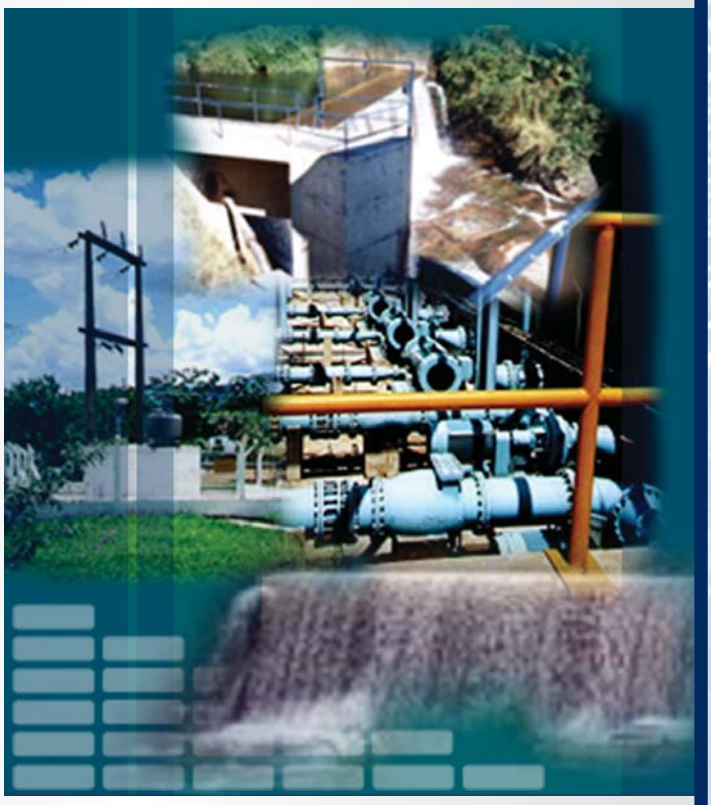

reducing energy costs in municipal water supply operations

"learning-while-doing" energy m&t on the brazilian frontlines

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A crisis looms in the urban water supply of the world's developing countries. Local governments cannot keep pace with the growing demand for water brought on by ever-increasing urban and peri-urban populations. Possessing inadequate public finances, municipal governments are turning increasingly to private utilities to supply potable water. These private utilities cannot make water policy or control user fees and so cannot increase charges to raise the necessary revenues. What they can do is reduce the cost of water treatment and delivery to bring it in line with available revenues (*"closing the revenue gap"*).

In Brazil, urban inhabitants reside in over 5,500 municipalities, the majority of which are small and medium sized. Most suffer the usual problems of huge water losses and excessive energy expenditures. Currently, 30 to 40 percent of the energy used in municipal water supply operations internationally is wasted due to poorly managed pumping and filtration systems. In Brazil, the majority of state-owned water supply utilities are no longer capable of securing adequate funds from the Federal and State governments to cover capital expenditures and maintain commercially viable water supply services. As a result, municipalities increasingly are taking over responsibility for water supply. In turn, municipalities are promoting greater participation by the private sector to take advantage of its expertise and financial resources.

A Brazilian association of private water supply utilities (ABCON) has been organized to encourage small and medium-sized municipalities to engage in public-private partnerships. ABCON members have formed public-private partnerships with some 50 small and medium-sized municipalities, ranging from 5-year operator permits and 30-year public service concessions to joint ventures. These private utilities have a strong incentive to hold operating

Sidebar 1.

Barriers to Reducing Energy Costs of Municipal Water Supply Operations

1. Lack of managerial know-how as far as pursuing opportunities to improve system efficiency and build operational synergy between water and energy acquisition systems.
2. Lack of metering, which allows collection and comparison of data on electricity consumption, and water treatment and delivery, on a day-to-day or week-by-week basis.
3. Lack of financing for investments in improved efficiency, because senior management lacks the technical data to make a strong case to banks.

costs below what local consumers are able to pay, but they acknowledge their failure to rein in electricity expenditures.

Perhaps the greatest barrier to reducing energy waste has been the assumption by municipal governments and private utilities that energy (primarily electricity for pumping) is a fixed overhead cost of water treatment and delivery, not a controllable cost. The lack of communication between company engineers, accountants, and supervisors overseeing field operations has contributed to this misconception. This mindset has kept company managers oblivious to energy savings possibilities. In fact, energy is a variable cost in water supply operations. For example, private utilities can take advantage of off-peak rates by cutting back on pumping operations at times of peak demand for power.

