

Global Energy Management System Implementation: Case Study

PORTUGAL

EPAL – Empresa Pública das Águas Livres, S.A.

Guia's WWTP 0% - 100% Energy Self-sufficient

“If this project was possible at the largest Portuguese WWTP, then it will certainly be possible to replicate these good practices to other facilities.”

— José Sardinha, EPAL S.A. CEO



Figure 1 - Guia's WWTP, municipality de Cascais - Portugal

Business Case for Energy Management

EPAL - Empresa Portuguesa das Águas Livres, S.A. is the successor of the centenary CAL - Companhia das Águas de Lisboa, a water supply concessionaire to the city of Lisbon, which began operating in 1868. Over the years, its activity has been extended to other municipalities and, most recently, it has included the activity of wastewater sanitation.

Currently, EPAL is as a state-owned enterprise, detained 100% by AdP - Águas de Portugal, SGPS, S.A., serving 96 municipalities that occupy a territorial area corresponding to 33% of the Portuguese continental territory, covering 3,8 million people.

One of its main assets, Guia's Wastewater Treatment Plant (WWTP) is the largest Portuguese WWTP and one of the main engineering works in Portugal due to the complexity of its technical solution, the requirements of the receiving environment (bathing area) and urban planning (tourist zone). The WWTP serves about 800,000 inhabitants and treats 55 million m³/year of wastewater, serving 4 municipalities in an area of 220 km².

Case Study Snapshot

Industry	Water and wastewater utility
Product/Service	Water supply and wastewater treatment
Location	Portugal
Energy Management System	ISO 50001
Energy Performance Improvement Period	1 year
Energy Performance Improvement (%) over improvement period	25%
Total energy cost savings over improvement period	\$ 438.571 USD
Cost to implement EnMS	\$ 47.875 USD
Payback period on EnMS implementation (years)	0,1 years
Total Energy Savings over improvement period	11406 GJ
Total CO₂-e emission reduction over improvement period	6.000 metric tons (considering the external energy that is not being consumed)

The main operating cost of water cycle management entities is associated with energy consumption. In Portugal this sector is responsible for about 2% of the energy consumed in the country. The trend towards increasing energy costs and the fact that the urban water cycle sector has increased responsibilities in reducing greenhouse gas emissions have led to the implementation of an Energy Management System (EMS) and subsequent certification by an external entity. For Guia's WWTP, the EMS encompassed an even more ambitious objective: to ensure that this WWTP is constituted as the first Portuguese Energy self-sufficient WWTP - and one of the first in the world - thus representing a benchmark for the sector and boosting projects in other management entities.

Business Benefits Achieved

The "Guia's WWTP 0% - 100% Energy Self-sufficient" project started in February of 2016, leading to the public announcement that the WWTP is 100% self-sufficient in energy consumption in January of 2017.. Due to a cogeneration system based on the use of the calorific value of biogas produced by the anaerobic sludge digestion to produce electric energy, as well as to the implementation of other measures, this WWTP changed from an intensive external energy consumer to an energy self-sufficient one. The total energy produced at the facility has an annual market value of about \$ 1,065M USD.



Figure 2 - Guia's WWTP: sludge treatment facility

The results achieved with this project, by placing the knowledge of Portuguese engineering to the service of sustainability, allowed consumption reductions of 11,406 GJ, with zero investment values - only by reinforcing the operational control of the energy-consuming treatment stages, through energy recovery from biogas produced and risk management.

The environmental results are also evident, through the energy neutrality achieved, ensuring a reduction of around 6,000 metric tons CO₂ equivalent/year.

EnMS Development and Implementation

In order to achieve the goal of making Guia's WWTP 100% energy self-sufficient, the advantage of implementing an EMS adopting the ISO 50001 standard became clear, since it was understood that the working methodology fit the principles of this project.

Organizational

The top management, in order to demonstrate its commitment to the EMS and to achieve the continuous improvement of its energy performance, approved an energy policy, integrating it in its already existing corporate responsibility system, which is based on the ISO normative references. In order to operationalize the EMS, the Chairman of the Board of Directors, as the management representative, appointed an energy management team responsible for the effective implementation of the EMS activities and for the improvement of energy performance. This multidisciplinary team includes elements of operations, maintenance, asset management and sustainability services.

