SANASA – Campinas, Sao Paulo State, Brazil

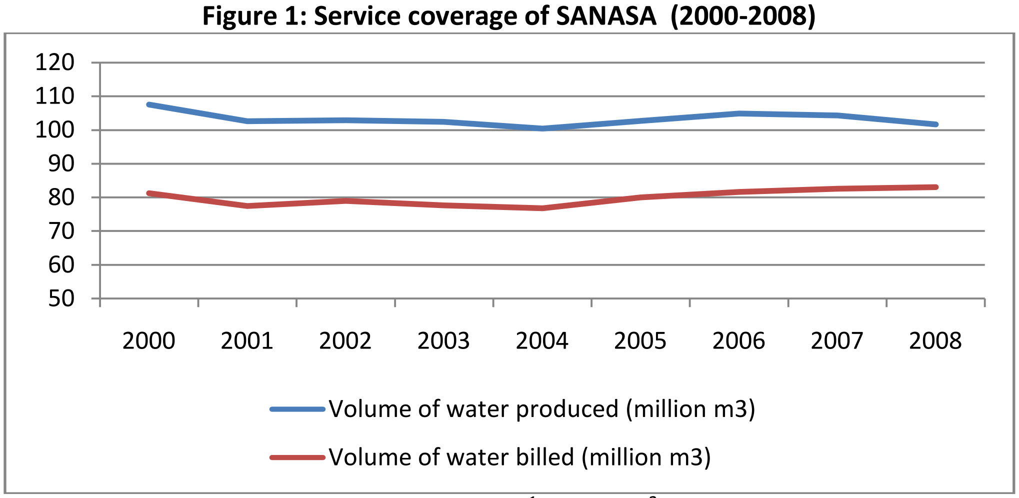
Utility Background

SANASA (*Sociedade de Abastecimento de Água e Saneamento S.A.)* provides water and sewage collection and treatment services for the municipality of Campinas. The utility is wholly owned by the municipal government. As such it is subject to public sector legislation regarding the procurement and budgeting of goods and services, as well as to the borrowing limits of the municipal government. The formal contract of concession with the municipality, which is required by recent legislation, is under preparation. Currently, the utility has no formal performance indicators to fulfill.

Campinas is the center of a relatively prosperous and fast growing metropolitan region in the State of São Paulo. Its population grew from 970,000 in 2000 to 1,060,000 in 2008. The surface area of the municipality is about 790 km^2. The topography of the service area is gently undulating. In 2000 there were 205,000 connections providing treated water. At the end of 2008 there were 252,000 connections. All connections are metered. Approximately 98 percent of the urban population in 2008 is served with treated water. Raw water is provided from two surface water sources. About 95 percent of the treated water is produced at the Atibaia plant and the remaining 5 percent at the Capivari plant.

The number of connections has increased much faster than population growth during this period: 22% versus 9%. This is mainly due to the increased connection to the urban poor in the *favelas*. The length of the water supply network grew by almost 16 percent between 2000 and 2008. In the meantime total water production has been reduced modestly (Figure 1).

Figure 1: Service coverage of SANASA (2000-2008)

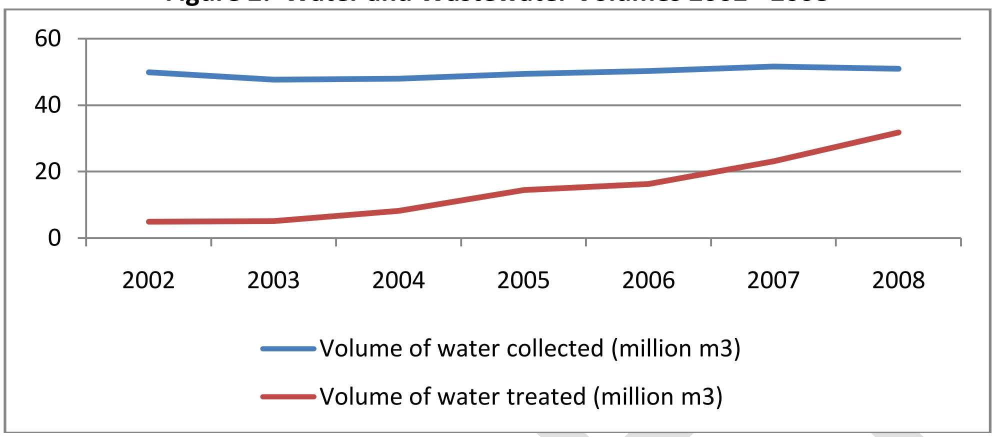


Source: IBNET[1] and SNIS[2]

[1] International Benchmarking Network for Water and Sanitation Utilities (IBNET)
[2] Sistema Nacional de Informações sobre Saneamento (SNIS) – National Information System on Water, Sanitation and Solid Waste

The expansion of the collection and treatment of wastewater has lagged far behind the supply of treated water as SANASA only started to treat wastewater in 2001/02 (although wastewater collection started earlier). In 2008 only 60 percent of the billed water consumption was collected. About 60 percent of the collected wastewater was actually treated but had been increasing fast (Figure 2).

