaffed workforce and are a key determinant of a utility's overall efficiency. Inefficiency affects cost recovery directly through low bill collection and high costs, and also indirectly through reduced willingness to pay (WTP) resulting from poor-quality services, which can hamstring a utility's ability to raise tariffs in the future. Thus, inefficiency can eventually lead to lower cost recovery as tariffs remain stagnant and costs rise over time. This creates a negative feedback loop, as the lower cost-recovery rate induces greater inefficiencies (e.g., stemming from low capital investments) and also directly reduces the quality of services (e.g., discouraging new connections, and thus slowing expansion of service coverage).

Evidence put forward in this report suggests that a 75 percent reduction in each of four dimensions of inefficiency (bill collection, nonrevenue water, overstaffing, and capital expenditure) would reduce the global average full cost-recovery tariff by an estimated US\$0.13 per cubic meter (m<sup>3</sup>) (or about 6 percent), equivalent to 14 percent of the global average water tariff. The effects of these efficiency improvements on the full cost-recovery tariff would differ widely across regions; Sub-Saharan Africa would experience the greatest impact (about 11 percent). On average, reducing inefficiencies in capital expenditure would result in the single-largest

marginal reduction in full cost-recovery tariffs across water utilities.

Finally, major externalities, such as environmental costs, can affect the efficiency of water supply services. A key challenge is estimating and internalizing these costs. This can be achieved by incorporating these costs into tariffs or through imposing regulatory measures on utilities—for example, limits on water extraction, water use conditions, or market-based mechanisms such as tradeable water rights. Given their complex nature relative to the calculation and compensation of total economic costs, environmental costs are rarely recovered. Yet as service providers come under increasing pressure to meet the growing demands of populations with fewer hydrological resources, environmental costs must be taken seriously.

### Key Message 2. Tariff Design Demands a Holistic Approach that Carefully Considers Competing Policy Objectives

The price of water almost never equals its value and rarely covers its economic costs. Price does not provide a clear value signal. For example, surveys show that most residential water customers are unaware of their consumption. Moreover, as water is considered a fundamental human right, attempts to price this scarce resource strike many people as unethical and are usually politically challenging. Hence, tariffs are tasked with harmonizing a set of wide-ranging, conflicting, and often highly political objectives. Most obvious perhaps is the need to ensure the financial viability of service providers while making water affordable for customers. At the same time, policy objectives reflect other important goals, such as water conservation.



The process of classifying customers—from the first step of determining how to differentiate various groups of customers to allocating costs across customer categories and creating appropriate signals for consumption—is central to the design process and a direct function of policy. The same applies to the process of determining the share of costs to be recovered by tariffs. Tariff design is thus a demanding yet delicate balancing act that is highly context specific.

The aspect of tariff design that typically garners the most attention is the core tariff structure. This report reviews five tariff structures in detail: flat rate, constant (or one block) volumetric, increasing block tariffs (IBTs), decreasing block tariffs (DBTs), and jump tariffs. Along with volumetric tariffs, IBTs are the most prevalent model globally: more than half of all utilities analyzed use IBTs to price water services. This stands true across countries of all income levels. Conversely, one-block tariffs are more common for wastewater services and are especially prevalent in countries with low average incomes. DBTs and jump tariffs are very rarely applied to water supply services, independent of customer income.

Tariff structures should not be overburdened with policy objectives. For example, two-part tariffs are the most effective at achieving economic efficiency and cost recovery, but on their own do not address affordability effectively. When affordability is a major concern, volume-differentiated tariffs (VDTs)—although uncommon—may be preferable because they cross-subsidize customers in a more targeted manner and better minimize distortions to efficiency. However, because they may inadvertently penalize large, low-income families that are likely to consume more water, as with all tariffs, their efficacy is context specific.

To better achieve more specific policy goals, tariff complements can be applied to core tariff structures or customer classifications in a way that balances competing policy objectives. Such complements may include social rebates and vouchers to tackle affordability. Additionally, tariff structures can incorporate some form of seasonal pricing or overconsumption penalty to promote environmental sustainability and the principles of a circular economy.

Compared to consumption tariffs, connection charges have received comparatively little attention and without significant subsidies remain unaffordable for many unconnected, poor households. Various options exist for subsidizing connection charges, though in reality these are often complex. Some utilities allow charges to be reduced or waived in exchange for labor or materials. Nonfinancial interventions designed to encourage connections should also be considered more broadly. For example, informational campaigns publicizing the benefits—and, if appropriate, the prevalence—of existing water connections are effective in encouraging new connectivity.

### Key Message 3. Tariff Complements Can Be Used to Effectively Address Affordability and Improve Services

Whether or not water tariffs should be set so as to support access to services by poor households has been extensively debated in the literature. The short answer is they are at best a blunt instrument and at worst produce perverse outcomes, and for one crucial reason: the need to have a policy tool for each policy objective precludes water tariffs efficiently meeting both financial viability and affordability





targets simultaneously.<sup>1</sup> While core tariff structures need to ensure sustainable funding for the provision of quality services, other targets like affordability may be best met through tariff complements and targeted social measures. For example, if tariffs are set at economic cost-recovery levels, then access by poor households relies on establishing a parallel, well-targeted subsidy mechanism such as tariff rebates or vouchers.

However, the determination of affordability is marred by scale: aggregate-level analyses commonly overestimate the extent of affordability, and alternative methods are sorely needed. Furthermore, tariff structures for networked services that aim to address poverty benefit only connected customers. This means the needs of the approximately 700 million unconnected, urban poor globally remain unmet.<sup>2</sup> In reality, large swathes of people rely on nonnetworked services as piped connections are not always economically feasible in the short term.

The needs of the unconnected must be carefully considered, and off-grid service provision is vital to bridging this gap. In urban areas, tariffs applied by informal service providers tend to reflect collusion rather than competition, making a strong case for regulating off-grid services through some form of light-handed regulation. Regulatory frameworks should be extended to these providers to grant them some form of legal recognition and incentivize their professionalization. Regulation should be adapted to mobile vendors through an acceptable relaxation of standards, whether in terms of tariffs, service quality, or coverage targets.

Customers of nonnetworked services are mostly poor households, which are thus disproportionately affected by unregulated pricing and the poverty

premium applied by informal water service providers. Although most government water supply strategies include nonnetworked services, subsidies are primarily targeted to networked services, benefitting the wealthiest customers (i.e., those who already have access to services or live within the utility's service area). The current distorted subsidy regime should therefore be rebalanced to equitably allocate subsidies to these off-grid, mostly poor customers. These could be channeled directly to poor customers or indirectly through performance-based payments to informal service providers.

#### Key Message 4. Regulation Is an Effective Tool for Increasing Efficiency and Ensuring Good Governance

Regulation<sup>3</sup> is critical in the water sector, where economies of scale and high start-up costs are fertile ground for natural monopolies. A primary role of regulators is to therefore prevent the abuse of power by monopolistic utilities. Theoretically, regulation can help prevent inflated prices and costs, maintain standards and quality of services provided, and avoid persistent failures to address environmental services. In practice, effective regulation is context specific.

There is no “one-size-fits-all” solution for the economic regulation of WSS services. Regulatory arrangements should be tailored to meet the specific needs of the country. To do this effectively, the country should first define its objectives, analyze the potential contribution of economic regulation to the overall sector accountability framework, specify regulatory functions, and select the legal instruments and organizations within which to embed these functions.



Regulatory frameworks can take various forms in line with a country's legal context. The most common include regulation by an agency or municipal regulator, or a contract between the government and provider. Regulatory tools can be cost or incentive based and the appropriate model is often a function of the utility's ownership. For example, a private utility may respond well to a cost-based approach, whereas a public utility may respond better to an incentive-based approach.

Cost-based regimes attempt to equate revenue with costs and minimize a utility's financial risk by preventing costs from exceeding revenues. This scenario works well for new utilities motivated by financial risk but may limit a utility's incentive to operate cost-efficiently and consider affordability and accessibility. Incentive-based regimes use budget constraints to encourage utilities to cut costs while improving performance, and work well for established utilities. Utilities that exceed their budget targets can keep all or part of the difference as a reward. This can lead to greater efficiencies and can also be used to motivate utilities to expand access, benefitting customers and society.

In both cases, information asymmetry between the utility and regulator makes the determination of a fair or competitive tariff difficult. Regulatory agencies that are transparent, accountable, and free of political interference contribute positively to sector performance by supporting economic cost recovery and reducing operational expenses. Different elements of regulatory governance affect performance differently. Take, for instance, the important role that regulation can play in reducing corruption, which is often deeply entrenched in the sector. Consistent and reliable flows of information between

supplier and consumer, grievance redress mechanisms, and customer engagement espouse transparency and accountability and lead to better outcomes and increased WTP. While technologies can provide the verification of financial flows needed by end customers, closer scrutiny by regulators is nonetheless critical.

The wide variety of potential arrangements calls for governance practices to be carefully systematized and successful experiences identified. Since state-owned enterprises are part of the public sector, factors of good and bad performance are directly and indirectly related to the overall governance of a country, province, or municipality. Hence, there is a need for a corporate structure that prevents political intervention, rewards performance, and is subject to public scrutiny. In this context, corporate governance appears essential.

#### Key Message 5. Resistance to Tariff Reform Is Reduced by Strong Political Leadership, Improved Service Quality, and Increased Stakeholder Engagement

The successful implementation of tariff reform requires more than a sound design: without an appropriate strategy that fosters support from customers and other stakeholders, there is a strong likelihood of failure. Such a strategy should generally entail: (1) strong political leadership; (2) enhanced performance that results in a service quality that is acceptable to customers; (3) increased stakeholder engagement; and (4) widely socializing the tariff design process and underlying costs of provision.

Successful reforms need strong political leadership. The political attractiveness of "free water" makes it an alluring way to dispense policy favors. However,



tariff reforms are possible and farsighted leaders can exploit catalytic events such as a health epidemic or a change in the political landscape to create momentum and build alliances that can alter the balance of political payoffs. This relationship is dynamic and mutually reinforcing. That is, as reforms produce tangible benefits and WTP improves, politicians are more likely to support the reform process.

As a general rule, customers are unwilling to spend more on low-quality services. Public water supply is inadequate in many countries and suffers from large water losses and intermittent service. This obliges households to look for alternative solutions that often result in huge coping costs. Inefficiencies and low-quality services lead to negative perceptions and low satisfaction rates among customers, who in turn become less willing to pay their bills. To break this vicious cycle, utilities should first embark upon a series of “quick wins” that improve their performance and efficiency, thereby improving the level of service experienced by customers and, in turn, their WTP.

Inclusive and participatory approaches can build trust between stakeholders and may even result in a more effective or sustainable tariff design. The absence of dialogue with end customers is one of the most frequently cited problems affecting water service delivery. When customers perceive that their concerns and perspectives are not considered in decision-making, they lose trust in public authorities and become reluctant to pay, much less accept tariff increases. A well-planned stakeholder engagement strategy can be used to promote a better understanding of the need for reform and enable two-way dialogue and more participatory planning. It must be flexible to accommodate shifting political, social, and cultural factors relevant to the

reform process. A wide range of mechanisms can be adopted to strengthen interactions between decision-makers, customers, and other stakeholders during the tariff reform process, including, for example, interministerial bodies, citizen committees, public hearings, media-based tools, and communication strategies. Ideally, these mechanisms gauge customer priorities in relation to various aspects of service quality, and in particular how they view the trade-off between quality of service and tariff level.

Finally, without transparent pricing, customers tend to overestimate the degree to which tariffs are recovering actual costs. This can lead them to resist even affordable tariff increases. To the extent possible, policy makers should strive to design tariffs that are simple and easy to understand. To improve understanding of the level of cost recovery achieved by existing and proposed tariffs, utilities should develop a multipronged communications strategy. Publishing regulatory information online, for example, including total costs and how costs are recovered through the three Ts (i.e., tariffs, taxes, and transfers), enables direct access by media, civil society, and customers. Documentation can also explain the process used to arrive at existing tariffs. Benchmarking against utilities in different regions or countries is important for contextualizing costs and performance and demonstrating an element of accountability. Regulators and utilities should ensure information is disseminated broadly through channels accessible to customers, which may include newspaper ads, flyers, radio or television spots, community meetings, and so on.

The results of this global study on tariffs can be summarized in the following overarching message:



*Tariffs are essential—but not the only pathway—to cost recovery, affordability, and water conservation. To maximize their potential, tariffs must be well designed, complemented by appropriate instruments, adequately regulated, and understood by customers.*

Historically, the water sector has operated under the assumption that tariffs should be designed to achieve full economic cost recovery. Against this backdrop, water utilities in low-income economies that face the difficult challenge of balancing tariffs against affordability and accessibility also lack the funds needed to maintain and expand services or address external challenges, such as climate change. Moving from a narrative that equates tariffs with full economic cost recovery to one that recognizes the roles of taxes and transfers in achieving financial equilibrium demands a paradigm shift and is critical to an effective tariff reform process.

This effort also reveals critical knowledge gaps and identifies important questions and themes that merit further research moving forward, including:

- *Tariff design and trade-offs.* Key subjects in this category include the price elasticity of demand as a basis for IBTs, direct subsidies to the poor in countries that lack an established social security classification system, and improved analytical methods to capture and analyze the effect of different tariff structures on affordability and subsidy allocation.

- *The expansion of access to services.* Related topics include how best to meet the needs of customers in off-grid water areas, connection charges and pro-poor tariff complements, the role of adaptation costs in expanding access to WSS services, and rationales for investing in emerging technologies.
- *Regulatory regimes and transparency.* Considering these is important in efforts to address corruption, and support water regulators' efficacy in incentivizing best practices among water utilities. Among other things, it is important to consider how the weighted average costs of capital differ across contexts.

Another key subject of further analysis is the best use of technology. Although advances in technology offer cost-effective solutions, the water sector has been notoriously slow to capitalize on these innovations. Various technologies are intended to support tariff design, and subsidy design and targeting, as well as improve provider-customer interactions. For example, automated water kiosks and smart payment systems facilitate the delivery of subsidies to the intended recipients, and smart meters enable the use of more sophisticated tariff structures. Technologies that engage customers and inform them of their use (e.g., through digital customer engagement) can change the way customers interact with tariffs. Finally, evidence suggests customers who use mobile payments as one of their payment methods pay bills more regularly and contribute more revenue. In addition, mobile payments reduce opportunities for corruption and enhance the quality of billing and payment data.





## Winds of Change: Is COVID-19 the Crisis the Water Sector Needs to Finally Spur Lasting Change?

If history has taught us one thing, it's that the water sector is notoriously reactive. Population growth frequently outpaces the expansion of infrastructure, and real change often occurs only on the heels of a crisis, and, even then, only when there has been a significant loss of life or major economic impact. Water systems are generally considered critical infrastructure; what does it take to spur lasting change?

A recent detailed analysis of successful utility reforms in Africa (World Bank 2016b) finds that sustained reform requires three mutually reinforcing conditions: (1) a catalytic event or space for reform, (2) a skilled technical leader motivated to improve

service, and (3) a relatively stable political leader who is supportive and protective of the reform. Tariff reform similarly hinges on effective leadership and political support for tariff design and efficient, sustainable water services. COVID-19 thus provides an important catalytic opportunity for change.

### Notes

1. As described in a recent study by OECD (2020, 7).
2. According to the Joint Monitoring Programme, 72 percent of these people live in lower- and middle-income countries.
3. Regulation is a policy intervention that aims to promote sector goals in the public interest, balancing the competing interests of the various stakeholders. Economic regulation refers to the “setting, monitoring, enforcement and change in the allowed tariffs and service standards for utilities” (Groom et al. 2006).



## Abbreviations

C&C	command and control
COD	chemical oxygen demand
CPI	consumer price index
DBT	decreasing block tariff
EIs	economic instruments
EU	European Union
GDP	gross domestic product
IBNET	International Benchmarking Network
IBT	increasing block tariff
KPIs	key performance indicators
NRW	nonrevenue water
O&M	operation and maintenance
RAB	regulatory asset base
ROR	rate of return
RPI	retail price index
SRMC	short-run marginal cost
TOU	time of use
US	United States
VDT	volume-differentiated tariff
WACC	weighted average cost of capital
WSS	water supply and sanitation
WTP	willingness to pay









## CHAPTER 1

# Setting the Context

Tariffs are the foundation of good financial governance and, ideally, enable water utilities to cover their operation and maintenance costs and make provisions for capital expenditures. By achieving this, service providers can attract investment to expand their infrastructure network, enhance service quality, or scale up other elements of service provision. However, without strong financial management and a proven track record achieving key service delivery indicators, utilities will struggle to secure the investments needed to maintain sustainable service levels, which in turn makes customers less willing to pay and further deteriorates quality of service.

The water sector in many developing economies is stuck in this situation, described as a low-level equilibrium trap (figure 1.1) (Savedoff and Spiller 1999). Historically, governments have kept tariffs artificially low or opposed tariff reforms to increase their popularity. A common tactic used to achieve short-term political gains, it ignores society's long-term interests in the financial viability of water utilities. In circumstances where political opportunism prevails, customers are typically insufficiently organized to demand accountability from politicians and utilities, but also unwilling to spend more to increase access and improve the quality of services.

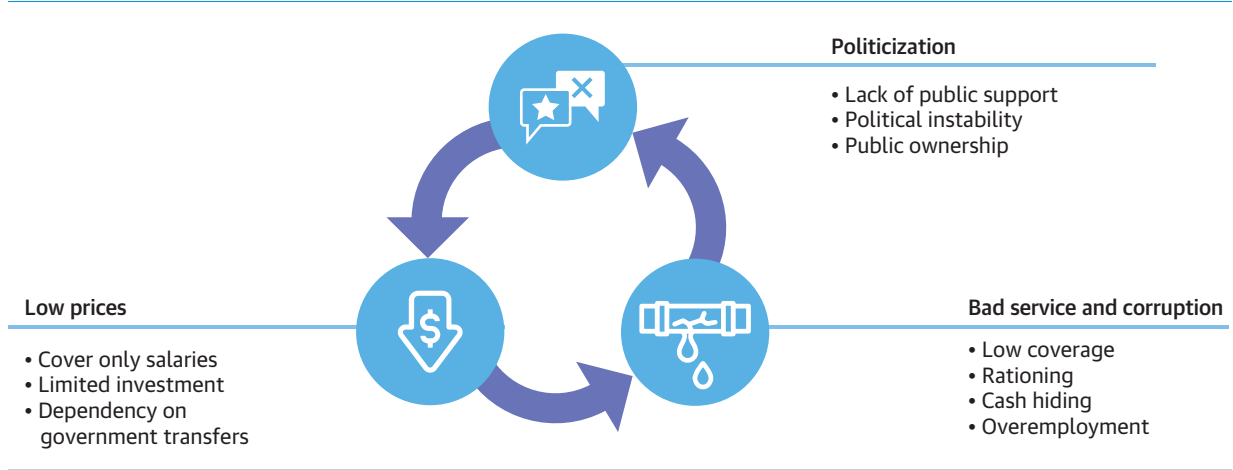
Low tariffs and inadequate revenues lead to the deterioration of assets and inefficient operation of utilities. The guiding question is therefore how to move from a vicious cycle, by which the poor quality of service generates resistance to reforms and tariff increases, to a virtuous cycle whereby good performance enhances willingness to pay (WTP), increasing revenues and leading to continuous improvements (figure 1.2).

The key factors preventing the move to a virtuous cycle can be grouped into the following categories:

- *Poor overall performance.* Public water services in many countries are poorly managed, with low billing and collection rates, large losses, and intermittent service, which often obliges households to look for alternative solutions for water supply, typically at higher costs.



**FIGURE 1.1. Low-Level Equilibrium Trap**



Source: Adapted from Savedoff and Spiller (1999).

- *Lack of trust and low WTP.* Inefficiencies and low-quality services lead to negative perceptions and low satisfaction among customers, who in turn become less willing to pay their bills, reinforcing the negative spiral of low revenues from low tariffs and collection rates. When water utilities and policy makers aren't held accountable for poor performance, customers lose trust in public authorities and become even more reluctant to pay for unsatisfactory and inadequate services, much less accept tariff increases. Building mutual trust between different actors is therefore a prerequisite for any intervention that aims to improve quality of service and cost recovery.
- *Lack of funding.* Insufficient revenues undermine the ability of utilities to make investment decisions and hamper the success of sector reforms. Revenues collected through tariffs should complement other forms of financing to support utilities' capital expenditures for maintenance and expansion, while keeping services affordable. In countries with unstable macroeconomic conditions, this means having the real value of tariffs protected through indexation formulae and ensuring significant funding through different revenue

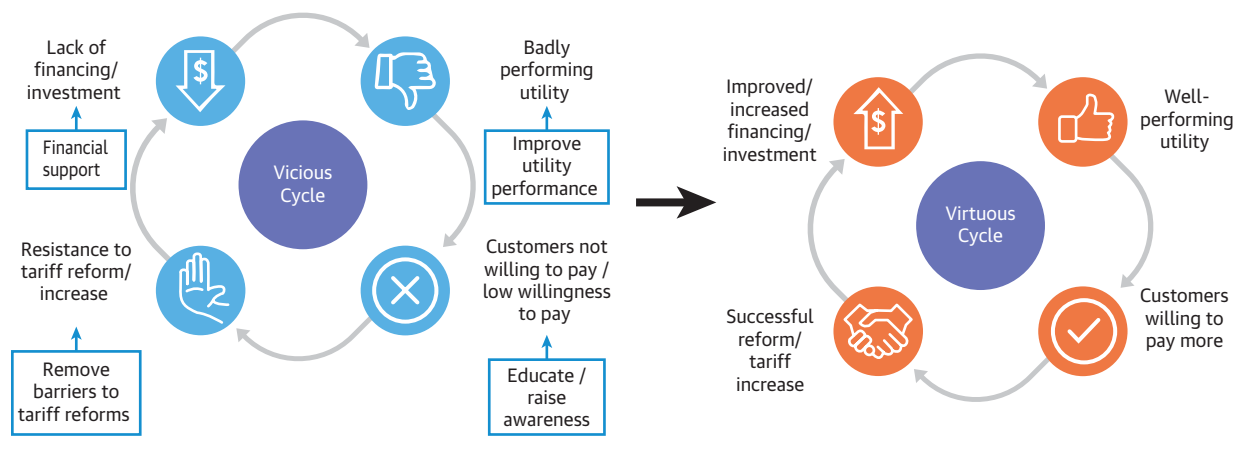
streams to back proposed reforms and compensate groups that are adversely affected.

Though tariff reform is invariably central to efforts to move beyond the vicious cycle, policy makers would do well to implement comprehensive reforms that embrace the policy, institutional, regulatory, and financial aspects needed to achieve sustainable improvements. Resistance to tariff reforms can be overcome through increasing investments, improving utility performance, and increasing the quality of services while engaging the public throughout the entire process.

### 1.1 The Case for Financial Equilibrium

Tariff structures are commonly based on the prevailing belief that tariffs should recover all costs associated with the production, supply, and delivery of water (i.e., full economic cost recovery). Against this backdrop, water utilities in low-income economies that face the difficult challenge of balancing tariffs against affordability and accessibility also lack the funds needed to maintain and expand services or address external challenges, such as climate change. This perpetual cycle of funding inefficiency renders

**FIGURE 1.2. Vicious and Virtuous Tariff Cycles**



Source: Original compilation.

them unattractive to savvy private investors. Shifting the current paradigm that equates tariffs with full economic cost recovery to one that recognizes the roles of taxes and transfers in achieving financial equilibrium, while improving economic efficiency, will be critical to effective tariff reform, a process that has historically lacked consensus.

There are three principal reasons for the prevailing discord (World Bank 2018b). First—and conceivably the most difficult challenge—is that because water is simultaneously an economic good, human right, and environmental resource, opinions on how best to price, protect, and allocate it vary considerably. Decision-making surrounding the corresponding policy objectives of cost recovery, economic efficiency, water conservation, and affordability is equally variable. Second, the potential impacts of overhauling tariff structures and pricing are poorly understood. In the face of such uncertainty, many policy makers prefer complacency over spending political capital. Lastly, the monopolistic nature of water utilities means they are often indifferent to market-driven incentives to improve service quality and efficiency.

There is a pressing need to revisit the fundamentals underpinning concepts of cost-recovery and to better understand the wider implications of different tariff structures and pricing mechanisms for investments and services. Developing a better understanding of the mix of revenue streams used to fund the provision of water—the so-called three Ts of tariffs, taxes, and transfers (OECD 2009)—is equally important. This knowledge can then be used to improve policy making while addressing the very real concerns of consumers.

### 1.2 The Pressing Need to Conserve Water

Population growth and urbanization, together with the effects of climate change, have put significant pressure on water resources worldwide. These challenges are commonly addressed through water pricing but also depend on tariff design. Water reuse can also support environmental sustainability by reducing raw water demand. Promoting water reuse will require a coordinated approach to water and wastewater pricing in addition to behavioral strategies.

In theory, progressively higher water prices should reduce consumption, but the evidence on the price

elasticity of demand and the role of tariffs in incentivizing water conservation is mixed. Price-based approaches to managing water demand offer multiple benefits in terms of ease of implementation, monitoring, and enforcement. However, household demand is not highly responsive to changes in water tariffs in many countries. At the same time, the level of tariff increases that would be needed to induce sufficient reduction in water consumption might be too high to be politically feasible. Therefore, pricing approaches to water demand management should be complemented by nonprice interventions to promote water savings among households. Specifically, tariff structures that incorporate some form of seasonal pricing or overconsumption penalties to reduce water consumption during periods of peak demand and/or lower resource availability are better at achieving environmental sustainability.

### 1.3 The Challenge of Affordability

A long-standing challenge of tariff design and reform is ensuring tariffs are affordable. A key challenge of ensuring affordable tariffs is defining affordability. While there is no consensus, a typical approach involves limiting costs to a share of total household expenditure. Thresholds used by international organizations range from 3 to 5 percent (Hutton 2012). However, these limits are arbitrary and not supported by robust theory.

Traditionally, the analysis of affordability has been conducted at an aggregate level and involves taking the average consumption and income levels for a specific group (e.g., an income decile or quintile) and calculating the average share of income spent on water tariffs. This approach fails to capture heterogeneity within groups and may fail to reveal the true extent of affordability constraints. This problem is particularly prevalent for poor, large households that may require significant quantities of water.

Traditional affordability analyses fail to account for differences in the quality of services provided, for example, in cases of frequent interruptions (World Bank 2020). Although particularly relevant to non-networked services, networked customers are also affected. Where the quality of services is low, households may need to complement their water service with alternative sources, adding to their financial burden. Finally, in many developing economies water theft and inadequate metering pose difficulties in measuring consumption levels and subsequently the affordability of prevalent water tariffs.

To fully analyze the equity and affordability impacts of different tariff structures, billing records (that show actual consumption) would ideally be matched to household income levels; however, such information is rarely, if ever, available. In some cases, property values, for example, from municipal tax databases, are used as a proxy for household income.

### 1.4 Emerging Questions

This report is the product of an extensive series of technical papers (listed in appendix A) covering some of the most relevant topics related to pricing performance in the water and sanitation sector. In the majority of cities in member countries of the Organisation for Economic Co-operation and Development, a single service provider is responsible for delivering both water and sanitation services. This is also the case for some middle-income countries with extensive sewage networks such as Brazil, Chile, Colombia, South Africa, and Uruguay. In most low-income countries, meanwhile, sanitation services are more commonly managed separately, if at all. For example, the majority of urban households in Sub-Saharan Africa and Asia rely on different forms of on-site sanitation such as septic tank and pit latrines. Given these unique differences, and recognizing that sanitation remains critical to achieving Sustainable Development Goal 6 (SDG 6),

a complementary analytical report on the implications of this study's findings on urban sanitation service provision is anticipated. Meanwhile, the present document focuses exclusively on residential water consumption tariffs in urban areas.

Grounded in economic theory, this report combines a detailed literature review with real-world examples constructed from data collected by the International Benchmarking Network for Water and Sanitation Utilities (IBNET) to arrive at a comprehensive assessment of water tariffs. This provides the backdrop for a discussion of the methodological approaches and tools needed to design and implement effective and efficient water tariffs. It explores the strengths and weaknesses of different tariff structures and provides guidance to policy makers on which contexts are most appropriate for their application. As such, it serves as a richly detailed, companion report to “Doing More with Less: Smarter Subsidies for Water Supply and Sanitation” (World Bank 2019).

The assessment seeks to address a series of emerging questions pertaining to tariff design and reform organized around three central themes of economic efficiency, water conservation, and affordability and accessibility.

### How Should Costs Be (re)Covered?

There is little agreement on which specific costs should be covered by tariffs, and in which contexts. Even the term “cost-recovery tariff” is fraught with confusion and uncertainty. In some cases, government plans explicitly prescribe a method for determining customer fees. Whatever the case, the difference between revenues collected through tariffs and full economic cost recovery constitutes an economic shortfall that must be offset by a subsidy if the service is to be sustained. This subsidy can be funded through a combination of taxes or transfers. When governments fail to provide the full subsidy,

the resulting revenue shortfall prevents the service provider from properly maintaining its infrastructure. This reduces the life of its assets and will eventually lead to reduced service quality. Therefore, full economic cost recovery depends not only on tariffs, but on achieving financial equilibrium from revenues collected through each of the “three Ts.” The size and contribution of each is context specific and generally determined by policy.

Lower levels of revenue collected through tariffs generally reduce the accountability of the service provider to its customers. The presence of subsidies can act as a soft-budget constraint but if not well designed, often distorts incentives for service providers. For example, while under free market conditions the potential increase in revenue gained from undertaking service improvements and extensions may outweigh the costs of any investment, under subsidized conditions this potential revenue may be offset by the corresponding loss of the subsidy. A loss of subsidies could inadvertently have an impact on poor households. Weak institutions and imperfect regulation exacerbate this problem. Thus, it's important to consider the trade-offs entailed in pricing water more efficiently in economic terms (with a focus on revenues collected through tariffs) versus more equitably (leaving revenues to be collected through taxes and transfers). This is especially evident in the case of overdesigned systems where newly constructed facilities, intended to serve an increase in demand that has not yet been achieved, potentially push costs beyond the affordability of current customers.

### What Is an “Affordable” Tariff?

Affordability is an important cross-cutting concern that evokes the human rights dimension of water, yet there is no consensus on how affordability should be defined or measured, and estimates are frequently



inaccurate. Households often face significant costs beyond customer fees paid to the service provider, such as investments in associated household fixtures (e.g., bathrooms, drains, plumbing, etc.). Affordability analyses must reflect all costs incurred by the household. As affordability is mainly determined by customer income and preferences,<sup>1</sup> measuring it requires a different definition of costs than that used by the service provider to determine tariffs.

### Which Tariff Structures Are Most Appropriate in a Particular Context?

Most utilities in developing economies use increasing block tariffs (IBTs), where volumetric tariff rates increase with total consumption. Based on the assumption that poor customers consume less water, reducing prices for the lower consumption brackets is believed to render services more affordable. However, there is little empirical evidence to support this assumption. To the contrary, poor households are often large or share their water supply with neighbors and therefore consume more water. As a result, many non-poor households benefit from IBTs while the poor and unconnected remain unserved.

IBTs are also used to promote environmental sustainability by influencing water consumption yet similarly there is limited empirical evidence to support their effectiveness in this capacity. Conceivably, greater efficiency could be achieved through a two-part tariff that contains a fixed charge and a volumetric component. The fixed charge could be adjusted to assure (full or partial) economic cost recovery, while the volumetric rate could be used to send a signal about the scarcity value of water and the marginal cost of the service.

Ultimately, tariff structures are country and utility specific, and trade-offs are inherent to different tariff structures—some are better than others at improving

affordability without too much distortion to efficient price signals.

### Should Costs Related to Externalities Be Recovered Through Tariffs?

Given the public good dimension of water, prices should accurately reflect the true costs of service provision including externalities such as environmental costs. Routinely neglected, environmental costs are vital to environmental sustainability and reflect the conditions of water supply resources and the potential contamination resulting from the improper treatment of wastewater. However, monetizing environmental pressures and impacts is a complex and imperfect exercise, since many hydrological services are nonpecuniary, unmeasured, and uncertain in the context of climate change.

### Are Prices Effective in Regulating Water Consumption?

Demand for water is not highly responsive to changes in water tariffs in countries where prices are low; yet reducing consumption is critical in water-scarce regions. Utilities seeking to reduce demand in periods of drought have experimented with seasonal tariff increases. However, there is insufficient evidence to determine the magnitude of price increases needed to induce changes in patterns of consumption.

Insights gathered using behavioral economics suggest customers can be “nudged” into using less water. These techniques include creating social norms by comparing household consumption to neighborhood consumption and presenting the benefits of reduced consumption—for example, cost savings or societal gains—in simple graphics on customer water bills. In addition, presenting the actual cost of services alongside the subsidized cost can reduce opposition to subsequent tariff increases.

## How Should Utilities, as Natural Monopolies, Be Regulated?

Water utilities are natural monopolies that face limited competition, so there are few market-driven incentives to induce improvements. When assets are publicly owned, the incentives to reduce costs, improve quality, or innovate are relatively weak given that management is unlikely to accrue any financial benefits. This creates the risk that utilities will exploit their market power by inflating costs or raising prices. Simple pricing rules that aim to “recover costs” without considering the scope for cost inflation might condone waste and aggravate inefficiencies. A utility knows more about its own cost structure and level of efficiency than does its regulator. This information asymmetry translates into a bargaining advantage that can lead to inadequate services, inflated costs, or the ad hoc renegotiation of contracts (a pervasive problem in the sector). Ensuring the independence of regulators when service provision is public is yet another challenge.

The task of policy and regulation is to recognize these asymmetries and ensure that affordable, quality services go hand in hand with a fair and “normal” rate of return to the service provider. How to achieve this remains unanswered and has received almost no attention in the literature. In this context, corporate governance appears essential. The wide variety of arrangements calls for governance practices to be carefully systematized and successful experiences to be identified. Since state-owned enterprises are part of the public sector, factors of good and bad performance are directly and indirectly related to the overall governance of a country, province, or municipality. Hence, there is a need for a corporate structure that prevents political intervention, rewards performance, and is subject to public scrutiny.

## How Can Policy Makers Promote Transparent Tariff Structures?

Subsidies delivered through opaque pricing structures contribute to a host of problems within the water sector. When incentives are misaligned, even large subsidies—whether in the form of improved service quality or reduced costs—can fail to benefit customers. When service providers are provided with a guaranteed revenue regardless of performance, customers may even observe a deterioration in service quality as maintenance becomes neglected.

Furthermore, subsidized tariff structures that obscure the true economic cost of service may cause customers to falsely assume they are being charged full economic cost-recovery rates. These structures may generate resistance to tariff reform since, in the customer’s view, any price increase is unwarranted. Moreover, taxpayers may also oppose tariff reform if they fail to perceive they are responsible for any costs, as well as any resulting inefficiencies not recuperated through tariffs or transfers. Depending on a country’s tax policies and service coverage, this may result in either regressive or progressive redistribution.

## Can Tariff Reform Be Successful?

Tariff reform remains elusive in many countries, suggesting that the political economy constraints confronted by decision-makers are poorly understood. The political attraction of “free water” makes it an alluring way to dispense policy favors—it can be marketed as a commitment to poverty reduction or as support for rural development. Even where subsidies are recognized as imprudent and counterproductive, their removal proves challenging. Governments are often reluctant to reform tariffs, particularly given the many recent examples of public backlash in the face of price increases.

Still, numerous case studies in the water sector suggest reform is possible. Catalytic events such as a cholera outbreak, or a change in the political landscape, can create momentum for change. Farsighted leaders can use these crises to create informed alliances that can alter the balance of political payoffs. But crises are rare and cannot be relied upon to facilitate reform. Lessons from trade protection and environmental legislation where radical and successful reforms have been sustained are informative. These often begin with recognizing that reform will be resisted in proportion to the economic losses it brings. In theory, compensating losers may be the necessary price of change. In practice, the end result is often a patchwork of the original objectives, which may endure, with the promise of further change.

Given the huge variation in the political economy of countries globally, the task of delivering a comprehensive toolkit to overcome resistance in all settings would be difficult. Instead, this report builds upon the framework developed in “Doing More with Less” (World Bank 2019) (which sought to classify a country’s political equilibrium into one of four cases, considering interest groups and generalized benefits), by identifying crucial considerations specific to tariff reform through the presentation of case studies of both successful and failed attempts.

## 1.5 Report Structure

Chapter 2 of the report introduces the tariff design process, starting with a discussion of key inputs such as the customer classification process before presenting a typology of major water tariffs and their

global prevalence. The chapter then discusses the complexities of pursuing cost recovery, including identifying costs, outlining the hierarchy of total costs (including connection costs), and different calculation techniques. Tariff objectives are then introduced with a focus on economic efficiency and affordability before the chapter summarizes the effects of different tariff structures on each. Finally, the different sources of revenue needed to achieve financial equilibrium are described and discussed.

Chapter 3 presents a detailed summary of common tariff complements alongside strategies to improve economic efficiency, conserve water and ensure affordability, and increase access—and their associated trade-offs. The chapter then moves on to consider barriers to connection before presenting the rationale for nonnetworked services and tariffs in urban areas.

Chapter 4 outlines the regulatory levers available for tariff setting in networked systems with a strong emphasis on the intricacies and barriers that regulatory tariff setting must address in practice, such as information asymmetry and transparency.

Chapter 5 explores the key components needed to design an effective and efficient tariff reform strategy before discussing how recent advances in technologies are slowly revolutionizing the water sector, and how they can be used to improve the utility performance and the tariff design process.

And, finally, chapter 6 offers concluding remarks.

## Note

1. See World Bank (2019) for a more detailed methodological discussion of affordability.







## CHAPTER 2

# Designing an Effective Tariff Structure

Designing an effective tariff requires a better understanding of the key inputs needed to support the tariff design process and the costs associated with the provision of water supply services. This chapter starts by defining efficient tariffs before identifying key inputs and presenting the main tariff typologies. It then classifies each of the costs across the water supply cost chain before grouping them into distinct categories, which combined give rise to the economic costs of providing water. Connection costs and external costs, such as environmental costs, are discussed separately. Thereafter the chapter quickly delves into the two most common methods used to calculate costs and discusses the distinct advantages and disadvantages of each. It then describes the primary objectives of tariffs, and the effects of different tariff structures on efficiency and affordability. It discusses the advantages and disadvantages of each of three revenue streams and their relevance to achieving financial equilibrium before considering cost-cutting efforts and the importance of efficiency. The chapter concludes with a brief summary of key findings.

### 2.1 What Is an Effective Tariff Structure?

First and foremost, a water tariff is a price assigned to water supplied by a utility through a piped network to its customers. The system of procedures and elements used to extract, treat, store, and distribute water determines a customer's total water bill. Any part of that bill can be called a charge, measured in money/time units (e.g., US\$50 per month) or money units alone, and any unit price can be called a rate, usually measured in money/volume units (e.g., US\$1 per m<sup>3</sup>) (OECD 1999).

To define the appropriate tariff structure, regulators and service providers must first determine the cost of providing services and the appropriate initial service access charge to cover the cost of connecting customers to the network.

