Global Development Network

Strengthening Institutions to Improve Public Expenditure Accountability

Policy Simulation for Water Enterprise in Guatemala City: Pricing Water towards Financial Sustainability

Jorge Benavides
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1. INTRODUCTION: Current Water Situation in Guatemala

Over the past several years, the availability, use, and appropriate compensation for the use of water resources in Guatemala have become a constant source of conflict between the various stakeholders. Although Guatemala is a potential water producer and exporter, problems of access, quality, and conservation are problematic. The major challenge today is not only to satisfy the basic needs of the population in terms of access and quality, but to guarantee that enough resources will be allocated to preserve the functioning of the water system in the long term.

We do have to recognize the regulatory amendment that should be made for an updated water law for the country, as has been stipulated by the Constitution in Article 127.[1] This topic has been debated for more than 27 years; however, we want to emphasize that the sector's problems go beyond the adoption of a specific law, and they deserve a rethink on how to address a very specific subject: the financial sustainability of the provision of water through local enterprises or municipalities.

The daily problem that Guatemala faces is largely related to the allocation of funds and demand for water by the people. According to the most recent National Environment Statistics Compendium (2010),[2] enough resources to better manage the water system in Guatemala is the key variable to solve the other problems related with the "production–consumption" process. Experts have identified eight issues on which to focus attention; however, we believe that financial sustainability is the first issue that should be addressed because lack of funds is the main constraint for the development of the sector.

This situation continuously affects the way people try to resolve the problem, resulting in a series of disputes among citizens, between governmental and local authorities, and across different geographical locations. People do not hesitate to take matters into their own hands, with complete disregard for the fact that other people or other locations might also need the service.The role of the Government has been misunderstood by the citizens, who see it as lacking authority and hence unable to provide coherent solutions for the whole country.

The World Bank has addressed this problem, affirming that "while water is regarded as a socially sensitive sector throughout the Latin American region, few countries have attempted to provide a clear definition of their social policy objectives or to evaluate the efficacy of the instruments traditionally chosen to achieve them". [3] Guatemala is not the exception. What we have to do is to confront the problem at its roots, identifying the most feasible solutions in the short term to ensure positive results in the long term.

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[1] Article 127: Water sources regime. All water sources are public property, inalienable and indefeasible. Its benefit, use and enjoyment, are awarded in the form prescribed by law, in accordance with the public interest. A special law shall regulate this matter.

[2] Instituto Nacional de Estadística (2011). *Compendio Estadístico Ambiental de Guatemala 2010.* Sección de Estadísticas Ambientales, Oficina Coordinadora Sectorial de Estadísticas de Ambiente y Recursos Naturales. OCSE/Ambiente. Guatemala.

[3] A. Estache, V. Foster and Q. Walden (2002). *Accounting for the Poor in Infrastructure Reform: Learning from Latin America's Experience.* World Bank´s Institute for Development Studies. Washington, D.C.

The simplest way to engage in this task is to analyze the relations between providers and users of the water system, paying attention to the most notable deficiencies and restraints to efficiency and transparency in the sector. Some idea of what should be the first step in our analysis is mentioned in Guatemala´s Environmental Profile 2012, which concludes that until we guarantee an appropriate costing system of the benefits and costs derived from the operation of water enterprises, it won´t be possible to correctly amend the other deficiencies in the water sector at the national level.[4]

Our aim is to present sound evidence to demonstrate that the first problem to be dealt with is the lack of sufficient resources to alleviate the current financial deficit in the provision of water services in Guatemala City. Our next step in the analysis will be an evaluation of how we can gather more resources to resolve the problems, trying to isolate the common causes of the malfunctioning water sector.

The information we want to capture in this policy document aims to focus the public´s attention on a national issue. However, due to complications arising from the availability of information and resources, we have to recognize that doing so goes beyond our scope of analysis. We therefore address the specific case of the Water Enterprise for Guatemala City–EMPAGUA–which potentially covers more than one million people and is a reasonable starting point to understand the problem and to find potential solutions to the current financial deficit related to the provision of water services in Guatemala.

EMPAGUA is the municipal institution that plans, designs, implements and oversees the construction, improvement, expansion, reconstruction, and maintenance of drinking water and sewerage services in Guatemala City and its areas of influence. Its main objective is to satisfy the demands and social needs of its users in an efficient, participatory, and consensual manner, contributing to the national development and social welfare of the Guatemalan population.

To preserve and enhance the quality of its services, EMPAGUA continuously makes improvements that will allow the institution to respond opportunely to the challenges of the current and future water users.

It´s vision is to be recognized—at the national and international levels—for being an efficient institution that delivers drinking water and sanitation services, operating under a self-financing principle, and achieving the highest number of satisfied users for quality and service continuity.

2. POLICY GOAL: Full Recovery of EMPAGUA´s Costs

In order to guarantee a financially sustainable water production process in Guatemala, many factors need to be considered for the feasibility of our proposal. These include enforcement, regulation framework, and institutionality to determine who will be in charge

[4] Instituto de Agricultura, Recursos Naturales y Ambiente (2012). *Perfil Ambiental de Guatemala 2010-2012: Vulnerabilidad local y creciente construcción de riesgo.* Universidad Rafael Landivar, Guatemala.

of administering the water resources, setting the rate, and collecting the revenue to compensate actual costs.

Our proposal is an economic instrument that should be seen as complementary to other mechanisms such as legislation and institutionality. Our policy analysis will include an accurate evaluation of the potential revenues, the actual cost that is incurred in the production of water, and the necessary modifications that should be designed to reinforce the way in which the consumption of water is being charged in Guatemala City.

Therefore, our policy goal is to define the tariff that should be charged to consumers of water of the Guatemala City utility, thus arriving at the financial cost recovery for water production by the water enterprise of the city, EMPAGUA. Through the introduction of this new tariff, we expect to adjust the fee that the users pay for consumption of water (volumetric tariff, sewerage tariff, and fixed charge for the connection), internalizing the full cost of consuming water in Guatemala City, and enhancing the capacity of EMPAGUA to be financially sustainable in the long run.

In addition, we also want to develop a tool that will help policy makers in the discussion and analysis of other costs that are currently not covered by EMPAGUA, but that are related with the production of water in Guatemala City—such as subsidies from the Central Government and other institutions, and the payment for environmental services. These variables will be considered at the end of this document as they could be possible extensions of our analysis in the near future.

Our general approach is that, through the analysis of the recent history of EMPAGUA, we can simulate a possible scenario for the next ten years, estimating the cost of producing water and the potential revenues derived from the implementation of the suggested tariff. After projecting population growth and potential water production, our analysis will try to estimate the financial balance of the utility at the end of each year and the changes that should be embraced by EMPAGUA´s authorities in order to obtain a full cost recovery model that could be sustainable in the near future.

Finally, to outline how this policy will improve the current water conditions in Guatemala City, we will alternate different values for each one of the key variables, trying to replicate the behavior of the users due to changes in the tariff, the projection of operative costs due to the increment in the extraction of water, and the variance in the demand of water due to demographic growth and increase in the coverage of users by EMPAGUA. In the end, the model we develop will allow people to evaluate the actual cost incurred in the production of water, and to demonstrate that if the actual tariff remains the same, the utility will continue to suffer from an unsustainable financial deficit.

3. THE FIRST ASPECT OF THE PROBLEM: How Much Does it Cost to Produce Water?

What is the basic, but complex, composition of the water sector in Guatemala? Traditionally, public policy analysts have focused their attention on revising what the legal framework says about the responsibility of the Government in the provision of funds to

municipalities, which are the administrative entities responsible for the provision of water to households. Then, these analysts establish certain criteria to increase the amount of resources that should be allocated for the provision of water in all the territories (mostly based on population), and which would be the best practice to execute these resources.[5]

However, this method is inaccurate in estimating the real cost of producing water because it ignores the related activities and services that go along with the production process. The cost of producing water is not only related to the population of a certain territory; instead, the cost of producing water should include a more "entrepreneurial" aspect, analyzing different variables such as the cost of extraction, the salaries paid to the workers, the maintenance of infrastructure, and the treatment of water, among others.

Our first objective is to understand how the production of water works in Guatemala City, then trying to use the case of EMPAGUA to calculate the cost of producing water for a very specific part of the country. We do not only want to analyze the amount of money that the Government allocates to assure the distribution of water; instead, we want to understand if this amount of money is enough to cover the costs associated with the production of water and the maintenance of the service over time.

Case Study: the cost of producing water in Guatemala City

The estimation of financial costs for producing water in Guatemala City is the first challenge in our analysis. As mentioned, it is not enough to know the magnitude of resources allocated by the Government to each municipality because these institutions are not directly responsible for the production of water at each watershed.

Public funds are used by municipalities as a general fund which goes towards solving the basic demands of the community. Additionally, Mayors are only interested in the provision of water to households, instead of optimizing the functioning of the institution in charge of producing water for the community. Most often, the funds allocated by the Central Government are not used by Mayors to cover the costs of producing water, nor to guarantee the financial sustainability of the watershed as the real provider of the water.

This is the reason why we have decided to present the case of the Guatemala City Water Enterprise, or EMPAGUA (Empresa Municipal de Agua), as already mentioned. Its relevance is not only that it contains accurate, public, and updated information about its financial statements, but also because this public enterprise is responsible for the functioning of one of the biggest watersheds in terms of water production (net caudal of water), the Maria Linda Watershed. This watershed provides water to more than 11 percent of the current users, and is the second most important watershed in Guatemala after the Motagua watershed (it covers 24 percent of the users).

To obtain financial information about EMPAGUA, we consulted the Integrated Accountability System—SICOIN—under the supervision of the Ministry of Public Finances in Guatemala (www.sicoin.minfin.gob.gt). This source compiles all the information related to

[5] For more information see Water resources in Guatemala: http://www.infoiarna.org.gt/guateagua/index.htm and Watersheds Guatemala: http://cuencasguatemala.wikia.com/wiki/Portada

the execution of the Government's budget, including data series since 2004. This update of information is on real time because it is the platform where all governmental institutions (including municipal enterprises) register their daily operations.

Taking into account the different components of EMPAGUA´s budget, it was necessary to process information, filter the data, and make specific queries to identify expenditure on the different aspects of the budget. The two main budget categories that we wanted to analyze are:

(1) Recurrent Expenditures: These expenditures refer to operational activities, including wages and other items not included here such as materials, office supplies, and different payments for rent, maintenance, and utilities.
(2) Capital Expenditures: These expenditures refer to investment activities and have a duration of over one year. These are expenditures related with the improvement of infrastructure such as pipelines and sewerages.

After gathering information for the last five years (there is no available online information for the years prior to 2008), we have illustrated below how much the production of water in Guatemala City costs under the administration of EMPAGUA.[6]

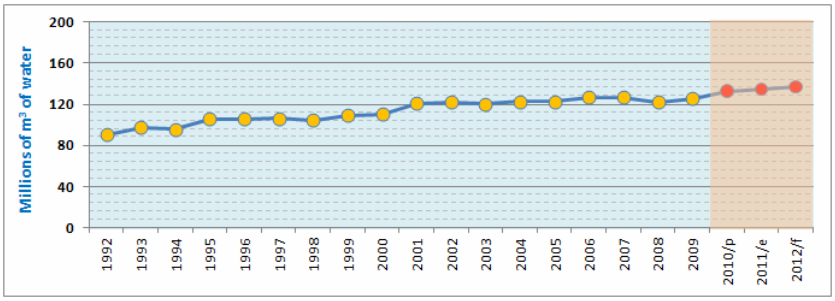
(Millions of current USD)	**2008**	**2009**	**2010**	**2011**	**2012**
Recurrent Expenditures	$ 34.79	$ 36.45	$ 43.17	$ 50.98	$ 51.73
• Wages	$ 11.11	$ 12.83	$ 14.20	$ 16.21	$ 16.70
• Non-wages	$ 23.68	$ 23.62	$ 28.97	$ 34.77	$ 35.03
Capital Expenditures	$ 0.85	$ 0.63	$ 0.55	$ 1.23	$ 0.94
Debt Services	$ 4.63	$ 5.50	$ 4.89	$ 5.20	$ 4.98
Total	$ 40.27	$ 42.58	$ 48.61	$ 57.41	$ 57.65
* All figures are actual figures as at the end of the fiscal year (January–December)					

These costs are associated with the regular functioning of EMPAGUA, including the payments to workers, the functioning of the offices, the maintenance of the equipment and the infrastructure, the investment in capital assets, and the payment of debt services.

Now, to complement our analysis, we should consider the amount of water extracted for public distribution during this timeline. This will help calculate the unitary cost for each cubic meter of water produced. It is important to note here that "water produced" is considered as only the net amount of water that was delivered to particular users, the people who have a direct impact on the revenues perceived by the institution. (Further in our analysis we will explain in a more detailed manner that other users, such as governmental institutions, do not pay for the water they consume.)

[6] Due to complications in the way that the government spends the funds during the year, there are important modifications to the budgeted data presented and approved by the Congress every year. Recognizing the importance of effective money spent in every sector, the analysis uses actual rather than budgeted data. Actual budget identifies executed funds, which could differ from budgeted data, but that effectively shows the public expenditure. Additionally, we used nominal instead of real numbers because we wanted to analyze how the tariff charged to users directly affects the financial result at the end of the year, instead of analyzing the effect of inflation in the amount of revenues perceived by EMPAGUA.

Having said that, and according to the information provided by the National Institute of Statistics[7] and the estimates made by functionaries of EMPAGUA, the graph below illustrates the annual production of water during the last 20 years:[8]



The trend is positive, with very little variation over the years. The water distributed to users is equivalent to more or less 6.2 percent of the gross availability of the Maria Linda Watershed, almost double the national standard (3.5 percent over domestic, industrial, and agricultural consumption). This estimation does not include the caudal of water used for energy purposes, or distributed to governmental users who do not pay for the service.

Now, combining the total cost information and the total production of water, we can calculate the unitary cost of producing water (i.e. cost per cubic meter of water). The table below shows this cost for the five-year timeline used in our analysis:

	2008	2009	2010	2011	2012
Total cost (millions USD)	$ 40.27	$ 42.58	$ 48.61	$ 57.41	$ 57.65
Production (millions of m^3)	122.4	125.9	132.9	134.9	137.0
Unit Cost per m^3 of Water	$ 00.33	$ 00.34	$ 00.37	$ 00.43	$ 00.42

The unit cost presents an incremental pattern along the years, varying from US$ 0.33 per cubic meter of water to US$ 0.43 per cubic meter of water. This situation, isolating the effect of EMPAGUA extracting more water every year, shows that the marginal cost of producing water in Guatemala City is increasing (27.9 percent in the last five years).

What we have to analyze is if this increment has been reflected in the tariff charged to consumers, or in the amount of funds that the Government is allocating to municipalities. Moreover, we have to define if this cost includes the impact that the extraction of water has on the environment, because this is the most neglected aspect in such an analysis.

Finally, we want to highlight the very low magnitude of resources that are allocated for capital investments, representing less than 2 percent of the total expenditures of EMPAGUA. This situation runs against evidence of what happens in other countries where

[7] Instituto Nacional de Estadística (2011). *Compendio Estadístico Ambiental de Guatemala 2010*. Sección de Estadísticas Ambientales, Oficina Coordinadora Sectorial de Estadísticas de Ambiente y Recursos Naturales. OCSE/ Ambiente. Guatemala.

[8] Information was available from 1992 to 2009. Data for 2010 is preliminary, for 2011 it was estimated, and for 2012 it was forecasted with the help of EMPAGUA functionaries.

the share of capital expenditures equals or surpasses the amount of recurrent expenditures.[9] This leads us to think that we might have missed something in our analysis or in the way the Ministry of Finance registers the capital investments for water in Guatemala City.

Looking at the national budget, we have found that other institutions subsidize the capital expenditure on water in Guatemala City. These investments, which are essential for the functioning of EMPAGUA, should be included in our analysis, going beyond the financial statements presented by the institution. Taking this into consideration, the table below shows that we have re-estimated the total cost of producing water in Guatemala City.

