

## Increasing block rate tariffs and water conservation: a case study of individually metered dwellings in multi-storey buildings in the Federal District, Brazil.

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**Abstract:** We proposed a pilot study in 12 buildings (all individually metered) in order to answer if the water and sewage tariff currently applied in the Federal District (BRAZIL) promotes the rational use of water and if it is effective for any consumption pattern and residential type. For this purpose, the individual consumption rates were analyzed for 36 months and compared to the values that would be charged if there was shared billing for the building (not individualized). As a result, we found that the service provider obtains greater profits with the individualized metering and that, for consumption below the minimum (10m<sup>3</sup>) it does not promote rational use.

### 1. INTRODUCTION

Law number 11.445 of January 2007 establishes national guidelines for basic sanitation and the federal policy on basic sanitation. This law also provides among its thirteen fundamental principles: universal access to the service; efficiency and economic sustainability; and the adoption of measures to promote responsible water consumption (BRAZIL, 2007).

The holder of the responsibility for providing water and sewage services uses its prerogative to delegate the provision of these services to a concessionaire, as well as to delegate regulation and oversight to a regulatory agency, in order to guarantee the proper execution of the concession agreement and the fulfillment of the public interest.

The concessionaire is compensated through the tariff paid by the users, determined at the time of the signing of the contract. This tariff is intended to pay for operation, maintenance, technological improvement and profits to the concessionaire (BRAZIL, 2007).

In order to be valid, contracts must contain studies that establish technical, economic, and financial feasibility of the services provided. According to the law, one of the objectives of the regulation is "to define tariffs that ensure both economic and financial balance of the contracts and low tariffs, through mechanisms that induce efficiency and effectiveness of services and allow for the social appropriation of productivity gains" (art. 22, IV). Thus, the law establishes that regulatory rules that define the conditions of service provision, in an efficient way, should include: 1) the billing system and the composition of fees and tariffs; 2) the system of readjustments and revisions of rates and tariffs; and 3) the subsidies policy (BRAZIL, 2007).

According to article 2, of District Law number 442 of May 1993, which provides the classification of Tariffs for Water and Sewage Services of the Federal District:

*"... tariffs will be differentiated according to the categories of users: residential, public, commercial and industrial; and according to consumption bands, ensuring the subsidy of small consumers by large consumers in order to reconcile economic aspects with social objectives."*

Thus, for each category, tariffs are phased by consumption band and tariff values are higher for bands with higher level of consumption in order to discourage excessive consumption. There is a social residential tariff, which is characterized by lower prices for the low income population, in the two lower consumption bands. Therefore, when the consumption of water and sewage of low income population reaches higher levels, the tariff becomes the same used for other residences. In the area covered by the study, the amount charged for the collection and treatment of sewage corresponds to 100% of the amount billed for the water.

In addition, the same law establishes that the monthly volume of water to be billed may not be less than 10m<sup>3</sup> per unit of consumption for all categories of consumption (Article 2, Paragraph 1, DISTRITO FEDERAL, 1993). According to the ADASA Resolution number 14 (DISTRITO FEDERAL, 2011), the objective is to cover the minimum cost necessary for ensuring the provision of services in adequate quantity and quality. Data provided by the concessionaire of these services indicate that 45% of active households fall within the minimum billing (DISTRITO FEDERAL, 2016).

Individualized metering is another subject analyzed in this study. The Federal District has a law imposing this obligation since 2005 (DISTRITO FEDERAL, 2005), and recently, in 2016, a national law was published reinforcing this obligation (BRAZIL, 2016). District Law 3,557 of 2005 was regulated by ADASA Resolution n.15 of 2011 (DISTRITO FEDERAL, 2011).

## 2. JUSTIFICATION

According to text of Resolution number 15 of 2011:

*"Art. 23. The difference between the volume measured in the master water meter and the sum of the volumes measured in the individual water meters must be billed... by the inscription of a meter that meets the common area of the condominium."*

This study proposes to evaluate article 23 of Resolution number 15 in order to answer whether the tariff, as it is charged today and with the current structure, promotes rational use of water and whether it is, in fact, fair to any amount of consumption and residential type.