Several steps are then involved in defining the tariff structure (figure 2.1) and summarized as follows:

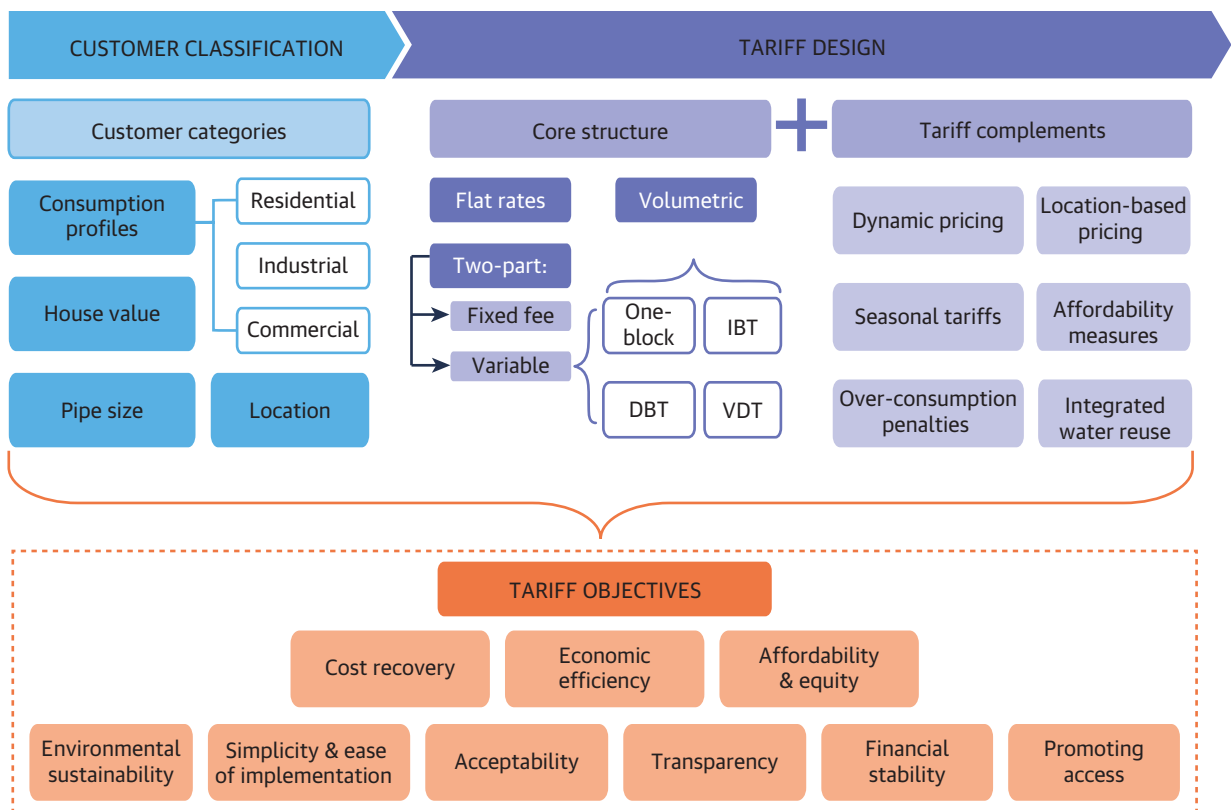
1. *Classify customers.* Central determinants of tariff design include differentiating customer groups, allocating costs among different customer categories, and creating appropriate signals for water consumption.
2. *Select core tariff structure.* The main types of core tariff structures involve flat charges, volumetric tariffs, or a combination of fixed and variable components, that is, two-part tariffs.
3. *Apply tariff complements.*<sup>1</sup> These can be applied to both core tariff structures or customer classifications to achieve competing policy objectives.

## 2.2 Customer Classification

Customers are grouped by cost of supply and also as a means of addressing other tariff objectives, such as ensuring tariffs are affordable. The most common methods of customer classification applied internationally center on:

- *Consumption profiles.* Residential, industrial, and commercial customers are differentiated to reflect differences in the water usage of households, institutions, and businesses.
- *Pipe diameter.* When customer water consumption data cannot be used, the size of the connection pipes is used to capture the volume of water flowing into the premises.

**FIGURE 2.1. Elements of an Effective Tariff Structure**



Source: Original compilation.

Note: IBT = increasing block tariff; DBT = decreasing block tariff; VDT = volume-differentiated tariff.



- *House values.* This classification uses the rated value of a customer’s property, under the assumption that higher-value houses and larger properties are associated with larger consumption volumes.
- *Geographic location.* Where poor households are typically clustered in the same area, grouping by geographic location can mitigate the impact of water tariffs on lower-income customers. Geographic targeting is also used to charge customers according to their underlying cost of supply.

### 2.3 Primary Tariff Objectives

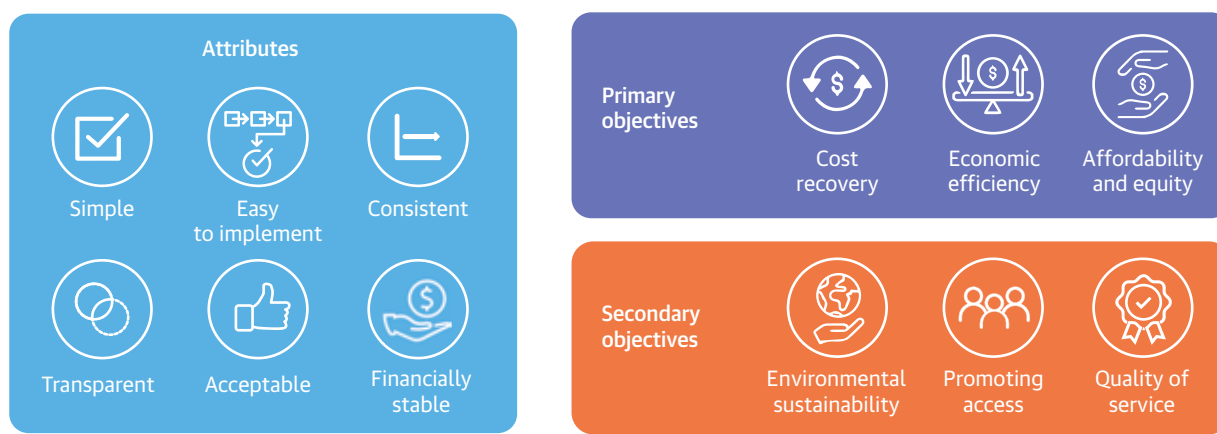
Some tariff objectives are interrelated and the successful implementation of one may positively or negatively influence another. Thus tariffs must strike a delicate balance between different policy objectives, which are often conflicting (figure 2.2).

While this chapter focuses primarily on the three primary tariff objectives of cost recovery, economic

efficiency, and affordability, tariffs also address many important secondary objectives:

- *Environmental sustainability.* Tariff structures can be an effective water demand management strategy to promote water conservation through pricing incentives.
- *Promoting access.* Tariff structures should be consistent with guaranteeing the provision of water and wastewater services to all consumers regardless of their socioeconomic situation or geographical location. Ensuring access to safe and sustainable WSS services is often challenging in rural and peri-urban areas where a large proportion of the population is covered by nonnetworked services.
- *Quality of service.* Tariff structures should ensure a quality of service commensurate with a customer’s needs and wants. This can increase willingness to pay (WTP), and address transparency and inequities.

**FIGURE 2.2. Key Tariff Objectives**



Source: Original compilation.



Additionally, an effective tariff has several key characteristics. It is:

- *Simple and easy to implement.* Tariff structures should be simple, understandable, and economic to implement and maintain. Simpler tariff structures are also likely to be more easily accepted by the public and less challenging from a political perspective.
- *Consistent.* Tariffs should generally remain stable over time as customers prefer stable bills, which in turn facilitates long-term decision-making. This implies that any change in the tariff structure or level should be phased over a transition period to allow customers to adjust to the tariff revision.
- *Transparent.* This is a desirable aspect of water tariffs to avoid informational asymmetries about cost structures and efficiency levels that can be exploited by water utilities to inflate costs or provide low-quality services.
- *Acceptable.* An important aspect of water and wastewater pricing is obtaining the required social and political support and acceptance to implement a given tariff structure. This is often a very difficult task.
- *Financially stable.* The risk of unexpected revenue fluctuations can be minimized by tariff structures that provide revenue stability and mitigate water utilities' vulnerability to demand variations.

## 2.4 Identifying and Calculating Costs

The failure to recover each element of the economic costs of water supply results in unique impacts on the sustainability of the utility and the wider water supply system in the short and long term. These impacts provide the underlying justification for cost recovery and the basis for the ensuing discussion on

the relevant aspects and impacts of limited cost recovery.

The specific costs associated with the provision of water supply services can be organized by cost groups and then categorized (figure 2.3).<sup>2</sup> Total economic costs relate to a utility's infrastructure, service delivery, and additional external costs related to water resources and the environment. Total economic costs do not necessarily refer to expenditure. Operation and maintenance (O&M) costs and capital costs are distinct from operational expenditure (OPEX) and capital expenditure (CAPEX), as the former include costs that are not captured by the latter. For example, a utility may avoid paying its electricity bills to keep OPEX lower, despite O&M costs being incurred in reality. Similarly, while CAPEX includes expenditure on an investment project, there are costs incurred in financing this spending through debt and equity that are included in capital costs.

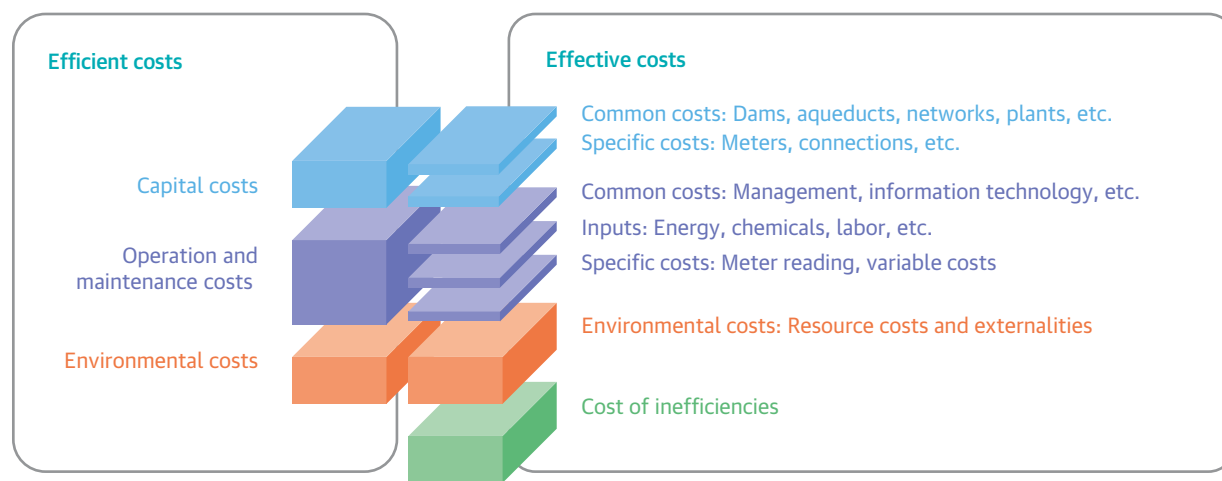
There are two broad approaches to calculating costs: (1) a backward-looking approach that focuses on the utility's historical average costs; and (2) a forward-looking approach that treats historical average costs as sunk and instead looks to future marginal costs.

### Backward-Looking Methods

Backward-looking approaches are the most common and typically used by regulators in price determinations, in part because they are simple and objective given their basis in recorded costs. Backward-looking approaches for determining average costs can be broadly categorized into cash-based or building block methods (table 2.1).

The cash-based approach is closely related to expenditure in financial documentation, while the latter models the costs of the utility instead. This has major implications for calculating capital costs. First, the building blocks approach distributes asset cost

**FIGURE 2.3. Cost Categories of Networked Water Supply Services**



Source: Adapted from Andres et al. (2019).

**TABLE 2.1. Backward-Looking Approaches for Determining Average Costs**

Method	Description	Advantages	Disadvantages
<b>Cash based</b>	Sum of cash outlays that appear in financial statements.  Typically includes operation and maintenance (O&M) expenditure, loan repayments, and debt interest.	Good for a utility's cash flow.  Simple to implement, requires low capacity.	Unfair for current customers to pay for assets that will be enjoyed by future customers.  Fails to recover some hidden costs that do not appear in financial statements, such as equity and subsidization.  Focus on financial documentation readily validates previous costs, paving the way for costs to be approved in future even if erroneous or inefficient.
<b>Building blocks</b>	Sum of imputed costs.  Typically includes O&M costs, return on capital, and depreciation.	Recovers hidden costs, such as cost of equity.  A weighted average cost of capital (WACC) term can incentivize an efficient capital structure (if notional gearing is used).  Expenditure is amortized over the economic life of asset.	Requires regulatory capacity, including for the often-controversial WACC term.

recovery over the asset's life through a depreciation term, while the cash-based approach allows recovery of debt repayments in real time, regardless of the lifetime of the asset. From a financial management perspective, the cash-based approach is best for the utility's cash flow, but results in current customers paying the debt repayments on assets that benefit future customers. Conversely, because the building blocks model recognizes the opportunity cost of equity via the WACC term, which is omitted from the cash-based model, the building blocks model more adequately recovers all financing costs and can incentivize an optimal capital structure if notional gearing is used (see appendix A, paper 4 on tariffs and regulation).

### Forward-Looking Methods

There are several arguments for a forward-looking approach based on future marginal costs. Kahn's marginal cost pricing doctrine stipulates that a utility's tariffs should be based on marginal costs in order to create the correct price signals for economic efficiency. Furthermore, as water utilities adopt new and expensive technologies to meet modern challenges, they may find they have a marginal cost that significantly exceeds their historical average costs, which can create a challenge for cost recovery. A forward-looking approach treats these historical costs as sunk and looks to future marginal O&M and capacity costs.

Economic theory indicates that resources are efficiently used when prices are set according to marginal costs. An efficient use of resources implies that supply and demand are balanced at a level of consumption that maximizes total producer and consumer surpluses. Marginal costs will rise sharply as the infrastructure's capacity is increasingly used up and decline rapidly after extension of the latter.

Since it is not practical to equate steep variations in the short-run marginal cost (SRMC) with revenue levels each time the infrastructure is extended, it would be more appropriate to set the latter according to the long-run marginal cost (LRMC) instead (McPhail, Locussol, and Perry 2012).

The SRMC is the cost of supplying an additional unit of water demand with capacity held constant. Since most costs are fixed, this approach is simple and broadly equates the SRMC with variable costs or average O&M costs. This approach might be appropriate where there are no capacity constraints. It can also serve as a price floor; for example, generally, volumetric tariffs should not be set below the SRMC.

The LRMC<sup>3</sup> is also the cost of supplying an additional unit of water demand. However, unlike the SRMC, the capacity is allowed to vary. In simple terms, it is the system expansion cost associated with a sustained incremental increase in demand, or equivalently the avoided cost for a sustained decrease in demand. Since capacity costs may vary, the approach is more sophisticated than the SRMC and requires a water system cost analysis. There are two key methods for estimating the LRMC cost: the Turvey and average incremental cost methods (table 2.2).

## 2.5 Core Water Tariff Structures

There is considerable variability in the design of water tariffs, as different combinations of core structures and tariff complements aim to achieve various policy objectives. Water tariffs typically comprise fixed charges, volumetric charges, or a combination, and are context specific. The advantages and disadvantages of each are presented below and summarized in table 2.1. A simple, step-by-step process intended to help identify the most appropriate core

**TABLE 2.2. Forward-Looking Approaches for Determining Average Total Costs**

Method	Description	Advantages	Disadvantages
Turvey	Change in present value of system expansion costs in response to incremental increase in demand each year over a fixed time period.	Close estimate of long-run marginal cost.	Requires substantial effort, such as production of optimal expansion plans.  Sensitive to demand forecasts, which are in turn difficult to produce due to uncertainty.
Average Incremental cost	Change in present value of system expansion costs in response to forecast increases in demand over fixed time period.	Closer representation of marginal cost than short-run marginal cost.	Pragmatic increment but can cause significant deviation from marginal cost.

tariff structure for urban water services is then included in figure 2.4.

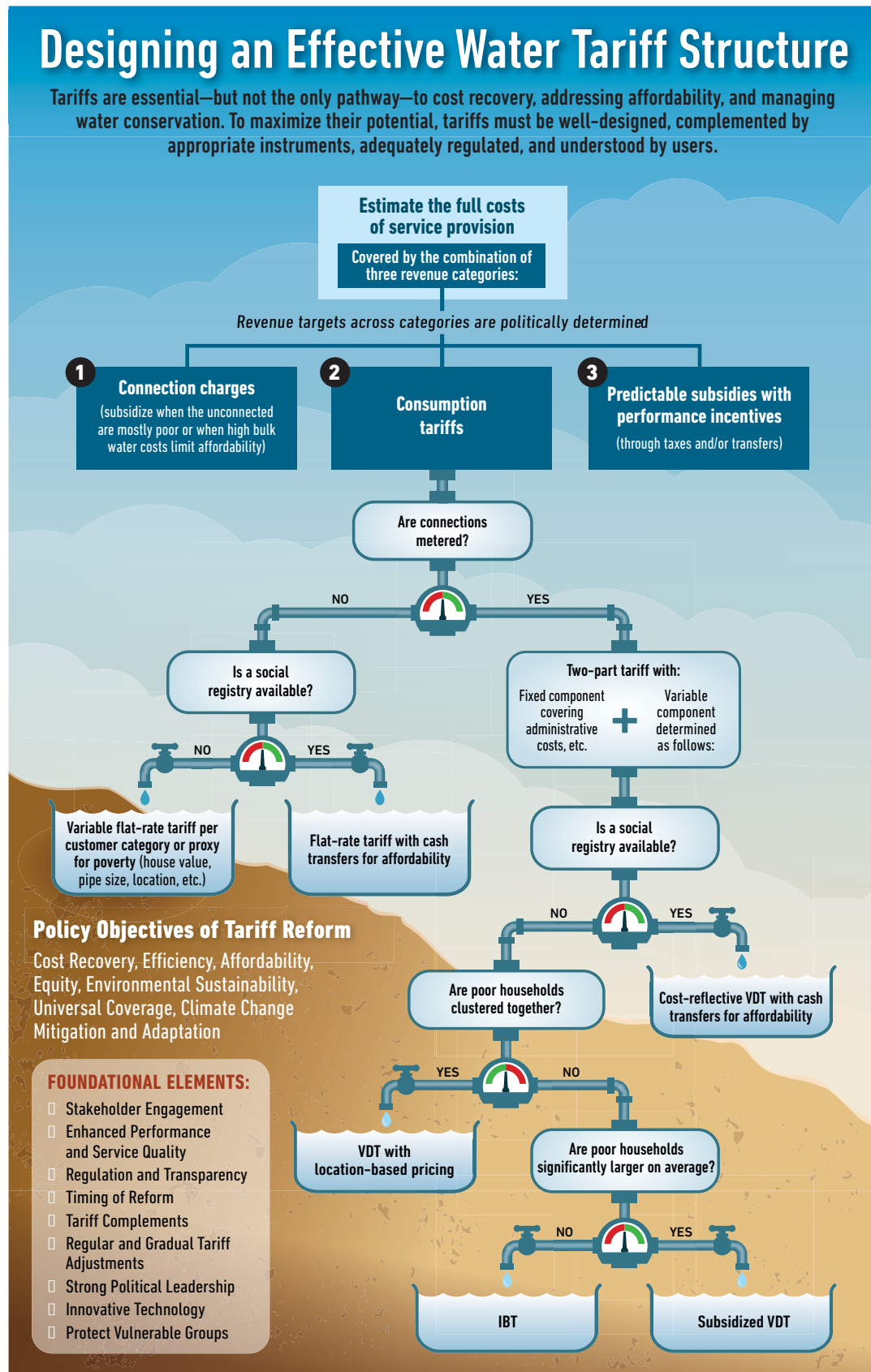
- *Flat rate tariffs.* Flat structures consist of a fixed nonvolumetric fee paid periodically regardless of the volume of water consumed. Flat rate tariffs provide a 100 percent fixed revenue that potentially allows water utilities to cover their operating and capital costs. The tariff level depends on the proportion of costs that service providers can recover through tariffs as part of the regulatory regime. Flat rate tariffs are often applied in regions where the water sector is in the first stage of development and metering cannot be installed. In the absence of a metering system, a flat rate charge is the only possible tariff structure. This model requires a stable agreement between regulators and water utilities with respect to the fraction of costs recovered by water operators through the fixed fee. Fixed charges are typically weighted using specific variables, such as the size of the property or diameter of the distribution pipe. This implies a slight variation in fees collected.
- *One block or constant volumetric tariffs.* This tariff structure consists of a variable charge with a constant unit price for each category or group of customers. Both fixed and variable costs are expected to be covered by variable revenues as the model is

fully dependent on the volume of water consumed. Constant volumetric pricing is adopted in various developed and developing economies given its simplicity and is common for nonresidential consumers throughout the world. Volumetric pricing requires a functional metering system to monitor consumption and provide regulators and water utilities with the necessary information for effective price revisions.

- *Increasing block tariffs (IBTs).* This tariff structure is based on a progressive unit price of water that varies between consumption blocks, with the unit price increasing with higher consumption. IBTs are typically adopted to provide water to poor households at an affordable rate for a volume equivalent to the basic minimum requirement and at a price lower than the cost of supply known as a “lifeline” tariff. Subsequent blocks are usually charged at higher rates above the cost of supply to generate cross-subsidies and encourage efficient consumption. IBTs are also used to address environmental sustainability by encouraging water conservation. This is particularly relevant in countries or regions that suffer from drought. IBTs require a functional metering system to monitor consumption. The different blocks of the IBT should be established under rational criteria and are typically based on reliable demand forecasting tools to estimate how total water demand will be separated



FIGURE 2.4. Decision-Making Tree for Designing an Effective Water Tariff Structure



Source: Original compilation.

Note: IBT = increasing block tariff; VDT = volume-differentiated tariff.

**TABLE 2.3. Strengths and Weaknesses of Core Tariff Structures**

Tariff structure	Strengths	Weaknesses	Requirements	Context for implementation
Flat rates	<ul style="list-style-type: none"> <li>Financial stability and predictability</li> <li>Simple and easy to implement (no need for metering)</li> <li>Not vulnerable to demand fluctuations</li> </ul>	<ul style="list-style-type: none"> <li>Does not promote efficient use of water (at all)</li> <li>Makes affordability difficult, unless tariffs are well below cost-recovery levels</li> </ul>	<ul style="list-style-type: none"> <li>Property/connection registration</li> <li>Ideally also accurate data on property features (i.e., pipe size, property value) or customers</li> </ul>	<ul style="list-style-type: none"> <li>Appropriate for regions in their first stage of development of water provision, or where metering cannot be installed</li> </ul>
One-block tariffs	<ul style="list-style-type: none"> <li>Easy to understand and implement</li> <li>Flexibility in determining the volumetric charge</li> <li>Customers can be incentivized to use water efficiently</li> </ul>	<ul style="list-style-type: none"> <li>Less revenue stability for the utility because the rate is completely variable</li> <li>Challenging for affordability if all residential customers pay the same rate</li> <li>Usually does not reflect marginal cost of supplying different customers, unless varying by time of day</li> </ul>	<ul style="list-style-type: none"> <li>Metering at level of household, or industrial or commercial establishment</li> </ul>	<ul style="list-style-type: none"> <li>Applied in countries where water supply service is in its developing stages and total water demand is gradually increasing and can generate higher revenues over time</li> </ul>
Increasing block tariffs (IBTs)	<ul style="list-style-type: none"> <li>Encourage customers to reduce consumption</li> <li>Make basic water needs affordable</li> <li>Flexible to adapt to different contexts</li> </ul>	<ul style="list-style-type: none"> <li>Definition of blocks often arbitrary</li> <li>Difficult to target vulnerable households (i.e., large, poor households end up in higher tariff blocks)</li> <li>Vulnerable to demand fluctuations</li> <li>Complex to monitor and administer</li> <li>May discourage large customers</li> </ul>	<ul style="list-style-type: none"> <li>Metering at household level</li> <li>Accurate data on household water use, income, and composition to design blocks and tariffs</li> </ul>	<ul style="list-style-type: none"> <li>Where affordability is challenging for a significant share of the customer base and there is no way of subsidizing those customers directly</li> <li>Regions with water scarcity issues and a mature water supply service where demand has reached a stable volume</li> <li>Appropriate where water demand does not fluctuate excessively, and basic service investment is already funded</li> </ul>

table continues next page

TABLE 2.3. continued

Tariff structure	Strengths	Weaknesses	Requirements	Context for implementation
Decreasing block tariffs (DBTs)	<ul style="list-style-type: none"> <li>Secure utility revenues and achieve cost-recovery objective</li> <li>Can be used to reflect the underlying cost of service in cases where a fixed charge is not viable</li> <li>Promote economic development and greater production levels by applying lower tariffs to large customers</li> </ul>	<ul style="list-style-type: none"> <li>Discourage water conservation</li> <li>Value judgement in setting the blocks</li> <li>Place a higher burden on low-income customers, while high-end customers pay lower-than-average tariffs</li> </ul>	<ul style="list-style-type: none"> <li>Metering at household level</li> <li>Data on water use, household income, and composition</li> </ul>	<ul style="list-style-type: none"> <li>Cities where large industrial customers enable the utility to capture economies of scale and do not require expansion of the distribution network for their supplies</li> </ul>
Jump tariffs	<ul style="list-style-type: none"> <li>Encourage customers to reduce consumption</li> <li>Make basic water needs affordable</li> <li>Flexible to adapt to different contexts</li> <li>Address affordability in a more targeted manner than IBTs, by reducing the error of inclusion</li> </ul>	<ul style="list-style-type: none"> <li>Perceived as inequitable</li> <li>Definition of blocks often arbitrary</li> <li>Difficult to target vulnerable households (i.e., large, poor households end up in higher tariff blocks)</li> <li>Vulnerable to demand fluctuations</li> <li>Semi-complex to monitor and administer</li> <li>May discourage large customers</li> <li>Not effective when billing period is not frequent, as consumers are not aware of excessive consumption</li> <li>Distorted/arbitrary value judgement in setting the blocks</li> </ul>	<ul style="list-style-type: none"> <li>Metering at household level</li> <li>Accurate data on household water use, income, and composition to design blocks and tariffs</li> </ul>	<ul style="list-style-type: none"> <li>Regions where IBTs present disadvantages (errors of inclusion) and with a stronger focus on water conservation</li> <li>Recommended in developing economies to improve targeting</li> </ul>
Two-part tariffs	<ul style="list-style-type: none"> <li>Fixed charge can achieve social aims and affordability objectives</li> <li>Ensure efficiency pricing and cost recovery when fixed charge recovers fixed costs and volumetric part covers variable costs</li> <li>Flexibility to meet other objectives</li> </ul>	<ul style="list-style-type: none"> <li>Fixed charge not linked to consumption implies lower water-saving effects</li> <li>Fixed charges can threaten affordability</li> </ul>	<ul style="list-style-type: none"> <li>Metering at household level</li> </ul>	<ul style="list-style-type: none"> <li>Regions willing to balance between efficient and social aims (application of a fixed charge and a volumetric rate to maintain the "user pays" principle) without significant water scarcity issues</li> </ul>

into tiers. Information on individual consumption patterns and cost profiles is therefore necessary to design an effective IBT structure.

- *Jump tariffs.* This tariff structure is commonly classified as a special case of IBT as it follows a similar pattern with one important difference. Once customers reach an upper block, they pay the last block price for all previous units of water consumed in that block. In other words, the highest block reached determines the unit price of all previous units of water used. This tariff model is uncommon in the water sector and more widespread in the electricity sector. Jump tariffs are also commonly referred to as volume-differentiated tariffs (VDTs) and are typically applied to avoid targeting errors in subsidies intrinsic to standard IBTs, wherein all consumers benefit from the subsidized lower block(s).
- *Decreasing block tariffs (DBTs).* This tariff structure applies a progressively lower volumetric rate to consecutive consumption blocks. The reasoning behind this tariff model was to recognize declining average costs of supply due to economies of scale and promote economic development and greater production levels by applying lower tariffs to large consumers. Similar to IBTs, the design of DBTs relies on decisions regarding the number of blocks, volume of water consumption, and unit price associated with each block. DBTs have largely fallen out of favor because they penalize consumers in low-consumption tiers, providing a disincentive for water savings. As water conservation has moved up the political agenda in many countries and the marginal cost of supplying water continues to rise, DBTs have become less profitable for utilities. This tariff structure is also politically

unattractive because it allows high-volume customers to pay less than average water tariffs.

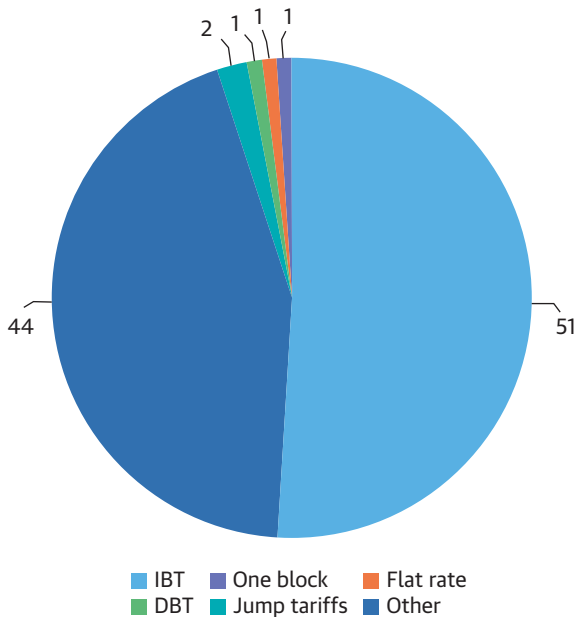
- *Two-part tariffs.* The two-part tariff model consists of a fixed payment per month that is not linked to the amount of water consumed and a variable part that is consumption related and hence called the volumetric rate. The fixed component of the tariff is typically considered as a service access fee and should at least cover services such as meter reading and maintenance, billing, and collection. The fixed component of the tariff can also be used to spread the connection cost over time. It can be set to different levels between customer types, that is, higher fixed charges for commercial and industrial customers as compared to households, or according to the size of the distribution pipe. As for volumetric tariffs and IBTs, metering systems are required for effective implementation of two-part tariffs and knowledge of the cost structure is essential to provide regulators and utilities with the necessary information to adequately price water and wastewater services. For this reason, two-part tariffs are more common in developed than developing economies.

## 2.6 Global Prevalence of Water Tariff Structures

There is a significant degree of flexibility in how tariffs are designed through various combinations of customer classifications, core tariff structures, and complements. A closer analysis of the geographical prevalence of core tariff structures suggests there is also considerable variability in the types of pricing structures adopted across different countries (appendix C). However, overall, IBTs and one-block tariffs are the most prevalent with approximately 60 percent of countries surveyed applying IBTs (figure 2.5).



**FIGURE 2.5. Global Prevalence of Water Tariff Structures, By Type, (%)**



Source: Original compilation based on data from IBNET (2020).  
 Note: DBT = decreasing block tariff; IBT = increasing block tariff.

## 2.7 Calculating Consumption Tariffs and Connection Charges

Once the economic costs have been calculated, the service provider must determine how best to allocate these costs across consumers in the form of tariffs to support cost recovery. Typically, service providers levy two types of tariffs on water users: consumption tariffs and connection tariffs. Consumption tariffs are charged based on some notion of the quantity of water used. However, connection tariffs are charged—at one time or in installments—to cover the fixed cost of connection. With policy often focused on consumption tariffs, connection charges have received comparatively little attention. Typically, water service providers are natural monopolies with large fixed capital investments in infrastructure (establishing reticulated piped networks, treatment facilities, etc.). However,

the marginal cost of providing water to an additional household is very low. Moreover, given low marginal costs, they enjoy economies of scale and scope and can meet the demand for a larger pool of customers. A two-part tariff structure, often recommended as the second-best solution to this natural monopoly problem, thus justifies the prevalence of connection charges (to cover the fixed costs) and consumption charges (to cover the variable costs) to facilitate full cost recovery.

However, the significant share of unconnected households and continued urban growth underscore the need to ensure that connection charges receive greater attention. Utilities and policy makers can pursue different avenues to recover connection costs while ensuring connections are affordable. In cases where new customers struggle with the liquidity needed to pay a large up-front fee, costs can be recovered over time through consumption charges. In instances where connections charges are prohibitively high, subsidies can help households gain a connection. Another option is to pursue alternative, lower-cost solutions for connecting households.

Beyond the connection costs, adaptation costs incurred by households to make use of water and sewerage connections must also be considered. So far, these costs have received little attention but are crucial in connecting households to piped water (or sewerage) networks. From a household perspective, adaptation costs can also be included in the overall connection costs. Thus connection costs can be split into four categories:

- *Adaptation costs.* These are costs behind the meter to accommodate a connection, for example, installing taps or toilets. If water supply is intermittent, households may also face “coping costs” to ensure a secure supply. For example, they may need to invest in tanks or jerry cans to

ensure access to water is maintained during interruptions.

- *Local costs.* The process of installing pipes from the boundary of a customer’s premises to the main pipeline, in addition to meters, involves material, labor, and administrative costs. These costs can be attributed to specific households.
- *Network expansion costs.* Utilities need to expand the main shared network to provide access to unserved areas or new settlements. The process involves material, labor, and planning costs that cannot be attributed to specific households. These costs can vary depending on the terrain and on whether extensive roadworks are needed to lay pipes.
- *Remote costs.* These are upstream costs in the network (such as reinforcement or storage) or at the production/treatment level (to meet increased capacity). As the number of connected households increases, extra water extraction, production, and treatment capacity needs to be provided to ensure

that additional demand can be met. Furthermore, the utility may require additional administrative capacity to provide billing, customer service, and maintenance to a larger number of households. However, it is difficult to identify and isolate the remote costs arising from additional connections from increased demand across the existing network.

### Calculating Environmental Costs

While O&M and capital costs can be calculated using the utility’s expenditure, this is not an option for calculating environmental costs. Ensuring the utility internalizes these costs is equally challenging. This can be achieved through incorporating the costs into tariffs or through regulatory measures including limits on water extraction, conditions on water use, or market-based mechanisms such as tradable water rights. These challenges, relative to the calculation and compensation of costs, are why environmental costs are very rarely recovered.

**TABLE 2.4. Methods for Calculating the Cost of Action for Environmental Costs**

Method	Description	Advantages	Disadvantages	
Cost based	Damage avoidance cost	Cost of preventing a water source from dropping below its rate of natural replenishment.	Direct and pragmatic measure of costs needed to maintain resources.	Closely linked to expenditure and may overlook hidden costs. Especially relevant to damage repair cost, since repair expenditures may not incorporate unrecovered harm resulting from depleted resources.
	Damage repair cost	Cost of replenishing a water source after it has dropped below its rate of natural replenishment.	Simple to administer, requiring only cost data and low regulatory capacity.  Represents the cost of the action actually taken rather than the cheapest action.	
Market based	Market value of a unit of the resource when rate of extraction is capped to prevent dropping below the rate of natural replenishment.	Reflects the market price and incentivizes use of the cheapest alternative resource.	Overallocation of permits can distort the market price and lead to overextraction of the resource.	

Environmental costs can be conceptualized as the cost of action or inaction. The former refers to the costs associated with preventing the depletion of water resources, while the latter refers to the costs of depletion, such as forgone opportunities. There are two broad ways to measure the cost of action: cost-based approaches, including the total cost of actions taken either to avoid the damage or to repair the damage, and market-based approaches. Their relative pros and cons are outlined in table 2.4.

## 2.8 Pursuing Efficient Cost Recovery

Services must be financially viable for the operators, meaning that tariff revenues plus any funding from public sources (local or central government, donors) should guarantee a stable revenue stream to deliver high-quality services over the long term.

Cost recovery exists on a continuum from zero to 100—that is, from fully subsidized to no financial support from either the government or development partners. Full cost recovery does not imply that each customer group pays the full cost of services they

receive. If one customer group pays less than the cost-recovery target, other group(s) must pay more than the cost-recovery target so the aggregate revenue covers the costs of serving all customer groups. Most water utilities in developing economies fall on the low end of the cost-recovery spectrum, with very few recovering more than 50 percent of total costs. Several utilities operate at 10-25 percent of full cost recovery with government and/or donors often covering all their capital costs and some of their operating expenditures. Even in higher-income countries, relatively few water utilities achieve full cost recovery (table 2.5).

Cost-recovery targets and the extent to which they are fulfilled depend in part on the country's regulatory framework. If the regulatory regime is such that the utility has significant exposure to volume risk, that is, a price cap rather than revenue cap, then it will be important that customer-specific tariffs reflect the underlying costs of supply. This will ensure that changes in demand relative to forecasts do not jeopardize cost-recovery targets.

**TABLE 2.5. Cost Recovery of WSS Services in Select European Countries**

Country	Total cost recovery (%)		Period
	Water	Wastewater	
Austria	84.0	84.0	2002-05
Bulgaria	48.0	55.6	2014
Czech Republic	77.9	77.9	2011
Estonia	69.0	69.0	2010
France	75.6	75.6	2009
Greece	83.4	83.4	2010
Italy	43.9	43.9	2004
Portugal	80.0	46.0	2009
Spain	74.4	74.4	2010

Source: Reynaud 2016.

Note: WSS = water supply and sanitation.

Given these competing objectives, what level of cost recovery is observed in practice? For simplicity, anything above 120 percent of O&M costs is interpreted as the minimum required for the recovery of financial costs, although in practice a much higher level of recovery will be needed if the capital costs of network expansion are to be recovered. Large variations in the average level of O&M costs recovered across countries in each region are observed. In North America, utilities recover over 120 percent of O&M costs (figure 2.6). Utilities in the Middle East and North Africa recover the least, which is primarily a result of the high degree of subsidization through taxes and transfers.

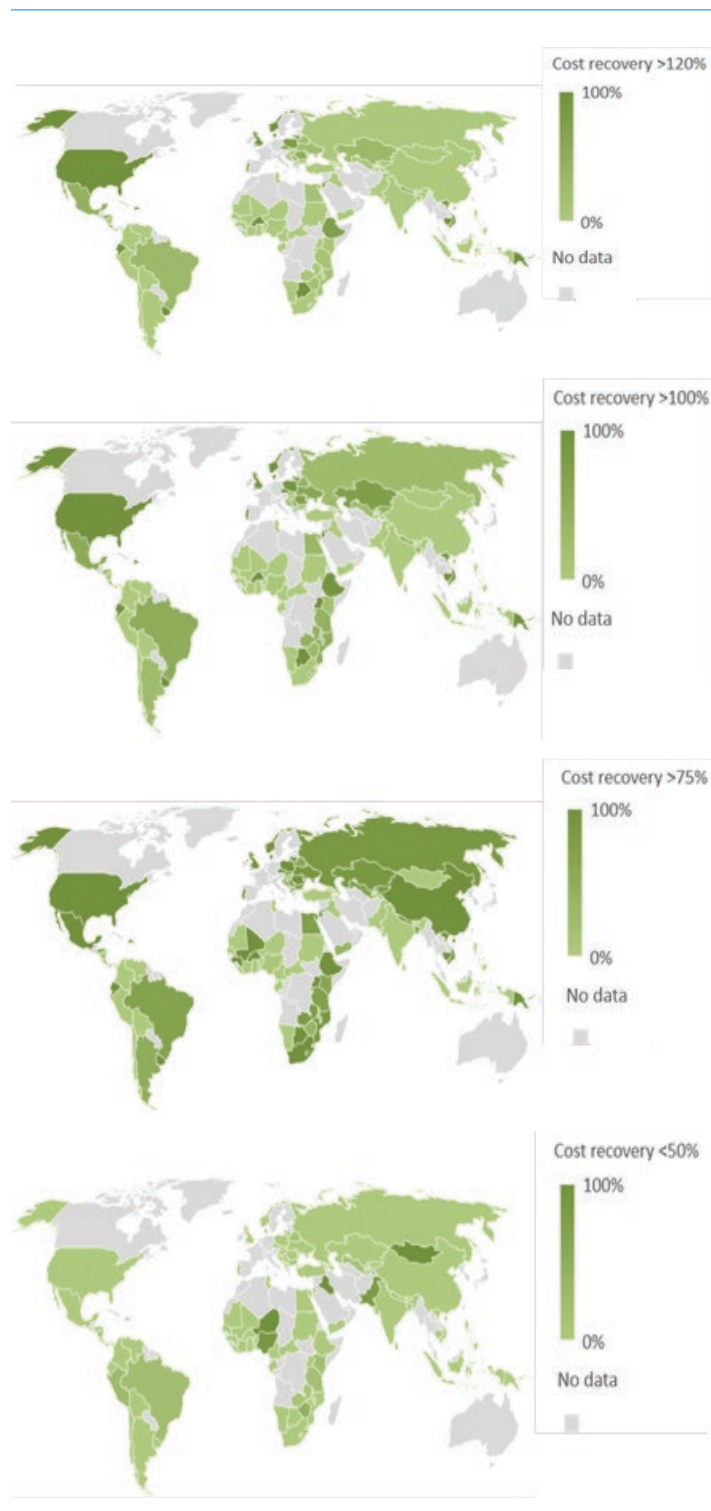
### Recovering Operational Costs

The recovery of O&M costs is generally understood to be essential for the short-term financial sustainability of a utility. When a utility's income fails to cover these costs, each additional unit of sale produces a loss. This can lead to immediate financial stress and rapid deterioration in the quality of services. In lower- or middle-income countries, the consequences can be especially severe, leading to a reduction in service provision and/or a reduction in water quality.

However, approximately 60-80 percent of total costs in networked water systems are for long-lived assets that take multiple decades to degrade (Komives et al. 2005). Thus, the impacts of underrecovery of these costs tend to materialize in the longer term.