(Millions of current USD)	2008	2009	2010	2011	2012
Recurrent Expenditures	$ 34.79	$ 36.45	$ 43.17	$ 50.98	$ 51.73
• Wages	$ 11.11	$ 12.83	$ 14.20	$ 16.21	$ 16.70
• Non-wages	$ 23.68	$ 23.62	$ 28.97	$ 34.77	$ 35.03
Capital Expenditures	$ 3.00	$ 3.10	$ 2.92	$ 3.34	$ 3.26
• EMPAGUA Expenditures	$ 0.85	$ 0.63	$ 0.55	$ 1.23	$ 0.94
• National Institute for Municipal Promotion (Local Development)	$ 2.08	$ 2.39	$ 2.27	$ 2.00	$ 2.27
• Ministry of Infrastructure	$ 0.08	$ 0.08	$ 0.10	$ 0.11	$ 0.05
Debt Services	$ 4.63	$ 5.50	$ 4.89	$ 5.20	$ 4.98
Total Cost for Guatemala City	$ 42.43	$ 45.05	$ 50.98	$ 59.52	$ 59.96
Re-calculation of per m^3 cost:					
• Total Cost (millions USD)	$ 42.43	$ 45.05	$ 50.98	$ 59.52	$ 59.96
• Production (millions of m^3)	122.4	125.9	132.9	134.9	137.0
Unit Cost per m^3 of Water	$ 00.35	$ 00.36	$ 00.38	$ 00.44	$ 00.44

Even though the increment in the capital costs has tripled from the original amount executed by EMPAGUA during the last five years, it is still below international standards.[10] This situation demonstrates a lack of capacity of the utility for improving the infrastructure in Guatemala City, or/and an excessive allocation of funds for recurrent expenditures such as wages and other services directly related with the production of water (i.e. variable costs). Our guess is that we should balance these costs with the number of users of this utility.

Figures for 2008 reveal a coverage of approximately 200,000 users from a potential population of 980,000 in Guatemala City; in other words, a rate of 20.58 percent. The rest of the users are connected to private wells or are served by the other public enterprise

[9] Food and Agricultural Organization (2009). *Depósito de Documentos de la FAO: Ingeniería Económica aplicada a la Industria del Agua* , Chapter. 4: "Production Costs" (title 4.2.4.3: Agua). United Nations.

[10] A.L. Manzán, L. Pagliettini and D. Robles (2012). "Valoración del Agua para la Producción Agrícola". *Aqua* LAC, Vol. 4, No. 1 (March 2012). Argentina.

called “Compañía de Agua del Mariscal, S.A.”. However, due to restrictions on the availability of information, our analysis will deal only with the municipal public water enterprise (i.e. EMPAGUA).

The next table illustrates how the number of users has grown in the last years:

	2008	2009	2010	2011	2012
Guatemala City population [1]	980,160	984,655	988,150	991,859	995,858
EMPAGUA Users [2]	201,719	209,046	217,019	224,537	232,248
Coverage rate	20.58%	21.23%	21.96%	22.64%	23.32%
(1) Data provided by the National Institute of Statistics, according to 2002–2020 population estimations. (2) Data provided by EMPAGUA according to its public records included in the annual report.					

Even though costs are directly related with the production of water, it is very interesting to analyze the relation between users and the recurrent and capital expenditures. This will give us an additional point of reference to evaluate if EMPAGUA´s operation is anywhere close to international standards.

	2008	2009	2010	2011	2012
EMPAGUA Capital Costs	$ 0.85	$ 0.63	$ 0.55	$ 1.23	$ 0.94
EMPAGUA Users	201,719	209,046	217,019	224,537	232,248
Capital Investment per User	$ 4.20	$ 3.03	$ 2.55	$ 5.47	$ 4.05

According to the previous information, EMPAGUA has a capital investment of around US$ 3.86 per user per year. This is an indication of EMPAGUA’s efforts to improve infrastructure to deliver water to users, which is consistent with the objective of enhancing its operation. It does not include the total capital cost (additional investments made by INFOM and the Ministry of Infrastructure) because the objective is not to cover the EMPAGUA users only, but the total population of Guatemala City.

In conclusion we highlight two major points. The first is the very low investment made by EMPAGUA in infrastructure and its maintenance, as is reflected in the capital expenditure per cubic meter of water produced and the capital investment per user. The second is the positive trend in the total budget administered by EMPAGUA, which is strongly correlated with the production of water, but not with the users covered by the utility.

Finally, we now have to analyze if the revenues are enough to cover the existing costs incurred by EMPAGUA, considering the way users are charged for their consumption of water and other services provided by EMPAGUA (e.g. sewerage and water connections).

4. THE SECOND SIDE OF THE PROBLEM: How much is paid by Consumers?

The environmental shortcomings of economic theory, based on the “resource abundance” approach, create a problem of environmental goods and services in Guatemala City. Water

resources are the main tangible resource for people as an input in production or in final consumption, a situation that implies an evident economic value of this resource.

Consequently, the whole society is responsible for the way water is valued, taking into consideration its relative abundance or scarcity, scaling up its value according to its usage and the quantity that is drained out from other users.

Actually, it is almost impossible to find information about water tariffs in Guatemala. Different surveys reflect that there are more than 4,000 providers[11] of water in the country, each one of them with varied structures of payment, indicating diverse criteria for pricing of water by users. Our objective is to continue analyzing the case of EMPAGUA in order to obtain reliable data about the tariff that is charged to users in Guatemala City. We could then estimate how much people pay for the water they consume.

How is the tariff that is charged to users defined?

The first thing to note is that not all the households in Guatemala City are registered with the same water provider, which implies that they pay different rates for the water they consume because they are not included in a common water network for the city. After gathering some information, we identified three types of providers: (i) private providers (e.g. private wells), (ii) public providers (EMPAGUA), and (iii) communal enterprises such as "Compañía de Agua del Mariscal, S.A.", which is constituted by civil society.

This clarification is very important because we have to understand who the provider is in order to identify who defines the tariff that will be paid by consumers. Basically, municipalities are responsible for defining the tariff that will be charged to more than 94 percent of users in Guatemala,[12] either through public enterprises or through Watershed Authorities.

Nevertheless, this tariff is not registered in any public source of information. Municipalities receive funds from the Central Government to guarantee access to water, which is an additional income, that won´t affect how the service is provided. With the exception of EMPAGUA, which only operates in Guatemala City, there are other enterprises that formally produce information about its management.

For this reason, and recognising the limitations of our analysis, we only present the current scheme of payments implemented by EMPAGUA to charge users according to volumetric consumption, differentiating among particular, governmental, and other users.

According to the most recent information,[13] we illustrate below the actual scheme of tariffs that EMPAGUA charges for volumetric consumption of water by Guatemala City users.

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[11] Cuerpo de Ingenieros De los Estados Unidos de América (2000). *Evaluación de Recursos de Agua en Guatemala.* Distrito de Mobile y Centro de Ingeniería Topográfica.

[12] Instituto Nacional de Estadística (2006). Household Survey: *Encuesta Nacional de Condiciones de Vida*.

[13] Instituto Nacional de Estadística (2011). *Compendio Estadístico Ambiental de Guatemala 2010*. Sección de Estadísticas Ambientales, Oficina Coordinadora Sectorial de Estadísticas de Ambiente y Recursos Naturales. OCSE/Ambiente. Guatemala.

Monthly Consumption (m^3)	Tariff (USD per m^3)	Share of Users (%)
Particular Users		84.4%
• Consumption: 0 – 20 m^3	US$ 0.24	42.7%
• Consumption: 21 – 40 m^3	US$ 0.37	27.6%
• Consumption: 41 – 60 m^3	US$ 0.47	8.9%
• Consumption: 61 – 120 m^3	US$ 0.94	4.0%
• Consumption: 121 – more m^3	US$ 1.17	1.2%
Governmental Users (Municipality)		0.51%
• Consumption: 0 – 20 m^3	- - -	0.11%
• Consumption: 21 – 40 m^3	- - -	0.03%
• Consumption: 41 – 60 m^3	- - -	0.03%
• Consumption: 61 – 120 m^3	- - -	0.08%
• Consumption: 121 – more m^3	- - -	0.26%
National Bank for Housing	- - -	3.1%
Public Settlements	- - -	12.0%
TOTAL		100%
• Sewerage Tariff	20%	
• Fixed Charge (Monthly Payment)	US$ 2.94	

The table describes how different levels of water consumption are charged with a progressive tariff. However, this scheme only applies for particular users (more or less 84 percent of total users served by EMPAGUA), because municipal institutions, houses financed by the National Bank for Housing (i.e. BANVI,) and Public Settlements do not pay according to the water consumption registered at the end of the month. These institutions make a direct transfer to the Municipality of Guatemala according to a contract that does not establish a payment for consumption; instead, it is a fixed payment set by EMPAGUA.

Due to the progressive tariff that is applied for every increment in the consumption of water, we could say that the simple average price of every cubic meter of water is more or less Q 5.10, or the equivalent of US$ 0.64. This figure gives us a rough idea of the price that EMPAGUA is charging for every cubic meter of water that is being consumed. Nevertheless, a more rigorous calculus will be based on a weighted average that recognizes the different levels of consumption of water and the number of users that pay each tariff. Following the analysis based on the data available for EMPAGUA, we now present a more precise price for each cubic meter of water consumed.[14]

It is important to mention that these numbers reflect the current structure of payments that is implemented by EMPAGUA, based on the monthly volume of water consumed by each user. Additionally, we recognize that the different percentages registered in each block are based on 2008 figures, but EMPAGUA has not revealed additional information indicating if this proportionality has presented any particular change in recent years.

[14] EMPAGUA registered 201,719 users in its 2008 annual report to the Board of Directors. From the total of users, 170,322 were registered as particular users (84.4%).

	TOTAL	0-20 m^3	21-40 m^3	41-60 m^3	61-120 m^3	120+ m^3
Users:	170,322	86,151	55,746	17,939	8,160	2,326
Weight:	100%	50.58%	32.73%	10.53%	4.79%	1.37%
Price of Each m^3:		US$ 0.24	US$ 0.37	US$ 0.47	US$ 0.94	US$ 1.17
Weighted Average:	US$ 0.35	The fixed cost is not directly related with marginal consumption, so it will only affect the total income of the watershed authorities if the number of users varies over time.				
Sewerage:	+ 20%					
Tariff per m^3:	US$ 0.42					

Using this information as reference, we can now infer that the tariff charged to the users is not enough to cover the financial cost of producing water in Guatemala City, although it is very close to the unitary cost registered by EMPAGUA. With a total cost of more or less US$ 0.44 per cubic meter of water produced, the deficit that EMPAGUA faces is around US$ 0.02 per m^3 of water consumed by particular users, a difference that should not be difficult to bridge.

However, here we are talking about averages without considering the marginal consumption reported by each user. We know how many users are located in the tariff blocks established by EMPAGUA, but we do not have detailed information about the consumption by each one of these users. To overcome this, as we did with the costs reported by EMPAGUA during the last five years we want to illustrate the total revenues of the utility, considering both the revenues originated by the volumetric tariff charged to particular users and by the fixed payments made by other users.

(Millions of current USD)	2008	2009	2010	2011	2012
Total Revenues	$ 39.39	$ 42.37	$ 48.41	$ 57.26	$ 57.23
• Operational Revenues	$ 38.68	$ 42.21	$ 48.01	$ 56.39	$ 56.77
• Complimentary Revenues	$ 00.71	$ 00.15	$ 00.40	$ 00.87	$ 00.46

When we compare costs and revenues, EMPAGUA registered a negative difference in its operation at the end of the fiscal year since 2008. This situation is more obvious when we analyze the financial statements of EMPAGUA during the last five years, comparing the total costs of functioning and the revenues generated by the tariff charged to particular users:[15]

[15] To better understand the figures, we proceeded to divide the net incomes perceived by EMPAGUA every year in two components: (i) incomes generated by the tariff charged to particular users (Budget Line 14,000: *"Ingresos de Operación"*), and (ii) incomes related to rents, transfers, debt, and the payments made by other types of users such as governmental institutions and other specific groups.

(Millions of current USD)	2008	2009	2010	2011	2012
• Recurrent Expenditures	$ 34.79	$ 36.45	$ 43.17	$ 50.98	$ 51.73
• Capital Expenditures	$ 0.85	$ 0.63	$ 0.55	$ 1.23	$ 0.94
• Debt Services	$ 4.63	$ 5.50	$ 4.89	$ 5.20	$ 4.98
Total Expenditures	$ 40.27	$ 42.58	$ 48.61	$ 57.41	$ 57.65
• Operational Revenues	$ 38.68	$ 42.21	$ 48.01	$ 56.39	$ 56.77
Operational Surplus/Deficit:	($ 01.59)	($ 00.36)	($ 00.61)	($ 01.02)	($ 00.88)
• Complimentary Revenues	$ 00.71	$ 00.15	$ 00.40	$ 00.87	$ 00.46
Financial Surplus/Deficit:	($ 00.88)	($ 00.21)	($ 00.21)	($ 00.15)	($ 00.42)

With the constraint of not including the capital investment made by INFOM and the Ministry of Infrastructure, because these numbers are not included in the financial statements of EMPAGUA, we notice a continuous deficit during the last five years, even though the institution incurred debt in 2008 and2011to cover the shortfall in its revenues.

Our main argument is that this situation is unsustainable in the long run, which is why we have to work on reducing the costs or increasing the revenues, not only to cover the current deficit, but also to obtain enough funds to cover the debt from previous years. We are not only talking about the financial sustainability of an institution like EMPAGUA; instead, we are trying to reiterate the point that we are not collecting enough resources to cover the deterioration of the environment; thus the necessity to change the model.

As an example, according to EMPAGUA authorities, the City of Guatemala is actually presenting problems of overexploitation of aquifers and therefore problems with the continuity of water services in many sectors of the city. EMPAGUA currently manages an accumulated deficit of US$ 4.55 million (about 6.5 percent of their annual income), and tariff revenues are insufficient to cover operating costs. For 2011, EMPAGUA estimated that only 7 percent of users pay fees that cover their respective costs.

Over the past 10 years, at least, different sectors have been discussing the importance of water value and water costs, because the actual model reveals a system where the average cost of producing water is higher than the tariff charged to users, without taking into consideration the few resources invested in capital. As a consequence, this structural deficit will worsen the functioning of EMPAGUA, resulting in indebtedness or the continuous subsidization by the Central Government, with negative consequences if the expectations are not met in time.

5. ESTIMATES AND CALCULATIONS: Which Tariff Equals the Cost of Water?

The simplest way to attend to the problem that EMPAGUA is facing is through an increment in the tariff that is charged to users, following the same logic of charging those users who consume more water a higher fee which is reflected in their monthly bill.

It is important to mention that this tariff will have an impact on household consumption of water, but we do not have information about the impact on the individuals. It is reasonable to suggest that larger families will consume more water, so the highest fee will affect them

more, spreading the impact over a large number of individuals. However, this is not always the rule. Additionally, we have to evaluate side effects of this implication, considering that in Guatemala the larger households are the poorest because of a high fertility rate among poor women.

With these two ideas in mind, we will analyze first, which tariff has to be charged to users in order to achieve a point of equilibrium between the revenues with the financial costs incurred by EMPAGUA. Then, we will dedicate a specific chapter to analyze modifications in the behavior of consumers, trying to simulate what could happen to the amount of resources perceived by EMPAGUA if the tariff is increased in the short run.

How to achieve an equilibrium point?

The deficit situation that EMPAGUA is suffering reinforces the necessity of redesigning how water consumption is charged by the current authorities. So, our proposal aims to introduce some specific changes that will have a positive impact, not only for the financial sustainability of the institution in the short run, but also in the long run.

We present calculations to determine an alternative tariff that could be charged in order to obtain economic benefits from water production, and the potential revenues that could be garnered if the changes are introduced in a timely manner. Then, we will dedicate a section to propose a different scheme of payments which will cover not only the operative costs, but will also generate enough funds to invest in capital or consider the payment for environmental services.

What would be the new scheme of tariffs?

If the goal is to achieve financial sustainability for EMPAGUA in the future, we have to define a tariff that compensates the costs of producing water. The easiest way to estimate "adequate" tariff is by resolving the difference between the financial cost of producing one m^3 of water and the price of the consumption of one m^3 of water.

The information that we previously presented reveals that the financial cost of producing one m^3 of water is around US$ 0.44 (estimations for 2012). Comparatively, the price for consuming one m^3 of water is more or less US$ 0.35, complementing this payment with an additional charge of 20 percent for sewerage, and a fixed charge of US$ 2.70 for a connection.

