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Setting Efficient Tariffs for Wastewater Infrastructure

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Observers have long noted that tariffs for water services are often not high enough to cover the costs of the network and offer efficient signals to customers, but this is also true for wastewater services. George Anstey discusses the results of a survey undertaken of five well-developed regimes from the UK, Australia, US and Brazil which found examples of good practice, but even at this level there are issues around recovering full costs of wastewater infrastructure.

Pricing in the water industry is a politically sensitive issue in many countries. As an industry often remaining in government hands and one with an important public health role, setting tariffs for water prices is often a compromise between a variety of social objectives. These social objectives can include 'fairness', transparency and potential conflicts with government environmental and social policy. In practice, satisfying these various objectives has come at the cost of adopting water pricing which reflects the cost structure of supplying water services.[1]

Setting prices for all water services in a manner that reflects the utilities' costs is a key management issue for increasing efficiency in the sector. Without cost-reflective tariffs, water utilities may run into financial difficulty or suffer from a shortage of capacity and have to ration services between users.

In recent years, rising water scarcity has brought the problem into starker relief in the water sector.[2] The water utilities of the fastest growing countries are subject to particular pressure, where subsidies are ballooning to keep pace with rapidly urbanising populations in China and the water-scarce Middle East. For example, in the fast-growing United Arab Emirate of Abu Dhabi alone, combined water and wastewater subsidies will almost double from AED 5.7 billion ($1.6 billion) to AED 10 billion (around $2.7 billion) between 2008 and 2015.[3] On the back of rising pressure on the water and wastewater systems, many utilities in emerging markets recognise that the future lies not just in meeting water demand, but using effective pricing to manage it.

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Whilst growing pressures on the water system are concentrating minds on the need for cost-reflective pricing for water, wastewater tariffs have often remained the poor relation. Even in many developed jurisdictions, wastewater tariffs have historically been unmetered and / or based on some measure of property value and that legacy continues to the present day. Nonetheless, cost reflective wastewater pricing is important for the financial viability of water utilities and for efficient consumption of both water and wastewater services.

This article explains why tariffs reflecting costs are important for increasing efficiency and provide a snapshot of the state of best regulatory practice. The survey covers five international jurisdictions:

- England and Wales
- Perth, Western Australia
- Melbourne, New South Wales, Australia
- Los Angeles, USA
- Sao Paolo, Brazil

The survey shows that even well-developed jurisdictions have a long way to go before pricing will fully reflect the underlying structure of costs of providing wastewater services.

Prices that Reflect Costs Enhance Economic Efficiency

Economic theory uses the term 'economic efficiency' to describe the allocation of resources which maximises the production of goods and services for society as a whole. The overarching lesson from the economics literature is that in order to enhance efficiency (and increase social welfare), prices in every sector of the economy should reflect the underlying structure of costs. In principle, there are three important categories of costs that tariffs in the wastewater sector should seek to reflect to enhance economic efficiency, for a mix of theoretical and pragmatic reasons: total costs, marginal costs and the costs of a customer class. Wastewater tariffs should reflect these costs for a variety of reasons (see Figure 1):

