

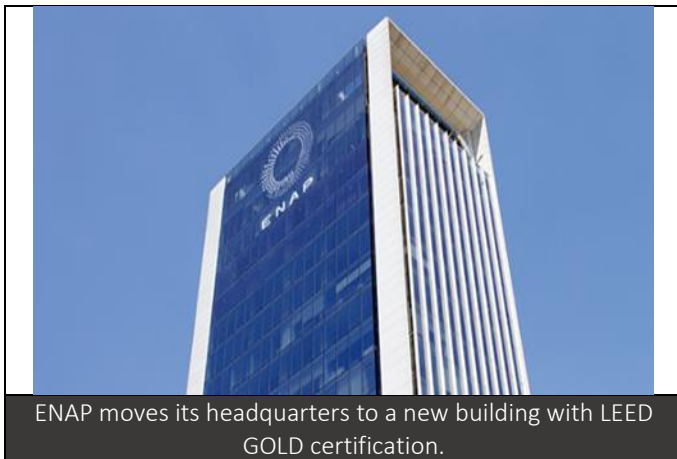
Global Energy Management System Implementation: Case Study

CHILE



Empresa Nacional del Petróleo (ENAP)

ENAP improved its energy performance by 4.2% compared to 2015.



Business Case for Energy Management

Profile: Empresa Nacional del Petróleo (ENAP) is a public company 100% owned by the State of Chile whose main purpose is the exploration, production, refining and commercialization of hydrocarbons and their derivatives. It was created by Law # 9618 in June 1950, operating as a commercial company, with a legal regime of public law and is administered autonomously.

ENAP participates in exploration and production of hydrocarbons through its subsidiary Enap Sipetrol S.A. and in the refining, transportation, storage and commercialization of petroleum products through Enap Refinerías S.A.

ENAP develops activities and operations in Chile, through 5 productive units (ERA, ERBB, DAO, MAG-R&C and MAG-E&P). It also has a presence in Argentina, Ecuador, and Egypt.

“By certifying the 5 production units in Chile under ISO 50001, ENAP will manage and operate one of the largest energy management systems in Latin America”

—Rubens Poblete O, ENAP Energy Management Manager.

Case Study Snapshot

Industry	Oil & Gas
Product/Service	Exploration and production of hydrocarbons and refining and commercialization of fuels.
Location	CHILE (5 sites) ERA, ERBB, DAO, MAG-E&P and MAG-R&C
Energy Management System	ISO 50001
Energy Performance Improvement Period	3 years
Energy Performance Improvement (%) over improvement period	4.2 %
Total energy cost savings over improvement period	15,006,000 [\$USD]
Cost to implement EnMS	1,575,195 [\$USD]
Payback period (years) on EnMS implementation	< 0.2 years
Total Energy Savings over improvement period	GAS: 1,681,218 [GJ] ELEC: 7,029 [GJ] 1,688,247 [GJ]
Total CO ₂ -e emission reduction over improvement period	GAS: 94,408 [ton] ELEC: 691 [ton] 95,099 [ton]

Drivers: In July 2014, ENAP signed a Cooperation Agreement with the Ministry of Energy, which promotes the efficient use of energy resources, through the promotion of energy management and energy efficient equipment, as well as promoting the realization of projects that contribute to innovation and culture in the proper use of energy, in ENAP Refinerías (ERA, ERBB, MAG-R&C and DAO) as well as in the exploration and production units of hydrocarbons in ENAP Magallanes (MAG-E&P). Within the agreement, there are the following activities and commitments:

I) The study of joint work alternatives to implement energy efficiency measures beneficial to ENAP, through specific activities and/or projects to be developed.

