Global Energy Management System Implementation: Case Study

Argentina

C.T.Genelba

The application of the standard ISO50001 improves energy performance 13.2% over 2 years.

The successfully implementation of Energy Management System under the ISO 50001 standard, has developed the Genelba Power Plant Energy Policy, being pioneers in the electricity generation industry certified in this standard in Argentina. (Certified by TUV).

Business Benefits Achieved

Central Termoeléctrica Genelba is a Power Generation Company located in Marcos Paz, 50 km away from Buenos Aires city. It has 57 employees and is ISO50001 certified by TUV since 2013.

This standard implementation allowed the company to reduce the energy consumption by 26 billion BTU (7635 MWh) in a period of two years. This improvement resulted in a reduction of the operating costs of u$s 271,034 and a decrease of CO_2 generation in 2,997 tonnes in the same period.

As the implementation of the EnMS was realized by internal staff, Genelba's u$s 14,750 investment was paid back in about three months.

Furthermore, the efficiency assurance process enabled guarantee and improve the availability and reliability of the plant, getting historical records of forced service outlets (0.39 % in 2014) and reached the highest availability of generation assets (98 % in 2014) according to a national benchmarking performed by CAMMESA (National Electricity Market Management Company).

These indicators allowed the company to increase the participation in its Market Share (4.6 %) although its participation in installed capacity is only 2.7 %.

"Implementing an EnMS provides a solid basis for driving individual actions ensuring continuous optimization of energy use"

— Sebastián Monetti, Operation Manager

Central Termoeléctrica Genelba

Case Study Snapshot	
Industry	Energy Industry
Location	Marcos Paz, Buenos Aires, Argentina
Energy Management System	ISO 50001
Product/Service	Electricity Supply
Energy Performance Improvement (%)	13.2% over 2 years
Annual energy cost savings	u$s 135,537
Cost to implement	u$s 14,750
Payback period	3 months

Company Profile

Central Termoeléctrica Genelba, Power Generation Plant of Petrobras Argentina S.A. Company, is located in Marcos Paz, 50 km away from Buenos Aires city. Its unique product is electricity generation. It is acting in the

National Wholesale Electricity Market (MEM). The total installed capacity is 825 MW conformed by a 660 MW Combined Cycle unit, in operation since 1999, and a 165 MW Gas Turbine, in operation since 2009. The plant is ISO 14001, OSHAS 18001, ISO 9001, and ISO 50001 standards certified. Genelba has achieved patents for projects developed by internal staff in USA and EU, has presented several technical papers in international congresses and published them in specialized magazines. Primary Frequency Regulation in Combined Cycle's Steam Turbines, a proprietary Genelba development, allowed the Company to achieve the Innovation Award powered by Power Gen Europe Conference in Brussels, Belgium. In 2013, Genelba won Quality National Award (equivalent to the Malcom Baldrige or Demming Awards given in other countries) and in 2014 obtained Ibero-American Quality Award second place.

Since Genelba is highly automated, **it has 57 employees** and numerous computer systems for operation, control and management support. Artificial Intelligence, Expert Systems, Operation Simulator and others systems technologies are included. Many of these have been developed by Genelba staff.

Business Case for Energy Management

Three factors make Power Companies lose money: Operating costs, reliability and efficiency.

While, by definition, the entire production process is characterized by high values of efficiency, ensure these values constitute a strategic framework for plant evolution process and to improve the results, positioning the company as a benchmark in the sector.

For this reason, Genelba decided to implement and certify the EnMS under the ISO 50001 standard, developing the Genelba Power Plant Energetic Policy, being pioneers in the Argentinian Electricity Generation Market to implement this standard.

From the social responsibility point of view, it is important to mention that in the context of energy national crisis, the application of this standard serves to sensitize the society about energy saving importance.

Regarding environmental perspective, application of ISO50001 allowed a reduction of CO_2 emissions of 2,997 tonnes in a period of 2 years.