Every month, the user's total bill includes these three components, and, if we sum up the bills of all users, we will get the operational revenues for EMPAGUA. To equal the current expenditures of the institution, the new tariff should have a 4.77 percent increment at all consumption levels, maintaining the 20 percent for sewerage purposes, which is on average the equivalent of US$ 0.37 per m^3 of water:

Monthly Consumption (m^3)	Tariff (USD per m^3)	Share of Users (%)
Particular Users		84.4%
• Consumption: 0 – 20 m^3	US$ 0.25	42.7%
• Consumption: 21 – 40 m^3	US$ 0.39	27.6%
• Consumption: 41 – 60 m^3	US$ 0.49	8.9%
• Consumption: 61 – 120 m^3	US$ 0.98	4.0%
• Consumption: 121 – more m^3	US$ 1.23	1.2%
Governmental Users (Municipality)	- - -	0.51%
National Bank for Housing	- - -	3.1%
Public Settlements	- - -	12.0%
TOTAL		100%
• Sewerage Tariff	20%	
• Fixed Charge (Monthly Payment)	US$ 2.94	

It is important to mention that the share of the fixed charge in the total income for EMPAGUA is not related with the consumption of water by users, but with the number of users. Actually, this charge only represents 1.2 percent of the total income, or the equivalent of around US$ 460,000 a year. This is the reason why we are not paying much attention to changing this tariff, because it is not significant to cover the current financial deficit of the institution. Instead, we want to analyze how to charge users according to their volumetric consumption, considering the option of introducing variations in the sewerage surcharge.

Having said that, the challenge we now face is to include the behavior of the users in our analysis, because it is reasonable to suppose that with the increment in tariff, their consumption will come down. In the next chapter we will evaluate the effect of this increment in the volume of consumption, considering if the effect will be negative, positive, or none. Additionally, going beyond the reasonable change of equalizing the cost with the price of one cubic meter of water, we will evaluate the final result in the total amount of revenues and costs for EMPAGUA, which will be the key variables in the determination of a positive financial result at the end of the fiscal year.

We will evaluate the relation between costs and revenues for the next 10 years, considering that the costs will vary according the expected production of water, and revenues will be affected by the expected number of users (correlated with demographic growth). Our objective is to effectively determine which tariff should be charged to users to guarantee financial sustainability in the long run.

6. POLICY SIMULATION ANALYSIS: Financial Sustainability in the Long Run

Once we have defined the changes that should be implemented to guarantee a full recovery of the financial cost of producing water in Guatemala City, we have to consider consumer reactions, if any, to the increment in the tariff that we are proposing, with some reduction in the volume of water they consume every month, thus affecting the total amount of revenues for EMPAGUA.

Our goal is to evaluate the possibility of determining a specific tariff that produces a full cost recovery for water production in Guatemala City, using as a reference the specific case of EMPAGUA. What we have to do is to verify the expected variations in costs and revenues, adjusting the scheme of tariffs to guarantee a zero financial deficit at the end of the year for the next decade[16] in order to conclude if this change is feasible and if it will harm people´s preferences.

In this chapter we want to present the main assumptions behind our simulation and the major results after the first round of simulations, evaluating how the households will react due to the change in tariff, which block of consumption is going to bear the cost of our proposal, and if the policy we are proposing will allow EMPAGUA to cover its expected operation costs with the expected revenues.

What are the assumptions behind the policy simulation?

To be transparent in our analysis, we proceed to make explicit all the assumptions that will be essential for our policy simulation. Some of them could be the subject for future discussion, but the most important thing is that we can justify why we selected certain values for specific variables and the way they are going to interact among them.

The first step is to describe the key variables used in our analysis and the assumptions we made about their behavior during the next 10 years. For each variable we explain the methodology used for the estimations and projections of the values, an aspect that will be essential for the modeling of EMPAGUA.

(1) Production of Water: EMPAGUA´s costs are directly related with their annual production of water which is the main input for the provision of water to Guatemala City's population. We consulted EMPAGUA´s functionaries to verify the production values for 2010 and 2011, at the same time forecasting the production of water for 2012. However, in our analysis we want to include the expected production for the next 10 years, which is why we used a specific methodology to estimate these values.

The methodology we used for the estimation of the future values for water production included moving averages adjusted by a linear tendency and a stationary component. In addition to this seasonal adjustment of the time series, the method allowed us to pick on the coefficients that generate the lowest square error (MSE) for the forecasting, evaluated as the difference between the real value and the estimation.

The method is known as "Holt-Winters´ Exponential Smoothing with Seasonality". This method combines the smoothed average, the adjusted linear tendency, and the stationary component for the forecasting. The logic of the method is based on four equations:

- Overall Smoothing: $S_t = \alpha \frac{Y_t}{I_{t-s}} + (1-\alpha)(S_{t-1} + b_{t-1})$
- Trend Smoothing: $b_t = \gamma(S_t - S_{t-1}) + (1-\gamma)b_{t-1}$
- Seasonal Smoothing: $I_t = \beta \frac{Y_t}{S_t} + (1-\beta)I_{t-s}$

[16] Due to the availability of information we only simulate the next 10 years, considering a reasonable period of time to guarantee financial sustainability for the operation of EMPAGUA in Guatemala City.

- Forecast: $F_{t+m} = (S_t + mb_t)I_{t-L+m}$

Where:

- y is the observation
- S is the smoothed observation
- b is the trend factor
- I is the seasonal index
- F is the forecast at m periods ahead
- t is an index denoting a time period
- L is the length of the seasonality
- α, β and γ are constants that must be estimated in such a way that the MSE of the error is minimized

Using as a basis the historical series reported by EMPAGUA for the period 1992–2012, we estimated the next 10 years in order to obtain the required data for our simulation.

After running the regression adjusted by the trend and seasonal smoothing, the results for the production of water are as follows: [17]

EMPAGUA: Production of Water (1992–2012)										
1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
90.4	97.4	96.1	106.1	106.0	106.6	104.5	109.6	110.6	121.0	121.9
2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	
120.2	123.1	122.6	127.0	127.0	122.4	125.9	132.9	134.9	137.0	
Forecasting: 2013 – 2022										
2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	
139.4	140.9	144.5	143.7	147.6	149.1	152.8	151.9	155.9	157.3	

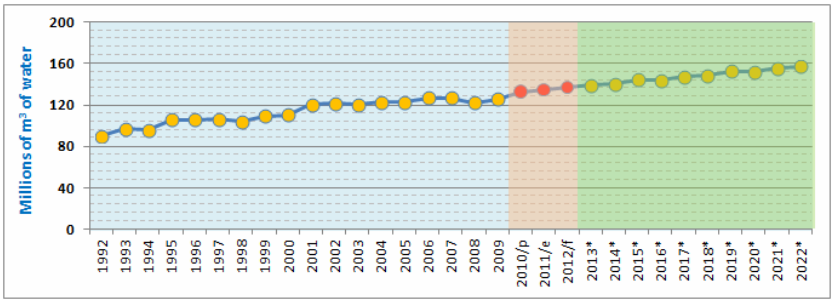
We want to clarify that the variable refers to the total amount of water that is extracted from the Maria Linda Watershed by EMPAGUA to supply Guatemala City. The most recent information about water availability in Guatemala presents detailed data about how much water is produced, the main sources of water availability, and the different uses of these resources.[18] Basically, the net caudal of water in the country is only 35 percent of the current caudal, due partly to natural deterioration of the ecosystems´ functioning, and by human pollution of these resources (40 percent). For the specific case of the Maria Linda Watershed, the current caudal is around 2,205 millions of m^3 of water a year.

Additionally, in the smoothening of the values estimated by linear regression, we considered the potential reduction in production as the utility reaches the maximum caudal

[17] The first two rows present the historical values for the production of water by EMPAGUA and the last row presents the estimated annual values for the next ten years. All the values are in millions of m^3 of water.

[18] Instituto Nacional de Estadística (2011). *Compendio Estadístico Ambiental de Guatemala 2010.* Sección de Estadísticas Ambientales, Oficina Coordinadora Sectorial de Estadísticas de Ambiente y Recursos Naturales. OCSE/Ambiente. Guatemala.

of water that could be produced by the Maria Linda Watershed. The graph below better illustrates this:



(2) Variable Costs: The production of water directly affects the portion of the costs that is related with the provision of the service to the final user. EMPAGUA incurs these costs when water is produced, varying according to the amount of cubic meters or water extracted from the Maria Linda Watershed.

These costs can be estimated by multiplying the annual production of water by the unitary variable cost; however, the better way would be the estimation of this value. Along this line of thought, the best estimate for the unitary variable cost could be obtained reviewing historical data for EMPAGUA, identifying those costs that could be attributable to the production of water, assuming that the value will be constant during the next 10 years.

Budgetary information for the period 2008–2012 shows us the composition of Recurrent Expenditures in four specific areas: (i) Personnel, (ii) Building, Properties, and Machinery, (iii) Debt Services, and (iv) Other Expenditures.[19] Analyzing these, the first three areas are not directly related with the production of water, leaving the last one as the only budget line that could be considered a variable cost.

Considering that we have already estimated the production of water, the calculation of the unitary variable cost will be equal to the Other Expenditures group divided by the historical production of water reported by EMPAGUA.

	2008	2009	2010	2011	2012
Variable Costs (millions)	$ 38.68	$ 42.21	$ 48.01	$ 56.39	$ 56.77
Production (millions m^3)	122.36	125.87	132.85	134.92	136.98
Unitary Variable Cost	$ 00.19	$ 00.18	$ 00.21	$ 00.25	$ 00.29

The values reveal an incremental tendency during the last five years, from US$ 0.19 per m^3 of water produced to US$ 0.29 per m^3 of water produced. To make our estimations for the next decade, we will instead set a constant equal to the average of the last three years (the ones with more relevance in our analysis). The figure—US$ 0.25 per m^3 of water—seems arbitrarily defined, but a further sensitivity analysis will allow us to analyze how the variations in this will affect the total cost of producing water in Guatemala City.

[19] In this group of expenditures we included three budget lines: (i) Group 1: Non-personal Services, (ii) Group 2: Supplies and Materials, and (iii) Group 4: Recurrent Transfers.

We do not have any reason to believe that this figure will continue to increase or decrease, even though the information from previous years denoted such a tendency. Comments from EMPAGUA´s functionaries mention a recent effort by EMPAGUA to maintain variable costs as low as possible, working on methods to introduce efficiency practices and economies of scale in the production of water.

Fixed Costs: There is a share of the recurrent expenditures that are not related with the production of water, representing around 40 percent of these costs. Fixed costs, such as personnel salaries, rent for buildings, or the payment of debt services result from the activity of the utility, but have no relation with the production of water.

As we mentioned in the previous sub-section, these costs will be equal to the sum of (i) Personnel, (ii) Buildings, Properties, and Machinery, and (iii) Debt Services. However, for the estimation of the values that will be used in our simulation, we have to consider how these variables will behave in the future.

Looking at the nature of these expenditures, we see that they depend on the number of personnel and on the variation of the prices and interest rates. For each one of the components, we have assumed the next trends:

- Personnel: Information provided by EMPAGUA reveals a natural tendency in the increment of personnel salaries, adjusted around 5.5 percent every year (included in the contract with the labor union for 2011). If we assume that this trend will continue over the next 10 years, we can easily estimate this share of fixed costs.
- Buildings, Properties, and Machinery: The higher cost included in this budget line goes towards the leasing of machinery, maintenance, and the rent for buildings. There is not a lot of information about this, but we can assume an annual increment equal to the inflation rate estimated by the Central Bank of Guatemal—BANGUAT. During the last 10 years, the inflation goal has been 4 percent (± 1 percent), so we can fairly safely assume that this share of fixed costs will increase in this percentage for the next decade.
- Debt Services: This is perhaps the most difficult item to forecast but which is mandatory for EMPAGUA. Over the last five years, EMPAGUA has spent, on average, more or less US$ 5.07 million every year for debt services, with almost no variation over the years. For the purposes of our simulation, we will maintain this figure, using moving averages to adjust the value every year.

(3) Capital Costs: We have to consider one more budget line related with the functioning of EMPAGUA, and that is, investments in capital. This is an item that is difficult to estimate because of the decision making process behind the allocation of funds for this purpose. We do not have any information about whether it is related with production, or if it is expected to increase at a specific rate for the next years, or if it will remain the same.

However, a general assumption can be made, making specific recommendations further on in our analysis about which could be considered as the “optimal” amount of capital investments that should be spent by EMPAGUA. To simplify our analysis, we will assume

that the capital investments evolve naturally according to a linear pattern, using as the base line the historical data for the utility.

After analyzing the information we have for the period 2008–2012, the equation we obtained is presented below:

$$CAPEX = 0.6066 + 0.0779(x)$$

We recognize the limitations of this assumption, but the sensitivity analysis will allow us to reconsider this figure, assuming a rate of capital investments in terms of the annual production of water.

This set of assumptions will be very helpful in estimating the total costs incurred by EMPAGUA for the next decade, using different methodologies to calculate the values for the main variables used in our simulation. The next part will include the assumptions related with the estimation of the total revenues that will be allocated to EMPAGUA; the tariff charged to the final user—the objective variable for our simulation.

(4) Number of Users: The first criterion to analyze is the demographic variable which will be essential for determining the potential users served by EMPAGUA. This variable is related with the growth of the population in Guatemala City, a situation that has been modeled by the National Institute of Statistics.

The only information we have is the increase in the number of users for the period 2008–2012, disaggregating the information according to particular and governmental users. However, we also count the population estimations for Guatemala City for the next decade, with an average growth of 0.5 percent every year. The basic assumption behind our forecasting is that the users will grow in this proportion, plus EMPAGUA´s coverage growth of 1.0 percent every year (a conservative scenario according to historical data).

The next table illustrates the population registered for Guatemala City according to national estimations, the total number of users who will be served by EMPAGUA, and the users who will effectively pay for the water they consume, classified as “particular users”, representing around 84 percent of the total number of users.[20]

	Guatemala City: Population and EMPAGUA Users (millions)									
	2008	2009	2010	2011	2012					
	0.980	0.985	0.988	0.992	0.996	(1) Population for Guatemala City				
	0.202	0.216	0.231	0.250	0.264	(2) EMPAGUA: Total Users				
	0.170	0.182	0.194	0.211	0.222	(3) EMPAGUA: Particular Users				
	▶ Forecasting: 2013 – 2022									
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
(1)	1.000	1.005	1.010	1.013	1.017	1.021	1.025	1.030	1.034	1.038

[20] Potential users are based on a factor estimated by the Institute for Agriculture, Natural Resources and Environment – IARNA – (http://www.url.edu.gt/PortalURL/Principal_01.aspx?s=51). They estimated that only a fraction of the population is in fact considered a user, because the main unit of distribution is not the population, but instead, it is the household. This factor is around 3.02, and represents the amount of people considered as a “user”.

(2)	0.276	0.280	0.285	0.289	0.294	0.299	0.303	0.308	0.313	0.318
(3)	0.232	0.235	0.239	0.242	0.246	0.250	0.253	0.257	0.261	0.265

These numbers will be the point of reference to estimate the total consumption of water reported by users, applying the specific volumetric tariff depending on their amount of m^3 of water consumed each month. To arrive at these values, there are other assumptions that we have to clarify in order to guarantee the replicability of our analysis.

(5) Distribution of Users: After obtaining information on the total number of users, it is important to identify how many users are located in each one of the five blocks defined by EMPAGUA for charging the volumetric tariff. The only information we have is the current distribution valid for 2012, which will be the initial scenario for the simulation.

We also will assume that within each block defined by EMPAGUA, the users will behave as a normal distribution, locating the arithmetic median in the center of the range and the total variation covering ±3 standard deviations (99.7 percent of the values).

Nevertheless, we have to adjust the distribution of the users depending on how they will react to an increase in the tariff for each block. The objective of our analysis is to estimate which tariff should be charged to users in order to guarantee financial sustainability for the next decade; therefore, we have to recognize that due to the increment in tariff, users will decide to reduce their consumption, thus affecting the block where they will be located.

(6) Elasticity of Demand: The previous sub-section highlights the importance of considering the reaction of users due to changes in the tariff. This is the reason why we have to make a specific assumption about how the users will be re-allocated among the five different blocks defined by EMPAGUA after simulating increments in the tariff.

Elasticity of Demand will indicate how much consumption will be lowered with every 1 percent increment in the volumetric tariff. And, if we assume that the users are normally distributed inside each block, we can estimate the number of users who, due to the increase in the tariff, will reduce their consumption until the point that they will be located in a lower consumption block.

Knowing the range of consumption for each block, we can estimate the number of users who will be located in the immediate lower block, a condition that will change the distribution of users, the median and the standard deviation. However, this new distribution will be the reference for the initial distribution of users in the next year, a situation that will be modified after the re-accommodations derived from the application of the elasticity value (iterative calculation).

The value of the elasticity of demand is relatively complicated to estimate because of the necessary rigor in the analysis. Nevertheless, literature[21] gives us a general idea about which could be the value to be used in our simulation. Different references set an elasticity

[21] Ignacio Vélez-Pareja (2007). *Nota sobre la Elasticidad Precio-Demanda*. Universidad Tecnológica de Bolívar. Cartagena, Colombia. The average coefficient estimated for some countries in Latin America is more or less --0.3692, with variations between –0.17 and –0.42.

value between 0.1 and 0.4, indicating that the higher consumption blocks will react more drastically (higher elasticity value) in comparison with the lower consumption blocks. This consideration takes into account that water is an essential good that will be consumed by users even though the utility increases the price.