By failing to recover long-term capital costs, the utility postpones capital replacement in existing assets, resulting in a period of lost productive capacity at the end of the assets' useful lives. Future generations would need to address this gap in funding through higher taxes or tariffs, resulting in an intergenerational subsidy (World Bank 2019). In the long

**FIGURE 2.6. Cost Recovery by Region**

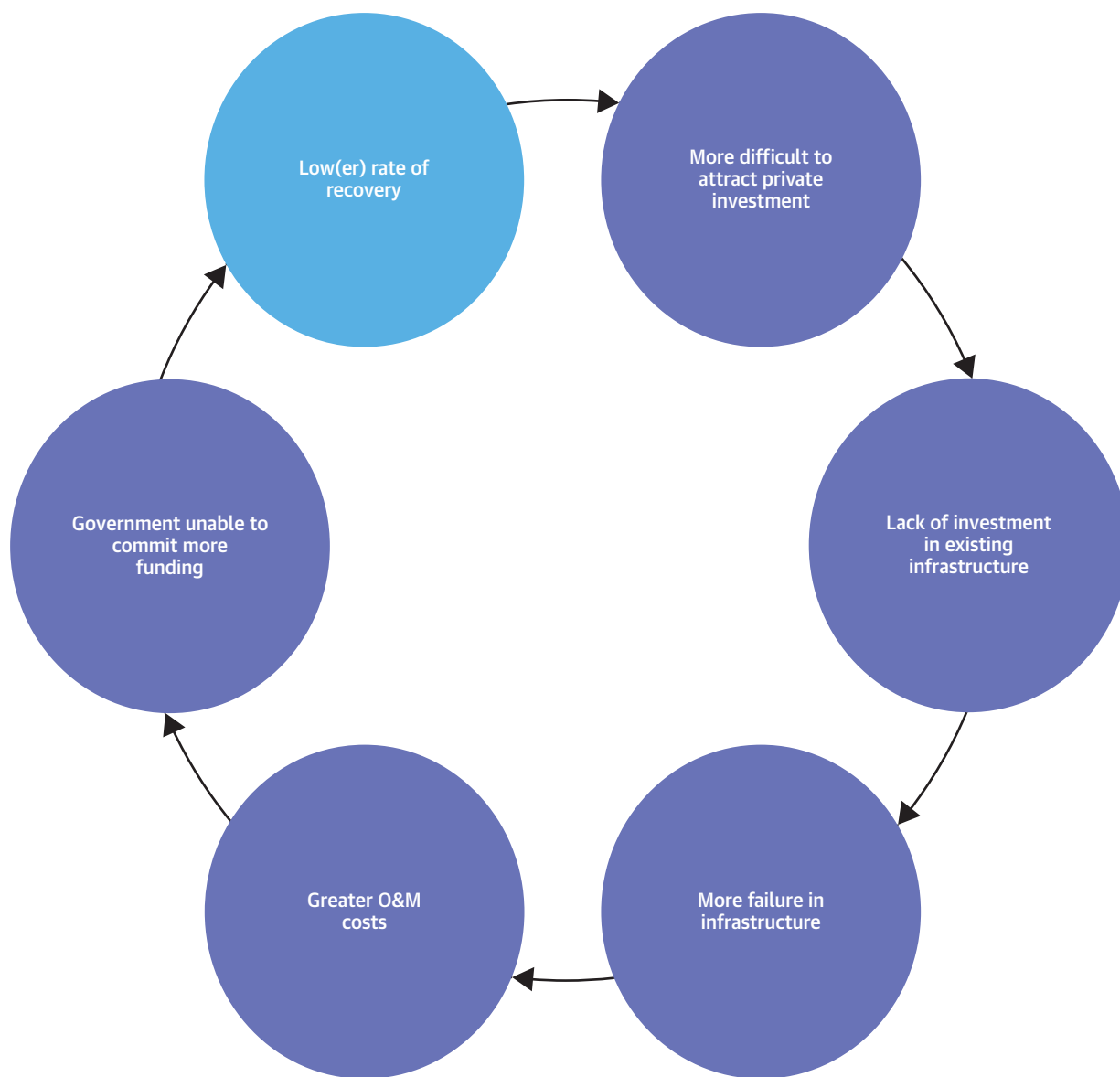


Source: Original compilation.

Note: Analysis is of 3,026 utilities across 84 countries using IBNET data.



**FIGURE 2.7. Feedback Loop of Poor Cost Recovery**



Source: Adapted from figure 1 in WHO (2019).

Note: O&M = operation and maintenance.

term, this can result in poorer reliability of services, a greater rate of nonrevenue water (NRW) or even a reduction in access to services, all of which have deleterious effects on human health.

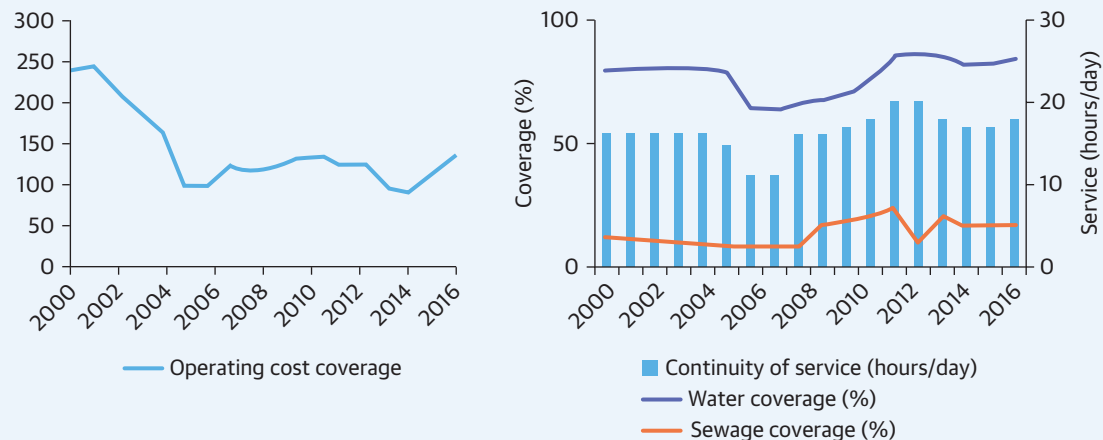
The deterioration of water infrastructure can also result in higher maintenance costs, and thus an even lower rate of cost recovery as total costs increase and

governments are unable to plug this growing gap (figure 2.7). This is especially pernicious in a private setting, as investors can be dissuaded from investing in response to a drop in the rate of cost recovery, which signals lower profitability, leading to further deterioration in infrastructure through lack of investment (Zambia, box 2.1).

### BOX 2.1. Financial Cost Recovery in Lusaka, Zambia

In recent decades, the Lusaka Water and Sewerage Company (LWSC) has managed to recover operation and maintenance costs, but failed to recover financial costs (figure B2.1.1, left panel).<sup>a</sup> This is primarily due to poor revenue collection, especially from government facilities, the intention to subsidize poorer customers, and an unclear regulatory and institutional framework, including the lack of a national policy. As a result, capital investments have suffered: in 2013, more than half of LWSC's infrastructure was past its useful lifetime. Consequently, sectoral outcomes have, over time, failed to improve. Water supply (and sanitation) coverage in the LWSC's region has barely improved since 2000, and quality of service (proxied by continuity of service) has shown a similar lack of progress (figure B2.1.1, right panel).

FIGURE B2.1.1. Cost-Recovery Rates and Quality and Coverage of Service, 2000-16



To overcome these challenges, various institutional and financial improvement programs have been implemented, including implementing a revised National Water Policy in 2010 that aimed toward recovery of operation and maintenance costs in the short term and the recovery of financial costs in the long term. To ensure investments in infrastructure, the US\$332 million Zambia Compact of the Millennium Challenge Corporation, 2013-18, was conditional on LWSC devoting at least 50 percent of its annual retained earnings to asset renewal and capital expansion and an “appropriate amount” toward repair and maintenance of water supply (and sanitation) infrastructure. Among other projects, these efforts appear to have produced an uptick in cost coverage and sectoral outcomes in recent years.

Source: WHO 2019; MCC 2019, 2020; Banerjee et al. 2010; IBNET 2020; NWASCO 2014.

<sup>a</sup> The Africa Infrastructure Country Diagnostic (AICD 2007) WSS Survey Database, reported in Banerjee et al. (2010), confirms that O&M costs were recovered while financial costs were not. In the left panel, we see similar levels of cost recovery from 2007, implying the situation has not yet resolved.

## Recovering Connection Costs

To maintain financial sustainability, utilities must recover connection costs, typically through connection charges. However, connection charges can act as a barrier to accessibility for poor households, creating an additional obstacle to achieving SDG 6. In such circumstances, they maintain the inequity of almost all subsidies being siphoned by wealthier, already connected households.

Connection charges levied by utilities are not always defined clearly nor designed with a common underlying theory or method (Franceys and Gerlach 2006). Some utilities charge application, surveying, and approval fees, and others restrict charges to material and labor costs only. The charge itself is frequently related to the size of the connection, the location of the property, and/or its distance to the nearest main (ADB 2008). The lack of a clear definition poses a challenge as it's not always clear what households are paying.

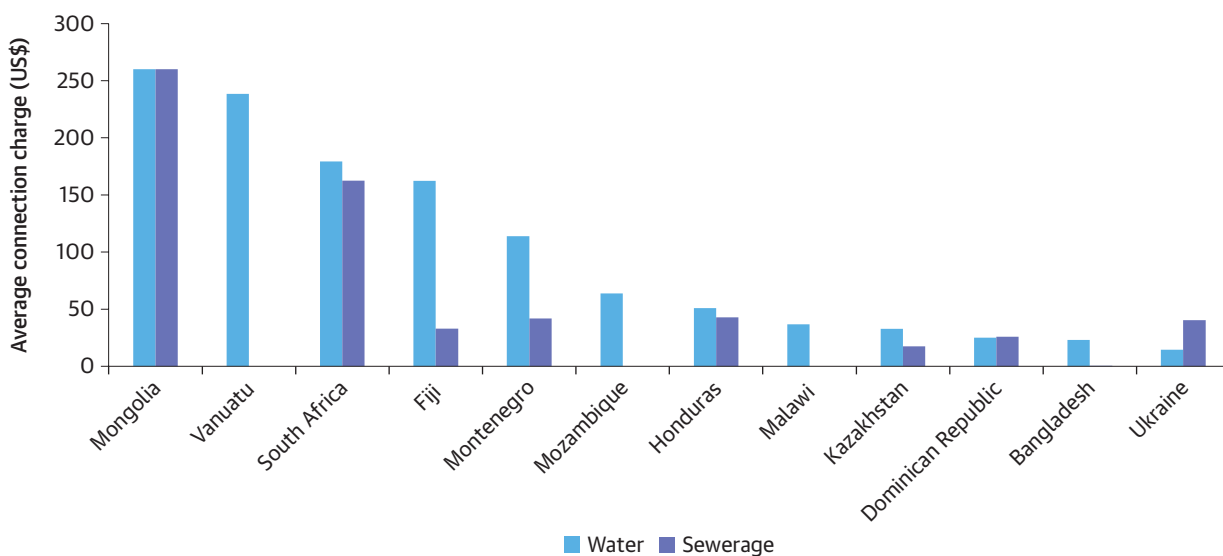
Connection charges vary significantly globally, in part due to differences in costs, but also due to

differences in the depth and definition of charges and level of subsidy provided (figure 2.8). In Mongolia, the average water connection charge is around US\$260, while in the Dominican Republic the average is US\$37. Even within countries significant heterogeneity is observed. In Bangladesh, the charge in Chittagong is US\$210 compared to US\$90 in Dhaka and as low as US\$3 in some divisions. The differences highlight that connection charges do not clearly reflect costs.

There is a lack of recent data illustrating the composition of connection charges globally. The most recent comparative study that provides a detailed overview of the full range of costs experienced in connecting to the piped water network in four countries dates from 2006 (Franceys and Gerlach 2006). This study highlights that in addition to explicit connection charges, which are the focus of this section, households can also experience informal costs, for example, “encouragement payments” to ensure an application is approved.

Connection charges can be categorized by different “depths.” Charges can fall into one of two extremes,

**FIGURE 2.8. Connection Charges for Water and Sanitation in Select Countries**



Source: Original compilation based on data from IBNET (2020).

**TABLE 2.6. Depth of Connection Charges**

Depth	Description	Evaluation
Deep	The charge covers the full marginal cost of the connection, including remote costs.	<p>May discourage connection to the network due to high up-front costs and first-mover disadvantages, undermining network economies of scale.</p> <p>Cost reflective, protecting existing customers from price increases and risk of stranded assets.</p> <p>Locational price signals incentivize efficient use of assets, lowering costs.</p> <p>Difficult to separate assets required only by the connecting party from assets required for general growth.</p>
Partially deep	A deep charge with some exemption from remote costs of facilitating the connection.	Reap some of the benefits of a shallow charge, such as lower up-front costs to incentivize network connections, and the benefits of a deep charge, such as locational pricing and cost efficiency.
Partially shallow	A shallow charge with some contribution to network remote costs.	
Shallow	The charge is the cost of connecting to the nearest appropriate point in the network, excluding remote costs.	<p>Lower up-front costs reduce barriers to connections.</p> <p>Simple charging methodologies.</p> <p>More stable and predictable charges than deep charges.</p> <p>No locational pricing signals.</p>

deep and shallow, or intermediate policies, slightly deep or slightly shallow (table 2.6). A shallow connection charge only covers the local cost of connection, whereas a deep connection charge covers both local and remote costs of connection. This means that in the case of a shallow charge, remote costs are subsidized. Another example is for local and extreme costs to be fully subsidized through a free connection.

### Recovering Environmental Costs

In principle, the recovery of environmental costs should be pursued wherever such cost externalities exist and/or there are significant opportunity costs, which are generally inevitable in the water sector. Failing to account for these external costs can lead to environmental degradation, drought, severe pollution, and other consequences in the long term. Furthermore, failure to recover costs can inhibit new investments, such as network expansion. In the long term, this slows the increase in access to services and if a utility fails to keep pace with population growth, access can even diminish.

There are two primary approaches to assessing environmental costs: focusing on damage avoidance costs and damage repair costs. Damage avoidance costs are typically measured by looking at the cost of extracting from the least-expensive alternative water resource once the current resource reaches its rate of natural replenishment. For example, this might be the cost of extracting from an alternative groundwater source, or in cases of extreme water scarcity it could be the cost of extracting and desalinating. It could also be the cost of providing services for maintaining resources such as watersheds (see, for example, the case of Peru in box 2.2, which mandates a floor on spending on maintaining and repairing watersheds). If the utility provides these services, the costs are internalized and can be calculated directly. In cases where a third party conducts damage repair services, such as the government, the costs could be internalized by the utility through taxation.

Damage repair costs are measured by looking at the cost of extracting from the least-expensive alternative water source, which allows the depleted resource to replete naturally, or through looking at the cost of



### BOX 2.2. Internalization of Resource Costs in Peru

Countries across South America are facing water shortages as a result of decreasing rainfall, contamination, and overextraction. Changes in rainfall alone could see 70 percent of South America's population living in water-scarce areas by 2025. A key solution to issues of water scarcity in the region is to secure upstream water resources through the protection of watersheds from conversion, development, extraction, and diversion. To ensure water utilities internalize the costs required to maintain these watersheds, Peru's water regulator (Superintendencia Nacional de Servicios de Saneamiento, SUNASS) introduced a new tariff framework in 2015 that requires utilities to recover costs of watershed conservation, restoration, and maintenance. In addition, laws were introduced requiring service providers to submit updated master plans every five years, detailing their 30-year investment strategy to protect watersheds. The cost of these investments would represent the damage avoidance cost for watersheds. In line with regulatory requirements, at least 1 percent of revenue must be invested in natural infrastructure, representing a floor on the damage avoidance cost.

Source: Nature Conservancy 2018; Forest Trends 2016; Pham 2016.

manually replenishing the depleted source using water from the least-expensive alternative water source. Equivalently, the latter could include the construction of rain gardens to replenish a depleted water source, which is the same principle as extracting water from another sustainable source.

Approaches that look at damage repair or damage avoidance costs are conceptually similar and produce broadly equivalent estimates despite representing very different activities. This underlines their key weakness: being closely linked to expenditure, hidden costs, including those related to inaction, may be overlooked.

The cost of inaction requires the calculation of the economic consequences resulting from allowing the abstraction to cause the water resource to fall below its rate of natural repletion. There are a number of costs associated with inaction, of which a primary cost is typically the lost opportunity through lower overall levels of the cheapest water resource, which leads market players to utilize a more expensive resource. Other costs could include the economic value of lost crops, any lost labor productivity through job losses or health costs associated with the

rationing of water, any costs associated with replenishing the water resource (above the ordinary costs of maintaining the rate of replenishment), and so on. The present value of these costs can be calculated across the period over which the resource is depleted.

## 2.9 Financial Analysis

The tenets of financial sustainability, and cost recovery in general, have been extensively discussed by the World Bank and others. The basic principles are erudite, persuasive, and based on thoroughly elaborated concepts and extensive evidence from academia, economic models, and field observations. The challenge therefore is not to find the missing link or identify new approaches, but rather to operationalize what is already well known, through policy guidance that is practical, unambiguous, and stable.<sup>4</sup>

In spite of repeated efforts to advocate for the gradual recovery of costs starting with O&M over the last three decades, very little progress has been made. Nonetheless, some of these historical principles remain the same:

- For urban WSS projects implemented by WSS utilities that use accrual accounting, the financial analysis should include, as a minimum, the last three years of audited financial statements (e.g., income and cash flow statements and balance sheets). Additionally, the analysis should include ten years of projected statements supported by a description of key assumptions. Select ratios to monitor the coverage of O&M costs, liquidity, or capital structure should be estimated and compared with industry standards. If ratios are significantly below industry standards, the financial analysis should describe the agreed action plan for correcting any identified shortcomings.
- For entities such as government departments or water user associations that use cash accounting, the financial analysis should include past and future cash revenues, cash expenses, and debt service as well as a summary of assumptions. In both cases incremental revenues and expenses should be identified to estimate the net present value of future cash flows and financial internal rate of return of the project.

The financial analysis should also clarify how explicit and implicit subsidies are provided to service providers and estimate current and future contributions. In particular, this analysis should assess:

- How central, regional, or local government budgets complement revenues collected from customers for covering the cash needs of WSS service providers and if any conditions are attached to such funding support;
- Whether WSS service providers are exempt from paying taxes, import duties or fees (e.g., bulk water fees, discharge fees, etc.) legally applied in the country;

- Whether WSS service providers are likely to benefit from other implicit subsidies through, for example, the payment of inflated bills to public customers; and
- How WSS service providers are protected against fluctuations in exchange rates.

## 2.10 Economic Efficiency

Arguments for cost-recovery tariffs only hold where total costs are efficient. Without reasonable expectations of efficiency, cost-recovery tariffs reward utilities for inefficiency and result in a misallocation of resources. A compromise is to set a reasonable, aspirational target. Incentive-based regulations can then motivate utilities to achieve this goal. For example, reductions of NRW or increases in bill collection rates can be incentivized, and often improved without significant investment in new capital, resulting in large increases in revenue as was the case in Algeria (box 2.3). A combination of cost-cutting measures, including nontariff options, has been shown to significantly improve the level of cost recovery in Zimbabwe (box 2.4).

Inefficiency can also reduce cost recovery indirectly through decreased WTP (figure 2.9). The first step in this indirect transmission is a reduction in service quality due to inefficiencies. For example, poor customer outcomes such as low engagement with customer complaints, slow processing of connection applications, and generally poor sectoral outcomes are often symptomatic of inefficient management. Poor quality of service can reduce a customer's WTP, making future tariff increases difficult. Tariffs stagnate and costs rise over time, creating a negative feedback loop, as lower cost-recovery induces more inefficiencies (e.g., stemming from low capital investments) and also directly reduces the quality of service (e.g., slower connections). Mechanisms for communicating what customers

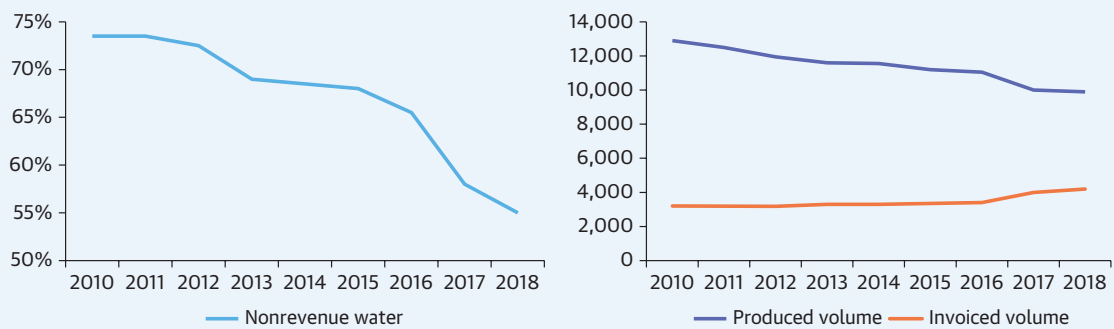
### BOX 2.3. Reducing Nonrevenue Water in Souk-Ahras, Algeria

Water supply services in Algeria are managed by the Algerienne des Eaux, ADE) and the National Sanitation Office (Office National de l'Assainissement, ONA). ADE and ONA have been facing financial difficulties, primarily due to low tariffs. The government provided grants to both companies while also looking at efficiency.

The municipality of Souk-Ahras has faced a particularly large gap between costs and revenues collected through tariffs. In large part, this resulted from high water losses along distribution networks. Over the last decade, it has reduced the level of nonrevenue water by almost 20 percentage points (figure B2.3.1, left panel), narrowing the gap between the volume of water produced and invoiced (figure B2.3.1, right panel). This will narrow the gap between costs and revenues.

Despite this improvement, the municipality still faces financial difficulties. Research indicates that while the tariff is unsustainably low, the situation could also be improved by reducing nonrevenue water further and applying other cost-cutting measures.

**FIGURE B2.3.1. Shares of Nonrevenue Water and Cost-Recovery Levels, 2010-18**



Source: Data and insights from Boukhari et al. (2019); further insights from Boukhari et al. (2011, 2018).

### BOX 2.4. Simulation of Nontariff Options for Cutting Costs in Zimbabwe

Utility-level data from Zimbabwe collected in 2013-14 (table B2.4.1) were used to simulate the impact of changes in efficiency on the level of cost recovery at each utility and at a national level. Based on these data, only 16 percent of utilities recover more than 120 percent of their operation and maintenance (O&M) costs through actual cash collection. Thirteen percent of utilities recover less than 120 percent of O&M costs, meaning they are unlikely to recoup their financial costs. All told, 71 percent of utilities were unable to cover their O&M costs. This can be partially explained by the performance indicators, which show a low rate of collection, a somewhat high proportion of nonlabor costs, and a high level of nonrevenue water (NRW).

The impacts of improving efficiency on cost-recovery rates were simulated. The additive effects of four improvements were investigated:

#### BOX 2.4. continued

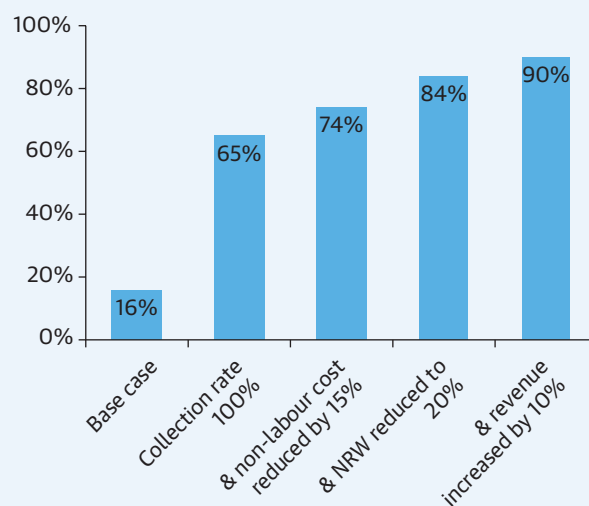
- Increasing rate of collection to 100 percent
- Reducing nonlabor costs by 15 percent
- Reducing NRW to 20 percent at any utility where this value is exceeded
- Increasing revenues by 10 percent

By ensuring a collection rate of 100 percent at all utilities, the cost-recovery figure rose to 65 percent (or a 51 percentage point increase) (figure B2.4.1). If, on top of this cost-savings measure, nonlabor costs are reduced by 15 percent, the proportion increases to 74 percent (+9 percentage points). Taking the additional step of reducing NRW to a maximum of 20 percent across all utilities, the proportion increases to 84 percent (+10 percentage points). Finally, a 10 percent increase in revenue, associated with miscellaneous efficiency improvements or small increases in tariffs, would lead to a proportion of 90 percent (+6 percentage points).

**TABLE B2.4.1. Zimbabwe's Utility-Level Data, 2013-14**

Utility performance indicator	National value
Water coverage (%)	88
NRW (%)	52
Operating cost-coverage ratio (based on billed revenue)	88
Billed revenue amount (US\$)	95,601,859
Collection rate (%)	48
Nonlabor cost (% of total cost)	64
Number of utilities	31

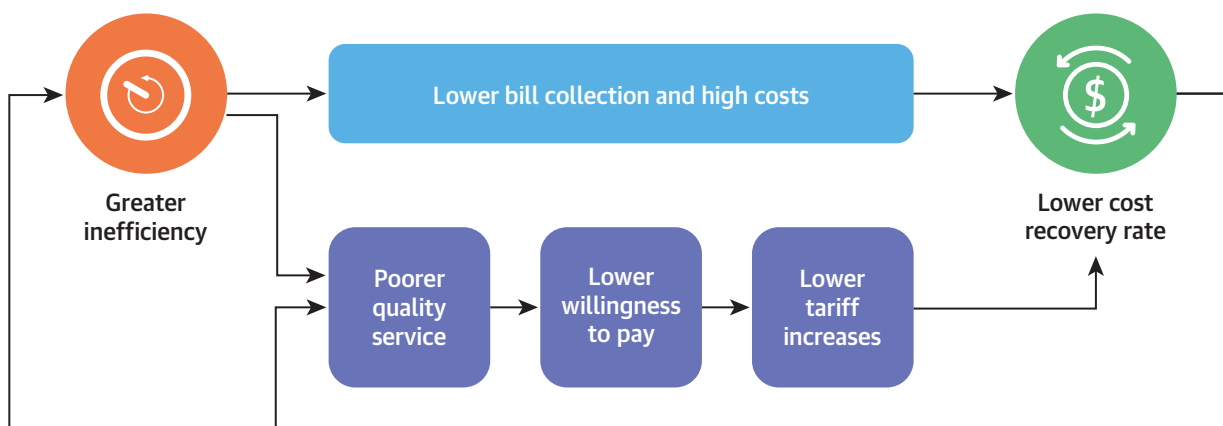
**FIGURE B2.4.1 Various Cost-Recovery Scenarios**



Source: See background paper 2, listed in appendix A.



**FIGURE 2.9. Direct and Indirect Effects of Inefficiency on Cost Recovery**



Source: Original compilation.

are required to pay and why are therefore important.

A strong case can therefore be made that inefficiencies should be the primary port of call (box 2.5). In general, the timing of tariff increases and wider reforms can only be justified after service improvements have been demonstrated.

Economically efficient tariffs reflect the underlying cost of providing services. More specifically, efficient tariffs will reflect the marginal cost of supply, ensuring pricing reflects the true economic cost of supplying a unit of water (figure 2.10). The cost of supplying water depends on many factors and may vary over time. Factors that influence this variance include:

- *Climate.* Temperature, rainfall patterns, droughts, and floods are important factors in determining the costs of water supply.
- *Hydrological aspects.* The use of different water sources and the varying quality of raw water is another aspect that typically affects total costs.
- *Water consumption demand.* Water utilities incur higher costs during peak demand periods because

they have to invest in more production capacity or revert to more expensive sources.

- *Network operation costs.* Some of a water utility's variable supply costs, in particular energy costs related to pumping, vary by time of day.

If costs vary by time of day (i.e., pumping costs), then ideally so will the volumetric tariff. A good example of this is in the electricity sector, where prices are set based on a competitive spot market and those prices are directly charged to customers by retailers through smart meters. Although rarely applied in practice, the ideal tariff complement is real-time pricing. This tariff structure consists of many different pricing periods throughout the day, increasing the granularity and frequency of price revisions to reflect real-time costs. These time-varying tariffs are however much more complex than current conventional pricing mechanisms and are achieved through smart metering.<sup>5</sup> There are other dynamic pricing options that are not as precise as real-time pricing but achieve a similar effect.

Given the complexity of dynamic pricing, it has been rarely applied to date. Yet research studies

### **BOX 2.5. Simulating Potential Cost Savings from Reducing Inefficiencies across Four Dimensions**

In this exercise, the full cost-recovery tariff (FCRT) is the cost-reflective tariff<sup>a</sup> plus any inefficiencies that a water utility incurred. These include inefficiencies resulting from: bill collection, nonrevenue water (NRW), overstaffing, and capital expenditure (CAPEX). The estimated global FCRT is around US\$2.13/cubic meter (m<sup>3</sup>) and ranges from a low of US\$0.69/m<sup>3</sup> among water utilities in South Asia to as high as US\$3.16/m<sup>3</sup> in Latin America and the Caribbean. Across income groupings, the FCRT is estimated to be around US\$0.97/m<sup>3</sup> among water utilities in high-income countries and US\$4.37/m<sup>3</sup> among those in low-income countries (see appendix E for full results). Ideally, the full tariff can be reduced by reducing inefficiencies. This exercise assumed an overall reduction of 75 percent across all four inefficiencies. Nontechnical inefficiencies resulting from bill collection and NRW were then combined 50-50.

#### **SCENARIO 1: A 75 PERCENT REDUCTION IN NONTECHNICAL INEFFICIENCIES**

The effect of a 75 percent reduction in nontechnical inefficiencies from bill collection and NRW is marginal: the estimated reduction in FCRT was around 0.63 percent globally (from US\$2.13/m<sup>3</sup> to roughly US\$2.11/m<sup>3</sup>). This reduction varied by region with the highest reduction observed among water utilities in Sub-Saharan Africa (up to 1.27 percent), followed by those in South Asia (up to 0.82 percent). Across income groups, the simulated reduction in inefficiencies resulted in a 0.86 percent reduction in FCRT among water utilities in low-income countries followed by a 0.69 percent reduction among those in upper-middle-income countries.

#### **SCENARIO 2: AN ADDITIONAL 75 PERCENT REDUCTION IN OVERSTAFFING INEFFICIENCIES**

The reduction in FCRT from reducing inefficiencies in bill collection, NRW, and overstaffing was also marginal and estimated to be around 0.73 percent globally, which does not affect the overall result. Regionally, the cumulative reduction in the FCRT was much more concentrated among water utilities in the Middle East and North Africa region (5.60 percent) and those in South Asia (4.07 percent). Across income groupings, the cumulative reduction in the FCRT was estimated to be highest among utilities in lower-middle-income (1.75 percent) and low-income (1.55 percent) countries.

#### **SCENARIO 3: AN ADDITIONAL 75 PERCENT REDUCTION IN CAPEX INEFFICIENCIES**

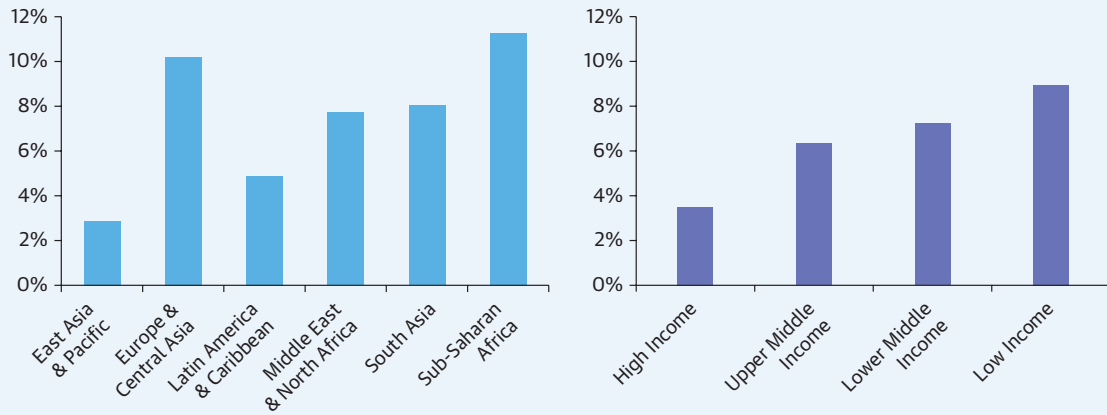
The cumulative reduction in FCRT from all four dimensions of inefficiency was estimated to be around 6.06 percent globally (figure B2.6.1, left-hand panel), corresponding to a decrease from US\$2.13/m<sup>3</sup> to US\$2.00/m<sup>3</sup> and corresponds to the single-largest marginal reduction in the full tariff. Regionally, the additional reduction in CAPEX inefficiencies resulted in significant cumulative full tariff reductions among water utilities in Sub-Saharan Africa (11.28 percent), Europe and Central Asia (10.19 percent), and South Asia (8.03 percent) (left-hand panel). Across income groups, the cumulative reduction in the FCRT is observed to be highest among utilities in low-income (8.95 percent) and lower-middle-income countries (7.23 percent) (figure B2.6.1, right-hand panel).

a. Cost-reflective tariffs were calculated for a number of utilities registered in the IBNET database using Chilean utilities as a benchmark. Subsidies were estimated by comparing the resulting tariff to what was actually charged. Cost-reflective tariffs are the average tariffs per m<sup>3</sup> of water produced that would cover the cost of providing the service under the assumption of no inefficiencies and are calculated at the utility level for a given year.

*box continues next page*

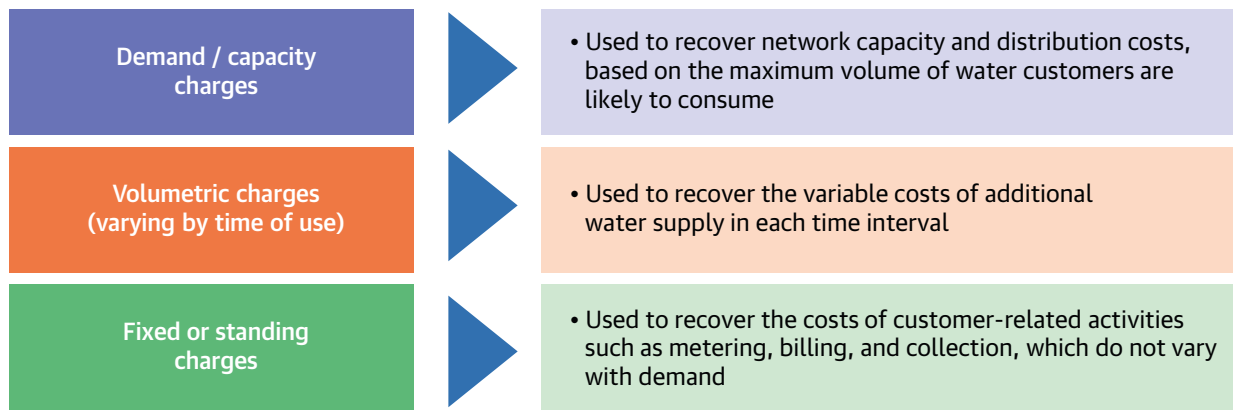
**BOX 2.5. continued**

**FIGURE B2.5.1. Total Potential Reduction by Region (left) and by Income Group (right)**



Note: Global average is indicated by the orange line.

**FIGURE 2.10. Efficient Tariff Design**



Source: Original compilation.

provide useful insights. For example, Cole, O’Halloran, and Stewart (2012) assess the impact of TOU tariffs on peak water demand in Queensland (Australia). Their case study shows how dynamic tariffs can be adjusted or modified to meet marginal pricing requirements while achieving other objectives, for example, equity and water conservation.

Efficient tariffs may also vary by location. Location-based pricing is a tariff complement that applies different water prices for different customers according to the cost associated with servicing those customers. This mechanism allows water operators to account for the higher costs of servicing customers that live in distant or isolated neighborhoods,

although it raises social concerns with regards to the socioeconomic condition of households located far from the network.

When smart metering is not practical, customer classifications that closely reflect consumption profiles (and therefore costs) facilitate economically efficient tariffs, for example, when setting volumetric charges to recover capacity-related costs.

Tariffs that reflect the marginal cost of providing supply send a precise signal to the consumer to use water and wastewater services efficiently. An efficient tariff reflects both the level of costs that have to be recovered and the structure of costs, and typically involves a two-part structure with a fixed charge per month and a volumetric charge per cubic meter.

### 2.11 Affordability

There are misconceptions regarding the human right to safe water and the meaning of affordable versus equitable tariffs. First, while safe drinking water is considered an essential human right, it does not entitle every customer to an unlimited free supply of water. Second, affordable water bills are not necessarily equitable. While “affordability” and “equity” are often erroneously used as synonyms, it is important to distinguish the two objectives:

1. Affordability implies all potential customers should be able to afford water. Water priced at full economic cost-recovery levels, for example, may not be affordable for low-income customers. There are various ways to define and measure affordability. A common method is to calculate an affordability indicator based on each household’s water bill as a percentage of their income. If water expenditures exceed a specified threshold, the tariff has generated unaffordable water bills for at least some of the households. However, this approach has

several limitations as discussed in Andres et al. (2020). Alternatively, determining affordability with the method commonly used to draw the monetary poverty line offers several advantages.<sup>6</sup>

2. Equity, on the other hand, is concerned with the fairness of the allocation of resources across a given population and demands that equals should receive identical treatment. If similar households do not receive a similar bill, it might be considered inequitable even if both bills are affordable. In tariff design, equity can be achieved at different levels:

- *Equity among income groups.* This is the most obvious social aspect of water pricing and implies that low-income customers should not pay a disproportionately larger fraction of their income on water services than higher-income customers.
- *Equity among customer types.* Measures that aim to provide a preferential treatment to lower-consumption customers could unintentionally penalize low-income but larger households, given the imperfect relationships between water consumption and income.
- *Equity among regions.* While achieving efficiency and cost-recovery objectives, location-based pricing is an example of a tariff complement that leads to geographic inequity in terms of water pricing. Inequity could also be assessed in terms of access and quality of service.
- *Intergenerational equity.* This is broadly related to another tariff objective, environmental sustainability, reflecting the need to address climate change and increasing water stress levels. Section 3.2 discusses how tariff structures and complements can promote water conservation through pricing incentives, with more details provided in background paper 7 (listed in appendix A).



Social tariffs seek to address the impacts of pricing policies on different income categories and customer categories/groups to mitigate the burden of water bills on low-income households. While lack of access to water is often due to the lack of ability to pay for the service, low-income families are not necessarily low-consumption households, raising equity concerns if they pay a disproportionately large share of their income on water services. Yet in the absence of a developed welfare system, tariff structures are used to address water affordability and equity challenges. The key challenge in designing social water tariffs is effectively targeting households facing affordability constraints and avoiding errors of inclusion and exclusion:

- *Errors of inclusion.* These stem from efforts that (often inadvertently) target households for whom services are already affordable. Given an overall lack of financial resources, only the poorest households should benefit from social pricing measures.
- *Errors of exclusion.* As many households do not have access or cannot afford to connect to the water supply network, targeting mechanisms often fail to reach low-income households or exclude those that do need assistance.

The more targeted tariffs are, the less “wasteful” the affordability mechanisms, in that affordability can be achieved without compromising as much on other tariff objectives such as cost recovery and efficiency. Where a national register of vulnerable/low-income households is available, this would in theory enable the more precise targeting of mechanisms to address affordability. Yet this is not always possible in practice, and customers are typically classified based on their customer type (residential, small commercial, etc.) or by use (i.e., through IBTs).

Other types of customer classifications based on proxies (e.g., property size, pipe diameter) can sometimes be more effective in supporting targeted subsidies than customer type or usage, depending on the degree of the population’s socioeconomic homogeneity within the given proxy, but are still much less effective than an up-to-date national register.

Ensuring affordability often conflicts with the tenets of cost recovery. And despite efforts to develop and implement pro-poor pricing mechanisms, certain tariff structures unwittingly penalize the poor:

- *Increasing block tariffs (IBTs).* These are among the most common tariffs used to ensure affordability. The first block can be set low enough to allow all households to consume a minimum amount of water. Conversely, higher blocks can be set above the cost-recovery rate to cross-subsidize the first block. However, as water is typically billed by household, this may inadvertently penalize large, poor households that consume larger volumes.
- *Volume-differentiated tariffs (VDTs).* These are also known as “jump” tariffs. Lower blocks can be subsidized to a greater extent. However, this may also adversely affect affordability among large, poor households.
- *Fixed rate.* Fixed or flat rate tariffs (whether as a stand-alone or a component of a two-part tariff) generally have a negative impact on affordability. Regressive in nature, they compromise a larger portion of a low-income household’s total expenditure.
- *Constant volumetric tariffs.* These aim to strike a balance between two-part tariffs with fixed rates (which make affordability challenging) and IBTs and VDTs (which are specifically designed to make tariffs affordable for low-income households).

