ISO 50001 Energy Management System
Case Study

Argentina

C. T. Genelba

The implementation of an EnMS improved energy usage by 8,3% over five years.

C. T. Genelba Power Plant

Organization Profile & Business Case

Central Termoeléctrica Genelba is a Power Generation Plant of Pampa Energía S.A. Company. Is located in Marcos Paz, 80 km away from Buenos Aires City. Its unique product is electricity generation. Genelba is one of the National Wholesale Electricity Market (MEM) biggest actors. The total installed capacity is 843 MW conformed by a 674 MW Combined Cycle unit, in operation since 1999, and a 169 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 the National Quality Award (equivalent to the Malcom Baldrige or Demming Awards given in other countries) and in 2014 obtained Ibero-American Quality Award second place.

Case Study Snapshot	
Industry	Energy Industry
Product/Service	Energy Supply
Location	Marcos Paz, Buenos Aires, Argentina
Energy management system	ISO 50001
Energy performance improvement period	5 years
Energy Performance Improvement (%) over improvement period	8,3%
Total energy cost savings over improvement period	u$s 1,469,600
Cost to implement EnMS	u$s 14,750
Total Energy Savings over improvement period	898,844 GJ
Total CO_2-e emission reduction over improvement period	96,490 ton

Since Genelba is highly automated, **it has 66 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 developed by Genelba staff.

Genelba´s drivers and motivation

For decades, Argentina´s energetic matrix has had a major component mostly based on fuel burning for electric generation. Even thou the government has started changing this unsustainable scenario with the

incorporation of new renewable energy generation, further actions carried out by the private sector like decreasing energy consumptions and energy efficiency training and activities, are key to Argentina´s progress. C.T. Genelba, as an interested party, understood the need of implementing additional efforts to collaborate accomplish success.

Genelba´s initiatives to manage energy consumptions are highly driven by achieving environmental sustainability. As the Company CSMS[1] Policy states:

"Pampa Energía has to act to the environmental protection, rationally using natural resources and applying appropriate and economically viable technologies."

As a Power Generation Plant, each MW that is not consumed by internal equipments (electronics, auxiliary systems or turbines), is power that we can supply to the grid, helping the MEM to work better and provide the final users with the energy they need.

But the Company´s motivations are not only based in the environmental care but in the rational use of its main production input, natural gas. To generate electricity in a sustainable way, technology has to be constantly reviewed and defied, in order to look up for the most efficient generation processes available.

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

— Sebastián Monetti, Operation Manager

Business Benefits

This standard implementation allowed the company to reduce the energy consumption in 851,3 billion BTU (249,679 MWh) in a period of five years. This improvement resulted in a reduction of the operating costs of u$s 1,469,600 and a decrease of CO_2 generation in 96,490 tons in the same period. As the implementation of the EnMS was realized by internal staff, Genelba's u$s 14,750 investment was paid back in about three months.

Cost-Benefit analysis:

At the moment that Genelba decided to implement the ISO 50001 EnMS, there was very few knowledge in the country (in fact, Genelba was the second company in Argentina to implement, first Power Generation Plant to do it). That is why 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 the running costs for the EnMS, training in specific solutions to reduce energy consumptions is one of the most relevant activities. In this category we can mention training in the use of wireless energy meters, DCS study to implement new functioning logics or engineering to determine how to replace lightning equipments and they represent 180 man hours per year and 5,600 u$s.

Regarding energy costs savings, the overall energy saving was u$s 1,334,600 in five years, with an 85% due to operational savings, for instance, replacement of cooling tower internal plastic material to improve its efficiency, cleaning the condenser system or changes in the design of vanes and blades of the gas turbines. The rest 15% belongs to EnMS initiatives, such as air

[1] Spanish acronym for "Quality, Safety, Environment and Health".

conditioning control, awareness campaigns, modifications in the control logic for industrial fans (cooling tower, lube oil system, etc.), migration from High Pressure Sodium lamps (400 W each one) to LED technology in different sectors in the Plant.

From environmental point of view, application of this standard allowed the Company to reduce CO_2 emissions in 96,490 tons in the period 2012-2017.

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.