Buildings with consumption below the minimum that, by law, pay for 10m<sup>3</sup>, are questioning the legality of the tariffs, since they are being wronged, because they pay for 10m<sup>3</sup> without actually consuming it and, with the individualized measurement, are also paying for the residual measurement. Thus, the study is only considering the positive difference between these volumes, called "residual", since it encumbers the user of the service.

### 3. OBJECTIVE

Through the data provided by the service provider, this study intends to simulate what is happening today and, if unfair charges are verified, to propose a specific change in the text of the resolution.

Since the adoption of the individual metering is considered to enable fair charges, because each user pays for their own consumption, the specific objectives of this study are:

- i) to verify if this fairness is evident in any residential type and for any amount of water consumption;
- ii) to verify if the service provider, in the examples above, always receives more with individual metering; and
- iii) to check if the residual, as charged today, penalizes units that consume less than 10 m<sup>3</sup>.

### 4. METHODOLOGY

The study analyzed 12 buildings in locations with the same income range (medium-high), but with very different characteristics: i) studios; ii) one or two bedroom apartments; iii) luxury apartments. Therefore, the consumption varied widely.

These buildings were evaluated for a period of 36 months (June 2013 to May 2016) and tariffs were estimated based on the volumes measured by both the Master water meter (GH) and the Individual water meters (IH) and on tariffs for May 2016. Thereby, it was possible to compare the amount that would be charged without individualized metering and the cost with the individualized metering. Even though the value metered in the shared hydrometer was charged separately, as part of condominium maintenance costs, the study used the data based on the amount charged per apartment, as a way of facilitating comparison (both in the amount charged by sharing the master water meter and in the individualized metering). It should be remembered that all buildings studied have individual meters.

The methodology is based on the average volume per consumer unit in these 36 months and in its conversion to current tariffs (May 2016 tariff). As a result, a value per apartment and a value for the common area were obtained. As discussed earlier, this common area was distributed among the residents and, for the purposes of this study, it was added to individual bills. In addition to these values, it was necessary to calculate the residual, which, according to Resolution 15, consists of "... *the difference between the volume measured in the master water meter and the sum of the volumes measured in the individual water meters must be billed (when the difference is positive) by the inscription of a meter that meets the common area of the condominium.*" Through the sum of these individual values (apartment and common area) with the value of the residual, we reached the value received by the concessionaire after the individualized metering, which, therefore, could be compared to the value measured by the master water meter.

To calculate the monetary value of the residual, first the volume measured in the master water meter was divided by the number of consuming units. With this value, the consumption band and the value charged for it are discovered, which allows the entire volume of the residual to be multiplied by the value of the band previously found.

## 5.RESULTS

The results will be presented in 3 groups, according to the average consumption presented.

- 1st GROUP - studios, with consumption up to 10m<sup>3</sup>
- 2nd GROUP - buildings with 1 or 2 bedrooms, with consumption between 11 and 20m<sup>3</sup>
- 3rd GROUP - luxury standard buildings, with consumption over 21m<sup>3</sup>

Two buildings were removed from the analysis because the first only had 9 months of measurement and only ¼ of the apartments were occupied, and the second had negative residual value.

The rate charged in May 2016 is listed in table 1 below:

Residential tariffs - May 2016		
Consumption bands (m3)		Tariff (R\$) per m3
1	0 up to 10	2.65
2	11 up to 15	4.92
3	16 up to 25	6.28
4	26 up to 35	10.15
5	36 up to 50	11.20
6	>50	12.27

*Table 1: Tariff per consumption band*

Each Figure bellow represents the comparison of the values collected with and without individualized water metering. While each tables shows the volumes measured by the service provider.

## 1st GROUP

### BUILDING 1

Building 1 has 134 individual water meters (IH) - 133 in apartments, 1 in the common area of the condominium - and a master water meter (GH). This building had an average consumption of 6.64m<sup>3</sup>, however, due to the minimum charge of 10m<sup>3</sup> determined by law, all units would pay the minimum plus the common area (R\$ 53.40), if the bill was shared, even with 29 user units (21.8%) consuming, on average, slightly more than 10m<sup>3</sup>.

According to the individualized metering, 100% of the apartments pay more than the R\$ 53.40 of the shared bill, even if consuming less than 10m<sup>3</sup>. This is a result of the residual that corresponds to the difference between the GH (877m<sup>3</sup>) and the IH (not adjusted to the minimum volume of 10m<sup>3</sup> - 580m<sup>3</sup>) which is equal to 297m<sup>3</sup> and is shared in the maintenance cost of the condominium.