IBTs are often applied to address the redistributive challenges related to water pricing. This tariff structure is usually adopted to guarantee a basic volume of water consumption for poor households at an affordable rate. The intention is that richer customers, assumed to have higher consumption rates, are charged higher tariffs to cross-subsidize the water usage of poorer households, assumed to have low consumption (box 2.7).

However, there are several difficulties with IBTs, which can even exacerbate negative impacts of the tariff on vulnerable customers. These include:

- **Targeting.** The advantages of this tariff structure are based on the assumptions that low-income households consume less water and that low tariffs for low-consumption customers will allow poor households to access affordable water services. In practice, however, this is not always the

case. Low-income households may be larger than assumed by the tariff design and may consume greater levels of basic water, while high-income customers with low consumption in second homes would also benefit from the subsidy.<sup>7</sup>

- **“Lifeline” block.** In order to successfully target low-income households, the lifeline block of IBTs should correspond to the minimum volume of water needed to meet basic needs. Determining this quantity can be rather complicated and while international standards estimate the basic needs of an average-sized household at 4-5 m<sup>3</sup> per month, the lifeline block threshold of most IBTs is much higher. This might provide a disincentive for wealthier households to conserve water and reduce water utilities’ revenues. Policy makers therefore face a difficult trade-off, as a restriction designed to discourage wealthier customers’

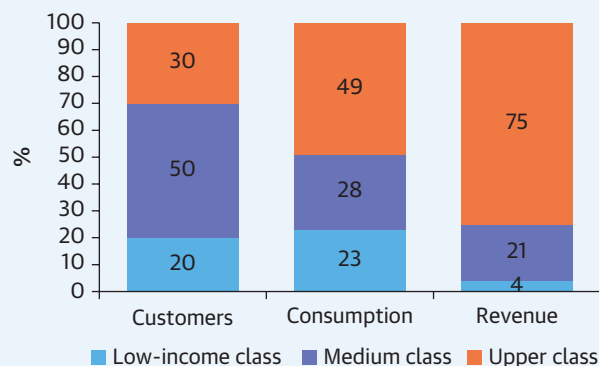
**BOX 2.6. Social Water Pricing in Indonesia**

The water operator in Indonesia applies a cross-subsidy mechanism between six groups of customers (divided between residential and nonresidential categories, the first of which is further divided by income level, or class).

The tariff structure is an increasing block tariff but each social group is charged a different rate with the highest tariff approximately 14 times higher than the lowest rate to subsidize low-income groups. The effect of the cross-subsidy is shown in figure B2.9.1. The graph shows that 20 percent of the customers are classified as low-income customers and account for around 23 percent of total consumption but only 4 percent of revenue.

The bulk of the revenue (75 percent of the total) is collected from upper-class groups with remarkable impacts on economic redistribution.

**FIGURE B2.9.1. Effects of Cross-Subsidy in Indonesia**



overconsumption is likely to have negative repercussions for poorer, larger households.

VDTs/jump tariffs share many of the same disadvantages as IBTs—notably the assumption that consumption is correlated with income. However, VDTs cross-subsidize less “wastefully” by targeting low-consumption households without inadvertently subsidizing the first water consumption blocks for higher consumption customers. Conversely, jump tariffs tend to attract more customer complaints due to the variability of monthly bills for customers who consume near the block boundary. Although still in use in a few countries, these have mostly been replaced by IBTs. Box 2.7 presents arguments against

IBTs, while box 2.8 outlines other methods for ensuring poor households’ access to water.

## 2.12 Raising Revenue through the Three Ts: Tariffs, Taxes, and Transfers

There are three key sources of revenue for funding water services. These are known as the three Ts: tariffs, taxes, and transfers. The difference between revenue collected through tariffs and total costs must be bridged using a combination of government subsidies (raised through taxes on current or future generations) and transfers (from development organizations). Each revenue stream involves a series of trade-offs (table 2.7).

### BOX 2.7. The Case for Revisiting IBTs

The most common pro-poor tariff mechanism is to include a heavily subsidized first block in an increasing block tariff (IBT) that is sized to represent a minimum amount of water required to meet basic consumption levels. To convey the message that the needs of the poor are being met, this is often referred to as a “lifeline block.”

There is extensive discussion in the literature on whether water tariffs (and especially IBTs) can and should be used to alleviate poverty. The clear answer that emerges is they are a blunt instrument at best and at worst can produce perverse outcomes. As the Tinbergen principle (OECD 2020, 7) explains, policy makers trying to achieve multiple objectives need a policy tool for each objective. This precludes water tariffs efficiently meeting financial viability and affordability targets simultaneously. Thus tariffs should be designed to secure sustainable financing for service provision while other targets such as affordability are best met through targeted social measures. Nauges and Whittington (2016) reach much the same conclusions throughout their quantitative analysis of IBT tariff structures, advocating instead for a much simpler uniform volumetric tariff structure.

The widespread use of IBTs is difficult to rationalize, in particular while knowing that the use of a (simple) uniform volumetric tariff where water provision is charged at its full cost could improve social welfare by removing price distortions and would be easier for households to understand. Despite the obvious conclusion that pro-poor measures should not be delivered through tariffs, the political nature of the tariff-setting process means much time and energy continue to be spent on pro-poor tariff structures. Policy makers may not be aware of existing criticisms and genuinely believe the tariff structure they have selected is effective but political expediency reinforces this claim, often made with donors in mind.

### **BOX 2.8. Mechanisms for Ensuring the Poor Access Water at Cost-Recovery Prices**

When water tariffs are set at cost-recovery levels, parallel mechanisms to ensure basic water requirements are met include:

- Tariff rebates, through which low-income customers receive direct cash transfers to pay part of their water bill, the proportion being related to a family's social situation.
- Vouchers that allow customers to receive a portion of their water consumption at a subsidized rate or even for free.

The problem with such schemes is the need for an accreditation scheme to identify eligible recipients. This is best managed not by the water utility but by a social welfare agency or a community-based organization. Due to the need for complete and accurate data at the household level, it is not surprising therefore that the examples given are drawn from high-income countries (e.g., France, Singapore, and Australia) (for a more detailed analysis, see Termes-Rifé and Bernardo [2015]).

Where affordability is not a challenge, a compelling case could be made that tariffs should be used to pay for all economic costs. First, tariffs can provide price signals to customers that incentivize the efficient use of water. Second, tariffs mostly target the recovery of costs to those who produce them. This is especially relevant in the case of environmental costs (where it is referred to as the “polluter pays” principle). Third, decision-making on tariffs can more easily involve stakeholders, ensuring community inclusion. Conversely, taxes and transfers are more volatile and generally beyond the reach of the community. Tariff revenues thus have some advantages relative to taxes and transfers.

Tariffs are not, however, without their disadvantages. For example, though tariffs can partially address affordability through cross-subsidization from larger customers to low-income households and provide social assistance in times of crises (box 2.9), cross-subsidies can create an economic distortion of price signals, disincentivizing efficient consumption. Nonetheless, the WSS sector has

characteristics that allow a degree of differential pricing without the distortion of price signals.

Additionally, directing tariffs toward specific costs may be less effective than directing taxes or transfers. For example, in some regimes, existing customers pay for the network's expansion through tariffs, despite not benefiting from the new infrastructure. This raises the question of who should pay for these costs and to what extent, known as deep versus shallow connection charges. In some cases it might be more justifiable to turn to taxes or transfers.

Another challenge is willingness to pay (WTP). Even when customers can afford to pay, they are often unwilling especially as water is viewed as an essential service and human right or when low tariffs are in place for a sustained period, as increases may be perceived as an abuse of power or unjustified. In these cases, the gulf between revenue captured through tariffs and economic cost recovery becomes difficult to bridge; consequently, taxes may have to be levied at least until the underlying problems are resolved.



**TABLE 2.7. Advantages and Disadvantages of the Three Ts**

Tariffs	Taxes	Transfers
<b>Advantages</b>		
<p><b>Efficiency:</b> Cost-recovery tariff <i>levels</i> can induce an efficient consumption response. Furthermore, the use of tariffs can be an enabler to design tariff <i>structures</i> with price signals that encourage efficient consumption.</p> <p><b>Targeting:</b> The payment of costs can be charged to those who induce them. This is especially relevant for external costs. However, in the case of network expansion, currently connected customers could pay while nonconnected customers ultimately benefit.</p> <p><b>Fiscal space:</b> The government's fiscal space can be increased through reducing the subsidy burden.</p> <p><b>Progressive:</b> Less regressive than taxation.</p> <p><b>Inclusion:</b> Stakeholders and the community can be involved in decision-making on tariffs.</p> <p><b>Reliability:</b> Transfers provide a reliable source of income to providers.</p>	<p><b>Affordability:</b> Can ensure the affordability of tariffs. However, unless designed adequately, subsidies may not target the poorest or those without service.</p> <p><b>Willingness to pay:</b> Customers may not be willing to pay a cost-reflective tariff due to quality of service or poor transparency.</p> <p><b>Economies of scope and scale:</b> Can encourage new customers to connect, densifying networks.</p> <p><b>Positive externalities:</b> Subsidies that encourage greater sectoral outcomes have further benefits for health, human capital, and the economy.</p>	<p><b>Reliable:</b> Development banks tend to be reliable in their commitments.</p> <p><b>Inclusion:</b> Transfers may be more within the control of the community and stakeholders than taxes.</p> <p><b>Political economy:</b> Funding from external development banks can give utilities more autonomy than assistance through taxes from government. Transfers might also be beneficial in economies where institutions are still being developed.</p>
<b>Disadvantages</b>		
<p><b>Affordability:</b> Some customers may be unable to pay for tariffs. While cross-subsidies can address this, they create a distortion in incentives, leading to inefficient consumption.</p>	<p><b>Inclusion:</b> Taxes are prone to volatility beyond community and stakeholder control.</p> <p><b>Political dependence:</b> Can reduce the political autonomy of the utility.</p> <p><b>Unreliable:</b> Risk of government sliding on commitments. Hence, private investors, especially, are reluctant to invest if revenue is reliant on taxes. However, targeted taxes can reduce this risk.</p>	<p><b>Loss of autonomy:</b> Country cedes opportunities to design its own policies, whether directly or indirectly. Particularly problematic in case of increased indebtedness.</p> <p><b>Loss of accountability:</b> Governments feel accountable to donors rather than citizens.</p> <p><b>Volatility:</b> Transfers from development agencies of other countries can be volatile or unreliable, undermining sectoral planning and growth.</p>

There are positive externalities associated with greater access to water. The most obvious are the public health impacts, for example, the reduction in disease within local communities as access to water increases. These benefits act as pathways to the improved accumulation of human capital by, for example, reducing childhood mortality. Thus,

charging below the economic cost can motivate greater accumulation of human capital, in turn generating economic benefits that result in greater tax revenues that compensate the initial subsidization via taxation.

An additional benefit of subsidies (or taxes) over tariffs is their ability to target specific costs. Targeted

### BOX 2.9. Social Assistance through Utility Tariffs during the COVID-19 Pandemic

During the COVID-19 pandemic, utility tariffs have been used to manage and alleviate social impacts. Privately owned utilities have been required to protect cash flows and to ensure the continuity of service to households. For example, in Germany, small businesses could temporarily delay energy payments, and utilities pledged not to cut off households during the crisis (Clean Energy Wire 2020). In Canada, the winter ban on electricity disconnections was extended to the end of July (Global News 2020).

Publicly owned utilities returned customer deposits and slashed tariffs, which is both quicker and simpler than increasing welfare payments, bearing a resemblance to “helicopter money.” For example, the government of Thailand reduced public utility bills by 3 percent, and electricity authorities returned cash deposits to customers (The Diplomat 2020). The government-owned electricity utility of Indonesia, PLN, pledged to supply 24 million households in the smallest tariff category with free electricity for three months. The second most vulnerable customers, across 7 million households, would get a 50 percent discount (The Jakarta Post 2020). These measures demonstrate an advantage of using utility bills to deliver income support. By linking discounts to consumption levels, a rough targeting of benefits to the lowest-income households can be created without the need for complex application and verification procedures.

It is important to note the implications of these measures on cost recovery: the World Bank found collection rates had dropped by 40 percentage points among the utilities monitored. Nonetheless, these examples illustrate the potential for water tariffs to have far-reaching socioeconomic impacts in times of crises.

*Source:* Holcroft 2020.

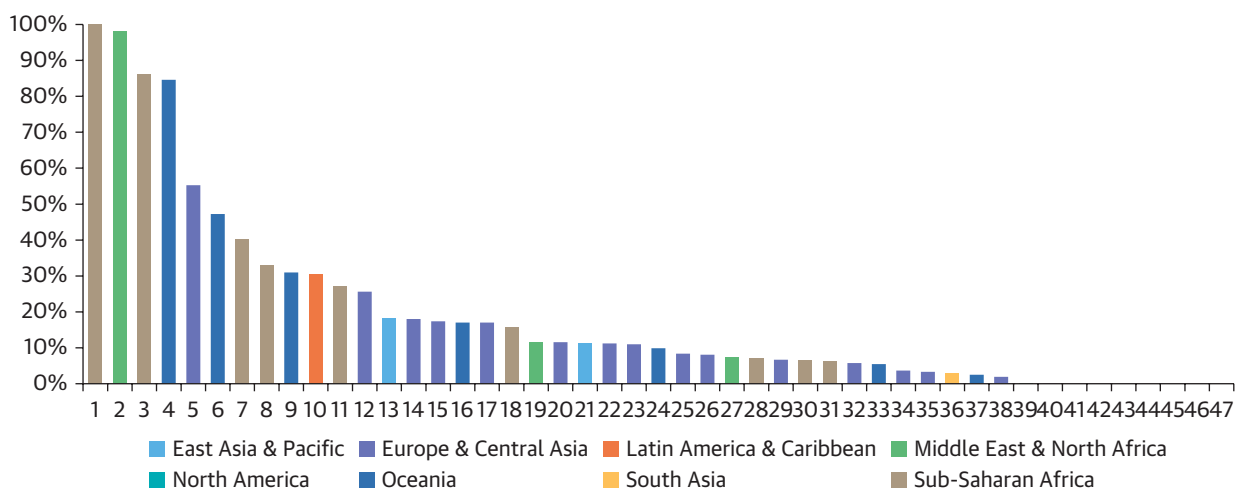
tariffs are less effective for some capital costs. For example, existing customers might pay for the expansion of the network through tariffs, despite not benefiting from the new infrastructure. This raises the question of who should pay for these costs and to what extent—that is, deep versus shallow connection charges? In these circumstances, taxes may be more justifiable.

The ratio of subsidies to revenue collected through tariffs and taxes differs internationally. The average ratio for utilities across 47 countries aggregated to the national level is highest in the Middle East and

North Africa region, followed by Sub-Saharan Africa (figure 2.11).

When subsidies are required to plug the gap between revenues collected through tariffs and economic costs, particularly with respect to CAPEX, a key benefit of transfers over taxes is the reliability of development banks over domestic governments, which in turn increases the confidence of private investors. Furthermore, transfers have political economy benefits. They reduce the dependence of utilities on the domestic government (box 2.13), which can erode the autonomy of the utility.

**FIGURE 2.11. Subsidies as a Proportion of Tariff and Tax Revenues in Select Countries, by Region (2010-19)**



Source: Original elaboration using IBNET data.

Transfers might also be beneficial in economies where institutions are still being developed. Finally, development banks often work closely with communities and stakeholders when devising subsidies, increasing the degree of inclusion. Figure 2.12 presents original analysis of how tax transfers relate to tariff and tax revenues across global regions.

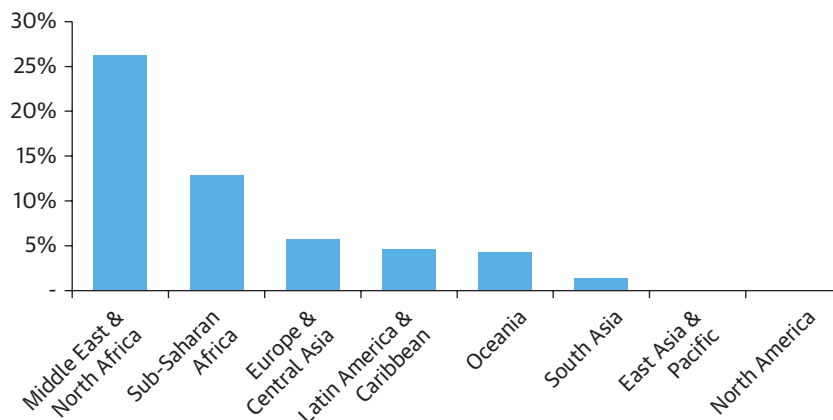
### 2.13 Conclusions

There are two main approaches to determining average costs. In the cash-based approach, the calculation is largely based on figures reported in financial documentation. In the building blocks approach, more work is required to infer the more abstract costs: O&M costs, depreciation, and return on capital. The marginal cost can be calculated on a short- or long-term basis. The long-term calculation can be based on an incremental increase in demand (Turvey method) or an increase in demand forecast in expansion plans (AIC approach). Both methods appear to be common among countries where marginal cost is used. The short-run approach might be appropriate where there are no capacity constraints. It can also serve as a price floor—volumetric tariffs should

generally not be set below the short-run marginal cost. However, the long-run approach is much more common.

The environmental cost can be calculated as the cost of action or of inaction. There are two broad approaches for measuring the cost of action. Cost-based approaches look at the cost of preventing or repairing overabstraction of resources, while market-based approaches simply look to the market price that emerges from volume-based controls. A weakness of the cost-based approach is that estimates are closely linked to expenditure, meaning they may overlook hidden costs and may not necessarily represent the least expensive action possible. Despite this, they are simple to understand and administer. Market-based approaches naturally determine the efficient price associated with systems of abstraction charges. However, the licenses can easily be overallocated with the right pressure from market players. Despite the merits of such systems of permits, volume-based controls are rarely adopted. The cost of inaction requires the calculation of the economic consequences resulting from allowing the abstraction to cause the water resource

**FIGURE 2.12. Tax Transfers as a Proportion of Tariff and Tax Revenues, by Region (2010-19)**



Source: Original analysis of 47 countries using IBNET data.

to fall below its rate of natural replenishment. The present value of these costs can be calculated across the period over which the resource is depleted. For example, this could be used to calculate the damage in the aftermath of a drought.

As water is a public good and a basic human right, customers need to be able to afford services. Water priced at full economic cost-recovery levels may not be affordable for low-income customers. External subsidies, or, more commonly, a cross-subsidy from other customer categories, may help address this need. Alternatively, as discussed in the next chapter, tariff complements, such as tariff rebates, vouchers, and subsidies, can be leveraged to help address affordability. These mechanisms may be especially important to address barriers to access, such as connection charges.

Countries across the world struggle to cover costs through tariffs alone. Given competing policy objectives, a more rational goal might be to set an aspirational target. The gap between revenues collected via tariffs and total costs must then be met through

taxes or transfers. Tariffs tend to increase efficiency by inducing efficient consumption while targeting those who incur the costs. Taxes and transfers may be necessary or desirable, for example, when balancing affordability. Though taxes can be unreliable and erode the political independence of a utility, targeted taxes can be ring-fenced to improve reliability.

Using tariffs to cover costs should not be perceived as the single policy lever for cost recovery. A strong case could be made that improvements in efficiency should be the first port of call for addressing cost recovery. Efficiency gains can spur improvements in services and WTP, in turn increasing cost recovery, resulting in a positive feedback loop. Where necessary, modifying service levels could be a route for cutting costs while increasing access.

Importantly, designing an effective tariff structure is only possible where robust, quality data are available. Different data are needed for different tariff structures and different tariff objectives. For example, the lack of metering largely limits utilities to flat

rate tariffs and in the absence of a social registry excludes even variable flat rates. Given the context-specific nature of tariffs, the availability of data and access to specific data are likely to influence the choice of tariff structure even further.

## Notes

1. Tariff complements are instruments that can be leveraged to support utilities in meeting their goal of financial equilibrium. While they are generally related to pricing (e.g., dynamic pricing), they may also be political or regulatory (e.g., overconsumption penalties). See chapter 3 for a detailed discussion of these complements.
2. Costs can be untangled and categorized in different ways, for example, operations, depreciation, capital maintenance, and financing (debt and equity) (AWWA 2017). However, figure 2.3 offers the most appropriate representation for this report.
3. Additional references for the LRMC include London School of Economics (1997) and Marsden Jacob Associates (2004).
4. For a summary of the history of financial sustainability and guidance on its implementation, see McPhail, Locussol, and Perry (2012).
5. According to the OECD (2020), “[i]ntroducing metering at household level in existing built up areas can be disproportionately costly to support sophisticated tariff structures. Depending on context and history, metering can be used at block level to detect leakage and raise users’ awareness of water use. Where in place, metering can be used to generate data that increasingly supports decision making though sophisticated data management techniques. [However, t]he installation of universal water metering comes at a cost, and its effects on water consumption may be limited [see section 3.2.1 on

elasticity of demand]. [Further, charging for metered services creates uncertainty about revenue streams... [i]n low water usage households, resource savings eventually driven by metering are not likely to outweigh [the] costs [of installing meters].” The point being, metering is not a panacea in and of itself to reduce consumption. Instead, “[i]t is primarily a measure to make customers aware of their level of usage, and a tool to identify and situate water leaks. This explains why metering is most effective when it comes with nudging techniques to drive water users’ behaviour [see Section 3.2.3].” However, “[a]n ancillary benefit of metering is the generation of data that can be used not only to determine the water bill of consumers, but also to drive improvements in tariff policy, water management and decisions on infrastructure maintenance and extension. If meters are used primarily with the purpose of detecting leakage and informing water policy, block or district metering is a fully adequate and less costly solution.”

6. First, it defines a “basket” of WASH services that accounts for the type and level of WASH services that a household receives (and that involves a threshold quality of service, deemed necessary for health and well-being). Second, it makes use of the actual costs of service, therefore moving away from household estimates of WASH expenditure that tend to be inadequate and rarely reflect actual costs. Third, it considers both initial fixed costs and recurring consumption costs, each of which pose their own unique challenges to affordability. Fourth, it makes use of household-level data on access to WASH services, which allows for the grouping of households into categories with distinct policy implications. Finally, this approach facilitates scenario analyses, whereby the impact of different pricing policies can be assessed (Andres et al. 2020).
7. Whittington and Nauges (2020) assessed IBTs in the municipal water supply sector and concluded they do not perform well in most situations in terms of subsidy targeting.







## CHAPTER 3

# Secondary Tariff Objectives and Tariff Complements

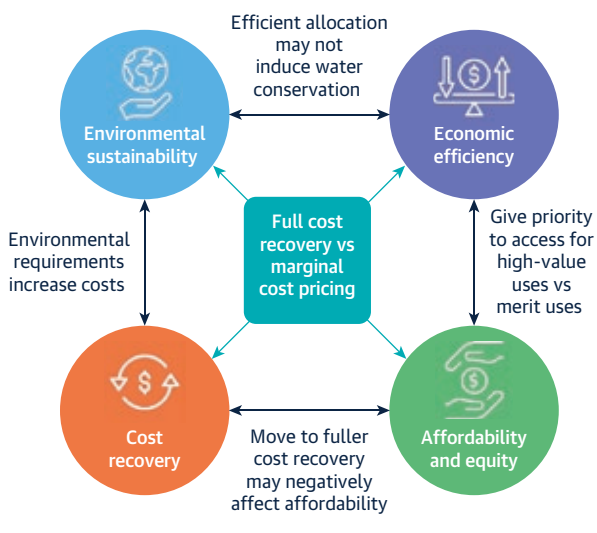
Tariff design inevitably entails trade-offs between different, often conflicting, policy objectives (figure 3.1). Such trade-offs can potentially be mitigated through the application of tariff complements. Tariff complements are instruments that can be used alongside core tariff structures to target specific tariff objectives while supporting utilities in meeting their goal of financial equilibrium. In this way, they can help balance the trade-offs between competing objectives, ideally without compromising financial stability. Although they are generally pricing related (e.g., dynamic pricing), they may also be political or regulatory (e.g., overconsumption penalties). They also include affordability measures to target lower-income households and efficiency measures to ensure customers are charged according to the underlying costs that correspond to their supply.

### 3.1 Strategies to Increase Economic Efficiency

Tariffs that reflect the real-time cost of supply encourage economic efficiency. Examples include peak pricing, peak rebates, real-time pricing, or time-of-use (TOU) tariffs, although the latter are relatively uncommon. Such tariffs are commonly applied in the electricity and other sectors, but are less common in the water sector, particularly in low-income countries, due to their reliance on smart metering. Location-based pricing reflects variations in a supplier's costs due to location, for example, the need to provide desalinated water in the absence of freshwater or gravity-fed distribution schemes versus pumping, and aims to pass these costs on to the customer. Although necessary at times, they are generally unpopular given the potential to disproportionately affect poor households who are often located further away from primary distribution networks.



**FIGURE 3.1. Trade-Offs in Water Tariff Design**



Source: Original elaboration, adapted from OECD (2020).

### Dynamic Pricing

Dynamic tariffs that reflect the real-time cost of supply are the ultimate means of encouraging economic efficiency. They are particularly useful when costs vary significantly by time and therefore provide an incentive for large consumers to shift water consumption to off-peak periods. However, they are costly and complex to implement as they require smart metering technologies. They are nonetheless expected to become increasingly used in the water sector with time.

A key feature of dynamic pricing is varying the price of services with time, building on the idea that the underlying costs of supply depend on the time of use. The main types of dynamic pricing schemes of relevance to water services include:

- **Critical peak pricing.** Customers are charged higher prices for water consumed during critical peak periods. Different events may be used to select critical periods. In the electricity sectors, these mainly relate to reserve capacity constraints. Notification about critical periods is given through

two-way communication meters or directly to the customers, in combination with smart tools that automatically adjust water consumption in critical peak days.

- **Critical peak time rebate.** The idea underlying this tariff mechanism is similar to critical peak pricing, with customers paying a given rate structure in normal periods (typically a TOU tariff) and receiving rebates for reducing their water usage during critical peak days. Average historical consumption levels are used to determine benchmarks under which water usage is eligible for rebates. As for critical peak pricing, the choice to notify customers might involve more or less advanced metering technologies.
- **Real-time pricing.** Increasing the granularity in TOU pricing and the amount of pricing periods, real-time pricing schemes aim to reflect real-time costs. The day is divided between several different charging periods and prices are regularly updated.
- **Time-of-use (TOU) tariffs.** Consumers pay different prices at different hours of the day, with the price distribution predetermined and known to customers. The simplest design is based on two pricing periods, peak (commonly daytime) and off-peak (commonly nighttime) hours, although TOU tariffs could also involve midpeak periods. TOU tariffs require less sophisticated metering options than alternative dynamic tariffs and are less common than other pricing strategies.

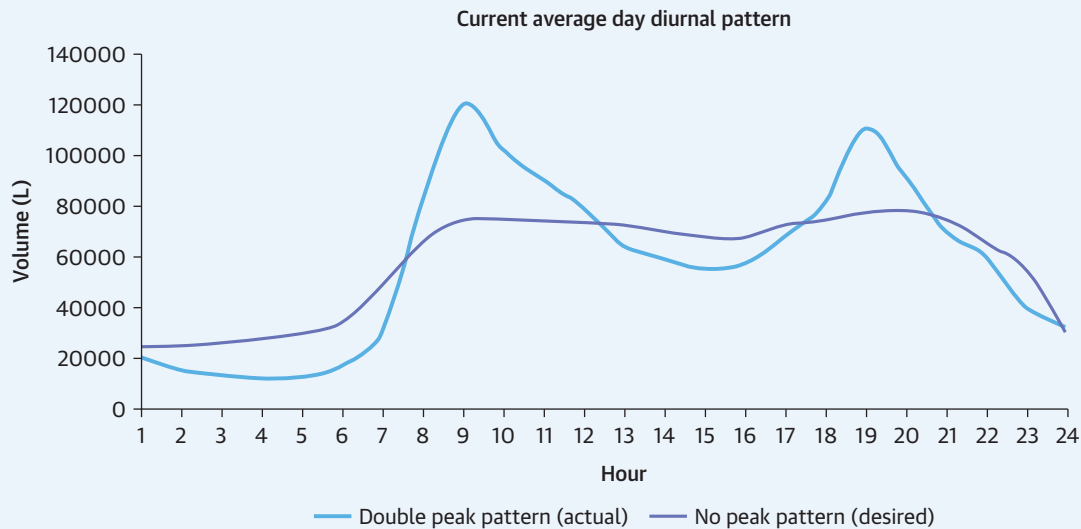
These time-varying tariffs are much more complex than current conventional pricing mechanisms and there is far less experience applying dynamic tariffs in the water sector. However, research on TOU tariffs has attempted to provide insights on the potential impacts of peak pricing (box 3.1).

### BOX 3.1. Automatic Meter Readers for TOU Tariffs in Australia

The Australian government's Water Fund, Water Smart Australia, and Wide Bay Water Corporation carried out a project in Queensland (Australia) in which automatic meter readers were installed on a number of customer properties. The project allowed the water utility to save on meter reading costs and identify leakages in the water network. It became the topic of several studies. For example, Cole, O'Halloran, and Stewart (2012) collected data on consumption patterns in Wide Bay showing two clear peak demand periods throughout the day (see figure B3.1.1, blue line).

The aim of the time-of-use (TOU) tariffs is to shift demand to achieve a softer consumption pattern (figure B3.1.1, red line) to minimize the risk of reaching the network capacity limit. The project highlighted that automatic meter readers and hourly metering provide useful insights for the design and implementation of TOU tariffs. The readers allow water utilities to collect and analyze information and figure out which type of consumption (i.e., indoor versus outdoor versus discretionary use) customers are likely to reduce when water restrictions take place.

FIGURE B3.1.1. A Comparison of Usage Scenarios



The application of these innovative pricing models has been spreading through many sectors such as electricity, telecommunications, insurance, and transport, to better recover the costs of supply and drive consumer behavior. Dynamic pricing has become a reliable option in

demand-side management through the advent of smart technologies (e.g., smart metering, real-time monitoring, and improved demand forecasting), which have revolutionized the relationship between water operators and customers (see chapter 4).



## Location-Based Pricing

Location-based pricing may be necessary in some cases but is often unpopular. It is particularly relevant where there is significant variation in the cost of supply by location, perhaps because water sources vary (i.e., boreholes versus desalination) or because network costs vary (i.e., gravity fed versus pumping). Location-specific tariffs, however, often raise social concerns as households located farther away from the central distribution network are likely to fall within the poorest segments of the population.

This pricing scheme charges different prices for different customers depending on their location inside the operator's service area and the underlying cost of supply. This could entail different tariffs for customers within the same supply network (i.e., depending on the water intake point along the network infrastructure) or apply to separate supply systems, as is more commonly observed. This approach ensures that costs reflect different infrastructure types and locations, avoiding the potential for

cross-subsidization between services and customer categories.

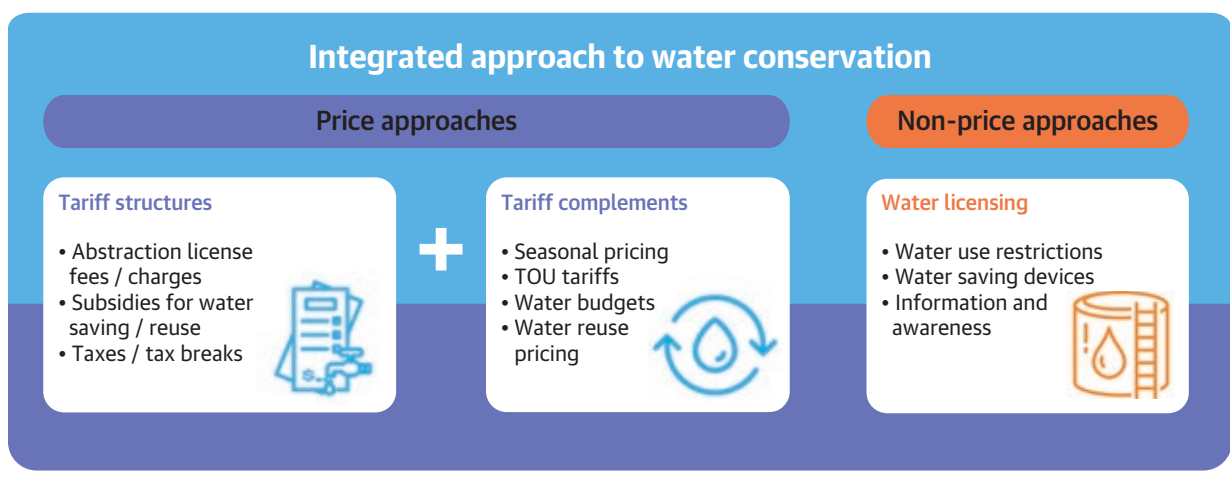
Location-based pricing, also known as “zonal pricing,” is rarely applied. Water utilities typically apply a uniform geographic charge similar to postage stamp pricing.

## 3.2 Strategies for Conserving Water

Population growth and urbanization, along with the effects of climate change, have put increasing pressure on water resources. Encouraging water use efficiency, water conservation, and water reuse have therefore become primary objectives of national governments and water utilities. The most common intervention to address these challenges and achieve environmental sustainability is through water pricing. There is a vast literature on pricing approaches for WSS services covering a wide range of instruments aimed at stimulating efficient water allocation and use (figure 3.2).

Overconsumption penalties and seasonal tariffs can be applied in locations with large seasonal peaks

**FIGURE 3.2. Price and Nonprice Approaches to Water Conservation**



Source: Original compilation.

Note: TOU = time of use.

in demand. These approaches are much easier to implement than real-time pricing but still effectively penalize high-end consumers in periods with high water demand or low availability to reduce seasonality and the costs generated when network capacity is reached. The relative strengths and weaknesses of various tariff complements are presented in table 3.1.

### Tariffs for Water Conservation

Water conservation is often one of the most important objectives in water management given the growing scarcity of water resources. Internationally, many water tariffs are below the cost of supply and do not reflect the full environmental impacts of water consumption and wastewater disposal.

When water conservation is the utility's primary objective, IBTs can be employed to progressively increase water tariffs until customers achieve sufficient reductions in water consumption. While theoretically attractive, the effectiveness of IBTs in promoting water conservation critically depends on whether they are appropriately designed and received by customers. IBTs are more difficult to understand than other tariff structures such as uniform pricing, and their complex nature requires customers to have accurate information about the tariff structure and their level of water consumption in order to make rational decisions.

Economic models typically assume that information has no cost and customers are well informed. However, this assumption is unlikely to hold in utility markets where obtaining data can be difficult and costly. It is common for IBTs to involve more than two blocks, increasing information costs for customers. Therefore, the impact of IBTs on water conservation is unlikely to be as straightforward as it appears in theory, since consumers do not accurately perceive pricing signals nor correctly predict their water consumption.

The economic literature has attempted to shed light on the impact of water tariffs on water demand by measuring the price elasticity of demand (PED), the percentage change in the amount of water consumption in response to a percentage change in the tariff. A summary of the range of PED estimates from the existing literature is provided in table 3.2.

Despite the heterogeneity in specifications, data, and estimation techniques, the following are key insights from the available literature on PED (Lu, Deller, and Hviid 2017): (1) the price of water is a statistically significant variable in explaining water demand, suggesting that water tariffs are effective instruments to reduce water consumption and achieve environmental objectives; (2) the range of PED estimates from existing empirical studies is wide and highlights that household-specific factors are important drivers of behavioral change in water consumption patterns; (3) PED is usually higher for IBTs than uniform pricing and other tariff structures, likely reflecting customers' higher awareness of large non-essential consumption feeding into larger bills under IBTs, regardless of whether they understand the block structure or not; and (4) water is traditionally considered a highly price-inelastic good, and significant price increases might be required to induce sufficient reductions in water demand. These tariff increases are unpopular and politically difficult, highlighting the role of nonpricing tools in promoting water savings (see background paper 15, listed in appendix A).

When alternative supplies are not available, IBTs are a potentially useful pricing instrument to reduce overall water consumption, in line with theoretical predictions. However, the wide range of PED estimates suggests that households and regional variables should be taken into account in assessing the impact of IBTs on water demand.

**TABLE 3.1. Strengths and Weaknesses of Tariff Complements**

Tariff complement	Strengths	Weaknesses	Requirements	Context for implementation
Core structures				
Time-of-use (TOU)/dynamic pricing	<ul style="list-style-type: none"> <li>Operates as peak-load pricing and sends the most efficient pricing signals to customers</li> <li>Generates incentives to adjust consumption and water savings</li> <li>Cost reductions from automatic readings, shift of demand to off-peak periods, and more efficient network management</li> </ul>	<ul style="list-style-type: none"> <li>Very costly and complex to implement (requires sophisticated metering technologies and determination of pricing periods)</li> <li>Could create a secondary peak during the off-peak period with adverse impacts for customers who do not contribute to peak demand with discretionary water use</li> </ul>	<ul style="list-style-type: none"> <li>Smart metering technologies (automated meter reading)</li> <li>Management and monitoring requirements</li> <li>Communication between water utility and customers</li> </ul>	<ul style="list-style-type: none"> <li>Used as a demand management strategy when water consumption presents peak and off-peak periods</li> <li>Applied by utilities to gain better knowledge of demand behavior before introducing specific measures and increase awareness of eventual leakages</li> </ul>
Seasonal tariffs	<ul style="list-style-type: none"> <li>Induce sustainable consumption and avoid demand fluctuations to achieve financial stability</li> <li>Promote water savings by penalizing high water consumption when demand is higher, or availability is lower</li> </ul>	<ul style="list-style-type: none"> <li>Regressive impact on regular residents when applied in response to demand increase due to tourism (as residents are asked to pay a higher rate while not contributing to the demand increase)</li> </ul>	<ul style="list-style-type: none"> <li>Knowledge about network capacity</li> <li>Information on household consumption profiles to establish an overconsumption penalty threshold and differential tariffs depending on the season</li> </ul>	<ul style="list-style-type: none"> <li>Used in cities or countries facing demand increase in certain months or seasons (i.e., seasonal tourism)</li> <li>Also applied to promote water conservation and avoid water resource depletion in periods when water becomes scarce</li> </ul>
Overconsumption penalties	<ul style="list-style-type: none"> <li>Induce consumers to reduce their seasonality and adopt regular water consumption</li> <li>Contribute to cost recovery and mitigate network externalities when network capacity is reached</li> </ul>	<ul style="list-style-type: none"> <li>Can be very regressive for large families if the number of people per connection is not considered</li> <li>Difficult to determine the threshold for applying the penalty</li> </ul>		
Location-based pricing	<ul style="list-style-type: none"> <li>Reflects changes in the costs of supplying customers in different locations within the utility's service area</li> <li>As simple and easy to implement as the customer classification method</li> </ul>	<ul style="list-style-type: none"> <li>Often perceived as unfair as customers living farther away are typically poorer households</li> <li>Does not promote service expansion to unserved areas</li> </ul>	<ul style="list-style-type: none"> <li>Information on customers' location with respect to the water network</li> </ul>	<ul style="list-style-type: none"> <li>Relevant for decentralized water service provision and the development of a market for microstations and supply systems</li> </ul>

*table continues next page*

**TABLE 3.1. continued**

Tariff complement	Strengths	Weaknesses	Requirements	Context for implementation
Integrated water reuse pricing	<ul style="list-style-type: none"> <li>Achieves full cost recovery in both potable and reused water services</li> <li>Improves environmental sustainability of water operations</li> <li>Promotes the use of recycled water at a price below its cost</li> </ul>	<ul style="list-style-type: none"> <li>Complex to implement (depends on technical feasibility of a double network and setting of the tariff levels)</li> <li>Decrease in potable water demand can significantly reduce revenues</li> </ul>	<ul style="list-style-type: none"> <li>Water regulations on the use of recycled water</li> <li>Sufficient demand and revenue for reused water</li> </ul>	<ul style="list-style-type: none"> <li>Good option in water-scarce regions as a solution to droughts and constraints in resource availability</li> </ul>
Affordability measures: <ul style="list-style-type: none"> <li>Free essential minimum</li> <li>Uniform surcharge</li> <li>Tariff rebates</li> <li>Vouchers or subsidies</li> </ul>	<ul style="list-style-type: none"> <li>Help poor customers pay part of the water bill</li> <li>Flexibility in the amount of the subsidy /rebate, depending on household's social circumstances</li> <li>Can target low-income households and vulnerable groups</li> <li>Not always dependent on specific tariff structures</li> </ul>	<ul style="list-style-type: none"> <li>Risks for water utility's financial stability and cost-recovery objective</li> <li>Does not promote water savings</li> <li>Distorts efficiency pricing as subsidized households do not face the full cost of supply</li> <li>Requires strong administrative capacity (complex to implement and manage)</li> </ul>	<ul style="list-style-type: none"> <li>Information on households' socioeconomic situation</li> <li>Funding for subsidy from government, utility, or donors</li> </ul>	<ul style="list-style-type: none"> <li>Appropriate for targeting not only low-income customers but also pensioners, the unemployed, and other groups facing payment problems and indebtedness</li> </ul>

**TABLE 3.2. Price Elasticity of Demand Estimates**

Study	PED range	Study	PED range
Sebri 2014	-3.05 to -0.002	Baerenklau et al. 2014	-0.76
Yoo et al. 2014	-0.66 to -1.55	Klaiber et al. 2014	-1.93 to -0.13
Nataraj and Hanemann 2011	-0.12	Kenney et al. 2008	-0.34 to -0.75
Olmstead et al. 2007	-0.33 to -0.61	Dalhuisen et al. 2003	-7.47 to 7.90
Pint 1999	-0.04 to -0.29	Espey et al. 1997	-3.33 to -0.02
Renwick and Archibald 1998	-0.11 to -0.53		

Source: Lu, Deller, and Hviid 2017; Ascii, Borisova, and Dukes 2016.