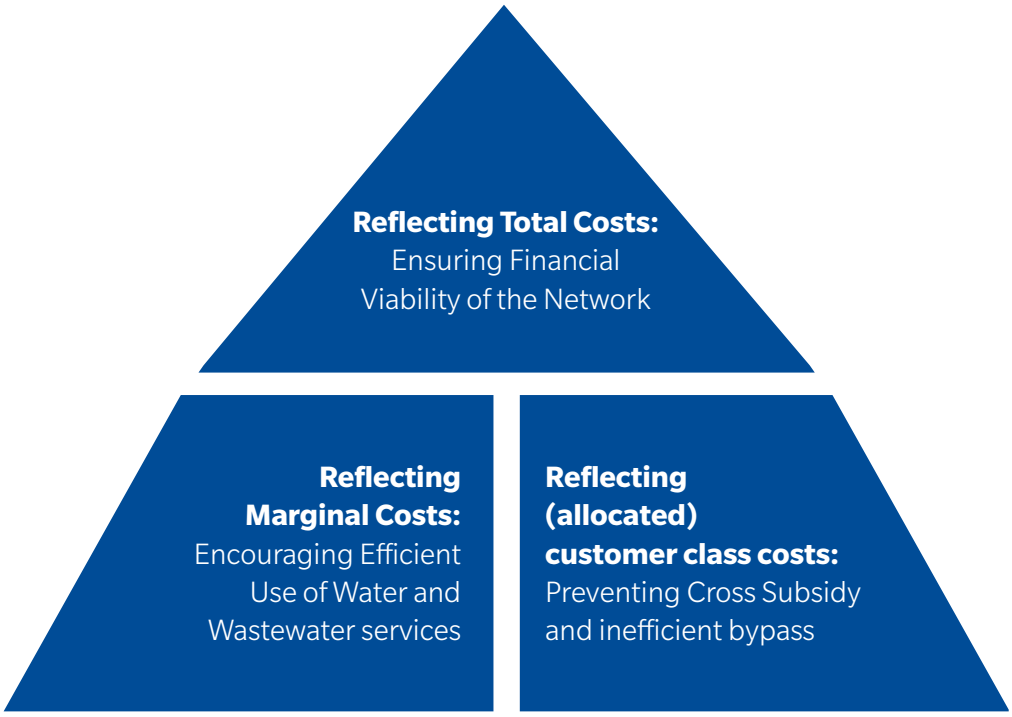
- Tariffs that do not reflect total costs (including depreciation, opex (operational expenditure) and return) may cause water utilities to run into financial difficulty, call on government funds, or hinder private sector involvement, which could otherwise increase the efficiency of the sector.

- Tariffs that do not reflect marginal costs mean that users will not make efficient use of water services. The absence of marginal cost signals in pricing results in over or under-provision in the service from a social perspective.

- Tariffs that do not reflect the costs of a customer class result in 'cross-subsidies' from other users that can either prevent efficient competition or encourage inefficient entry in the sector.

Reflecting total and marginal costs and the costs of a customer class in final tariffs will tend to increase efficiency in the use of the wastewater network. In general, it is not possible to reflect all of these costs perfectly or simultaneously and all tariffs regimes are a compromise between reflecting these different categories of costs. The balance between reflecting these different cost categories depends on the priorities of the utility and the regulator. A survey of five well-developed regimes illustrates that tariffs remain relatively unsophisticated and focus on total cost recovery, albeit that there are some moves to sharpen the marginal signals offered by prices.

Figure 1. **Efficient tariffs reflect different costs for different reasons.**



Source: NERA Analysis

Sophisticated Regimes Recover Total Costs

The starting point for cost-reflectivity for many regulatory regimes is that total revenues from wastewater tariffs reflect the total costs of the service – a principle also widely known as the 'user pays principle', 'full cost recovery' or FCR.[4] Total costs include depreciation of the assets that make up the wastewater network, operating expenditure, tax and return on past investments.