The work developed by this team, together with other staff of the company, namely from the engineering and communication divisions, led to the certification of the EMS, by an external entity, in October of 2016.

Energy review and planning

The reference situation of Guia's WWTP was obtained by evaluating a two-year historical data (2014-2015), adopting the principles of the International

Performance Measurement and Verification Protocol (IPMVP) published by the Efficiency Valuation Organization (EVO). The treatment stages of the WWTP were evaluated regarding energy consumption and energy production, through measurements in the equipment associated to the energy uses. Based on this evaluation, significance criteria were defined taking into account the energy consumptions and the improvement opportunities to increase the energy efficiency, selecting the significant uses of energy. These significant uses correspond to about 80% of the total energy consume in the WWTP.

For the infrastructure as a whole, but also for the treatment stages (energy uses), models, simple and absolute ratios were established according to the energy uses, seeking to accommodate relevant variables such as variability in wastewater quality and quantity treated. Whenever possible - and in a wide range of uses this objective was reached - regression models with adjustment coefficients above 75%, according to the IMPVP methodology, were sought.

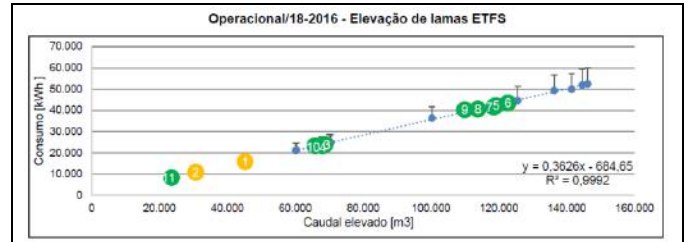


Figure 5 - Energy consumption in lifting of sewage sludge

A number of opportunities for improvement, related to significant energy uses and others, were identified by the multidisciplinary team, with a strong commitment from the operations and maintenance teams. These opportunities were mainly characterized as having a reduced investment, being eminently operational and associated to a careful, and well thought, risk analysis.

Each opportunity for improvement was evaluated based on criteria associated with the investment values, the period of return and its contribution to reduce energy consumption or increase energy production. I was also based on International Organization for Standardization Annex SL and ISO 31000, evaluating each opportunity taking into consideration risks for the environment, workplace safety and health, production, image and reputation and asset management. The approach to energy management was thus holistic, being one of the main reasons for the success of this project.

“Asset management is all about realizing value from assets (ISO 55000). And the energy management system is an excellent way to accomplish this.”

— Ana Luís, Asset Management Director

Cost-benefit analysis

Between the identification phase of the improvement opportunities and their effective implementation, less than a year has passed, and the first measures already implemented were carried out with reduced costs, associated fundamentally to the time spent by the workers for their implementation. However, a set of interventions, which together have a residual value of less than \$ 430.000 USD, will lead to additional energy performance gains.

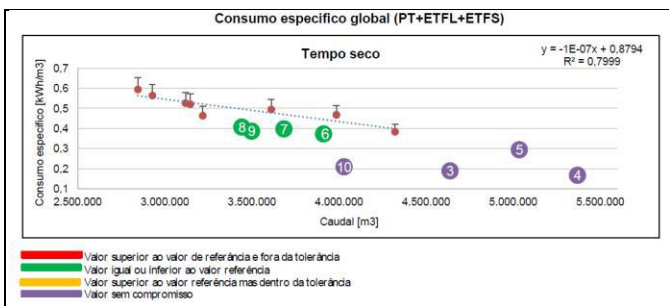


Figure 3 - Specific energy consumption

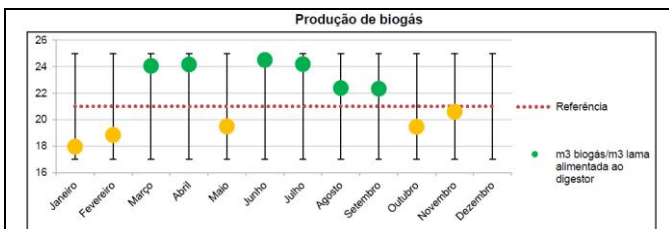


Figure 4 - Biogas production

All measures already implemented and those that will be implemented have a return period of less than four years, being primarily operations management measures, with a strong commitment to operational planning and control.