Note: PED = price elasticity of demand.

The environmental aim of IBTs is to prevent excessive and nonessential water consumption by high-income customers, based on the assumption that low-income households consume less water. In practice, however, this is not always the case. Low-income households may be larger than assumed by the tariff design and may consume higher levels of basic water. Despite these caveats, in the context of water consumption, there is generally a high level of overlap between income and water demand, with wealthier customers usually consuming more water for outdoor water use (e.g., gardens, swimming pools). High-income customers, however, are typically less responsive to price increases in block tariffs, as water bills account for a smaller percentage of their income. The evidence on the effectiveness of IBTs in promoting water savings is mixed and the conclusion is that IBTs can have a perverse effect on water consumption if there is limited information on the sociodemographic characteristics of households and their impact on total water demand.

When the frequency of billing increases, customers are likely to have a better understanding of how water bills reflect their water consumption. This increased transparency may allow households to be more



responsive to higher tariffs and is particularly relevant to IBTs. Various studies have investigated the impact of billing frequency on customers' reactions to price changes and have shown that increased billing frequency improves customers' understanding of their water usage, allowing them to respond to updated price signals. The impact on water consumption is, however, unclear. Frequent bills might make households more sensitive to higher tariffs and increase PED. On the other hand, as water bills account for a small proportion of a household's income, it might also reduce price sensitivity of demand.

Residential water consumption generally displays seasonal fluctuations, which significantly affect PED estimates. Summer water demand has been shown to be considerably more elastic than winter demand, and outdoor use more elastic than indoor use (table 3.3). This makes a strong case for applying IBTs as the elastic segment of the water demand curve is likely to reflect nonessential or discretionary use.

Various empirical findings on the short-run impacts of IBTs highlight that PED is considerably higher in the long run, reflecting households' clearer understanding of the IBT structure and their own consumption pattern. Costly information may limit



**TABLE 3.3. Seasonality of Water Demand**

Country	Study and key findings
 Australia	<ul style="list-style-type: none"> <li>• <b>Xayavong et al. (2008)</b> estimate water demand in Perth and suggest that a large percentage of water consumption involves nonessential water use for outdoor purposes.</li> </ul>
 USA	<ul style="list-style-type: none"> <li>• <b>Kenney et al. (2008)</b> assess residential water demand in Aurora (Colorado) between 1997 and 2005 and find that water usage is 30 percent higher in summer months compared to the rest of the year, highlighting that increasing block tariffs should target the more elastic summer period.</li> <li>• <b>Klaiber et al. (2014)</b> find that high-volume customers in Phoenix (Arizona) are more responsive to water tariffs in summer, but their elasticity of demand drops substantially in dry years. They also conclude that high-consumption customers are less sensitive to price changes, regardless of weather and season, in line with the earlier discussion of sociodemographic variables.</li> </ul>

Source: Lu, Deller, and Hviid 2017.

customers’ responsiveness to price signals in the short run. Similarly, it might take a long time to change consumption habits even for customers with more accurate perceptions of their water usage and willingness to respond to pricing incentives.

### Tariff Complements for Water Conservation

The effectiveness of tariff structures in inducing responsible water consumption can be enhanced by tariff complements aimed to address environmental sustainability objectives. Tariff complements can be applied to different core tariff structures to create incentives toward water conservation and promote the sustainable use of resources in water-stressed countries, particularly when the utility faces:

- *Demand-side constraints.* Some regions experience sharp demand peaks in certain periods of the year due to tourism, when supply availability needs to be increased to match the higher demand.
- *Supply-side constraints.* Water becomes scarcer in certain periods of the year (e.g., summer if the

rainy season is in winter). Tariffs could be modified to induce customers to use water resources efficiently in these periods through environmental sustainability complements.

Tariff structures that best achieve environmental sustainability by promoting water savings are those that incorporate some form of seasonal pricing or overconsumption penalties to reduce water consumption during periods of peak demand and/or lower resource availability:

- Seasonal tariffs are the most effective complement to promote water conservation and are based on differential rates to price water depending on the season. The tariff is higher in periods when water demand is higher (e.g., summer/drier months) or when water availability is low to induce sustainable water use. Seasonal tariffs act as a peak-load pricing scheme, shifting water consumption toward off-peak periods.
- Overconsumption penalties consist of adding a penalty on regulated prices if water

consumption exceeds a threshold for a certain period. This complement is often applied in combination with seasonal tariffs. An example is Santiago (Chile), where customers pay a fixed charge and volumetric rate depending on the season and incur an additional charge if their consumption exceeds a threshold of 40 m<sup>3</sup>/month during the high season (box 3.2).

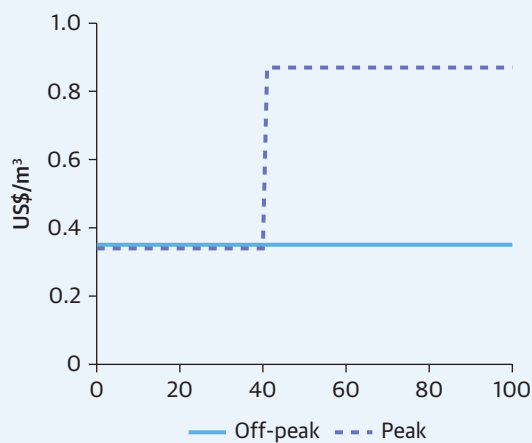
TOU tariffs may also incentivize water consumption. Time-varying tariffs reflect the underlying cost of supplying customers at different hours of the day and encourage water customers to shift their water consumption toward off-peak periods. TOU tariffs

generate incentives to adjust consumption to avoid incurring the higher cost of consuming water during peak hours. This pricing structure is typically used as a demand management strategy and is often applied by water utilities to acquire information on demand behavior before introducing specific water conservation measures. TOU tariffs are, however, very complex as they require sophisticated metering technologies such as automated meter reading (AMR) and there are very few applications in the WSS sector. Various research studies draw out useful insights on the role of dynamic pricing on water conservation (see box 6 in background paper 7, listed in appendix A).

### BOX 3.2. Seasonal Tariffs and Overconsumption Penalties in Chile

Water utilities in Chile apply a penalty on water consumed after a threshold in the high demand season (December to May) to avoid reaching the capacity limits of the water distribution network. The threshold is defined by the customers' average yearly consumption if above 40 cubic meters per month. If consumption in the high season surpasses the threshold, customers pay an additional overconsumption charge on top of the regular tariff. In the case of Santiago, the unit price is more than doubled.

FIGURE B3.2.1. Usage Patterns and Tariffs



	Tariff schedule		
	Consumption threshold	Off-peak	Peak
Fixed charge	N/A	0.77 US\$	0.77 US\$
Variable charge	0–40 m <sup>3</sup>	0.35 US\$/m <sup>3</sup>	0.34 US\$/m <sup>3</sup>
	>40 m <sup>3</sup>	0.35 US\$/m <sup>3</sup>	0.87 US\$/m <sup>3</sup>

Source: Termes-Rifé and Bernardo 2015.

## Nonpricing Measures for Water Conservation

Price-based approaches to managing water demand offer multiple benefits in terms of ease of implementation, monitoring, and enforcement. However, the tariff levels required to induce sufficient reduction in water consumption might be too high to be politically acceptable. In other cases, price does not seem a significant determinant of water demand. Therefore, pricing approaches to water demand management should be complemented by nonprice interventions to promote water savings among households.

Nonpricing tools to reduce water demand take different forms, ranging from command-and-control approaches involving regulatory restrictions, technological tools such as water-efficient household appliances, and informational campaigns aimed at increasing public awareness of water scarcity and the importance of water conservation. These measures can also be used in combination to exert a stronger influence on a household's consumption patterns.

The allocation of water rights and licensing of abstractions are the main tools of integrated water resource management. Reforms of water rights and the refinement of licensing schemes have become an imperative in countries where growing water scarcity poses serious environmental threats. Licensing of water abstractions can take many different forms according to legal frameworks in different countries. The key challenges with water licensing and rationing concern the costs and complexities of administrative and enforcement mechanisms. Licensing is most effective when licensed volumes are close to water demand and tailored to the environmental and ecological conditions of local water bodies (e.g., seasonality and variability of water flow). Another relevant and effective strategy for maximizing environmental

benefits of water consumption is to enable trading of water permits and abstraction allocations between water customers to optimize the allocation of water rights while monitoring overall water demand.

Restrictions on water use or rationing of water supply to households are typically applied during periods of severe water shortages. This is usually done by establishing a “water hierarchy” setting out a ranking of priority uses. For instance, drinking water supply is typically considered a priority use, exempted from restrictions on water abstractions. An example is the restrictions on washing sidewalks and driveways and prohibiting lawn and landscape watering as well as filling of swimming pools introduced during a drought in California (the United States) in the late 1980s. Water use restrictions effectively reduced nonessential water use and total municipal water consumption by approximately 30 percent. Water use restrictions are often used in combination with other nonpricing tools to promote water conservation when water becomes scarce.

Another water demand management approach is to improve water use efficiency in houses and buildings. Water-saving devices include low-flow fixtures such as shower heads and dual-flush toilets, and more efficient dishwashers and washing machines. These can be promoted by local authorities through various means: (1) direct distribution of devices among households is typically triggered during periods of low availability of water resources; (2) regulation and standards can also be applied to promote the uptake of water-efficient appliances during periods where water scarcity does not pose serious challenges; and (3) awareness and educational campaigns can also be an effective means to inform households about the impact of water-saving devices on their water consumption, and therefore total water bills, as well as the environment.

The effectiveness of water-efficient appliances in reducing water demand and consumption can be reinforced by complementary measures to the installation of water-saving appliances. These include:

- *Metering technologies.* Measuring water usage makes customers more aware of their consumption levels and the savings achieved by adopting more efficient water conservation tools. The role of metering and the latest technological innovations in smart metering are discussed in chapter 5.
- *Leakage reduction measures.* Water conservation tools can also be an effective means of reducing network leakages. Reducing water losses in the water infrastructure is often a difficult task and a major driver of inefficiencies. The assessment and monitoring of leakage levels has therefore become a key strategy for many utilities. Water leakage reduction measures usually include improved asset and pressure management through regular pipe replacement and repairs and active leakage control.

However, it is important also to note that poor design and inadequate maintenance of devices that are supposed to be water saving can lead to perverse results. A case in point is the recent study in the United Kingdom of dual-flush toilets “wasting more water than they save” (*The Guardian* 2020).

Finally, awareness-raising and educational campaigns are aimed to drive behavioral change among households and highlight the benefits of water savings (box 3.3). Informational campaigns take several forms, including the distribution of information through websites, social media or mailings, events and workshops, and efforts to gather comparative feedback and raise awareness of water scarcity issues. While the adoption of nonprice measures to reduce water demand is an effective tool to promote

water conservation, several challenges with their implementation exist.

### 3.3 Alternative Strategies for Ensuring Affordability and Increasing Access

Increasing access to water is critical to achieving the SDGs. Commonly included as part of the primary policy objectives, this chapter discusses the challenges of tackling this essential yet conflicting dimension of tariff design. This section explores the role and effectiveness of tariffs and subsidies in ensuring accessibility, with a particular focus on IBTs, given their global prevalence. A detailed discussion on connection charges and related subsidies is presented before delving into the rationale for nonnetworked services in urban areas.

Affordability complements can help address the impacts of tariff structures on different income categories to mitigate the burden of water bills on low-income customers. These complements include uniform surcharges, cross-subsidies generated through IBTs, a free essential minimum, tariff rebates, vouchers, and direct subsidies. The key challenge in designing social tariffs is effectively targeting the households facing affordability constraints, avoiding errors of inclusion or exclusion.

Common affordability measures include:

- *Integrated water pricing for reused water.* This mechanism consists of strategically setting the prices of potable and recycled water to achieve full cost recovery in both services. The unit price of reused water is set below its unit cost of production, while the price of potable water is set above costs to recover part of the costs of nonpotable water. Water reuse schemes are often adopted in water-scarce regions, such as Australia and Cape Verde.

### BOX 3.3. Behavioral Nudges Implemented in Chennai (India)

"A nudge is any aspect of the choice architecture that alters people's behavior in a predictable way without forbidding any options or significantly changing their economic incentives" (Thaler and Sunstein 2009). In a program to save water among residential consumers in Chennai, India, nudges were designed to address behavior bottlenecks identified in consumer discussions, underlying the knowledge-action gap. The intervention sought to encourage two fundamental behaviors:

- Pause and think at decision points
- Social norms of being frugal and caring about others

FIGURE B3.3.1. Example Graphics



Informational and reminder stickers were placed at points of water use in households, creating decision points. One of the biggest challenges in behavior change is addressing the attitude of discounting future gains. When future gains are equated with the needs of future generations, they are not so easily discounted.

Postcards were also sent out, highlighting:

- The plight of have-nots in the rural countryside
- Positive actions of peer groups in reducing water consumption
- Quantifiable water-saving actions

Nudges such as these trigger the pressure of social norms to change individual consumption behaviors.

Source: IJBSS 2017.



- *Free essential minimum.* Some countries have attempted to address the issues of IBTs by introducing a first block that provides basic water volumes for free. Tax revenues are typically used to fund this free quantity.
- *Uniform surcharges.* These are applied to the unit price of water to provide a direct income-related subsidy to poorer households. The surcharge increases the water price for all customers and the additional funds are subsequently redistributed among low-income customers.
- *Social rebates.* Poor households receive direct cash transfers to assist them in paying a fraction of the bill. The amount of the rebate can be determined according to the socioeconomic situation of the household.
- *Vouchers, transfers, and subsidies.* These can be provided by the government, water utilities, private sector, or development partners. Hence, policy makers must take the challenge of coordination into account when designing transfers and subsidies. Vouchers often provide a better solution as they can only be spent on water bills.

### Reducing the Cost of Connections

Connection charges, particularly one-time charges, can be a major barrier for the poor in accessing water. Given the positive externalities of access to piped water, the social benefits of making connections affordable affect society as a whole. Moreover, maximizing access may also benefit the utility as it ensures the full capacity utilization of its infrastructure. Globally, the use of full connections by WSS utilities varies significantly. Of the 70 countries providing data to the IBNET database in 2010, at least one utility in each of 26 different countries provides “free” water connections (i.e., the connecting party does not pay an up-front connection charge). However, in most countries (44), no utilities provide free connections. Examples of utilities providing free connections can be found across the world (box 3.4).

When the options to ensure that connections are affordable are not feasible or do not go far enough, it may be necessary to seek alternative solutions and approaches that can reduce the costs of connecting to a household (table 3.4). This can be done by the household opting to provide materials or

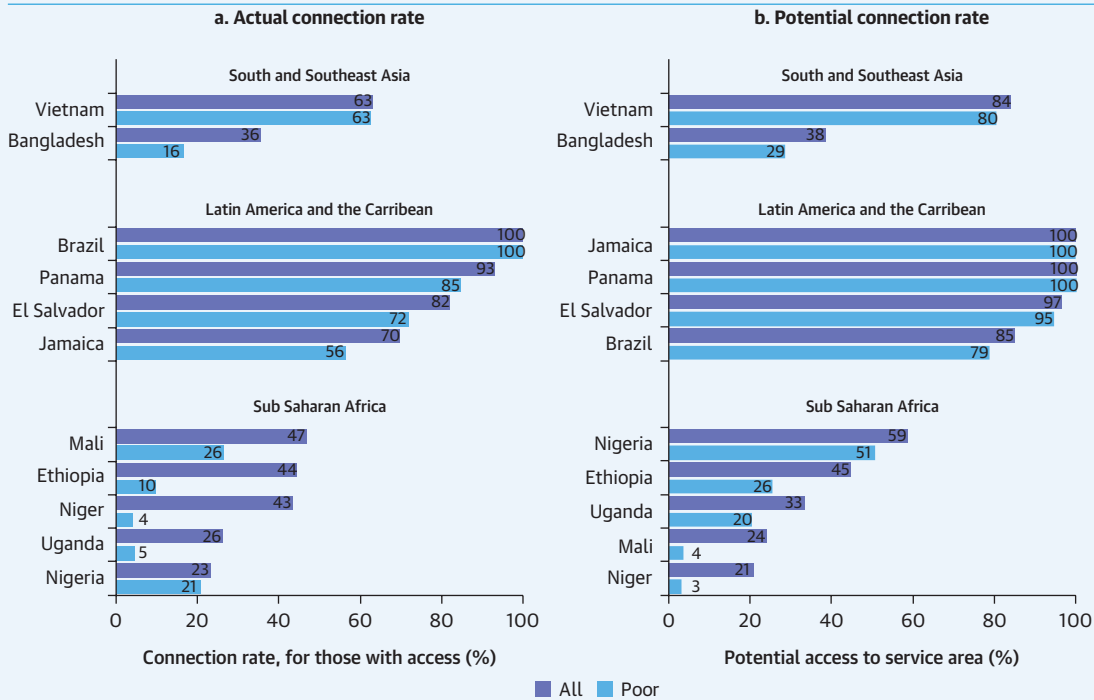
#### BOX 3.4. Piped Water Access and Connections in Selected Countries

The poor often find it difficult to access piped water, for two main reasons: geographical exclusion and high connection charges. That is, service providers may not offer services in areas where the poor tend to live and even if the poor live in areas where services are available, high connection charges may prevent them from connecting. A recent study (Abramovsky et al. 2020), using the latest available household survey data, highlights the importance of focusing on increasing access to services, particularly for the poor.

Data from four African countries—Ethiopia, Mali, Niger, and Uganda—show that poor households tend to have a lower probability of: (i) being located in an area where services are available, and (ii) being connected to a water network (conditioned on being located in a service area). In three countries in Latin America and the Caribbean—El Salvador, Jamaica, and Panama—the probability of living in a service area is high for both poor

**BOX 3.4. continued**

**FIGURE B3.4.1. Actual vs. Potential Connection Rates in Select Countries, by Poverty Status**



Source: Abramovsky et al. 2020.

and non-poor households (figure B3.4.1, panel b). However, connection rates are significantly lower for poor households (panel a). These countries would benefit from focusing on making connection charges affordable for the poor. In Brazil, the opposite problem of providing services persists, although where services are available the poor tend not to be excluded. Bangladesh falls in between African and Latin American countries: both service provision and connection rates are low in general, and especially low for poor households. Finally, in Vietnam, service provision and connections for the poor are high, with the inference being that policy makers could improve water access by improving expansion of services to unserved areas.

Source: Abramovsky et al. 2020.

labor or accepting a lower level of service. These approaches equate to a subsidy based on self-selection. An alternative approach is to pursue innovative, alternative models of supplying WSS services, for example, through supplying several households with a shared connection.

**Spreading Costs Over Time**

In some cases, households are willing to pay a connection charge but face a liquidity constraint in doing so. This is because they may budget on a short timescale and lack the ability to save over time. In such cases, the connection charge can be

recovered if it is spread over a longer period. This can either be facilitated by the utility spreading the cost over time via ongoing use charges, or through a third party, such as a microfinance organization, covering the connection charge and subsequently recovering the costs from the households (table 3.5).

### Connection Subsidies

Connection subsidies are broadly categorized as either targeted (a subset of connecting parties receives the subsidy, e.g., properties in specific neighborhoods or properties below a predefined household income threshold) or untargeted (e.g., all connecting parties receive the subsidy). Given that it

**TABLE 3.4. Reducing Connection Costs**

Approach	Description	Evaluation
Self-provision of labor and materials	Households contribute labor and/or materials to lower the connection cost	<ul style="list-style-type: none"> <li>Opportunity to engage households and lower administrative costs</li> <li>Only feasible in smaller communities</li> <li>Quality of connections may be poor without clear guidelines and supervision</li> </ul>
Provide alternative solutions	<ul style="list-style-type: none"> <li>Lower-cost connections: Smaller connections, connections using cheaper materials or ones that only reach the yard are laid instead</li> <li>Shared/condominium connections: Connection is provided to a group of households</li> </ul>	<ul style="list-style-type: none"> <li>Reduce costs and facilitate additional connections</li> <li>May not be efficient in the long run</li> <li>Disparities in service quality</li> <li>Reduce costs significantly</li> <li>Useful in informal or dense, low-income settlements</li> </ul>
Exploit scale economies	Universal service obligations lead to scale economies	<ul style="list-style-type: none"> <li>Reduction in average cost of connecting</li> <li>High administrative costs</li> <li>Some households may continue to face barriers</li> </ul>

Source: Original compilation.

**TABLE 3.5. Spreading Connection Charges Over Time**

Approach	Description	Evaluation
Absorb connection costs into the regulatory asset base (RAB)	Connection costs are fully absorbed into the utility's RAB and recovered through consumption tariffs	<ul style="list-style-type: none"> <li>Reduces barriers to connection</li> <li>Benefits from economies of scale and lower administrative costs</li> <li>Small additional financing costs</li> <li>Absence of price signals</li> </ul>
Explicit recovery through bills	Connection costs are recovered through the connected households' water bill	<ul style="list-style-type: none"> <li>Recovered as a customer-specific asset</li> <li>Utility can offer financing at a lower cost than the customer</li> </ul>
Microfinance	Microfinance lenders provide a loan to cover the connection charge	<ul style="list-style-type: none"> <li>Households can opt in to a financing scheme</li> <li>Need to pay financing charges</li> <li>Opportunity for partnerships between utilities and microfinance organizations</li> </ul>

is predominantly poor households that are not connected, the lack of a connection acts as a proxy for being poor. This means even untargeted connection subsidies can be an effective way to target subsidies toward the poor, particularly when compared to common consumption subsidies.

There are two key untargeted subsidies: full subsidies and a subsidized interest rate for connection loans (table 3.6). Targeted subsidies include flat charges and administratively selected subsidies. Within this context, there may also be no subsidy at all.

The most comprehensive subsidy is to fully subsidize the connection charge. There are multiple

benefits to this approach, including its simplicity for regulators and utilities to administer and for customers to understand. Further, it significantly reduces the up-front capital costs for network connection, incentivizing network connections that increase the customer base and can drive down average costs across all customers through economies of scale and scope across WSS networks. Data indicate that utilities with a full subsidy for connections tend to have higher levels of access than those that do not, which can be observed through variation in connection subsidies for utilities globally. However, full subsidies can be very expensive for the taxpayer or the

**TABLE 3.6. Subsidies for Connection Charges**

Subsidy		Description	Evaluation
Untargeted	Full subsidies	Government pays for the connection charge for all new connecting customers.	<p>Easy to understand and administer.</p> <p>Significantly reduces barriers to connections, lowering average costs as customer base increases.</p> <p>No price signals, leading to inefficiencies and potentially higher costs.</p> <p>Expensive to implement, requiring transfers.</p>
	Subsidized interest rate	Government subsidizes the interest rate for financing of new connections. Targets all new customers using finance.	<p>Removes high up-front costs as connecting parties are incentivized to take out a loan with low-interest payments (rather than paying the full connection cost up front).</p> <p>Locational price signals intact.</p> <p>Easy to understand and administer.</p> <p>Reduces incentive to choose low-interest debt and can cause inflation of interest rate by debtors.</p>
Targeted	Flat charge	Same connection charge for all new residential customers. Indirectly targets new customers with connection costs above average.	<p>Removes connection barriers to those with the highest costs and thus the largest barriers.</p> <p>The flat charge can subsidize all customers if it is set low enough (i.e., if it is not simply set at the level of average cost).</p> <p>Simultaneously removes locational price signals.</p> <p>Highly simplistic.</p> <p>Poor targeting.</p>
	Administrative selection	Subsidies based on geographical discrimination, means testing, etc. Directly targets new customers meeting the requirements. Can include <i>developer charges</i> .	<p>More accurate targeting, but not necessarily perfect.</p> <p>Requires costly administration.</p>

Source: World Bank 2019; Irish Water 2018; Ofgem 2003.

donor providing the subsidy. Further, there is a distortion in locational pricing. That is, connecting customers do not seek to connect to the network at a location with lower connection costs, which may include remote infrastructure costs to support additional capacity. This can lead to cost inefficiencies that undermine the gains achieved through economies of scale. Without cost-reflective pricing, there is also a risk of asset stranding.

A subsidized interest rate for loans to cover the up-front capital costs might allow a party to overcome the high up-front connection costs by taking out a loan if they ordinarily could not afford the full debt interest payments (box 3.5). It could therefore incentivize an increase in connections without expensive subsidies of the full cost. The approach also ensures that relative locational price signals are intact, which prevent inefficiencies associated with full subsidies. Further, the approach is simple to understand and administer. As a degree of self-selection is required in taking out such a loan there may be an element of targeting of such subsidies, as only households who face a liquidity constraint require such a loan. However, a subsidizing interest rate could diminish the incentive to choose low-interest options or could result in the inflation of interest rates by debtors, so careful policy design is required.

A flat charge is a flat connection charge for all new customers. It indirectly targets new customers whose connection costs are above average.

The subsidy removes barriers to connections for those with higher costs, and thus the highest barriers to connection. If set below the average connection charge, a flat charge can also target customers with lower-than-average costs. This approach can be credited for its simplicity. It may also be particularly effective where the cost of connecting low-income households is generally higher than connecting richer households, as low-income households could be situated in geographically difficult locations or are poorly accessible, leading to higher costs.

However, this is not always the case and if low-income households—for example, in urban or peri-urban areas—face a marginal connection cost lower than the average, such an implicit cross-subsidy could be poorly targeted. It simultaneously erodes the locational price signal and allows inefficient connections at the expense of existing customers. The indirect targeting may also fail to reach customers who merit a subsidy. For example, a large dwelling on the outskirts of a settlement would have higher connection costs than a small dwelling within the settlement, yet the former would receive greater subsidies than the latter. This subsidy also necessitates that there is a sufficiently large number of households that face a connection cost below the average and are willing to pay an above-average charge.

An administratively selected subsidy directly targets subsets of new customers, for example, households in certain neighborhoods with large

#### **BOX 3.5. Interest-Free Loans in Tangier, Morocco**

In 2007, Amendis, the utility serving Tangier, Morocco, initiated a social connection program. This offered low-income households in three zones in the city a water (and sanitation) connection at full price with interest-free credit. The credit could be paid at US\$15 a month over a three-, five-, or seven-year period, depending on the zone's distance from the grid (which determined the cost of connection).

*Source:* Devoto et al. 2012.



proportions of poor residents, households earning below a predefined income threshold, or those with a certain plot size (box 3.6). This approach is more precise than indirect flat charges. However, there is a trade-off within administrative approaches; geographical selection is cheaper but less precise than means testing. The cost here refers to the level of administrative work required for implementation.

### Subsidizing Adaptation Costs

Although these have often received little attention from utilities and policy makers in the WSS sector, these adaptation costs form a crucial complement to a piped connection. Consequently, the barriers to paying adaptation costs must be addressed in tandem with the barriers to connection charges.

Adaptation costs are simpler than connection charges as there are no remote costs, meaning assets

#### BOX 3.6. Subsidies Based on Plot Size in Hyderabad, India

In Hyderabad, India, connection charges are distinguished by the size of the plot for the property requesting connection (and individual houses are considered separate from multistory apartment buildings). Smaller properties pay lower fees, for example, a house on a plot size of less than 200 square meters (m<sup>2</sup>) pays a fixed charge of only ₹2,500, while a household on a plot of 400 m<sup>2</sup> pays a fixed charge of ₹90,000 (figure B3.6.1). The intention of this approach to subsidies is to target poorer households, under the assumption that lower-income households are on smaller plots of land, without requiring expensive means of testing or other more complicated approaches to administrative targeting.

FIGURE B3.6.1. Connection Charges Across Various Water Connection and Plot Characteristics

Size of water connection		Plot area in square meters		Connection charges	
mm	Inches	From	Up to	Fixed amount	Rate per each square meter of plot area in excess of the area in column(3) to be added to the fixed amount in column(5)
1	2	3	4	5	6
15	1/2	up to	200	Rs.2,500	Nil
		81	200	Rs.2,500	Rs.47.92
		201	300	Rs.8,250	Rs.82.50
		301	400	Rs.16,500	Rs.75.00
		401 and above		Rs.24,000	Rs.60,000
20	3/4	Up to 200		Rs.15,500	Nil
		201	400	Rs.15,500	Rs.150.00
		401 and above		Rs.45,500	Rs.75.00
25	1	Up to 400		Rs.90,000	Nil
		401 and above		Rs.90,000	Rs.90.00

Source: HMWSSB 2020; ADB 2010.

are simpler to confine to the connecting property. Again, the discussion can equivalently be framed in terms of the subsidies connecting parties receive to cover these costs. There are two key untargeted subsidies: partial subsidies and a subsidized interest rate for loans to cover adaptation costs (table 3.7). Targeted subsidies include self-selected and administratively selected subsidies. There may also be no subsidy at all. An alternative to subsidies is to adopt an approach used in the energy sector whereby energy service companies provide services to customers, typically around energy conservation, and recover the costs of these investments from the utility via on-bill financing. This approach helps households address liquidity constraints in paying adaptation costs.

Without subsidies, the connecting party is expected to pay the full cost of adapting their

property to accommodate the WSS connection. This could include full installation of bathrooms, drains, plumbing, or the installation of individual fixtures, such as toilets (World Bank 2019). A problem is that some households cannot afford these often-overlooked adaptation costs due to high up-front costs, which can produce a barrier to connecting.

In the case of partial subsidies, the cost of adaptation is partially covered through subsidies. This has most of the strengths and weaknesses of fully subsidizing the connection charge, although locational price signals are irrelevant. The cost per household is also low, representing a lower cost than subsidies for sewer networks and wastewater treatment works, which are typically ongoing over years (GIZ 2019). Furthermore, if one household can buy a toilet through subsidies, it may further encourage nearby

**TABLE 3.7. Subsidies for On-Premise Adaptation Costs**

Subsidy		Description	Evaluation
No subsidy		Connecting party must pay the full adaptation cost.	High up-front costs can produce barriers to connection, particularly in low-income countries.
Untargeted	Partial subsidies	Government pays toward the adaptation costs for all new customers who require adaptation.	Similar strengths and weaknesses as untargeted subsidies for connection charges, but locational price signals are irrelevant.
	Subsidized interest rate	Government subsidizes the interest rate for financing adaptation where new customers are using finance to cover its costs.	Subsidizing private assets may be unpopular with existing customers, policy makers, and development financiers. Postconstruction subsidies can be conditional on meeting government standards. Low implementation cost per household. Can encourage nearby houses to purchase a toilet or latrine too.
Targeted	Self-selection	Subsidies for customers providing materials/labor, or for certain service levels or technical designs. Directly targets new customers choosing these.	Similar strengths and weaknesses as untargeted subsidies for connection charges. No locational price signals. Subsidizing private assets may be unpopular with existing customers despite positive externalities of more connections.
	Administrative selection	Subsidies based on geographical discrimination, means testing, etc. Directly targets new customers meeting the requirements.	

Source: World Bank 2019.

households to get a toilet, overcoming behavioral or cultural barriers to increasing access (Rosenboom et al. 2011). Further, it can ensure that facilities are constructed in line with government standards if the subsidies are given post construction.

A key distinction from subsidizing the connection charge is that the subsidy covers private rather than public assets. Although there are positive externalities from reducing the barrier to connections associated with the subsidy, subsidizing private assets can be unpopular with the public and policy makers. Further, and perhaps linked to this negative perception, is that development financiers typically finance larger projects related to infrastructure and the behavioral change of citizens than programs involving a multitude of small transactions (GIZ 2019). However, recognition has been growing that current approaches to WSS subsidies must challenge preconceptions to overcome existing shortfalls in performance seen in practice (World Water Week 2020). Greater openness to subsidizing private assets could be part of this development process. Many of the same parallels can be drawn between interest rate subsidies for loans covering the connection charge and the adaptation costs.

As with the connection charge, administrative or self-selection can be used for targeting connecting parties for subsidies. Again, these bear similar strengths and weaknesses to their connection charge counterparts, and subsidizing private assets may prove unpopular with existing customers on the network, despite positive externalities. Due to administrative limitations in low-income countries and incomplete records of low-income residents, geographical targeting is sometimes relied upon for targeting these.

### Leveraging Nonnetworked Services

Customers with access to shared yard taps are typically either charged flat rates for unrestricted water

consumption or billed according to their water usage. Flat rates are the simplest tariff structure for shared taps as each customer household pays a fixed fee regardless of the water consumed. In its simplest form, the total amount of money required to operate and maintain the water system is equally split between the number of households using the water. Flat rates are easily applied to shared taps or community standpipes when the customers are known and feature similar consumption profiles. Flat rates, however, raise several problems as they impose a heavier burden on low-income households and do not take into account the amount of water consumed. Once it becomes clear that certain households consume considerably larger volumes of water than others, it is preferable to fit a meter and charge customers for the exact amount of water consumed.

As households are collectively responsible for paying the water bills, shared yard taps and communal standpipes face several challenges:

- *High consumption rates.* The collective water consumption of a group of households may exceed the lifeline block established by the utility and could result in families having to pay a higher average tariff than wealthier customers with a private household connection, depending on the structure of the tariff. Utilities should therefore consider the number of households served by each connection when calculating the shared water bill. Multiplying the number of households using the standpipe by the lifeline tariff allocation could be one way to prevent low-income customers from paying commercial rates.
- *Free riding.* Shared yard taps and public standpipes are not usually staffed and rely on trust and social cohesion among community members to ensure that every household pays its share of the water bill. A key issue with communal standpipes is that some

customers will pay their water bill while others may not, increasing the risk of disconnection by the utility if there is a shortfall in the payments. Disconnections penalize all customers, regardless of whether they paid their share of the bill or not. Hence, utilities need to implement solutions to avoid this outcome. One option is to create water customer associations among participating households with responsibility for payments of bills.

Public standpipes and kiosks are located in a public place and shared by several households individually paying the bill. This option is most appropriate for densely populated low-income communities with small infrastructure investment requirements and can be efficiently managed through prepayment mechanisms. The initial versions were prepayment standpipes, which have recently come to be referred to as water ATMs. Prepayment mechanisms are implemented through customers topping up electric card systems or tokens (increasingly through mobile phone transactions), and then drawing whatever quantity of water they would like to buy at any point in time.

Recognizing the affordability constraints of customers relying on communal standpipes and water taps, utilities typically set formal/wholesale standpipe prices below the unit price applied to private household connections. As most households living in rural and peri-urban areas fall within the lower-income segment of the population, standpipe prices are usually subsidized to allow these customers to benefit from affordable water services. However, evidence from several countries shows that the prices charged by standpipes or kiosk operators can be considerably higher than networked water supply, even higher than the tariff paid by low-consumption piped customers.

While numerous utilities and governments are increasingly trying to set a formal retail price for standpipe water, standpipe managers tend to determine the final “informal” tariff paid by customers.

The underlying cause of high standpipe water prices therefore lies with the price-setting agent operating the standpipe or kiosk, who may be a private individual or community member under a delegated management model. In standpipes and kiosks managed by utility staff, there is no price-setting agent and the tariff paid by customers is more likely to match the formal retail price. Meanwhile, where kiosks and standpipes are not directly regulated by the utility or regulatory agency, customers are likely to incur a disproportionately higher tariff, due to the lack of resources and monitoring capacity of local authorities.

Hence, standpipes and kiosks should ideally be operated by utility staff or by private operators with light-handed regulation to close the gap between formal and informal tariffs and ensure affordable access to water supply among poor households in off-grid areas. Utilities can absorb the costs of supply through economies of scale and charge lower tariffs than private operators, ensuring that the cross-subsidy applied for nonnetworked services targets poor customers in informal settlements. Alternatively, private operators can supply these services subject to increased light-handed regulation to prevent standpipe attendants and kiosk managers from applying a markup on formal tariffs. A third option gaining greater traction and on course to become the dominant model in the future is fitting prepaid meters or water ATMs as a means of avoiding the markups charged by intermediaries to pass on additional costs to households and absorb the costs within the overall costs of the utility.

### Mobile Vendors

Many people in villages, small towns, and rural areas throughout the developing world are served by vendors taking the water from available sources and delivering it in containers (jerry cans or storage tanks) to households. This category of nonnetworked water service provision includes pushcarts, animal-drawn

carts, and tanker trucks. Regardless of the delivery method, the distribution of water by mobile vending remains quite expensive when compared to alternative service providers, due to the cost of delivering water directly to households. Prices for water vending can be set competitively or determined at various points in the vending system. For example, distributing vendors may buy water from wholesale vendors with monopoly power. On the other hand, wholesale vendors may compete freely unless distributing vendors organize themselves to control prices.

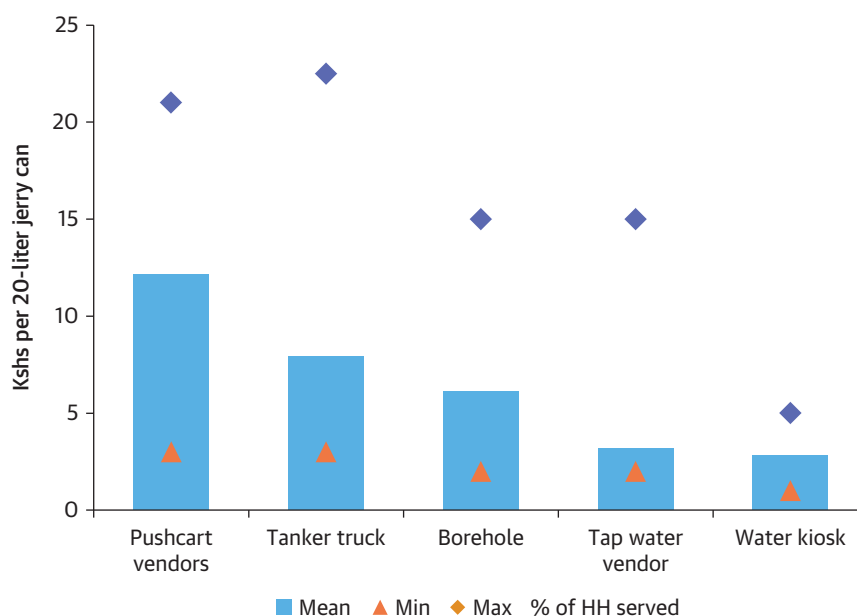
Data from the Africa Infrastructure Country Diagnostic (AICD 2007) WSS database show that there is little difference in the tariff charged by different types of mobile vendors (water carters and tankers) in Sub-Saharan Africa, possibly due to the strong competition between the two categories of service providers in many areas lacking access to private connections to the network. Water tariffs vary considerably across cities and countries, depending on

the extent to which customers rely on alternative water providers.

Another survey of water tariffs applied by different types of mobile vendors was carried out in 2010 among households and small-scale service providers in peri-urban and urban areas of Nairobi (Kenya). The water supply system in Nairobi involves a broad range of service providers. In addition to the water utility supplying individual households as well as fixed-point sources through piped connections, water carters and tanker trucks serve households on the outskirts of the city. Details on the price-setting strategy of different service providers show the importance of various factors when setting tariffs. The average water tariff across vendors and the range of water unit prices charged by service providers (as well as the share of households they serve) are illustrated in figure 3.3.

Pushcart vendors and tanker trucks charge the highest average tariffs for water and exhibit the

**FIGURE 3.3. Average Water Pricing across Vendors in Nairobi, Kenya**



Source: Original elaboration, based on UNDP (2011).  
 Note: HH = households; Kshs = Kenyan shillings.



highest degree of price differentiation. This suggests that despite setting their tariffs based on the price charged by competitors, pushcart vendors also collude on prices. Approximately one-third of carters declared setting prices based on a cost markup (supporting the hypothesis of price collusion). Critically, the Nairobi survey also found that low-income households buying water from pushcart vendors pay over 30 times the tariff charged by the utility through a piped connection.