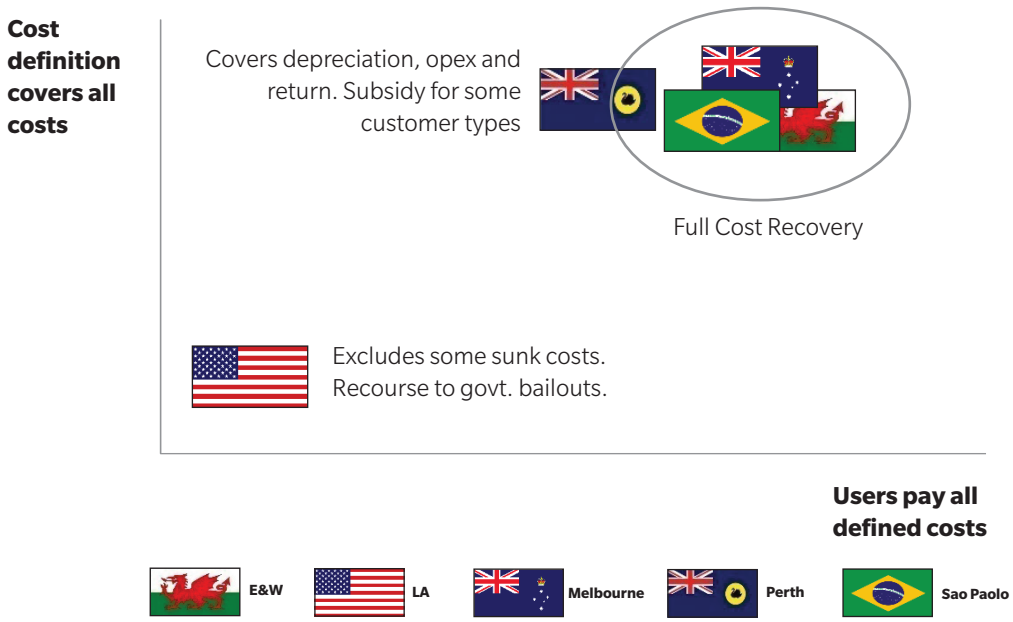
Part of the reason for setting tariffs that cover total costs is pragmatism; tariffs ensuring full cost recovery remove the need for government subsidy and ensure the financeability of wastewater utilities. In the current backdrop of rising costs in the water sector and as economic conditions place pressure on government funds, ending government subsidy can seem particularly attractive to policymakers.

In principle, tariffs which reflect total costs need not increase economic efficiency in the short-term. For example, if the cost of providing additional wastewater services is negligible because the costs of the necessary infrastructure have already been sunk, it might be efficient in the short run to charge a price for water services that does not recover total costs. However, over the longer-term, designing tariffs which reflect total costs will tend to increase efficiency where:

- Such tariffs encourage private sector investment in the provision of wastewater services by establishing a precedent that costs will be recovered
- The alternative is no charge for water services, which can encourage overuse of the network and shortages or rationing of services
- Simple charges are a first step along the road toward adopting more efficient pricing signals

FCR requires, first, a complete definition of costs (including depreciation, opex, tax and return), and second, a contract or regulator that allows those defined costs to be recovered in practice. Most regulatory regimes in developed countries ensure FCR, a fact reflected in the five regimes surveyed (see Figure 2).[5]

Figure 2. **Even in OECD countries, tariffs do not always ensure full cost recovery.**



Source: NERA Research and Analysis.

Of the five regimes reviewed, four had reasonable rules for updating the asset base and depreciating the value of existing assets over time (to provide incentives for cost-efficiency, some regulatory incentive mechanisms did not guarantee full cost pass through, which may also allow regulators over time to deny full cost recovery). Of these four regimes, only Perth allowed any kind of subsidy from the (state-owned) water company to cover the costs of serving particular customer types. Los Angeles was the only significant exception to ensuring FCR and provides a cautionary tale.

When the Bureau of Sanitation in Los Angeles first introduced tariffs for wastewater in 1972, the municipal authorities made no allowance for the sunk costs of investing in existing infrastructure. Early tariffs only covered a small portion of the wastewater network's costs. Even today, tariffs cover the Pay-As-You-Go costs of the system and do not reflect either investments undertaken before 1972 or any investments undertaken with government funds since then. Given the long life of assets in the wastewater industry, current tariffs may still be significantly lower as a result of omitting these cost categories.

The low level of tariffs has caused a number of problems for the wastewater utility. The city's 'Clean Water Programme' (CWP) was not financially independent until 1987. Even since then, the CWP has had to repeatedly call on government funds to reduce sewer spills and comply with environmental legislation, including a $1.6 billion subsidy during the 1990s.

