Part 3

Energy Efficiency in the Water Supply and Sanitation Sector in Brazil

World Bank/ESMAP Report

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Table of Contents

List of Tables

List of Figures

List of Boxes

Acronyms and Abbreviations

ABESCO	-	Brazilian Association of Energy Service Companies
ABRADEE	-	Brazilian Association of Electricity Distributors
ANEEL	-	Brazil's National Regulatory Agency for the Electricity Sector
ASE	-	Alliance to Save Energy
ASTAE	-	Asia Alternative Energy Program (World Bank)
BEN	-	National Energy Balance
BNDES	-	Brazil's National Bank for Economic and Social Development
BREES	-	Brazil Energy Efficiency Study
CDM	-	Clean Development Mechanism
CESB	-	State Water and Sanitation Companies
CONPET	-	Brazil's National Efficiency Program for Fuels (Petrobras)
DSM	-	Demand side management
EEP	-	Energy Efficiency Program (regulated by ANEEL)
Eletrobras	-	Brazilian State Electricity Company
EPC	-	Energy Performance Contract
EPE	-	Electricity Research Corporation, Brazil
ESMAP	-	Energy Sector Management Assistance Program (WB, UNDP)
GDP	-	Gross Domestic Product
GEF	-	Global Environment Facility
GHG	-	Greenhouse Gas
IDB	-	Inter-American Development Bank
IWA		International Water Association
M&T	-	Monitoring and Targeting
MME	-	Ministry of Mines and Energy, Brazil
NRW	-	Non-Revenue Water
PAC	-	Brazil's growth acceleration program
Planasa	-	Brazil National Water Supply and Sanitation Plan
PPP	-	Public private partnership
PROCEL	-	Brazil's National Electricity Efficiency Program (Eletrobras)
RELUZ	-	PROCEL program focused on municipal public lighting
RGR	-	Reserva Global de Reversao (fund within PROCEL/Eletrobras)
SANEAR	-	PROCEL program focused on WS&S
SNIS	-	Sanitation Sector National Information System
WS&S	-	Water Supply and Sanitation
Watergy	-	ASE program to promote energy efficiency in the water sector
WWTP	-	Waste Water Treatment Plant

Exchange Rate

1 US Dollar = 1.648 Brazilian Real (May 19, 2008)

Executive Summary

1. This report constitutes Part 3 of the three-part Brazil Energy Efficiency Study (BREES), which was prepared by the World Bank, with funding from the Energy Sector Management Assistance Program (ESMAP). The objective of BREES is to support the evaluation of energy efficiency (EE) programs and opportunities in Brazil based on good practices nationally and internationally. The topics included in the study were selected as a result of consultations with the Brazilian Government, academia, and the private sector in December 2006 and March 2007. As agreed by the Bank with the Government, the study would be organized around two major themes:

- Review of and recommendations for revising Brazil's Energy Efficiency Program (EEP), in support of ANEEL's recent decision to improve regulation of the program (Part 1); and

- Analysis of policy, institutional, and market issues related to realizing energy efficiency potential in public sector buildings (Part 2) and in the water and sanitation sector (Part 3).

2. **Energy efficiency in the WS&S sector.** This report summarizes the potential, constraints, and promising initiatives for promoting energy efficiency investments in the water supply and sanitation sector in Brazil. Through the use of selected case studies, the report provides examples for overcoming the barriers to energy efficiency investments in the WS&S sector in Brazil, including various institutional and financing mechanisms for undertaking such investments. The target audience of the report is water and sanitation utilities in Brazil and the government organizations at local, state, and federal levels that are involved in the sector.

3. **Energy efficiency is important for Brazil.** Improving energy efficiency is critical for Brazil for a number of reasons: to reduce energy demand in the short-term, to delay needed construction of new higher-cost electric generating capacity, to increase competitiveness by lowering production costs, and to reduce fossil-fuel consumption and the emission of local and global pollutants. Energy efficiency is particularly important for Brazil in the near-term as a means to reduce the growth in energy demand and the difficulties and time needed for planning, licensing, and constructing new generating capacity. Brazil is moving ahead to expand electricity supply through the construction of new thermal (gas) and hydro plants, but this takes time. Reducing demand through energy efficiency measures should be an integral part of Brazil's energy plan since they can be cost-effective and implemented more quickly than new generating capacity.

4. **Energy efficiency improvements can benefit the WS&S sector in numerous ways.** One of the promising public sector areas for energy efficiency improvement in Brazil is the water supply and sanitation (WS&S) sector. Energy consumption (mainly electricity for pumping) is typically the largest variable cost item for a water utility after personnel. Energy efficiency can be improved directly through a number of technical and operational measures, such as improving the efficiency and sizing of pumps and other equipment, reducing excessive water pressure in the distribution system, and moving pumping operations to off-peak times. In addition, energy as well as all inputs can be reduced through the reduction of physical water losses -- every liter of water, whether it reaches the final consumer or not, requires significant amounts of inputs, including the energy used for extraction, treatment, and distribution. In this way, the financial savings provided through improvements in energy efficiency in the WS&S sector would help enable utilities to reduce the overall costs of service, which in turn would allow resources to be used for both service improvement and expanded service.

5. **Energy efficiency potential in the WS&S sector remains largely untapped.** Moreover, there is good potential for improving energy efficiency in many Brazilian WS&S utilities with available and proven technologies. Many efficiency projects have high financial rates of return and relatively short payback periods ranging from a few months to about four years. A survey of some of the largest and better-performing WS&S utilities in Brazil found that the majority of these utilities had Non-Revenue Water (NRW)[1] ranging from 35-40 percent. There is a wide range of real (physical) losses in Brazil, estimated at between 20 and 80 percent of NRW, demonstrating that there are substantial opportunities for both energy and water savings. For comparison, it is estimated that NRW (including both physical and commercial losses) for developing countries are in the range of 40-50 percent, while the average for developed countries is 15 percent (Kingdom, 2006).

6. **Barriers to EE in Brazil are similar to those found elsewhere.** The barriers to energy efficiency investments in the WS&S sector have been identified in a number of studies and are similar to those found in other public sector areas in Brazil, as well as to those of many water utilities internationally.

- ***Lack of information, awareness and knowledge.*** Many WS&S utilities have a weak understanding of their energy consumption and their water usage and losses. Many utilities have only incomplete records of the equipment they operate and metering of inputs and outputs is very limited.
- ***Limited incentives.*** Improving energy efficiency in water utilities suffers from many of the same disincentives for reducing NRW – it requires time, dedication, staff, and usually upfront funding; the problem is largely invisible and management usually prefers to focus on increasing output rather than decreasing costs, and; it is

[1] See definition of NRW on page 8, footnote 2.

easier to close revenue gaps by spending less on asset management or asking the government for more money. The losses associated with inefficient energy use may pale by comparison to other problems facing the utility, with management simply trying to keep the utility running.

- ***Procurement and budgeting issues.*** Similar to other public entities, there are often limitations on the involvement of private companies, such as energy service companies (the Brazilian association of ESCOs, ABESCO, has some 75 members), for undertaking investments in water utilities. Among these are bidding processes that typically favor lowest first cost as opposed to lowest life-cycle costs (including energy). Budget procedures can also limit the duration of contracts to one or two years, which can eliminate contracting for all but the shortest-payback investments.
- ***Fiscal and financing constraints.*** A combination of reduced federal investment in the water sector over the past decade, and fiscal controls on sub-national entities, has limited the amount of investment in the sector, including for energy efficiency improvements. Commercial bank lending to the sector, either directly or through ESCOs, is also limited in Brazil due to high interest rates, lack of familiarity with energy efficiency projects by commercial banks, and excessive financial guarantees required for ESCOs. While the PAC pledges to increase investments in WS&S, the plan is focused primarily on system expansion rather than efficiency improvements.
- ***Lack of a convenient delivery mechanism.*** Although there are a number of cost-effective energy efficiency and water saving measures to be implemented in Brazilian utilities, an effective delivery mechanism that can bring together the technical, commercial, and financial aspects in primarily public WS&S utilities has not yet developed.

7. **Relevant experiences from case studies.** A number of initiatives have been undertaken in recent years in Brazil and internationally which show promise for overcoming the barriers to energy efficiency investments in the WS&S sector. Among the case studies that are included in the report are the following:

- **COM+AGUA Demonstration Projects.** Energy and water saving demonstration projects for mainly smaller utilities under the COM+AGUA program of PMSS show the benefits of both energy and water savings. In the first phase, the utilities participating in the pilot were able to reduce their annual expenditures by 15 percent, largely through low-cost administrative measures.
- **Efficiency Investments in CAGECE.** The "watergy" pilot project in the utility CAGECE in Ceara demonstrates the financial and other benefits of properly designing water systems, improving the efficiency of key equipment (pumps), as well as monitoring and managing water and energy use. As a result of the investments, CAGECE was able to reduce its total energy use by 8 percent compared to 2000. The payback time for the investment was less than six months,

and the utility was able to add 88,000 new customers (nearly a 10 percent increase), comprised of mostly poor households, using the same amount of water.

- **EPC in SABESP.** Energy performance contracting (EPC) by SABESP, the first such contract in the WS&S sector in Brazil, shows how private companies can undertake investments and provide financing for energy efficiency projects. Under the contract signed in 2007, a Brazilian ESCO provided the entire financing (US$4 million) to improve the efficiency of a wastewater treatment plant, with a simple payback period of 3.7 years.
- **RELUZ and EEP.** Public lighting initiatives in Brazil, specifically the RELUZ program under PROCEL from 2000-2005, and the EEP from 1998-2003, shows how political commitment and financing programs for public sector energy efficiency can substantially increase EE investments nationwide in a particular sector. Under the RELUZ program, investments in energy efficient public lighting averaged over R$200 million per year between 2002-2004, reaching more than one-third of all municipalities in Brazil, and with expected reductions in energy consumption over ten years of 35 percent compared to the beginning of the program.
- **WS&S Energy Efficiency Projects in Mexico, South Africa, and India.** The Alliance to Save Energy (ASE) has worked on energy efficiency in the water sector for the past decade to identify high-return projects, provide training, and promote investments in water sector energy efficiency projects. In Mexico, the utility reduced the amount of electricity per unit of water produced from 0.48 kWh/m3 to 0.39 kWh/m3, a reduction of 23 percent, largely through low-cost measures. In South Africa, water losses were reduced by 30 percent, through the installation of a water pressure management system. In India, the average payback time of investments was less than seven months, while investment in a single pumping station reduced the energy intensity of the utility by 6 percent.
- **Private Contract for Reducing NRW in Malaysia.** The State of Selangor (Malaysia) signed a contract in 2000 with a private consortium to design and implement a series of measures to reduce NRW. Under Phase 2 of the contract, the consortium reduced physical losses by 117,000 cubic meters per day and commercial losses by 50,000 cubic meters per day, representing savings of about 10 percent of total water produced.