The higher water tariffs likely reflect the wider range of water resources mobile vendors rely on and their discretion in setting prices. The large price variance also captures the lack of regulation of this type of small-scale water provider, which remains largely unregulated in terms of tariffs and service quality. Water kiosks and tap vendors, on the other hand, offer lower tariffs on average, reflecting the higher degree of compliance with official water tariffs, particularly in the case of licensed kiosks buying water at a subsidized bulk rate from the utility. Mobile vendors tend to charge higher tariffs given that their main reason for entering the market is often unemployment. Most tanker trucks and carters start operations because they need a source of income and mobile vending is perceived as a profitable activity. In contrast, tap vendors and kiosks are mainly driven by community needs to enter the business.

Interventions aimed at removing mobile vendors from the market are likely to push these operators back into unemployment. This is expected to further undermine the precarious livelihoods of already vulnerable households. Pro-poor interventions should therefore aim to reduce the poverty premium paid by customers while considering service providers. While mobile vendors should be granted some form of legal recognition, applying very stringent regulations is likely to drive them out of business. This will not only push many service operators into unemployment but also deprive informal dwellers of access in a context where the main utility may not be able to fill that gap. Light-handed regulation is a means to achieve this:

- A potential strategy to formalize independent providers was adopted in Colombia (see box 10 of background paper 13, listed in appendix A).
- Without a regulatory agency with legal powers, customers could alternatively be mobilized to insist on lower water tariffs or municipalities could publish the water prices charged by different vendors to ensure fair pricing and reduce markups.

Box 3.7 summarizes best practices for regulating informal water providers, as observed in Colombia and Peru.

#### **BOX 3.7. Differentiated Regulation of Informal Water Providers in Colombia and Peru**

In the 1990s, Colombia introduced a comprehensive sector policy of decentralization to increase water and sanitation investments through targeted transfers to municipalities, improving service quality and efficiency by promoting private sector participation where public utilities were not performing well, establishing autonomous regulatory agencies at the national level, increasing cost recovery, and protecting the poorest through cross-subsidies in the form of area-based tariffs.

**BOX 3.7. continued**

There are several different delivery models available for WSS provision in Colombia. Service providers that wish to be considered “public service providers” have to follow a registration procedure at the Superintendency of Public Services (Superintendencia de Servicios Públicos Domiciliarios, SSPD), monitoring and enforcing the performance of WSS operators. Nevertheless, the population outside small towns is too dispersed to make centralized water supply economically viable, and many organizations still provide WSS services informally without having registered at the SSPD.

**TABLE B3.7.1. Tariff Differentiation by Provider Size in Colombia**

Large providers				Small providers	
The tariff methodology is based on a “building block” approach with operation and maintenance costs set based on target levels to incentivize efficiency improvements and capital costs passed through based on actual expenditures to minimize the risk to service operators.				The tariff methodology applying to small providers serving less than 5,000 connections in urban areas and rural operators aims to ensure affordability by making provisions for government contributions to the investment cost, rather than setting a maximum tariff.	
Tariff				Tariff	
Fixed charge per user	Consumption charges			User	Government (national & local contributions)
Administrative costs	OPEX	CAPEX	Environmental cost	Administration, O&M	CAPEX

Note: CAPEX = capital expenditure; O&M = operation and maintenance; OPEX = operating expenditure.

To address the issues of informal service provision, and minimize the number of nonregistered providers, the SSPD issued a regulation defining the procedures for the subscription, update, and cancellation of WSS providers in the national register, splitting service providers between:

- **Large providers** which are subject to regulation and may therefore only charge regulated tariffs for the provision of WSS services.
- **Small providers** which are subject to a different tariff methodology as of 2014. They can be registered with the SSPD or unregistered. In the latter case, they are considered informal providers as they do not follow the legislation or the norms related to the provision of WSS services.

Regulating the rural and peri-urban WSS sector remains a big challenge in many Latin American countries. Throughout the past 20 years, the heavily decentralized structure of the WSS sector in Colombia and the distinction between large- and small-scale service providers has proved a useful source of knowledge for many other countries (Baskovich 2018).

In **Peru**, a recent reform in the WSS legal framework has extended the regulatory role of the Superintendence of Water Supply and Sanitation Services of Peru (SUNASS) beyond urban areas to include small towns and rural communities. In the attempt to develop a regulatory framework for small and rural water operators, SUNASS has been exploring different regulatory models to gain key insights into what tariffs should be charged in these cases.

### 3.4 Simulating the Effects of Different Tariff Structures on Efficiency and Affordability

One of the most pressing challenges faced by water utilities, particularly in developing economies, is how to make water tariffs affordable for low-income residential customers without inadvertently also subsidizing other customer categories with greater ability to pay. For example, under an IBT tariff, all residential customers typically receive the first block of water consumption at a low rate, regardless of income. When some customers are subsidized unnecessarily, the subsidy “burden” is higher, and assuming there are no external sources to fund the subsidy, either cost recovery is compromised or

other customers, for example, nonresidential have to pay a significantly higher tariff to fund the subsidy. The more targeted tariffs are, the more affordability can be addressed without compromising cost recovery and efficiency.

A simulation<sup>1</sup> was designed to test a tariff structure’s ability to achieve affordability without compromising cost recovery and with minimal distortions to economic efficiency (figure 3.4). Two policy objectives were held constant—cost recovery and affordability—while tariff levels were varied to achieve the best economic efficiency. Theoretically, the tariff structures that result in the least distortion to economic efficiency will be the most targeted and are therefore optimal.

**FIGURE 3.4. Efficiency Ranking of Core Tariff Structures and Complements**

Tariff objective	CORE TARIFF STRUCTURES						TARIFF COMPLEMENTS			
	Flat rate	One-block	Two-part tariffs	IBT	Jump tariff (VDT)	DBT	TOU / Dynamic pricing	Location-based pricing	Over consumption penalties	Affordability measures
<b>PRIMARY OBJECTIVES</b>										
Cost recovery	2	3	4	2	3	2	4	3	3	2
Economic efficiency	1	2	4	2	3	2	4	3	3	1
Affordability and equity	2	2	3	4	4	1	2	1	1	4
<b>SECONDARY OBJECTIVES</b>										
Environmental sustainability	1	2	2	3	3	1	4	3	4	2
Simplicity and ease of implementation	4	3	3	2	2	2	1	3	3	2
Transparency	1	4	4	2	2	2	4	3	3	2
Acceptability	3	4	4	2	2	1	3	1	3	2
Financial stability	4	2	3	2	2	2	4	3	4	2

Note: IBT = increasing block tariff; DBT = decreasing block tariff; TOU = time of use; VDT = volume-differentiated tariff. Full methodological details are included in background paper 12, listed in appendix A.

The appropriateness of tariff structures depends very much on the country- and utility-specific circumstances. Nonetheless, this analysis illustrates the trade-offs inherent to different tariff structures—some are better than others at improving affordability without too much distortion to efficient price signals. In summary:

- When affordability concerns do not pose significant constraints, two-part tariffs send the most efficient pricing signals because they can reflect both fixed and variable costs of supply. However, a large proportion of water supply costs are fixed and having a high fixed charge often does jeopardize affordability. The more utilities shift recovery of fixed costs to volumetric charges, the less efficient the tariffs become and jump tariffs start to become a more efficient option.
- When affordability is challenging, jump tariffs (also known as VDTs) are preferable to IBTs because they cross-subsidize in a more targeted manner and therefore send more efficient price signals. Because jump tariffs do not subsidize the first consumption blocks of high-consumption customers (as IBTs do), the tariffs for high-consumption blocks do not need to be as high and therefore can be closer to efficient levels.
- Despite jump tariffs being a more effective means of cross-subsidizing, IBTs are still commonly used, perhaps because they are perceived as fairer. IBTs also have the advantage of not leading to a large jump in the water bill when a customer moves from the upper reaches of one block into the lower reaches of another.
- DBTs are useful in cases where affordability is not a concern but the utility is unwilling to set high fixed charges, perhaps because they are unpopular with customers. DBTs capture the same economies of scale effect (of average costs coming down

as fixed costs are spread across increased consumption), but are rarely applied because they make tariffs less affordable for low-consumption customers and do not encourage water conservation.

- One-block tariffs (without fixed charges) are generally worse than two-part tariffs, because they do a poorer job reflecting the underlying cost of supply.
- Flat rate tariffs (fixed charge only) do nothing to incentivize efficient water use and make affordability challenging and should therefore be avoided.

### 3.5 Conclusions

Tariffs serve multiple purposes, such as allocating the costs of service among customers and creating incentives to affect the production and improve the use of water. Tariff design therefore inevitably entails trade-offs between different, often conflicting, policy objectives. Such trade-offs can potentially be mitigated through the application of tariff complements. These include affordability measures to target lower-income households or efficiency concerns to ensure that customers are charged according to their underlying costs of supply. The challenge of water tariff design therefore consists of achieving an appropriate compromise.

Tariff complements can be used alongside the core structures to target specific objectives. Dynamic tariffs that reflect the real-time cost of supply are the ultimate means of encouraging economic efficiency. They are particularly useful when costs vary significantly by time and therefore provide an incentive for large consumers to shift water consumption to off-peak periods. However, they are very costly and complex to implement as they require smart metering

technologies. But they are expected to be increasingly used in the water sector, as seen in the electricity sector in recent years.

Price-based approaches to manage water demand offer multiple benefits in terms of ease of implementation, monitoring, and enforcement. However, household demand is not highly responsive to changes in water tariffs in many countries. At the same time, required tariff increases to induce sufficient reduction in water consumption might be too high to be politically feasible. Therefore, pricing approaches to water demand management should be complemented by nonprice interventions to promote water savings among households, ranging from command and control approaches, water-efficient devices, or informational and awareness-raising campaigns.

As the success of water conservation plans in reducing water demand has often been achieved by the combination of multiple price and nonprice interventions, an integrated approach to water demand management with better pricing schedules that reflect the true cost of water and promote water savings among high-volume customers as well as nonpricing incentives to install water-efficient fixtures and reduce nonessential water use is recommended. This has more recently come to the fore in light of the significant impact the COVID-19 pandemic has had on household water demand.

Using the structure of water tariffs to address poverty is a blunt instrument. Economic theory and practical experience in cross-subsidy systems of different forms lead to the conclusion that water tariffs should be designed to secure financing for sustainable service provision, while affordability is best met through targeted social measures. This is easier to achieve in developed countries, which have established social welfare systems through which the target beneficiaries are already defined. In developing

economies, the proportion of poor customers is much higher, and targeting them is problematic. Ideally, this should not be made the responsibility of the water utilities, whose core business is supplying water rather than alleviating poverty.

Having tariffs that focus on the sustainable financing of utilities, with affordability being addressed through nontariff interventions, is relatively rare. For a variety of reasons, including the inherently political nature of the tariff-setting process, tariff structures that claim to be pro-poor will continue to be designed and applied. The most common structure is an IBT with the first block being a heavily subsidized “lifeline” centered on a minimum amount of water required for basic levels of water consumption. The free essential minimum model is a variant of this.

Addressing poverty through the provision of water therefore requires finding ways of ensuring that the majority of low-income households do gain access to water that is properly treated by the utility. Reduced tariffs for intermediate technological solutions have been shown to work. An alternative solution is to spread the cost of the connection over a longer period. This can be achieved through the utility providing an indirect loan to the household and recovering the cost over a longer period or through a third-party microfinance organization. This is particularly effective in situations where households may be able to afford the connection but struggle to make a large up-front payment. These measures can also be combined with subsidies (e.g., subsidized interest rates) to reduce the cost to the household while reducing the overall level of subsidies required.

Finally, utilities may seek to reduce the cost of connections. This can be done through offering alternative, lower-cost solutions, including connections shared by several households. Such measures may



be necessary to ensure that access to piped water can be achieved in rapidly growing urban settlements. If a universal service obligation requires a utility to provide connections to all households and the connection barriers are overcome through a selection of the above measures, economies of scale can be achieved, lowering average connection costs.

Informal service providers often charge higher tariffs, severely penalizing customers in off-grid areas. Meanwhile, it is the poorer segments of society that are forced to rely on nonnetworked services. These customers typically live below the poverty line and

are therefore disproportionately affected by unregulated pricing of water services and the poverty premium applied by informal water service providers. Although most water government strategies include nonnetworked water supply, subsidies are primarily targeted at networked services, benefitting the wealthiest customers at the expense of sustainable service provision.

### Note

1. Full methodological details are included in background paper 12, listed in appendix A.





## CHAPTER 4

# Regulatory Levers to Control Pricing and Increase Efficiency

No discussion of tariff design would be complete without considering the role of regulation. Given the potential for natural monopolies and significance of affordability, the case for regulation is not difficult to make. Tariff regulation does not exist in a vacuum but forms part of the overall regulatory environment in the water sector that pertains to service standards for water quantity and quality, accountability and governance, and regulatory standards for performance. Tariffs are directly affected by price or revenue controls and indirectly affected by regulatory standards. For instance, regarding service quality and quantity, a discussion of prices and revenues naturally leads to a conversation on incentivizing cost efficiency and inducing cost cutting through regulation.

There is no “one-size-fits-all” solution for the economic regulation of WSS services, and importing regulatory models designed for other countries is seldom a wise option. In this context regulatory arrangements should be suited to the specific needs of the country. But first, the desired objectives should be defined and the potential contribution of economic regulation to the overall sector accountability framework identified. Next, the regulatory functions and choice of legal instruments and organizations within which to embed them should be identified (McPhail, Locussol, and Perry 2012).

This chapter begins by outlining the rationale for regulation before entering a discussion on the relationship between price controls and revenue. The chapter then discusses the regulation of tariffs and services and the four primary mechanisms through which a comprehensive regulatory regime can be achieved: command and control, suasive instruments, economic instruments, and customer empowerment. Finally, the chapter concludes with a discussion on the importance of transparency, and offers practical solutions to realize this goal.

## 4.1 Rationale for Regulation

In competitive markets, firms compete to sell their products and services. A key parameter upon which customers base their purchase decision is price, resulting in downward pressure on a firm's prices toward the short-run marginal cost (SRMC), inclusive of a competitive profit margin. Since water supply networks exhibit economies of scope and scale (primarily due to high start-up costs), and average costs typically are higher than marginal costs, it is more efficient for a single utility to provide all services within a defined area, creating natural monopolies. This can lead to situations where the monopoly adopts pricing strategies that can lead to departures from allocative efficiency. For instance, this market power allows utilities to sell at a price above the SRMC with a supernormal profit margin, resulting in network tariffs that are "too high." At the other extreme, under a monopoly, those utilities driven only by social welfare maximization motives would incur losses if they follow marginal cost pricing since they will not be able to cover the cost of up-front

fixed investments. A third situation is where the existence of market power also creates the opportunity for utilities to price some services below and others above cost to prevent competition, through predatory pricing, thus creating unfair competition for existing competitors and barriers to new entrants. Regulation is a policy intervention that aims to promote sector goals in the public interest—balancing the competing interests of the various stakeholders to generate second-best outcomes. Economic regulation refers to the "setting, monitoring, enforcement, and change in the allowed tariffs and service standards for utilities" to affect the behavior of consumers and utilities, eventually leading to more efficient outcomes (Groom et al. 2006).

Determining what constitutes fair or competitive costs is not straightforward, as there is information asymmetry between the utility and regulator on how efficiently the utility is operating. In a competitive setting, firms naturally compete to lower their costs in order to lower their prices, or ease of entry allows more competitors to join the market and the exit of

**FIGURE 4.1. Rationale for Regulation**



the higher-cost ones. Water utilities do not face this pressure due to their monopolistic characteristics. This can lead to overall costs far exceeding competitive costs, known as “X-inefficiency.” Another primary role of regulators is thus to incentivize utilities to cut their costs even without the regulator necessarily fully knowing the utility’s efficient costs, due to information asymmetries.

In markets with many sellers, customers also base their purchase decisions on quality of service, resulting in pressure on firms to offer a better quality of service than their competitors (or to offer lower prices for lower quality). This situation may be relevant in those segments of the water market where informal providers tend to operate. However, in many cases, the customer is limited to a single water provider. Without adequate regulation, the market power of the utility allows it to reduce the quality of service to customers and increase its profits and extract rent from customers. Thus, a role of the regulatory framework is to account for this perverse incentive and ensure quality of service commensurate with customer needs and wants. This problem is also compounded by the pervasive information failures in the sector, for example, the quality of drinking water is not readily discernible and therefore consumers might lack the capacity to determine the required standard.

In providing services, utilities also produce environmental and opportunity costs. When utilities do not provide clean water devoid of chemical or biological contaminants, customers face negative externalities that tend to be costly for them as well as the environment. Such costs include an increase in the cost of water treatment, health costs, and productivity losses associated with waterborne diseases, as well as a reduction in fish populations, among others.

A second area of increasing concern in the present context of climate change and climate variability is the need for regulators to ensure that water scarcity is reflected in prices, especially given the service provider’s limited incentive to accomplish this. Furthermore, in the absence of regulation, opportunity costs associated with competing water demands are generally not properly addressed. For example, since supplies are finite, the abstraction of irrigation water means the same water cannot be used for drinking. In a regulatory vacuum, the monopolist is free to impose these costs on third parties to maximize profits at the expense of the best interests of the wider sector and beyond.

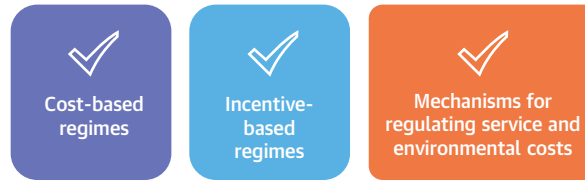
## 4.2 Controlling Price and Revenue

The overarching administrative arrangement governing price controls can take various forms that differ across countries, usually according to their legal context. The most common administrative arrangements for regulation include regulation by an agency or a municipality, or a contract between the government and utility. Two regulatory instruments are used in mitigating monopoly pricing under these regimens: price (tariff) controls and control of revenue earned from prices (tariffs).

Within each of the administrative arrangements, the price or revenue control mechanism must specify how often the control is updated and whether the control should be determined using the utility’s actual costs or forecasted costs. Based on these factors, the underlying pricing schemes can be split into distinct regulatory regimes, including rate of return (ROR), cost plus, revenue cap, and price cap. They are often combined in practice. While these regimes usually refer to regulation by agency, they can also be used to describe the terms of regulation in contracts.



FIGURE 4.2. Controlling Price and Revenue



These regimes can be further split into incentive- and cost-based regimes.

*Cost-based regimes.* These regimes, including ROR and cost-plus approaches, attempt to equate revenue with cost. While this minimizes the utility’s financial risk by preventing costs from exceeding revenues for prolonged periods, there is limited incentive for the utility to operate cost efficiently, although “regulatory lag” does allow some degree of incentive. This is exacerbated by information asymmetry between the utility and regulator on efficiency and the inherent incentive to inflate costs in the cost-plus regime to earn a higher return, such as through “gold-plating” investments (Averch and Johnson 1962). While cost-based regimes may be beneficial to ensure financial security in the short term, the resulting inefficiencies can jeopardize long-term financial sustainability, since efficiency is essential for ensuring cost recovery. Further, cost-based regimes can lead to a greater unpredictability in price, as cost-plus regimes renew the tariffs regularly, while ROR regimes set them at unspecified intervals. Despite these shortcomings, cost-based regimes tend to be simpler methodologically, making them easier to implement in newly established regulators.

*Incentive-based regimes.* These regimes, including revenue and price caps, attempt to overcome information asymmetry on utility efficiency by encouraging the utility to cut its own costs while improving performance. They set a budget constraint, in this case the allowed revenue, over a predetermined time interval. If the business can outperform the

constraint by cutting costs, it may keep all or part of the difference as a reward. This incentive can lead to greater efficiency. Incentive-based regimes can trade off the cost-cutting incentive and the financial risk by adjusting the duration of the regulatory period and/or by calibrating the incentive mechanisms (e.g., by allowing the utility to retain savings for set periods of time that may stretch across regulatory periods). A benefit of incentive-based regimes is that further direct incentives can be built into the individual elements of the framework, such as efficiency factors.

### 4.3 Incentivizing Cost Efficiency

While a broad incentive-based regime can encourage cost reduction, incentives can be placed in the details of regulatory mechanisms to prevent X-inefficiency and encourage cost minimization and innovation. Furthermore, the regulatory mechanism must be designed with care to ensure that it does not distort incentives and encourage inefficient behavior. These ideas are discussed in the context of calculating O&M costs, the regulatory asset base (RAB), and in using efficiency factors.

#### Efficiency Factors

A benefit of incentive-based regimes is that the regulator can incentivize efficiency improvements over time. There are two components of efficiency that regulators are usually interested in:

- *Relative static efficiency (“catch-up”).* The difference between a utility’s current level of efficiency

and that represented by the most efficient firms at this point in time (defined as those firms lying on the “efficiency frontier”).

- *Productivity growth or dynamic efficiency (“frontier shift”).* This represents the expected movement of the efficiency frontier over time. Even the most currently efficient firms will have scope to continue to improve efficiency over time as new technologies and work practices become available.

These efficiency improvements can either be assumed at the general level of total costs or at a more granular level. An efficiency factor at the general level is known as an X-efficiency factor and typically captures productivity growth. In a price- or revenue-cap regime, the cap is usually allowed to grow in line with CPI-X, where CPI is the inflation rate (consumer price index), and X is the efficiency factor. At a more granular level, the regulator can use an O&M efficiency factor that assumes efficiency improvements in O&M costs over time. The regulator could be even more granular and assume improvement in particular O&M costs, for example, by assuming a reduction in nonrevenue water (NRW) in each year. This may take the form of informed decisions about reasonable reductions that differ in their proportional reduction in each year.

### Allocation of Risk

In a cost-based regime, there is generally a low financial risk to utilities since allowed revenues are either frequently reset or can be reset quickly if costs exceed revenues. However, there is a risk for the utility that regulators may disallow expenditure ex post (if it is considered imprudent, that is, unnecessary or inefficient).

In an incentive-based regime with multiyear tariff reviews, there is a higher level of financial risk to utilities since costs could end up exceeding revenues throughout the regulatory period, resulting in the

accumulation of debt. Conversely, costs could be reduced below expectations through efficiency measures, resulting in accumulation of profit, which provides the cost-cutting incentive.

The risk can be reduced through indexation to inflation or currency fluctuations. There are different indices for inflation across countries. What precisely is indexed also matters and differs across regulatory regimes. For example, in a revenue- or price-cap regime, the cap can be adjusted in line with CPI-X or RPI-X, where the CPI or retail price index (RPI) are inflation indices and X is an X-efficiency factor. Alternatively, individual cost items can be indexed to inflation. In this sense, price reviews, where the tariff is reset, represent “noncore” changes in the tariff (i.e., changes for technical, political, and other reasons), while annual adjustments in the tariff between these regulatory reviews represent “core” changes in the tariff (i.e., resulting from core inflation or long-term price trends) (Borja-Vega 2020). Studies have found that this noncore change in the tariff was over double the core change on average globally between 2016 and 2017 (Frankson 2017).

### 4.4 Mechanisms for Regulating Service and Environmental Costs

Tariff and nontariff regulatory mechanisms can be used to incentivize utilities to cut costs through efficiency improvement. Some of the nontariff mechanisms, such as service coverage and service quality standards, are often used to exert pressure on utilities to improve their efficiency. Further, nontariff regulatory mechanisms can also encourage the internalization of environmental costs in the decision-making of a water utility.

There are three primary mechanisms within the gamut of tariff and nontariff regulation that have been utilized in isolation or in combination for regulating the standard of service and environmental costs (O’Connor 1999; IPART 2001) (table 4.1):

**TABLE 4.1. Advantages and Disadvantages of Tariff and Nontariff Mechanisms to Regulate Services and Costs**

Service		Environmental costs	
Advantages	Disadvantages	Advantages	Disadvantages
Command and control (C&C)			
<ul style="list-style-type: none"> <li>• Observable and quantifiable, thus easy to monitor and enforce</li> <li>• Effective for guaranteeing minimum technical requirements, e.g., chemical quality</li> </ul>	<ul style="list-style-type: none"> <li>• Ineffective at achieving anything above minimum requirements</li> <li>• May create compliance mentality, e.g., connecting least expensive customers to achieve coverage targets</li> <li>• Difficult to decide between trade-offs in price and level of service, therefore less appropriate for regulating peripheral aspects, e.g., customer service standards</li> <li>• Efficient design of fine system requires detailed knowledge of production costs and customer preferences</li> <li>• Fine systems can be highly complex</li> <li>• Cost of complying may be higher than noncompliance (Gunningham and Sinclair 2002)</li> <li>• Threat of fines ineffective at controlling state-owned utilities</li> </ul>	<ul style="list-style-type: none"> <li>• Prescribed in law or as part of license conditions, thus licensee is obliged to internalize costs</li> <li>• Quantifiable and verifiable standards are relatively easy to enforce</li> </ul>	<ul style="list-style-type: none"> <li>• Without adequate enforcement capacity, license conditions can be easily broken, e.g., research in Australia has shown that noncompliance in water abstraction typically occurs when there is low probability of successful prosecution or small penalties (Greiner et al. 2016).</li> </ul>
Suasive instruments			
<ul style="list-style-type: none"> <li>• Creates transparency</li> <li>• Reputational incentive to perform well</li> <li>• Theory suggests utility managers may have underlying intrinsic incentive to achieve good outcomes (ECA 2017b)</li> <li>• Considered as a stepping stone to economic instruments (EIs)</li> </ul>	<ul style="list-style-type: none"> <li>• Utilities are often motivated more by vested economic and political interests than pro-poor outcomes (Heymans et al. 2016)</li> <li>• Without financial incentive may lack teeth as utilities may not pursue high-cost improvements</li> <li>• May not be appropriate for achieving Sustainable Development Goals in a timely fashion</li> </ul>	<ul style="list-style-type: none"> <li>• Light handed (often voluntary) and market oriented</li> <li>• Can be placed on scale of increasing coercion (Harrison 1998), e.g., from raising awareness to voluntary codes and agreements to flexible enforcement</li> <li>• Initially perceived to have greater cost-effectiveness than C&amp;C approaches, but this concept has been challenged in recent years</li> </ul>	<ul style="list-style-type: none"> <li>• Studies indicate that suasive instruments work best under threat of regulation (Antweiler and Harrison 2007).</li> </ul>

*table continues next page*

TABLE 4.1. continued

Service		Environmental costs	
Advantages	Disadvantages	Advantages	Disadvantages
Economic instruments (EIs)			
<ul style="list-style-type: none"> <li>• Step up from simple fines</li> <li>• Light handed</li> <li>• Efficient trade-offs</li> <li>• Can be adopted to motivate progression toward the SDGs</li> <li>• Minimal regulatory burden</li> </ul>	<p>In the case of customer compensation:</p> <ul style="list-style-type: none"> <li>• Only workable where failures for specific customers can be identified and verified</li> <li>• Level of compensation is arbitrary and inadequate to counter the cost of disruption</li> </ul> <p>In case of tying outcomes to revenues:</p> <ul style="list-style-type: none"> <li>• Only viable when customers accept trade-offs between price and quality of service</li> <li>• In the context of high-stake key performance indicators, e.g., time spent collecting water, small pecuniary incentives can potentially undermine or erode any intrinsic incentives, so it is important to ensure that rewards or penalties reflect stakes</li> <li>• Weighing trade-offs often considered subjective</li> </ul>	<ul style="list-style-type: none"> <li>• Prices and charges can be used to raise revenue to cover cost associated with externality or incentivize behavior to reduce cause of externality. In this cost-incentive case, money raised from financial instruments can be used to address environmental costs, e.g., irrigation system operation and maintenance and water resource management</li> <li>• Example of EIs include: sewerage charges, effluent charges (e.g., based on volumes of biochemical oxygen demand, chemical oxygen demand, heavy metals, etc.), and tradable pollution permits (e.g., maximum permissible amount of pollutant)</li> <li>• In the case of incentive-based instruments, such as tradable abstraction permits, a cap is placed on abstractions and the price of the permit is naturally determined by the market, making pricing efficient</li> </ul>	<ul style="list-style-type: none"> <li>• Designing optimal effluent charge can be challenging, since it requires detailed information on prevalence of pollutant in area covered, and requires information on quantity of pollutant discharged.</li> <li>• Since some pollutants are typically associated with one another, permits for the entire set of associated pollutants would be required, in contrast to effluent charges.</li> <li>• Compared to abstraction permits, the location of the discharge heavily determines the environmental consequence of a pollution permit.</li> </ul>

- *Command and control (C&C)*. The historically standard approach to reduce certain undesirable behaviors of monopolists, including the achievement of service goals, has been C&C tools, in which certain requirements are prescribed in the license terms. However, it is difficult to design efficient C&C instruments when the underlying costs incurred by the utility are unknown and would only work when the expected benefits from compliance are more than the expected costs.

- *Suasive instruments*. A *suasive* approach is based on persuasion and voluntary compliance, and monitoring and reporting of performance. *Suasive* instruments that rely on voluntary compliance, in particular to address environmental concerns, have been used in many countries where the role of media and public response is relatively strong. Recently, this discussion has been complemented by a circular economy narrative. While untreated water expelled into the

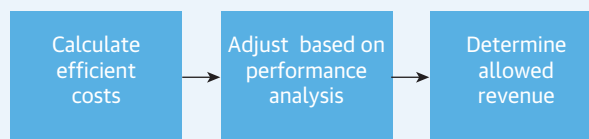
#### BOX 4.1. Key Performance Indicators in Albania

The allowed revenue for each water supply and sanitation utility is calculated according to three key steps (see figure B4.1.1). First, the costs are analyzed and benchmarked against comparable utilities. Second, an analysis of the performance of the utility is undertaken by observing key performance indicators (KPIs) related to cost efficiency, quality of service, and prosocial outcomes. Third, the allowed revenue is determined by adjusting the calculated fair costs based on this performance analysis, using rewards and penalties.

To analyze performance, the regulator looks at 11 KPIs: (i) nonrevenue water (administrative losses, technical losses); (ii) the metering ratio (household, nonhousehold); (iii) water quality (level of chlorine residue, coliform level); (iv) water supply hours (service hours); (v) efficient energy use (three groups based on the service provided); (vi) staff efficiency (staff/1,000 connections); (vii) water supply coverage; (viii) sewerage coverage; (ix) regulatory perception; (x) special efforts and measures to improve efficiency, service, and performance; and (xi) the collection rate.

To tie these KPIs to allowed revenue, the first 10 KPIs receive points that may reach a total minimum of -150 across the 9 KPIs or a total maximum of +150. The points are awarded according to the achievement of agreed objectives. The points are converted into rewards or penalties when adjusting the total costs into allowed revenues. These rewards and penalties are capped at +/-5 percent for some companies where operation and maintenance cost recovery has not yet been achieved, while they are capped at +/-10 percent for companies where it has already been achieved. Albania's approach thus represents a good example of benchmarking efficiency to determine fair costs and incentivizing good quality of service and prosocial outcomes without placing utilities at undue financial risk.

FIGURE B4.1.1. Determining Utility Revenue



Source: Water Regulatory Authority 2015.

environment imposes a cost on third parties, it also represents a lost opportunity to the service provider to sell nutrients from treating the water, from reusing treated water for human consumption or irrigation, and a lost opportunity for generating energy.

- *Economic instruments (EIs)*. An approach in more recent decades has been the adoption of EIs, which

rely on financial incentives rather than laws and regulations alone or voluntary compliance. Albania (box 4.1) provides a good example of a regulatory mechanism that ties KPIs to allowed revenues (EIs). Common EIs for addressing the cost of pollution include sewerage charges, effluent charges, and tradable pollution permits (table 4.1). Typically, tariff regulations fall under



the class of economic instruments of regulation, which can affect the service-provision-related decisions of the utilities as well as the consumption decisions of customers. Water pricing, sewerage charges, and water trading are various types of EIs used in the water sector.

Measures to empower customers, especially those within the remit of larger utilities, can be used to complement regulatory mechanisms. This has a dual purpose. First, it can enhance the protection of customers under existing rules. For example, bills of rights for customers can be introduced (as in the United Kingdom and the United States), or customers can be empowered through education on their options of remedy. Second, it can provide customers with a voice that can guide the formation of rules, for example, through the representation of various customer groups in advisory boards or customer councils. The latter is essential for the effective formulation of EIs as the regulatory framework can effectively gauge whether, and if so how, customers wish to trade off aspects of service quality for price or access. Thus, it can be used to gauge how citizens wish to trade off the speed of increasing access to WSS services against the level of service provided. This compromise approach, which relies on community engagement, could be important for meeting SDG targets 6.1 and 6.2 within the tight deadlines that have been set out.

#### 4.5 Rationale for Transparency

Information asymmetry that exists between the utility and the regulator is exacerbated by difficulties in estimating the utility's actual costs or level of efficiency relative to other utilities. This gives the utility a bargaining advantage that can lead to high levels of inefficiency, inflated costs, and poor quality of service.

The same problem extends to customers who rarely know the utility's true efficiency and who are often excluded from accessing information on a utility's costs and thus the extent of subsidization. They may also lack information on the procedures used to calculate the tariff.

Beyond customer awareness of the importance of cost recovery, needed to prevent resistance to tariff increases, it is important for transparency and accountability across the whole chain of the regulatory process to ensure legitimacy, public acceptance, and to apply pressure on people in positions of responsibility to deliver good sector outcomes. Regulatory decision-makers should be accountable to customers for their decisions, utilities should be accountable for the service they provide, and the government should be accountable to citizens for its decisions affecting the sector.

#### Promoting Transparency Before the Regulator

While incentive-based approaches might encourage efforts to find efficiencies, if the regulator cannot obtain sufficiently reliable information on a utility's costs—for example, through direct examination of its business plan, historical costs, or benchmarking—utilities can game the process to obtain high revenue allowances. Therefore, to reap the efficiency gains of incentive-based approaches, it is important to ensure there are mechanisms to provide a consistent and reliable information flow from the business to the regulator. Such mechanisms could include:

- Regulatory reporting guidelines and templates that ensure that cost information can be provided and compared consistently over time;
- A requirement that businesses prepare business or investment plans that have been subject to a consultation process and rigorous internal governance procedures;

- Requirement that financial and regulatory statements are routinely audited by independent parties; and
- Publication of the above information in the public domain.

### Promoting Transparency Before Customers

Ensuring transparency before customers on pricing and the wider regulatory process is important for ensuring cost recovery and the accountability of decision-makers. These, in turn, are important for securing good sector outcomes and information publication. Grievance redress mechanisms (GRMs) and customer engagement can play a part in this.

### Publishing Documentation

To improve customer understanding of the level of cost recovery achieved by existing tariffs, utilities can publish regulatory information online. Information on utility total costs and how these costs are covered through the three Ts are best for achieving this purpose and could be used by customers or by news outlets for communicating this information to customers. Documentation could also relate to the processes used to arrive at existing tariffs, including: the allowed revenue methodology, tariff and allowed revenue calculation models, tariff proposal consultation papers, comments from stakeholders, and final regulatory decisions. Without this transparency, customers tend to overestimate the level of cost recovery through tariffs. This can lead to resistance to tariff increases even when customers can afford the tariff increase.

Publication of information on utility costs and the procedures used to determine the tariff are important for improving customer awareness of the level of cost recovery, which must take consideration of total economic costs and costs relative to other utilities.

However, disseminating information is also important for holding regulatory decision-makers to account. Accountability depends on decision-makers being required to explain their decisions, exposing these to scrutiny, establishing a right to challenge decisions, and having open and committed consultation on important proposals so interested parties can understand the rationale and direction of policy decisions and choices (OECD 2014). Relevant information could extend to financial flows, staff information, and other data intended to prevent corruption and misconduct. “Sunshine regulation” consists of the public disclosure, comparison, and discussion of a set of performance metrics often based on KPIs. Accordingly, poor performance of service providers is publicly exposed, incentivizing service providers to improve their performance. It is particularly effective in improving the quality of services. The examples of the state of Ceará in Brazil or of Zambia are noteworthy as is the case of Portugal (box 4.2) or the state of Victoria in Australia.

While the publication of information for the benefit of customers is often discussed in theory, it is generally overlooked otherwise. In practice, an information pipeline occurs between the regulated entity and customers, typically including the collection of information by the regulated entity at the beginning and the receipt of accurate information by the customer at the end (figure 4.3).

Any leaks in this pipeline can undermine the effectiveness of the dissemination of information. For example, poor cooperation of utility workers can cause leaks at various steps of the pipeline when mechanisms designed to disseminate information are scaled up. Thus, robust systems and procedures are required to ensure that the intended information is sufficiently and accurately generated and reaches the targeted customer.

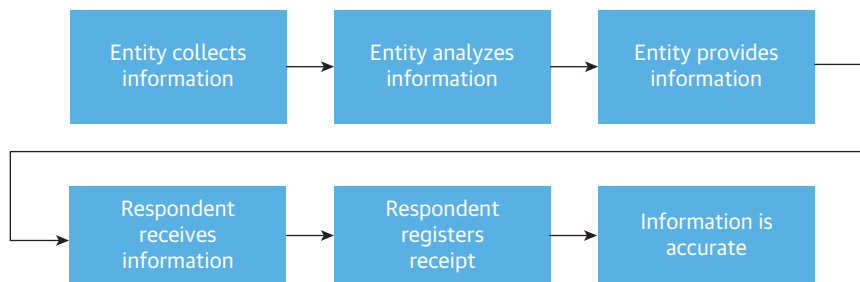
#### BOX 4.2. Successful Regulatory Practices in Portugal



The success of the Portuguese water sector's governance owes to the strong institutional framework of state-level bodies and municipalities as well as the degree of participation of other stakeholders. The Portuguese National Water Council is the consultation body engaging in discussions between municipalities, public administration bodies, nongovernmental organizations, customers, and research centers on water sector policy. Two other consultative bodies are in place within the water sector regulatory framework—the Consultative Council and Tariff Council—including all relevant stakeholders in policy making and tariff setting. The regulatory authority in Portugal has also recently developed a mobile app to provide relevant information about the quality of service provided by different suppliers to water and wastewater customers. Indicators are compared for 278 municipalities across various geographical areas in mainland Portugal, and display information on service quality, tariffs, as well as advice to reduce water consumption.

Source: Original compilation.

FIGURE 4.3. Information Pipeline between Regulated Entities and Customers



Source: Figure 3 in Kumar, Post, and Ray (2017).

### Benchmarking Performance

Comparison across utilities in different regions or countries is important for placing the level of cost recovery or efficiency into context. Such benchmarking would need to be mindful that total cost definitions adopted at utilities or regulators differ across the globe, and the total economic cost includes external environmental and resource opportunity costs. Further, it is important to account for variation in supply sources, customer composition, demand patterns, age and configuration of the networks, geography, topology, and other factors. Thus, fair

comparison is needed. Indeed, benchmarking is a tool that can be useful not only to customers but also to utilities, to help them identify their own weaknesses and work toward the top of the rankings, which can be motivated financially through tying the outcomes to allowed revenues.

Performance management using benchmarking and monitoring KPIs is widely implemented across Latin America. Benchmarking generates competition between service providers and creates the incentive to improve performance, and public disclosure of utility performance indicators can highlight

poor-performing utilities. Some countries in Latin America have developed information systems that collect, organize, and (to a greater or lesser extent) disseminate data from service providers at the national level. Among these systems, the performance indicators and regulatory benchmarking of SUNASS (Peru) stand out (World Bank 2018a).

### **Grievance Redress Mechanisms**

GRMs are important for customers to be able to hold providers to account. GRMs are “institutions, instruments, methods, and processes by which a resolution to a grievance is sought and provided.” Utility performance in addressing GRMs can be measured as a KPI and tied to allowed revenues. Some examples of KPIs could include number of complaints, customer satisfaction, number of timely connections, responses to emergencies, and availability of call centers. These instruments create an economic incentive to effectively address complaints and improve the standard of service. For this reason, it is unsurprising that data demonstrate that water utilities with GRMs tend to exhibit greater efficiency, water supply coverage, and quality of service due to a greater level of accountability to customers.

### **Communication Programs**

Regulatory processes can engage customers through customer stakeholder groups, designed to gauge customer priorities for different aspects of service quality and their preferences regarding the trade-off between service quality and the tariff level. While such processes are intended to ensure transparency and accountability to customers, it is important that these processes are themselves transparent, given that they ultimately affect the price determined. Such transparency can be ensured, for example, through publishing data from customer engagement and clearly detailing the processes online. Beyond gauging their preferences on quality of service, high

customer engagement can build trust in necessary tariff increases.

### **Preventing Corruption, Fraud, and Misconduct**

According to Transparency International, corruption is estimated to increase the cost of a water connection by 30 percent at the household level. Poor households are especially affected given their reliance on informal connections, which are more prone to corruption. Corruption in the water sector is far reaching and is the result of numerous factors, including noneconomic, institutional, and governance factors.