Energy Monitoring and Target Setting

A proven management tool for curbing energy costs is energy monitoring and target setting, or Energy M&T, pioneered, field tested, and institutionalized at more than 1,000 industrial and commercial sites in the United Kingdom during the 1980s. The fundamental objective of Energy M&T is to put management firmly in control of energy use and to motivate managers to ensure that energy resources are used to maximum economic advantage.

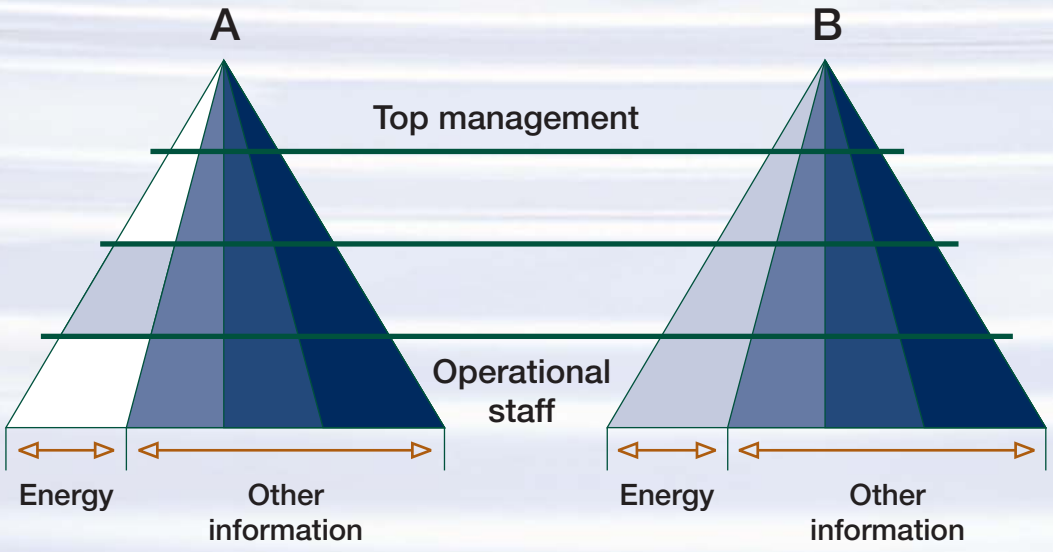
Energy M&T enables commercial enterprises, especially those that have a large number of sites (such as water utilities) to manage energy use as a controllable resource. A site is divided into Energy Accountability Centers (EACs). An EAC may be a department, a process, or a cost accounting unit where the energy consumed is monitored on a regular basis..

By analyzing past performance, a standard energy consumption level is set for each EAC. This relates 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.

Sidebar 2.

Energy M&T Requires Strategic Information Sharing

- **Energy M&T implementation requires commitment at all levels of management, from senior management setting broad policy objectives down to area supervisors who become accountable for the energy use under their control.**
- **Too often energy information stays with mid-level management, making it difficult for senior management to question performance (to determine the reason for differences in the actual and target performances).**
- **Data is collected for Cost Accounting, not Cost Reduction. Cost Reduction requires regular monitoring of important factors ("variables"), such as volume of treated water, particulate content of raw water, or pumping hours per unit of treated water, which affect energy consumption on the site.**
- **The figure below shows a situation ("A") where data on important variables is locked at middle-management level, in contrast to ("B") where there is full flow of information up to senior management and down to operators.**



Furthermore, targets are set for achievement of better-than-standard-performance. For example, achieving close control of water flow avoids a pressure build-up in distribution lines from supply exceeding demand, which, 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.

The potential benefits of Energy M&T include:

- Better control of energy use, increased awareness of the energy costs of operations, and a greater commitment to reducing the energy costs of service delivery.
- More timely and accurate acquisition of energy cost information for making commercial decisions and for forecasting future energy cash flow needs.
- More reliable procedures for measuring actual energy cost savings achieved and evaluating the return on energy-saving investments.

Sidebar 3.

How Energy M&T Came to Brazil

In the mid-1990s, collaboration began between the World Bank and UK-Department of Trade and Industry under the auspices of the World Bank's Energy Sector Management Assistance Program (ESMAP) to identify, isolate, and disseminate "critical success factors" of energy management companies that had adopted performance-based energy efficiency improvement services. See the ODA publication *Establishing Energy Efficiency in a Developing World—National Programmes for the Industrial and Commercial Sector* (April 1996).

