Case Study

Ingersoll Rand Manufactura S. de R.L. de C.V. : Implementation of an Energy Management System

Monterrey, Nuevo Léon, Mexico

After implementing the ISO 50001 energy management system (EMS) at its facility in accordance with the processes and criteria of the Superior Energy Performance (SEP) certification program, the Ingersoll Rand Manufactura S. de R.L. de C.V. manufacturing plant in Monterrey, Mexico, improved its energy performance by 29% over four years.

ISO 50001 certification audit by AWS, March 2018.

Financial justification for the implementation of the energy management system (EMS)

Organizational context

Ingersoll Rand is a world leader in the creation of comfortable, sustainable, and efficient environments for our clients, employees, and communities. We grow by means of client-centered innovations that improve the quality of life and our environment, including those that promote sustainable commercial practices.

We offer our clients products and services that help reduce energy use and greenhouse gas (GHG) emissions and thus help minimize the effects of climate change. At the same time, we work to reduce the energy footprint of our own operations.

Our climate commitment

In 2014, Ingersoll Rand made an industry-leading commitment to help resolve some of the world's most pressing challenges, such as the unsustainable demand for energy resources. This commitment benefits our clients in the form of more sustainable product options that continue to offer the safety, performance, and reliability they expect.

The Climate Commitment increases energy efficiency and reduces GHG emissions from our operations and products, for example:

- A 50% reduction in the GHG footprint of the coolants in its products by 2020, and alternatives throughout its portfolio with low-global warming potential (GWP) by 2030.
- An investment of US$500 million in research and development related to products to finance the long-term GHG reduction.
- **A reduction of 35% in the GHG footprint of its own operations by 2020**.

In Mexico, Ingersoll Rand Manufactura S. de R.L. de C.V. started on the path to implement energy management on February 3, 2016, when it formally joined the North American

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Energy Management Pilot Program (NAEMPP) of the Commission for Environmental Cooperation (CEC). This program, implemented in partnership with Mexico's *Comisión Nacional para el Uso Eficiente de la Energía* (Conuee), the US Department of Energy (DOE), and Natural Resources Canada, was created for private-sector industrial facilities in Canada, Mexico, and the United States, with the object of promoting the adoption of and certification according to standard ISO 50001 & Superior Energy Performance® (SEP)—systems occupying a position of international leadership in energy management.

Snapshot of the case study

Industry	Manufacturing
Product or service	A/C equipment and HVAC units
Location	Monterrey, Nuevo Léon
Energy management system (EMS)	ISO 50001 & SEP
Period of energy performance improvement	4 years (2014-2017)
Energy performance improvement (%) throughout the improvement period	29%
Total energy cost savings throughout the improvement period	US$608,960.00
Cost of EMS implementation	US$60,000.00
Total energy savings throughout the improvement period	1.55 GJ
Total CO_2 emissions reduction throughout the improvement period	3,147 tons

The support of the CEC, assistance from Conuee, and the energy-related technical support, experience, and knowledge provided by the Georgia Institute of Technology (Georgia Tech) made it possible to concretize the structure of the organization's energy management system.

At Ingersoll Rand Manufactura S. de R.L. de C.V., it is our mission to develop comfort and efficiency solutions with sustainable, competitive, high-quality products, with the most advanced technology and operational excellence; to go beyond the needs of our clients and add value for our shareholders with the commitment and talent of our people. Our vision is to be a global leader in operational excellence and have the best working team.

"The implementation of ISO 50001 in our operations confirms our continuous energy improvement and adds value to our manufacturing process."

Rigoberto Mena Alanís, energy leader

Business benefits achieved

At Ingersoll Rand Manufactura S. de R.L. de C.V., we can now say that we possess the tools and knowledge necessary to administer energy resources, which are a fundamental aspect of manufacturing operations. This is the first and only Ingersoll Rand facility in the Americas to obtain both certifications in energy management: ISO 50001 and Superior Energy Performance Platinum Level.

The SEP program administered by DOE consists of a certification scheme for auditing energy savings in facilities holding ISO 50001 certification. Organizations can use this program as a guide to improve their energy performance, allowing them to achieve continuous energy efficiency improvement in their facilities and generating attractive returns on the investment.