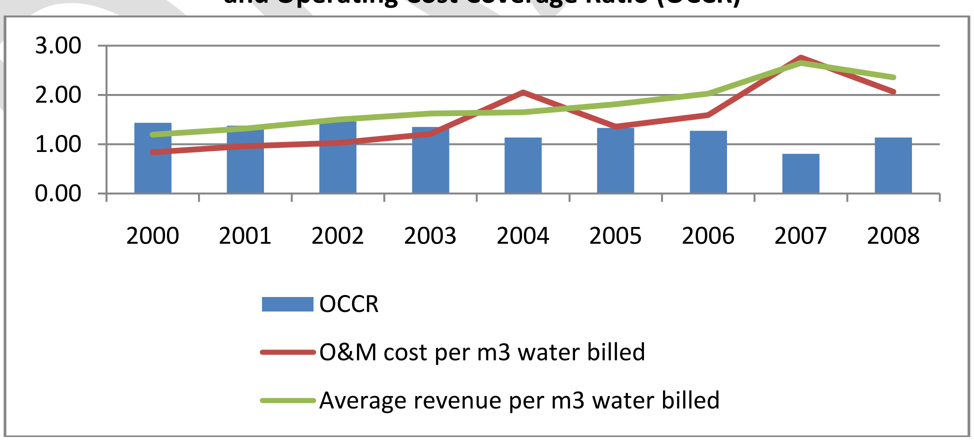
Figure 2: Water and Wastewater Volumes 2002 - 2008



Source: IBNET and SNIS

The utility's revenue covers at least its operation and maintenance (O&M) costs, and is likely to generate sufficient funds for depreciation (replacement investment), but is unlikely to be sufficient to pay for expansion investments (Figure 3). Water tariffs have been going up steadily, from R$1.19 in 2000 to R$2.35 in 2008.[3] In real terms, though, the increases have been about 0.3 percent annually between 2000 and 2008.

Figure 3: Average water and wastewater tariffs, average O&M costs (in R$ per m3) and Operating Cost Coverage Ratio (OCCR)[4]



Source: IBNET and SNIS

[3] Average exchange rate in December 2008 was R$1 = US$0.417.

[4] OCCR measures how far operating revenues cover O&M costs. The rule of thumb is that if the OCCP is below 1, the utility would not be able to cover its O&M costs with its revenues. If the OCCR is between 1 and 2, the revenue would be able to cover O&M, partial to full depreciation, and even capital costs as the margin increases. In reality much depends on the actual capital costs and the types of depreciation for instance.

Compared with similar-sized water utilities in the State of Sao Paulo, SANASA stands out in significantly lower NRW and much higher energy intensity in terms of water produced and waste water collected (Table 1).

Table 1: SANASA Profile in Numbers, 2008

Indicators (as of 2008)	Unit	SANASA	*Others**
Households with direct water connection	%	98%	99%
Households with sewer connection	%	88%	96%
Total annual water production per capita	Liters/capita/day	270.37	287.27
Total annual water consumption per capita	Liters/capita/day	220.74	185.60
Percentage of total connections metered	%	63%	73%
Non-Revenue Water	%	21%	39%
Total annual wastewater collected	million m3/year	50.85	37.77
Wastewater receiving primary treatment	%	63%	70%
Average water tariff	R$/m3	1.95	1.48
Average wastewater tariff	R$/m3	2.97	1.52
Operating cost coverage ratio		1.13	1.16
Electricity use per m3 water (production volume)	kWh/m3	0.75	0.36
Electricity use per m3 wastewater (collection volume)	kWh/m3	0.29	NA
Share of electricity costs in total O&M costs	%	6%	7%

Source: IBNET
**Median values calculated across utilities of similar size operating in the State of Sao Paulo*

Energy Consumption

SANASA purchases all of its electricity from the local electric utility, CPFL. SANASA has more than 200 points of consumption which are billed separately. Of these consumption points about 80 percent of the consumption is for water supply, 17 percent for wastewater and 3 percent for administrative facilities. In terms of electricity tariff categories, 80 percent of accounts are for low-voltage connections, and about 20 percent are medium voltage (A4: 2.3 to 25 kV). The cost per kWh of electricity purchased at a low voltage is considerably higher than for electricity purchased under either of the medium voltage options (see Table 3).