The cheapest energy is the “noWatt”, to which we have associated the concept of “noCAPEX”, relying on the capacity of the human resources, knowledge and control of the operational issues.

We have proven with this project that the economic constraints, in times of scarce resources, can be overcome by a commitment to planning and operational control based on the competence of human resources.

Approach used to determine whether energy performance improved

The approach taken adopted IPMVP recommendations, using regression models whenever considered possible and placing energy consumption dependent of relevant variables, such as the quality of wastewater and its dependence on climatic variables.

This way, it was possible to establish models dependent on their relevant variables in different situations, with different resolution scales: the installation as a whole, different process steps and equipment by itself in a drill down approach, comparing energy performance for equal input and output conditions.

The indicators were established to provide more aggregate responses relevant to intermediate and top management (management indicators) associated with significant energy uses and, on a third level, other operational indicators to follow specific themes and actions.

Approach used to validate results

On a monthly basis, the energy performance indicators are evaluated/analyzed and the tendency towards the achievement of the objectives verified. The detailed analysis of deviations, positive or negative, allows the

definition of actions leading to the improvement of energy performance.

The variables necessary to ensure the monitoring, measurement and analysis of the key characteristics of the EMS are defined in a specific measurement plan, intrinsically linked to the energy assessment carried out.

The conduct of internal audits, using external auditors, allowed the verification of compliance of the EMS and identified opportunities for improvement that allowed the system, still young, to point out strategies for the extension of its borders.

Steps taken to maintain operational control and sustain energy performance improvement

Regarding the fact that the EMS was born integrated with the other normalized systems already existing in the company, namely ISO 9000, ISO 14000 and OHSAS 18001, the work of implementing operational control measures was facilitated. There was only a need to reinforce some existing practices, so as to incorporate the strengthening of the energy dimension into them.

“It is an initiative of great merit that has the particularity of showing that we must be able to free ourselves from the status quo and question things considered to be right until now. Much of the results were achieved by rethinking solutions previously considered to be suitable but which were found to be possible to change with obvious gains and without any loss of performance.”

— José Martins, Sanitation Operations Director

The biggest challenge of the project was undoubtedly the change needed in behaviors, a goal that is only fully achievable when the change agents themselves make the decision to change and take the lead in these processes, which was strongly supported by top management that launched itself the strategic challenge of ensuring a 100% energy self-sufficient WWTP.

Focused on this goal are the operations and maintenance teams that find the tactical and

operational actions to better achieve the strategy defined by top management, supported by an EMS that adds simple and useful information to the improvement process.

The awareness of teams and a strong commitment in ensuring training actions associated with energy uses, promoting the exchange of knowledge between operating and maintenance matters were also pillars of this project.

“The EMS helped us to structure and implement the opportunities we identified”

— João Santos Silva, Guia’s WWTP Coordinator

Development and use of professional expertise, training, and communications

In the course of this project, several training actions were developed, trying to bring a better understanding of ISO 50001 normative and, more specifically, technical issues associated with the operation and maintenance of the infrastructure.

The project team was supported by an external consultant, with recognized experience in the area, which allowed a broader analyzes/discussion of the best possible solutions for the establishment of an energy assessment and to ensure compliance with regulatory requirements.

In order to reach all workers and demonstrate the involvement of the top management in this project, an internal communication campaign was launched, aiming to inform all workers to energy performance improvement, under the theme "Together We Are + Energy".

Appealing to the fact that energy efficiency is a shared environmental responsibility and that the reduction of energy consumption represents a challenge that can only be overcome through the contribution of all, a series of posters have been launched over time regarding the different operational equipment. Using workers as lead characters, good practices in operating and maintaining equipment were disseminated.