II) Implement an Energy Management System (EnMS) with high international standards, which has the following elements:

- Have an Energy Policy, supported by senior management, in which the company is committed to improving its energy performance continuously over time.
- Define a person in charge of the energy management of the company, duly trained, who joins the top management of the company.
- Conduct independent energy audits, executed by specialized consultants, which will be agreed between the Parties. These should establish an energy baseline (EnB), performance indicators (EnPI) and measurement, reporting and verification protocols (M&V).
- Prepare and implement a medium and long-term Energy Efficiency Plan based on the results of the audit that includes specific goals and objectives and that addresses operational improvements, maintenance, replacement of equipment and introduction of new technologies, among others.
- Develop permanent awareness-raising activities throughout the organization on energy efficiency issues from top management to contractors.
- Incorporate in the Annual Sustainability Report the progress of the Energy Efficiency Plan, indicating the evolution of performance, energy savings, awareness plans and the benefits for the community as a result of the measures adopted.

III) Design of a corporate methodology for the evaluation of projects that incorporate the variable energy efficiency as a main or secondary actor.

Energy reduction approach: ENAP operations demand a large amount of energy, so any initiative or improvement in this matter is a direct contribution to the benefit of the company. According to this, efforts to reduce energy consumption and operate more efficiently are inherent within the organization. However, prior to the implementation of EnMS, there was no uniform criterion regarding the evaluation and implementation of projects in pursuit of improving energy efficiency. Likewise, a standard methodology was not applied to measure and verify the energy savings generated by these initiatives.

This situation has been changing progressively as the implementation of EnMS in the company was prepared. Currently, through the Energy Management Department, a manual has been developed that allows incorporating the variable efficiency in the evaluation and development of projects, as well as promoting a standard that allows monitoring and projecting energy and economic savings in all units. In this way, it is possible to determine the impact of all the initiatives developed at the company level and establish goals that allow ENAP to improve its energy performance.

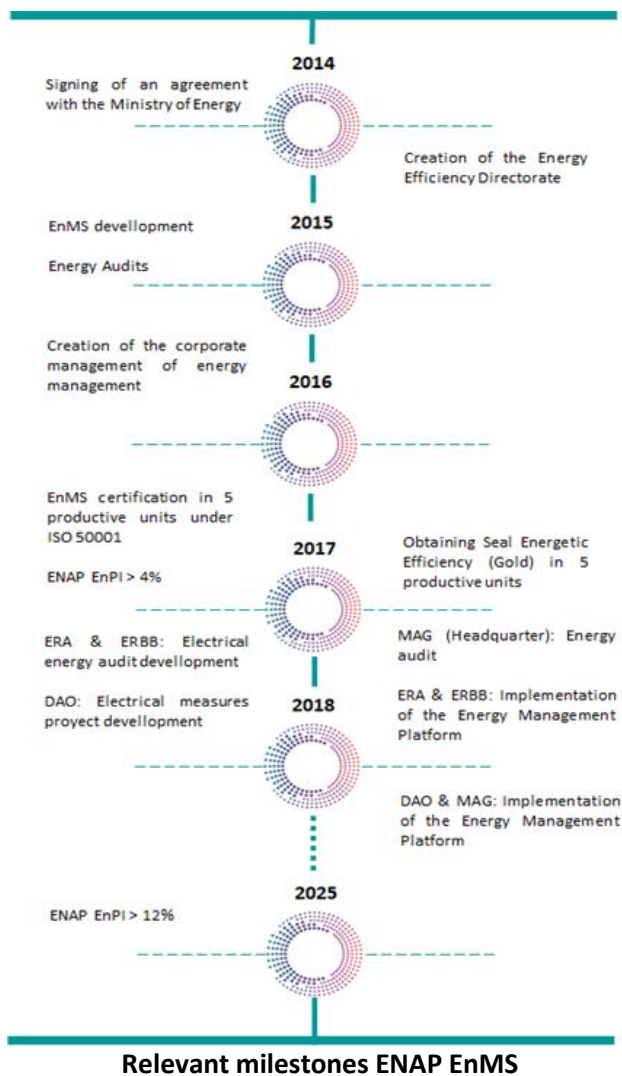
Business Benefits Achieved

At the end of 2017, ENAP quantified savings of more than 15 million dollars per year, thanks to the projects that have been implemented since 2015, which means a reduction in energy consumption of more than 4% compared to the baseline established in 2015. Additionally, these measures allowed avoiding the emission of more than 95 thousand tons of CO₂-e.