Electricity has been a moderately significant part of annual operating costs, mostly falling between 5 to 9 percent (Table 2). Energy consumption for wastewater collection and treatment is still less than 30 percent of that for the supply of treated water, due to the relatively small coverage and the much lower energy intensity of waste water collection and treatment. Table 2 shows an increase in the average electricity cost since 2003.

Table 2: Energy use and costs of SANASA 2000-2008

Year	Share of electricity cost in total O&M Costs	Total electricity costs in R$	Total annual electricity consumption for water supply (MWh)	Total annual electricity consumption for sanitation (MWh)	Average electricity cost R$/kWh
2000	6.37%	6,952,536	NA	NA	NA
2001	6.32%	7,519,222	NA	NA	NA
2002	7.40%	9,578,490	NA	NA	NA
2003	7.46%	11,274,995	60,016	4,690	0.174
2004	5.30%	13,139,028	60,144	4,560	0.203
2005	9.15%	15,990,005	56,852	9,681	0.240
2006	8.67%	18,194,638	60,975	11,637	0.251
2007	5.26%	19,428,760	63,209	12,828	0.256
2008	6.21%	17,144,124	59,890	14,935	0.229

Source: IBNET and SNIS

SANASA faces very high peak hour charges – about 10 times higher than off-peak charges (Table 3) – in its operating units with middle voltage accounts (20 percent of total consumption).

Table 3: Evolution of medium voltage tariff levels at CPFL *

Year	Nominal Prices R$/MWh consumed			Constant Prices 2001 R$/MWh consumed			GDP deflator
	Average Price	Peak	Off Peak	Average Price	Peak	Off Peak	
2001	139.90	802.37	78.00	139.90	802.37	78.00	1.00
2002	139.90	802.37	78.00	126.55	725.80	70.56	1.11
2003	190.37	1065.16	108.62	151.41	847.19	86.39	1.26
2004	190.37	1065.16	108.62	140.16	784.22	79.97	1.36
2005	190.37	1065.16	108.62	130.73	731.48	74.59	1.46
2006	282.53	1336.73	184.01	182.78	864.79	119.04	1.55
2007	282.53	1336.73	184.01	176.21	833.69	114.76	1.60
2008	282.53	1336.73	184.01	166.44	787.47	108.40	1.70
2009	288.52	1235.70	200.01				

Source: Based on Resolutions of ANEEL defined tariffs[5]

* Price paid by a hypothetical medium voltage [A4: 2.3-25 kV] consumer with the same demand contracted peak and off-peak and with a 45% capacity factor

Energy intensity in water production has remained more or less constant over time although energy intensity measured in water actually billed has seen a decline. Energy intensity in sanitation (collection and treatment) has been increasing reflecting continued increase in the share which is treated (Figure 4).

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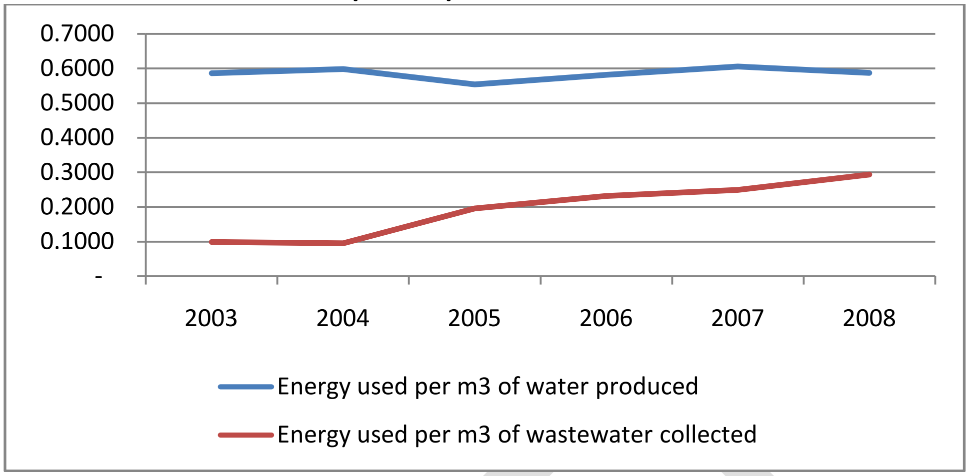
[5] ANEEL – Agência Nacional de Energia ElétricaL – is the National Electricity Regulatory Agency of Brazil.