- There are multiple tools for preventing financial corruption. Some new technologies offer a more secure and transparent means of payment than traditional methods, with the added layer of verification systems. Mobile banking has become an especially prominent and effective method for customers to pay their monthly bills.
- In theory, increasing the availability of information that can reveal corrupt transactions may lead to a reduction in corruption as corrupt officials know they have a greater chance of being caught and punished. This is more effective when the potential victims are enforcing anticorruption crimes, implying that freedom of information (FoI) through requests or publication of data could reduce corruption. However, the corresponding reduction in bribery has been shown to negatively affect poorer customers. For example, a recent study found that FoI laws in India increased voter registration processing times for slum dwellers relative to wealthier households, coinciding with a reduction in the rate of bribery.
- Procurement corruption typically equates to officials awarding contracts based on personal connections or as a result of bribery, rather than in the interests of customers. This can result in inflated

costs and the prevention of the development of the most competent parties for providing services. A standard solution to this problem is to use an open tender. In creating corruption-resistant procurement processes, it is important to ensure they are effective not only on paper but also in practice. For example, contractor cartels (collusion between competing contractors to drive up the value of the winning bid) and political influence in contractor selection can take place even within an open procurement process and, in the case of the latter, even when auditing is used.

### Nonnetworked Services

Millions of people in low- and middle-income countries are not connected to water supply services either because they live below the poverty line and cannot afford a connection, connections to informal settlements are illegal, or they live too far from the network. Thus, the discussion is not complete without considering the regulatory framework for non-networked services. Regulatory frameworks must be

extended to nonnetworked service providers to grant them some form of legal recognition and incentivize service quality, performance, and professionalization. In practice, it is easy to find examples of countries that provide nonnetworked services, but it is difficult to find examples of regulatory frameworks that govern them, either due to poor governance or lack of formal regulation.

Currently, small-scale independent service providers (SSIPs) often operate in parallel with the utility, providing a complement to or substitute for utility water for households that do not have access or are dissatisfied with the quality or reliability of water utility provision. To maximize connection rates to high-quality water supplies, be this from a large utility or SSIP, it is preferable that boundaries are set regarding the responsibility and roles of each to facilitate this. An example is the institutional arrangement between the utility and water tankers for water ATMs in the urban slums of Nairobi (Kenya), where water tanks are currently filled up by tankers sent from the public utility (box 4.3).

#### **BOX 4.3. Water ATMs in Nairobi Slum, Kenya**

According to the National Water Services Strategy for 2007-15, it was estimated that approximately 60 percent of residents in Nairobi live in slums and informal settlements, lacking access to safe and affordable drinking water. In line with achieving Sustainable Development Goal 6 and ensuring access to affordable and reliable water to the unserved urban poor, water ATMs were introduced in 2015 for the first time in urban Kenya in the Mathare slum of Nairobi through a public-private partnership with the Danish engineering company Grundfos. Water ATMs are coin-operated- or smart-card-operated standpipes dispensing a given amount of water. They are considered a better alternative to standpipes and water taps, which feature a high risk of misappropriation of funds by kiosk managers or standpipe attendants, while also providing availability and cost advantages to customers. Water ATMs were initially designed to obtain water from the utility network. However, due to illegal cutting of water pipes, the pressure was not sufficiently high for the water to reach the tanks, which are currently filled up by tankers sent from the public utility Nairobi City Water and Sewerage Company.

*box continues next page*



### BOX 4.3. continued

Water cards cost Ksh 300 (US\$3) and can be topped up at a kiosk or through a mobile app. Water is priced at half a Kenyan shilling (half a US cent) for 20 liters, and payments per unit volume are fixed and processed through the cards, without the need for ATM managers. As tariffs are fixed, ATMs have been shown to provide water at lower costs than standpipes and water vendors, selling water for 50 to 100 times the price of ATM water. Table B4.2.3 compares tariffs for various sources of water available in the Mathare slum. ATM managers were also given a master ATM card with 40 percent water credit fee of cost as profit.

In 2019, the Water Services Regulatory Board of Kenya (WASREB) published guidelines for water vending. Water vending is defined as a “formal or informal reselling or onward distribution of water from other sources by small-scale vendors for domestic use.” The purpose of the guidelines is to include water vendors in the regulatory framework, through licensing, to regulate and monitor water and service quality provided to customers. The license should be renewed annually subject to an inspection of the vendor’s water sources, premises, transport, storage containers, equipment, and water handling practices.

**TABLE B4.3.1. Tariffs for Different Water Sources in Mathare Slum**

Water source	Tariff per 20-liter jerry can
Water ATMs	50 cents (US\$0.005)
Water standpipes	Ksh 2-10 (US\$0.02-0.10)
Water vendors	KSh 2-50 (US\$0.02-0.50)

Source: Sarkar 2019.

Nonnetworked providers could also be regulated through contracts, either with the utility or with the municipality or local government, or even with the local community. Guidelines or other regulations can provide market rules to promote competition for such contracts, thereby ensuring that the cost of provision remains at efficient levels. In Latin America, the piped water and other sectors such as off-grid electricity and solid waste management have shown that contracts and licenses can spur competition from local and international firms.

## 4.6 Conclusions

Since water utilities are natural monopolies, there is a clear rationale for regulation. The market power of

utilities can result in inflated prices, inefficiency, and an eroded quality of service. The presence of other market failures may also mean that external environmental costs and resource opportunity costs are not addressed. Another important objective of regulatory regimes is to address social concerns, such as affordability and access to services, which solutions to problems must be weighed against.

Three broad problems can hinder governance in pricing:

- Information asymmetry between the utility and regulator regarding the utility’s efficiency can give the utility a bargaining advantage that leads to inefficiencies, inflated costs, and poor quality of service;

- A lack of transparency and accountability of utilities and regulatory decision-makers before customers can lead to customers overestimating the degree of cost recovery, leading to resistance to tariff increases, and to poor sector outcomes;
- A lack of scrutiny and transparency can lead to corruption that undermines sector performance.

To regulate prices, regulators usually work within a wider overarching regulatory framework, which can include sector-specific, multisector, municipal, and contractual regulation. The adopted approach is highly dependent on the legal, institutional, and historical and cultural background of the country in question. Within this overarching framework, the regulatory regime outlines the methodology for determining the price or revenue and the frequency

of such determinations. These regimes can be split into cost- and incentive-based approaches, in which there is a trade-off between recovering the utility's costs and ensuring its financial sustainability (in the former) and ensuring cost-cutting incentives (in the latter). The efficiency trade-off is evidenced in Europe, where cost-based ROR regimes exhibit a higher labor cost as a proportion of total costs than incentive-based price and revenue cap regimes. While cost-based approaches may be beneficial in newly established utilities with higher financial risk, this evidence indicates that incentive-based approaches are important to ensure efficiency in the long run, which itself is important for the financial sustainability of the utility as it is the only way of ensuring recovery of costs through tariffs.





## CHAPTER 5

# Key Elements of an Effective and Efficient Tariff Reform Strategy

Successful tariff reform requires more than a sound design. Without an appropriate strategy that garners support for its implementation from across the spectrum of interested actors, there is a strong likelihood of failure. An effective strategy should generally entail the following four key elements: (1) strong political leadership; (2) enhanced performance that leads to a service quality that is acceptable to customers; (3) increased stakeholder engagement; and (4) widely socializing the tariff design process and underlying costs of provision.

### 5.1 Strong Political Leadership

The one incontrovertible element of successful reforms has been strong political leadership to comfort advocates of low tariffs, or at the other end of the scale, actively support reforms. This is not static, and part of the virtuous cycle is that as the reforms produce tangible benefits and consumer willingness to pay (WTP) improves, politicians are more likely to back off from populist positions and start putting their weight behind the reform process.

Governments are often reluctant to increase tariff levels and implement tariff reforms as the political attraction of “free water” makes it an alluring target for dispensing policy favors—it can be marketed as a commitment to poverty reduction or as support for rural development. However, a number of case studies suggest that not only are tariff reforms possible but farsighted leaders can exploit catalytic events such as a cholera outbreak, or a change in the political landscape, to create momentum and build informed alliances that can alter the balance of political payoffs.

In Zambia (box 5.1), a cholera outbreak precipitated a long-overdue reform process needed to address fundamental weaknesses in urban water supply. Elevating the importance of efficient water tariffs was one of the major achievements of the reform process.



### BOX 5.1. Zambia's Water Sector Reforms

In the 1980s and early 1990s, there was very limited water supply in Zambia's urban areas. Water was available for only 6–8 hours a day, there was low service coverage and poor quality of water that caused serious health risks. The municipal water departments had the primary responsibility for water supply, but there was no national policy or regulatory framework, the legislation left gaps and overlaps, and there had been inadequate investment over prior decades.

Numerous attempts at water sector reform through decentralization had been tried in the period 1980–90 but policies were either not implemented or followed up, or were not consistent with the government's policies on decentralization. A new government in 1991 brought policies of market liberalization more in line with the water sector requirements, and cholera outbreaks in 1991, 1992, and 1993 put water into the limelight. In 1994, a new National Water Policy was introduced, thereby initiating a radical reform of urban water. The policy articulated seven main principles which guided the reforms, the one on tariffs being: achievement of full cost recovery for water services (capital recovery, operation, and maintenance) through customer charges in the long run.

The key phrase is “in the long run.” From around 2000, the municipal water departments were replaced by “commercialized utilities” (CUs) but in their first 15 years the CUs failed to achieve financial sustainability. This had multiple causes, including low tariffs, poor commercial performance, and continuing inefficiencies, notably a failure to reduce nonrevenue water. These issues have been systematically addressed over time and from the latest benchmarking report it appears that 8 of the 11 CUs had revenues projected to be at or above full cost-recovery levels by 2019.

Effective stakeholder communication has been crucial to achieving sector improvements that have involved significant increases in the average tariff level. This has been achieved partly through the innovative scheme of the regulator, the National Water Supply and Sanitation Council (NWASCO), which is aimed at improving communication with local communities to give them proper representation with the CUs servicing their towns. The scheme centers on water watch groups, the first being established in Lusaka as a pilot project in 2002 to increase NWASCO's presence on the ground and handle unresolved complaints. These groups are voluntary and have operated in as many as 12 towns across Zambia, but as of 2019 there were only 6 in operation.

*Source:* ECA 2017a; NWASCO 2019 sector report.

In 2020, COVID-19 brought a new health-driven focus on water, with particular attention toward accelerating Sustainable Development Goal 6 in rural areas. In urban areas, commercialized utilities are being assisted by the World Bank and other donors and nongovernmental organizations to formulate and implement emergency response strategies.

At the end of the civil war in Mozambique in 1992, urban water supply systems were in a parlous state. Decades of underinvestment had been compounded by damage to water assets during the civil war and there were very few trained personnel able to effectively run water utilities. A comprehensive reform process, embracing major policy, institutional, and



regulatory changes coupled with intensive training and capacity building, was imperative. The structures that were established required setting cost-recovery tariffs, fundamental to the sustainability of Mozambique's reforms (box 5.2).

If water tariffs are denominated in nominal terms and are not regularly reviewed, high levels of inflation sharply diminish the real value of tariffs, wreaking havoc on a utility's finances. In the extreme case of hyperinflation in Brazil in the

mid-1980s and early 1990s, the rate of annual inflation was in the hundreds, with grave implications for livelihoods, public service provision, and welfare, particularly among the poor. This experience paved the way for the Law of Fiscal Responsibility, passed in 2000, which stipulated that state-owned enterprises must cover their costs (box 5.3). Over the last two decades, this federal law has guided municipalities, which are tasked with setting water tariffs.

#### **BOX 5.2. Mozambique's Water Sector Reforms**

By the mid-1990s, the water sector in Mozambique was in dire need of improvement. Tariffs were set well below cost-recovery levels, which meant that the public sector service providers were losing money on every unit of water supplied. Piecemeal solutions would not have worked. With the support of international donors (led by the World Bank) a set of comprehensive reforms were formulated for the water supply and sanitation sector. The reforms began with the approval of a new National Water Policy in 1995, which outlined the principles for water sector reform and defined water as an economic as well as a social good. This paved the way for financially sustainable water services to be established.

Reduction of nonrevenue water was an important factor in achieving financial sustainability, but there were also significant tariff increases. To regulate tariffs, the Water Supply Regulatory Council of Mozambique (CRA) was created in 1998 with the authority to review and approve tariffs, regulate service quality, protect consumers, and promote and improve the delegation of water supply services to third parties.

Services were not only delegated to public sector bodies, but the private sector was also permitted to provide services and charge cost-reflective tariffs. In peri-urban areas this is mainly done through private water providers supplying water derived from boreholes. At first, the tariff they charged was often more than double the tariff for the main water utility in Maputo, but a regulatory framework was subsequently developed to provide incentives for efficiency improvements and competition, thereby reducing tariffs.

A sector expert close to the reforms noted "a great deal of progress has been made and it has been sustained, with some setbacks, over 18 years. The fact that it was messy, that mistakes were made, and lessons learned has made the process more sustainable . . . credit is due to the government's commitment to institutional reform" (Thelma Triche's comments on an earlier draft of the Mozambique case study). With the reforms taking place over a long period, tariff increases were made in stages, thereby avoiding public resistance. According to a regulatory peer review, CRA could have done more to engage customers in tariff setting, but credit was given for the CRA's systemic inclusion of local delegates and commissions. There have been good initiatives in reaching out to customers, including being on hand to react to consumer complaints.

*Sources:* ECA 2017a; Wilson and Carilho Dias 2016.

### BOX 5.3. Countering Inflation in Brazil and Uganda

Brazil is a large, federal country with a complex water sector history. The states have an important quasi-autonomous, meso-level role between the federal government and the local government structures (the municipalities), which have direct responsibility for water supply and sanitation (WSS). There have been periods where strong political commitment, through forcefully articulated national policies, well-formulated WSS plans, and the backing of adequate allocations of financing for WSS investments, have provided strong incentives for improved WSS performance. However, the incentives deliver positive outcomes in already strong and capable municipalities, particularly with growing disparities with weak municipalities.

In recent times, the lowest point in sector performance was during the years of hyperinflation in the mid-1980s. The real value of tariffs dropped precipitously, and utility viability was dramatically undermined. Hyperinflation was brought to an end by the Plano Real, launched in 1994, which produced a restoration of normal commercial conditions. The crucial legal step that followed was the 2000 Law of Fiscal Responsibility, which stipulated that state enterprises had to cover their costs. In Brazil, there is no national economic regulator for the water sector and tariff setting is left to the municipalities, but the federal Law on Fiscal Responsibility has been a crucial anchor that imposes implicit cost-recovery requirements on publicly owned service providers. While fiscal transfers provide resources for major investments, tariffs generally cover recurrent costs, so WSS is not treated purely as a social service, and there is private sector participation in a variety of forms in some parts of the country.

In Uganda, inflation in the 1980s was at very high levels and the 1990s started at 45 percent but declined to under 5 percent by the end of the decade, with commensurate declines in the value of the local currency versus hard currencies. As tariffs of the National Water and Sewerage Corporation (NWSC) at the time were denominated in nominal terms, high inflation had the effect of eroding the real value of tariffs with adverse consequences for the utility's finances. For example, by the year 2000, the real value of the tariff was only 45 percent of the value set in 1994.

In 2002, the government addressed this problem through gazettement of a Statutory Instrument (No. 23 of 2002) that specifies an indexation formula for NWSC tariffs. This allows an annual adjustment to the domestic component of tariffs and an exchange rate adjustment to the foreign component, thereby preserving the real value of the tariffs. This had the effect of protecting NWSC's revenue base from the impact of inflation. At the time, NWSC was rightly commended for service improvements attributed to dynamic leadership but it is also to be acknowledged that the stability in NWSC's financial position arising from the indexation formula provided the base for effectively shifting the utility into the self-reinforcing virtuous cycle.

When the reforms started, the utility had unserviceable debts to the government. During the 2000s, it achieved financial self-sufficiency largely through expenditure reduction and efficiency improvements rather than through tariff increases other than indexation. Half of an ambitious US\$100 million investment program between 2002 and 2011 was financed from internally generated resources.

*Sources:* ECA 2017a; ECA and Mott MacDonald 2012; Heymans et al. 2016. Data on inflation rate in Uganda from: <https://www.statista.com/statistics/447810/inflation-rate-in-uganda/>.

Inflation was very high in Uganda in the 1980s, peaking at 215 percent in 1987. In the 1990s, rates declined as fixing tariffs in nominal terms severely undermined the financial viability of the National Water and Sewerage Corporation (NWSC). The introduction of an indexation formula in 2002 was the basis for their successful turn-around under a dynamic management team (box 5.3).

In Colombia, water tariff reform was delivered as part of a much broader public sector restructuring and decentralization program. The key starting point was the 1991 Constitution, which established the

principle that the criteria for tariffs are to include costs and economic efficiency as well as solidarity and income redistribution. Although tariffs were significantly increased, and the water service providers are financially viable, fiscal transfers still remain the main source of sector financing (box 5.4).

## 5.2 Timing of the Reform

Catastrophic events that influence the attitudes of customers—for example, the cholera crisis in Zambia, the end of the civil war in Mozambique, and the end

### **BOX 5.4. Colombia's Water Sector Reforms**

In the late 1980s, many issues faced the water supply and sanitation (WSS) sector in Colombia. Service provision resembled a “low-level equilibrium” characterized by low tariffs and low levels of coverage and service quality (Sánchez Torres and Pachón 2013). In many of the country's important cities the poor provision of water was critical. Many utilities were experiencing financial distress and there were some bankruptcies (Andres, Sisen, and Marin 2010).

As part of a broader program of economic reform the Government of Colombia in the early 1990s adopted a significant package of reforms aimed primarily at incorporating competition and strengthening the business capabilities of entities providing domestic public services, including WSS, while retaining the social elements of cross-subsidies. This was enshrined in the Constitution of 1991 and elaborated in the comprehensive utility law of 1994, which inter alia created the Water Supply Regulatory Council of Mozambique (CRA) with responsibility for promoting competition among service providers and economic and tariff regulation in water.

Another major aspect of the reforms was decentralization, which in the water sector took the form of devolution of responsibility for WSS services to the municipalities. Although the national regulator, CRA, which issued its first tariff methodology in 1995, has overall responsibility for tariffs, the municipalities have a “residual regulation” capacity in tariff issues. Municipalities at the time of assigning the services to an operator through a bidding process can arrange a “contract” tariff as long as this has been part of the selection criteria in the process. The mayors and the municipal council are in charge of establishing the subsidies and “solidarity” contributions although the maximum percentage of subsidies that can be granted to low-strata customers are defined by law and can only be modified by the National Congress.

*box continues next page*

#### BOX 5.4. continued

Colombia's comprehensive reforms began 35 years ago and much has been achieved in terms of performance and outcomes. They have been successful in both increasing local participation and voice in the management of WSS services and in opening the door to a range of innovative public, private, and mixed approaches with often positive impacts on service delivery.

In particular, the reforms have created the financial stability in the sector, which underpins the improvements in coverage and service continuity in urban areas. Defining tariffs on the basis of production costs has been found to send adequate signals for rationalizing consumption with a positive impact on the environment (Andres, Sislen, and Marin 2010). However, while the tariff component of utility financing has increased steadily due to the CRA tariff methodologies, improved collection, and higher levels of willingness to pay, the decentralized revenue sharing system has remained the most important source of funds for the sector.

Source: ECA 2017a.

of hyperinflation in Brazil—often lead to successful reforms. The political focus on water, which feeds into populist resistance to water tariff reforms, can also be diminished when water sector reforms are part of a broader restructuring of the provision of private services, coupled with decentralization as was the case in Colombia. While these examples provide useful lessons on how resistance to tariff reforms can be mitigated, there will always be differences in political and institutional culture, not just between different countries, but even within countries when different historical periods are considered.

It is therefore inherently difficult to identify characteristics that can be factored into the design of future tariff reform or broader water sector reforms. Even something as obvious as specifying that there should be a national economic regulator to have independent oversight of water tariffs cannot be claimed to be essential. While the role of the regulator in Colombia (CRA) has proven to be crucial, Brazil's state-owned enterprises have managed to improve services despite the absence of a national

regulator. In Africa, a similar comparison can be made between Zambia and Uganda, though the role of strong regulators in improving sector performance, such as in Kenya, should also be noted.

### 5.3 Utility Performance and Quality of Services

Revenues collected through tariffs, taxes, and transfers are insufficient to cover the full costs of water supply in many countries. This is a consequence of low tariffs, low levels of revenue collection, and operational inefficiency, notably the large amount of NRW lost due to leakages and water theft, which drive up costs of supply and forces service providers to postpone investment and maintenance of infrastructure. As a result, service quality deteriorates, decreasing customer WTP and acceptance of tariff increases.

To address this negative spiral, revenues need to be increased. Before considering an increase in tariffs, utilities should focus on improving billing and collection rates and increasing the efficiency of water utilities, as well as the quality of services.

- *Improved billing.* Utilities often do not know all their customers or how to contact them. This can be addressed by compiling a robust database of the customer base served by the utility and digitizing billing to help the service provider plan and compare revenues across years.
- *Improved revenue collection systems.* Even when customers are billed accurately, the money does not always reach the utility's account. In these cases, service providers should carefully analyze trends in NRW and leverage mobile phones and online networks for digital payments of bills to ensure transparency and close the gap between billing and collection.
- *Increased efficiency.* The problem of efficiency is particularly important as improved operations and reduced NRW can often be achieved through leadership and better management without significant investment being made.

As discussed in chapter 2, addressing inefficiencies should be the first point of call to raise revenues as the total cost savings will also increase consumer WTP and hence improve bill payments.

This occurs because when billing and collection rates improve, service quality also improves, and customers are then less likely to resist price increases. In some cases, the drop in NRW and increase in revenues might even make tariff adjustments unnecessary to achieve cost recovery.

#### 5.4 Using Technology to Improve Tariff Design and Utility Performance

Many tariff structures require accurate data. Data collection and monitoring can be difficult and expensive. Technology holds out the prospect of cost-effective solutions. For example, manual inspection of water use is expensive and, in many cases, inaccurate or insufficient. Smart meters, remote sensing,

and street view data, combined with machine learning, can be used to design more precise, effective, and efficient tariffs.

A number of technological innovations in the wider domain of water are important, but the focus of this chapter is on those technologies that help shape and provide tariff design and that facilitate the interaction between customers and tariffs.

Technological innovations leverage the power of real-time data collection and big data analytics to minimize water losses in the distribution system and maximize operational efficiency, service quality, and environmental sustainability. Given the size of the challenges, it is not surprising that many key agencies across many countries are increasingly urging a more strategic approach to technological innovations among water utilities. For example, the water services regulatory body for England and Wales, OFWAT, stated in 2017 that water companies would in future be required to put innovation at the heart of their corporate strategies. Big data is central to many discussions about new technology in the water sector. The term is often used to “describe data that is high volume, velocity, and variety; requires new technologies and techniques to capture, store, and analyze it; and is used to enhance decision making, provide insight and discovery, and support and optimize processes” (Adamala 2017, 10). Big data is relevant to advances in machine learning, digitalization, and artificial intelligence (AI).

Adoption of advanced technologies by the water sector lags behind many other industries (Li et al. 2021; Ghernaout et al. 2018). Some of these innovative, legacy-disruptive technologies are, however, already in operation in select areas; others are more nascent. For example, in the latter category satellite-based remote sensors linked to the Internet of Things are at an early stage but carry the potential to align satellite surveillance with smartphone-based



surveys and online big data tools. Likewise, high-resolution smart water meters and advanced data analytics allow for a new era of using the continuous big data generated by these meters to create an intelligent system for water management. Drones and unmanned aerial vehicles offer further opportunities to harness new technologies.

### Smart Metering

Smart metering is a key enabling technology for dynamic tariff structures and a variety of other capabilities that utilize their ability to log and transmit high-frequency data in real time. Smart metering is set to be a foundational technology for utilities of the future, acting as a key enabler for other technologies and innovative ways of managing and supplying water.

Smart meters fall on a spectrum of varying degrees of sophistication. Smart metering systems can be placed in two categories: (1) automated meter reading (AMR) allows automated one-way collection of meter readings without physical inspection, and (2) advanced metering infrastructure (AMI) involves a two-way communication with water meters. Utilities receive water usage information and can issue commands for the meters to undertake specific functions. Smart metering provides a number of benefits:

1. High-frequency meter readings enable more sophisticated tariffs such as time-of-use (TOU) tariffs to be applied.
2. Utilities can reduce costs, given that traditional meter reading services are no longer needed.
3. Additional sensors can be installed that record and transmit data on water quality and temperature as well as volumes.
4. Smart meters increase interactions with customers, providing information on their use and

expenditure. If this information is communicated effectively, for example, through an in-home display or an online information service, customers become more informed and more responsive to price signals. Customer service is more efficient and cost-effective as queries can be answered automatically.

5. High-frequency data allow the utility to detect unusual usage patterns that may be indicative of leaks or inefficient usage.
6. Smart metering is often effective in enhancing revenue collection because high-frequency transmission of usage data limits opportunities for theft and collusion between customers and meter readers (World Bank 2016a).

However, a number of challenges are also associated with introducing smart meters: (1) potential job losses and subsequent unemployment of manual meter readers; (2) large capital costs associated with the initial introduction of smart metering; (3) resistance by some customers to smart metering due to negative perceptions of the technology; and (4) limited engagement with the technology by some customers (box 5.5).

### Digital Customer Engagement

In addition to in-home displays, web-based or mobile services can also present information to customers on their consumption and bills. These systems can include an interactive element that allows two-way communication between the customer and the utility. AI chatbots, for instance, allow customers to ask questions and receive alerts and information on their consumption and conservation. Communication systems may also be integrated with payment management options to help create a central hub for customers to engage with their water service provider.

### **BOX 5.5. Prepayment Meters Are Not a Panacea for Utilities or Customers**

In the electricity sector in developing economies, prepayment meters (PPMs) have been extensively rolled out and have made an enormous difference to revenue collection, but have thus far failed to have the same impact in the water sector. In a major study of prepaid water in Africa (World Bank 2014), the authors examined three applications of PPMs: prepaid standpipes, PPMs for institutional customers, and PPMs for individual domestic connections.

PPMs for institutional customers consuming large volumes were found to facilitate customer demand management and reduce the debt risk for utilities. For households, prepayment was found to be appealing because it allowed customers to manage their own consumption, without the risk of arrears, disconnection, or unexpected debt, but not all PPMs have the capability of delivering an initial subsidized block. For the utilities, PPM systems were considered difficult to implement for individual households, and not a panacea for inefficient billing and collection and the avoidance of customer debt.

This is primarily because water PPMs are relatively more expensive than electricity PPMs and require closer operational monitoring. Utilities need to establish rapid response teams to deal with problems and still maintain meter reading to track real-time consumption against prepaid sales. There is a need to work closely with customers to deal with faults that may affect the supply that customers have already purchased. There is also the risk of poor households losing access to water if their credit runs out. Similar concerns arise regarding PPMs for institutional customers such as hospitals, schools, and prisons.

Technological advances that reduce the cost and improve the reliability of water PPMs will undoubtedly lead to higher levels of uptake. But there have not been any breakthroughs in this regard. The World Bank study referred to above is six years old, but recent studies are reaching much the same conclusions. Komakech, Kwezi, and Ali (2020), for example, assessed the performance of prepaid technologies in Tanzania and found an increased burden on water customers, suggesting that PPMs “can simplify water revenue collection, but are not a panacea to deliver sustainable and equitable water services.” The highlight: “strong institutional capacity and knowledge is required alongside the technology.”

### **Automated Water Kiosks**

Automated water kiosks provide automated water dispensing services purchased with cashless payment systems using mobile phones, prepaid tokens, or cards. Automated water kiosks allow for a sharp reduction in distribution costs and benefit customers by reducing the time it takes to collect water, and providing unrestricted access at favorable rates. Kiosk operators often mark up the price of water despite having purchased it at a subsidized rate to support low-income consumers (see background

paper 13, listed in appendix A). Automated water kiosks ensure subsidies are directed to the intended recipient. Lastly, cost savings to utilities or vendors mean that more water access points can be installed.

### **Mobile Payments**

The term “mobile payments” refers to payment for goods and/or services through a mobile device such as a mobile phone. When water tariffs are of a block payment type—for example, bundled with local taxation—mobile payments provide limited added value

for customers or their water providers. But where tariffs are more individualized and variable according to volume, for example, changing with the seasons, then payment methods that allow more frequent, variable payments become advantageous for both provider and customer. Under these circumstances, cumbersome postal notifications followed by a requirement to travel to a payment office become inconvenient and expensive.

Innovations in mobile payments generate more reliable and transparent data records, and reduce opportunities for petty theft and corruption by intermediaries. Mobile payment methods also allow quarterly and monthly bills to be split into multiple smaller amounts and allow payments with minimal or zero transaction costs. Additionally, mobile payments allow entry to the wider applications offered by mobile banking, which in turn carries the potential to extend the reach of financial services to poorer households and the unbanked. Finally, water providers can offer more flexible prices as there is greater transparency and agility in the tariff system.

### Water Flow Limiters

Flow limiters shut off water supplies after a set volume of water has been delivered. They are used in the municipality of eThekweni in South Africa to provide basic water requirements for free, similar to a “lifeline tariff” (World Bank 2016b). Flow limiters could also be used in cases where there is no free water allowance but households wish to limit their use to avoid excess charges.

### Advanced Data Processing

AI creates new opportunities for data processing that are more sophisticated, on a larger scale, and automated. AI refers to computer systems that can perform tasks that would normally require human intelligence. While many subfields exist in AI, including language and voice recognition and computer

vision, machine learning is the subset of AI that seems likely to have the most useful application for the water sector. Machine learning refers to systems that learn to recognize patterns in data. This may range from simple approaches using traditional statistical techniques such as regression analysis or more complex systems such as artificial neural networks that use an architecture that loosely approximates a biological brain. These advanced data-processing methods are at their most effective when used alongside big data, a term that refers to data which are too large or complex to be analyzed using traditional methods. AI and machine learning provide a route to extracting useful information from big data, while large data sets can improve the accuracy of machine learning models by expanding sample size.

For water utilities, the use of AI and big data has implications for both operational management and for business processes. On the operational front, AI integrated with physical sensors can be used to aid the management of water assets and networks. This allows a transition away from water flow models using physical laws to more sophisticated probabilistic models combining physical laws with probabilistic insights from AI. Commercial solutions have been developed to use artificial neural networks to detect pipe bursts in real time (Romano and Kapelan 2014), machine learning to predict risk of faults in pipes (Myrans, Kapelan, and Everson 2018), and machine learning to predict wastewater treatment needs (IWA 2020). Such applications hold promise to improve network efficiency and reduce cost of service. AI also allows for more efficient investment in water assets and sensors. One way in which investment can be made more efficient is that AI can help network design to be planned with the optimal configuration of CAPEX versus OPEX. With regard to sensors, the ability of AI to extract greater insights from a given

set of data allows fewer sensors to be used provided they are placed strategically. For example, AI can reduce the required number of smart meters to be installed by classifying customers into groups and exploiting the similarity of behavior of consumers within each group (Jenny et al. 2020).

AI and big data can enhance business processes in the areas of business intelligence, knowledge management, and cybersecurity. Business intelligence, which can be understood as the use of data at the managerial level, can make use of AI through advanced trend forecasting, whereby machine learning identifies patterns in the data that can be used to predict the evolution of variables of interest. Alongside systems that capture and make sense of big data, advanced trend forecasting provides a richer set of information that can not only be used for business decisions within the utility but also for benchmarking exercises by the utility. Knowledge management encompasses a broader set of activities than business intelligence, including how the organization creates, structures, and shares knowledge and information. AI applications can contribute to an organization's knowledge-sharing platforms by providing enhanced features for messaging, research, and collaboration tools. AI is also increasingly being used in the hiring process to identify and analyze candidates (Jenny et al. 2020). Cybersecurity is a crucial issue in the water sector both because water is an important social resource and because water utilities store private information on individuals. AI tools have been developed to identify abnormal behavior while "robo hunters" automatically scan for threats and take remedial action once a threat has been identified.

### Digitalization of Business Information Systems

In addition to advances resulting from AI, water utility business information systems can be improved

through digitalization. The primary driver of this digital transformation is the use of enterprise resource planning (ERP) systems, such as SAP, Salesforce, and Oracle. ERP systems support a broad range of activities that help an organization manage its resources (Ngai, Law, and Wat 2008). The chief benefit of ERP systems is the integration of many systems such that a single system can be used to manage all financial and nonfinancial information in the organization (Pycraft et al. 2010). This increases efficiency by reducing duplication of information across multiple systems and allowing for a simpler customer interface for employees. It has been reported that organizations using ERPs provide better customer service, reflecting improvement in business processes (Al-Fawaz, Al-Salti, and Eldabi 2008). Such a system has benefits for water utilities and regulators. Utilities gain better understanding of their costs and revenues and, using this information, regulators can set tariffs that better reflect the costs of supply.

Despite the benefits of ERPs, implementation of these systems can be difficult. ERP implementation frameworks, such as the Accelerated SAP methodology associated with SAP software, are generally recommended to provide correct training and to ensure business processes are redesigned around the new approach without introducing additional complexity (Makipaa 2003; Muscatello and Chen 2008). ERP systems have also been accused of being poor at displaying and reporting financial information (Rom and Rohde 2006). Following implementation of ERP software, it has been reported that accountants often continue to use stand-alone systems such as Excel for budgeting and reporting (Granlund 2011; Grabski, Leech, and Schmidt 2011). In a survey of management accountants in a South African water utility, 100 percent of respondents reported a lack of integration between the ERP system and management

accounting techniques. Respondents also commonly cited lack of reporting capabilities in the ERP system, lack of data cleaning, and lack of customer training (Mudau 2012).

### Barriers to Technological Innovation in the Water Sector

A fundamental barrier to the introduction of innovative technologies facing water and sewerage utilities is the extent of legacy systems and investment in the status quo. Vested interests may be reluctant to relinquish their hold on familiar systems and activities. For example, managers and staff in area utility payment offices may be fearful of losing their jobs to the technologies that enable mobile payments. Incumbents of legacy systems are often well connected to political support networks. Political systems throughout the world have often been found to offer a defense to their industrial constituents and supporters. Utility operators in advanced and developing economies alike are often constituted as part of the actual or quasi civil service. Installing new technologies and dismantling existing structures may require the status quo to be challenged.

Shifting from legacy systems to new technologies requires up-front capital and operational investments. Securing such funding can be a challenge. Concerns about short- versus long-term budgets and investments may also be a barrier. For example, the cost of installing smart meters may be higher than the ongoing short-term budget costs of continuing with manual meter readings.

Providers may also be slow to adopt new technologies due to lack of incentives and a lack of workforce training in digital technologies. There may be skill deficits limiting the capability to make use of data analytics. With new digital technologies, providers need to handle and manage large volumes of data—this may also require new management skills. While some technologies such as smart metering have

become increasingly established in some developed economies, the benefits in developing economies are still largely unproven. The lack of proven benefits may be a further barrier to adoption of some technologies.

Despite the many barriers, there are a number of factors that can serve to drive the shift toward the adoption of innovative technologies to facilitate advances in tariff design and delivery.

Multi-stakeholder governance models may also be helpful. These may stem from public-private partnerships. These partnerships can bring extra financial resources, new expertise and experience, and a sharper focus on customer responsiveness. Trials of various types of contract arrangements may prompt innovation. These can include service contracts, management contracts, leases, and concessions.

Consumer attitudes can be a driver. Consumers may come to expect digital and high-quality services from their water provider in the manner that they are accustomed to receiving elsewhere. Far from being a barrier to innovation, such customers may provide impetus for change. Similarly, as digital natives gain seniority within water service providers, they may become internal agents of change.

## 5.5 Stakeholder Engagement

The water sector involves a plethora of stakeholders with different interests and incentives with regard to tariff setting. This institutional fragmentation is often the result of weak legal and regulatory frameworks that limit decision-makers' incentives to improve service delivery and their commitment to address challenges surrounding water pricing. The multiplicity of stakeholders and interests, often conflicting, adds complexities to the tariff reform process and requires effective coordination and engagement strategies. This means considering the different stakeholder perceptions of problems and



incentives through inclusive and participatory approaches for the various actors across the water chain.

The case study of Saudi Arabia (box 5.6) highlights how the lack of public participation in the reform process was the main driver of the strong opposition to the tariff increase implemented in 2015 in an attempt to achieve cost recovery. This example adds to the extensive literature highlighting that effective

stakeholder engagement involves, on the one hand, a bottom-up approach that allows the community to express their views and concerns, and on the other, institutional rules and frameworks to ensure accountability. Governments are increasingly recognizing the demand of citizens to be more involved in water tariff decisions and shifting toward “open” decision-making and implementation. Several countries have started engaging stakeholders in water

**BOX 5.6. Water Tariff Reform in Saudi Arabia**

Saudi Arabia's water resources are extremely limited and meeting water demand is a major challenge for policy makers. However, tariffs have been historically low, with domestic tariff revenues covering only 7 percent of the costs. The fall in oil prices in 2014-15 highlighted the environmental and economic sustainability challenges of the pricing strategy and led to a sharp increase in the domestic water tariff to secure more revenues from public services. In December 2015, the Saudi cabinet announced a revised tariff structure that remains in force today. The tariff rates before and after the reform are illustrated in table B5.6.1.

**TABLE B5.6.1. Tariff Rates before and after the Reform**

Block tariff rates before 2015			Block tariff rates after 2015		
Block	Monthly consumption (m <sup>3</sup> )	Tariff (US\$/m <sup>3</sup> )	Block	Monthly consumption (m <sup>3</sup> )	Tariff (US\$/m <sup>3</sup> )
1	1-50	0.027	1	Less than 15	0.0027
2	51-100	0.04	2	16-30	0.27
3	101-200	0.53	3	31-45	0.8
4	201-300	1.07	4	46-60	1.067
5	>300	1.6	5	>60	1.6

The revised tariff rate retains the five-block IBT structure, with the size of consumption blocks considerably reduced and higher volumetric charges for the second and third block. The tariff revision was aimed at increasing cost recovery to approximately 30 percent of the marginal cost of supply and led to a 10-fold rise in the monthly water bill of most households, spurring unprecedented public criticism. The magnitude of the price increase and resulting opposition were unique for a country such as Saudi Arabia, where open criticism of the government is very rare. Although there is no formal analysis of the extent of the backlash, people publicly expressed their criticism by sharing photos of their new bills online and speaking out publicly.

*box continues next page*

### BOX 5.6. continued

Many commentators pointed out the lack of public participation in the decision-making process as a key driver of the opposition, reflecting the changing nature of Saudi society as a result of the Arab Spring. While the country has an established means to ensure public debate to reach consensus (i.e., *majalis*, *diwaniyyat*, and *istirihat*), these types of social gatherings are increasingly mediated via social media. The public reaction to the tariff increase highlighted the lack of dialogue between policy makers and customers, particularly with regard to the true costs of supply and the urgency to address water scarcity issues.

Another effect of the higher tariffs was increasing customer awareness of the inaccuracies in their water bills, which exacerbated the wave of public criticism. To overcome the backlash, the minister of water and the CEO of the water utility were replaced. The government also announced that a new tariff schedule would be developed and the Ministry of Environment, Water and Agriculture announced a range of awareness campaigns to encourage the preservation of water resources.

This case study stresses the importance of community participation in the decision-making process. Public consultation and stakeholder engagement can:

- Assess customers' willingness to pay and design progressive and gradual schedules for increasing prices, considering inputs from customers and other stakeholders.
- Raise awareness about the gaps between the costs of supply and revenues, and the limited availability of water resources, including strategies to promote water conservation.

In addition to emphasizing the need to carry out publicly acceptable reforms, the case study also shows how tariff structures should address the need for cost recovery while incentivizing utility performance and efficiency gains.

Source: McIlwaine and Ouda 2020.

sector reforms to facilitate policy implementation by mobilizing citizens and customers to make tariff reforms more responsive to public needs through consultation and other forms of engagement.

A well-planned stakeholder engagement strategy must be flexible to accommodate shifting political, social, and cultural factors relevant to the reform process. Planners would benefit from taking the following steps:

1. Clearly define the strategy's primary goal, characterize the political and socioeconomic context in which it will be developed, and understand what

makes the reform urgent as well as the possible obstacles to its implementation.

2. Identify the relevant interest groups and determine the degree to which they stand to benefit or lose from the prospective tariff reform. This requires estimating how much subsidy each group receives under the current tariff policy, and how it compares with the prospective tariff policy. Map the policies according to the proposed simple, political economy framework (box 5.7) to identify circumstances or actions that could facilitate the reform.