(7) Tariff´s Structure: The last values that should be considered for our simulation are the variables that comprehend the structure of the tariff defined by EMPAGUA. The tariff is composed of three different values: (i) volumetric tariff divided in five increasing blocks, (ii) sewerage tariff equals to an additional 20 percent of the volumetric consumption, and (iii) a fixed charge for connections equal to US$ 2.94 per user.

In our first round of simulations, we will keep the sewerage tariff and the fixed charge with no variations, which will be discussed later in this document. However, the key variable for our analysis will be volumetric tariff, which will be the starting point to solve the difference between costs and revenues. Additionally, the structure among blocks will remain the same, only adjusting the values depending on the average value settled for the volumetric tariff. If the average volumetric tariff should introduce an increment in order to guarantee financial sustainability, all the blocks will be adjusted, maintaining the original proportionality that is valid for EMPAGUA.

Now, after having clarified the fundamental assumptions in our simulation, the next step is to present the logical framework behind the analysis, explaining the interactions we expect among the variables. We have to explicitly illustrate the analytical path that will lead us to estimate the annual amount of costs and revenues, deriving the financial status at the end of the year. The following diagrams describe how the simulation will be conducted:

EMPAGUA´s Costs					
	Variable Costs	=	Forecasted Water Production: 2013-2022 (Holt-Winters´ Exponential Smoothing with Seasonality)	*	Unitary variable cost (US$ 0.25 per m^3)
	Fixed Costs	=	Personnel Costs (5.5% increment each year)		
			Buildings, Property, & Machinery (4% increment each year)		
			Debt Services (US$ 5.07 million each year on average)		
	Capital Costs	=	CAPEX = 0.6066 + 0.0799(x) | where x = 2013, 2014, 2015… 2022		
	Annual Costs	=	Variable Costs + Fixed Costs + Capital Costs		

The first sequence is about the costs, summarizing the different components of this item and the calculations made to obtain the values for the next decade. These values will be considered as the independent side of our equation in order to determine the optimal tariff that equalizes the costs with the revenues. Now, the second sequence is divided in two components. The first one is an estimation of the users who will be served by the utility, using as reference the demographic growth for Guatemala City and the expected coverage growth for EMPAGUA. The second component includes a very detailed diagram of how the total revenues will be calculated, mentioning the variables involved, such as personnel salaries, rent for buildings, or the payment of debt services and the interactions among them.

EMPAGUA´s Revenues							
	Users (t)	=	Users (t-1) * [1 + demographic growth (0.5%) + coverage growth (1.0%)]				
				Particular Users (t) = each year´s Users (t) * 84% (variable factor)			

	Different Blocks of Consumption for Particular Users				
(Framework for Particular Users)	**0 – 20 m^3**	**21 – 40 m^3**	**41 – 60 m^3**	**61 – 120 m^3**	**121 – … m^3**
• Year 0: Volumetric Tariff	US$ 0.24	US$ 0.37	US$ 0.47	US$ 0.94	US$ 1.17
• Lower Consumption limit	0	21	41	61	121
• Upper Consumption limit	20	40	60	120	250*
▶ Original Amount of Users	X0	X1	X2	X3	X4
	Particular Users Distributed According to (t-1) Percentages				
• Elasticity	Literature Review: Variable Number between 0.1 and 0.4				
• New Lower Consumption	0	Previous limit +|elasticity|*(% change in Tariff)*(range)			
• New Upper Consumption	(adjusted by the new lower consumption limits)				250*
• Median for the Range	(New upper limit + New lower limit) / 2				
• Standard Deviation	Block range / 6: 99.7% of users are located at ± 3 standard deviations				
▶ Users Moved to a Lower Block	---	Y1	Y2	Y3	Y4
	(area between new lower limit and previous lower limit) * Original Users				
• New amount of users	X0+Y1	X1-Y1+Y2	X2-Y2+Y3	X3-Y3+Y4	X4-Y4
• Average Consumption	median	median	median	median	median
• New Volumetric Tariff:	Previous year Volumetric Tariff + α% of Increment | α: Objective				
▶ Volumetric Revenues:	New amount of users * new Volumetric Tariff * average consumption				
▶ Sewerage Revenues:	Volumetric Revenues * 20% of sewerage charge				
▶ Fixed Charge Revenues:	US$ 2.94 * new amount of users				
Annual Revenues =	Volumetric Revenues + Sewerage Revenues + Fixed Charge Revenues				
	(value*12) To Annualize the Amount of EMPAGUA´s Revenues				

The previous sequence aims to present in a more explicit way the logical framework behind the estimation of the total amount of revenues that could be perceived by EMPAGUA,

assuming that the variables behave according to the estimations that we detailed previously in this section. It is important to mention that two values are defined as exogenous to our analysis: (i) the literature revision for the elasticity value, and (ii) the optimization of the volumetric tariff as the anchor variable in our analysis. This last variable will be presented not only as the average, but the value for each block defined by EMPAGUA.

Additionally, we have to clarify two more figures that will affect the simulation but which are not directly related with the decision making process in EMPAGUA:

- The first consideration is Complimentary Revenues. This value varies depending on the contributions made by Government users, the National Bank for Housing, and public settlements. We do not have information concerning the method to realize these payments or the contract with EMPAGUA. However, we will assume that this amount of revenues, although not considerable, will vary, given past trends.
- The second consideration is the Exchange Rate. It is important to mention that values are expressed in US dollars, using as reference the expected Reference Exchange Rate published by BANGUAT. This institution forecasts the exchange rate based on the estimated depreciation of the Guatemalan Quetzal and the international variations in the purchasing power of the currency. Exchange rate is based on monetary policy, as stipulated by the legal framework, Resolución Junta Monetaria: 126-2006. The terminology used by the Central Bank is the Reference Exchange Rate—Tipo de Cambio de Referencia.

Now, after the development of the basic design of our simulation, we want to present the first round of results, focusing on those topics that will later in our analysis be given more detailed attention because of its incidence in the financial results at the end of the year. The next section presents the financial result after processing the information for both the annual costs and the annual revenues derived from the operation of EMPAGUA during the next decade.

What were the results after the first round of simulations?

It will be very important for EMPAGUA not only to determine the reasons why the financial deficit has worsened the sustainability of the utility, but to understand which changes should be implemented in order to guarantee better results in the near future. Our proposal should include not only the analysis about which tariff will allow the institution to cover its expected costs with the expected revenues, but the discussion about its feasibility for the next 10 years, a reasonable period of time to consider some amendment in the current accumulated financial deficit.

As mentioned before, according to EMPAGUA authorities, the utility is currently managing an accumulated deficit of US$ 4.55 million plus a total debt of more or less US$ 1.02 million acquired between 2008 and 2012.

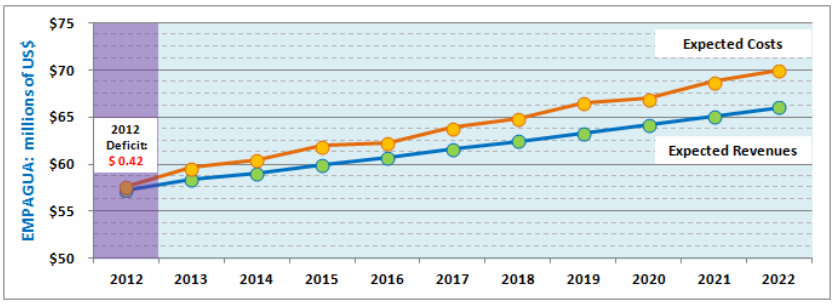
This first round of simulation focuses only on year-by-year sustainability, leaving space for a further discussion of how to compensate the current deficit plus the debt obligation to the Central Government and private lenders. The total amount of money that should be

recovered by EMPAGUA during the next 10 years is more or less US$ 5.57 million, without taking into account variations in the inflation rate (annual goal of 4 percent, ±1 percent).

Having said this, the next table illustrates the year-by-year results considering that the current tariffs do not show any change, implying that there won´t be any reduction in water consumption by the users. It is therefore not necessary to discuss the assigned elasticity value. This will be our "status quo" scenario, the point of reference for comparison.

(millions)	Financial Balance	Expected Costs	Expected Revenues	Operational Revenues	Complimentary Revenues
• 2012:	(US$ 0.42)	US$ 57.65	US$ 57.23	US$ 56.77	US$ 00.46
• 2013:	(US$ 1.21)	US$ 59.63	US$ 58.42	US$ 57.85	US$ 00.57
• 2014:	(US$ 1.52)	US$ 60.52	US$ 58.99	US$ 58.41	US$ 00.58
• 2015:	(US$ 2.07)	US$ 61.97	US$ 59.89	US$ 59.30	US$ 00.59
• 2016:	(US$ 1.57)	US$ 62.31	US$ 60.74	US$ 60.13	US$ 00.61
• 2017:	(US$ 2.31)	US$ 63.90	US$ 61.59	US$ 60.97	US$ 00.62
• 2018:	(US$ 2.45)	US$ 64.91	US$ 62.46	US$ 61.83	US$ 00.63
• 2019:	(US$ 3.21)	US$ 66.55	US$ 63.34	US$ 62.70	US$ 00.64
• 2020:	(US$ 2.79)	US$ 67.02	US$ 64.23	US$ 63.58	US$ 00.65
• 2021:	(US$ 3.68)	US$ 68.81	US$ 65.13	US$ 64.48	US$ 00.65
• 2022:	(US$ 3.94)	US$ 69.99	US$ 66.05	US$ 65.39	US$ 00.66

The table shows us that, with the expected increase in the costs, revenues won´t be enough to cover this increment, and will worsen each year´s financial deficit. In other words, additional users won´t be enough to cover the increment in the annual costs; this will make it necessary to introduce some modifications in the tariff charged to users. The next graph better illustrates EMPAGUA´s situation for the next 10 years.



After reviewing the "status quo" scenario, now we can compare the numbers with the optimal alternative, defining which tariff should be charged each year to particular users in order to guarantee financial sustainability in the long run, reflected as a "not-negative" financial balance at the end of each year (zero deficit policy goals). To do this, we will try to find the optimal value for the volumetric tariff that will give EMPAGUA enough revenues to cover the expected costs, maintaining as valid the rest of the assumptions and introducing behavioral analysis through the consideration of price elasticity (reaction of the consumers due to increments in the volumetric tariff).

Our purpose in a yearly analysis was to develop an optimization model that increases operational revenues through the modification of the volumetric tariff charged to users,

maintaining the same structure among the different blocks defined by EMPAGUA and keeping the sewerage tariff at 20 percent and the monthly fixed charge of US$ 2.94 per user. Basically, our objective was to find the tariff that guarantees financial sustainability (zero deficit policy goals) each year during the next decade.

The results are presented below:

		Different Blocks of Consumption for Particular Users				
	Average Tariff	**0 – 20 m^3**	**21 – 40 m^3**	**41 – 60 m^3**	**61 – 120 m^3**	**121 – … m^3**
• 2012:	US$ 0.35	US$ 0.24	US$ 0.37	US$ 0.47	US$ 0.94	US$ 1.17
• 2013:	US$ 0.36	US$ 0.24	US$ 0.38	US$ 0.48	US$ 0.96	US$ 1.20
• 2014:	US$ 0.36	US$ 0.24	US$ 0.38	US$ 0.48	US$ 0.97	US$ 1.21
• 2015:	US$ 0.36	US$ 0.24	US$ 0.38	US$ 0.49	US$ 0.98	US$ 1.22
• 2016:	US$ 0.36	US$ 0.24	US$ 0.38	US$ 0.48	US$ 0.97	US$ 1.21
• 2017:	US$ 0.37	US$ 0.25	US$ 0.38	US$ 0.49	US$ 0.98	US$ 1.22
• 2018:	US$ 0.37	US$ 0.25	US$ 0.39	US$ 0.49	US$ 0.98	US$ 1.23
• 2019:	US$ 0.37	US$ 0.25	US$ 0.39	US$ 0.50	US$ 0.99	US$ 1.24
• 2020:	US$ 0.37	US$ 0.25	US$ 0.39	US$ 0.49	US$ 0.99	US$ 1.23
• 2021:	US$ 0.37	US$ 0.25	US$ 0.39	US$ 0.50	US$ 1.00	US$ 1.25
• 2022:	US$ 0.37	US$ 0.25	US$ 0.39	US$ 0.50	US$ 1.00	US$ 1.26

Due to variations over the years, we see certain differences in the increment for the volumetric tariff, increasing every year on average, but with variations for each block. However, if we compare the baseline year—2012—with the last value for 2022, the total increment will be more or less US$ 0.02 on average, affecting the blocks with higher consumption more than others. Comparing these years (one decade in between), the variations for each block are shown below:

		Consumption Blocks: Variation in the Tariff Charged to Particular Users				
	% Variation	**0 – 20 m^3**	**21 – 40 m^3**	**41 – 60 m^3**	**61 – 120 m^3**	**121 – … m^3**
Change	7.03%	US$ 0.01	US$ 0.02	US$ 0.03	US$ 0.06	US$ 0.09
• 2012:	US$ 0.35	US$ 0.24	US$ 0.37	US$ 0.47	US$ 0.94	US$ 1.17
• 2022:	US$ 0.37	US$ 0.25	US$ 0.39	US$ 0.50	US$ 1.00	US$ 1.26

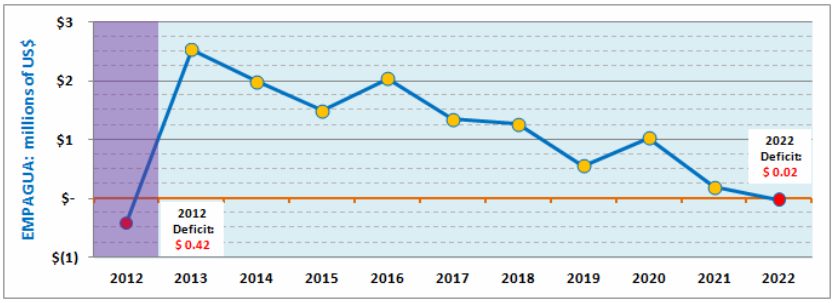
Even though the general variation in the tariff will be an increment of 7.03 percent between 2012 and 2022, this increment could be gradually implemented year by year, an initiative that will be less of a burden in terms of what is absorbed by users. It is very important to mention that, in monetary units, the highest consumption block will face the highest increment, while the other blocks will be less affected and proportional to their consumption.

It is equally important to mention as a last point in this analysis, that if we introduce the change in the tariff in a single increment for the next year, EMPAGUA would have enough revenues to cover the year-by-year costs and pay the accumulated debt by 2022. The next chart illustrates what will happen to EMPAGUA´s financial statements if the increment of 7.03 percent in the volumetric tariff is introduced in 2013, bringing about a surplus that could help to pay the current debt to the Central Government and private lenders.

(millions)	Financial Balance	Expected Costs	Expected Revenues	Operational Revenues	Complimentary Revenues
• 2013:	US$ 2.54	US$ 59.63	US$ 62.17	US$ 61.60	US$ 00.57
• 2014:	US$ 1.99	US$ 60.52	US$ 62.51	US$ 61.93	US$ 00.58
• 2015:	US$ 1.49	US$ 61.97	US$ 63.46	US$ 62.87	US$ 00.59
• 2016:	US$ 2.04	US$ 62.31	US$ 64.35	US$ 63.74	US$ 00.61
• 2017:	US$ 1.38	US$ 63.90	US$ 65.26	US$ 64.64	US$ 00.62
• 2018:	US$ 1.27	US$ 64.91	US$ 66.17	US$ 65.54	US$ 00.63
• 2019:	US$ 0.56	US$ 66.55	US$ 67.11	US$ 66.47	US$ 00.64
• 2020:	US$ 1.03	US$ 67.02	US$ 68.05	US$ 67.40	US$ 00.65
• 2021:	US$ 0.19	US$ 68.81	US$ 69.00	US$ 68.35	US$ 00.65
• 2022:	(US$ 0.02)	US$ 69.99	US$ 69.97	US$ 69.31	US$ 00.66

This “one-shot” initiative has a greater impact on the ´t+1´ period, when the consumers will react to the increment in the volumetric tariff. Nevertheless, once this increment is introduced, users will have a higher degree of certainty that no additional change will be implemented by EMPAGUA. As a direct result of this initiative, the utility will progressively incur a financial surplus, accumulating more or less US$ 12.46 million by 2022.