Figure 4: Energy intensity of water supply and waste water treatment in kWh per m3 produced or collected



Source: IBNET and SNIS

Implementation of energy efficiency and non-revenue water initiatives

In 1994 SANASA received a loan from the World Bank, which involved resources for reducing non-revenue water (NWR), which was then at around 38 percent, compared with the national average of 40 percent. As part of the World Bank project, the utility introduced a system of automatic data collection and control. However this early system was vulnerable to lightening and went down. By 1999 a more robust system was in place and information began to be more systematically collected. At about this time SANASA began to prepare for an ISO 9001 and subsequently for an ISO 14001 which were granted in 2004.

In June 2001, electricity rationing was rather suddenly declared in Brazil and maintained until February, 2002. The operations of a basic service such as water supply were not subject to rationing. But administrative functions had to reduce their electricity use by 30 percent. In addition, the population was alerted to reduce water use in order to reduce the "embodied" energy. The emergency-response nature of the energy conservation efforts and the subsequent glut of energy after the rationing dampened the long-term effect on energy efficiency. Nonetheless, the experience of rationing heightened awareness of the importance of energy and efficiency improvement measures began to be implemented. Examples of these measures are:

(i) *the Jambeiro storage tank and distribution centers (startup in March and April of 2002):* Use of the system's pressure to direct supply of the elevated storage tanks. The total savings of the two sub-projects were 334 MWh/year.

(ii) *Leste and Barreiro supply sectors (start up in July 2003):* Automation and use of variable frequency drives in pumps in order to control pressure to the minimum needed by the system. The results included a reduction of water losses, a reduction of energy use by 360 MWh/year (from 0.176 to 0.121 kWh/m^3) and a reduction in demand from 270 kW to 220 kW.

Operational data collection was initiated in 2000. But it was only in 2006 that the full software was implemented for on-line automation and control. The supervisory control and data acquisition (SCADA) system now in operation informs water data (flow, pressure, etc.). These data are recorded continuously. Energy data is only available from two sources: (i) electric utility meters on a monthly basis according to the invoice received and (ii) portable meters, which are used in specific situations without a regular schedule.

One thus sees a gradual progress towards a "monitoring and targeting (M&T)" approach – first focused on water loss reduction then progressively towards energy rationalization, though this M&T effort is still incipient and is not explicitly recognized as being M&T, and in particular, Energy M&T. The approximately 200 billing points which are metered by the electric utility are systematically monitored, though until April 2010 there was no separate metering and logging of electricity use by SANASA using its own equipment (except portable meters for spot checks). In its energy management activities, emphasis was, at least until recently, put on reducing energy costs (by reducing the use of peak electricity and other billing penalties) rather than on energy consumption reduction measures.

NRW reduction has long been a priority program in its own right and has, as a by-product, brought the largest energy savings for SANASA. Distinct programs to improve energy efficiency performance were also started, gradually building upon the monitoring and control systems used for water loss management operations. Since 2007, the main actions affecting energy efficiency have been:

- Measures to reduce water losses were intensified, resulting in a significant decrease over the next three years until now (from 25.8% in 2006 to 20.8% in 2009) after a 6 year period of little change. As already observed, the biggest energy savings have been a by-product of this.
- A significant investment in energy efficiency was made at the Capivari water catchment and treatment plant (Box 1). The investment of R$ 1.8 million was made with resources provided by the local power utility CPFL under the EEP program mandated by ANEEL - the power sector regulator.[6]
- Small investments in capacitors to increase the power factor (i.e., reduce reactive energy) were made in 18 facilities during 2007. This was to avoid fines which were being incurred for a power factor below 0.92.
- Operational changes using automation and control to shift pumping off peak with subsequent renegotiation of contracts with the electric power utility, two in 2007 and at least two in 2008.
- Renegotiation of contracts with the power utility to shift from the "Blue" tariff schedule to the "Green" tariff schedule in 17 facilities in 2007, followed by Capivari in 2008.[7]
- Starting in May 2010, the Maintenance Department will invest R$ 600,000 to replace standard motors with high efficiency motors, as well as R$ 90,000 for electricity meters for energy management. The investment in meters represents an important deepening of energy monitoring capability

[6] The mandatory energy efficiency program (EEP) for power distribution utilities overseen by the power sector regulator ANEEL. Under the EEP electric distribution utilities must spend 0.5% of their gross revenue on energy efficiency projects with consumers. A few have been performed with water utilities, including this one at SANASA.

