Incentive Regulation for Local Water Utilities: Reducing Non-Revenue Water

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ABSTRACT

Non-revenue water management and energy efficiency are fundamental aspects of water supply and sewage systems worldwide. It is important that local regulators be aware of these issues when formulating tariff reviews and adjustments, establishing the correct incentives so that utilities can aim to reduce losses in their production and distribution processes. Based on the municipalities of Passos’ and Itabira’s previous experiences, both belonging to Minas Gerais State in Brazil, this paper proposes tariff incentive mechanisms for reducing non-revenue water and increasing energy efficiency, which can be used even to regulate non-profit local water supply and sewage utilities.
KEYWORDS

Incentive Regulation, Local Regulation, Non-Revenue Water, Non-Profit Utilities, Water Supply and Sewage Services, Brazil.

INTRODUCTION

The Federal Law 11.445, January 5th 2007, established national guidelines for sanitation services in Brazil. Also known as National Sanitation Law (NSL), it determined that the regulatory agencies, which are autonomous and independent institutions responsible for regulating and inspecting this sector’s service provision, must work in order to balance the interests of customers, utilities, and municipalities.

The NSL has encouraged the introduction of regulatory incentive mechanisms regarding efficiency and social appropriation of productivity gains (art. 22, items III e IV). In order to achieve the service provision economic equilibrium, the regulatory agency must perform a tariff review. In this moment, the regulator defines the average tariff to be applied during the tariff cycle (usually 4-5 years) as well as the efficiency incentive mechanisms to be used at the subsequent tariff adjustments, until the end of this tariff cycle. In other words, the NSL promotes the adoption of Incentive Regulation methodologies.

These methodologies were developed so as to enforce limits to natural monopolies’ profits, using market dynamics to stimulate productivity gains. In this regulatory framework, utilities are able to appropriate profits by reducing their operational costs beyond the targets established by the regulator. At the end of the tariff cycle, such surplus must be shared with the customers through just and reasonable tariffs. This is what the Brazilian legislation is seeking to promote without paying enough attention to the specific features of non-profit local utilities.

In Brazil, sanitation utilities are classified in three different categories: regional, micro-regional, and local. Regional utilities, known as Brazil Water Supply and Sewage Regional Companies (Cesb), are public or semi-public institutions providing services to many municipalities from the same state. Micro-regional utilities provide services for two or more adjacent municipalities from the same state. Local utilities, commonly structured as autarchies or municipal departments, provide services for a single municipality.

The Water Supply and Sewage Autonomous Services (Saaes) are non-profit local utilities in Brazil. As profits are not a goal pursued by Saaes, it is necessary to establish a particular regulatory framework with differentiated incentives for these autarchies.

Non-revenue water management and energy efficiency are fundamental aspects for water supply and sewage systems worldwide. It is important that local regulators be aware of these issues when formulating tariff reviews and adjustments, establishing the correct incentives so that utilities will aim to reduce losses in their production processes. Based on the previous experiences of the municipalities of Passos and Itabira, both belonging to Minas Gerais State in Brazil, this paper proposes tariff incentive mechanisms for reducing non-revenue water and increasing energy efficiency, which can be used to regulate non-profit local water supply and sewage utilities.

According to Berg (2000), the regulators do not prescribe specific acts to the utilities, allowing them to decide how to promote the continuous performance improvements. In this context, regulatory agencies have to introduce incentive mechanisms to stimulate utilities, suppressing command and control initiatives. In practice, the regulators define quality levels and efficiency goals associated with the equilibrium revenue. The utilities are free to manage their own strategies in order to reach or overcome the defined goals.

METHODOLOGY

According to the NSL, a tariff review should determine the revenue level that covers the efficient operational costs and remunerates the prudent capital investment. Nevertheless, the concept of capital remuneration is not applied for Saaes in Brazil since they are non-profit utilities. For the sake of meeting NSL, Saaes’ regulators ought to assess operational costs coverage, preferably considering efficiency incentives, and provide resources for future needed investments.
A tariff review can be done according to the incentive regulation framework so as to stimulate operational efficiency. This methodology does not consider the regulated company costs, focusing instead on benchmarking processes between similar utilities or on a reference company built by the regulatory institution. However, the Brazilian databases are not mature enough for setting strong benchmarking processes. It could substantially increase the economic imbalance risk taken by the utility. In addition, building a reference company is quite a complex process and requires a high discretion degree from the regulator. (ACENDE BRASIL, 2007).