Table 1. **In practice, most regimes do not estimate marginal costs but do seek to signal costs to end users.**

Jurisdiction	LRMC Modelling	Fixed and variable costs	Fixed and variable tariffs	Volumetrc Rate	Varies by strength (industrial)
 E&W	No	For Metered users	For Metered users	For Metered users	BOD & SS
 LA	No	Industrial only	Industrial only	All users	BOD & SS
 Melbourne	Whole-sale level	Varies	Yes	All users	BOD & SS & Other
 Perth	Industrial-strength only	Industrial only	Industrial only	Industrial users	BOD & SS & Other
 Sao Paolo	No	No	No	All users	Customer class

Source: NERA Research and Analysis. BOD = biochemical oxygen demand. SS= suspended solids. 'Other' = other factors such as metals and nitrates. Red = not at all. Amber = to some extent. Green = widespread.

Sophisticated Regimes Employ Some Marginal Cost Signals

Marginal costs are the costs of producing an additional unit of output. Economic theory suggests that customers will make economically efficient choices about their consumption levels when the marginal price is equal to the marginal cost of provision. In the case of wastewater tariffs, that would usually equate to the unit rate on tariffs being equal to the marginal cost. If the unit rate on tariffs is below the marginal cost of provision, customers will tend to over-consume wastewater services, putting an excessive financial burden on the utility.

Evidence on the demand for water services shows that marginal prices have material impacts on consumption and economic efficiency in practice.[6] The importance of adopting tariffs that reflect marginal costs is further reinforced when one considers the knock-on impacts in the water sector. The consumption of water and wastewater services is a joint decision whenever a consumer discharges water it has consumed to the sewer. As a result, ensuring that wastewater charges reflect marginal costs is important not just for efficient consumption of wastewater services, but also for efficient water use.[7]

In the short run, the marginal costs of a wastewater utility are likely to be low and involve principally additional pumping and treatment. Setting charges equal to marginal costs in the short run is likely to result in very low charges whilst there is spare capacity on the network. On the other hand, when capacity is scarce, the short run marginal cost of coping with additional sewage would be very high, including the additional costs of new infrastructure. As a result, charges based on short run marginal costs are likely to be volatile over time, which can cause problems for financeability and the acceptability of tariffs. Instead, utilities and regulators may prefer to set tariffs which reflect the Long Run Marginal Costs (LRMC) in their tariffs. LRMC covers the costs of collecting, treating and disposing of effluent over the long-term (usually 20-plus years), including the costs of future infrastructure necessary to meet an additional unit of load.

In practice, signalling marginal costs through marginal prices is not widespread, even in OECD (Organisation for Economic Co-operation and Development) countries. However, many regimes provide at least some incentives for customers to make efficient use of the wastewater network by employing charges which vary by volume and strength, for at least some customer classes (as demonstrated in Table 1 for the four countries surveyed).

The most sophisticated regimes surveyed were in Perth and Melbourne where the regulators make use of LRMC (long run marginal cost) modelling as the basis for marginal prices. Melbourne Water uses LRMC modelling only at the wholesale level, and in Perth only industrial customers pay charges based on the LRMC of their discharge.

Four of the regimes estimated fixed and variable costs separately and then allocated them separately to different charges for at least some users. Whether separate calculation of fixed and variable costs and charges is more efficient than other methods is an empirical question. At the very least, separating fixed and variable costs and charges reflects the structure of the underlying costs of the utility.

In all five well-developed regimes we surveyed at least some customers pay volumetric charges, including all customers in Los Angeles, Sao Paolo and Melbourne. However, 60% of domestic customers in England and Wales and the entire group of domestic customers in Perth pay completely fixed annual wastewater charges.