[7] There are two variants of the medium voltage A4 tariff: the Blue tariff and the Green tariff. In both of these tariff schedules peak power is far more expensive than off-peak power. If a consumer can get its load factor low enough it has an incentive to shift to the Green tariff which, unlike the Blue tariff, does not apply specific demand charge for the peak usage.

Box 1 The Capivari Water Treatment Plant Energy Efficiency Project

In October 2007 SANASA commissioned an investment of R$ 1.8 million in the Capivari Water Treatment Plant. This involved the installation of variable frequency drives in three 100 HP pumps for raw water and three 400 HP pumps for treated water which reduced energy consumption by 33% and contracted demand by 19%. It had the immediate effect of reducing energy consumption by 33 percent as shown in the table below. This meant a reduction of cost of R$ 27,570 per month. Then in June 2008, the electricity contract of the plant was renegotiated. The contracted demand was reduced from 825 kW to 670 kW and there was a shift from the Blue to Green Tariff. This renegotiation led to a further R$ 19,200 per month of savings.

kWh savings of Capivari Water Treatment Plant Project

		Monthly average in each period				
		Total R$	kWh-P	kWh-OP	kWh Total	% kWh on P
Before project	Oct 2006-Set 2007	107,555	44,844	308,855	353,699	12.7%
Before new contract	Oct 2007-May 2008	79,985	23,069	214,613	237,682	9.7%
After new contract	Jun 2008-May 2009	60,784	21,162	215,751	236,913	8.9%

According to SANASA, the total energy savings of this project amount to 1.4 GWh, whereas the financial gains were at least R$560,000, indicating a simple payback period of less than 4 years.

Source: SANASA

The actions directly related to energy efficiency are further described in the section below on results. By far the largest energy cost savings have been from reducing water losses and renegotiating contracts – especially shifting from the Blue to the Green tariff. In the view of SANASA, the potential for further cost savings from shifting contracts to the Green schedule has now been exhausted.

Motivations for undertaking activities associated energy optimizations and NRW reduction

Increasing cost of electricity has been the key motivation for undertaking the activities associated energy optimization. Electricity prices increased significantly up to 2006. Since then, the nominal electricity prices have only increased by about 2 percent as shown in Table 2. The utility values activities which has a large impact on its financial performances and service quality vis-à-vis tariff levels and is concerned about its public image (Table 4). As water tariffs have doubled since 2000, there is more pressure on the utility to reduce costs (either through NRW reductions or energy efficiency) so as to keep the tariff increases limited.

Table 4: Key drivers for implementing M&T and associated measures

Possible drivers ranked on a scale from 1 to 5 (5 most important)

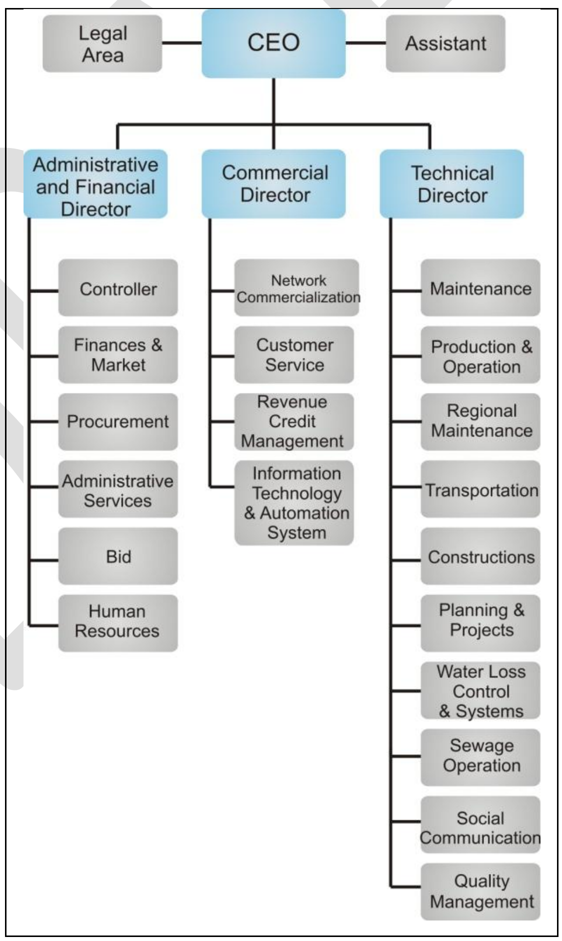
Possible Driver	Importance Then (2003)	Importance now
1. High cost of energy as a share of operational costs	2	4
2. Increasing energy costs (electricity tariff increasing faster than inflation)	4	3
3. Reducing technical water losses reduces energy use	1	5
4. Reduced operational impact allows lower water tariff and lower non-payment	2	2
5. Reduced operational costs allow increase of investment to expand services	1	5
6. Reduced operational costs improve the utility's financial performance	1	5
7. Environmental concern, as it projects a positive image of the utility to its clients	1	5

