ISO 50001 Energy Management System
Case Study

México

Ingersoll Rand

World-Class Energy Efficiency

ISO 50001 certification audit by AWS, March 2018

Organization Profile & Business Case

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

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

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

—Rigoberto Mena Alanis, energy leader

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 greenhouse gas emissions in connection with our operations and products. It includes:

- A 50% reduction in the GG footprint of the coolants in its products by 2020, and low-GWP alternatives throughout its portfolio by 2030.
- A $500 million investment in research and development related to products to finance the long-term GG reduction.

Case Study Snapshot	
Industry	Manufacturing
Product/Service	A/C equipment and HVAC units
Location	Monterrey, Nuevo Leon
Energy management system	ISO 50001 & SEP
Energy performance improvement period	5
Energy Performance Improvement (%) over improvement period	28.8%
Total energy cost savings over improvement period	785 k
Cost to implement EnMS	74 k
Total Energy Savings over improvement period	25,399 GJ
Total CO_2-e emission reduction over improvement period	3,140 TonCO2

- A 35% reduction in the greenhouse gas footprint of its own operations by 2020.

For Mexico and **Ingersoll-Rand Manufactura S. de R.L. de C.V.**, the path to the implementation of energy management started on 3 February 2016 when the company formally joined the North American Energy Management Pilot Program (NAEMPP) of the Commission for Environmental Cooperation (CEC).This program, implemented in partnership with the Comisión Nacional para el Uso Eficiente de la Energía (CONUEE) of Mexico, the Department of Energy (DOE) of the United States and Natural Resources Canada, was created for private-sector industrial facilities in Canada, the United States, and Mexico with a focus on promoting the adoption of standard ISO 50001 & Superior Energy Performance® (SEP) — systems occupying a position of international leadership in energy management — and achieving certification under these standards.

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, using 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 the best working team.

Business Benefits

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 (ISO 50001 and Superior Energy Performance Platinum Level) in energy management.

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

With the adoption of this system, we have achieved an 8.1% decrease in our average annual energy consumption, in addition to US$152,000 in savings due to the implementation of 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

In this way, and working assertively, we successfully detected areas of opportunity, including energy consumption. In addition, our "A3" planning and problem-solving tool enables us to stratify the steps to be followed so as to address this area of potential improvement continuously over time. The steps are divided into nine focus boxes in order to ensure effective progress on the analysis of the actions and their results, so that we can effectively correct any deviations before they adversely affect the desired final outcome.

The structure of ISO standards based on the well-known Deming cycle (Plan-Do-Check-Act) did not disrupt the industrial dynamic of operations in the organization; quite the contrary, it specifically and singularly helped solidify our management model since, by its very nature, it served to configure — step by step, phase by phase —

each and every clause of ISO 50001 using the DMAIC and A3 methodologies deployed by Ingersoll Rand across all its strategic business units. The comprehensive model is shown in the following figure:

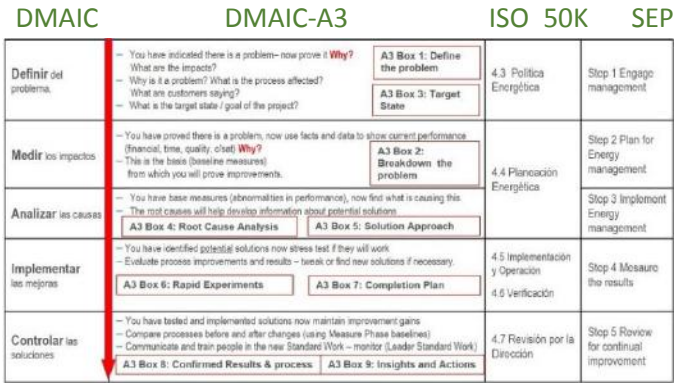


Illustration 1. Energy management model of Ingersoll Rand Manufacture

Plan

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

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

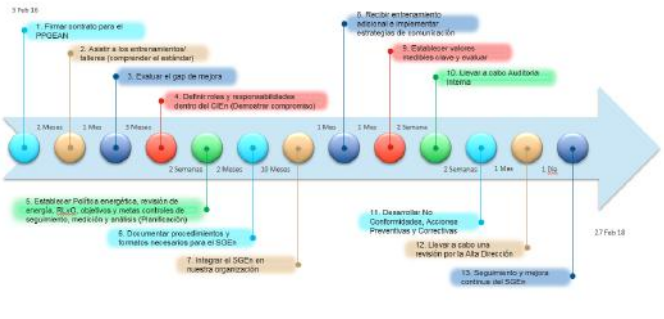


Illustration 2. EMS implementation timeline

To this end, 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 set out in 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 the identification of the USEn. In our case, these are the three most important systems for our energy consumption and its variables (HDD, CDD, °C, production units, air compressed). We identified them thanks to a tool provided under NAEMPP that serves to statistically ascertain 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 shows a stable cyclical trend, and a consideration of the necessary specifications established for the baseline (2013 year) as per MSE 50021 helped us establish those of our EMS.