8. **The road ahead.** Going forward, Brazil is well-placed to make improvements in the efficiency of energy use in the WS&S sector, which is part of the broader process for improving the overall efficiency of the sector. Among the factors that have improved the environment for energy efficiency in the WS&S sector in the past decade are: the doubling of real electricity prices, the passage of energy efficiency legislation requiring minimum efficiency levels for key energy-consuming equipment in the sector – such as motors and pumps, and the establishment or revision of several prominent government programs, some focused specifically on the water sector, to promote energy efficiency,

including PROCEL SANEAR, PMSS, and the Energy Efficiency Program (EEP) regulated by ANEEL.

9. **Case studies provide examples of successful approaches.** The case studies presented demonstrate that energy efficiency opportunities abound in the WS&S sector in Brazil and that investments are economically attractive, and that the technologies, engineering, and operating approaches to improve energy efficiency and reduce water losses are well known to experts. However, similar to the situation in other emerging economies, WS&S utilities in Brazil have implemented only a small portion of the overall potential investments. The case studies were selected for their potential for overcoming the key barriers to achieving energy efficiency improvements in Brazil's WS&S sector, including: (i) information, (ii) the demonstration of experiences, and (iii) financing and delivery mechanisms. The case studies provide examples for addressing these barriers, including providing information to managers on energy use and potential savings, demonstration projects of pilot energy efficiency investments, and alternative mechanisms for implementing and financing investments (with a focus on involving the private sector).

10. **Recent initiatives provide important lessons for financing.** The case studies confirm that one of the barriers that WS&S utilities face is financing of energy efficiency investments. Very few attempts have been made in Brazil to experiment with new ways of bringing financing for efficiency improvements to the WS&S sector. Third party financing based on EPCs is an unfamiliar concept in most environments and ESCOs may encounter problems finding customers and financing sources. Energy performance contracting between WS&S utilities and ESCOs, such as the contract between SABESP and Vitalux in 2007, offers some promising lessons on involving the private sector in financing energy efficiency investments (while the contract is applicable to many other types of investment). But also in this case, third party financing through ESCOs will work only if ESCOs can access financing, either from the local banking industry or from dedicated funds. Other challenges in ESCO projects are clients' unfamiliarity with the concept of energy performance contracting and public sector procurement and budgeting rules. Experiences in many ESCO programs worldwide have shown that especially public sector clients need support of impartial experts, at least in the beginning, to understand and negotiate the complex issues in EPCs (see BREES, Part 2, Meyer/Johnson 2008). Other potential funding sources for financing energy efficiency investments in Brazil include the use of RGR funds from the electricity sector under PROCEL SANEAR, the water sector initiative under Brazil's national energy efficiency program, as well as dedicated funding for WS&S through BNDES and CAIXA, and private sector investments through ESCOs.

11. **Priority components of a national EE program for the WS&S sector.** A national program for energy efficiency in the WS&S sector (and public sector more generally) could be an effective way of increasing investments in the sector. Such a program could usefully include: (i) information dissemination on available programs and positive experiences, (ii) demonstration projects for typical and high-yield investments, and (iii) incentives for promoting EE investments by public and private investors,

including ESCOs. Incentives for the WS&S sector could be provided through a number of existing government funding programs, including the EEP, PROCEL SANEAR and the RGR resources, and funds from CAIXA and BNDES.

12. **Scale-up of investments is possible.** If the barriers to energy efficiency investment could be removed, the WS&S sector could move from the implementation of demonstration projects to a scale-up of investments in the sector. Based on global experience and conditions in Brazil, a reasonable target for Brazilian water utilities would be to reduce energy consumption by 25 percent and NRW by half through an intensive nationwide program over a decade. Electricity savings from reducing NRW by half would total 1.5 billion kWh/year, while those from improving energy efficiency by 25 percent would be 1.8 billion kWh/year, for a total of 3.3 billion kWh/year, equivalent to 34 percent of total electricity used by the sector in 2006. This amount of electricity was valued at R$792 billion in 2006, or 44 percent of total annual electricity expenditures by the water sector, or about one percent of total electricity consumption in Brazil in 2006.. Water and energy conservation programs in Brazil have identified the types of interventions that would be most cost effective, while the case studies have elaborated some of the implementation and financing mechanisms for moving towards these goals. Overcoming the barriers will require a combination of supportive government policies and regulations, improved access to financing, and the involvement of various actors involved in the implementation of projects, including the private sector and commercial banks. The challenge lies in finding delivery mechanisms that are adaptable to the varying conditions in different parts of Brazil and in utilities with a variety of technological, financial, and organization conditions.

I. Introduction

1. Improving energy efficiency is critical for Brazil for a number of reasons: to reduce energy demand in the short-term, to delay needed construction of new higher-cost electric generating capacity, to increase competitiveness by lowering production costs, and to reduce fossil-fuel consumption and the emission of local and global pollutants. Energy efficiency is particularly important for Brazil in the near-term as a means to reduce the growth in energy demand and attenuate the difficulties and time needed for planning, licensing, and constructing new generating capacity. Brazil is moving ahead to expand electricity supply through the construction of new thermal (gas) and hydro plants, but reducing demand through energy efficiency measures should be an integral part of the energy plan since they are typically more cost-effective and can be implemented more quickly than new electricity supply capacity.

2. One of the promising and largely untapped areas in the public sector for energy efficiency improvement in Brazil is the water supply and sanitation (WS&S) sector. The importance of WS&S energy efficiency in Brazil is due not so much to the fact that the sector accounts for over 3 percent of national energy consumption – but because improving energy efficiency would reduce overall costs of service, which in turn would allow resources to be used for both service improvement and expanded service. Energy consumption (mainly electricity for pumping), is typically the largest variable cost item for a water utility after personnel. Energy efficiency can be improved directly by improving the sizing and efficiency of pumps and other equipment, and indirectly by reducing physical water losses – every liter of water, whether it reaches the final consumer or not, requires significant amounts of energy for extraction, treatment, and distribution. Moreover, there is good potential for improving energy efficiency in many Brazilian WS&S utilities with available and proven technologies.

3. The Brazilian Government has ambitious plans to substantially increase connection rates to modern water supply and sanitation (WS&S) services. In urban areas of Brazil, access to potable water extends to more than 93 percent of the population, up from 83 percent in 1990. Access to sewage collection and sewage treatment is less ubiquitous, even in urban areas these services are available to only 48 percent and 32 percent, respectively, of the population. The rural population has far lower coverage ratios. The goal of the federal Government is to increase overall access to potable water from 82 percent in 2005 to 86 percent in 2010 and from 48 to 55 percent for sewage (Table 1).

Table 1. Access to WS&S Services in Brazil 2006 and 2010 (percent of total population)

<table>
<tr><th></th><th>Urban</th><th>Total</th><th>Total
Goal for 2010</th></tr>
<tr><td>Water</td><td>93.1</td><td>82.3</td><td>86</td></tr>
<tr><td>Sewage collection</td><td>48.3</td><td rowspan="2">48.2</td><td rowspan="2">55</td></tr>
<tr><td>Sewage treatment</td><td>32.2</td></tr>
</table>

Source: Urban - SNIS 2006, Totals - http://www.brasil.gov.br/pac/infra_estrutura/social_urb/pac_no7

4. However, the technical and operational inefficiencies of many water and sanitation utilities and the lack of government finances for investments including for improved access are working against the goal of universal access. Electricity is one of the major operating costs for WS&S utilities. Projects to reduce energy and Non-Revenue Water (NRW)[2] have been shown to be a good business, with sound economic returns that could reduce operating costs of utilities considerably and enable them to connect more users without having to provide additional water. The financial savings provided through improvements in both energy and water efficiency would help enable utilities provide greater access to those in underserved remote and poor communities.

5. Funding sources for such improved infrastructure access are scarce. The level of federal funding has fallen since the mid-1990s, and most utilities face severe financial constraints. The PAC intends to significantly increase the amount of investment in the WS&S sector, but the plans address system expansion more than energy efficiency. Most utilities are also constrained by water and sanitation tariffs that are not covering costs. This has resulted in underinvestment in new capacity as well as maintenance of existing systems, while operational inefficiency is substantial.

6. Unless the substantial inefficiencies in WS&S operations are addressed, the costs of such inefficiencies could increase substantially over the next few years, as the Government implements its plans to increase rates of connection to modern water and sanitation services.

7. Investments in improving the energy efficiency in the WS&S sector are not only cost-effective, but they also have important environmental benefits, including a reduction of greenhouse gas emissions. The weak finances of municipalities and public utilities in

[2] Non-Revenue Water is the difference between the volume of water that is put into a water distribution system and the volume that is charged to consumers. NRW comprises three components: physical or technical (real) losses, commercial (or apparent) losses, and unbilled but authorized water consumptions, such as for social purposes (e.g., firefighting, free water to low income consumers). Generally, water losses in urban and metropolitan areas tend to be higher than in rural areas, a matter of the relative length of the network, the higher density of valves in urban areas and sometimes very old distribution systems in city centers.

many countries, however, mean that many investment opportunities in the WS&S sector go unaddressed. Pumping and other efficiency improvements, while economically attractive in the long-run, do not attract financing reserved for more urgent needs.

8.	There are a number of initiatives that are underway in Brazil and internationally that provide useful examples of how WS&S utilities can reduce their energy expenditures while at the same time reducing physical water losses and thus freeing up finances for expanded and improved service. This report examines selected initiatives in detail.

II. Background

A. *Management and Regulation of the WS&S Sector*

9. Until the late 1960s, the responsibility for water supply and sanitation services was municipal. Beginning in 1971, as part of the National Water Supply and Sanitation Plan (Planasa), State Water and Sanitation Companies (CESBs) were set up in all Brazilian states and obtained licenses from municipalities to run the services under long-term contracts. As of 2006, according to the Sanitation Sector National Information System (SNIS),[3] there were 26 water utilities at the state level, regulated by both public sector and private corporate laws, with responsibility for providing water service to over 3,900 of Brazil's more than 5,500 municipalities. Most of these utilities are controlled by the public sector, but many have some private ownership. There are also around 1,600 water utilities at the municipal level, 388 of them included in SNIS. Additionally, there are around 70 municipalities (less than 1 percent of municipalities in Brazil) that have awarded concession contracts to private operators with durations of 20 to 25 years. Private water utilities serve around 4 percent of Brazil's urban population, but serve less than one percent of Brazil's municipalities. There are a number of associations in Brazil representing local, regional, and private WS&S utilities (Table 2).