ENAP for the year 2025 has the objective of reducing its energy consumption by at least 12%, reaching annual savings of more than 50 million dollars, as well as considerably reducing its greenhouse gas emissions. On the other hand, the implementation of EnMS has brought other benefits to the company, one of them supporting a strategic objective related to the strengthening of the corporate image, through internal recognition, governmental and our clients.

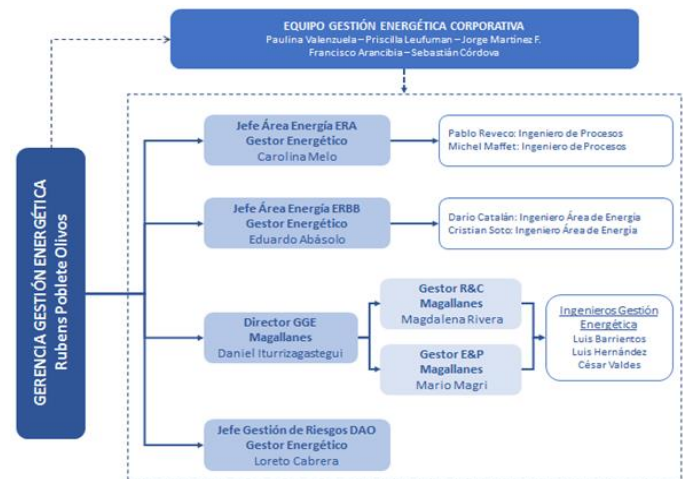
EnMS Development and Implementation

As part of the cooperation agreement with the Ministry of Energy, ENAP commits the implementation of the EnMS with an international standard, which motivated the creation of the Energy Efficiency Directorate, which will become an Energy Management Department, positioning it as a transversal and strategic unit within the company, reaffirming in this way the commitment of the Senior Management with the efficiency and energy management.



Organizational: EnMS is operated and managed by the Energy Management team located in the corporate building of ENAP in Santiago, Chile.

Understanding that the productive activities of ENAP are divided into 5 units is that an energy manager has been designated per site, supported by a group of local engineers. This personnel organization that operates outside the corporate building has been called the Energy Management Team (EMT).



Structure of the ENAP's Energy Management Team

Thanks to this organizational structure, ENAP managed to implement and develop its EnMS, achieving the certification of this under ISO 50001 standard in 2017.

Energy review and planning: During 2015, the Energy Efficiency Directorate developed a plan to carry out energy audits in the 5 productive areas of ENAP whose objective in each of the units was to establish a baseline of energy consumption (EnB), propose and calculate energy performance indicators (EnPI), in addition to preparing a portfolio of investment projects in pursuit of the improvement of energy efficiency, assessing their technical, environmental, economic and financial viability according to the reality of the company. These audits were carried out by expert consultants in energy, energy efficiency and project development.

The final reports of these studies were the basis for implementing an EnMS that allows structuring the decision making regarding the allocation of resources and the planning of actions in the medium-short term.

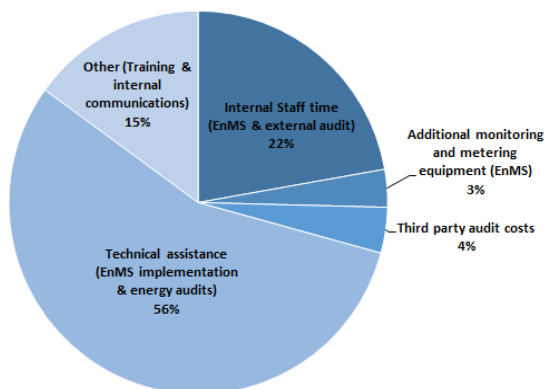
It should be noted that these studies were financed in part with non-reimbursable funds by the Banco de Desarrollo de América Latina, through the Corporación Andina de Fomento (CAF) and Banco Interamericano de Desarrollo (BID).