However, for the purposes of this study, the value of the residual was added to the billed value (including common area) and compared to the value of the GH (including common area). Then, the 1334m<sup>3</sup> was added with the residual (RCA) of 297m<sup>3</sup>, which adds up to 1631m<sup>3</sup>. As a result, the individualized metering caused an increase of **27.43%** in favor of the service provider.

The individualization of water meters with these studios caused the tariff to increase in 100% of consumer units. Even without accounting for the residual, the concessionaire would earn a profit of **13.68%** compared to the shared bill based on the GH, due to the correction made by the minimum of 10m<sup>3</sup>.

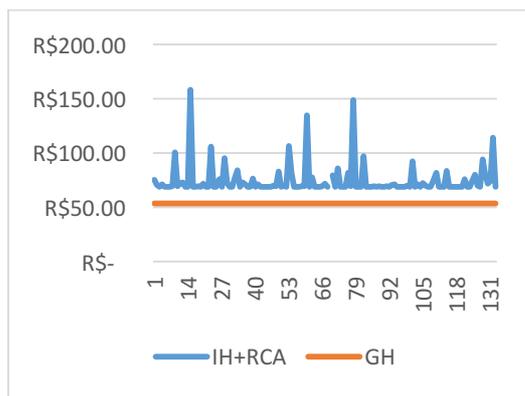


Figure 1: Building 1

<i>Billed volume with 10m<sup>3</sup> - IH</i>	1334m <sup>3</sup>
<i>Measured volume (without 10m<sup>3</sup>) - IH</i>	580m <sup>3</sup>
<i>Measured volume without 10m<sup>3</sup>- GH</i>	877m <sup>3</sup>
<i>Residual</i>	297m <sup>3</sup>

Table 2: Volumes

## BUILDING 2

Building 2 has studios with 238 individualized water meters, common area with 1 water meter and the master water meter. It presented an average consumption of 4.38m<sup>3</sup>. However, due to the minimum charge of 10m<sup>3</sup>, all units would pay the minimum plus the common area (R\$ 53.22), if the bill was shared, even with 57 user units (23.95%) consuming, on average, slightly more than 10m<sup>3</sup>.

According to the individualized metering, 100% of the apartments pay more than the R\$ 53.22 of the shared bill, even if consuming less than 10m<sup>3</sup> on average. This is a result of the residual that corresponds to the difference between the GH (1047m<sup>3</sup>) and the IH (not adjusted to the minimum of 10m<sup>3</sup> - 962m<sup>3</sup>) which is equal to 85m<sup>3</sup>. The value of the residual was added to the value adjusted to the minimum of 10m<sup>3</sup> (2354m<sup>3</sup>). Thus, the 2354m<sup>3</sup> was added with the residual of 85m<sup>3</sup> that presented as final result 2439m<sup>3</sup>, which was the charged volume used in this study. As a result, the individualized metering caused an increase of **21.85%** in favor of the service provider.

The individualization in studios caused tariffs to increase in 100% of consumer units. Even without accounting for the residual, the concessionaire would earn a profit of **19.03%** compared to the shared bill based on the GH, due to the correction made by the minimum of 10m<sup>3</sup>.

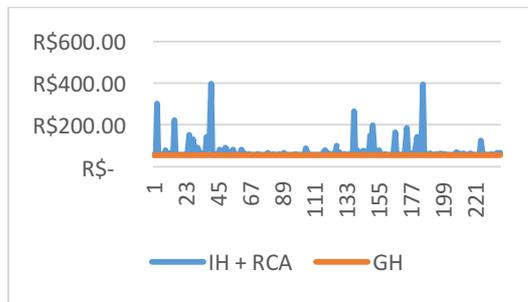


Figure 2: Building 2

<i>Billed volume with 10m<sup>3</sup>- IH</i>	2354m <sup>3</sup>
<i>Measured volume (without 10m<sup>3</sup>) - IH</i>	962m <sup>3</sup>
<i>Measured volume (without 10m<sup>3</sup>)- GH</i>	1047m <sup>3</sup>
<i>Residual</i>	85m <sup>3</sup>

Table 3: Volumes

### BUILDING 3

Building 3 is a residential building with 29 individual studios, common area with 1 water meter and a master water meter. It presented an average consumption of 6.14m<sup>3</sup>. However, due to the minimum charge of 10m<sup>3</sup>, all units would pay the minimum plus the common area (R\$ 54.82), if the bill was shared, even with 9 user units (31.04%) consuming, on average, slightly more than 10m<sup>3</sup>.