Keys to Success

- Consider energy efficiency as a global and common strategic target for all company sectors.
- Develop efficiency indicators that are the **Key Performance Indicators** of the Efficiency Assurance process, and are shared for all Genelba's staff (daily).
- The objectives set for these indicators have become "the cathedral to be built" by the whole team.
- Continuous staff awareness and training

EnMS Development and Implementation

A traditional Management process in Electric Power Plants usually illustrates, in the unit Process Map, the areas that make up the Plant Functional Organization chart and which include processes such as Operations, Maintenance, etc. The disadvantage of this kind of approach is that only the individual objectives assigned to each area are considered and the global results, which are really important for the unit, are not taken into account. For instance, the objective of the Maintenance area will be considered fulfilled once its Preventive Maintenance Plan is done, or when the area has "the best vibrating analysis for the rotating equipment" -even the best vibrating analysis in the industry. But, what's about the real purpose of the Power Plant? What happens when the purpose is not the sole responsibility of one of the functional areas as is the case of Energetic Efficiency?

In the next sections, the experience in Genelba is presented with a management approach which considers "Efficiency Assurance" as Strategic Processes which work in a cross–sectional way with all the areas. These process indicators are reflected in the outcomes of

the unit control board. They have tools and specific practices that allow the whole organization to focus on achieving relevant results for the purpose of the Plant. This production management system developed in the plant is called GPS (Genelba Production System) and it is a Control and Follow-up System which is part of Genelba Management Processes; it allows finding deviations, sorting out problems and to achieve the set goals.

Efficiency Assurance Process

Figure 1 shows in detail the "Efficiency Assurance" process and activities and tools that make up each of the stages in this process.

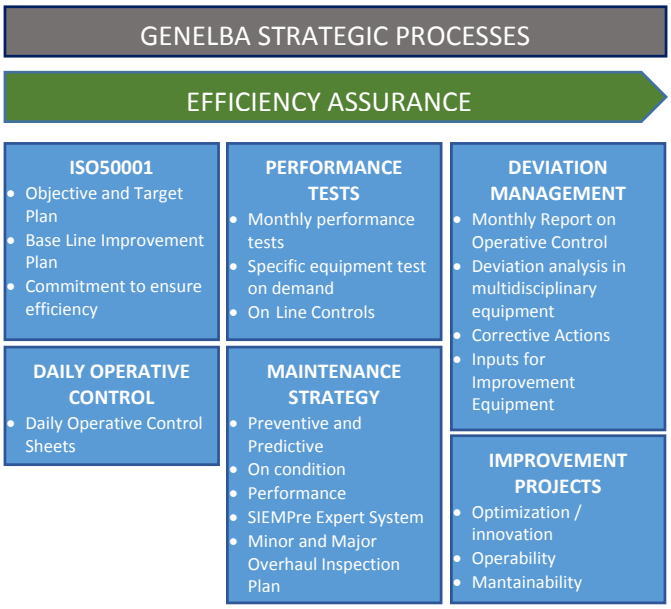


Figure 1. Efficiency Assurance

ISO50001 EnMS and Energy Team

Plant Energy Management System complies with ISO50001 standard. This System is a frame for all plant activities in terms of efficiency.

The Management System Indicators are divided in three main focuses: Power Generation Production Process Efficiency, Industrial Consumption and Non-Industrial Consumption.

Figure 2 shows energy classification that was realized in order to define the energetic planning. As seen, the 52 % is Power Plant efficiency (It is important to take into account that this kind of Thermal Power Plants have an efficiency about 54.3 %). The 47.3 % is power generation process losses and is not possible to reduce it because of turbine physical and constructive design. So, we consider the last 0.7 % as internal energy consumption and we define objectives to achieve a reduction in this group keeping the process efficiency in 52 %.

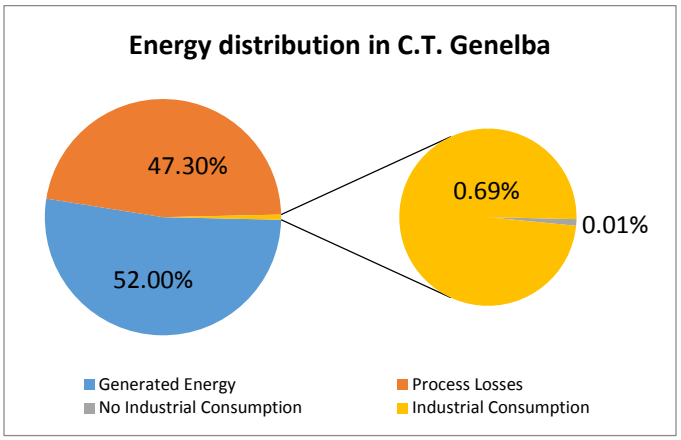


Figure 2. ISO50001 Management System Indicators

It is important to note that this 0.7 % represents 60,576 MWh per year and is divided in Industrial Consumption (59,712 MWh) and Non-Industrial Consumption (865 MWh).