Plan

First steps to implement Genelba´s EnMS

Around mid-2011, Genelba started to realize that, as one of the major Power Plants in Argentina, should have systematic approach to rational use of energy. With the ISO 50001 publication, the framework for management had been set and in December 2011, this has been presented in the Annual Technological Update (ATEC) seminary with a three sides approach: economical, environmental and strategic. This laid the foundations to implement an EnMS in Genelba and got full support of the top decision makers who were receptive immediately. The EnMS became part of Genelba´s Efficiency Assurance Process as a strategic support item and it has been successfully incorporated into the Integrated Management System, together with to the other management systems based on ISO 9001, ISO 14001 and OSHAS 18001 standards.

In the next sections, the experience in Genelba is presented with a management approach which considers “Efficiency Assurance” as a Strategic Process which works in a cross–sectional way with all the company areas. These processes indicators are reflected in the outcomes of the unit control board that has 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 on site is called GPS (Genelba Production System) and it is a Control and Follow-up System which is part of Genelba´s 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.

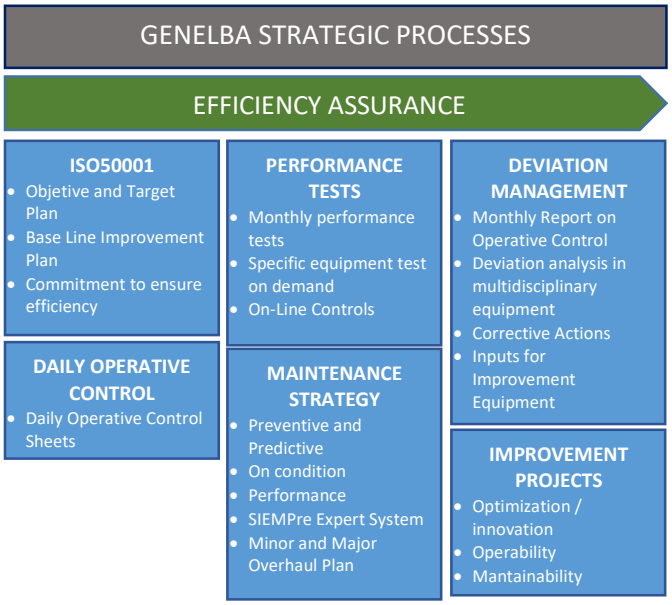

Figure 1. Efficiency Assurance

ISO50001 Energy Management System

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

Figure 2 shows the Management System Indicators

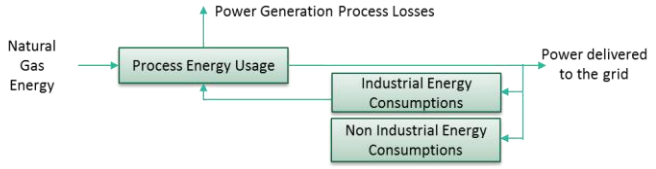

Figure 2. ISO50001 Management System Indicators

which are divided in three main focuses: Power Generation Production Process Efficiency, Industrial Consumption and Non-Industrial Consumption.

Figure 3 shows energy classification that was realized in order to define the energetic planning. As seen, the 53,87 % 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 45.13 % is power generation process losses and is not possible to reduce it because of turbine physical and constructive design. So, we consider the last 1 % as internal energy consumption and we define objectives to achieve a reduction in this group keeping the process efficiency in 53,8 %.

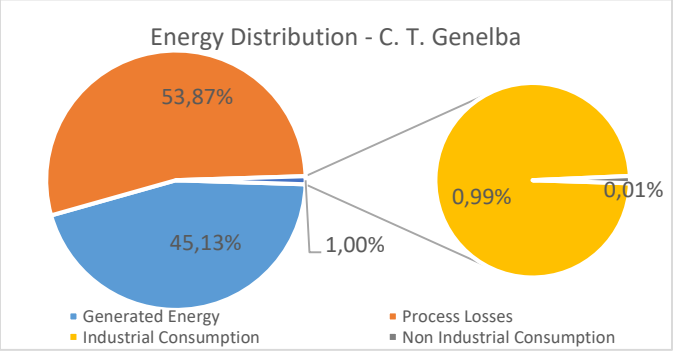

Figure 3. Energy distribution in Genelba

It is important to note that this 1 % represents 78,686 MWh per year and is divided in Industrial Consumption (77,775 MWh) and Non-Industrial Consumption (941 MWh).