These studies generated sufficient information to characterize the company in terms of energy use and consumption, identification of gaps and detection of measurement and instrumentation needs that support the EnMS. In general terms, the following is listed:

- Energy flows are identified, managing to define patterns of generation and consumption of energy.
- Almost all the energy consumed by ENAP is thermal, being the exception the operative unit DAO whose energy consumption is electric.
- Consumption baselines and energy performance indicators are defined for each unit.
- Regarding the performance indicators, its basic definition responds to the ratio between the amounts of energy consumed [MMBTU] or [kWh] and the quantity of valuable product [m³] generated, transported or stored.

Cost-benefit analysis: The cost of developing, implementation and certification of EnMS, amounts to a sum close to 1.6 million dollars, within this amount are considered the following items:

- Internal personnel for the development, implementation and certification of EnMS.
- Additional monitoring required by EnMS.
- Audits carried out by external consultants.
- Technical assistance.
- Others (Internal communication and training).



Cost distribution ENAP EnMS

At the corporate level, until 2017, ENAP has invested approximately 3.8 million dollars in energy efficiency, of which 2.2 million are investments related to the implementation of energy efficiency measures.

Consequently, if the cost of these projects is included, the return period of the investment is extended to 3 months.

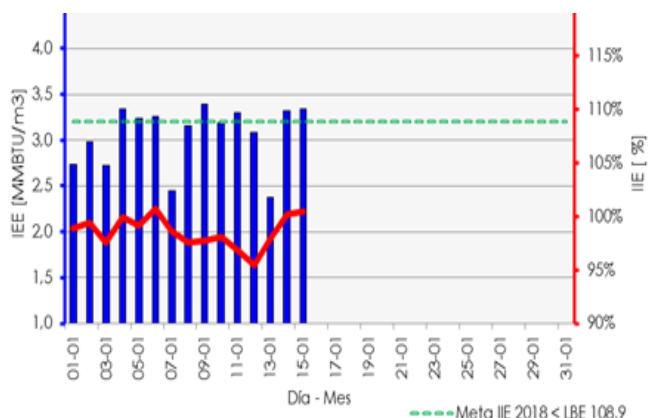
Executed Projects	# Projects	Capex [USD]	Energy Savings [MMBTU/year]
2015	5	0	356,820
2016	16	1,642,000	1,026,635
2017	3	522,000	216,779
Total	24	2,164,000	1,600,234

Approach used to determine whether energy performance improved: The energy savings and the improvement in the performance of the company have been determined based on ENAP's energy consumption in 2015. As indicated above, in each ENAP operating unit, there is a person in charge of energy management. Among its functions, is reporting on energy efficiency projects and those that are not necessarily managed by efficiency issues (maintenance for example), but have a significant impact on the energy consumption of an equipment or unit of process.

The information sent from all the units is consolidated by the Energy Management Department, which is in direct communication with the energy managers of each unit. Additionally, and as energy efficiency projects and initiatives are developed and put into operation, the units must report the generated savings, which can be obtained from energy meters installed in the field, control and supervision process systems, calculations made by the Engineering departments in each unit or savings estimates made by external consultants.

Regardless of the resources or tools used by the energy managers to determine the savings, they additionally have the task of linking and analyzing the energy saving data with the productive reality of each unit. This includes, among other things, establishing the following definitions:

- Define the scope in which energy savings have been determined.
- Calculate energy performance indicators, established in each unit.
- Analyze data and make the necessary corrections to normalize energy performance based on the operational behavior of the unit.
- Determine the use and consumption of energy. Analyze and promote energy improvements.



Monitoring of energy efficiency indicators in refineries

Approach used to validate results: ENAP is aware of the importance of establishing a methodology for measuring and verifying savings that is traceable and recognized. It is in this line that together with the Chilean Energy Efficiency Agency (ACHÉE), Measurement and Verification (M&V) courses have been developed based on the international IPMVP protocol in the different productive units of the company. The objective of this training is being to promote the use of this methodology at the corporate level when developing and monitoring energy efficiency projects.

In November 2017, ENAP obtained the Energy Efficiency Seal sponsored by AChEE and the Chilean Ministry of Energy. Within the requirements, 2 energy efficiency initiatives (max. 2 years old), had to be implemented, while verifying improvement in energy performance.