In relation to the individualized metering, 100% of the apartments pay more than the R\$ 54.82 of the shared bill, even if consuming less than 10m<sup>3</sup> on average. This is a result of the residual that corresponds to the difference between the GH (184.36m<sup>3</sup>) and the IH (not adjusted to the minimum of 10m<sup>3</sup> - 135m<sup>3</sup>) which is equal to 49.36m<sup>3</sup>. The value of the residual was added to the value adjusted to the minimum of 10m<sup>3</sup> (297m<sup>3</sup>). Thus, the 297m<sup>3</sup> was added with the residual of 49.36m<sup>3</sup> that presented as final result 346.36m<sup>3</sup>, which was the charged volume used in this study. As a result, the individualized metering caused an increase of **21.24%** in favor of the service provider.

The individualization in studios caused tariffs to increase in 100% of consumer units. Even without accounting for the residual, the concessionaire would earn a profit of **9.53%** compared to the shared bill based on the GH, due to the correction made by the minimum of 10m<sup>3</sup>.

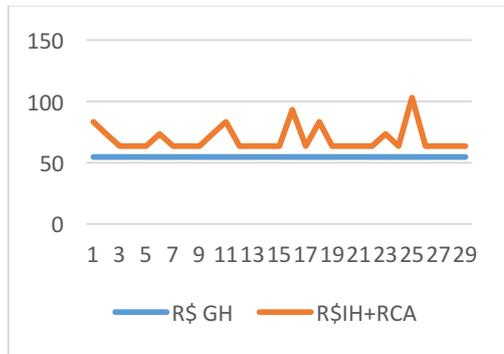


Figure 3: Building 3

<i>Billed volume with 10m<sup>3</sup>- IH</i>	297m <sup>3</sup>
<i>Measured volume (without 10m<sup>3</sup>) - IH</i>	135m <sup>3</sup>
<i>Measured volume (without 10m<sup>3</sup>) - GH</i>	184.36m <sup>3</sup>
<i>Residual</i>	49.36m <sup>3</sup>

Table 4: Volumes

## BUILDING 4

Building 4 is a residential building with 144 individual studios, common area with 1 water meter and a master water meter. It presented an average consumption of 7.19m<sup>3</sup>. However, due to the minimum charge of 10m<sup>3</sup>, all units would pay the minimum plus the common area (R\$ 54.37), if the bill was shared, even with 9 user units (6.25%) consuming, on average, slightly more than 10m<sup>3</sup>.

In relation to the individualized metering, 100% of the apartments pay more than the R\$ 54.37 of the shared bill, even if consuming less than 10m<sup>3</sup> on average. This is a result of the residual that corresponds to the difference between the GH (1038m<sup>3</sup>) and the IH (not adjusted to the minimum of 10m<sup>3</sup> - 979m<sup>3</sup>) which is equal to 59m<sup>3</sup>. The value of the residual was added to the value adjusted to the minimum of 10m<sup>3</sup> (1382m<sup>3</sup>). Thus, the 1382m<sup>3</sup> was added with the residual of 59m<sup>3</sup> that presented as final result 1441m<sup>3</sup>, which was the charged volume used in this study. As a result, the individualized metering caused an increase of **25.69%** in favor of the service provider.

The individualization in studios caused tariffs to increase in 100% of consumer units. Even without accounting for the residual, the concessionaire would earn a profit of 23.21% compared to the shared bill based on the GH, due to the correction made by the minimum of 10m<sup>3</sup>.