Therefore, a good alternative to regulate non-profit utilities is applying a hybrid methodology combining aspects of both Cost of Service Regulation and Incentive Regulation. To ensure economic and financial balance, the regulator can perform the tariff review based on the assessment of the regulated utility costs, but also implementing tariff incentive mechanisms to encourage efficiency improvement.

Cost of Service Regulation tends to promote operational costs inefficiencies if such incentive mechanisms are not adopted. Cost of Service Regulation ensures that utilities will always have their costs covered by tariffs, even if efforts are not made to improve service provision performance. Consequently, assessing non-profit utilities costs allied to the introduction of incentive mechanisms is the key to promote a continuous improvement in operational efficiency.

Since most local utilities incentives are not related to profit purposes, it is necessary to find other goals to be pursued by Saaes. In this case, the regulator may establish high performance targets to the regulated utility. As long as regulatory goals are achieved or overcame, the non-profit utility must receive extra resources to share with its employees, through performance bonus, or increase investment levels. On the other hand, if regulatory goals are not achieved, the utility will face difficulties to cover its inefficient operational costs.

For this hybrid methodology to be effective, the goals defined by the regulatory agency have to be SMART goals, which means they must be: Specific; Measurable; Attainable; Relevant; and Time-Based. (DRUCKER, 1954).

An important instrument to determine appropriate goals for regulated utilities is the use of benchmarking techniques. In this context, it is possible to use parametric or non-parametric methods in order to analyze comparable utilities groups and set attainable performance goals. (CARRARA & TUROLLA, 2013).

In this paper, the incentive mechanisms proposed for non-profit utilities to reduce non-revenue water incorporate elements of two different models belonging to the Incentive Regulation framework: Price Cap Regulation and Yardstick Competition. It is important to highlight that those models comprise the hybrid methodology, allied to Cost of Service Regulation, by introducing tariff incentives to performance improvement.

In Price Cap Regulation tariffs are kept constant during a predetermined period of time. This period is called tariff cycle, in which tariffs cannot change except by annual adjustments - to account for inflation effects - and by a factor related to productivity gains, the X Factor. (KING, 1998).

During the tariff cycle, the utility has incentives to reduce its operational costs and achieve the defined goals in order to receive the revenue level associated with its economic equilibrium. If the utility is able to overcome these goals, the extra resources received could be used to pay employees’ productivity bonus or to make new investments. In the following tariff cycle, a new equilibrium level is set and, in this moment, the regulator converts the previous cycle efficiency gains into just and reasonable tariffs, sharing the utility’s productivity gains with its consumers.

Yardstick Competition defines tariffs through comparison among utilities, controlling its differences through measurable context variables (SHLEIFER, 1985). In this proposed hybrid model for regulating non-profit utilities, the association of Price Cap Regulation to Cost of Service Regulation frameworks seem to bring longstanding incentives for the improvement of operational efficiency in water and sewage utilities.

One of the main issues faced by the utilities of developing countries is non-revenue water levels reduction. The average non-revenue water level in water supply and sewage services in Brazil is around 40% (GO ASSOCIADOS, 2013). This volume is wasted during the distribution process - technical loss - or through failures in measurement and frauds performed by customers - commercial loss (KINGDOM et al, 2006).
The improvement on the management of non-revenue water levels may reduce electrical energy usage and the cost of water treatment chemicals, both extremely relevant inputs in water supply and sewage industry. In addition, decreasing non-revenue water levels contributes to reduce the risk of water shortages. From the considerations stated, it is evident that the regulation methods must establish mechanisms to encourage reduction of non-revenue water levels also for non-profit local utilities.

The tariff review methodology performed by the Water Supply and Sewage Regulatory Agency of Minas Gerais State in Brazil (ARSAE, 2011 and 2012) assessed those considerations through the application of a Non-Revenue Water Reduction Factor ($R_p$) over the costs of electrical energy and water treatment chemicals.

In order to obtain the non-revenue water level, it is first necessary to calculate the difference between the water volume produced by the utilities’ water treatment systems and customers’ water volume consumption, measured by their hydrometers. The non-revenue water level is then calculated as a proportion of the produced water volume, such as shown below:

$$P = \frac{V_p - V_M}{V_p}$$

in which:

$P = \text{non-revenue water level}$;
$V_p = \text{produced water volume (macro-measurement)}$;
$V_M = \text{customer’s measured water volume (micro-measurement)}$.