By adopting this system, we have achieved an 8.1% decrease in our average annual energy consumption, in

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addition to US$152,000 in savings from implementing improvements and projects derived from the various activities carried out by the system, including periodic measurement, review, and analysis of energy consumption, energy audits, and energy planning.

Operational excellence has been maintained at Ingersoll Rand with the use of the DMAIC methodology:

- ☑ **D**efine the problem
- ☑ **M**easure the impacts
- ☑ **A**nalyze the causes
- ☑ **I**mplement the improvements
- ☑ **C**ontrol the solutions

Following this methodology, we successfully detected opportunities for improvement, among them, in energy consumption. In addition, our "A3" planning and problem-solving tool enables us to stratify the steps to be followed to address this potential improvement continuously over time. The steps are divided into nine focus boxes that ensure effective analysis of the actions to be taken and their results, allowing us to correct any deviations before they adversely affect the desired outcome.

Participants from Ingersoll Rand Manufactura and NAEMPP coaches at Conuee.

The structure of ISO standards, based on the well-known Deming cycle (Plan-Do-Check-Act), did not disrupt the industrial operations of the organization. Quite the contrary: it specifically strengthened our management model by configuring—step by step, phase by phase—each clause of ISO 50001, using the DMAIC and A3 methodologies deployed by Ingersoll Rand across its strategic business units. The comprehensive model is shown in the following table below.

Table 1. Energy management model of Ingersoll Rand Manufactura

DMAIC	DMAIC-A3	ISO 50001	SEP
Define the problem	- You have indicated there is a problem – now prove it. **Why?** What are the impacts? - Why is it a problem? What is the process affected? What are customers saying? - What is the target state/goal of the project? ✔ Define the problem ✔ Target state	4.3 Energy policy	**Step 1**: Engage management
Measure the impacts	- You have proved there is a problem, now use facts and data to show current performance (financial, time, quality, customer satisfaction). **Why?** - This is the basis (baseline measures) from which you will prove improvements. ✔ Breakdown the problem	4.4 Energy planning	**Step 2**: Plan for energy management
Analyze the causes	- You have base measures (abnormalities in performance), now find what is causing this. - The root causes will help develop information about potential solutions. ✔ Root cause analysis ✔ Solution approach		**Step 3**: Implement energy management
Implement the improvements	- You have identified potential solutions; now stress test if they will work. - Evaluate process improvements and results – tweak or find new solutions, if necessary. ✔ Rapid experiments ✔ Completion plan	4.5 Implementation and operation 4.6 Checking performance	**Step 4**: Measure the results
Control the solutions	- You have tested and implemented solutions; now maintain improvement gains. - Compare processes before and after changes (using Measure Phase baselines). - Communicate and train people in the new Standard Work – monitor (Leader Standard Work) ✔ Confirmed results and process ✔ Insights and actions	4.7 Management review	**Step 5** : Review for continual improvement

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Preparation and implementation of the EMS

During the preparation and implementation of the EMS, the basis of the system was put in place progressively with the support of senior management. In addition, a multidisciplinary team was formed with attributes and functions that enriched the development of the system.

Figure 2 depicts the time period and each of the steps followed for the implementation of the EMS.

An internal energy committee was formed at the Monterrey plant, bringing together the necessary talents and profiles so that, over a period of slightly more than 18 months, under the guidance, supervision, and coaching of experts from the Georgia Tech energy management department, the full energy management cycle was implemented under the Deming continuous improvement structure of ISO 50001 and ANSI/MSE 50021 (SEP). In tandem, energy audits of the plants were conducted to assist with the analysis of the energy data as well as identifying significant levels of energy use (USEn). In our case, these are the three most important systems for our energy consumption and its variables. We identified them thanks to a tool provided under NAEMPP that serves to ascertain statistically the relationship with the consumption of each system. Simple energy performance indicators, such as kwh/unit produced, were established.

A review of historical consumption patterns showed a stable, cyclical trend, and the baseline specifications established by MSE 50021 helped us establish those of our EMS.