3. Better understand the views, feelings, perceptions, motivations, beliefs, and practices of each interest group by conducting opinion research, focus groups, in-depth interviews, and so on.
4. After internalizing how the target audiences think, feel, and may react, identify the stakeholder engagement mechanisms with the most potential to meaningfully engage with the broader public. The comprehensive strategy should both convey compelling messages that harness the power of emotion and storytelling and enable two-way dialogue for more participatory planning.
5. Implement a “monitoring-evaluation-learning” process to gauge the impact of the campaign and adjust the strategy if and as required.

**BOX 5.7. Classifying the Political Economy of Subsidies: A Basic Framework**

Tariff reform will necessarily shape the amount that the service is subsidized, as well as how those subsidies are allocated across customer groups. Understanding the status quo and how different interest groups stand to benefit or lose is therefore a crucial element in both understanding the potential obstacles to reform and in designing an effective stakeholder engagement strategy that can facilitate its implementation.

A strategy to both foster supportive political coalitions and mitigate the impact of opponents is an essential element of any tariff reform strategy.<sup>1</sup> Broad and diffused interests tend not to be well organized, whereas concentrated interest groups can mobilize more readily and effectively to advance their narrower causes. This basic logic is behind a simple, political economy framework that categorizes the political equilibrium of a country’s subsidy policy (table B5.7.1) along two axes: (i) the size of benefits accruing to all households or individuals in the population (generalized benefits); and (ii) the size of benefits accruing to only particular segments, or interest groups, within that population. It is important to note that an interest group can be any group with a stake in the system; that is, either intended beneficiaries (such as the poor) or unintended beneficiaries (such as the rich who may disproportionately access networked services, or service providers or government actors profiting from inefficiencies in the system).

**TABLE B5.7.1. Characterizing Subsidy Policy Benefits: Basic Framework**

	Generalized benefits are large	Generalized benefits are small
Interest group benefits are large	Case 1	Case 2
Interest group benefits are small	Case 3	Case 4

Source: Adapted from Inchauste, Victor, and Schiffer (2018, 11).

*box continues next page*

### BOX 5.7. continued

Ultimately, the goal is to understand how interest groups might support or oppose government efforts toward tariff reform.<sup>2</sup> This will depend on the level of organization and political power of the groups concerned, as well as the ability of reformers to choose political allies and to weaken or even win over the political influence of groups that could potentially block a proposed reform's implementation.

A tariff reform may seek to shift this equilibrium, but of the four cases outlined in table 4.2, none is preferable in all contexts. For example, a tariff reform that effectively targets subsidies with the primary goal of benefiting the poor should strive toward case 2, while a reform seeking to gradually remove subsidies in order to attain cost-recovery tariffs should strive toward case 4.<sup>3</sup>

To design feasible reforms and implementation plans, it is crucial to figure out the current political equilibrium in a country and to develop a strategy for how to shift the status quo. For example, when generalized benefits and benefits accruing to interest groups are both large (case 1), the following may improve the feasibility of reform:

- The government communicates a strong, simple, and credible narrative, outlining the risks of the status quo and breaking complex economic processes down to a simple relatable logic;
- Citizens develop a better understanding of how the existing system is harmful to their interests—by, for example, effectively redistributing public funds to the wealthy—and mobilize to counter it;
- The government credibly commits to citizens and interest groups that reform will leave them either better off or the same. This may require offering them medium-term benefits to offset the loss of subsidies;
- Interest groups that would oppose reform find it difficult to mobilize, or the government finds a way to satisfy their core aims;
- The costs of providing benefits rise sharply (e.g., because of a fiscal crisis or impending water security crisis);
- The costs of subsidies are not sustainable, coupled with declining service quality; and
- External pressure from donors or lenders changes the political equilibrium.

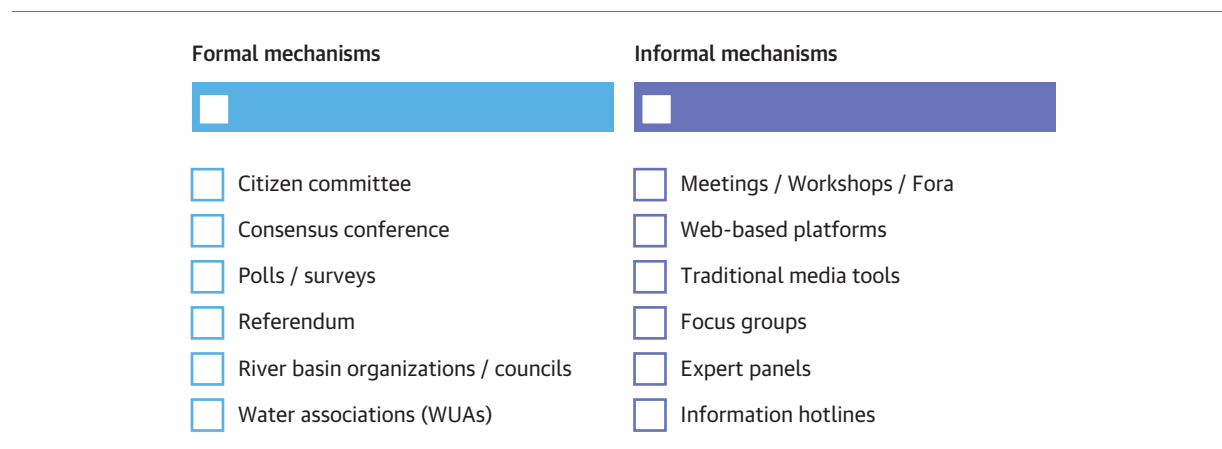
A detailed description of each type of case, as well as possible strategies for reform in each context, is provided in appendix C of "Doing More with Less: Smarter Subsidies for Water Supply and Sanitation" (World Bank 2019).

A wide range of mechanisms can be adopted to strengthen decision-makers' interactions with customers and other stakeholders in water tariff reforms. These mechanisms range from institutional arrangements such as interministerial bodies and citizen

committees to media-based tools and communication strategies (figure 5.1).

The OECD (2015) has developed a comprehensive taxonomy of mechanisms<sup>4</sup> to promote stakeholder engagement and community participation in water

**FIGURE 5.1. Formal and Informal Stakeholder Engagement Mechanisms**



Source: Adopted from OECD (2015).  
 Note: WUA = water user association.

sector governance. These also apply to tariff setting and reforms and are usefully classified into two categories:

- *Formal mechanisms.* These are institutionalized, typically stemming from an official agreement, and defined by clear operating rules. Examples are citizen committees, consensus conferences, polls or surveys, and water user associations.
- *Informal mechanisms.* These do not have an institutional or legal basis but deal with a variety of issues related to water governance, including tariff reforms, at the discretion of those involved. These include informal meetings or workshops, web-based platforms, media, focus groups, and expert panels.

### 5.6 Protecting Vulnerable Groups

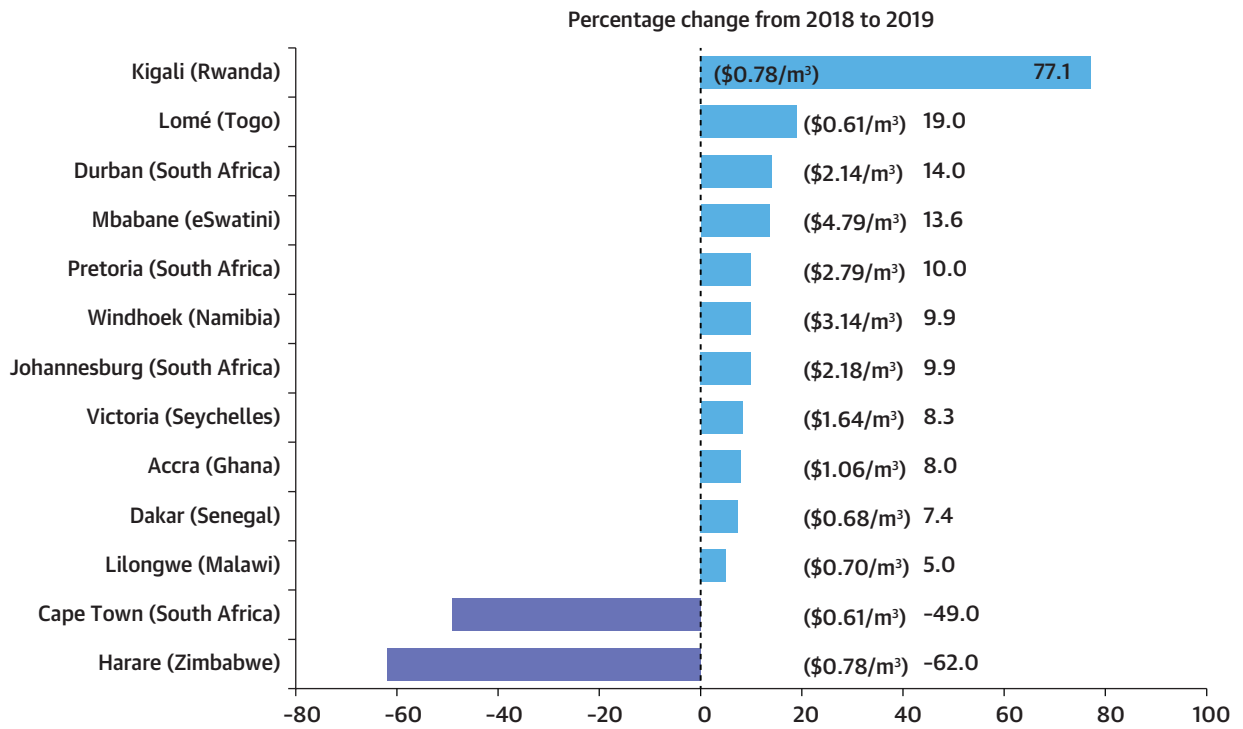
Resistance to tariff increases and restructuring becomes acute when there is a vicious spiral of bankrupt utilities providing poor services but not able to improve without higher revenues. Such utilities cannot readily increase collection rates and improve service delivery, and unpopular tariff increases then

become imperative to achieve cost recovery. This situation has occurred in all continents but is exemplified by examples from Sub-Saharan Africa where changes to tariffs in select countries exhibit huge variation across the region, with double-digit swings in both directions (figure 5.2). The negative spiral of production costs and investment needs significantly pushes up tariffs in most of the countries listed. The tariff increase of 77 percent in 2019 in Kigali (Rwanda) was particularly drastic and the largest in Africa. The only exceptions are tariff reductions in Harare (Zimbabwe), reflecting the sharp devaluation of the local currency, and Cape Town (South Africa), where the increase in heavy rainfall reduced water scarcity concerns and water restrictions, resulting in the largest drop in tariffs.

Where large tariff increases are to be implemented, tariff reform proposals should ideally make provisions to compensate vulnerable groups through a targeted subsidy or securing sufficient funding to improve the quality of water services for all and ultimately increase public acceptance of higher water tariffs as is the case in Portugal.



**FIGURE 5.2. Major Tariff Revisions in Sub-Saharan Africa in 2019**



Source: SIWI (2020), adapted from Figure 2: based on Global Value of Water White Paper 2019.  
 Note: m<sup>3</sup> = cubic meter.

## 5.7 Conclusions

The COVID-19 pandemic has put water at the forefront of the public policy agenda in developing economies. The immediate financial impact on utilities has typically been negative because industrial demand has declined, the ability to pay for water has been reduced, and in some cases, governments have instructed utilities to reduce tariffs or defer payments.

But as this chapter has confirmed, crises are times that can be exploited by farsighted leaders to bring about positive change through initiating tariff and broader sector reforms. One important area of further research would be to investigate how countries could turn the adverse COVID-19 impacts into an opportunity to more rapidly advance targets and ensure long-term sustainability of utilities, through

getting customers to accept and commit to paying tariffs commensurate with recovering the costs of an efficiently run utility. In other words, how to use COVID-19 as the launching pad for new reform initiatives, tying together financial investments, stakeholder engagement, and utility performance improvements to produce sustainable virtuous-circle outcomes.

Technological innovations that will make utilities more efficient and/or improve billing and revenue collection will also indirectly benefit consumers, provided the savings are passed on through lower tariffs. Smart metering has shown promise for applications in the electricity sector and the water sector in developed countries. There are also benefits for the water sector in developing economies but it remains to be demonstrated whether the costs

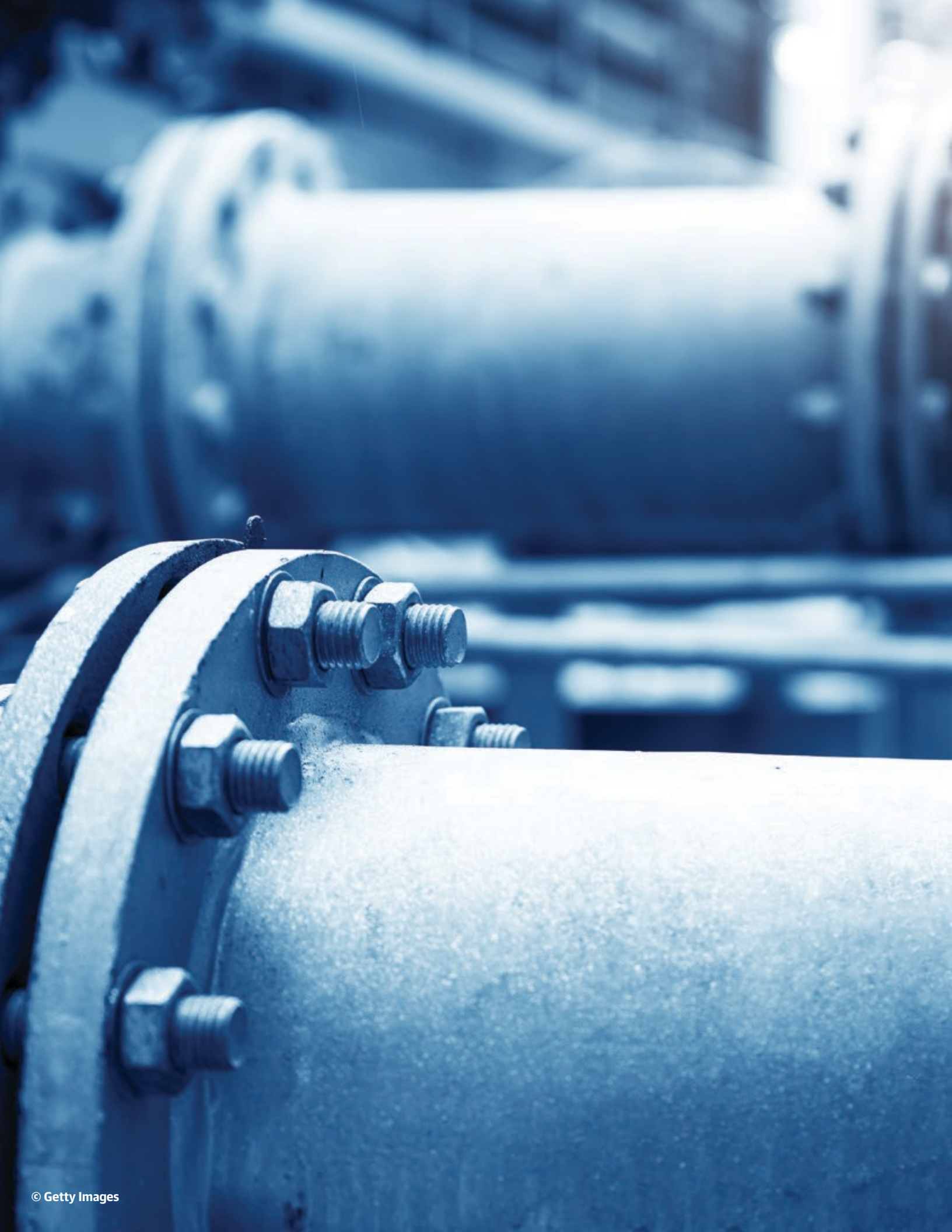
involved would be justified. Providing benefits for those already accessing piped water does nothing to address the needs of the much bigger group of low-income consumers who are not connected. Resources that would be needed for a water utility to implement smart metering could instead be used to roll out more automated kiosks.

The adoption of some of the innovative technologies discussed is likely to be resisted by incumbent providers and other entrenched interests. Initial costs are substantial, and this presents a problem when the return on investment is less clear in these situations than in those territories where adoption has already occurred. The relevance of the new technologies in the context of developing economies is variable with a clearer cost-benefit case being more easily made in regions subject to severe water scarcity. It should also be noted that the pace of adoption

of new technologies is being influenced by regulators and external agencies as well as by the commercial drive of firms developing and manufacturing the new technologies.

## Notes

1. This section is borrowed from “Doing More with Less” (World Bank 2019) and based on Inchauste, Victor, and Schiffer (2018, 11).
2. Note that not all interest groups will be politically organized. Moreover, within governments themselves, officials may hold conflicting positions regarding subsidy policy.
3. Note that only those situations where costs accrue largely to the government (taxpayers) while benefits accrue to interest groups and the general populace are considered in these four cases. In reality, the costs borne by citizens and interest groups would need to be considered in any comprehensive political economy analysis.
4. Regulatory public hearings are an equally important stakeholder engagement mechanism. For a summary of this practice in Latin America, see table 4.3 in World Bank (2018a).





## CHAPTER 6

# Final Remarks

The purpose of this study was to develop a deeper understanding of the wider implications of tariff structures and pricing on investments and water services, and the people who depend on them. Using real-world data and illustrative case studies collected from utilities across the globe, this report tackles some of the most pressing emerging questions in the water sector today, including: *How to identify and recover costs?; How to address affordability?; What is the most appropriate tariff structure for a given context?; Should external costs be recovered through tariffs?; Are tariffs a good mechanism to address water consumption?; What role should regulators and policy makers play?; and What are the key elements of successful tariff reform?* In discussing these topics, this report also highlights significant gaps in the current knowledge base that have been identified as part of this process and provides practical information to implement better-designed tariffs to further the economic efficiency, affordability, and environmental sustainability of services.

### 6.1 Core Concepts of Effective Tariff Reform

The results of this study are summarized in a series of core concepts founded upon longstanding principles of financial sustainability alongside a new paradigm that recognizes the important roles of taxes and transfers in achieving financial equilibrium.

- 1. Designing an effective tariff requires a sound understanding of underlying costs.** Total costs must be determined using the most appropriate calculation method. Improved financial literacy and management can lead to efficiency gains that can translate into increased service quality, willingness to pay, and cost recovery generating the scope to expand access and improve service quality while creating a positive feedback loop. Reconsidering service levels in line with customer expectations may lead to additional cost benefits and enhanced access.
- 2. Tariff design demands a holistic approach that carefully considers competing policy objectives.** Tariff structures should not be burdened with too many

policy objectives that in any case are context-specific. Instead, tariff complements can be applied to achieve specific aims, for example, addressing affordability and tackling barriers to access, as well as water conservation.

3. **Tariff complements are an effective means for addressing affordability and improving services.** Tariffs in isolation are ineffective at ensuring affordability. For example, increasing block tariffs (IBTs) with a “life-line” first block are intended to be pro-poor but are not necessarily fit-for-purpose. Current analytical methods designed to measure affordability are commonly undertaken at the macro scale, fail to capture local realities, and overestimate affordability. Thus pro-poor tariff structures in urban areas generally only benefit households that are already connected. Tariff complements and alternative affordability measures offer valuable solutions to address affordability while well-designed subsidies are intended to close residual gaps.
4. **IBTs can be enhanced by improving their design and combining them with tariff complements.** IBTs fail to send efficient pricing signals and are ineffective at targeting subsidies to poor households. The evidence is mixed on price elasticity of demand and likewise their effectiveness at addressing water conservation. However, IBTs are relatively easy to understand and implement, hence their wide utilization. Improving their design and combining them with select tariff complements can render them more effective.
5. **Regulation can help address the needs of unserved populations.** Light-handed regulation with links to off-utility business models in urban areas and slums can help ensure affordable and sustainable access by the poor. Leveraging subsidies toward connection charges is an effective tool to address pro-poor dimensions of expanding access. Nonfinancial interventions designed to encourage

connections—such as informational campaigns publicizing the benefits and prevalence of existing water connections—are effective in encouraging new connectivity and should be considered more broadly.

6. **Regulation can prevent inflated prices and costs, and encourage standards of service.** Lack of transparency and accountability can lead to customers resisting tariff increases and poor sector outcomes. Information asymmetry between utilities and regulators can give the utility a bargaining advantage that leads to inefficiencies, inflated costs, and poor quality of service. A strong regulatory agency, equipped with qualified personnel and leadership, can break the cycle of opacity and espouse transparency, thereby gaining societal consensus for increasing cost recovery.

In sum, tariffs are essential—but not the only path—to achieving cost recovery, addressing affordability, and managing water conservation. To maximize their potential, tariffs must be well designed, complemented by appropriate instruments, adequately regulated, and understood by customers.

Finally, new and innovative technologies exist that can support tariff design and lead to improved efficiencies. For example, innovations in mobile payments provide more flexible payment options, reduce transaction costs, and improve transparency. Prepayment meters for large institutions facilitate customer demand management and reduce the debt risk for utilities. Smart metering reduces water losses and theft. Coupling the introduction of more sophisticated tariff structures, such as dynamic pricing, with smart meters, can support customers to efficiently manage their demand, thereby reducing the costs imposed on the system. However, because smart meters can be expensive at the outset, their adoption requires a thorough assessment and thoughtful implementation strategy.









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## APPENDIX A

# List of Background Papers

- |           |   |
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| Paper 1.  | Cost of service provision               |
| Paper 2.  | Pursuing cost recovery                  |
| Paper 3.  | A classification of tariff structures   |
| Paper 4.  | Tariffs and regulation                  |
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## APPENDIX B

# Data Sources

The most comprehensive source of data on tariff structures is the International Benchmarking Network for Water and Sanitation Utilities (IBNET) tariff database on which this report primarily relies for analyses. The IBNET database contains data on tariffs for networked services for over 2,000 utilities, of which 75 percent provide both water and wastewater services.

### Grouping Data for Comparison

With data for over 2,000 utilities over the last 30 years, there are a variety of options for summarizing these data meaningfully. They were summarized in three main ways:

- *By utility.* This shows the percentage of utilities applying different tariff structures worldwide. This can skew the results toward countries with many utilities. For example, the database includes 71 utilities for Australia but only 1 utility for Uganda.
- *By country.* This shows the percentage of countries applying different tariff structures worldwide, by using the tariff structure of each country's most populous city as representative. This comparison obviously treats small and large countries as equivalent—for instance, the Republic of Kiribati has a population of 116,000 whereas India a population of 1.4 billion inhabitants according to 2019 IBNET data, but each will have equal weighting when comparing tariff structures.
- *By population served.* This shows the approximate percentage of persons being charged different tariff structures worldwide. It relies on population data from the IBNET tariff database, which may vary from the actual population served. This comparison will obviously skew results toward the tariff structures of the most populous countries, such as China, India, and the United States.

In some cases, a further breakdown by region is also shown. The regional categorization is summarized in table B.1.

IBNET also contains data over several years. Except for graphs that show prevalence over time, the data point in the most recent year available for each utility was employed. In other words, most of the graphs show the latest available data for each utility (as retrieved from the IBNET tariff database).

### Types of Tariff Structures

In assessing the prevalence of tariff structures worldwide, we rely on the definitions used in the IBNET tariff database, which are broadly consistent with those discussed in chapter 2 and are summarized again here as follows:

- *Flat rate tariffs.* Single fixed charge for water and wastewater services, independent of the volume of water consumed.
- *Constant volumetric/“one block” tariffs.* A single charge per unit volume of water consumed, with the same unit price for each consumption level.

- *Increasing block tariffs (IBTs),* with increasing rates for higher tiers of consumption.
- *Decreasing block tariffs (DBTs),* with the unit price decreasing with water usage to stimulate high-end users.
- *Jump tariffs,* commonly referred to as volume-differentiated tariffs (VDTs), where every unit of water consumed is priced at the highest tier in which total volume of usage falls.
- *Other tariffs.* These refer to other types of tariff structures including both fixed and variable elements that might change depending on the season or location of customers (i.e., tariff complements), or other arrangements such as value of the property. The category pools different tariff structures and complements and does not allow to distinguish between various types.

By IBNET’s definition, one-block tariffs, IBTs, DBTs, and VDTs may or may not also have a fixed component and therefore be two-part tariffs. We have done our own analysis on the same dataset and discuss two-part tariffs, but do not address them in the overview section because they are not mutually exclusive from other tariff types.

**TABLE B.1. Countries and Utilities Surveyed by Region**

Regions	Number of countries	Number of utilities surveyed
Sub-Saharan Africa (SSA)	40	281
East Asia and Pacific (EAP)	38	379
Europe and Central Asia (ECA)	59	910
Latina America and the Caribbean (LAC)	41	606
Middle East and North Africa (MENA)	19	156
North America region (NAR)	3	162
South Asia region (SAR)	7	69
Total	207	2,563

Source: IBNET 2020.

## Data Limitations

IBNET only provides data for the domestic/residential category. This means that we are unable to assess the prevalence of tariff structures for nonresidential

customers, although in many cases it is reasonable to assume that the tariff structure will be the same as for the residential category.









## APPENDIX C

# Simulating the Effects of Different Tariff Structures on Affordability and Efficiency

The approach to designing flat rates was twofold: (1) to satisfy the affordability objective, the residential tariff was set based on the affordable level for low-consumption households; and (2) to satisfy the cost-recovery objective, the nonresidential tariff was set to recover the costs of supply. The result is that low-consumption customers cross-subsidize high-consumption customers when viewed on a per cubic meter basis. This is especially true for low-consumption nonresidential customers. The simulation confirms common knowledge that flat rates do not send efficient pricing signals to customers as they fail to reflect the underlying cost of supplying different customer groups (table C.1).

The twofold approach to designing one-block tariffs is: (1) to satisfy the affordability objective, the residential tariff is set based on the affordable level for low-consumption households; and (2) to satisfy the cost-recovery objective, the nonresidential tariff is set to recover the costs of supply across all customer categories. The result is that nonresidential customers cross-subsidize residential customers, but the differentials are smaller than under other tariff structures.

Constant volumetric tariffs can be linked to marginal costs, but do not fully reflect the cost of supplying user groups. The average percentage deviation from the efficient tariff is 16 percent across customer categories, assigning one-block tariffs a score of “good” with respect to the economic efficiency objective (table C.2).

IBTs can be employed on their own as a fully volumetric structure or be combined with a fixed charge. In the latter case, they can be considered a special case of two-part tariffs where the volumetric component is based on a nonlinear unit price that increases with the volume of consumption (table C.3).

To satisfy the affordability objective, the first block tariff for residential customers was set based on the maximum affordable monthly bill for residential



**TABLE C.1. Flat Rate Efficiency Ranking**

	Residential			Nonresidential			
	Low	Medium	High	Low	Medium	High	Very High
Cost of supply (US\$/m <sup>3</sup> )	3.3	2.4	2.2	3.0	2.3	2.2	2.0
Average tariff (US\$/m <sup>3</sup> )	2.0	1.1	0.9	3.2	2.5	2.4	2.2
Deviation from efficient tariff (%)	40	75	86	394	65	33	93
Summary							
Average % deviation:	112		Ranking:		Bad		1

Note: m<sup>3</sup> = cubic meter.

**TABLE C.2. One-Block Efficiency Ranking**

	Residential			Nonresidential			
	Low	Medium	High	Low	Medium	High	Very High
Cost of supply (US\$/m <sup>3</sup> )	3.3	2.4	2.2	3.0	2.3	2.2	2.0
Average tariff (US\$/m <sup>3</sup> )	2.0	2.0	2.0	2.3	2.3	2.3	2.3
Deviation from efficient tariff (%)	40	17	9	23	3	5	14
Summary							
Average % deviation:	16		Ranking:		Good		3

Note: m<sup>3</sup> = cubic meter.

**TABLE C.3. IBT Efficiency Ranking**

	Residential			Nonresidential			
	Low	Medium	High	Low	Medium	High	Very High
Cost of supply (US\$/m <sup>3</sup> )	3.3	2.4	2.2	3.0	2.3	2.2	2.0
Three-block IBT							
Average tariff (US\$/m <sup>3</sup> )	2.0	2.6	3.3	1.5	2.1	2.3	2.3
Deviation from efficient tariff (%)	40	8	50	49	5	3	16
Four-block IBT							
Average tariff (US\$/m <sup>3</sup> )	2.0	2.5	3.0	1.5	2.1	2.3	2.4
Deviation from efficient tariff (%)	40	5	35	49	6	5	19
Ranking							
Average % deviation: three-block IBT	24		Moderate				2
Average % deviation: four-block IBT	23		Moderate				2

Note: IBT = increasing block tariff; m<sup>3</sup> = cubic meter.

households and the following step changes in the residential block tariffs were applied:

- *Three-block IBT.* The second block tariff is 50 percent higher than the first block, and the third block tariff 100 percent higher than the first block tariff. The consumption block thresholds are 20 cubic meters (m<sup>3</sup>)/month for the first block and 50 m<sup>3</sup>/month for the second block.
- *Four-block IBT.* The second block tariff is 20 percent higher than the first block, the third block tariff is 50 percent higher than the first block, and the fourth block tariff is 100 percent higher than the first block tariff. The first consumption block reaches 15 m<sup>3</sup>/month, the second block threshold is at 30 m<sup>3</sup>/month, and the third block covers 80 m<sup>3</sup>/month.

To satisfy the cost-recovery objective, the nonresidential tariff was set to recover the costs of supply across all customer categories, assuming the same step changes in the block tariffs as for residential customers:

- In the three-block scenario, the resulting tariffs deviate from the efficient tariff by 24 percent on average across all customer categories.
- Because the tariff increases are less steep, there is not as much distortion to the efficiency objective

in the four-block scenario. Although the percentage deviation from the efficient tariff is only marginally lower than under three-block IBTs, the difference would become more pronounced as more blocks are added.

Using the same block thresholds as the three-block IBT, jump tariff increases were set across consumption blocks such that they are less steep, while still keeping average tariff levels the same. The second block tariff was 30 percent higher than the first block tariff, and the third block tariff 65 percent higher than the tariff applied to the first block. To satisfy affordability, the first block tariff for residential customers is set based on the maximum affordable bill for low-consumption residential households. To satisfy cost recovery, the first block tariff for nonresidential customers is set as to cover all remaining costs of supply.

For the same average residential tariffs, jump tariffs achieve cost recovery with less steep tariff increases across subsequent consumption blocks than IBTs (table C.4). Jump tariffs charge the higher block unit price of all previous units of water consumed and avoid subsidizing the first consumption blocks for medium- and high-consumption customers as is the case in IBTs. Jump tariffs also appear to send more efficient pricing signals as the percentage

**TABLE C.4. Jump Tariff Efficiency Ranking**

	Residential			Nonresidential			
	Low	Medium	High	Low	Medium	High	Very High
Cost of supply (US\$/m <sup>3</sup> )	3.3	2.4	2.2	3.0	2.3	2.2	2.0
Average tariff (US\$/m <sup>3</sup> )	2.0	2.6	3.3	1.8	2.2	2.2	2.2
Deviation from efficient tariff (%)	40	8	50	42	1	1	10
Ranking							
Average % deviation:	22			Ranking:	Moderate		<b>2</b>

Note: m<sup>3</sup> = cubic meter.

average deviation from efficient tariffs is 22 percent against 24 percent for three-block IBTs. This comparison of deviation is however based on average tariffs and omits an additional effect—under an IBT the marginal price faced by a high-consuming customer is the rate for the highest block, which is significantly more than the jump tariff rate.

The DBT scenario assumes that the second block tariff is 30 percent lower than the tariff applied to the first block, and the third block tariff 60 percent lower than the first block tariff. The same consumption block sizes are also applied. To satisfy affordability, the first block tariff for residential customers is set based on the maximum affordable bill for low-consumption households. To satisfy cost recovery, the first block tariff for nonresidential customers is set to recover the costs of supplying different customer groups.

DBTs reflect the higher cost of supplying low-consumption nonresidential customers (large customers are cheaper to supply) and deviate from the efficient tariff by 24 percent on average (table C.5). However, this tariff structure allows high-end users to pay less than average water tariffs, while penalizing consumers in low-consumption tiers, and is therefore often considered to promote unfairness. For this reason, DBTs are in most cases politically

difficult and seldom employed to price water and wastewater services.

To satisfy efficient pricing, the fixed charge for two-part tariffs was set to recover the fixed costs for each customer category. To satisfy affordability, the residential volumetric charge was based on the maximum volumetric tariff to ensure affordability. This is lower than the residential cost of supply for low-consumption residential customers. To satisfy cost recovery, the nonresidential volumetric charge was set such as the costs of supply are recovered.

The resulting pricing structure is more efficient than flat rates but does not fully reflect the underlying cost of providing services to different customer groups according to their marginal costs of supply. This is due to the affordability constraint on low-consumption residential customers.

When affordability constraints are not so stringent, however, two-part tariffs are the most efficient pricing option (table C.6). Where the volumetric charge is based on the maximum affordable bill and on top of that, fixed charges are set to recover the fixed costs of serving each customer category, the resulting tariff is an efficient structure, which exceeds the 5 percent affordability threshold (low-consumption residential customers spend approximately 8 percent of their monthly income on water bills).

**TABLE C.5. Decreasing Block Tariff Efficiency Ranking**

	Residential			Nonresidential			
	Low	Medium	High	Low	Medium	High	Very High
Cost of supply (US\$/m <sup>3</sup> )	3.3	2.4	2.2	3.0	2.3	2.2	2.0
Average tariff (US\$/m <sup>3</sup> )	2.0	1.6	1.2	4.1	2.5	2.2	2.0
Deviation from efficient tariff (%)	40	32	45	38	13	1	1
Ranking							
Average % deviation:	24			Ranking:	Moderate		2

Note: m<sup>3</sup> = cubic meter.

**TABLE C.6. Two-Part Tariff Efficiency Ranking**

	Residential			Nonresidential			
	Low	Medium	High	Low	Medium	High	Very High
Cost of supply (US\$/m <sup>3</sup> )	3.3	2.4	2.2	3.0	2.3	2.2	2.0
With 5% affordability constraint							
Average tariff (US\$/m <sup>3</sup> )	2.0	1.1	0.9	3.2	2.5	2.4	2.2
Deviation from efficient tariff (%)	40	56	61	7	10	10	11
Without affordability constraint							
Average tariff (US\$/m <sup>3</sup> )	3.3	2.4	2.2	3.0	2.3	2.2	2.0
Deviation from efficient tariff (%)	0	0	0	0	0	0	0
Ranking							
Average % deviation—with affordability constraints	28			Moderate		2	
Average % deviation—without affordability constraints	0			Very good		4	

Source: Original analysis.

Note: m<sup>3</sup> = cubic meter.







## APPENDIX D

# Simulation of Potential Reductions in Tariff Levels Resulting from Reducing Inefficiencies

<b>**Assuming 50%-50% split in nontechnical efficiencies between these two</b>										
	Current value (USD/m <sup>3</sup> )		Reduce nontechnical inefficiencies by bill collection by 75% (a)		(A) + Reduce nontechnical inefficiencies by nonrevenue water by 75% (b)		(A) + (b) + Reduce overstaffing inefficiencies by 75% (c)		(A) + (b) + (c) + Reduce CAPEX inefficiencies by 75% (d)	
Regions			(A)		(A) + (b)		(A) + (b) + (c)		(A) + (b) + (c) + (d)	
	Average tariff (USD/m <sup>3</sup> )	Full tariff (USD/m <sup>3</sup> )	Adjusted value (USD/m <sup>3</sup> )	Variation	Adjusted value (USD/m <sup>3</sup> )	Variation	Adjusted value (USD/m <sup>3</sup> )	Variation	Adjusted value (USD/m <sup>3</sup> )	Variation
World	\$0.90	\$2.13	\$2.12	-0.36%	\$2.11	-0.63%	\$2.11	-0.73%	\$2.00	-6.06%
South Asia	\$0.18	\$0.69	\$0.68	-0.47%	\$0.68	-0.82%	\$0.66	-4.07%	\$0.63	-8.03%
Europe & Central Asia	\$0.75	\$2.07	\$2.06	-0.29%	\$2.06	-0.51%	\$2.04	-1.18%	\$1.86	-10.19%
East Asia & Pacific	\$1.26	\$1.12	\$1.12	-0.20%	\$1.12	-0.34%	\$1.12	-0.63%	\$1.09	-2.86%
Latin America & Caribbean	\$0.84	\$3.16	\$3.15	-0.39%	\$3.14	-0.68%	\$3.17	0.25%	\$3.00	-4.88%
Middle East & North Africa	\$0.31	\$1.29	\$1.28	-0.22%	\$1.28	-0.38%	\$1.22	-5.60%	\$1.19	-7.72%
Sub-Saharan Africa	\$0.79	\$2.94	\$2.92	-0.73%	\$2.91	-1.27%	\$2.86	-2.86%	\$2.61	-11.28%
High income	\$1.21	\$0.97	\$0.97	-0.26%	\$0.97	-0.45%	\$0.96	-1.43%	\$0.94	-3.49%
Upper middle income	\$0.81	\$3.06	\$3.05	-0.40%	\$3.04	-0.69%	\$3.05	-0.23%	\$2.87	-6.34%
Lower middle income	\$0.27	\$2.19	\$2.19	-0.29%	\$2.18	-0.51%	\$2.16	-1.75%	\$2.03	-7.23%
Low Income	\$0.72	\$4.37	\$4.35	-0.49%	\$4.34	-0.86%	\$4.30	-1.55%	\$3.98	-8.95%

Note: CAPEX = capital expenditure; m<sup>3</sup> = cubic meter.











## APPENDIX E

# Estimating Revenues to Meet Financial Objectives

The following case is one possible example for meeting financial objectives.<sup>1</sup> Let's assume a water utility's current annual sales by volume (100 million m<sup>3</sup>/year) are expected to grow at an average of 2.5 percent per year. Operation and maintenance (O&M) costs are estimated at US\$0.20/m<sup>3</sup>. Fixed assets have a historical value of US\$150 million and are depreciated over a 30-year period. A total of US\$90 million was financed through loans that have been repaid in full and a total of US\$15 million was received through a development grant. A further US\$45 million was recently financed through debt (with a tenor of 20 years at an interest rate of 6 percent), to be repaid until year 15. Future debt is expected to be raised on similar terms. The average annual capital expenditure for distribution network extensions is US\$5 million and a major production project valued at US\$70 million is expected to be commissioned in year 6. All the above figures are given in constant prices for year 0. The average inflation rate is estimated at 3 percent.

The regulator has been requested to propose a sequence of revenues<sup>1</sup> that limit future annual increases to 3 percent, i.e., the expected inflation rate.

*Cash needs.* If future capital expenditure (CAPEX) is entirely financed on debt, the revenues needed to cover each year of O&M costs and the debt service would have to be gradually increased from US\$0.24/m<sup>3</sup> in year 0 to US\$0.29/m<sup>3</sup> in year 5 and more steeply to US\$0.36/m<sup>3</sup> in year 6 (a 25 percent increase). This sequence of revenues meets cash needs but does not comply with annual tariff adjustment restrictions. An initial tariff of US\$0.2775/m<sup>3</sup> increased by 3 percent per year during the following 10 years would cover all cash costs, and initially build a cash reserve that would gradually disappear over the 10-year period.

*Cash needs with contribution to CAPEX.* If 25 percent of the predicted CAPEX is to be financed by cash surpluses, the revenue increase needed in year 6 to contribute to the lumpy investment would be almost 80 percent. Such high revenues would not be needed after year 6, so to limit increases in annual revenues, a cash reserve would have to be built before year 6. An initial revenue set at

US\$0.29/m<sup>3</sup> and gradually increased by 3 percent per year would be sufficient to contribute to the CAPEX, after which cash reserves would be at a minimum.

*Utility costs.* If the utility is to cover its O&M costs, depreciate its fixed assets and yield an average 8 percent return on fixed assets, the tariff would have to be set at an initial level of USD\$0.4225/m<sup>3</sup> and gradually increased by 3 percent per year thereafter. This sequence of revenues would result in a cash reserve of almost US\$200 million by year 10, or about two-thirds of the value of assets. Lowering the initial revenues to US\$0.3225/m<sup>3</sup> would limit the return on assets to 2 percent and the cash surplus to US\$50 million, while still meeting all cash needs during the 10-year period.

*Hybrid utility costs.* A “hybrid” model would consist of setting revenues to cover O&M costs, the debt service, the depreciation of equity financed assets and a return on equity of 8 percent. An initial average revenue of US\$0.3625/m<sup>3</sup> gradually increased by 3 percent per year would meet this objective and limit the cash reserves to about US\$100 million in year 10. Limiting the return on equity to 2 percent would require an initial revenue of US\$0.31/m<sup>3</sup> and reduce the cash reserve in year 10 to about US\$30 million.

### Note

1. In this appendix, revenues refer to average revenues per cubic meter.