The Non-Revenue Water Reduction Factor ($R_p$) is determined by the complement of the ratio between the produced water volume when the regulatory goal is achieved ($V_{PR\text{REG}}$) and the produced water volume verified during the reference period of a tariff adjustment ($V_{PR\text{REG}}$). Hence, the customer’s measured water volume ($V_M$) could be rewritten as:

$$V_M = V_p \times (1 - P)$$

The same customer’s measured water volume ($V_M$) may be obtained from the produced water volume verified during the reference period ($V_{PR\text{REG}}$) with current non-revenue water level ($P_{PR}$) or from a lower produced water volume ($V_{PR\text{REG}}$) when regulatory non-revenue water level ($P_{REG}$) is achieved. This fact makes it possible to calculate the Non-Revenue Water Reduction Factor ($R_p$):

$$V_{PR\text{REG}} \times (1 - P_{PR}) = V_{PR\text{REG}} \times (1 - P_{REG})$$

$$\frac{V_{PR\text{REG}}}{V_{PR\text{REG}}} = \frac{(1 - P_{PR})}{(1 - P_{REG})}$$

$$R_p = 1 - \frac{V_{PR\text{REG}}}{V_{PR\text{REG}}} = 1 - \frac{(1 - P_{PR})}{(1 - P_{REG})}$$

Therefore, the regulatory agency defines a goal associated with the desirable non-revenue water level. Regulated utilities’ performance may be lower, equal or higher than the regulatory goal. However, no more than the efficient levels of electrical energy and water treatment chemicals costs are considered to set tariffs. Ergo, if the water supply and sewage utility does not achieve its performance goals, it will face difficulties to cover its inefficient operational costs. On the other hand, high performing utilities which are able to overcome regulatory goals will generate a revenue surplus to be shared with employees and/or to be reinvested. Table 1 summarizes these aspects.

**Table 1: Non-Revenue Water Reduction Factor Effects on the Regulated Utilities’ Equilibrium**
RESULTS

The methodology described on the previous section has already been applied in Saaes of two municipalities from Minas Gerais State in Brazil, Passos and Itabira, showing interesting results. Passos’ Saae tariff review, performed in 2011, established cost reducers of electrical energy and treatment chemicals related to non-revenue water levels. The hypothesis was that the greater the non-revenue water levels, the more significant the losses related to water pumping and treatment would be, which could be avoided through better utilities’ management. Therefore, in order to encourage non-revenue water reduction, energy and treatment chemicals costs should not be totally taken into consideration to set tariffs. (ARSAE, 2011).

Passos’ Saae non-revenue water levels were compared to those from similar municipalities of Minas Gerais State, with population from 50,000 to 150,000 inhabitants, using data obtained from the Brazilian National Information System on Sanitation (SNIS). There were 46 comparable municipalities that were sorted in ascending order considering non-revenue water levels and divided into four similar sized groups. For lower non-revenue water level municipalities, denominated group 1, it was determined the Non-Revenue Water Reduction Factor of 0.25% each year. For the other groups (2, 3 e 4), the reduction factors were respectively 0.5%, 0.75% and 1% each year. Passos’ Saae was part of group 2, resulting in a non-revenue water reduction goal of 2% in 4 years, considering the tariff cycle duration. (ARSAE, 2011).

Non-Revenue Water Reduction Factors were also applied to Itabira’s Saae, during the tariff review performed in 2012. The sample for benchmarking was expanded to municipalities of Minas Gerais State with population ranges varying ±60% comparing to Itabira. However, the regulator was stricter, rising Non-Revenue Water Reduction Factors to 1% and 2% for groups 3 and 4 respectively. Itabira was part of group 3, resulting in a Non-Revenue Water Reduction Factor of 4% in 4 years, considering the tariff cycle duration (ARSAE, 2012). Table 2 shows non-revenue water benchmarks assessed by Arsae in Passos’ and Itabira’s tariff reviews.

For Passos’ Saae, the non-revenue water level at the beginning of the reference period (P_{PR}) was equal to 27.7%. With the purpose of achieving the regulatory goal (P_{REG}) during tariff cycle, Passos’ Saae would have to reduce 2% of its non-revenue water within a four-year period. To make it possible, Arsae established a non-revenue water reduction trajectory, which means an average non-revenue water level of 26.5% during those years.

The same logic was applied in Itabira’s Saae tariff review. The non-revenue water level at the beginning of the reference period (P_{PR}) was equal to 40.1%, a little higher than Passos’. Arsae set a regulatory goal (P_{REG}), during the tariff cycle, of 36.1%, which represented a 4% reduction within four years. The regulatory agency considered a decreasing trajectory for non-revenue water level, with an average of 37.6% during this period.