At the beginning of the year, a strategic planning meeting with all sectors of the Plant is performed in order to establish the objectives and assign budget and man-hours to achieve them. During the year, the Energy Management Team conformed by the Maintenance Engineer, Electrical Maintenance Supervisor and Operation Manager follow-up the proposed actions, (using different tools that are going to be described in the following sections), to ensure compliance with these objectives. The EnMS team is revised in the strategic planning meeting to evaluate the need of new collaborators but always requires management participation to assure commitment of the top decision makers.

Genelba´s Energy Matrix

In order to analyze energy uses, prioritize them and come up with actions to accomplish its reduction, Genelba developed an energy matrix where all the consumption categories (either Process, Industrial or Non Industrial) are taken into account. First of all, every category must be divided into groups containing families of equipments (for instance, all valves, all pumps, all compressors). The next step is to determine its annual energy use, either by an electrical meter incorporated the equipment, physical measurements or indirect estimation between the informed power and usage factor. Industrial Energy Consumptions (2nd largest category before Process Consumptions). As seen, almost 81% (62,858 MWh/year) of the energy destined for Industrial purposes -except generation itself- is consumed by the electric pumps used for the steam generation installation, followed by the forced ventilation (14% - 11,106 MWh/year) in the cooling tower system. Figure 4 summarizes this distribution.

Regarding Non Industrial Consumptions, air conditioning & heating take over 82% of energy consumptions (566 MWh/year and 209 MWh/year respectively), follow by illumination (11%) and other minor consumptions of electronics and minor equipments (7%).

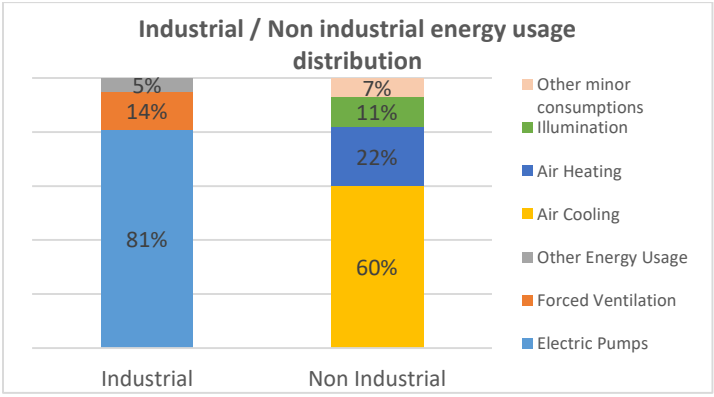

Figure 4. Industrial / non industrial Energy usage dist.

Every energy usage is analyzed with a systematic approach. Some questions are asked in order to know more about the energy consumption group background and determine its potential of improvement. For instance, if the equipment in analysis has a preventive maintenance routine or its energy usage can be reduced while maintaining its performance, will have less score that an equipment that does not have this specific actions taken over it, so, its enhancement possibilities will be less effective and, consequently, there will be less actions to perform in this category. The EnMS efforts and resources to accomplish energy usage reduction are focused on the groups that have a high and medium level of significance, and this is captured in Genelba´s Energy Consumption Matrix.

"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

Do, Check, Act

Before the ISO50001 implementation in Genelba, different external consultants were evaluated to help us with this process. But as they have little experience in this standard in our country, this was developed entirely by internal collaborators.

EnMS objectives and targets program

As every Management System, Plant EnMS requires a systematic methodology to plan, follow up and verify results for the proposed actions tending to reduce energy usage or improve systems functionality.

At the beginning of the year specific objectives are planned, involving, if required, the estimated cost and man hours. These objectives include revision of the energy matrix and base line, early preparation for internal and external audits and relationship with other ISO 50001 certified companies, among others. Table 2 summarizes the main objectives set for the EnMS.