The regulatory environment ensures that the utility can retain the benefits from any reduction in the operational costs. This provides the utility with an incentive to undertake energy and other operation efficiency programs as the gains translate into increased resources for replacement or expansion investment or into an improved financial performance of the utility.

Organization for energy management

SANASA does not have a formally constituted energy efficiency group *per se*. Energy issues are addressed on a day-to-day basis by different departments of the company, such as management of water losses, management of information and automation and management of maintenance (see Figure 5). A Task Force brings together these departments, especially during the implementation of specific projects. Monitoring of monthly energy use is centered in the maintenance department. The purchase of new and more energy efficient equipment to replace older equipment is usually placed under the budget of the maintenance department. There is a department that specifically focuses on reducing NRW.

Figure 5 Organization Diagram of SANASA



Top management receives a monthly operational report. However, the data are basically about water losses. These reports can influence decisions or even modify plans already laid out. In one water loss project only the branch lines were substituted after such a report with an analysis.

Most work related to NRW and energy efficiency is done in-house, though some is outsourced. Since SANASA is a public company, it is subject to public procurement rules (Law 8666). This makes obtaining the best value for goods and services difficult. Life cycle costing is not feasible in public bids. The government accounting watch dogs regard almost any minimum technical standard as an unwarranted restraint on competition. It has proven easiest to achieve energy savings in large operational units. The greatest difficulties have been with the reservoirs, due to the constraints of water management needs on shifting peak loads.

Financing for energy efficiency improvement and NRW reduction

Both energy efficiency and water loss reduction projects are financed by a combination of internal cash flow and external resources (loans and grants):

- The Capivari project was financed by CPFL (the local electric utility) under the mandatory public benefit wire charge overseen by ANEEL
- Water meters were financed by Banco Nacional de Desenvolvimento Economico e Social (BNDES) and with own in-house cash flow
- Some pipeline replacement was financed by the Inter-America Development Bank
- Other measures have been financed by Caixa Econômica Federal and BNDES (traditional public sector banks) while a NRW loss program was funded earlier under a World Bank loan[8].

Although there is no formal threshold for project viability, the projects to date were reported to have had a simple payback of 1 to 4 years.

The utility has limited capacity to borrow as it only manages to cover its operating costs and part of its depreciation costs. In 2009 R$ 17.5 million (plus R$ 4 million of grants and subsidies) were invested to reduce water losses and in energy efficiency measures. Investments in water loss reduction have been far greater than in energy efficiency. Information regarding the share of investment from internal cash flow and other external sources is not available. In general, the primary source of credit is Caixa Econômica Federal.

Impacts of NRW and energy efficiency activities on energy consumption

One approach to evaluate the impact of NRW and energy efficiency activities on energy consumption (i.e., avoided energy consumption derived from a baseline which did not materialize because of the implementation of the activities) is to analyze their impact on the energy intensity coefficients of the utility for water supply and wastewater treatment. A first rapid analysis is to determine what happened since 2003, the first year on which energy

[8] SANASA also manages three Brazilian Government's Growth Acceleration Plan (called PAC) projects, but these are for expansion of the system – especially to expand wastewater treatment.

consumption data are available, making a before and after analysis assuming that the trends of 2003 would have continued.

Table 5 shows the impact of energy efficiency measures over the period 2003 to 2008 (as for earlier years no data is available about the actual energy consumption). Total nominal energy costs increased by 52 percent over this period (as is shown in Table 5).