In addition, the energy savings obtained from these projects must be validated by an external consultant, privileging the use of the IPMVP or another recognized protocol. For these purposes, ENAP hired a consulting company with extensive experience at the national level and certified professionals (CEM and CMVP).

The energy savings generated by the 10 initiatives submitted for the contest was more than 1 million GJ per year, which means that 70% of the savings that ENAP has quantified up to 2017 is certified and validated by expert consultants.

Steps taken to maintain operational control: The operational controls are carried out based on the activities associated with the operation of the plants and their preventive maintenance systems.

From these activities, the operational controls associated with the significant uses were defined, and this information is crossed with the activities associated with the Operational Integrity Management Systems. In this way, given that in the 5 units there are procedures associated with Quality Management Systems (ISO 9001) it is that the activities associated with EnMS are supported. These controls were defined from energy planning reports and specific identification records.

For regulatory compliance, there is a document system in intranet, where there are backups associated with procedures, instructions, and associated record formats. The preventive maintenances are associated with the monthly programming carried out by SAP (PM) in the units, in such a way that a traceable record is kept, which also includes the activities of calibration and maintenance of the meters, along with the instructions and orders of work.

Development and use of professional expertise, training, and communications: In terms of training and skills development, ENAP has an Annual Training Plan (ATP) directly linked to the workers' curriculum vitae in each unit. During 2017, a series of training activities were developed (EnMS e-learning course, EUREM diploma course, Measurement and Verification course, internal auditor courses ISO 50001, among others).

In the future, courses and trainings are planned according to the knowledge of teams, process units and management systems, understanding that the development of skills and competencies of workers with an active role within the energy management system of ENAP will facilitate the progressive improvement of the company's energy performance.

Tools & resources: In the design and implementation of EnMS, structural procedures and record formats associated with the existing quality management systems (ISO 9001) were integrated, whose documentation is available on the company's intranet. Within this system are included the procedures and documents associated with operational issues, production and maintenance, which were considered within the operational controls. For the Monitoring of the EnMS, the units have specific records for each of their realities, delivering reports periodically, regarding energy performance.

Likewise, there is an annual planning associated with EnMS, where all the necessary activities are considered, for the correct operation, verification and follow-up.

During 2017, ENAP began the development of an energy management platform. The objective of this project is to centralize the information (uses, consumption and generation of energy, variables that affect the energy performance of equipment, calculation and monitoring of energy indicators, among others) that generate the units and manage them. Currently the project is oriented in refineries (ERA and ERBB), but in the next few years it will be extended to Magallanes and DAO.

Lessons Learned

During this work, in general, two groups of needs related to the operation of EnMS were detected, the first of which is related to the knowledge and skills of the company's workers on issues of efficiency and energy management. The second group, directly related to shortages of instruments and energy measurement systems that allow obtaining timely and reliable information on the energy performance of each of the units and, as a consequence, knowing the corporate behavior in terms of energy. Thanks to the structuring of Senior Management committee, focused on the promotion of management and energy efficiency in the company have been able to manage the resources necessary for the development of studies, projects and prioritize respect to the needs existing. Additionally, the creation of Energy Management Team with representatives in each unit has strengthened the development of EnMS, thanks to the experience and knowledge that they can provide from each unit.

The introduction of energy efficiency and performance at the corporate level has allowed to obtain considerable economic benefits, support the image of a responsible company with the environment and oriented to sustainable development. This positions us as a leading and exemplary company within the country, encouraging other companies to promote energy awareness beyond social responsibility, demonstrating with facts that making energy efficiency is an investment with highly attractive returns.

Keys to Success

- Recognition as a leader in efficiency and energy management (ISO 50001).
- Establish energy performance as a fundamental indicator for the company.
- Definition of roles and responsibilities in all operating units (involvement of all workers)
- Establish corporate goals and promote collaboration among the units.



ENAP received the highest number of distinctions in the 2017 version of Energy Efficiency Seal.

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.