Table 2. WS&S Associations in Brazil

ASSEMAE	National Association of Municipal Sanitation Services, a forum for both private and public municipal water utilities.
ABES	Brazilian Association of Sanitary and Environmental Engineering.
AESBE	Brazilian Association of Sanitation Utilities of which all regional water utilities are members.
ABCON	Brazilian Association of Private Sanitation Operators, a forum for private water utilities, both regional and municipal.
ABAE	Brazilian Association for Water and Energy, an NGO set up under USAID's Brazil Watergy project to identify opportunities for cutting energy costs in water utilities.

10. The WS&S sector in Brazil is beginning a new regulatory phase under the new regulatory framework created by Federal Guidelines Law 11.445 of January 2007. The law sets new policy and regulatory requirements and procedures which are mandatory for the municipalities and the states in any new service provision contract. Existing

[3] www.snis.gov.br SNIS is a voluntary program in which participating utilities agree to provide data and information on their operations.

concession contracts (about 3,200 for state water companies and 70 for private concessionaires) remain under the previous regulatory regime and will transition to the new law. The new federal law allows for WS&S service to be provided by: municipal departments, full individual private concession or PPP contracts, and individual or regional program contracts to state water companies. The new regulatory regime also allows municipalities and states to jointly develop associated management, to provide services directly or to hire a public or private concessionaire, and/or to regulate services. The management of service provision could be based on consortia arrangements or co-operation agreements. There are currently eight water utilities operated by groups of municipalities. One example is Águas de Juturnaiba (part of the ADB group; see case study), which operates WS&S services in the municipalities of Araruama, Silva Jardim and Saquarema.

B. *How Energy is Used in the WS&S Sector*

11. WS&S utilities are intensive energy consumers. Water utilities generally carry out the following water supply and wastewater operations:

1. raw water intake (and possibly raw water storage)
2. raw water transportation
3. raw water treatment (and possibly treated water storage)
4. treated water distribution (and possibly distributed treated water storage)
5. sewage collection (and possibly rain water collection)
6. sewage transportation
7. sewage treatment
8. sewage waste disposal.

Table 3 shows the energy used by WS&S utilities at different stages of operation.

12. In Brazil, substantial amounts of electricity are required for pumping water from rivers (the predominant water source in the country), cleaning and filtering the water, and then pumping it to reservoirs and throughout the network. The cleaning and filtering process is more energy intensive during the rainy season, when sand and pollutants stirred up in the river make the water more difficult to clean. Water from wells is cleaner than river water and has a more regular composition, and often requires only chlorination for bacterial control. Little pumping is needed for newer wells, but older and deeper wells require significant amounts of energy for pumps to secure water.

Table 3. Main Energy Consuming Processes in Water and Wastewater Utilities

STAGE	OPERATION	ENERGY-USING SYSTEMS
EXTRACTION	Deep well extraction	Submersible or shaft turbine deep well pumping systems
	Extraction from a surface source	Horizontal or vertical centrifugal pumping systems
TREATMENT	Chemical (disinfection and clarification)	Piston-type dosing pumps
	Physical (e.g. filtration and sedimentation)	Pumping systems, fans, agitators, centrifugal blowers
PIPING BETWEEN SOURCE AND DISTRIBUTION NETWORK	Sending the drinking water to the distribution grid	Submersible or shaft turbine deep well pumping systems; horizontal or vertical centrifugal pumping systems
	Booster pumping	Horizontal or vertical centrifugal pumping systems used to increase pressure of water going into the distribution system or to pump water to a higher elevation.
DISTRIBUTION	Distribution to end users	Horizontal or vertical centrifugal pumping systems
STORM AND SANITARY SEWER SYSTEMS	Piping of sewage and/or rainwater	Horizontal or vertical centrifugal pumping systems
	Wastewater treatment and disposal	Pumping systems, fans, agitators, centrifugal blowers
SUPPORT SYSTEMS	Support functions associated with the utility building(s)	Lighting systems, HVAC (Heating, Ventilation and Air Conditioning), etc.

Source: Barry 2007.

13. The amount of energy used for wastewater treatment is even greater than for water treatment and supply. As the rate of wastewater treatment increases in Brazil under government plans, even more energy will be needed in the WS&S sector, providing additional incentives for efficiency measures.

C. *Electricity Costs for the WS&S Sector*

14. Electricity costs are among a utility's largest operating costs (excluding capital costs), representing 50 percent of operating costs in water and 60 percent in wastewater treatment.[4] Typically around 90 percent of the utilities' energy consumption relates to pumping operations. In the Brazilian WS&S sector, electricity costs average about 16.3 percent of overall costs (including capital) for regional utilities and typically 18.9 percent of overall costs for municipal utilities. Only personnel costs have a higher share of operating costs. Overall, the sector consumes 9.7 billion kWh annually, resulting in an electricity bill of around R$1.8 billion (US$1.1 billion).[5] Although the WS&S sector in

[4] Estimates by World Bank/ASTAE (2003).
[5] SNIS 10, 2005

Brazil accounts for only around 3 percent of total energy consumption, energy costs are quite significant for utilities and such consumption and consequent expenses can account for a large percentage of the energy consumption of municipalities.

15. If energy losses and related costs could be reduced, tariffs could be lowered and nonpayment rates by the WS&S utilities could decrease – now estimated at 19-35 percent.[6] Under such a scenario, WS&S utilities would be better able to finance non-operating costs, including investments in infrastructure and other service improvements. A reduction in energy costs would particularly benefit the publicly owned WS&S utilities, many of which are now forced to use operating revenues to finance high inherited debt.

16. Although low voltage tariffs in Brazil are high in comparison to other countries, electricity tariffs for WS&S utilities in Brazil are lower than for the other productive sectors. The WS&S sector receives a 15 percent discount on regular tariffs, based on the 2007 resolution 563/07 by ANEEL. For example, in the case of WS&S utilities supplied by LIGHT in the state of Rio de Janeiro, the resulting discounted tariff for supply with low voltage electricity would be R0.49/kWh (US$0.30), whereas medium/high voltage electricity would be charged with an average tariff of R0.25/kWh (US$0.15). Despite the 15 percent discount, the low voltage tariff is among the highest in Latin America.

17. Peak tariffs are also relatively high in Brazil. Peak tariffs would appear to provide a financial incentive for WS&S utilities to shift their pumping operations as much as possible to off-peak times, such as the pumping of potable water to reservoirs. Furthermore, some WS&S utilities have potential to generate their own internal power for operations – for example, from methane, a byproduct of wastewater treatment, and from the installation of mini hydro-electric generating plants in water distribution systems.

D. *Potential for Energy Savings in the WS&S Sector*

18. Despite impressive increases in access to improved water and sanitation services over the past 35 years, the WS&S sector in Brazil continues to be characterized by considerable technical, operational and managerial inefficiencies. According to PROCEL SANEAR, the inefficient use of electrical energy in the WS&S amounts to more than R$450 million (US$273 million) per year.[7] A major source of energy losses are caused by inefficient management of pumping and filtration operations – about 25 percent of the energy used in WS&S operations in Brazil is wasted due to poorly managed pumping

[6] This is a rough estimate, based on the nonpayment rates of public services in general, for which the national figures range from 19.4 percent to 31.5 percent (Source: ABRADEE – www.abradee.org.br)
[7] PROCEL SANEAR 2006.

stations and filtration systems.[8] Every liter of water that passes through a water supply system, whether it is delivered to the final consumer or not, has a significant cost of production, including energy costs. NRW, a measure of physical and commercial losses of water, averaged 40 percent in 2006 (SNIS, 2006), which was roughly the same for both state and municipal level public utilities. As of 2006, the NRW for private utilities was at about 50 percent (SNIS 2006).

19. Based on SNIS data, Table 4 shows the relationship between NRW and energy losses. NRW in Brazil totaled 4.4 billion cubic meters in 2006. Based on the estimated energy intensity, which is the amount of energy per unit of water produced, results in 3.0 billion kWh consumed for NRW in 2006, and equivalent to R$723 million.

Table 4. Loss Analysis for the Brazilian Water Sector (2006)

Region	Volume of Water Produced (1000 m3/yr)	NRW (1,000 m3/year)*	NRW (%)*	Energy Intensity (kWh/m3)*	Energy Losses (1,000 kWh/ year)	Effective Electricity Rate (R$/kWh)	Losses from Energy Consumption (R$/year)
North	407,487	221,602	53.4	0.79	175,066	0.22	38,514,428
Northeast	2,492,984	1,154,988	45.1	0.75	866,241	0.26	225,222,660
Southeast	5,786,289	2,449,099	39.8	0.62	1,518,441	0.23	349,241,517
South	1,328,017	373,019	26.6	0.77	287,225	0.24	68,933,911
Center-West	603,693	203,142	32.9	0.80	162,514	0.25	40,628,400
Average			**39.5**	**0.68**		**0.24**	
Total	**10,618,469**	**4,401,849**			**3,009,486**		**722,540,916**

Source: SNIS 2006. Table is an updated and adapted version of Table X of the ASE report"Municipal Water Infrastructure Efficiency as the Least Cost Alternative," 2003.

20. To get a sense of the potential for energy efficiency in Brazil, a survey was conducted of ten of the better-performing WS&S utilities in Brazil. For these WS&S utilities (Table 5), NRW ranged from 20 to 60 percent, with most utilities in the mid-30s. Physical losses (leakages) vary enormously in Brazil by region and utility. For example, as a percentage of NRW, estimates of physical losses range from 18 percent for CAGECE, to 38 percent for SABESP, to 81 percent for COMPESA (Pernambuco).