As a follow-up, the European Union teamed up with ESMAP to promote transfer of the relevant know-how on performance-based energy management techniques to several prospective market economies in Latin America. Specifically, the THERMIE Program of the European Union and ESMAP Regional Energy Management Initiative for Latin America cofunded activities in Brazil, Colombia, and Peru, which led to the transfer of know-how about the UK "best practice" known as M&T (Monitoring and Target Setting). See *Energy Monitoring and Target Setting (M&T) in Latin America–Pioneering the Way Forward.*

NOVACON catalyzed ESMAP's collaboration with ABCON. Its managing director, Antonio Carlos Franco Zuccolo, recognized the potential merits of Energy M&T and asked ESMAP to transfer know-how to private utilities in ABCON, for whom he was the technical adviser.

"Learning-While-Doing" Energy M&T in Brazil

Energy M&T is one of several techniques and strategies the World Bank Group is promoting to deal with water supply problems highlighted in the *Report of the World Panel on Financing Water Infrastructure*. The World Bank's Energy Sector Management Assistance Program (ESMAP) has been sponsoring a learning-while-doing approach to transfer know-how and on-the-ground experience with Energy M&T to developing country clients, such as ABCON members in Brazil. In so doing, ESMAP hopes to replicate it elsewhere in Brazil and in other countries.

In January 2001, ABCON agreed to collaborate with ESMAP on an "Action Research" activity involving Energy M&T. Later that year, three ABCON members *the companies Águas do Brasil (ADB), Novo Conceito em Serviço Publico (NOVACON), and Empresa Montagens de Sul Americana (EMSA)*—signed on to determine if they could apply "best practices" in energy management to curb waste in the municipal water supply operations they control and thereby lower the costs enough to make their participation profitable. The fieldwork actually began in January 2002.

The stakes in Brazil could not be higher: testing a way to ward off the threatened collapse of Brazil's municipal water supply systems and to enable the public-private partnerships involved to survive. Some

Sidebar 4.

Developing Energy M&T Implementation Plans

Developing Energy M&T by water supply utilities involves these steps:

- **Establish a corporate strategy to "improve system efficiency by reducing energy costs of operation." This strategy should give prominence to energy use as one indicator of efficiency.**
- **Conduct—with expert assistance—an audit of operational sites to identify prospective Energy Accountability Centers (EACs).**
- **Review existing metering capabilities for water and energy and identify additional requirements.**
- **Define an appropriate energy management structure for the entire organization, from senior management setting broad policy objectives down to site supervisors, who become accountable for energy use under their control.**
- **Develop reporting procedures to ensure that energy information does not reside exclusively at middle-management level but routinely is available to senior management as well.**

Limited investments have to be made up front to put an Energy M&T system into operation, including expenditures to:

- **supply tools (metering, software for data analysis) critical for monitoring water and energy use;**
- **build in-house competence in establishing benchmarks for conservation and loss minimization activities;**
- **identify, evaluate, and justify investments needed for further improvement in energy efficiency.**

private utilities in Brazil have already opted out of public-private partnerships because of financial losses. Since municipalities cannot raise rates above what local consumers can afford to pay, Energy M&T implementation plans provide private utilities with a ”road map” to reduce their costs to the point they become profitable.

Because NOVACON supplies water to very small municipalities (populations under 10,000) that have relatively simple water supply systems, however, the Action Research concentrated on two public-private partnerships established by the two other ABCON members—Águas do Brasil’s water supply concession for Petrópolis in Rio de Janeiro State, and EMSA’s joint venture utility, which operates water supply systems for Palmas, Paraíso, and Porto Nacional in Tocantins State.

Petrópolis

Petrópolis is a growing city of 286,000 people. Although only 65 kilometers from Rio de Janeiro City, Petrópolis is spread over several hills rising as high as 809 meters (2,654 feet) and is largely surrounded by rain forest. Water supply and sewage treatment are provided by Águas do Imperador (ADI), a special purpose subsidiary of Águas do Brasil. ADI has a 30-year concession from Petrópolis and is regulated by a municipal department—Companhia de Águas e Esgotos do Municipio de Petrópolis.

Montevideo water treatment station

When ADI took over Petrópolis’ water supply operation in 1998, consumers got water sporadically and service was extremely unpredictable, even chaotic. Since then, ADI has regularized water delivery so that it runs 24 hours a day in many places and has made other major improvements. By July 2002, it had increased the number of connections by 47 percent, the number of citizens served by 50 percent—from 142,000 to 214,000—and the municipal area covered from 53 percent to 77 percent. Water flow had soared by

Sidebar 5.