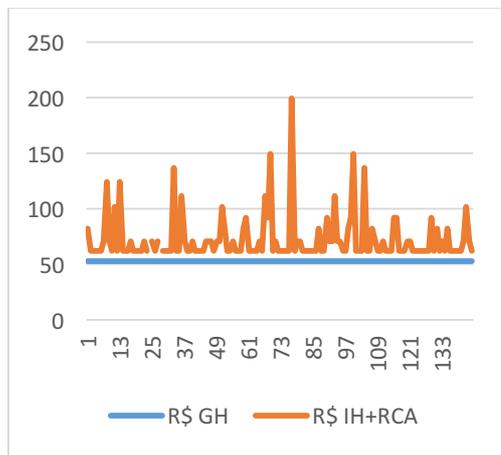


Figure 4: Building 4

<i>Billed volume with 10m<sup>3</sup>- IH</i>	1441m <sup>3</sup>
<i>Measured volume (without 10m<sup>3</sup>) - IH</i>	979m <sup>3</sup>
<i>Measured volume (without 10m<sup>3</sup>) - GH</i>	1038m <sup>3</sup>
<i>Residual</i>	59m <sup>3</sup>

Table 5: Volumes

## 2nd GROUP

### BUILDING 5

Building 5 is composed of 96 apartments, arranged in 6 floors, a common area and a party hall that has 1 water meter each, which, when added, represent 98 consuming units. The building has 98 individual water meters and a master water meter. It presented an average consumption of 12.85m<sup>3</sup>, which means that, if the bill was shared, each apartment would pay R\$ 82.83 (already including common area and party hall).

During the period of 36 months, the average difference between the volume measured (not considering the minimum of 10m<sup>3</sup>) and the billed volume (with the minimum of 10m<sup>3</sup>) was 166m<sup>3</sup> (1304-1138), which is, by law, paid to the concessionaire. Today, according to Resolution n° 15, the provider would also receive the 123m<sup>3</sup> (1261-1138) of the residual in the bill of the common area, through the charging of the condominium maintenance cost. For the purpose of this study, the residual was added to the billed volume.

The value obtained by the GH would correspond to 1261m<sup>3</sup>, which divided by the 98 user units would correspond to an average higher than 10m<sup>3</sup>. This volume, using the tariff on May 2016, would correspond to R\$ 7,951.95 against R\$ 10,267.90 of the IH + residual + common area (**22.55%** in favor of the concessionaire).

The individualization in this building caused a tariff increase in 60.42% of the consumer units – 58 units. Even without accounting for the residual, the concessionaire would earn a profit of **12.21%** compared to sharing the bill of the GH, due to the correction made by the 10m<sup>3</sup> minimum.

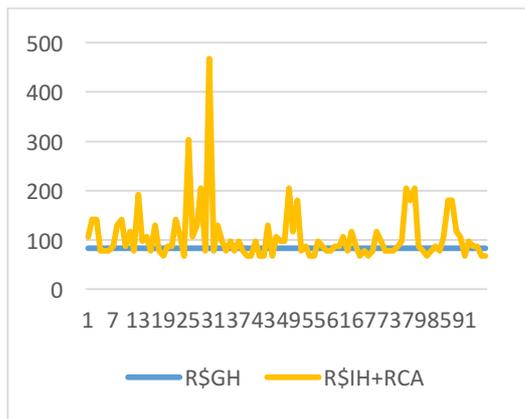


Figure 5: Building 5

<i>Billed volume with 10m<sup>3</sup>- IH</i>	1304m <sup>3</sup>
<i>Measured volume (without 10m<sup>3</sup>) - IH</i>	1138m <sup>3</sup>
<i>Measured volume (without 10m<sup>3</sup>)- GH</i>	1261m <sup>3</sup>
<i>Residual</i>	123m <sup>3</sup>

Table 6: Volumes

## BUILDING 6

Building 6 is composed of 60 apartments and a common area, which has 1 water meter, representing a total of 61 consuming units. The building has 61 individual water meters and a master water meter. It presented an average consumption of 18.39m<sup>3</sup>, which means that, if the bill was shared, each apartment would pay R\$ 147.20 (already including the common area).

24 units consumed less than the average (40 %) and 36 units consumed more (60%).

During the period of 36 months, the average difference between the volume measured (not considering the minimum of 10m<sup>3</sup>) and the billed volume (with the minimum of 10m<sup>3</sup>) was 66m<sup>3</sup> (1077-1011), which is, by law, paid to the concessionaire. Today, according to Resolution n° 15, the provider would also receive the 111m<sup>3</sup> (1122-1011) of the residual in the bill of the common area, through the charging of the condominium maintenance cost. However, in this study, the residual was added to the billed volume to check the concessionaire's profit.