Regarding the Energy Team, as Genelba implemented the ISO50001 with internal staff; at the beginning it was composed by 10 members (about 20 % of all employee of the Plant) from all departments: Maintenance, Operations, Process, Administration, Warehouse and representatives of the permanent contractors.

Actually, the team is integrated by Process Engineer, Electrical Maintenance Supervisor and Operational Manager (Management Representative) and it participates in a strategic planning meeting with the leaders of all sectors of the Plant. As a result of this meeting, the Energy Team defines the objectives and assigns budget and man-hours to achieve them. During the year, the team meets monthly with staff involved from each department in order to review the progress in the projects that are being made on energy efficiency.

More details about these follow-up actions and tools are going to be described in next sections.

Daily Operative Control

Currently, information in the Daily Operative Control Sheets is mainly entered automatically in a Visual Basic Software developed in Genelba. They consist in some time values of the main variables which are lately used for daily consolidations and performance evaluation. It also plays a vital role in assuring Availability and Reliability as it has information about turbines availability and critical auxiliary equipment. The plant operator also enters relevant information about the equipment and the so called Extraordinary Events. All this information, which is then analyzed, is used for monthly evaluations and deviation detection. As a result of the reports generated from this software, the most important KPIs are done automatically and they are shown in employee computers start-up. Figure 3 shows a screen of the principal KPIs of the Plant.

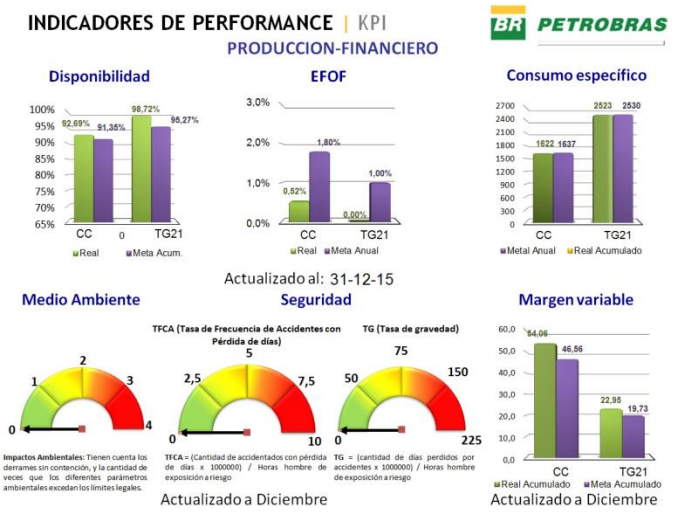


Figure 3. Most important KPI's of Genelba.

Performance Tests

Monthly performance tests are carried out taking the process to base load (Plant full capacity) and when temperature and atmospheric pressure are about reference conditions to minimize the effects of corrections on calculations. While daily tests provide early alerts about any relevant deviation, monthly tests allow seeing the development of the plant energetic efficiency as they are performed under predetermined conditions. This development is analyzed in the monthly Operative Control meetings and corrective actions are determined if necessary.

Apart from the programmed tests mentioned above, specific tests of the whole process or particular equipment are carried out when it is necessary to further evaluate a deviation or abnormality is found.

Maintenance Strategy

As shown in Figure 1, maintenance strategies based on the actual equipment performance are included. SIEMPre (Spanish acronym for "Predictive Maintenance Expert System") as well as the Analysis of Weak and Obsolete Systems are tools that contribute to that purpose.

SIEMPre software was fully developed by Genelba internal staff. The purpose of this system is to continuously monitor via online the functioning and performance of the main and critical equipment. Based on this monitoring, the SIEMPre system gives early alerts about deviations; long before plant operators notice any abnormality. These early alerts are sent via e-mail or SMS to the corresponding maintenance person.

Another important maintenance activity is the annual analysis carried out with another system developed in Genelba, which aims at determining systems or pieces of equipment which are "weak" (with high rate of failures) and "Obsolete" (discontinuous spare part or support service). This is a multidisciplinary study which allows a proactive and anticipated development of plans and making some assumptions for these systems, which may affect the efficiency and reliability in the near future.