[8] PROCEL SANEAR http://www.metodoeventos.com.br/3eficienciaenergetica/downloads/2905/manha/fernando_pinto_dias_perrone.pdf slide 9

Table 5. Survey Results of Selected Brazilian WS&S utilities

	Municipalities served	Connections, '000	NRW (%)*	Energy costs, R$million per year	Energy costs (R$) per connection per year
ADJ	3	30.3	62.4	2.4	79.21
AND	1	79.2	36.8	6.2	77.65
SABESP	368	5846.7	33.8	400.0	68.41
SANASA	1	232.4	27.1	13.0	55.94
COPASA	566	2928.1	30.7	140.0	47.81
ADI	1	39.8	21.2	1.7	42.71
EMBASA	352	1890.7	33.0	76.0	40.20
ADP	1	71.0	35.7	2.8	39.44
CAGECE	150	1057.9	33.7	41.0	38.76
CAESB	1	2333.1	23.7	30.0	12.86

Note: ADJ, AND, ADI and ADP are private concessions held by ADB; the other utilities are public utilities with some private sector shareholding

Note (*): Indice de Perdas na Faturamento, except for the private concessions (ADJ, AND, ADI, and ADP), plus SANASA, which are Perdas na Distribuicao.

21. Technologies and measures to reduce energy consumption and physical water losses are well established. Table 6 shows some of these investments and typical payback periods. On the level of individual utilities, such investments would have payback periods ranging from a few months to about four years.

Table 6. Efficiency Improvement Measures in the WS&S Sector

Area	Function	Typical Payback Period (years)
Electricity Rates	Reduce demand during periods of peak electricity rates	0 – 2, depending on storage capacity
Electric installations	Power factor optimization with capacitors	0.8 – 1.5
	Reduction in voltage imbalance	1 – 1.5
Operations and maintenance	Routine pump maintenance	2
	Deep well maintenance and rehabilitation	1 – 2
Production and Distribution	Use automation (such as telemetry, SCADA, and electronic controllers on modulating valves), for example, to control pressure and output in the networks, and to optimize the operation of pumping equipment	0 – 5
	New efficient pumps	1 – 2
	New efficient motors	2 – 3
	Replace impellers	0.5
	Optimize the distribution network (e.g., by removing unnecessary valves, sectoring, and installing variable speed drives and regulating valves)	0.5 – 3
End Use	Incentive program for the use of efficiency technologies	1 – 3
	Effective metering of consumption	1 – 2

Source: Barry 2007

22. For the many Brazilian utilities where there is potential for improving efficiency, the savings from such investments could free up funds for system maintenance and network expansion. To achieve these results on a wider scale, however, a number of barriers must be overcome.

III. Barriers to EE Investments

23. A number of studies have addressed the barriers to energy efficiency investment in the WS&S sector in Brazil (Amar 2003; USAID 2005; Poole 2006; Gomes 2007; Taylor 2008). Despite significant potential for energy savings in Brazil, there has not been an active investment program in the sector compared to other public areas, such as public lighting. Among the reasons why energy efficiency projects in the WS&S sector are not being implemented, are those discussed below.

24. **Lack of information, awareness and knowledge.** Many WS&S utilities, including management and operational staff, are not aware of the energy efficiency savings potential and good practices to avoid energy as well as physical water losses. Thus they cannot present projects when the few programs that fund the implementation of projects issue calls for proposals, for example, PROCEL SANEAR or power utilities through the wire-charge program. Many utilities have only incomplete records of the equipment they operate and metering of inputs and outputs is very limited. Not surprisingly, there is little awareness of potential energy efficiency savings, and few energy audits have been carried out or feasibility studies prepared. Lack of training and knowledge among the various participating actors (i.e., design, construction, expansion, operation and maintenance) also inhibits the examination of efficiency issues during operation/upgrade/retrofit of WS&S facilities.

25. **Limited incentives.** Improving energy efficiency in water utilities suffers from many of the same disincentives for reducing NRW – it requires time, dedication, staff, and usually upfront funding; the problem is largely invisible and management tends to favor output expansion rather than cost reduction, and; it is easier to close revenue gaps by spending less on asset management or asking the government for more money. And related to physical water losses, every liter of water produced requires energy for extraction, treatment, and distribution. Electricity companies generally regard water utilities as good customers who pay their bills, have higher-cost efficiency investments and, exhibit less potential for reducing peak load (unlike public lighting). For these reasons, electricity utilities have not focused their attention on energy efficiency in the water sector.

26. **Procurement and budgeting issues.** Similar to other public entities, there are often limitations for undertaking investments by private companies in water utilities. Among these are bidding processes that typically favor lowest first cost as opposed to lowest life-cycle costs (including energy). Budget procedures also often limit the duration of contracts beyond one or two years, which can eliminate multi-year performance contracting for all but the shortest-payback investments.

27. In general, equipment is procured based on the criterion of lowest first cost. However, over the lifetime of an inefficient pump, the purchase price accounts for only about 3 percent of total costs, while energy to run the pump accounts for about three-quarters of the costs. An inefficient pump also has higher costs of maintenance and more downtime (Barry 2007). Procurement rules in many municipalities and public utilities typically procure substandard components based largely on low purchase cost which discriminates against more efficient equipment.

28. One of the main issues currently preventing the use of EPCs by ESCOs in the water sector (with a prevalence of public sector enterprises) is the requirement that a detailed technical description of project parameters has to be provided before services can be tendered. In addition, the entity bidding for the service has to be legally separate from the entity developing the technical description. This clause would prevent ESCOs from entering into performance contracts in the water sector, as they would be reluctant to guarantee savings based on audits carried out and investment measures proposed by those with a comparatively weak base of information.

29. **Fiscal and financing constraints.** A combination of reduced federal investment in the water sector and fiscal controls on sub-national entities under Brazil’s Fiscal Responsibility Law has, appropriately, limited overall public spending and thus also limited the amount of investment in the sector (until recently). Commercial bank lending to the sector, either directly or through ESCOs, is also limited in Brazil due to high interest rates, lack of familiarity with energy efficiency projects by commercial banks, and excessive financial guarantees required for ESCOs.

30. **Lack of a convenient delivery mechanism.** Although there are a number of cost-effective energy efficiency and water saving measures to be implemented in Brazilian WS&S utilities, an effective delivery mechanism that can bring together the technical, commercial, and financial aspects in primarily public WS&S utilities has not yet been developed.

31. If the barriers to investment could be removed through the concerted efforts of governments at various levels, utilities and regulators in both the WS&S and power sectors, financial institutions, the private sector, and donors, then the WS&S sector could move from the implementation of demonstration projects to a scale-up of energy efficiency investments in the sector.

IV. Current and Potentially New Sources of Support for EE Investments

32. According to the Ministry of Cities, R$178 billions are needed by the WS&S sector over the next 20 years based on expected population and economic growth rates, equivalent to sector demand growth of around 4 percent per year. This represents roughly R$8.9 billion per year. However, according to SNIS data, only R$3.5 billion were invested in 2005.

33. For many WS&S utilities, incomplete cost coverage, low metering and collection ratios, and ineffective management have resulted in an inability to generate internal funds for financing investments. External financing is severely restricted by the *Lei de Responsabilidade Fiscal* applicable to public sector WS&S utilities, but not PPPs. Water utilities in the South and Southeast in general have higher water tariffs, representing greater affordability, as well as superior metering and collection ratios, and hence, are better able to finance investments.

34. There are several potential sources of support for energy efficiency investments in the WS&S in Brazil:

- Lending by state development banks (Caixa Economica Federal and BNDES);
- Public energy efficiency programs and funds, such as PROCEL SANEAR and the EEP (ANEEL);
- Financing by the private sector, including energy service companies (ESCOs).

A. *Lending to the WS&S Sector in Brazil*

35. Investments in Brazil's WS&S sector are financed primarily by state-owned water companies through loans, bonds etc.; through Federal disbursements to city systems through the Caixa Economica Federal (CEF), with limited funding through BNDES; and through international financial organizations.[9] Caixa is the second largest public bank in Brazil and has nationwide coverage. It administers a Federal Guarantee Fund,[10] dedicated to private sector investments in public infrastructure, and which has been the most important source of investment in the WS&S sector over the last 45 years. These funds can also support PPP investments in infrastructure, such as municipal sanitation and solid waste projects. BNDES has a credit line for environmentally and socially focused investments in the WS&S sector.

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[9] See, for example, USAID 2005.
[10] http://www.stn.fazenda.gov.br/hp/downloads/Comunicado_STN_FGP_2701061.pdf

36. In early 2007, Brazil launched the Growth Acceleration Plan (PAC), which plans to promote economic growth beyond 4 percent annually through investments focusing on infrastructure (roads, energy and public services like water and sanitation). Under the PAC, the level of investment of several billion R$ is supposed to be achieved through public and private sector funding.

B. *Public Energy Efficiency Programs in the Water Sector*

37. **PROCEL SANEAR.** A national energy efficiency program for the electricity sector, PROCEL, was established as early as 1985 and coordinates energy efficiency initiatives, such as the Brazilian Standards and Labeling Program, and programs in several sectors, such as SANEAR for the WS&S sector and RELUZ for municipal public lighting. Despite having one of the larger program budgets within PROCEL (R$8 million in 2003/4), there have been very few energy efficiency investments in the WS&S sector carried out under SANEAR. By comparison, the PROCEL RELUZ program for public lighting, created in 2000, was averaging around R$200 million per year in the early 2000s, with projects in municipalities across the country.

38. **Energy Efficiency Program (EEP)**. Regulated by ANEEL, the EEP program is the largest source of investment in energy efficiency in Brazil. Established in June 2000, Law 9.991 requires that electricity distribution companies spend at least 0.5 percent of their gross revenues on energy efficiency measures (including research) in end-users facilities (see Part 1). While not many projects have been carried out in the WS&S sector, a number of positive experiences have been gained, and changes in the guidelines governing the EEP could provide increased investment to the WS&S sector.

39. **PMSS.** Program for Modernization of the Sanitation Sector; it reports to the National Secretariat of Environmental Sanitation (SNSA) of the Ministry of Cities and operates with support from the World Bank. There is also the National Program for the Reduction of Water Waste (PNCDA) that reports to SNSA. Both have coverage that extends to the WS&S sector.

C. *Private sector investment through ESCOs*

40. Private sector energy service companies (ESCOs) developed in the US and other OECD countries in the 1980s to identify, design, package and finance energy efficiency projects. They also provide oversight of installation and commissioning of energy efficiency projects; measurement and verification of savings; and operation and maintenance of facilities and equipment for the contract period. There are three basic types of ESCOs: (1) consulting engineers that specialize in efficiency improvements; (2) energy efficiency equipment vendors that offer energy audits and provide a service for a fixed fee; and (3) companies that enter into energy performance contracts (EPCs) with their clients and guarantee the energy savings through a performance guarantee (see Box 1).

Box 1. What are Energy Service Companies and Energy Performance Contracts?