As of this moment, this “one-shot” initiative appears very suitable for EMPAGUA’s current situation, not only because it introduces financial sustainability for each fiscal year, but =because it generates enough money to cover the accumulated debt without causing uncertainty in users about the possibility of additional increments in the near future. But, we have to recognize the downward tendency in the financial result for EMPAGUA, a situation that will result in another financial deficit in 2022, as is illustrated in the next graph:



This situation will require a more detailed discussion about the changes that would be necessary to introduce in 2022. It is reasonable to suggest an additional increment in the volumetric tariff, and maybe some modifications in the basic assumptions behind our simulation.

7. SENSITIVITY ANALYSIS: Modifications in the Main Assumptions

In Chapter 5 we estimated the negative difference between the cost and the price per m^3 of water that is produced and distributed by EMPAGUA in Guatemala City, a situation that led

us to think that some changes should be implemented quickly in order to guarantee financial sustainability in the long run. In Chapter 6 we simulated the conditions that the utility will face in the next 10 years, obtaining a specific value for the volumetric tariff that will allow EMPAGUA to equalize expected costs with expected revenues, guaranteeing financial sustainability for the next decade.

Now, we have to recognize that the future is unpredictable and some values we set for the key variables in our simulation could vary in one or other direction, affecting the final results derived from our analysis. For this reason, in this chapter we will discuss the assumptions behind the key variables in the simulation, analyzing if the volumetric tariff could differ from the value we estimated before we can achieve a zero deficit financial result.

Which variables should be treated differently?

A sensitivity analysis will allow researchers to be more flexible about the restrictions set for the variables in order to simulate the behavior of the key variables that will directly affect the costs and revenues derived from the provision of water in Guatemala City. In Chapter 6 we specified which variables are fundamental to define which values should be adopted by the volumetric tariff in order to guarantee financial sustainability in the long run; however, now we have to analyze possible variations in those variables.

To simplify our analysis, and taking into consideration the length of time we are considering for the simulation, we will compare the difference between the original structure of tariffs and the resultant structure in 2022, derived from the iterations in the optimization of the model. This difference will be affected by the modifications in six key variables in our analysis which are detailed below:

(1) Price Elasticity for Water Consumption:

The key variable for analyzing the behavior of consumers in reaction to the increment in the volumetric tariff is the price elasticity value. A literature review shows us that this value, for international analysis, could vary between 0.1 and 0.4, as a measure of the reduction in consumption due to an increment in the tariff.

Following the structure of differential tariffs applying to different consumption blocks as defined by EMPAGUA, the households which are closer to the lower margin of higher consumption blocks will reduce their consumption so that they will be able to avail a lower tariff, modifying the amount of revenues that will be realized by the utility. The number of users that will drop into a lower consumption block will be determined by the magnitude of the elasticity.

With this information, we proceeded to simulate the scenario with no changes in the remaining variables, only changing the value for the price elasticity criterion. The next table compares the two scenarios, one with a value of 0.1 for the elasticity and one with a value of 0.4, detailing the structure of payments in year 2022 after guaranteeing no deficit in each of the 10 years.

		Different Blocks of Consumption for Particular Users				
Elasticity	**Average Tariff**	**0 – 20 m^3**	**21 – 40 m^3**	**41 – 60 m^3**	**61 – 120 m^3**	**121 – … m^3**
• ε = 0.1	US$ 0.37	US$ 0.25	US$ 0.39	US$ 0.50	US$ 1.00	US$ 1.26
• ε = 0.4	US$ 0.37	US$ 0.25	US$ 0.39	US$ 0.50	US$ 1.00	US$ 1.26
▶ Change:	US$ 0.00	US$ 0.00	US$ 0.00	US$ 0.00	US$ 0.00	US$ 0.00
	0.0%					

What we see is that the elasticity value does not affect the structure of the tariff that should be charged to users in order to achieve financial sustainability for the next decade in EMPAGUA. This situation could be attributable to the fairly low increment in the volumetric tariff, provoking an almost imperceptible variation in the reduction of water consumption by users. What we can conclude is that the model is not sensitive to variations in the value of the price elasticity (range between 0.1 and 0.4).

(2) Unitary Variable Cost:

The largest share of the costs relate to variable costs, those that are directly affected by the expected production of water and the unitary variable cost. In terms of the quantity of water produced, we used a very complex methodology, considering the additional capacity of extracting water from Maria Linda Watershed, the positive tendency during the last years, and the seasonal component affected by climatic phenomena and its relevance in the near future.

The other component related with the variable costs is the unitary variable cost. This figure was estimated as the simple average of the last three years' values (variable costs divided by the annual production), i.e. US$ 0.25 per m^3 of water. We do not have too much to say about this figure, but maybe we have to consider the trend for the last five years. If we consider the last five years in our analysis, the unitary variable cost has been growing continuously, varying between US$ 0.18 and US$ 0.29.

For this reason, we want to propose the worst case scenario, assuming that the unitary variable cost is not constant but continues increasing following the historical trend. We estimated the possible values for this variable for each year, re-calculating the volumetric tariff that equals the expected revenues with costs for each of the 10 years included in our previous round of simulations.

As before, the results of this modification are presented below, indicating for each year the unitary variable cost and the new average volumetric tariff, disaggregating the information for the five different consumption blocks. Our objective is to demonstrate how the variations in the unitary variable cost directly affect the tariff that should be charged to water users served by EMPAGUA (an obvious positive relation between the variables).

			Different Blocks of Consumption for Particular Users				
	Unitary Variable Cost	**Average Tariff**	**0 – 20 m^3**	**21 – 40 m^3**	**41 – 60 m^3**	**61 – 120 m^3**	**121 – … m^3**
• 2012:	US$ 0.29	US$ 0.35	US$ 0.24	US$ 0.37	US$ 0.47	US$ 0.94	US$ 1.17
• 2013:	US$ 0.30	US$ 0.41	US$ 0.27	US$ 0.43	US$ 0.54	US$ 1.09	US$ 1.36
• 2014:	US$ 0.33	US$ 0.44	US$ 0.29	US$ 0.46	US$ 0.59	US$ 1.17	US$ 1.47
• 2015:	US$ 0.36	US$ 0.47	US$ 0.31	US$ 0.49	US$ 0.63	US$ 1.26	US$ 1.57
• 2016:	US$ 0.38	US$ 0.49	US$ 0.33	US$ 0.52	US$ 0.65	US$ 1.31	US$ 1.64
• 2017:	US$ 0.41	US$ 0.52	US$ 0.35	US$ 0.55	US$ 0.70	US$ 1.40	US$ 1.75
• 2018:	US$ 0.44	US$ 0.55	US$ 0.37	US$ 0.58	US$ 0.73	US$ 1.47	US$ 1.84
• 2019:	US$ 0.46	US$ 0.58	US$ 0.39	US$ 0.61	US$ 0.78	US$ 1.56	US$ 1.95
• 2020:	US$ 0.49	US$ 0.60	US$ 0.40	US$ 0.63	US$ 0.80	US$ 1.61	US$ 2.01
• 2021:	US$ 0.52	US$ 0.63	US$ 0.43	US$ 0.67	US$ 0.85	US$ 1.70	US$ 2.12
• 2022:	US$ 0.54	US$ 0.66	US$ 0.44	US$ 0.70	US$ 0.88	US$ 1.77	US$ 2.21

The table gives us enough information to confirm that the model is very sensitive to modifications in the assumption for the unitary variable cost, which is the key variable that should be controlled in order to achieve financial sustainability for the utility. Additionally, the table below summarizes the analysis for both scenarios (constant value and variable value), detailing the structure of payments in the year 2022 after guaranteeing no deficit in each of the 10 years.

		Different Blocks of Consumption for Particular Users				
Unitary VC	**Average Tariff**	**0 – 20 m^3**	**21 – 40 m^3**	**41 – 60 m^3**	**61 – 120 m^3**	**121 – … m^3**
• US$ 0.25	US$ 0.37	US$ 0.25	US$ 0.39	US$ 0.50	US$ 1.00	US$ 1.26
• US$ 0.54	US$ 0.66	US$ 0.44	US$ 0.70	US$ 0.88	US$ 1.77	US$ 2.21
► Change:	US$ 0.29	US$ 0.19	US$ 0.31	US$ 0.38	US$ 0.77	US$ 0.95
	78.4%					

What we find is that, if the unitary variable cost continues growing as has happened during the last five years, the volumetric tariff should be adjusted every year, reaching a value of US$ 0.66 in 2022, US$ 0.31 more than the current volumetric tariff implemented by EMPAGUA, or US$ 0.29 more in 2022 in comparison with the option that assumes a constant value for the unitary variable cost. Thus, for every US$ 0.01 increment in the variable cost of EMPAGUA producing water, the average volumetric tariff should be increased in the same amount.

This is the most relevant variable in the analysis which will deserve special attention by the functionaries of EMPAGUA, especially in controlling the ongoing value for the last years which implies a continued increment in the variable cost of producing water, maybe due to deficiencies in the management or in the maintenance of infrastructure. Our suggestion is to concentrate a little bit more on those variables that directly affect this figure, considering a further analysis of why the costs related with supplies and materials and with non-personnel expenditures have increased in the last years.

(3) Amount of Capital Investments:
One of the most impressing findings in our analysis is the very low level of capital investments that have been made by EMPAGUA during the last years. As mentioned before, international institutions such as FAO and UNESCO reveal that capital expenditures (CAPEX) represent close to 1 or 1.5 times the recurrent expenditures in several countries; but, for Guatemala City, these costs represent less than 10 percent of the recurrent expenditures. For this reason, we believe that it will be important for EMPAGUA to be aware of the magnitude of the effect in tariff.

Our analysis includes a simple variation in the capital expenditures in order to resolve the optimization model, considering that CAPEX are equal to recurrent expenditures every year, having a direct impact on the increment of the operational costs of the utility. The alternative that we are going to compare includes a scenario along with capital investment equal to recurrent expenditures (50/50), assuming that the other variables remain the same (ceteris paribus principle).

With this information, we proceeded to simulate again the scenario with no changes in the rest of variables, changing only the value of each year´s CAPEX. The next table compares the two scenarios, one with the estimated tendency for CAPEX and one with the 50/50 relation between O&M´s (Operation and Maintenance) expenditures and CAPEX, detailing the structure of payments in the year 2022 after guaranteeing no deficit in each of the 10 years.

		Different Blocks of Consumption for Particular Users				
Elasticity	**Average Tariff**	**0 – 20 m^3**	**21 – 40 m^3**	**41 – 60 m^3**	**61 – 120 m^3**	**121 – … m^3**
• Current	US$ 0.37	US$ 0.25	US$ 0.39	US$ 0.50	US$ 1.00	US$ 1.26
• 50/50	US$ 0.80	US$ 0.54	US$ 0.84	US$ 1.07	US$ 2.14	US$ 2.68
▶ Change:	US$ 0.43	US$ 0.29	US$ 0.45	US$ 0.57	US$ 1.14	US$ 1.42
	113.4%					

What we see is that the CAPEX relation with EMPAGUA expenditures does affect the structure of the tariff that should be charged to users in order to achieve financial sustainability in EMPAGUA for the next decade. This situation could be attributable to the significant magnitude of the increment in operational expenditures, causing almost a double variation in the tariff that should be paid by users. What we can conclude is that the model is very sensitive to variations in the value of CAPEX (50/50 relation with recurrent expenditures).

(4) Market Coverage by EMPAGUA:
One of the variables that has an inverse effect on the tariff that will be charged to users is the number of users covered by EMPAGUA. Depending on the number of users, total costs will be diluted over a large portion of payers, which will lead to a reduction in the tariff that each water consumer can afford. Until now, we have considered the historical demographic growth for Guatemala City as the main variable to determine the number of users served by

EMPAGUA, adjusting the number by the natural increment in the number of consumers connected to the utility.

However, we should include a rational variation in our estimations, considering efficiency as one strategic criterion for the development of the institution in the long term. Currently, EMPAGUA is competing against particular providers of water and the public enterprise "Compañía de Agua del Mariscal, S.A."; but a notable improvement in the coverage of users could positively influence the financial results for the next decade.

This is why we are trying to identify a reasonable value for the capacity of EMPAGUA to serve more users, going beyond the natural increment in the population, taking into account instead the participation of other providers and the natural demographical limit that represents an additional constraint to our analysis.

When discussing this alternative with functionaries from EMPAGUA, they proposed a more optimistic value of 2.2 percent growth in the coverage of users, plus the natural demographic growth of Guatemala City's population (0.5 percent). With this information, we proceeded to simulate the scenario with no changes in the rest of the variables, changing only the value for the number of EMPAGUA´s users. The next table compares the two scenarios, one with the original value of 1.0 percent in the increase of coverage, and one with the value of 2.2 percent, detailing the structure of payments in the year 2022 after guaranteeing no deficit in each of the 10 years.

		Different Blocks of Consumption for Particular Users				
Elasticity	**Average Tariff**	**0 – 20 m^3**	**21 – 40 m^3**	**41 – 60 m^3**	**61 – 120 m^3**	**121 – … m^3**
• 1.0% growth	US$ 0.37	US$ 0.25	US$ 0.39	US$ 0.50	US$ 1.00	US$ 1.26
• 2.2% growth	US$ 0.33	US$ 0.22	US$ 0.35	US$ 0.44	US$ 0.89	US$ 1.11
► Change:	-US$ 0.04	-US$ 0.03	-US$ 0.04	-US$ 0.06	-US$ 0.11	-US$ 0.15
	- 11.54%					

The table shows that the coverage growth positively affects the structure of the tariff that should be charged to users in order to achieve financial sustainability for the next decade in EMPAGUA. This situation could be attributed to the distribution of costs among a broader base of users, resulting in a reduction in the tariff (below the current value applied by EMPAGUA). What we can conclude is that the model is sensitive to variations in the value for the coverage of users (2.2 percent instead of 1.0 percent).

(5) Sewerage Charge:

Concerning the tariff applied to users and the three components included in it—volumetric tariff, sewerage tariff, and fixed fee—we have noted that a variation in the sewerage surcharge could better internalize the cost of treating water after draining the resource out of the households. In this manner there will be a more direct relation with the volume of water that each user consumes.

The greater cost in the functioning of the utility is the treatment of the water drained out of the households. This is a necessary process not only for environmental purposes, but for efficiency in the administration of the resource. However, EMPAGUA only charges 20 percent of the value of the bill for this purpose, which can possibly be amended to a higher rate.

Our analysis considers a tradeoff between the volumetric tariff and the sewerage charge, reducing the cost for water consumption but increasing the rate for water treatment. What we want to present is a modification in the logical framework presented until now, considering an increase in the sewerage charge as a compensation for a lower volumetric tariff that will be charged to users. It is important to mention one other point. EMPAGUA provides water services only to domestic users, and not to commercial, industrial, or agricultural users. Even though there are domestic users in Guatemala City and more in other territories of the country, it is very important to note that EMPAGUA does not include this classification in the register of the users served by the utility.

Taking into account this consideration, we can assume that every user will be charged the same tariff, including an equal treatment for sewerage purposes. The variation that we are going to evaluate is a 100 percent rate for the sewerage tariff, compensated by a reduction in the volumetric tariff that will be adjusted by the trends in the other variables included in our simulation.

With this information, we proceeded to simulate the scenario with no changes in the rest of the variables, only changing the value for the sewerage surcharge. The next table compares the two scenarios, one with a value of 20 percent and one with a value of 100 percent, detailing the structure of payments in the year 2022 after guaranteeing no deficit in each year.

		Different Blocks of Consumption for Particular Users				
Elasticity	**Average Tariff**	**0 – 20 m^3**	**21 – 40 m^3**	**41 – 60 m^3**	**61 – 120 m^3**	**121 – … m^3**
• S = 020%	US$ 0.37	US$ 0.25	US$ 0.39	US$ 0.50	US$ 1.00	US$ 1.26
• S = 100%	US$ 0.22	US$ 0.15	US$ 0.24	US$ 0.30	US$ 0.60	US$ 0.75
▶ Change:	-US$ 0.15	-US$ 0.10	-US$ 0.15	-US$ 0.20	-US$ 0.40	-US$ 0.51
	- 40.03%					

The sewerage charge positively affects the structure of the tariff that will be applied to users in order to achieve financial sustainability for the next decade in EMPAGUA. This situation could be attributed to compensating volumetric tariff with a higher sewerage surcharge, bringing about a reduction in the tariff (below the current value applied by EMPAGUA). We can conclude that the model is sensitive to variations in the value for the sewerage charge (100 percent instead of 20 percent).

(6) Production of Water:

The last variable that we want to analyze is crucial because of its direct incidence in the total costs incurred by EMPAGUA each year: the production of water. It´s logical to think that the production of water is a linear function of the demand for water, measured as the total consumption of water made by the users served by the utility. However, we have to once again clarify that EMPAGUA does not only serve particular users; instead, the institution produces water for other purposes that are not directly related with the demand for water.