Companies that also participated in the NAEMPP included Cummins, Arcelor Mittal, and 3M, among others. The workshops were held on the premises of Conuee in Mexico City; the training, comprehension, and analysis sessions focusing on ISO 50001 and ANSI/MSE 50021 were held in 2016 and the first half of 2017. The organizational contexts for each particular sector were discussed, and energy-related best practices for manufacturing were shared by the experts, who participated actively in these workshops, based on their combined experience.

The final session consisted of training on the practical aspects of internal auditing and final system documentation, and was held at Ingersoll Rand Manufactura S. de R.L. de C.V. in Monterrey, Nuevo León.

The Internal Energy Committee of Ingersoll Rand Manufactura S. de R.L. de C.V. is composed of Rigoberto Mena Alanís (senior management representative), Estefania Espinoza Treviño, Wendy Regalado Cruz, David Torres Medina, and Jesús Hernández Caballero. They are in charge

Figure 1. EMS implementation timeline

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Table 2. Stages of the NAEMPP

Preparation of infrastructure for project implementation (webinar)	February-March 2016
Implementation phase I: "Plan"	April-August 2016
Implementation phase II: "Do"	September-October 2016
Implementation phase III: "Check" and "Act"	November 2016-March 2017
Implementation phase IV: Measurement and evaluation	April-June 2017
Monthly training webinars and advisory conference calls	Throughout program
Review of quarterly reports	Throughout program
External documentary review and feedback	Throughout program

of deploying the EMS implementation strategy throughout the facility according to what was learned in the initial phases of the NAEMPP learning network, with follow-up and technical support as needed from Randy Green and Sandra Enciso (of Georgia Tech). Through progress report sessions held remotely, a solid EMS structure has gradually been put in place and has begun making progress in line with the organization's strategic objectives.

From February 27 to March 2, 2018, third-party (external) auditing was performed by Advanced Waste Management, Inc., a US-based auditing firm, which concluded with a recommendation for certification of the EMS in accordance with ISO 50001:2011 and ANSI/MSE 50021 Superior Energy Performance standards of the US Department of Energy.

Cost-benefit analysis

The investment in the EMS considered short-term benefits, such as:

- Serving as a pilot program for the implementation of EMS in North America
- Establishing sub-measure infrastructure (Boomerang Energy)
- Skill building
- Use of third-party auditing.

These helped to develop competencies, which, in combination with the initiatives of the Conuee learning networks, are now bolstering and solidifying energy management in our facilities. This represents a benefit not only in economic terms but also in knowledge innovation, building teamwork, and synergy aligned with the values of Ingersoll Rand.

Figure 2. Phases in the implementation of the EMS at Ingersoll Rand Manufactura S. de R.L. de C.V.