Energy Service Companies (ESCOs) offer technical (and financial) services to end-users in the identification, design, packaging, possibly financing, overseeing of installation and commissioning of energy efficiency projects, measurement and verification of savings, and operation and maintenance of facility and equipment for the contract period. In OECD countries, ESCOs, sometimes associated with equipment suppliers, are significant financers of energy efficiency investments. While some ESCOs are essentially consulting engineers specialized in efficiency improvements or energy efficiency equipment vendors offering energy audits and providing a service for a fixed fee, other ESCOs provide financing, and/or enter into energy performance contracts with their clients. The Brazilian ESCO association, ABESCO, has more than 75 members, and undertakes energy efficiency investments – under both performance contracts and fee-for-servce – primarily in the industrial sector.

Energy Performance Contracts (EPCs) in the ESCO business can be defined as contracts between ESCOs and their clients, where the ESCO carries out an energy efficiency investment in the client's facilities, guarantees the performance of the investment project (i.e., the savings) and is remunerated based on its performance. Their remuneration is directly tied to the energy savings achieved or stipulated. Project energy cost savings are typically used to cover financing costs. Contracts where the ESCO provides the financing are known as *shared savings* contracts, while the client obtains the financing, based on the guarantee provided by the ESCO, in a *guaranteed savings* contract. The performance contract signed between SABESP and Vitalux in 2007, the first in Brazil's WS&S sector, is an example of an EPC contract.

41. While the number of ESCOs in Brazil has grown, most of them provide engineering and consulting services on a fee-for service basis, and there have been few ESCOs that have undertaken EPCs or provided financing of efficiency investments. The main barriers in the water sector (as noted above) have been the lack of sufficient information assembled by the predominantly public WS&S enterprises, and the inability of ESCOs to obtain commercial financing. The EEP program and its requirement that electricity distribution utilities invest 0.5 percent of their total revenues in energy efficiency have allowed a number of ESCOs to develop and grow their businesses. However, it is estimated that fewer than twenty-five ESCOs in Brazil that have sufficient project flow and professional capacity to allow them to enter into EPCs. Total investments by these Brazilian ESCOs are estimated to be on the order of US$40 million per year.[11] In comparison, Brazil's overall market for investment in energy efficiency retrofits is estimated at about US$5 billion, with paybacks up to 30 months and annual savings of about US$2 billion (see Poole 2006).

42. As a means of overcoming the credit problem for Brazilian ESCOs, BNDES established PROESCO in May 2006 as an innovative risk-sharing credit facility for

[11] Taylor et al 2008.

energy efficiency.[12] It seeks to make the project finance approach viable for energy efficiency projects, by using the future income stream of energy savings under EPCs to guarantee loans. While PROESCO is expected to overcome some of the difficulties with obtaining financing for the ESCO industry, there remain other problems for the establishment of an energy efficiency market in Brazil, including the lack of familiarity with energy efficiency projects on the part of commercial banks (through which BNDES loans flow), continuing high interest rates for loans in Brazil, and the small size and capitalization of Brazilian ESCOs which limits the size and number of project that can finance, and their ability to obtain loans from commercial banks.

[12] http://www.bndes.gov.br/ambiente/proesco.asp. PROESCO differs from conventional financing mechanisms in several key aspects: (i) Collateral is not required to obtain the credit. While personal guarantees by the borrower are required, they need not bear a minimum relation to the size of the loan; (ii) A report by an accepted third party must validate the technical and economic soundness of the proposed project; and (iii) BNDES assumes up to 80 percent of the credit risk; the rest remains with an intermediate commercial bank, which signs an agreement with BNDES.

V. Energy Efficiency Initiatives in the WS&S Sector in Brazil and Internationally

43. The case studies below describe several demonstration projects and small-scale commercial EE investments that have yielded promising results in the WS&S sector, in terms of both: (i) reducing energy consumption and operating costs; and (ii) enabling utilities to connect more customers without any increase in water use. At present, these initiatives remain largely small-scale demonstration projects and the challenge will be to replicate and expand them across Brazil.

A. *Brazilian Cases*

1. COM+ÁGUA Demonstration Projects

44. The COM+AGUA ("With+Water") demonstration projects are being implemented in ten WS&S utilities between December 2006 and May 2008, under the World Bank-supported Program for Modernization of the Sanitation Sector (PMSS). The selected utilities represented three different size categories of municipal WS&S systems:

- 10,000 to 30,000 connections: Ilhéus (State of Bahia); Ituiutaba and Viçosa (State of Minas Gerais) and São Bento do Sul (State of Santa Catarina);
- 30,000 to 100,000 connections: Guaratinguetá (State of São Paulo), Santa Maria and Caxias do Sul (State of Rio Grande do Sul) and Montes Claros (State of Minas Gerais);
- 100,000 to 180,000 connections: Santo André and Sorocaba (State of São Paulo).

45. The objective of the program is the development of an integrated management system to reduce NRW and increase energy efficiency in water supply systems, based on the water audit concept developed by the International Water Association (IWA) Water Loss Task Force. The specific project interventions were based on the understanding that the reduction of NRW depends not only on technical solutions (including investment in new construction and equipment), but also on the integrated management of all aspects of utility operations. Water audits were carried out for each water system,[13] with the participation of all sectors of the utility, and integrated management systems were then elaborated to reduce NRW and increase energy efficiency in the systems. Before the projects (2005) specific electricity consumption ranged from 0.14 to 0.81 kWh/m3. COM+AGUA provided on-site training programs focused on raising the awareness of the

[13] The water audit concept was developed by the International Water Association (IWA) Water Loss Task Force.

utilities' operational staff of the need to reduce NRWand improve energy efficiency as a regular part of their operating and maintenance routines.

Results

46. Although these projects have only recently been completed, the results so far are promising. Substantial financial gains, on the order of 15 percent of total annual expenditures, were achieved solely through low-cost administrative measures, such as correcting deficient billing practices or ensuring that tariff discounts and peak/off-peak rates are properly applied by the electricity supplier. Interestingly, the smaller systems with fewer employees presented more operational deficiencies, particularly related to maintenance activities, but showed better results, on average than the larger systems.

47. As a result of the pilots, COM-AGUA project has proposed actions for other similar utilities in three major areas affecting energy efficiency:

- *Reducing "real"(physical) losses* (production water that does not pass through customers' meters, due to leaks, breaks, and storage tank overflows that occur before reaching the meters): training activities on master meters, automation, technical records, utility plans, pressure reduction on distribution network, invisible leak detection, water audit methodology (water balance) and the use of some tools to help the analysis and operation;

- *Reducing apparent losses* (water available for sale but not measured and invoiced due to accounting errors, inaccurate customer meters, illegal connections, and bypassed meters): training activities on customer databases, residential meters, and all types of illegal commercial actions;

- *Actively improving energy efficiency*: training activities on equipment records, measurement of electric and hydraulic parameters, identification of energy efficiency opportunities, and control of energy accounts.

2. CAGECE Watergy Pilot Project

48. CAGECE *(Companhia de Águas e Esgoto do Estado do Ceará)* is the regional water utility for the state of Ceará, one of the important northeast states of Brazil. The Government of Ceará is the majority owner, and private investors hold the remaining shares. CAGECE serves 6.7 million people across 150 municipalities (see Table 5). Since 2001, CAGECE has been participating in the Watergy Program, under which it has developed and implemented measures to improve the efficiency of water and energy use, with the aim of increasing access to WS&S services, while reducing operational costs and environmental impacts (see Box 2).

49. During the first two years of the project, a technical audit was carried and a detailed engineering and automation plan for the utility's energy savings program was developed. During the third and fourth years, project results were monitored, and results and actions were disseminated to other stakeholders in the sector. After implementation of the project, the ASE team actively evaluated project impacts, including at 24 remote operations, through macro-metering and monitoring of pressure controls and pumping stations.

50. The utility also developed a proposal for PROCEL to fund energy efficiency projects – including the installation of high-efficiency motors, implementation of power generation at wastewater treatment plants, and the introduction of an energy management system – which PROCEL has funded in the amount of R$5 million (US$3m). Based on the success of the program, CAGECE received PROCEL's annual Efficiency Award.

Box 2. CAGECE Watergy Project – Issues and Approaches

Issues

- System over-designed: this is a common mistake in WS&S systems worldwide, which causes excessive energy use due to oversized pumps, unnecessary booster stations, and other mismatched equipment.
- Many inefficiencies: pumps, O&M, system management
- Many households not connected to service (only 442,400 households out of a total population of 6.7 million were connected)

Approach

- Improved data collection and analysis
- Automation: pressure controls, centralized pumping controls, e.g., suspended pumping during high electricity rate periods
- Increased storage capacity to allow the shutdown of pumps during peak hours
- Improved motor efficiency through replacement with high efficiency motors or re-winding of motors
- Operations manual for daily O&M procedures

Source: USAID 2005.

Results

51. The CAGECE project yielded the following results:

- Reduction in operational energy consumption: savings of 88 GWh over four years, of which there was nearly an 8 percent reduction in electricity consumption by the operational control center of the utility
- 88,000 new connections added compared to a total of 918,000 connections in 2002 (an increase of nearly 10 percent), mostly for poor inhabitants, using the same amount of water;

- Financial savings of US$2.5 million/year with investment of only US$1.1 million (R$3 million), resulting in a simple payback time of 5.5 months;
- System-wide reports: the program developed reports for 50 plant operations, such as reservoir levels, pumping needs, water flows, allowing the optimization of systems;
- Contract renegotiations: the improved information on resource use generated through the automation process allowed for contracts to be renegotiated, including with the electric utility;
- Standardization of internal processes, improved operations management and customer satisfaction by reducing the time for responding to customer claims and information sharing.

3. SABESP Energy Performance Contract (EPC)

52. In early 2007, SABESP began implementing an energy performance contract which became for the first one in Brazil in the WS&S sector. SABESP *(Companhia de Saneamento Básico do Estado de São Paulo)* is the regional water utility for the state of São Paulo, the most populous and industrialized state in Brazil. It serves a population of about 25 million in 368 municipalities. Its NRW before the project was 34 percent, and energy costs were R$400 million a year. The utility has a public-private ownership structure, with shares split equally between the Government of São Paulo and private investors. While the company is majority owned and regulated by the Government of São Paulo, it has an independent budget and balance sheet, providing additional incentives for efficient energy use compared to a utility that operates as a government department. Any savings in operational costs remain in the company budget and can be used for investments, loans, or other purposes. SABESP has an ongoing technical cooperation agreement with PROCEL SANEAR, and has implemented other energy efficiency projects, including the Santana project, but not through energy performance contracts (see Box 3).