Table 5: Estimation of Energy Efficiency Impacts
expressed in percentage increase between 2003 and 2008

Energy Efficiency Impacts		
Total Nominal Energy Cost Increase		52
• Price Effect		31
○ Effect of Nominal Price Increases	48	
○ Effect of Change in Electricity Tariff Structure	-12	
• Volume Effect		
○ Net Production volume increase		16
○ Gross Production volume increase	24	
○ Decline in NRW	-4	
○ Energy Intensity Improvements	-3	

<u>Price Effects</u>. A large part of the increase in energy costs was the result of price effects. A nominal electricity price increase was effectuated in 2006 of 48 percent (assuming that this price increase was similar along all different electricity tariffs as we only were able to collect data on medium voltage tariffs), this means that the as the overall energy prices increased by 48 percent, the remainder of the effect was caused by a change in the electricity tariff structure. Apart from the change in the nominal tariffs, changes in the structure of the electricity rates dampened the increase in overall energy costs.

The energy rationalization measures undertaken from 2006 onward sought to maximize economic gains, and were mainly focused on changes in the reduction of energy costs. They included

- Simple low cost measures to increase the power factor (decrease reactive power to the grid) in some of their plants;
- A small set of savings was made by reducing contracted demand;
- More significant savings were achieved by switching from the Blue to the Green tariff schedule.

As can be seen in Table 6, electricity cost increased less than the nominal rates would apply only since 2006, saving the utility about RS$ 1 million per year since 2006. Yet, before SANASA's actual energy costs increased much faster than nominal rates would imply, generating energy cost losses larger than the savings generated since 2006. As electricity rates increased in 2006, energy prices seem to have a significant positive impact on utility's behavior towards efficiency programs.

Table 6: Estimation of Energy Efficiency Impacts

Year	Actual Energy Costs	Energy Cost without changes in tariff structure	Actual Energy Cost Savings (plus= cost savings)
2003	11,274,995	11,274,995	0
2004	13,139,028	11,274,647	-1,864,381
2005	15,990,005	11,593,349	-4,396,656
2006	18,194,638	18,777,867	583,229
2007	19,428,760	19,663,591	234,831
2008	17,144,124	19,350,161	2,206,037
Total Additional Costs	95,171,550	91,934,610	3,236,940
Annual Additional Costs			647,387.95

Source: IBNET and SNIS

Volume or Consumption Effect. At the same time, a volume or consumption effect can be estimated. Apart from changes in the energy prices, changes in energy consumption or volumes can also be observed. These volumes are affected by two factors: water production (and wastewater collection and treatment) and energy intensity (energy use per cubic meter of water produced (and wastewater collected and treated).

Because of decreases in NRW, less water needs to be produced. The NRW effect resulted in a decline of energy use of 4 percent[9] from 2003 to 2008. It should be noted that this is a hypothetical benefit in the sense that it is assumed what would have happened in the case the trends of 2003 would have continued. It is possible that in the case of SANASA, which is still expanding its water supply and wastewater services, any decline in NRW would have allowed SANASA to expand water supply without increasing water production, with overall energy consumption remaining unchanged.

The other effect is the decline in (actual) energy intensity as measured by energy consumption per cubic meter of water produced or wastewater treated. Energy intensity declined by 3 percent over the period between 2003 and 2008.

Obviously, this consumption effect can be translated in energy consumption saved. As can be seen in Table 7, the overall consumption savings have been large. They amount to annual savings of about 2 GWh. Assuming the current nominal energy tariffs, these savings translate to average annual savings of about R$ 400,000 – reducing the share of energy cost from 7.5 percent of O&M costs in 2003 to 6.4 percent in 2008. In the case of SANASA, the actual benefit could be even larger when one assumes that the water saved through the NRW loss reduction can be

[9] This decrease looks relatively limited, but that is because the decrease in NRW has been accompanied by a sharp increase in wastewater collection and treatment – which have added to the total energy consumption. In 2000, SANASA had a NRW index of 26.5 percent which declined to 24.1percent in 2003 and decreased to 18.4 percent in 2008. At the same time, wastewater treatment increased six folds.

actually sold to consumers. In this case, the benefits from NRW reductions can be valued against the average tariff that SANASA can charge to its customers. Here, though, only the energy cost savings are accounted for (Table 7).