The value obtained by the GH would correspond to 1122m<sup>3</sup> which divided by the 60 user units would correspond to an average higher than 10m<sup>3</sup>. This volume, using the tariff on May 2016, would correspond to R\$ 8,832.00 against R\$ 10,086.88 of the IH + residual + common area (**12.44%** in favor of the concessionaire).

In this building, even without the residual, the concessionaire would earn a profit of **0.42%**.

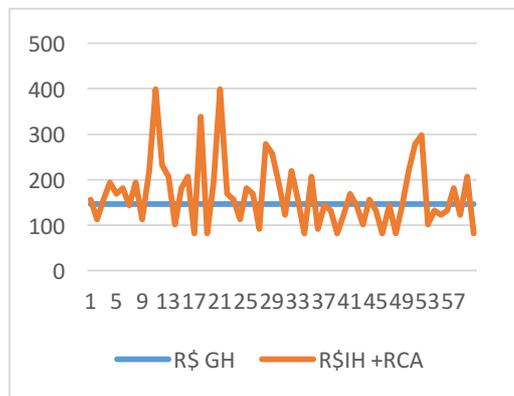


Figure 6: Building 6

<i>Billed volume with 10m<sup>3</sup>- IH</i>	1077m <sup>3</sup>
<i>Measured volume (without 10m<sup>3</sup>) - IH</i>	1011m <sup>3</sup>
<i>Measured volume (without 10m<sup>3</sup>) - GH</i>	1122m <sup>3</sup>
<i>Residue</i>	111m <sup>3</sup>

Table 7: Volumes

## BUILDING 7

Building 7 is composed of 36 apartments and 2 common areas that have 2 water meters, which, if added, represent 38 consuming units. The building has 38 individual water meters and a master water meter. It presented average consumption of 20,68m which means that, if the bill was shared, each apartment would pay R\$ 183.20 (already included the 2 common areas).

22 units consumed less than the average (61.11%) and 14 units consumed more (38.89%).

During the period of 36 months, the average difference between the volume measured (not considering the minimum of 10m<sup>3</sup>) and the billed volume (with the minimum of 10m<sup>3</sup>) was 31m<sup>3</sup> (783-752), which is, by law, paid to the concessionaire. Today, according to Resolution n° 15, the provider would also receive the 34 m<sup>3</sup> (786-752), of the residual in the bill of the common area, through the charging of the condominium maintenance cost. This study added the residual to the billed volume.

The value obtained by the GH would correspond to 786 m<sup>3</sup> that divided by the 38 user units would correspond to an average higher than 10m<sup>3</sup>. This volume, using the tariff on May 2016, would correspond to R\$ 6,594.48 against R\$ 7,722.96 of the IH + residue + common area (**14.61%** in favor of the concessionaire).

In this building, even without the residual, the concessionaire would earn **9.62%** profit when compared to sharing the bill.

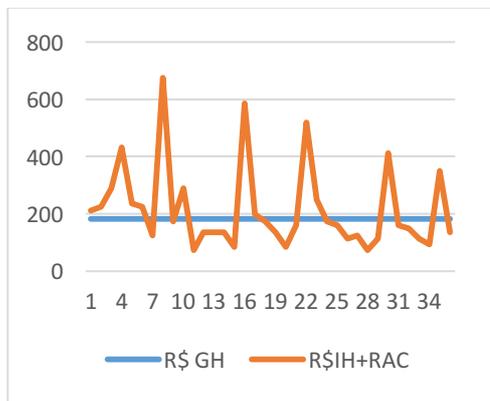


Figure 7: Building 7

Billed volume with 10m <sup>3</sup> - IH	783m <sup>3</sup>
Measured volume (without 10m <sup>3</sup> ) - IH	752m <sup>3</sup>
Measured volume (without 10m <sup>3</sup> ) - GH	786m <sup>3</sup>
Residual	34m <sup>3</sup>

Table 8: Volumes

### 3rd GROUP

#### BUILDING 8

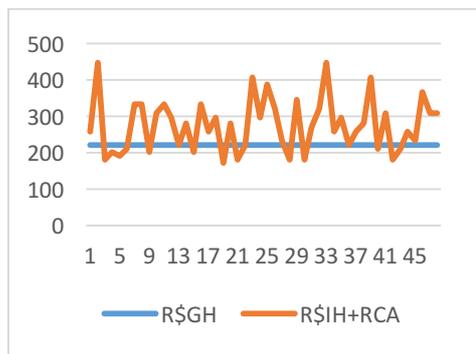
Building 8 is composed of 48 apartments, a common area and a boiler that have 1 water meter each, which, if added, represent 50 consumer units. The building has 50 individual water meters and a master water meter. It presented an average consumption of 23.83m<sup>3</sup>, which means that, if the bill was shared, each apartment would pay R\$ 221.98 (already including the common area and the boiler).