Box 3. The Santana Project
SABESP implemented the Santana project together with the power utility Bandeirante Energia S.A., which contributed almost two-thirds of the investment funds of R$1 million. The installation of individual macrometering and variable speed drives, and the replacement of old motor pumps with new efficient sets, resulted in the reduction of demand and of power consumption at the Água Santana Booster Pumping Station by more than 50 percent, resulting in a monthly cost reduction of R$28,600 (equivalent to US$16,350). Substantial reduction of NRW) was also achieved due to better control of water pressure in the distribution network, through the installation of variable speed drives, which also enabled a more intensive leak detection and remediation program. The resulting decrease in average water delivery to the Santana region produced monthly financial benefits of R$146,154 (US$83,550).

53. In 2006, SABESP entered into an EPC with the ESCO Vitalux to improve the performance of the *Parque* Novo *Mundo* wastewater treatment plant, which has a treatment capacity of 2.5 m^3/sec and serves 1.12 million inhabitants. Under the contract, the ESCO is financing about US$4 million worth of energy efficiency investments at the plant, with the aim of improving the aeration process through the replacement and retrofit of air diffusers of three aeration tanks, the installation of high-efficiency motors for fans and ventilators, the retrofit of blowers, and other measures. Expected benefits are a reduction of energy consumption and energy costs, estimated at R$146,680/month, with a simple payback of 3.7 years. While this was a very small investment for SABESP, yearly energy savings from this one treatment plant amount to about 0.45 percent of SABESP's total annual energy expenditures.

Box 4. SABESP's Approach to Selecting and Contracting an ESCO

SABESP evaluated the ESCO proposals both technically (including qualifications of team members) and financially, as required by federal and state law. Evaluation criteria included the minimum monthly energy saving to be achieved and the maximum share of the savings to be paid to the ESCO. If the actual performance is better than predicted, the difference will be absorbed solely by SABESP and not be shared with the ESCO. This mechanism is critical to establishing a ceiling on the amount to be paid to the ESCO. The bidding documents were approved by the company's legal department and by the legal department of the state government.

The contract with the winning ESCO included the following provisions:

- Contract duration – 58 months (10 months for implementation, 48 months for sharing savings)
- Minimum amount to be saved – R$125,000/month;
- ESCO's share of savings is progressive, based on financial results – from 70 percent of minimum savings up to 120 percent of maximum savings, with all savings above 120 percent solely benefiting SABESP (estimated effective savings share – 89 percent ESCO, 11 percent SABESP).

Results

54. Based on this experience, SABESP plans to continue implementing projects that NRW and energy waste; potential projects include the installation of controls (such as water meters), and the capture and use of biogas from wastewater treatment plants. Any

investments would have to be preceded by feasibility studies, which could possibly also be contracted to ESCOs similar to the Vitalux contract, or be developed as part of the ANEEL EEP program. The SABESP experience should also prove useful to other utilities in Brazil, many of which have limited borrowing capacity. Third-party financing through ESCOs could enable them to implement investments that would reduce their water and energy waste and thus their operating costs and thus improve their financial position.

55. Notwithstanding the legal and administrative challenges of EPCs (see Box 4), the São Paulo state energy authorities hope to introduce performance contracts in other regional water and sanitation utilities with a similar capital structure (i.e., public-private, with an independent budget). They are also considering the possibility of using performance contracts in solely state-owned companies.

4. Lessons for the WS&S Sector from Municipal Public Lighting in Brazil

56. One public sector area that has received considerable investment in energy efficiency in Brazil, including through ESCO investments and third-party financing, is municipal public lighting.

57. The municipal public lighting sector – which like the WS&S sector also comprises about three percent of annual national electricity consumption – has seen substantial investments and improvements in the efficiency of its energy use. There have been two main sources of concessional funds for financing energy efficiency investments for public lighting, the RELUZ program of PROCEL and the EEP.

58. **RELUZ.** The RELUZ program under PROCEL is dedicated to improving energy efficiency and expanding public lighting. The goal is to substitute 9.5 million (about 2/3) of existing lights between 2000 and 2010, and to add 3 million new efficient public lighting units. The substitution of existing lights with more efficiency bulbs and ballasts is expected to reduce peak demand by 540 MW and energy consumption by 2,400 GWh – approximately 35 percent of energy consumption for public lighting at the beginning of the program. The program is administered through PROCEL, using mostly funding from the Global Reversion Reserve (RGR), a surcharge on utility receipts administered by Eletrobrás. Since the RGR is a power sector resource, the loans (for a maximum of 75 percent of total project cost), must be made to utilities that present projects together with municipalities in their concession area. Financing is at substantially subsidized interest rates. Overall, investments of about R$2.6 billion are planned to achieve the above goal, with about R$2 billion coming from the RGR. Between 2002 and 2004 total financing was about R$660 million for projects in more than 1400 municipalities, roughly a third of all municipalities in Brazil.

59. **EEP.** Between 1998 and 2003 more than R$180 million were invested in efficiency improvements of public lighting, which accounted for more than half of all EEP financed investments during that period. One of the reasons for the disproportionate use of funds in this sector is the desire by electricity distribution utilities to reduce peak load (early evening in Brazil), and reduce their losses, given the relatively low tariff[14] for street lighting, and the relatively poor payment history of many municipalities. From the power utilities' perspective, energy efficiency investments are a way to minimize losses from sales to municipalities. In addition, EEP resources can be used for the required cost-sharing under the RELUZ program.

60. Municipal public lighting provides potential lessons for the WS&S sector in terms of the establishment of dedicated funding for the sector and a nationwide program involving key stakeholders. Energy efficiency investment for public lighting has attracted more investment than any other single sector in Brazil – both through PROCEL and the EEP program – over the past ten years. By comparison, energy efficiency improvements in the WS&S sector have received only minor funding from either PROCEL (on the order of R$8 million/year in recent years) or the EEP (only R$5.5 million between 1998 and 2002 out of a total of R$722.6 million). Perhaps the more important lesson from the municipal public lighting experience is that the objectives of the program were promoted nationwide both through the RELUZ and EEP programs and the program was able to reach nearly a third of all municipalities in Brazil. To the extent that a similar program could be established for the WS&S sector – which would not need such heavily subsidized funding – energy efficiency improvements would likely become more common in WS&S utilities across Brazil.

5. Energy Monitoring and Targeting Project with ABCON Members

61. Beginning in 2002, the World Bank's Energy Sector Management Assistance Programme (ESMAP) collaborated with the Brazilian Association of Private Water Utilities (ABCON), to provide know-how and on-the-ground experience with energy monitoring and targeting (M&T) to its members (see Box 5).

[14] For example, CEMIG's (the Minas Gerais power utility) low-voltage energy tariff for public lighting is R$204/MWh (US$123/mWh), compared with R$379/MWh (US$230/mWh) for low-voltage business customers. A medium-voltage customer with a load profile similar to public lighting would pay about R$280–285/MWh. Source: Poole (ed) 2006.

62. The participating utilities were:

- *Águas do Imperador* (ADI), a special purpose subsidiary of *Águas do Brasil* (ADB), which operates a number of private water utilities in the state of Rio de Janeiro.[15] ADI has a 30-year concession contract to provide water supply and sewage treatment in the city of Petrópolis. It serves a population of 230,000, and has energy costs of R$1.7 million a year.
- *Empresa Montagens de Sul Americana* (EMSA), a joint venture utility that operates water supply systems for the cities of Palmas, Paraíso, and Porto Nacional in the state of Tocantins. Water supply and sewerage services are provided by SANEATINS, a joint venture between the state of Tocantins and EMSA.

Box 5. What is Energy Monitoring and Targeting?

Energy monitoring and targeting (M&T) is an established technique to help reduce energy costs through improved energy efficiency and energy management control. It enables commercial enterprises, especially those with a large number of sites (such as water utilities), to manage energy use as a controllable resource. It also contributes to better environmental performance, better production budgeting, and more effective environmental management activities within recognized standards such as ISO14000.

Under an M&T program, a site is divided into several Energy Accountability Centers (EACs) – an EAC may be a department, a process, or a cost accounting unit – where energy consumption is monitored on a regular basis. By analyzing past performance, a standard energy consumption level is set for each EAC. This makes it possible to relate the energy used to a relevant variable; e.g., volume of treated water, particulate content of raw water, or pumping hours per unit of treated water. Actual energy use is compared to this baseline and the findings are presented to managers. Further, targets are set for the achievement of better-than-standard performance. For example, achieving close control of water flow prevents pressure from building up in distribution lines due to supply exceeding demand; and this, in turn, reduces ruptures or leaks in the network. It also minimizes the loss of chemicals and electricity both from leaks and the overflow of reservoirs.

Investments needed to put an energy M&T system into operation include:

- Tools (metering, software for data analysis) critical for monitoring water and energy use;
- Capacity building to develop in-house competence in establishing benchmarks for conservation and loss minimization activities;
- Studies to identify, evaluate, and justify other energy efficiency investments.

Source:
www.unep.fr/energy/projects/EMPRESS/docs/M&T%20Information%20Brochure%20Sept04.doc, www.oursouthwest.com/SusBus/susbus9/m&tguide.pdf , www.worldbank.org/html/fpd/esmap/cd2003amaquaye/M&T%20Precis%20document(5-05).pdf

[15] ADB's three other subsidiaries in Rio de Janeiro state have water losses ranging from 35.7 to 62.4 percent, and energy costs ranging from R$2.4 to 6.2 million. ADI's lower water loss rate may be due to its previous experience with energy efficiency projects. All utilities emphasized their need for capacity building to reduce water losses and improve energy efficiency.

63. Both utilities had electricity costs that amounted to 20 percent of their operating costs. They participated in the project to determine whether the application of M&T, which is considered best practice in energy management, could curb waste in their municipal water supply operations, and thereby lower the costs enough to make their participation in the utilities profitable. In the two utilities, energy audits were carried out, M&T implementation plans designed, energy meters and data collection systems installed, and (at ADI only) data analysis software installed.

Results

64. In the two utilities, energy use and costs were controlled through the introduction of energy management systems and procedures. In addition, the following energy efficiency projects were identified:

- Introduction of variable speed drives at the pumps in water treatment plants, which, in conjunction with water pressure meters, would reduce pumping during periods of low demand;
- Replacement of oversized pump motors, which would reduce energy consumption by 5 to 6 percent;
- Acquisition of software for analysis of energy bills;
- Installation of micro-hydro power turbines to generate electricity at some of the sites.