Four of the wastewater companies charge industrial customers according to strength-reflecting formulae. The formulae base annual charges on the average unit cost of treating waste discharged by the industrial customer according to at least two strength factors (biochemical oxygen demand (BOD) and suspended solids (SS)). In Sao Paolo, the level of the tariff is higher for industrial customers, although it is not clear whether those tariffs reflect pragmatic considerations or the higher costs associated with industrial strength waste.

Regulators Make Some Attempt to Allocate Costs According to Which Groups Impose Them

Segmenting tariffs so that different groups of customers pay different tariffs is an important mechanism for ensuring that customers make efficient use of the network. Where utilities do not reflect the costs of customer groups accurately in tariffs, customers with alternative options may go 'off system' and treat their own waste as a way of avoiding tariffs.

The accepted definition is that a customer class is receiving cross-subsidy, if it does not cover its incremental costs (or net avoidable costs).[8] The problem for policymakers is that this criterion does not provide a unique allocation of the costs of the network in the presence of economies of scale. After charging customer classes their net avoidable costs, the utility must allocate a residual cost between customers in order to achieve full cost recovery. The process of allocating costs to customer classes establishes a cap and floor:

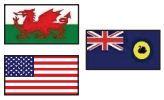
- Each customer class should pay at least its net avoidable cost, so that each customer group pays for its collective burden on the network

- Utilities should keep tariffs below the standalone cost for that customer class, to ensure that customers do not inefficiently bypass the system

Allocating costs between customer classes using avoidable cost principles means that some customers will pay less for wastewater services than others. However, every group of customers will pay less overall than they would do if they had to go it alone, and each customer class contributes to the joint fixed costs of the network.

In practice, all five regimes we reviewed had policy statements prohibiting cross-subsidy but none had established rules defining minimum and maximum proportions of costs that each customer class should bear. The tariff-setting procedures in all five jurisdictions lack explicit definitions for net avoidable or incremental costs and firm legal definitions of those costs. Neither do the tariff-setting procedures explicitly define tariffs for customers by seeking to minimise inefficient bypass or overuse of the wastewater infrastructure.

Table 2. **Some regulators separate fixed and variable costs, others allocate costs using volume, strength and geography.**

	Used	Not used	Unknown
Estimate Separate Costs of Billing or I&C			
Volume Drivers	 *		
Strength Drivers			
Geography	 ** **		

 **E&W**  **LA**  **Melbourne**  **Perth**  **Sao Paolo**

Source: NERA Analysis and Research.

Notes: * In Perth, the regulator has argued that there may be cross subsidy because revenues do not reflect volumes. Tariffs for industrial customers take account of wastewater strength

** In England and Wales and in Melbourne prices do not vary geographically within wastewater retail companies' regions. I&C = Industrial and Commercial customers.

Regulators do take some practical steps to allocate costs among customer classes by: identifying the additional costs from serving a particular customer group; ensuring these are recovered in full from the respective customer class; then dividing left-over costs by transparent criteria. Various methods are used to allocate costs among classes.

- In Los Angeles, Perth and England and Wales, industrial users and subcategories of industrial users pay separate charges to cover the fixed costs of inspection, control and monitoring of the industrial waste permitting programme.

- In Los Angeles, England and Wales, Melbourne and Perth the tariff regime allocates costs among customer classes on the basis of the volume and strength of waste produced by that customer class.

- In England and Wales and Melbourne, customers pay different charges if they are served by the different retail companies, which are located in different geographies. In Sao Paolo, SABESP charges customers in different locations different charges based on the costs of serving different jurisdictions.

Concluding Thoughts

Introducing more cost-reflective pricing of wastewater services in developing and emerging economies could substantially increase economic efficiency. The benefits are arguably the greatest in fast-developing countries where the ability of tariffs to influence decision making is greater. For example, by setting higher (or lower) prices, utilities may be able to influence industrial customers' location decisions and the technologies that they install for wastewater treatment at the outset of operations.