The reason behind why we treated the production of water separately from the demand for water relates to two specific conditions for EMPAGUA's operations: (i) losses due to malfunctions in the infrastructure, and (ii) EMPAGUA provides water to other users—more or less 16 percent of the total number of users—and is involved in social programs administered by the Municipality of Guatemala City related with the provision of water for social purposes (e.g. recovering of public spaces, or "Pasos y Pedales", runs as 10K and 21K, contributes cisterns for municipal settlements and schools, and maintains "green spaces" as municipal parks and sports facilities).

It is important to mention that these activities consume a lot of water in comparison to the regular provision to particular users, and there is no corresponding payment for the resource. EMPAGUA has no register of the effect of leaks and losses which, according to some experts, is in the range of 20 and 35 percent.[22] This is a concern that should be dealt with urgently by the authorities of the institution, but a discussion on this is beyond the scope of this analysis.

In addition, a considerable amount of water is extracted from the Maria Linda Watershed that is used for municipal purposes which are not clearly defined by the statutes of EMPAGUA. EMPAGUA is under the administration of the Guatemala City Council, and is managed in a rather arbitrary manner. We do not have access to this kind of information, but we can analyze some interesting numbers:

- The average production of water during the last 20 years is around 115 million m^3 of water a year, but the quantity of water that is distributed among particular users is more or less 76 million $m^{3.}$ This indicates that about 34 percent of the total production of water has been used for other purposes.

Therefore, we cannot relate the production of water only to the demand of customers connected to the utility. Instead, we have to consider another criterion to include some measure of volatility in our analysis.

The best means we believe is to consider some variation associated with a degree of uncertainty in production— more or less 5 percent above or below the original value—considering the same trend. With this information, we simulated the scenario with no changes in the rest of the variables, only considering the positive and negative variation for the production of water. The next table compares the two scenarios, one above the original

[22] Emilio Lentini (2010). "Servicios de Agua Potable y Saneamiento en Guatemala: Beneficios Potenciales y Determinantes de Exito". CEPAL: LC/W.335-P/E, No. 335 (julio).

value and one below the original value, detailing the structure of payments in the year 2022, and after guaranteeing no deficit in each of the 10 years.

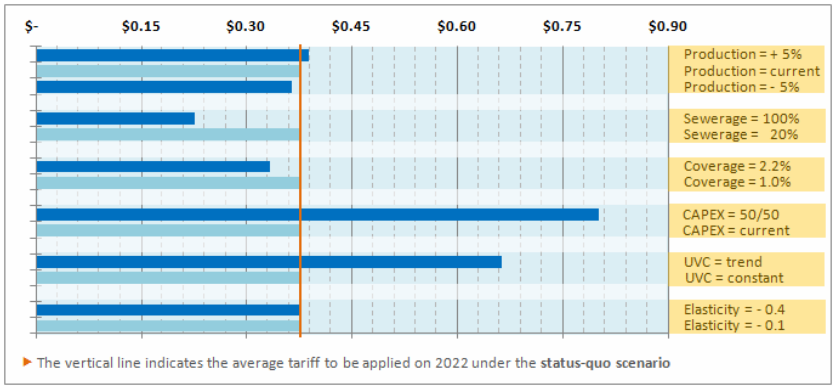
		Different Blocks of Consumption for Particular Users				
Elasticity	**Average Tariff**	**0 – 20 m^3**	**21 – 40 m^3**	**41 – 60 m^3**	**61 – 120 m^3**	**121 – … m^3**
• – 5%	US$ 0.36	US$ 0.24	US$ 0.38	US$ 0.49	US$ 0.97	US$ 1.21
• Current	US$ 0.37	US$ 0.25	US$ 0.39	US$ 0.50	US$ 1.00	US$ 1.26
• + 5%	US$ 0.39	US$ 0.26	US$ 0.41	US$ 0.52	US$ 1.04	US$ 1.30

The table illustrates that the volumetric tariff is more sensitive to increments in the production rather than to detriments in the expected production of water. This situation could be due to the effect that the production has in terms of costs: while an increase in the production positively affects the total costs and the volumetric tariff, the detriment in the production obviously reduces the variable costs, but not the other costs associated with the production of water (i.e. capital costs); a situation that affects the volumetric tariff in a lower magnitude in comparison with the other scenario. Technically speaking, the elasticity coefficient between the volumetric tariff and the production of water is higher when the production rises rather than when the production declines.

What are the best and worst possible scenarios?

All the variations presented in this document help us to understand the magnitude of the changes in the tariff due to modifications in the main assumptions used for our analysis. Those variables related to the costs of producing water have a direct relationship with the volumetric tariff that would be applied to the users connected to the utility. Meanwhile, those variables related with the coverage and efficiency of EMPAGUA have an inverse relationship with the volumetric tariff that would be applied to the users.

The next diagram better illustrates the effects in the volumetric tariff caused by a modification in the basic assumptions considered for our policy simulation, presenting the value for the tariff in 2022 if the changes were applied during the next 10 years (zero deficit policy goals):



Going beyond this graph to better understand the effect of the variables´ variations on the main assumptions of our analysis, we combine the best and the worst alternatives to define the best and worst possible scenarios. This kind of analysis will allow us to present the

maximum variations—in one direction or another—that the suggested change in the volumetric tariff could have.

Following is the combination of variables that will constitute each scenario:

- Worst possible scenario: This scenario will combine a strong reaction by consumers to the increment in the tariff (elasticity = 0.4), a unitary variable cost following the past tendency (increasing along the years), an increment in the capital expenditures equal to the amount of recurrent expenditures (CAPEX 50/50), a conservative growth for the coverage of users by EMPAGUA (coverage growth of 1.0 percent a year), a sewerage rate of 20 percent (no change), and production above the current estimates (+ 5 percent), which will represent an increment in the total costs incurred by EMPAGUA.
- Best possible scenario: This scenario will combine an insignificant reaction by consumers to the increment in the tariff (elasticity = 0.1), a constant unitary variable cost along the years (US$ 0.25 per m^3 of water), an increment in the capital expenditures according to the past tendency, a promissory growth for the coverage of users by EMPAGUA (coverage growth of 2.2 percent a year), a sewerage rate of 100 percent, and a production of water below the current estimates (–5% percent), which will represent a reduction in the total costs incurred by EMPAGUA.

These two options should be compared with the "status quo" scenario, defining which tariff should be charged each year to particular users in order to guarantee financial sustainability in the long run, reflected as a not-negative financial balance at the end of each year (zero deficit policy goals). To make this happen, we will try to find the optimal value for the volumetric tariff that will allow EMPAGUA enough revenues to cover the expected costs, maintaining valid the assumption specified for each scenario, considering that the rest of the values remain the same as in the original situation.

Our purpose in this year-by-year analysis continues to be the development of an optimization model that increases operational revenues trough the modification of the volumetric tariff charged to users, maintaining the same structure among the different blocks defined by EMPAGUA. With this in mind, the following presents the results for both scenarios, considering the option of adjusting the tariff that will be applied to the users served by EMPAGUA each year.

The first scenario corresponds to the worst possible conditions that EMPAGUA will have to face in the next 10 years, considering a substantial increment in the costs that should be compensated by a proportional increment in the volumetric tariff.

		Different Blocks of Consumption for Particular Users				
	Average Tariff	**0 – 20 m^3**	**21 – 40 m^3**	**41 – 60 m^3**	**61 – 120 m^3**	**121 – … m^3**
• 2012:	US$ 0.35	US$ 0.24	US$ 0.37	US$ 0.47	US$ 0.94	US$ 1.17
• 2013:	US$ 0.68	US$ 0.46	US$ 0.72	US$ 0.91	US$ 1.83	US$ 2.29
• 2014:	US$ 0.86	US$ 0.58	US$ 0.91	US$ 1.15	US$ 2.31	US$ 2.89
• 2015:	US$ 0.96	US$ 0.64	US$ 1.01	US$ 1.28	US$ 2.57	US$ 3.21
• 2016:	US$ 1.01	US$ 0.68	US$ 1.07	US$ 1.36	US$ 2.72	US$ 3.40
• 2017:	US$ 1.08	US$ 0.72	US$ 1.13	US$ 1.44	US$ 2.89	US$ 3.61
• 2018:	US$ 1.13	US$ 0.76	US$ 1.19	US$ 1.52	US$ 3.03	US$ 3.79
• 2019:	US$ 1.19	US$ 0.80	US$ 1.26	US$ 1.60	US$ 3.21	US$ 4.01
• 2020:	US$ 1.24	US$ 0.83	US$ 1.31	US$ 1.66	US$ 3.32	US$ 4.16
• 2021:	US$ 1.30	US$ 0.87	US$ 1.37	US$ 1.74	US$ 3.49	US$ 4.37
• 2022:	US$ 1.36	US$ 0.91	US$ 1.43	US$ 1.82	US$ 3.64	US$ 4.55

Due to variations over the years, we notice certain differences in the increment for the volumetric tariff, increasing every year on average, but with variations for each block. However, if we compare the baseline year—2012—with the last value for 2022, the total increment will be more or less US$ 1.00 on average, affecting more blocks with higher consumption. Comparing these years (one decade in between), the variations for each block are given below:

		Consumption Blocks: Variation in the Tariff Charged to Particular Users				
	% Variation	**0 – 20 m^3**	**21 – 40 m^3**	**41 – 60 m^3**	**61 – 120 m^3**	**121 – … m^3**
Change:	287.9%	US$ 0.67	US$ 1.06	US$ 1.35	US$ 2.70	US$ 3.38
• 2012:	US$ 0.35	US$ 0.24	US$ 0.37	US$ 0.47	US$ 0.94	US$ 1.17
• 2022:	US$ 1.36	US$ 0.91	US$ 1.43	US$ 1.82	US$ 3.64	US$ 4.55

In opposition to this scenario, we have to analyze the other alternative that corresponds to the best possible conditions that EMPAGUA will face in the next 10 years, considering a higher degree of efficiency by increasing the coverage and reducing the costs.

		Different Blocks of Consumption for Particular Users				
	Average Tariff	**0 – 20 m^3**	**21 – 40 m^3**	**41 – 60 m^3**	**61 – 120 m^3**	**121 – … m^3**
• 2012:	US$ 0.35	US$ 0.24	US$ 0.37	US$ 0.47	US$ 0.94	US$ 1.17
• 2013:	US$ 0.21	US$ 0.14	US$ 0.23	US$ 0.29	US$ 0.57	US$ 0.72
• 2014:	US$ 0.21	US$ 0.14	US$ 0.22	US$ 0.28	US$ 0.55	US$ 0.69
• 2015:	US$ 0.21	US$ 0.14	US$ 0.22	US$ 0.28	US$ 0.55	US$ 0.69
• 2016:	US$ 0.20	US$ 0.13	US$ 0.21	US$ 0.27	US$ 0.54	US$ 0.67
• 2017:	US$ 0.20	US$ 0.13	US$ 0.21	US$ 0.27	US$ 0.54	US$ 0.67
• 2018:	US$ 0.20	US$ 0.13	US$ 0.21	US$ 0.27	US$ 0.53	US$ 0.67
• 2019:	US$ 0.20	US$ 0.13	US$ 0.21	US$ 0.27	US$ 0.53	US$ 0.66
• 2020:	US$ 0.19	US$ 0.13	US$ 0.20	US$ 0.26	US$ 0.52	US$ 0.65
• 2021:	US$ 0.19	US$ 0.13	US$ 0.20	US$ 0.26	US$ 0.52	US$ 0.65
• 2022:	US$ 0.19	US$ 0.13	US$ 0.20	US$ 0.26	US$ 0.52	US$ 0.64

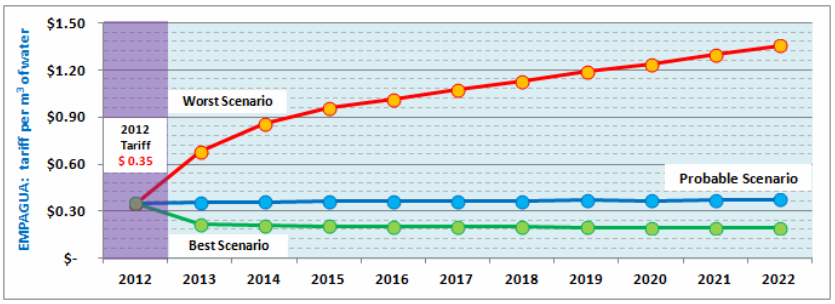
Yearly variations show up certain differences in the increment of the volumetric tariff, decreasing in comparison with the base year, but with variations for each block. However, if

we compare the baseline year with the value for 2022, the total reduction will be more or less US$ 0.16 on average, with a greater effect on the blocks with higher consumption. Comparing these years (one decade in between), the variations for each block are as below:

		Consumption Blocks: Variation in the Tariff Charged to Particular Users				
	% Variation	**0 – 20 m^3**	**21 – 40 m^3**	**41 – 60 m^3**	**61 – 120 m^3**	**121 – … m^3**
Change:	- 45.10%	- US$ 0.11	- US$ 0.17	- US$ 0.21	- US$ 0.42	- US$ 0.53
• 2012:	US$ 0.35	US$ 0.24	US$ 0.37	US$ 0.47	US$ 0.94	US$ 1.17
• 2022:	US$ 0.19	US$ 0.13	US$ 0.20	US$ 0.26	US$ 0.52	US$ 0.64

With the fundamental restriction of guaranteeing full financial recovery each year, we see that the model is more sensitive to the worst case scenario than to the best possible alternative, indicating that even though we can assume favorable conditions for the future, we should keep on mind the magnitude of the negative variations in the key variables for the next decade. The lowest tariff that EMPAGUA could charge to users is more or less US$ 0.20 per m^3 of water, but the worst possible scenario could imply that users will be charged a tariff of US$ 1.36 per m^3 of water, a very significant variation.

The next graph better illustrates both scenarios in comparison with the most probable situation that was presented in the previous chapter:



The most probable scenario maintains a certain degree of stability in the tariff for the next 10 years due to the low variation in the conditions expected for the operation of EMPAGUA in the short run. We notice that the best possible scenario represents a lower tariff for the users served by the utility, more or less US$ 0.15 below the simulated tariff that guarantees financial sustainability over the next decade.

Finally, we have to discuss the results of the worst possible scenario for EMPAGUA in the next 10 years. Two costs are important to consider in our simulation due to their relevance in the financial statements. The first one is the unitary variable cost, which is actually being controlled by EMPAGUA´s authorities. These authorities have discussed with us their plan to maintain this cost as low as possible, with a very low probability of following the same pattern that has existed during the last five years. Nevertheless, it is important to keep an eye on this to control possible variations outside the limits we have set for our simulation.

We are also concerned about the treatment of capital expenditures. We have recognized the low level of investment in capital assets in comparison with international experiences in Latin America, which is why we decided to simulate a 50/50 relationship between O&M´s and CAPEX. This is the key driver of the considerable variation in the tariff in the worst

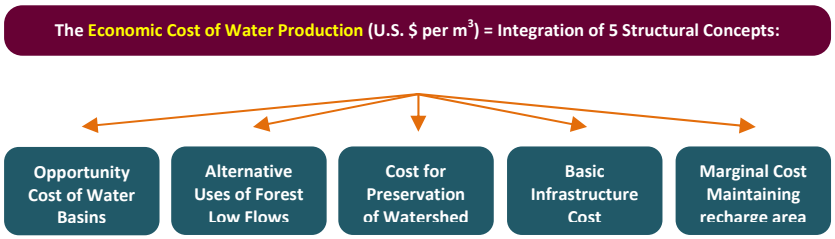
possible scenario, almost doubling the tariff that should be charged to users in the next 10 years. It is very improbable that EMPAGUA will decide to increase its level of CAPEX dramatically, but it is also important to observe the potential effect that a change in this budget line could have on the tariff applied to users.