65. ADI developed an energy M&T implementation plan that would reduce annual electricity expenditure by up to R$582,000, or more than half of its electricity bill in 2002. The payback period for the necessary investments was estimated at 3 to 4 years. Due to lack of funding, only some of the proposed measures were implemented, financed through either the wire charge program or the utilities' own funds. Most notably, the proposed mini-hydro power turbines and water storage systems were not implemented due to their relatively high costs.

66. SANEATINS estimates that the energy M&T plan will result in energy savings of about 13 percent, largely through low-cost measures, including maintenance improvements and tariff analysis and modification of power usage. In addition to direct energy expenses, SANEATINS estimates that it will save even more money on its non-energy expenditures (chemicals, personnel costs) amounting to 16 percent of its total energy bill.

67. Energy M&T has shown that efficient energy management is sustainable only if (i) accurate information on energy use and water production is available; (ii) a convenient energy management structure is created and staff trained accordingly; and (iii) an efficient information system is designed to disseminate information through the entire organization. Substantial benefits come from management's attention to not only energy

performance, but also proper operating behavior and adequate tools to sustain results achieved and also help to identify new energy efficiency measures.

B. *International Experiences*

1. Good economic returns for WS&S projects in China

68. Potential cost-effective investments to yield both water and energy savings were identified at five water utilities in Hebei province in a 2003 World Bank study. The recommendations, in the three broad categories of pumping systems, backwashing modifications, and biological process improvements, were based on international best practices, with adaptations to Chinese plant conditions. Table 7 shows the investment amounts and expected benefits. Simple payback times for all investments range between 1.7 and 5.9 years. In China, where electricity is primarily generated with coal, the addition of carbon finance revenues could improve the financial returns and reduce the average payback time from 4.3 to 3.8 years.

Table 7. Aggregate investments proposed and expected benefits in water utilities in Hebei province

Project	Total Investment Million RMB (Million USD)	Water Savings M^3/year	Annual Water Savings RMB (USD)	Energy Savings kWh/year	Annual Energy Savings RMB (USD)	Payback Time (years)	FIRR (%)
Beijiao Backwashing	13.0 (1.57)	1,825,000	2,792,250 (337,636)	24,820	12,012 (1,452)	4.2	29.04
Tangshan Running Water	7.4 (0.89)	-	-	2,592,208	1,244,627 (150,499)	5.9	18.29
Xijiao No.1 WWTP	2.6 (0.32)	-	-	1,466,091	835,718 (101,054)	3.1	38.38
Xinqu WWT	1.16 (0.015)	-	-	1,227,787	699,838 (84,623)	1.7	87.50
Qiaoxi WWTP	4.1 (0.5)	-	-	2,000,000	1,000,000 (120,918)	4.2	27.35
Total	**28.3 (3.4)**	**1,825,000**	**2,792,250 (337,635)**	**7,310,906**	**3,792,195 (458,548)**	**4.3**	**-**

Source: World Bank/ASTAE 2003

69. In the current environment in China, it is difficult to attract commercial financing for energy efficiency project in WS&S utilities. In addition to the typical barriers for energy efficiency projects (see Taylor et al 2008), other reasons specific to China are the relatively low financial returns due to low water tariffs, and because lending to municipal companies is unattractive, even if it is an independent accounting unit and thus responsible for its profits and losses. For similar reasons, state banks are typically unwilling to provide funds to municipal utilities. The report therefore proposed the creation of a specific financing mechanism – an efficiency fund for water – to promote

cooperation between water and electrical utilities in the joint implementation of energy efficiency projects in the water sector.

70. Despite the identification of a range of cost-effective investments in the WS&S sector in Hebei Province, there is no indication that such investments have been carried out on a large scale in Hebei or other parts of China. An ongoing World Bank project in the water sector in Hebei was a possible avenue for financing the investments, but it was apparently not possible to retrofit the project with additional components. It is possible that some utilities have undertaken some investments on their own, though it is also likely that the investments remain to be carried out. One of the conclusions to be drawn from the Hebei example is that it is not just the identification of good investments, but a combination of internal management incentives, the availability of financing, and a convenient delivery mechanism (such as the involvement of an ESCO that specializes in the water sector). It appears that the scarcity of efficiency investments in the water sector in China has been due to a number of these barriers.

2. Private Contract for Reducing NRW in Malaysia

71. After a 1997 water crisis precipitated by El Nino, the Malaysian State of Selangor decided to reduce the high level of NRW by accepting a proposal from a private consortium led by a local firm. At the time, an estimated 40 percent of the water produced was not invoiced and water leakage was estimated at 25 percent or around half a million cubic meters per day.[16] By lowering NRW, it was estimated that the city could supply water to approximately 1.5 million more people.

72. The private contractor committed to a specific target in NRW reduction within a given timeframe, and had full responsibility and flexibility for designing and implementing the plan. The parties agreed upon a lump sum payment and the contract included incentives for achieving targets, a performance guarantee of 10 percent of contract value, and penalties for noncompliance of up to 5 percent of the total lump sum.

73. A phased approach was agreed upon: (i) an initial 18 month pilot phase to test the validity of the plan; and (ii) a second phase with a larger scale and timeframe (over a nine year period). Successful implementation of Phase I was a precondition for Phase II. The performance of Phase I exceeded the targets and, although working in 29 separate districts (NRW reduction zones), it achieved savings of 20,898 cubic meters per day. The cost to the State Waterworks Department was equivalent to US$215 per cubic meter per day. Total savings represented a quarter of the total losses at the beginning of the contract or approximately 10 percent of water produced. Similarly, Phase II started in April 2000, has had significant interim results: physical loss reductions of 117,000 cubic

[16] B.Kingdom, R. Liemberger, P.Marin. "The Challenge of Reducing Non-Revenue Water (NRW) in Developing Countries – How the Private Sector Can Help: A Look at Performance-Based Service Contracting", Paper No. 8, December 2006.
http://siteresources.worldbank.org/INTWSS/Resources/WSS8fin4.pdf

meters per day (already 20 percent below the 2009 contract target) and commercial loss reduction of 50,000 cubic meters per day.

74. The initiative demonstrates the possibilities of undertaking investments in NRW, or other WS&S sector investments, with private firms. By setting specific targets, and providing flexibility to the firm, it was possible to reduce NRWin a short period of time. The contract used simple but appropriate performance indicators and performance monitoring, such as savings in cubic meters per day for physical and commercial loss reduction, zoning and night-flow techniques. Although the model can be improved (for example, through a competitive procurement/selection negotiation process, a more integrated approach to the selection of NRW zones, and options for the firm providing financing), it demonstrates that impressive results in NRW can be achieved through private sector contracting.

3. Watergy Case Studies in Mexico, South Africa and India

75. Similar to the demonstration project in CAGECE in Ceara, the Watergy program has identified and carried out efficiency investments in the WS&S sector in a number of countries. With funding from USAID, the Alliance to Save Energy (ASE) has worked with water utilities in more than 40 cities worldwide since the late 1990s to implement projects designed to improve the efficiency of water supply, including the efficiency of energy use in the systems.

76. The experiences in three countries – Mexico, South Africa and India – are summarized in Boxes 6, 7, and 8. Overall, the watergy case studies show that water efficiency measures pay for themselves quickly and yield many rewards, including immediate improvements in water service, increased water delivery, reduced water and energy consumption, and increased revenue for system upgrades and new customer connections. Additional lessons are the following:

- It is important to identify cost-saving opportunities and for this information to be discussed with management, although non-monetary benefits (such as service quality and the ability to connect more customers) are also important.
- Investments with short paybacks (1-2 years) are most likely to be financed by the water utilities (or municipal commissions) themselves.
- The involvement of ESCOs can be important in some cases, such as where they are associated with technology supply companies, as in the case of South Africa where the ESCO was associated with a water pressure management firm.

Box 6. Watergy Case Study: Veracruz, Mexico

Energy was the second highest cost for water utility Agua y Saneamiento de Veracuz (SAS), which serves 628,000 users. In addition, service was sporadic and severe interruptions were common. A pilot project was carried out in the Volcanes sector of the Veracruz system, serving a population of 25,000.

Technical solution

- Hydraulic modeling to optimize pressure and flow in the system
- Leak detection
- Sectorization: isolation of sections of the distribution system using valves eliminated the problem of two pumps working against each other
- Installation of a Supervisory and Data Acquisition (SCADA) system, including a variable frequency drive on the main pump, which reduced pump energy use by 45 percent; reduced leaks; eliminated the need for construction of a storage tank; and reduced pressure in low-demand hours.

Results

- Energy savings: 25 million kWh/year (24%)
- Cost savings: US $394,000/year
- Improved reliability; frequent complaints eliminated; substantial water savings due to pressure control.

Source: Based on Barry 2007
http://www.watergy.org/resources/casestudies/veracruz_mexico.pdf

Box 7. Watergy Case Study: Emfuleni, South Africa

In the Sebokeng and Evaton residential areas (total population of 420,000), water pressure in the network is relatively high, causing premature failure of plumbing fixtures and loss of about 80 percent of water flowing to homes (enough to fill two Olympic-size swimming pools every hour).

Technical solution

- Pressure management with automated pressure management valves on each supply line
- Reduced high bulk pressure
- Further reductions at night.

Financing solution for $800,000 construction investment project

- Performance contracting, with water pressure management firm acting as ESCO
- Build-Operate-Train-Transfer to municipality after 5 years
- Firm gets 20 percent of savings as fees.

Results

- Payback period less than 3 months
- Cost savings: US$ 3.8 million/year
- Water savings: 8 million kiloliters annually (reduction of more than 30 percent), about one medium-sized dam/reservoir each year
- Energy savings: greater than 14 million kWh/year
- CO_2 Reductions: 12,000 tons/year.

Source: Based on Barry 2007.
http://www.watergy.org/resources/casestudies/emfuleni_southafrica.pdf

Box 8. Watergy Case Study: Pune, India

This city of 3 million inhabitants has substantial electricity shortages and inadequate water supply. On average, households receive 200 liters/day (the minimum recommended by the World Health Organization), but distribution among households is very uneven. Cooperation between the Pune Municipal Corporation, that manages the water system, and the Alliance to Save Energy, began in 1997, and carried out energy audits and identified low-cost efficiency measures, some of which were undertaken in 2000. Staff training and the identification of additional investments were carried out in 2005-6. Convinced that the investments were sound, the PMC financed US$189,000 in energy efficiency investments.