Growing water scarcity due to climate change, rapid population growth and industrialisation in many emerging markets is focusing minds on the problem of water pricing. Wastewater pricing, long the poor relation, has remained less affected by the growing trend towards efficient pricing. As a result, there are few regimes that exemplify cost-reflective wastewater pricing for utilities in developing and emerging economies.

There are some key examples of cost-reflective pricing that rapidly growing economies with urbanising populations could follow. Most of the well-developed regimes we reviewed allowed utilities to recover their full costs from tariffs. Some regimes have introduced tariffs based on LRMC, although they still only apply at the bulk supply level. Regulators do recognise the need to discourage cross-subsidy and utilities make some effort to allocate costs to the customer groups that drive them, even in the absence of firm legal cost definitions which prevent cross-subsidy. The most cost-reflective prices ensure full cost recovery, whilst providing users with signals to use the wastewater infrastructure efficiently.

The overall picture is that there is a long way to go before waste water tariffs reflect the underlying costs necessary to promote economic efficiency, even in well-developed regimes.

Notes

[1] For example, Rogers et al (2002), list 17 objectives that policymakers typically target when setting water tariffs. As the authors put it "The problem faced by the water sector is that prices and tariffs are almost universally below the full-cost of supply". Rogers, P., de Silva, R., and Bhatia, R., (2002), "Water is an economic good: How to use prices to promote equity, efficiency, and sustainability", *Water Policy*, Vol 4, page 6.

[2] See for example, Jiang, Y., (2009), "China's water scarcity", *Journal of Environmental Management, Vol 90, page 3185-3196 and Jian Xie (2009), Addressing China's Water Scarcity, The World Bank, pages 83 to 95, Kirkpatrick, C, Parker, D and Zhang, Y (2006), State Versus Private Sector Provision of Water Services in Africa: An Empirical Analysis, The World Bank Economic Review. Vol 20, Iss 1. p143.*

[3] Regulation and Supervision Bureau (2011), Review of costs, tariffs and subsidies in the water, wastewater and electricity sectors of Abu Dhabi for 2010, 1 October 2011.

[4] Most existing reviews of cost reflectivity consider whether tariffs recover total costs, perhaps in part as a stepping stone towards providing more sophisticated marginal pricing signals. See for example, the discussion in See for example, Banerjee, S., Foster, V., Ying, Y., Skilling, H. and Wodon, Q. (2010), "Cost Recovery, Equity, and Efficiency in Water Tariffs Evidence from African Utilities", *Policy Research Working Paper, World Bank.*.

[5] For a discussion of the wide accepted of FCR principles in tariff setting in OECD countries, see: Christian-Smith, J., Gleick, P., and Cooley, H. (2011), *The Worlds' Water, Chapter 7, US Water Policy Reform, page 144.*

[6] As far back as 1999, the OECD commented that: there was "evidence that households, businesses and agricultural producers generally do change their water consumption patterns in response to changes in such variables as price levels, metering penetration and seasonal pricing" *OECD (1999), The Price of Water, page 11. More recent evidence includes Ward, M. and White, C. (2012), Managing residential water demand in the OECD, Discussion Paper, Global Water Forum, January 2012. Nataraj, S. and Hanemann, M., (2011), "Does Marginal Price Matter? A Regression Discontinuity Approach to Estimating Water Demand", Journal of Environmental Economics and Management, Elsevier, especially page 5.*

[7] A number of researchers have pointed to the importance of using water pricing to achieve efficient water consumption, see for example: B Dziegielewski (2011), "Management of Water Demand: Unresolved Issues", *Journal of Contemporary Water Research, page 5.*

[8] See Ralph (1992) for a summary of perspectives on cross subsidy in network industries. Ralph, E., (1992), *Cross subsidy: A Novice's Guide to the Arcane, Conference paper for "Telecommunications Costing in a Dynamic Environment" hosted by the BELLCORE and BELL CANADA Industry Forum*

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