Energy Management Team at Águas do Imperador

The corporate-level energy management team at Águas do Imperador consists of: Director; General Operations Manager; General Energy Manager, Águas de Brasil; Chief Operations Engineer; Head of Engineering Department; and Engineering Department.

about 80 percent and the volume of water treated had ballooned from 13 to 93 percent.

Comparable progress was made in sewage service. One-third more connections were installed, the number of people covered rose from 122,000 to 168,000, and the treatment rate grew tenfold. In the meantime, the payment delinquency rate fell sharply from 30 percent to 9.5 percent.

However, ADI ran into a wall in its efforts to deal with electricity expenditures, which were projected to be 1.2 million Reals (currently, R$3.50 is equivalent to US$1) in 2002, amounting to 20 percent of its costs. The high electrical bills were undermining all its efforts.

Recognizing it had to pay more attention to electricity expenditure, ADI requested ESMAP's assistance in developing an Energy M&T implementation plan. From January 2002 onwards, ADI assembled a multidisciplinary team and embarked on a series of initiatives to identify opportunities to reduce electricity consumption. Most intriguing was the realization that ADI could self-generate electricity by installing micro-hydropower turbines at water intake points. As a result, ADI has developed a multi-faceted Energy M&T implementation plan that would reduce annual electricity expenditure by up to R$582,000, 52 percent of its electricity bill for 2002.

Mosela water treatment station

Specifically, by strategically deploying additional water and electricity metering systems and instituting low-cost measures—such as resizing of pumps, reconfiguration of power substations, and power factor correction—ADI

Ponte de Ferro water intake

would reduce annual electricity expenditures by about 15 percent. In addition, ADI could self-generate about 30 percent of its electricity requirements by investing in micro-hydropower turbines at three existing water intake structures. Other investments, including the retrofit of pipelines to eliminate water leaks and construction of an intermediate water storage reservoir, would account for the remaining 7 percent.

Indications are that the low-cost measures plus the investments in micro-hydro and other water supply system retrofits could be recovered from the value of energy savings within three to four years of completing the Energy M&T implementation plan. For example, the installation of two new power substations to enable ADI secure a more favorable tariff from the local power utility would cost an estimated R$13,400, but would save an estimated R$48,576 a year. It would thus pay for itself in three months. Likewise, the installation of the three micro-hydro turbines at the Cachambu Pequeno, Ponte de Ferro, and Rio Cidade water intake points would cost an estimated R$875,000, but would save an estimated R$293,789 a year and pay for itself in 36 months.

Palmas, Porto Nacional, and Paraíso

These three municipalities are in the sprawling new Brazilian state of Tocantins, created in 1989 to spur development in the north. The capital Palmas (“palm trees”) has been built from the ground up since then. Tocantins’ expanding population was last put at 1,156,000.

Water supply and sewerage services are provided by SANEATINS, a joint venture between the state of Tocatins and EMSA, a founding ABCON member. Electricity costs had been running at about 20 percent of the company’s operational costs, leading SANEATINS to develop an energy management program over the past three years, which will now be reinforced with Energy M&T. SANEATINS has focused its Energy M&T implementation plan on the

municipalities of Palmas, Porto Nacional, and Paraíso. The company's energy bill, which in 2001 was approximately R$4.2 million, was projected to reach R$5 million in 2002. However, the energy management measures taken have already led to an overall drop in energy use from 0.67 kWh/m3 to 0.61kWh/m3.

Palmas, the largest of the three municipalities and the largest user of electricity, serves some 133,000 people with 40,000 connections. Current capacity is sufficient to supply treated water to as many as 340,000 people.

Sidebar 6.

Energy Management Team at SANEATINS

The corporate-level energy management team at SANEATINS consists of: President, Operations Director, Energy Manager, Accountant, and Operations Manager.

Compared to Palmas, where SANEATINS consumes 7,438,500 kWh of electricity a year to produce 14.4 million cubic feet of water at a cost of R$1,403,000, its operations are considerably smaller in Porto Nacional—1,431.624 kWh of electricity a year to provide 3.36 million cubic feet of water to 55,000 inhabitants at a cost of R$176,000—and in Paraíso—1,552,872 kWh of electricity to provide 2.18 million cubic feet of water to 34,000 inhabitants at a cost of R$195,000.