16 units consumed less than the average (33.33%) and 32 units consumed more (66.67%).

During the period of 36 months, the average difference between the volume measured (not considering the minimum of 10m<sup>3</sup>) and the billed volume (with the minimum of 10m<sup>3</sup>) was 29m<sup>3</sup> (1090-1061), which is, by law, paid to the concessionaire. Today, according to Resolution n° 15, the provider would also receive the 130m<sup>3</sup> (1191-1061) of the residual in the bill of the common area, through the charging of the condominium maintenance cost, totaling 1220m<sup>3</sup>. In this example, it was observed, for the first time, that the GH had a value higher than the amount billed.

The value obtained by the GH would correspond to 1191 m<sup>3</sup> that divided by the 38 user units would correspond to an average higher than 10m<sup>3</sup>. This volume, using the tariff on May 2016, would correspond to R\$ 10,655.04 against R\$ 13,262.54 of the IH + residue + common area (**19.66%** in favor of the concessionaire). Even if the GH (in volume) was higher than what was billed for the individual water meters, even without the residual, there would be a profit of 8.39% as a result of the progression to higher tariff bands.

In this building, even without the residual, the concessionaire had profit. The visit of a technician is recommended to verify if the individual water meters are being submetered.



<i>Billed volume with 10m<sup>3</sup>- IH</i>	1090m <sup>3</sup>
<i>Measured volume (without 10m<sup>3</sup>) - IH</i>	1061m <sup>3</sup>
<i>Measured volume (without 10m<sup>3</sup>)- GH</i>	1191m <sup>3</sup>
<i>Residual</i>	130m <sup>3</sup>

## BUILDING 9

Building 9 consists of 24 apartments and a common area that has a water meter that, if added, represent 25 consumer units. The building has 25 individual water meters and a master water meter. It presented average consumption of 27.32m<sup>3</sup>, which means that, if the bill was shared, each apartment would pay R\$ 286.35 (already including the common area).

12 units consumed less than the average (50%) and the 12 units consumed more (50%).

During the period of 36 months, the average difference between the volume measured and the billed volume was 26m<sup>3</sup> (705-679), which is, by law, paid to the concessionaire. Today, according to Resolution n° 15, the provider would also receive the 4m<sup>3</sup> (683-679), of the residual in the bill of the common area, through the charging of the condominium maintenance cost, totaling 709m<sup>3</sup>.

The value obtained by the GH would correspond to 683m<sup>3</sup>, which divided by the 25 user units would correspond to more than 10m<sup>3</sup>. At the value of May 2016 the volume would correspond to R\$ 6,872.40 against R\$ 7,743.98 of the IH + residual + common area (**11.25%** in favor of the concessionaire).

In this building, even without the residual, the concessionaire would earn **10.31%** of profit when compared to the shared billing. The visit of a technician is recommended to verify if the individual water meters are being submetered.

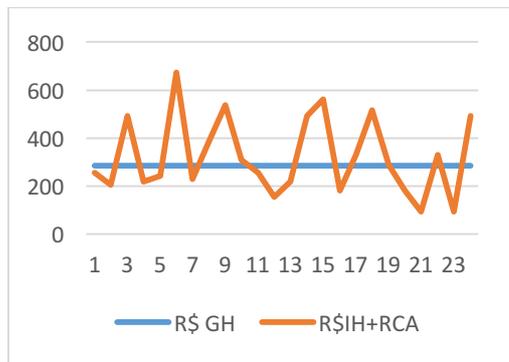


Figure 9: Building 9

<i>Billed volume with 10m<sup>3</sup>- IH</i>	705m <sup>3</sup>
<i>Measured volume (without 10m<sup>3</sup>) - IH</i>	679m <sup>3</sup>
<i>Measured volume (without 10m<sup>3</sup>)- GH</i>	683m <sup>3</sup>
<i>Residual</i>	4m <sup>3</sup>

Table 10: Volumes

## BUILDING 10

Building 10 is composed of 36 apartments, 1 garden, 1 caretaker's apartment, 3 common area water meters, which, if added, represent 41 consuming units. The building has 41 individual water meters and a master water meter. It presented average consumption of 25.85m<sup>3</sup>, which means that, if the bill was shared, each apartment would pay R\$ 286.35 (already including the common area).