Deviation Management

The main purpose of this system is to learn the most from all the abnormal events. When there is a deviation in Efficiency and/or Reliability, all the associated costs are already added up. The only way to compensate this negative situation is to turn it into an opportunity to

learn from the deviations; then the Genelba team can become more knowledgeable on this issue.

As part of the Deviation Management System, a monthly Operative Control Report is presented to the plant Management Committee and other members from different sectors.

The report provides detailed information about the plant operation, Extraordinary Events recorded during the period, the results from the Performance Tests and a Statistical Analysis of the monthly and accumulated deviations, classified by type of cause. A critical analysis is carried out and the actions to take are determined.

Complex deviations are dealt with either by the plant Reliability Committee (a multidisciplinary team that analyzes all the deviations in the processes) or, in some cases, by an ad-hoc Improvement Team which is knowledgeable on specific issues and makes a thorough analysis.

All the conclusions from the deviation analysis drawn by the Improvement Teams are recorded together with the corresponding corrective/preventive actions. These actions are followed up regularly every month in both the Operative Control Report and Reliability Committee meetings.

Improvement Projects

Improvement Projects involves carrying out projects to change the facilities, automatic control system, operative procedures, etc. These Improvement Projects contain the initiatives proposed by the Energy Efficiency Team, Reliability Committee, Strategic Planning meetings and the monthly Operative Control Report meetings.

Actually, Genelba has several projects, some of them very innovative, which have contributed to obtain positive results. Once an Improvement Project is assigned to a specific department in the plant, it becomes part of its Objectives and Goals Program and this department is responsible for the project management and follow-up.

For example, last year, a migration from High Pressure Sodium lamps (400 W each one) to LED technology in Water Plant, Warehouse and Maintenance Workshop were done.

Before the implementation, a simulation in specialized software was realized in order to verify that the results will be as expected. After the implementation, verification with a calibrated lux meter was realized with the provider in order to compare the lux/watt obtained by simulation with the experimental result.

This project reduced the energy consumption by 60 % improving the visual quality of the sector. Figure 4 shows the situation before (a) and after (b) the lamps changes in Water Plant.

(a)

(b)

Figure 4. Situation before (a) and after (b) the migration to LED lamps in Water Plant.

This procedure is common for all projects. Before making a modification, an analysis in the energy efficiency is realized (theoretically or using specialized software when it is possible). After the implementation, a measure is done in order to validate the improvement.

This methodology minimizes the discrepancies between the planned and the real project. Besides, allow not to lose quality such as result of a reduction in energy consumption.

Employee Engagement & communications

There are several ways to engage the staff.

Genelba has a Suggestion Program in which all the staff participates. The participation in this program is motivated by awarding a prize to the best suggestions in three categories: "Production, SMS[1] & Energy Efficiency" and by an acknowledgment in a special meeting with all the staff. This program is a valuable source of ideas for the Improvement Projects.

After a project has been realized, the working group explains the development and results to all employees. This is a very valuable instance since the exchange of views between colleagues is often very helpful.

The KPIs showed in employee computers start-up is also a way to obtain employee engagement because they can monitor the Energy Efficiency of the Plant every day.

Regarding trainings and awareness, the Energy Team, plans the internal and external courses that are going to take place in the year. The team also sends monthly emails to staff with advice and tips to improve energy efficiency both in the workplace and outside it.

Cost-Benefits analysis

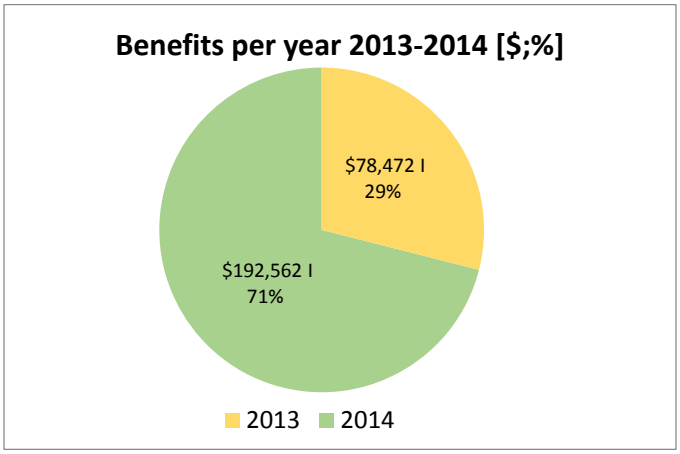
Before the ISO50001 implementation, different external consultants were evaluated to help us with this process. But as they had little experience in this standard in our country and considering the experience of Genelba in Management Systems, implementation was realized with internal staff. So the principal costs are related with trainings, time spent to write the procedures and external audits. Table 1 summarizes these costs.