Palmas water treatment station

SANEATINS' figures indicate that adoption of an Energy M&T plan will result in a further 13 percent savings in energy costs through low-cost or no-cost measures: tariff analysis and modifications, adjustments in power, maintenance improvements, and small investments. SANEATINS has also been able to isolate favorable byproducts of Energy M&T—changes in the volume of chemicals used, vehicle fuel costs, water quality, and personnel costs—and the savings they entail. SANEATINS' figures suggest that, all in all, the additional nonenergy

savings will be on the order of R$ 290,000 per year, the equivalent of 16 percent of its energy bill.

Palmas booster pumping station

The experience of ADI and SANEATINS illuminates the potential of Energy M&T implementation to promote synergy between energy and water in municipal water supply operations. Synergy operates there in two important ways. First, when treated water is lost, the energy used to pump the water is wasted. By the same token, each time water losses are reduced, so is energy consumption. Second, by taking advantage of a fall in water due to topography and installing micro-hydropower turbines, Petrópolis made itself a producer as well as a consumer of electric power. Such connections between water and energy must be kept in mind by those in municipal water supply operations.

Next Steps

Both ABCON members intend to replicate Energy M&T implementation plans in other municipalities. For example, Águas do Brasil has requested continuation of ESMAP support to set up Energy M&T implementation plans for their other concessions in Rio de Janeiro State—Niterói (pop. 400,000), Paraíba-Campos (pop. 270,000), and Juturnaíba (pop. 270,000)—and Paranagua (pop. 115,000) in Parana State. In Tocantins State, SANEATINS intends to develop Energy M&T implementation plans for other medium-sized municipalities, including Gurupi and Araguaína. NOVACON is preparing Energy M&T implementation plans in small municipalities in Sao Paulo State—Tuiuti, Pereiras, Guaiçara, Cáceres, and Artur Nogueira, among others.

Sidebar 7.

Low-to-Medium Cost Energy Saving Measures Identified for Petrópolis, Palmas, Porto Nacional, and Paraíso

Áquas do Imperador in Petrópolis and SANEATINS in Tocantins have both agreed to the following series of short-term projects to reduce energy costs:

- Introduce an energy management system to ensure sustainability of the initiatives adopted in the short term and help identify and act on other savings opportunities. This would basically include the M&T system, including meters, the data collection system, data analysis software, consultancy, and training.
- Use of variable speed drives at water treatment stations jointly with water pressure control to reduce pumping during periods of low demand.
- Replacement of oversized pump motors after an audit at all pumping and water treatment stations to evaluate the need to replace or relocate the motors. An estimated 20 percent of all pumps will require some sort of intervention in Petrópolis and 30 percent in Tocantins, reducing energy use in the range of 5–6 percent.

Acquisition of energy bills analysis software to reduce billing errors that led to paying more for energy than was owed. The software will also permit choosing the most favorable contract option, based on updated rates. A 5 percent reduction in costs is expected from this measure.

- Use of micro-hydro power turbines in Caxambu Pequeno, Ponte de Ferro, and Rio Cidade to generate up to 350 kW of power in Petrópolis, and preparation of feasibility study reports concerning such micro-hydro power turbine installations at two sites near Palmas, Tocantins.

As a first step in helping ADI and SANEATINS secure financing for their Energy M&T implementation plans, ESMAP teamed up in September 2002 with SEBRAE/RJ, an affiliate of the Federation of Industries of the State of Rio de Janeiro (FIRJAN). They cohosted a roundtable discussion entitled “Financing Energy Efficiency in Municipal Water Supply Operations”. The roundtable brought together ABCON members and local banks (Banco do Brasil, Caixa Economic Federal, and UNIBANCO) to determine the optimal financial arrangements for the Energy M&T implementation plans of private utilities. A follow-up event is to be held in Petrópolis in the summer of 2003.

Through an ongoing energy efficiency partnership with the German Technical Cooperation Agency (GTZ), SEBRAE/RJ intends to extend its collaboration with ESMAP and ABCON to more actively disseminate Energy M&T within Brazil. The aim is to establish it as a “best practice” tool for reducing energy costs in municipal water supply operations.

As noted, ESMAP hopes to replicate this Action Research activity on Energy M&T elsewhere in Brazil and in other countries. Preliminary discussions are already underway both with provincial water utilities in China and the Water Utility Partnership for Capacity Building in Africa.

Further Information

For further information, a copy of the ESMAP Annual Report, or copies of project reports, etc., please visit the ESMAP website www.esmap.org. ESMAP can be reached by email at esmap@worldbank.org or by mail at:

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