Technical solution

- Rotating assembly changed on pumps
- Impellers replaced on pumps
- Power factors optimized
- Old pumps replaced with more efficient ones
- Staff training

Results

- Total investment of $198,000, with a simple payment of 6.7 months
- Energy savings: 3.8 million kWh/year
- Cost savings: $336,000/year
- 10 percent more water delivered with no additional new capacity
- CO_2 emissions avoided: 38,000 tons/year

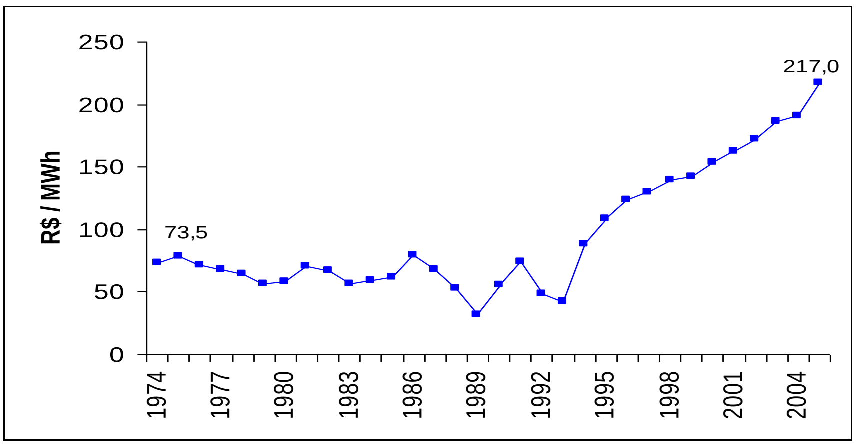
Source: Based on Barry 2007.
http://www.watergy.org/resources/casestudies/pune_india.pdf

VI. The Road Ahead

77. The environment for increasing investments in public sector energy efficiency in Brazil has improved during the past few years, including opportunities in the WS&S sector. Among the developments responsible are the following:

- Increases in real electricity tariffs since the mid-1990s encourage energy efficiency. The electricity price level has more than doubled in Brazil since the mid 1990s, due to reduction of subsidies, increases in fossil fuel prices, and application of correction factors according to concession contracts (Figure 1). This makes the implementation of energy efficiency projects more attractive financially.

Figure 1. Average Electricity Tariff in Brazil 1974 – 2006 (in R$ of 2005)



Source: IPEA, ELETROBRÁS, adjusted to inflation rates by IPC-FIPE

- Law 10.295 of October 17, 2001, the Energy Efficiency Law, establishes maximum energy consumption or minimum efficiency levels for machines and energy consuming devices manufactured or sold in Brazil, including for motors and pumps which are important in the WS&S sector.

- During the past few years many pilot projects have demonstrated high economic returns of energy efficiency and NRW reduction measures - ranging from 30 percent to several hundred percent.

78. A number of possible funding sources have also been developed during the past few years. Among the most important are:

- **BNDES** already has an environmentally focused credit line for the WS&S sector (http://www.bndes.gov.br/english/environmental.asp. and http://www.bndes.gov.br/social/saneamento.asp), which is currently very little used due to substantial guarantee and co-financing requirements. This program could potentially be combined with the PROESCO pilot project, designed to provide improved borrowing conditions for ESCOs.

- **Energy Efficiency Program (EEP) under ANEEL.** New guidelines for the EEP funds have been adopted by ANEEL (see Part 1), which call for a reform in the way projects are identified and approved. Specifically, additional investments could be forthcoming in the WS&S sector under "priority projects," which would allow the prioritization of sectors rather than leave the selection of investments entirely the electric distribution companies as is currently the case.

- **RGR funds.** PROCEL SANEAR is in the process of accessing RGR funds for energy efficiency projects in the WS&S sector that reduce peak demand.[17] It is expected to be structured in a way similar to the RELUZ program with the financing going through the utilities.[18]

79. Both the EEP and the proposed RGR funding mechanisms for WS&S will need to leverage greater additional private sector funding. While this may have been less of an issue for the smaller and less economically attractive public lighting projects, it will need to be addressed to provide adequate funding for the more extensive investment requirements in the WS&S sector.

A. *Lessons Learned from the Case Studies*

80. The case studies presented in section V above demonstrate that there are a number of avenues and approaches available for promoting energy efficiency in the WS&S sector. Efficiency opportunities abound in the WS&S sector and, when water utilities are able to implement investments to improve the efficiency of water delivery and

[17] Source: http://www.eletrobras.com/elb/procel/main.asp?ViewID={4077F61B-E768-4580-8E87-CC64B1B43B90}

[18] The proposed rules are as follows: (i) RGR/ELETROBRAS can provide up to 75 percent of investment funds and the balance has to be supplied by the power utility and/or WS&S utility; (ii) Interest rate is subsidized, 5 percent per year + 2.5 percent (admin tax + credit reserve commission); (iii) Grace period up to 24 months; (iv) Submission documents include detailed project and feasibility study; (v) Minimum eligibility criteria include Benefit Cost Ratio, BCR > 1; (vi) Proposed technical solutions are accepted measures such as improving pumping systems, reducing pumping pressure in distribution networks, improving efficiency of equipment, load modulation using variable speed drives; load shedding and/or peak time demand reduction, encouraging pumping during off peak hours and thus optimizing water reservation, but also technological innovations.

wastewater treatment, experiences have been very good. Energy consumption and energy costs go down substantially freeing up funds to allow more customers to be connected, often with no additional new production/distribution capacity.

81. The case studies have demonstrated that the technologies and engineering and operating approaches to improve energy efficiency and reduce water losses are well known to experts and that often low-cost administrative options are the first place to start. The importance of metering both energy use and water production and establishing an information and energy management system are crucial first steps. They are the basis for identification of cost-effective investments. Staff training is important to maintain more sophisticated equipment, improve operating efficiency, and continue to identify cost-saving measures, and for larger utilities, the ability to carry out many investments in-house.

82. The case studies confirm that one of the barriers that WS&S utilities face is financing. Very few attempts have been made in Brazil to experiment with new ways of bringing financing for efficiency improvements to the WS&S sector. Third party financing based on EPCs is an unfamiliar concept in most environments and ESCOs may encounter problems finding customers and financing sources. Nevertheless, energy performance contracting between WS&S utilities and ESCOs, such as the SABESP experience, offers some promises. Still, third party financing through ESCOs will work only if ESCOs can access financing, either from the local banking industry or from dedicated funds. Other challenges in ESCO projects are clients' unfamiliarity with the concept of energy performance contracting and public sector procurement and budgeting rules. Experiences in many ESCO programs worldwide have shown that especially public sector clients need support of impartial experts, at least in the beginning, to understand and negotiate the complex issues in EPCs (see BREES, Part 2, Meyer/Johnson 2008).

83. However, the case studies also show that the availability of good investments is no guarantee that they will be implemented, and that a concerted effort is needed to raise management awareness, identify and obtain financing, train staff, and provide a convenient and reliable delivery mechanism (such as through an ESCO).

B. *Recommendations for Scaling-up Energy Efficiency Investments in Brazil*

84. Similar to the situation in many emerging economies, WS&S utilities in Brazil have implemented only a very small portion of the overall potential investments. Many utilities are looking for solutions to evaluate and fund the implementation of energy efficiency projects, but need support due to the lack of information, limited implementation experience, borrowing capacity and funding sources, and convenient and trusted modalities for carrying out the investments.

85. Subsidies could more often be used productively to address the problems associated with accessing the funding sources. They could help WS&S utilities identify

investment opportunities, install sub-metering, and train staff. They could support the design and piloting of financing schemes that allow public utilities to borrow for cost-reduction measures or take advantage of third party financing, including helping to resolve the barriers to utility borrowing. A convenient mechanism could include commercial banks as direct partners in the EPC contracts, which would mitigate the risk of non-payment by the water utilities whose receivables typically constitute collateral in the EPC. Such a mechanism has been tried successfully in energy efficiency projects in the power sector, for example in Sri Lanka and India (see Taylor et al 2008).

86. International funds for climate change mitigation could be another potential source of financing for the WS&S sector. To date, there have not been any CDM projects undertaken in the sector in Brazil and international experience is also limited. The main potential for generation of carbon credits lies in the WWTP (Waste Water Treatment Plants) with anaerobic digestion reactors installed. Methane (CH4) generated in the process is highly damaging to the ozone layer (around 21 times more than CO2) and can be burnt and used for several applications, like sludge drying (thus reducing the volume of sludge transferred to the landfill site, less fuel by trucks, and so on) and power generation.

87. A national program for energy efficiency in the WS&S sector (and public sector more generally) could be an effective way of increasing investments in the sector. Such a program might include information dissemination on available programs and positive experiences, demonstration projects for typical and high-yield investments, and incentives for promoting EE investments by public and private investors, involving private ESCOs and attracting funds from a number of existing government programs, including the EEP, PROCEL SANEAR and the RGR resources, and WS&S funds from CAIXA and BNDES.

88. If the barriers to energy efficiency investment could be removed, the WS&S sector could move from the implementation of demonstration projects to a scale-up of investments in the sector. Based on global experience and conditions in Brazil, a reasonable target for Brazilian water utilities would be to reduce energy consumption by 25 percent and NRW by half through an intensive nationwide program over a decade. Electricity savings from reducing NRW by half would total 1.5 billion kWh/year, while savings from improving energy efficiency by 25 percent would be 1.8 billion kWh/year, for a total of 3.3 billion kWh/year, equivalent to 34 percent of total electricity used by the water sector, or about one percent of total electricity consumption in Brazil in 2006. This amount of electricity was valued at R$792 billion in 2006, or 44 percent of total annual electricity expenditures by the sector.[19] Water and energy conservation programs in

[19] These estimates are based on figures from Table 4, which in turn are taken from SNIS 2006. Although only illustrative, they demonstration the electricity and financial savings of reducing NRW and improving energy efficiency.

Brazil have identified the types of interventions that would be most cost effective, while the case studies have elaborated some of the implementation and financing mechanisms for moving towards these goals. Overcoming the barriers will require a combination of supportive government policies and regulations, improved access to financing, and the involvement of various actors involved in the implementation of projects, including the private sector and commercial banks. The challenge lies in finding delivery mechanisms that are adaptable to the varying conditions in different parts of Brazil and in utilities with a variety of technological, financial, and organization conditions.

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