16 units consumed less than the average (44.44%) and the remainder (20 units) consumed more (55.56%).

During the period of 36 months, the average difference between the volume measured and the billed volume was 3m<sup>3</sup> (944-941), which is, by law, paid to the concessionaire. Today, according to Resolution n° 15, the provider would also receive the 5m<sup>3</sup> (1060-941), of the residual in the bill of the common area, through the charging of the condominium maintenance cost, totaling 1060m<sup>3</sup>.

The value obtained by the GH would correspond to 1,060m<sup>3</sup>, which divided by the 25 user units would correspond to more than 10m<sup>3</sup>. At the value of May 2016 the volume would correspond to R\$ 9,777.24 against R\$ 11,432.46 of the IH + residue + common area (**14.47%** in favor of the concessionaire). Even if the GH (in volume) was higher than what was billed for the individual water meters, even without the residual, there would be a profit of 2% as a result of the progression to higher tariff bands.

In this building, even without the residual, the concessionaire would earn **2%** profit when compared to the shared billing. The visit of a technician is recommended to verify if the individual water meters are being submetered.

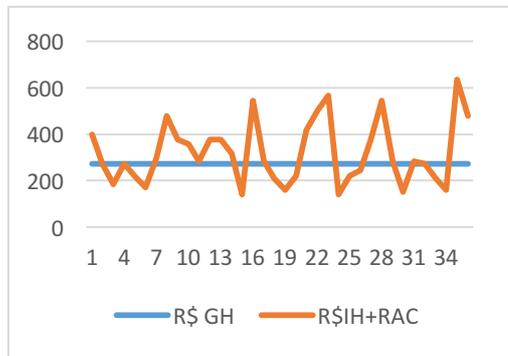


Figure 10: Building 10

Billed volume with 10m <sup>3</sup> - IH	944m <sup>3</sup>
Measured volume (without 10m <sup>3</sup> ) - IH	941m <sup>3</sup>
Measured volume (without 10m <sup>3</sup> )- GH	1060m <sup>3</sup>
Residual	116m <sup>3</sup>

Table 11: Volumes

## 6. CONCLUSION

As all the buildings provided a profit when compared to the method of shared billing (without individualized bills), and all, without exception, if they ignored the residual, would also generate profit to the service provider, we may conclude that: i) the current tariff structure for consumption below the minimum does not promote the rational use of water; ii) the tariff structure after the individualized metering adds extra costs to the tariffs as a result of the residual, being users with consumptions below 10m<sup>3</sup> the most affected; and, iii) the progressivity in the tariff value fulfilled its function in the study, because even in cases where the billed volume was smaller than that of the master water meter, the billed value was higher.

As a result of the findings, it is recommended that the reading mode of the water meter be replaced by an alternative technological model, such as remote reading or telemetry, which has the advantage of providing greater data reliability, because it reduces the errors of reading to practically zero, besides identifying leaks and frauds quicker. The greatest benefit of this practice according to this study would be the reduction of the volume found in the residual and of the amount to be paid by the water meter of the common area of the building.

In order to reduce the value of the residual, it is suggested to change the text in Article 23 of Resolution 15/2011, so that where it says that the "... difference between the volumes measured in the master water meter and in the volumes measured in the individualized water meters " (not adjusted to the minimum), should be changed to the "... difference between the volumes measured in the master water meter and the billed volumes of the individual water meters" (adjusted to the minimum). With this change, the buildings with consumption below the minimum will no longer pay the residual.

With regard to the collection of a minimum volume of 10m<sup>3</sup>, further studies should be carried out in order to promote rational water consumption without compromising the principles of universal access to service, efficiency and economic sustainability.

## 7. BIBLIOGRAPHIC REFERENCE

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