Graph 1 shows the non-revenue water level evolution of Passos’ (triangles) and Itabira’s (squares) Saees’ over the years. The blue lines symbolize the Saees’ paths in order to leave non-revenue water level at the beginning of the reference period (P_{PR}) and reach the regulatory goal (P_{REG}) at the end of the tariff cycle. The red lines symbolize the regulatory non-revenue water level, which is the reference value used to determine the Non-Revenue Water Reduction Factor (R_{p}).

Graph 1: Passos’ and Itabira Saees’ non-revenue water level evolution and regulatory goals.
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<thead>
<tr>
<th>Municipality</th>
<th>Non-Revenue Water (liter/connection/day)</th>
<th>Municipality</th>
<th>Non-Revenue Water (liter/connection/day)</th>
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<tr>
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<td>Paracatu</td>
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<td>Lavras</td>
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<td>57</td>
<td>Vargem</td>
<td>194</td>
</tr>
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<td>São João Del Rei</td>
<td>194</td>
</tr>
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<td>113</td>
<td>Caratinga</td>
<td>198</td>
</tr>
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<td>116</td>
<td>João Monlevade</td>
<td>198</td>
</tr>
<tr>
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<td>119</td>
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</tr>
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<td>Araxá</td>
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<td>Uiba</td>
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</tr>
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<td>196</td>
<td>Passos</td>
<td>227</td>
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<tr>
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<td></td>
<td>Pouso Alegre</td>
<td>236</td>
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**Table 2: Non-Revenue Water Benchmarks assessed by Arsae in Passos’ and Itabira’s Tariff Reviews**

Itabira’s Saae non-revenue water levels are being constantly monitored by the regulatory agency through annual inspection reports. As a result from non-revenue water regulatory levels definition, Itabira’s Saae is developing a partnership with the Federal University of Minas Gerais (UFMG) to assess the hydrometers substitution effect in a controlled area. This would shift old hydrometers to new ones, which are more accurate to measure lower water volumes. These efforts seem to be producing very positive results, since Saae’s non-revenue water level is reaching the defined regulatory goal. However, as non-revenue water levels from tariff review until the last inspection report were greater than the average regulatory goal during the same period, Itabira’s Saae should keep decreasing non-revenue water levels in order to maintain the downward trend and make it possible to reach the regulatory goal for this tariff cycle (ARSAE, 2013).

**DISCUSSION**

Results shown in the previous section confirm the thesis that Non-Revenue Water Reduction Factors are able to encourage Saaes, non-profit local utilities, to increase water supply and sewerage services performance through reducing non-revenue water levels. By empiric observation and by analyzing Itabira’s Saae non-revenue water effective levels, the success in applying tariff incentive mechanisms is corroborated.

It is also important to mention that the regulator ought to determine challenging goals in a very careful manner. If the goals set are unattainable or poorly designed, the regulated utility’s financial-economic balance may be seriously compromised. What this means is that, if the utility does not make the necessary effort to reach the goals set by the regulator, its economic equilibrium may not be achieved, jeopardizing its sustainability. This is a very complex regulatory task and it must include a wide discussion with the population, through public hearings, and it also has to be well understood by the utility itself.

Moreover, it is necessary to monitor service quality, service efficiency and the utility’s financial-economic evolution over time. It can be achieved when the regulator performs effective inspections on the regulated utility actions towards higher operational efficiency and does this in partnership with the public prosecutor.

It is also recommended that the regulator supports the regulated utility during this process, aiming a higher operational performance and internal controls improvement of the utility. In general, local non-profit utilities are less well structured and face greater difficulties to implement changes to improve efficiency. However, without a wide institutional support, even a technically competent regulatory agency will find itself marginalized by political powers that are far stronger (BERG, 2013). Thus, risk factors, such as municipal political interference, must be observed and mitigated.

**CONCLUSION**

This paper presents study cases of municipalities from Minas Gerais State in Brazil, Passos and Itabira, as examples in which tariff incentive mechanisms were applied, associated with the hybrid model that incorporates Incentive Regulation and Cost of Service Regulation elements. The application of electric energy and water treatment chemical cost reducers, allied to the X Factor introduction, are able to stimulate non-profit local utilities to decrease non-revenue water levels and improve energy efficiency.

Besides being important to achieve cost savings, utilities’ better performances are also related to fundamental aspects of environmental sustainability. Therefore, given the relevance of those issues, new studies and initiatives towards these goals ought to be implemented so as to continuously improve the design of tariff incentive mechanisms of non-revenue water reduction.

**REFERENCES**