Description	Man-hours	u$s
Energy policy drafting and printing of posters	20	200
Procedure elaboration	144	3000
Preparation of broadcasts and communication	20	400
Measurements of internal consumption	40	900
Perform external audit report for certification	16	300
Internal audit	8	150
Train 4 persons in advanced introduction to ISO50001	62	1600
Train 5 persons as internal auditors of ISO50001	40	1200
External training for own personal about introduction to ISO50001	120	2000
External Auditory	64	5000
Total	534	14750

Table 1. Implementation costs.

Regarding benefits, it is important to take into account that the reduction of internal consumption by 26 billion BTU (7635 MWh) was obtained without investment because major reduction (7576 MWh) was achieved in Industrial Consumption, making a change in the control logic for industrial fans (Cooling Tower, Lube Oil System, etc). The rest (59 MWh) was obtained with awareness campaigns of air conditioning and energy rational use.

This saving resulted in operative cost reduction of u$s 271,034 in two years, distributed as it is shown in Figure 5 (u$s 78,472 during 2013 and u$s 192,562 during 2014).



[1] Spanish acronym for "Safety, Environmental and health"

Figure 5. Benefits per year.

So considering implementation costs of u$s 14,750, the payback period is about 3 months.

On the other hand, as it was said in the introduction of this paper, the efficiency assurance process allowed the company to reach the highest power generation availability (98 % in 2014) according to a national benchmarking performed by CAMMESA. Figure 6 shows the comparison between Genelba and its competitors. Keeping these values helps the company to increase its participation in the Market Share. For example, in 2014, it was about 4.6 % although installed capacity is only 2.7 %. Furthermore, this high availability allowed the company to obtain a plus of 4.7 MMUSD compared with the average of the competitors and 0.84 MMUSD over the best competitor in 2014.

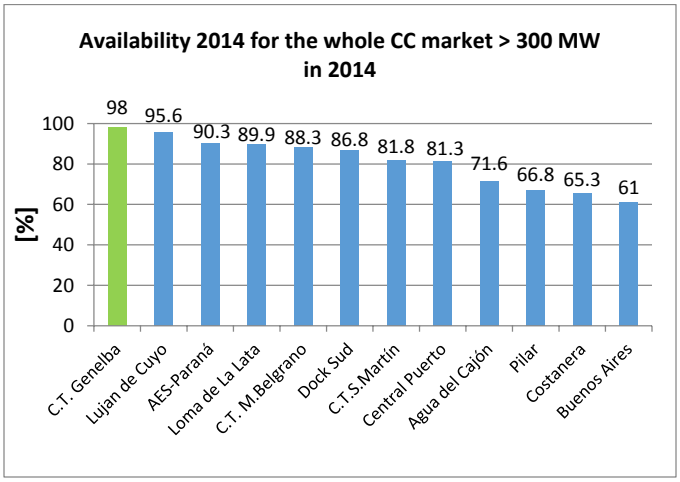


Figure 6. Source Cammesa.

From environmental point of view, application of this standard allowed the Company to reduce CO_2 emissions in 2,997 tonnes in the period 2012-2014.

Regarding non-financial benefits, implementation and certification of EnMS under ISO50001 standard, has developed Genelba Power Plant Energetic Policy, being pioneers in national electricity generation industry and reaching the quadruple certification of management systems according ISO14001, ISO9001, ISO50001 and OHSAS18001.

"The implementation of the ISO50001 standard helped me not only to improve energy efficiency in the scope of work but also outside it."

—Marcos Garcia Aguilar, Electrical Technician

Lessons Learned

At the beginning, the implementation process was complicated because of the little national experience in this standard. Genelba was the second company ISO50001 certified in Argentina and the first one in the Power Generation Market. As all the job was realized by internal staff (10 employees – about 20 % of all employees of the Plant - from different areas), the employee involvement was grater.

The awareness campaigns realized in rational energy use, motivate employees to take this acknowledge and spread it out of the Power Plant (such as schools, sport clubs, etc.).

The initiative to implement the EnMS encouraged other sites of the company to develop an Energy Policy such is the case of Lubricants Plant S.A., which achieved the certification last year (December 2015).