Table 7: Energy Savings in MWh and in cost savings (in R$)

Year	Energy Savings in MWh			Energy Cost Savings		
	Decline in NRW	Decline in Energy Intensity	Total	Decline in NRW	Decline in Energy Intensity	Total
2003	0	0	0	0	0	0
2004	-2,951	460	-2,491	-599,227	93,414	-505,814
2005	-950	2,462	1,512	-228,280	591,637	363,357
2006	3,003	-1,222	1,781	752,382	-306,108	446,274
2007	4,235	-1,492	2,743	1,082,107	-381,195	700,912
2008	2,593	1,956	4,549	594,040	448,192	1,042,232
Total Savings	5,929	2,164	8,094	1,601,021	445,939	2,046,961
Annual Savings	1,186	433	1,619	320,204	89,188	409,392

Source: IBNET and SNIS

Conclusions and lessons learned

SANASA has been able to expand water services to more people while managing to keep water production level unchanged, thanks to efforts in NRW reduction. That is a real achievement in energy efficiency in delivering water services. But if judged solely by the changes in energy intensities of water production and waste water (collection and treatment), it is difficult to discern whether SANASA has made progress in operational energy efficiency. The energy intensity of water production has more or less remained flat from 2003 to 2008 while that of the waste water has increased significantly because of increased treatment.

The analysis of the utility data indicates that NRW efforts by SANASA constitute the predominant source of energy savings so far, amount to annual savings of about 2 GWh per year (equivalent of R$400,000 per year) from 2003 to 2008. In comparison, the energy savings resulted from reduction in actual energy intensity for water produced are less than 1 GWh over the entire period. This, to some extent, reflects the limited efforts by SANASA to invest in improving operating efficiency of pumps and other electric and mechanical equipment. The opportunities do exist as indicated by the Capaviri water treatment plant.

In responding to the electricity rate schedule, especially the big disparity between peak and off-peak rates of mid voltage connections, much of the effort in energy management so far has been geared toward measures which can bring immediate cost reduction – principally through reducing the cost of consumption during peak rate periods. Such financial sensitivity and prudence are good for any energy efficiency program and has the benefit of making the utility monitor and analyze its electricity bills more closely and improve metering. This also underscores the importance of utilities having transparent and full financial accountabilities in their operational management. Substantive energy efficiency investment could follow if opportunities are identified and often require substantially more efforts and higher costs than basic house-keeping activities.

SANASA does not yet have a specific corporate energy management program (thus neither a strategy nor a team/committee with a clear mandate for energy efficiency) to seek out energy efficiency opportunities. The utility management does view energy management as a part of the operational control at least from the cost minimization point view. As NRW reduction potential decreases and associated cost increases, energy efficiency improvements may become a more attractive proposition. Unfamiliarity with and inadequate information of energy efficiency opportunities and cost-effectiveness may also have been a reason for the observed flat trend in energy intensity for produced water. To that end, initiation of an Energy Monitoring and Targeting program, generally relatively low cost, would help the utility systematically identify energy cost reduction opportunities in a systematic manner.

SANASA's experiences in reducing NRW and energy cost offer both good practices and lessons for promoting energy efficiency in water and sanitation utilities. The following takeaways are noted:

1. NRW and energy efficiency of water service delivery is so intimately related that NRW reduction is likely the most important and highly cost-effective energy efficiency strategy of any WSU with significant NRW problems (for example, with a NRW ratio higher than 30%). Clearly recognizing this linkage and better integrate the synergistic aspects of both could help WSUs better package and sequence their operational efficiency improvements.

2. It is thus important that the WSU has a management that support such a comprehensive approach to improving operational efficiency, as well as an organizational structure that ensure relevant data and information are collected, analyzed and passed through the management hierarchy and actions taken when decisions are made.

3. Having a group of people in the company with clearly assigned responsibility for energy management (such as an energy efficiency committee that meets regularly) may be necessary. In the early stages, the minimum a WSU should do is to assign energy management responsibilities to key operational management personnel, such as the key members of the maintenance and production teams. This is the case of SANASA. To make active energy management an operational management routine, an energy manager may be required for a large utility like SANASA.

4. Energy price increases can provide an important incentive to embark on an energy (cost) management program, as is the case for SANASA. In environments with low electricity costs, energy efficiency programs may therefore be less likely to take off and be sustained than in environments were energy is a costly resource. Yet, when energy price increases become more manageable this incentive shows its limits, especially for encouraging energy efficiency investments which have relatively long payback period

(for example, longer than 5 years) but still financially attractive if longer term finance can be obtained.

5. Wastewater collection and treatment are increasingly important and becoming a larger part of the business. This changes the energy structure of a utility and increases the overall energy consumption and cost of the utility, raising the importance of improving energy management.

6. With political pressure on level of water and wastewater tariff, utilities need to reduce the cost of operations so as to keep the increment of tariff in check, and hence efficiency improvements become an important, if not critical, option.

This case study was prepared by Alan D. Pool, Caroline Van Den Berg, and Feng Liu, with contributions from Elvira Morella and Pedro Paulo da Silva Filho.