OBJECTIVES AND TARGET PROGRAM
EnMS - 2018

Month 12

Objective N°	Objective Description	Relative Weight	Acumulated values Real value	Acumulated values Target
1	REVISE AND UPDATE THE IMPLEMENTATION OF ISO 50001	20%	100%	100%
2	TRAINING AND FORUM PARTICIPATIONS	10%	100%	100%
3	IMPROVE INDUSTRIAL, NON INDUSTRIAL AND IMPROVEMENT PROJECTS MEASUREMENTS	30%	100%	100%
4	REDUCTION OF INDUSTRIAL ENERGY CONSUMPTIONS	20%	100%	100%
5	REDUCTION OF NON-INDUSTRIAL ENERGY CONSUMPTIONS	10%	100%	100%
6	AWARENESS AND DIFFUSION	10%	100%	100%
	Total ponderado	100%	100,0%	100,0%

Table 2 EnMS Objectives and targets program

Monthly, this program is revised with the Plant Management Committee in order to follow up and verify results of each target.

For each objective the EnMS sets targets to accomplish success. For instance, for the "Reduction of industrial energy consumptions" objective, one of the key activities in 2017 was the migration of the lightning equipments (high pressure sodium to LED technology) in the cooling tower, HRSGs and administration buildings.

Energy Performance Improvement

Genelba calculates the energy performance by comparing the current year indicator versus the baseline indicator. The EnMS has the following indicators to measure energy performance:

- Specific Fuel Consumption of both units per KWh of energy produced – CECC & CETG21 [Kcal/KWh]
- Industrial energy consumption per KWh of energy produced – ICI [MWh/MWh]
- Non Industrial energy consumption per year – ICNI [MWh/year]

As Genelba´s unique production output is electric energy, we use that variable to normalize the industrial consumptions and Specific Fuel consumption. Non Industrial consumptions is a global indicator, it doesn´t depend on electricity generation. The improvement or

losses are determined by comparing the current year indicator versus the baseline indicator using the following formula:

$$\left[\frac{\text{Baseline Period Energy indicator} - \text{Reporting Period Energy indicator}}{\text{Baseline Period Energy indicator}}\right] x\ 100$$

Positive values indicate an improvement while negative values show a loss. Validation and verification of results is made by the EnMS team, considering that almost all the consumptions are measured by online energy meters with communication with PI System, punctual measurements done with certified amperometric meters or equipment plate information combined with usage factor, calculated by PI System as well.

Table 3 shows the EnMS energy performance since it was implemented (baseline was set in 2012 and achievement period is 5 years, 2012-2017).

	Specific Consumption Combined Cycle	Specific Consumption Single Cycle	Industrial Consumption Index	Non - Industrial Consumption Index
	CECC	CETG21	ICI	ICNI
	KCal/KWh	KCal/KWh	MWh/MWh	MWh/year
2012	1604,0	2455,4	1,28	957
2013	1581,1	2460,3	1,29	953
2014	1615,3	2439,0	1,27	895
2015	1612,6	2448,6	1,27	988
2016	1592,6	2503,9	1,29	966
2017	1566,5	2475,52	1,37	940
Var 2017-2012	-2,34%	0,82%	7,32%	-1,75%

Table 3. EnMS indicators

Operational Control

Currently, we apply operational control techniques to the categories with a high-medium level of significance, for instance, performance test done in the CC and SC, daily operative control, energy consumption measurements, preventive maintenance, among others.

Procurement requirements for energy efficiency

Since 2017, our procurement department incorporated an energy efficiency approach to all the purchases, giving advice to the providers that the technical offers would be revised, among other departments, by the EnMS team and the proposes with better energy efficiency would be considered.

Transparency

Genelba has a very close relationship with all the interested parties and the channels of communication are analyzed yearly in the Planning Process. Specifically, for the ISO 50001 EnMS, Genelba announces its certification in the official web site of the company (http://www.pampaenergia.com/en/Pages/Termoel%C3%A9ctrica-Genelba.aspx).

Lessons Learned

- One of the biggest issues about implementing an EnMS is to change the company´s culture and requires all levels committed and aligned to achieve success. Management of changes is always a weak item and requires attention from the first moment including, for example, taking care of new energy consumptions in new projects, equipments or suppliers. Genelba´s case was not the exception and this was something that the EnMS could have taken care from the beginning.
- As there was very little experience in the country with the ISO 50001 EnMS, Genelba got a very big challenge during the implementation in terms of EnMS development. Further relations with

companies that have already implemented an EnMS during this stage would be a strength.