8. VARIATIONS IN THE CURRENT TARIFF: What about the Environmental Services?

Going beyond the financial cost of producing water, we have to consider recent publications about the estimation of the economic cost of producing water in Guatemala. The Capacity Building Program for Environmental Policy, sponsored by the EPIQ Project of USAid, has developed a very detailed analysis about how to include the payment for environmental services (PES) in the cost of producing water in Guatemala, using as the basis the Xaclbal Watershed case study. [23]

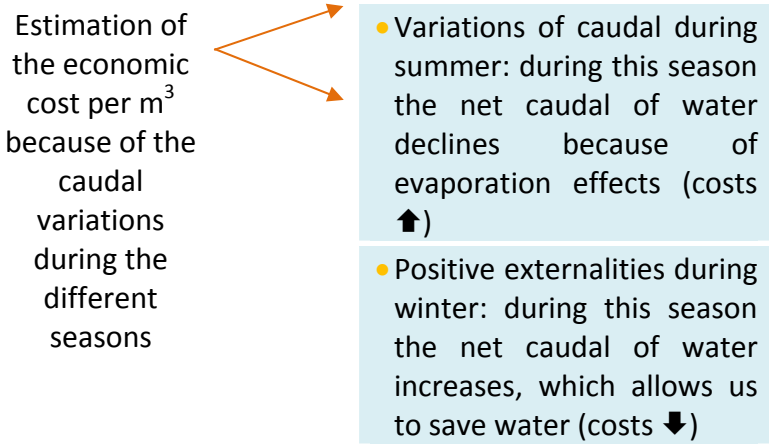
The study involves an estimation of the economic cost (US$ per m^3) of the production of water in the forest—"sponge effect"—the methodology being the application of valuation techniques for environmental services. The objective of the study is to generate basic information about how to formulate compensation policies for the water sector in Guatemala in order to bring about a structural modification on the current mode of payments.

The analysis is based on the close relationship between the watershed and forest production of low flows of water. Basically, the calculation aims to integrate, in a single measure, the opportunity cost of unexploited water basins, the alternative uses of the forests' low flows, the cost of the preservation of the watershed, the basic infrastructure cost, and the marginal cost of maintaining the water recharge areas.



[23] Óscar Hernández Vela, Carlos Cobos, and Ariel Ortiz (2008). Valoración Económica del Servicio Ambiental de Regulación Hídrica: Sierra de las Minas, Guatemala. FIPA / EPIQ USAID.

The methodology developed by the Capacity Building Program for Environmental Policy is explicitly explained in the document, but we want to highlight two specific conditions that were taken into account by the researchers:



This simple scheme illustrates that the cost of producing water varies along the year due to a specific country´s environmental conditions. Taking this into account, the research defined a kind of annual average cost for producing water that compensates the effect of water reduction during summer and the increment of the net caudal of water during the rainy season in Guatemala. We believe that using an average cost will simplify the determination of the tariff that should be charged to consumers in order to compensate the environmental costs associated with the production of water.

After evaluating different scenarios to estimate the real cost of producing water in Guatemala, the researchers conclude that an additional payment of US$ 0.43 should be charged to cover the cost of delivering environmental services for water consumption.

It is important to note that a tariff that covers both the financial and economic cost of producing water won´t be enough to repair existing damages to the watershed from pollutant residuals from human, industrial, and agricultural activities. Nonetheless, this tariff will be very useful to alleviate future conditions that could arise because of a lack of compensation for environmental damages.

At this point we should mention that the production of water involves more than financial costs associated with the institution in charge of serving the people connected to the utility. From an economic point of view, the total cost of producing water involves the side effects that could derive from the utilization of water for such non-exploitative uses as preservation of the natural heritage (the positive side) and the payment for damages to the environment (the negative side).

We want to clarify that this chapter is included in the study because of the recent worry on the part of EMPAGUA´s authorities on how to better preserve the environment due to the threats that the overexploitation of the resource could pose in the long run. The accuracy of the numbers could be questionable, but a reflection on this topic is very important in setting the tariff over the next few years.

What if we include the PES in the tariff charged to users?

One of the biggest challenges that we want to emphasize is that institutions in charge of the provision of water do not take into account the cost of environmental services when they register the cost of producing water. They tend to forget that without these environmental services, there would be no production of water.

We have demonstrated in this document that the financial problem of EMPAGUA could be solved with a proportional increment in the tariff that is charged to the users, equaling the revenues of the institution with the financial costs of general administration, salaries, maintenance, and capital investments. Nevertheless, we have to elaborate some more the real dimension of the economic deficit derived from ignorance that we have to pay for the environmental services that are provided by each watershed.

The first logical solution is to again increase the tariff charged to users, the bill reflecting the specific amount that will be paid in order to compensate environmental services. This differentiation in the tariff takes into account two specific aspects: (i) the user will know exactly how much of the bill corresponds to the payments for environmental services, and (ii) it will be easier to allocate the funds for the specific treatment of recharge areas at the watershed, either by the institution that is in charge of the distribution of water (e.g. EMPAGUA), or through the functioning of another institution, like a watershed authority or the Ministry for Natural Resources and Environment (MARN).

The increment to the financial cost that has to be added for the environmental services is more or less US$ 0.43 per cubic meter of water produced at the watershed. This figure will represent an increment of almost double the tariff suggested to cover the financial costs incurred by EMPAGUA. For this reason, we have to first analyze how we can structure the scheme of payments to include this cost according to the damage that different users cause to the environment, and then, we will have to analyze the impact of this increment in the level of water consumption by each user. The most recent information about water availability in Guatemala[24] presents very detailed data about how much water is produced in Guatemala, the main sources of water availability, and the different uses of these resources. This information will allow us to understand the logic behind the economic costs incurred to produce water in the country.

	m^3 millions	%			m^3 millions	%
Gross Availability	93,391	100%		Net Availability	32,689	100%
• Underground	53,366	57%		• Domestic Use	326	1%
• Superficial	40,025	43%		• Industrial Use	1,886	6%
Natural Reduction	60,702	65%		• Agricultural Use	929	3%
• Ecosystems	23,347	25%		• Electricity	4,511	13%
• Pollution	37,355	40%		Total Use	7,652	23%
Net Availability	32,689	35%		Surplus	25,037	77%

[24] Instituto Nacional de Estadística (2011). *Compendio Estadístico Ambiental de Guatemala 2010.* Sección de Estadísticas Ambientales, Oficina Coordinadora Sectorial de Estadísticas de Ambiente y Recursos Naturales. OCSE/Ambiente. Guatemala.

Basically, the country´s net availability of water is only 35 percent of the current caudal due to the natural reduction in any ecosystem's functioning, and the pollution of these natural resources caused by human beings (40 percent). Once these resources have been contaminated, their reuse is determined by adequate treatment techniques that are not so common in Guatemala, one of the reasons why we are proposing a specific charge for environmental services.

Now, from the net availability of water, we can split the consumption among domestic (1 percent), industrial (6 percent), and agricultural users (3 percent), with the addition of usage of electricity (13 percent). The relevance of this information lies in the fact that we have to clarify that different users produce different pollutant residuals, and the damage to the environment varies accordingly.

It is important to mention that pollution of water resources caused by human activities is a practice that is not appropriately regulated by the Government of Guatemala— not the municipalities, nor the Ministry for Natural Resources and Environment. The main source is problems of sewerage and polluted rivers, residuals produced by industries and small crafts workshops, and contaminated water drains that are generated by agricultural practices such as fumigation and the use of pesticides.

What we wish to highlight is that the availability of water is diminishing every year because the main sources of usage are not being responsible for their residuals, a situation that is increasingly reducing the natural caudal of water. Some experts agree[25] that the country has enough resources to cover its actual consumption pattern; nevertheless, we have to say that the country is "financing" this consumption through the reduction of the current water surplus, without taking into consideration the increment in the pollution of water basins.

We can now analyze how to charge tariffs according to the type of users. To date, EMPAGUA has not make any differentiation among different types of users, charging the same tariff independent of the water residuals they produce or the impact they have on the environment.
Our objective is to generate enough economic resources for the long-term funding of each watershed in Guatemala, analyzing the specific case of Guatemala City. Furthermore, we want to balance the way the users are charged according to water consumption, registering different tariffs to different users in order to guarantee that the revenues will be used to invest in the preservation of the watershed.

The basis of our analysis is an article published by Stefano Pagiola (2002), entitled "Paying for Water Services in Central America: Learning from Costa Rica".[26] In this paper, the author illustrates the importance of setting an accurate tariff for the consumption of water, such that it has a positive outcome on the preservation of the hydrological recharge areas:

[25] National System of Permanent Dialogue: Guatemala´s National Water Policy and Strategy; http://www.dialogo.gob.gt/politica-nacional-del-agua-de-guatemala-y-su-estrategia

[26] S. Pagiola, J. Bishop, and N. Landell-Mills (2002). Selling Forest Environmental Services: Market-Based Mechanisms for Conservation and Development. Chapter 3: "Paying for Water Services in Central America: Learning from Costa Rica". Earthscan Publications, Ltd.: USA.

"The impact of deforestation on hydrological flows is a major concern throughout Central America. Sedimentation of reservoirs, dry season water shortages, flooding and the severity of the damage caused by Hurricane Mitch in 1998 have all been widely attributed, at least in part, to deforestation. […] The perceived failure of previous efforts to address these problems has led to new approaches. Perhaps the most promising is the development of systems of payments for environmental services, under which water users directly compensate community members for the water they consume. In this way, water users would have a direct incentive to include this payment in their decisions, resulting in a more socially-optimal water use."

The author shares a very interesting diagram illustrating the Costa Rican program of payments for environmental services, of which water services is one of the four basic services provided by watershed authorities at the community level. After consulting the National Fund for Forest Financing (Fondo Nacional de Financiamiento Forestal [FONAINFO]), we tried to replicate how they settled a very basic scheme of payments for water consumption.

- Domestic Users: They are the control group for the analysis, considering the current tariff as the base to introduce changes, trying not to negatively affect the current pattern of consumption. FONAINFO's suggestion is to not change the tariff charged per m^3 of water consumed, but to add an additional standard of 5 percent for environmental services.
- Industrial Users: Most of the water in Central America is consumed by industries such as breweries, mineral, and metal exploitation, and related activities such as housing, clothing industry, and craft workshops. Due to the residuals they produce (e.g. soaps produce phosphate residues, bisphenols [BFA´s], galvanized compounds, etc.), experts from FONAINFO suggest that the tariff charged to industrial users should recognize the greater damage to the environment and their higher consumption of water. Costa Rica adopts an increase of 90 percent in the tariff for industrial users and an additional charge of 15 percent for environmental services.
- Agricultural Users: Finally, agriculture represents the largest sector from which the poor derive their livelihood. FONAINFO suggests adopting a policy that favors this sector, reducing the current tariff that is charged for their consumption by more or less 6 percent (basically because agriculture could re-use the water without any particular treatment process), but charging an additional 10 percent for environmental services, mainly because the effect on the reduction of natural flows of water in rivers/canals due to the prevalent irrigation practices in the country. .

This framework will be very useful to initiate our analysis; nevertheless, we will have to evaluate other alternatives that enable us to achieve the same objective of establishing a tariff that compensates the total cost incurred for producing water for Guatemala City.

Graphically, the new scheme that we have structured to include differentiation in the tariff charged to users and the fee for environmental services, is as follows:

	Gross Availability of Water at National Level					
	(–)	• Functioning of Ecosystems (Hydrological Recharge Areas)				
	(–)	• Pollution from Domestic, Industrial and Agricultural activities				
		Net Availability of Water at each Watershed Level				
		Domestic (1%)	Industrial (6%)	Agriculture (3%)	Electricity (13%)	
	• Tariff per m^3	US$ 0.38	US$ 0.74	US$ 0.36	This user is regulated by specific laws	Surplus (77%)
	• Sewerage	20%	20%	20%		
	• Environment	5%	15%	10%		
	• Fixed Payment	US$ 2.94	US$ 2.94	US$ 2.94		

The graph illustrates how the whole system is articulated and how a particular fee will be defined to cover specific problems related with the provision of environmental services, such as maintenance of hydrological recharge areas and the reduction of pollution. Additionally, this figure also illustrates the different tariffs that will be charged to different users according to FONAINFO´s design.

Two things are important to clarify:

(1) We are using as reference the average tariff of US$ 0.37 per cubic meter of water consumed by particular users. This tariff was calculated previously (see Chapter 6) in order to recover financial costs from the functioning of EMPAGUA.

(2) The number of users reported by EMPAGUA will be divided according to the national distribution of domestic, industrial, and agricultural users, maintaining the percentages that are valid at the national level. This will allow us to estimate the weighted average of the tariff that will be charged per m^3 of water consumed.

Replicating the scheme defined by FONAINFO in Costa Rica, we proceeded to estimate the weighted average for the tariff charged to the users, with the objective of it being at least equal to or marginally more than the estimated cost of US$ 0.90 per cubic meter of water produced. To simplify the analysis, we are using the average for the different levels of consumption, but, at the end of the day, we will also determine the specific tariff that should be charged to each user according to the volume of water that they consume.

The results are shown below (for reasons cited before, we are not taking into account the fixed charge for connection purposes):

	Domestic (1%)	**Industrial (6%)**	**Agriculture (3%)**		**TARIFF (Weighted Average)**
• Tariff per m^3	US$ 0.37	US$ 0.74	US$ 0.36	➡	US$ 0.59
• Sewerage	20%	20%	20%		20%
• Environment	5%	15%	10%		12.5%
• Average Tariff:	US$ 0.48	US$ 0.99	US$ 0.47		US$ 0.78

The first thing we should note is that these changes won´t be enough to compensate for the financial cost of producing water and the payment for environmental services. Nevertheless, the framework proposed by FONAINFO illustrates the kind of modifications that we have to adopt in order to effectively charge the different users not only by the volume of water they consume, but also the impact they have on the environment.

In our analysis, the most innovative topic is the introduction of PES, which varies depending on the environmental impact that has been evaluated, using as reference the current scheme of tariffs implemented in Costa Rica. We recognize that this figure could seem arbitrarily defined, but the most important thing is the recognition that the authorities should charge an additional tariff for the preservation of the watershed and the provision of environmental services.

Which assumptions could be relaxed?

Now, if we analyze every element of this new tariff, we have to compare each component with the objective. This is the only way to determine the best means of rearranging figures in order to cover the cost of US$ 0.90 per m^3 of water consumed, resolving the difference of US$ 0.12 per cubic meter of water that our simulation reveals. Some assumptions could be relaxed—changing the model suggested by FONAINFO for the case of Costa Rica—but with the same goal of guaranteeing full recovery of the costs.

At this point, however, we cannot continue with the analysis if we do not clarify which component of the tariff will be covered by which fee charged to each user. As a general assumption, previous information has led us to accept that almost half of the tariff (US$ 0.47 = 52 percent) should cover operational activities at EMPAGUA and the other half of the tariff (US$ 0.43 = 48 percent) should be oriented to maintaining environmental services.

This differentiation is very important because it will allow users to track the destiny of their resources, as also which institution should be responsible for the management of these funds. And, with this assumption in mind, we can now make a more rigorous analysis of the components included in the tariff. In the next sections we evaluate which changes we can adopt while at the same time maintaining our goal of charging users for the exact value of the water they consume.

- The first aspect to analyze is that the volumetric tariff is designed to cover the financial costs associated with the consumption of water charged by EMPAGUA with the

intention of solving the problem of its operational deficit. Inclusively, we could expect that this tariff was a little bit higher than the current financial cost for water production, so that the institution could get revenues to repair the deficit incurred in the past.

This tariff was obtained because of modifications to the fee charged to agricultural and industrial users as they are the last ones to be affected. Therefore, we can relax these components to work according to our expectations. If the figure we are looking for is around US$ 0.47, the scheme proposed by FONAINFO crosses the requirement by US$ 0.12.

So, if we reduce the 90 percent increment proposed by FONAINFO to only 6.3 percent (increment in the tariff charged to particular users), we arrive at the objective of compensating the operational costs incurred by EMPAGUA with the tariff charged to the users, including differentiations based on the different types of users that the institution would attend to, and applying the additional 20 percent for sewerage purposes.

- The second thing we have to analyze is how we are going to treat the payment for environmental services, with the objective of covering the total cost for the provision of water to the users connected to the utility.

The suggestion from FONAINFO is to charge the users an additional fee of 12.5 percent (average) for every cubic meter of water they consume, with the purpose of covering environmental services. It is very important to make this tariff explicit because it will be more transparent for the user to know the amount of funds that are going to be allocated to cover the provision of environmental services.

However, this fee won´t be enough to cover the current cost of producing water at the watershed, estimated as more or less US$ 0.43 per m^3 of water. Now, after charging the new volumetric tariff discussed earlier and adding the 20 percent for sewerage purposes, the PES should, on average, be an additional 110.2 percent of the original volumetric tariff, ranging over domestic users (44 percent), agricultural users (88 percent), and industrial users (132 percent). This variation is proportionately the same as that proposed by FONAINFO, but it could change as long as the final result remains the same.

This amount is almost 11 times that proposed by FONAINFO, but it is more accurate in the way the environmental cost should be charged to the users for each cubic meter of water they consume. Also, it is important to mention that, instead of increasing the volumetric tariff, the increment be included in PES so that the fee corresponds to its original objective.