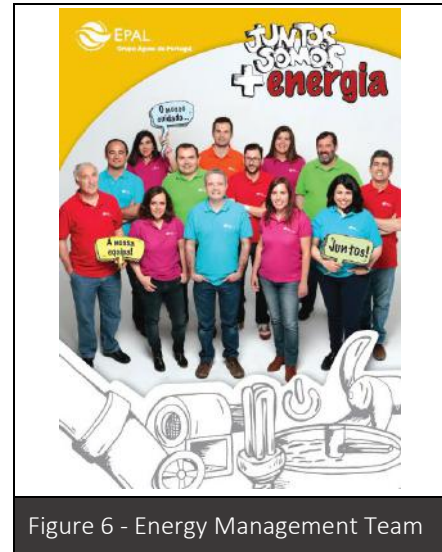
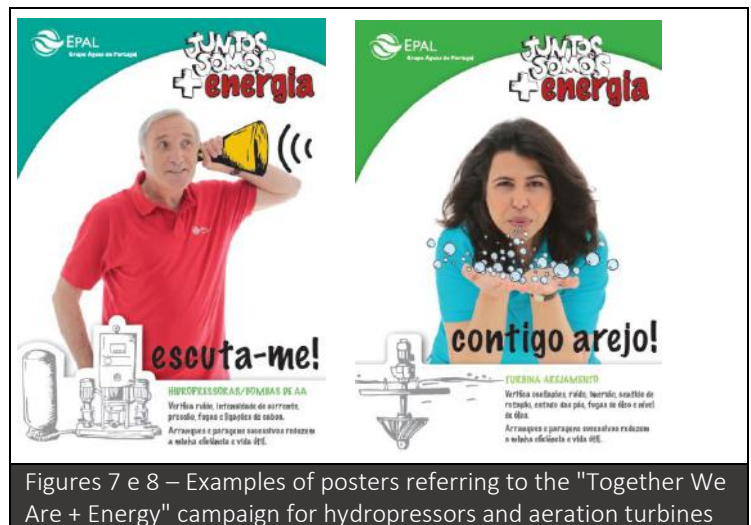


Figure 6 - Energy Management Team



Figures 7 e 8 – Examples of posters referring to the "Together We Are + Energy" campaign for hydropressors and aeration turbines

“In addition to the enormous environmental value of this project, the fact that the team was united around an innovative and stimulating goal has changed our paradigm of energy management, feeling that there was no limit to our will and wit.”

— Alexandra Cristóvão, Corporate Sustainability Director

Tools & resources

Top management has made the commitment to provide the resources needed to establish, implement, maintain and improve the EMS and the resulting energy performance.

The human force used for the development of this project was based exclusively on internal resources, responsible for the definition of the energy assessment evaluation and consequent fulfillment of the main objective: to make the Guia's WWTP 100% Energy self-sufficient.

The necessary investments, whose return period was very attractive, were duly presented and consequently approved by the top management who maintains an attentive and interested attitude towards the development of the project.

Naturally, since the company had already implemented management systems based on the aforementioned normative references, their potentialities have been taken into account in the requirements that are mutual, keeping the methodologies already in place and known to the workers.

Lessons Learned

The main lessons with this project were, in a positive way:

- The advantage of a holistic approach in order to increase energy performance;
- The strong commitment of the top management in the triggering and monitoring of the project;
- The importance of behavior change and attitudes, given the issues of sustainability and energy consumption;
- The importance of enhancing the capabilities of the company's worker force;

- The role of the EMS in structuring the first evaluation, implementing and monitoring the measures taken as appropriate and, essentially, providing a simple, useful and credible information to those who conduct operations in the field. The EMS functions as a logistical information support structure for operational teams;
- The need to find solutions to increase the participation and commitment of logistics structures in the periphery of the main activities (procurement, legal support, human resources, among others).

“This project had not only impact by itself, but on all the infrastructures we manage, and on ourselves.”

— Luísa Branco, EPAL S.A. Administrator

Keys to Success

- Valuing of internal human capital;
- Aiming to increase knowledge of systems and equipment;
- Simple and pragmatic approach to problems and their solutions;
- Evident presence of top management;
- Accepting that taking risks is part of normal operation of an infrastructure as long as these are controlled and kept under a tolerable limit;
- Rationalizing consumption without investment or with reduced investment is possible;
- Willingness, from the direct agents involved, to change.

Through the Energy Management Working Group (EMWG), government officials worldwide share best practices and leverage their collective knowledge and experience to create high-impact national programs that accelerate the use of energy management systems in industry and commercial buildings. The EMWG was launched in 2010 by the Clean Energy Ministerial (CEM) and International Partnership for Energy Efficiency Cooperation (IPEEC).

For more information, please visit www.cleanenergyministerial.org/energymanagement.