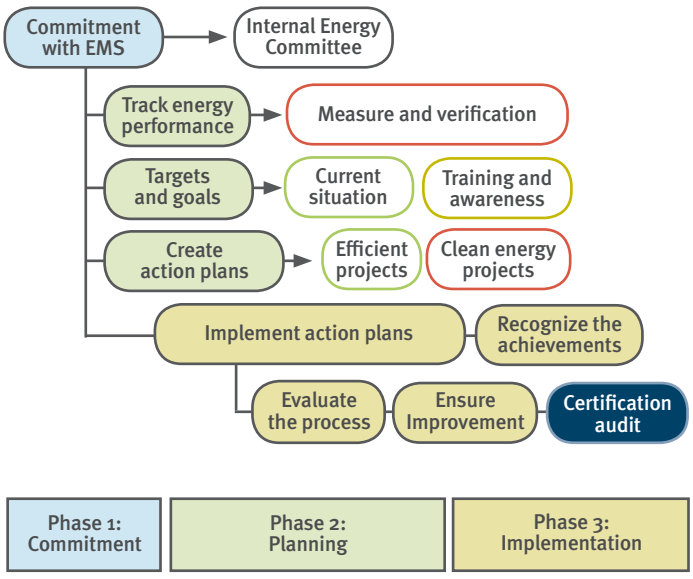

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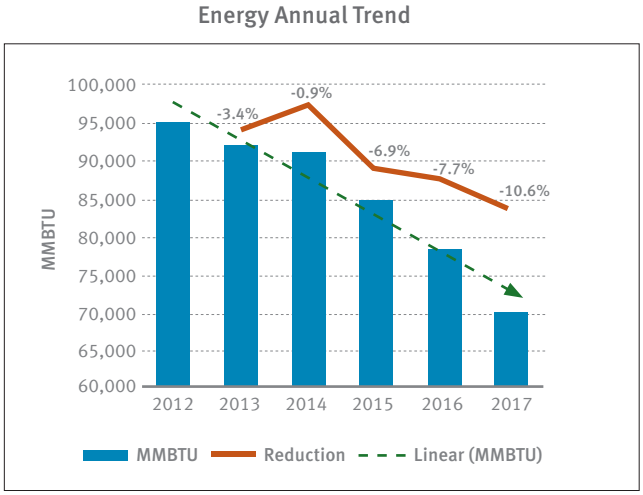
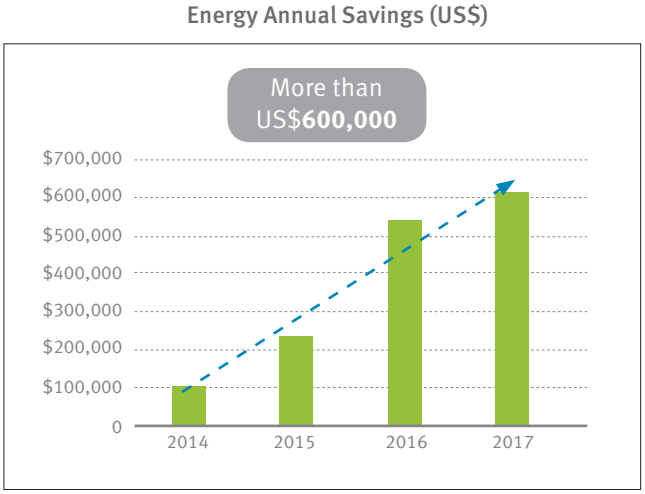
Figure 3. Energy consumption behavior and energy savings





The improvement in energy savings achieved up to 2016, consolidated with the implementation of the ISO 50001 EMS, yielded over $600,000 in savings, in addition to reducing energy consumption and GHG emissions.

Measures to maintain control of operations and prolong energy performance improvements

We concluded that in order to achieve successful control of energy in an operational context, we must:

- Deploy a culture of strong energy performance in all manufacturing operations as a component of the operational excellence already existing in the organization.
- Raise awareness of the importance of operational control among persons directly responsible for or involved in significant levels of energy use (USEn).
- Communicate intensively the goals, objectives, and gains made with the EMS and the importance of employee participation in order to achieve these.

"ISO 50001 has enabled us to assess energy performance as a key component of our manufacturing operations."

Rigoberto Mena Alanís, Maintenance Manager

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What we have learned

Lessons learned

1. Understanding and implementing a standard based on performance compliance.
2. Building skills to demonstrate continuous improvement through energy performance indicators and auditing of energy goals and objectives.
3. Long-term strategic focus on ensuring sufficient projects to achieve energy goals and objectives.
4. Understanding possible instances of noncompliance caused by the failure to achieve anticipated energy performance.
5. Energy planning and monitoring/measurement/analysis.
6. Developing and maintaining an energy review.
7. Establishing baseline indicators and energy performance.
8. Setting and auditing goals and objectives.
9. Monitoring significant deviations and acting to resolve them.
10. Improved monitoring, measurement, and calibration.

Keys to success

- Continually advocate for a system-wide focus.
- Require constant leadership and commitment.
- Involve the EMS in activities with adherence to organizational control mechanisms.
- Be sure all participating departments benefit, with all types and manner of support for the manufacturing operation.
- Ensure that all staff members of the organization understand that optimal energy performance is being implemented.

This case study was prepared for the Commission for Environmental Cooperation (CEC) as part of the 2017–2018 project, *Increasing Industrial Energy Efficiency through ISO 50001*, implemented in partnership with Mexico's ***Comisión Nacional para el Uso Eficiente de la Energía***, Natural Resources Canada, and the US Department of Energy. The CEC facilitates collaboration and public participation to foster conservation, protection and enhancement of the North American environment for the benefit of present and future generations, in the context of increasing economic, trade, and social links among Canada, Mexico, and the United States. To date, the CEC has published over 400 reports, maps, tools and resources related to the North American environment, all accessible at **www.cec.org**.