After these two considerations, the next scheme of payments could be considered more aligned with the specific objective for each surcharge, as was stated at the beginning of this document. Our final proposal is presented below:

	Domestic (1%)	**Industrial (6%)**	**Agriculture (3%)**		**TARIFF (Weighted Average)**
• Tariff per m^3	US$ 0.37	US$ 0.41	US$ 0.36	➡	US$ 0.39
• Sewerage	20%	20%	20%		20%
• Environment	44%	132%	88%		110.2%
• Average Tariff:	US$ 0.63	US$ 1.03	US$ 0.75		US$ 0.90

We can see the tariff that should be charged to each type of user, considering both the differences in their level of consumption and the type of environmental services they consume due to the pollutants they produce. Now, instead of being charged an average tariff of US$ 0.42 (US$ 0.35 per m^3 of water plus a 20 percent charge for sewerage), the users will be charged with the following tariffs:

- Domestic Users: US$ 0.63, with an increment of US$ 0.21 per m^3 of water (⬆ 50 percent)
- Industrial Users: US$ 1.03, with an increment of US$ 0.61 per m^3 of water (⬆ 145 percent)
- Agricultural Users: US$ 0.75, with an increment of US$ 33 per m^3 of water (⬆ 79 percent)

With this new differentiation in the tariffs, we can now re-write the scheme of payments that is used by EMPAGUA, including the variations according to the volume of consumption:

Monthly Consumption (m^3)	**Tariff: USD per m^3 of Water**			**Share of users (%)**
	Domestic	**Industrial**	**Agricultural**	
Particular Users				84.4%
• Consumption: 0 – 20 m^3	US$ 0.26	US$ 0.27	US$ 0.24	42.7%
• Consumption: 21 – 40 m^3	US$ 0.40	US$ 0.43	US$ 0.38	27.6%
• Consumption: 41 – 60 m^3	US$ 0.51	US$ 0.55	US$ 0.48	8.9%
• Consumption: 61 – 120 m^3	US$ 1.03	US$ 1.09	US$ 0.97	4.0%
• Consumption: 121 – more m^3	US$ 1.29	US$ 1.37	US$ 1.21	1.2%
Governmental Users (Municipality)	- - -	- - -	- - -	0.51%
National Bank for Housing	- - -	- - -	- - -	3.1%
Public Settlements	- - -	- - -	- - -	12.0%
TOTAL Share of Users:	8.44%	50.64%	25.32%	100%
• Sewerage Tariff	20%	20%	20%	
• Environmental Tariff – PES –	44%	132%	88%	
• Fixed Charge (Monthly Payment)	US$ 2.94	US$ 2.94	US$ 2.94	

This scheme better articulates the different tariffs that should be charged to users in order to achieve the objective of recovering the financial cost of producing water in Guatemala City and the payment for environmental services. This effort contemplates the differences not only among the different types of users, but also among the same users according to their level of monthly volumetric consumption.

This kind of analysis, besides being a very useful theoretical exercise, is a tool that will help us to introduce the payment for environmental services in the political discussion with the authorities of EMPAGUA. Maybe this is a topic that should be treated with a higher degree of academic rigor and with more details in the components of the PES (i.e. consideration of the capital expenditures that could lead to duplicity in the account of the costs). But we should emphasize its relevance if EMPAGUA is considering defining a more accurate tariff in relation with the “full” cost of producing water in Guatemala City.

9. CONCLUDING THOUGHTS: What are the Policy Implications?

Until now, we have presented our proposal to fully cover the cost of producing water in Guatemala City, with the objective that EMPAGUA achieves financial sustainability in the next decade. The main contribution of our proposal is to enhance the capability of the authorities, providing them a tool to obtain sufficient funds to preserve the function of the utility.

Additionally, our main recommendations are that all users should internalize the cost of their consumption of water, and should be made aware of what they do to the environment.

Nevertheless, we have identified some topics that deserve special attention, clarifying some important issues about the implications of the proposal we have presented. These topics are not directly related with the analysis we have proposed, but we believe that they should be considered for discussion because of the consequences of the implementation of a new tariff and the impact on the consumption of water by the users.

Why should we not use public funds to cover the deficit?

After reviewing the financial unsustainability of the water system in Guatemala City, we have to face the fact that more funds will be necessary to remedy the current deficit situation. Instead of only listing the most relevant issues that should be addressed to improve water services in Guatemala City, we have to begin with a more conscious analysis about the amount of resources that are allocated to this sector and to evaluate if they are sufficient.

According to the Ministry of Public Finances,[27] the water sector covers all the actions related with the elaboration and administration of the legal framework for water supply, sewerage, and elimination of excreta. It also includes maintenance of the infrastructure and emergency repairs of the pipelines and installation of water taps.

Every quetzal spent on these characteristics was registered under "Función 306" (function 306) until 2009 in the budget of every public institution—Central Government, decentralized institutions and municipalities. From 2010 onwards, this methodology changed, reporting water expenditures under "Finalidad 7" (finality 7), function 3, which corresponds to water provision services. For further analysis, one can look at the detailed description of how the past budget classification fits the new categories established by the Government; an implementation of IMF's methodology.

This classification identifies how the Government homogenizes budget treatment for different administrative levels. Nevertheless, due to the complexity of registering all Government expenditures, we use this scheme as a general framework for our analysis. [28]

[27] Ministerio de Finanzas (2008). Dirección Técnica del Presupuesto: Manual de Clasificaciones Presupuestarias para el Sector Público de Guatemala. Fourth Edition, Guatemala.

[28] All this information is publicly available through online tools that have been implemented by the Ministry of Public Finances under the Accountability System for Integrated Information (SICOIN). For the purposes of our analysis, two sources provided all the information used in this report:

Using the most recent information about the water sector during the last years, some considerations should be noted about the data: (i) each year´s information refers to the fiscal year (January to December), (ii) expenditures for the period 2006 to 2011 are expressed in actual figures (iii), for 2012, the expenditures appear as effective numbers as of 30 June 30, and (iv) all figures are expressed in real terms, using 2006 as the base year.

After reviewing the numbers, the total amount of resources that the Government allocates for the water sector is more or less US$ 140.65 million for 2012, with 65 percent of the resources oriented to increasing access to water and to maintaining the infrastructure (i.e. capital expenditures). However, these numbers are not enough to determine if the Government could contribute in a certain way to reducing the tariff that would be charged to users, subsidizing a portion of the water consumption.

Now, beyond figures, trends, and percentages, some interesting findings describe how public expenditure is distributed for water purposes, establishing direct relations with production and population. We want to cautiously compare the historical budget with annual production and demographic growth. Some considerations are discussed below.

(a) Public Expenditure as a Percentage of GDP: Relating public expenditure to production will allow us to make an in-depth analysis of the growing amount of funds assigned to high-priority programs. Being an underdeveloped country, it will be necessary to invest in water services.
   - Water expenditure in 2006 rose to 0.56 percent of GDP. After a two-year period of stability, there was a significant increase in 2009. After 2009, reduced funding made it even worse than in 2006. In 2012, the share of the GDP is expected to be 0.42 percent, the second lowest in the last seven years.
   - Despite the fact that the GDP has been growing constantly over the period 2006 to 2012, the increase in water expenditure as a portion of GDP is not as good as it could be, having negative implications for the continuity of projects and maintenance of basic infrastructure.
   - Public expenditure in water shows a negative tendency over the last three years, denoting a lack of interest in solving the main constraints faced by the sector.

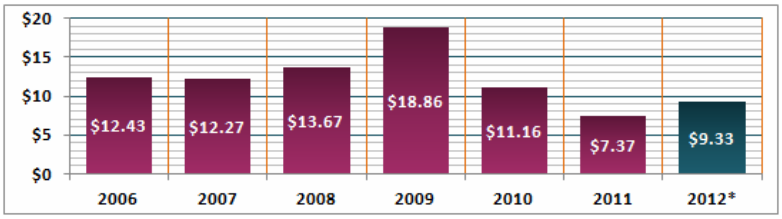
(b) Water Expenditure per Capita: Our main interest is to discover how many beneficiaries benefit from social funds in the water sector. However, institutions in charge of providing social services do not process data about beneficiaries, leading to serious criticism about the reliability of Government estimations.

- SICOIN: Integrated Accountability System (www.sicoin.minfin.gob.gt): This source compiles the budget´s execution for the Central Government and decentralized institutions.
- SIAF-MUNI: Integrated System of Financial Information (www.siafmuni.gob.gt): This source is used to register expenditures of municipalities, including data series since 2004. Observing the autonomy of these institutions, Central Government only registers what every financial division at local level reports as its budget execution (334 municipalities)

It is important to say that at these sites people can find electronic manuals that indicate how to search and interpret available information. Nevertheless, thanks to the Free Access to Public Information Law, any individual can ask the Public Finance Ministry for specific information, obtaining a response over the next few days.

Hence, trying to get as much information as possible, analysis will be directed at revealing how expenditure is distributed in society as a whole. This assumption is not vague nor naïve because it is based on the universality principle for the provision of these services, emphasizing no discrimination and gratuity for all people.

Using the population estimations and projections prepared by the National Institute for Statistics,[29] we proceeded to calculate expenditure per capita for the water sector in each year covered by our analysis (US$ per capita / real numbers: base year 2006).



There is not much to add, because the trend is the same as in the GDP analysis. The most remarkable finding is that in 2009, water expenditure per capita was greater than in previous and later years (constant prices, base year 2006), rising to US$ 18.86 per capita. By contrast, the estimation for 2012 is an annual investment of less than US$ 10 per capita, the second lowest rate in the last seven years, only surpassing 2011.

All the previous information allows us to reinforce our basic assumption that the water problem in Guatemala involves both lack of funds and lack of coordination among institutions to provide better services to the population. To correctly undertake a serious analysis of the deficiencies of the water sector in Guatemala, we have to advocate the allocation of more resources to solve the problems.

With an average monthly bill of more than US$ 20 per household, the funds that are currently allocated by the Government of Guatemala to solve the water problem in the country won´t be enough, barely helping to cover a very small part of the increment in the tariff that we are proposing.

In conclusion, we have to accept that the water policy of the country should be oriented towards redefining the current scheme of payments, enhancing the relationship between the producers of water at the local level, and the different consumers of water. Instead of re-allocating the funds that the Government invests in increasing access to water, we have to introduce structural changes to cover the financial deficit in the system. Consequently, the discussion should be oriented as to how to obtain the consent of the people for charging them a higher tariff; after all, transparency in communication is the key factor for the success of our proposal.

[29] Instituto Nacional de Estadística (2004). *Estimaciones y Proyecciones de Población 1950-2015.* Sección de Estadísticas Ambientales, Oficina Coordinadora Sectorial de Estadísticas de Ambiente y Recursos Naturales. OCSE/Ambiente. Guatemala.

Why is our proposal a feasible option for EMPAGUA?

We have defined a very specific problem that deserves the attention of EMPAGUA´s authorities because of its relevance to financial sustainability in the long run. What we have defined is the necessity of increasing the current tariff that is charged to users, with the objective of equalizing the revenues of the institution with the expected expenditures.

We could focus our attention on the structure of the tariff (different blocks according to the volume of water consumed each month by the users), the progression of the tariff or the values defined for sewerage and connectivity purposes. However, EMPAGUA´s authorities have requested our contribution to estimate the magnitude of the increment to the current tariff in order to achieve financial sustainability in the next decade.

Actually, the Government of Guatemala invests less than US$ 10 a year on water services. However, the revenues received by EMPAGUA are not enough to compensate this deficit, nor enough to cover its operational costs. Going beyond technical approaches, the feasibility of our proposal relies on the awareness of the authorities that the changes are necessary. However, they first have to be efficient in communicating the difficulties to the population so as to gain their confidence about the expected results.

With the commitment of providing the most feasible solution to the problem without struggling with technical suggestions that are contrary to the current system implemented by EMPAGUA, we proceeded to simulate the most probable scenario for EMPAGUA in the next decade, with the objective of defining a tariff that provides enough resources to the institution in order to cover its costs; not only costs related with the provision of the service, but also those related with the administration of social programs and the compensation of the losses caused by an outdated and poorly maintained infrastructure.

Our proposal includes different alternatives depending on the favorable or unfavorable conditions expected for the future, but maintaining the five blocks' structure defined by EMPAGUA, the fixed charge for connectivity purposes, and the sewerage surcharge. Basically, we arrived at the conclusion that the financial problem could be solved through an increment of US$ 0.02 in the tariff per m^3 of water consumed each month by the particular users connected to the utility. This increment, if implemented at once, will have the additional benefit of garnering enough resources to cover the current deficit situation of the institution, further guaranteeing financial sustainability for the next ten years.

Nevertheless, we highlight the importance of considering possible variations in the main assumptions that support our analysis. We have discussed the level of attention that EMPAGUA authorities should place on the variable and capital costs which could be a restraint to financial sustainability in the long run. Finally, we also discussed the questionable share of production losses due to social uses. An adequate treatment of these issues could reduce the structural of costs supported by EMPAGUA, resulting in a lower volumetric tariff because of the lower share of the costs that would be borne by users served by the utility.

Guatemala´s historical economic growth has been very stable (3.72 percent on average for the last 25 years according to the Central Bank of Guatemala), with no expectations of

drastic variations in the near future. In such conditions we can expect that the users won´t change their consumption of water unless the country suffers an extraordinary reversal or calamity, giving us a sound idea that consumer behavior won´t negatively affect our expectations about the tendency of the demand.

Finally, we have to consider the complementary topic of payment for environmental services. Even though this is not the main subject of our analysis, we believe it is important to initiate a discussion about how to introduce this fee in the monthly bill that is charged to the users connected to the network. There is a lot of work to do regarding how to accurately measure this cost and how to convince the people that this is a cost that cannot be ignored. If Guatemalans do not begin to take on the costs associated with the use of natural resources, we are destined to suffer from its deterioration in the near future.

There are many factors that we have to consider, such as proper enforcement, regulations, and institutions. This is why we are proposing a very sound structure based on strengthening the institution of EMPAGUA, which will be the entity in charge of setting the tariff, collecting the revenues, and investing in improving the water sector.

All this is a matter of defining the right incentives. If people are aware of their responsibilities, they will be committed to achieving results. Today, the authorities are not interested in preserving natural resources as they lack adequate monetary resources and they are not responsible for the damage that the people do to the environment. But, if we want to change this, we have to make people bear the costs of their actions. Our proposal invites users to first, pay the true value of the resources they are consuming, and second, assume the costs that are borne by others when they engage in their regular activities. If EMPAGUA gets serious about the problem it is facing, we believe that it is feasible to reduce the financial deficit currently being faced and generate resources sufficient to guarantee the adequate preservation of water in the long run.

ANNEXURE: Databases and Calculations

The information used to develop this document includes references to EMPAGUA's budget, its regular functioning, and the expected values for several variables included in the simulation. Following is the most relevant information that will be essential for replication and revision of the calculations made in our analysis.

(1) EMPAGUA´s Historical Budget (numbers in current GTQ, millions)

	2008	2009	2010	2011	2012
Revenues	Q 306.44	Q 343.16	Q 387.26	Q 443.76	Q 449.25
Operational Revenues	Q 300.91	Q 341.92	Q 384.05	Q 437.03	Q 445.64
Complimentary Revenues	Q 005.53	Q 001.24	Q 003.21	Q 006.73	Q 003.61
Costs	Q 313.30	Q 344.88	Q 388.91	Q 444.95	Q 452.55
Capital Costs	Q 006.60	Q 005.13	Q 004.42	Q 009.52	Q 007.38
Recurrent Costs	Q 306.70	Q 339.75	Q 384.49	Q 435.43	Q 445.17
Fixed Costs	Q 127.27	Q 153.55	Q 156.59	Q 171.37	Q 182.11
• Personnel Costs	Q 086.46	Q 103.88	Q 113.61	Q 125.67	Q 131.09
• Buildings, Property & Machinery	Q 004.81	Q 005.13	Q 003.82	Q 005.37	Q 011.92
• Debt Services	Q 036.01	Q 044.54	Q 039.15	Q 040.33	Q 039.09
Variable Costs	Q 179.42	Q 186.20	Q 227.91	Q 264.06	Q 263.07
Net Balance for EMPAGUA (deficit)	Q 006.85	Q 001.71	Q 001.65	Q 001.18	Q 003.30
► INFOM (local development)	Q 016.19	Q 019.35	Q 018.17	Q 015.49	Q 017.81
► Ministry of Infrastructure	Q 000.59	Q 000.65	Q 000.79	Q 000.87	Q 000.38
➡ Exchange Rate for reference	Q 007.78	Q 008.10	Q 008.00	Q 007.75	Q 007.85

(2) Other Information used for the Analysis:

Throughout the document we have listed a lot of information that will be essential for the replication of our simulation.

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