Companies that also participated in the NAEMPP included Cummins, Arcelor Mittal, and 3M, amongst others. The workshops were held on the premises of CONUEE in Mexico City; the training, understanding, 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 best energy-related manufacturing practices were shared on the basis of the combined experience of the experts who participated actively in these workshops. 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 the city of Monterrey, Nuevo Leon.

Puntos relevantes del programa	Calendarización
Preparación, vía seminario web, de la infraestructura para la instrumentación del proyecto	Febrero a marzo de 2016
Fase de instrumentación I: "Planificar"	Abril a agosto de 2016
Fase de instrumentación II: "Hacer"	Septiembre a octubre de 2016
Fase de instrumentación III: "Verificar" y "Actuar"	Noviembre de 2016 a marzo de 2017
Fase de instrumentación IV: Medición y evaluación	Abril a junio de 2017
Seminarios web de capacitación mensuales y conferencias telefónicas de asesoramiento	Durante todo el programa
Revisión de informes trimestrales	Durante todo el programa
Revisión documental externa y retroalimentación	Durante todo el programa

Illustration 3. Stages of the NAEMPP

Illustration 4. Participants from Ingersoll Rand Manufacture and NAEMPP coaches at CONUEE

Do, Check, Act

The internal energy committee of **Ingersoll-Rand Manufactura S. de R.L. de C.V.** is made up of Rigoberto Mena Alanís (senior management representative), Estefania Espinoza Treviño, Wendy Regalado Cruz, David Torres Medina, and Jesus Hernandez Caballero. These employees are in charge of deploying the EMS implementation strategy throughout the facility as per 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 (Georgia Tech). Through progress report sessions held remotely a solid EMS structure has gradually been put in place and taken its first steps in line with the organization's strategic objectives.

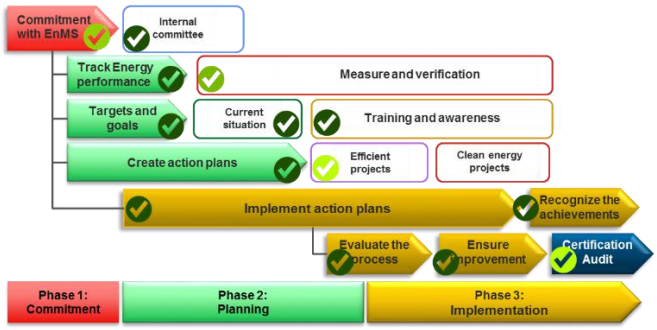
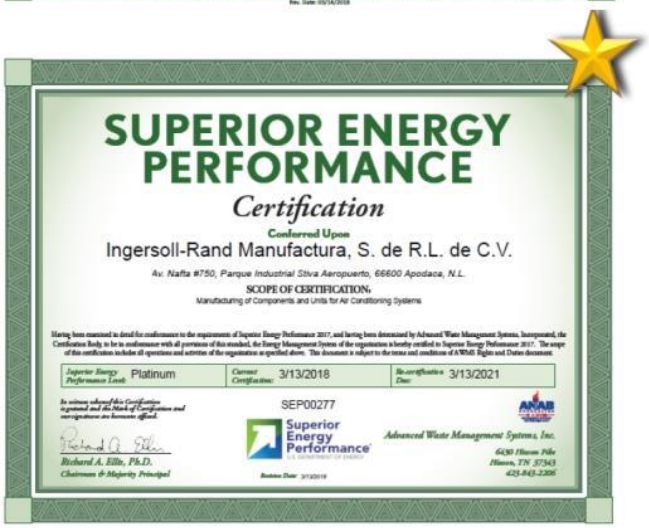


Illustration 5. Esquema

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


ISO 50001
Certification
Conferred Upon
Ingersoll-Rand Manufactura, S. de R.L. de C.V.
Av. Nafta #750, Parque Industrial Stiva Aeropuerto, 66600 Apodaca, N.L.
SCOPE OF CERTIFICATION: Manufacturing of Components and Units for Air Conditioning Systems
Initial Certification: 03/13/2018 | Current Certification: 03/13/2018 | Re-certification Due: 03/13/2021
CERTIFICATION #: En00277
Advanced Waste Management Systems, Inc.


SUPERIOR ENERGY PERFORMANCE
Certification
Conferred Upon
Ingersoll-Rand Manufactura, S. de R.L. de C.V.
Av. Nafta #750, Parque Industrial Stiva Aeropuerto, 66600 Apodaca, N.L.
SCOPE OF CERTIFICATION:
Manufacturing of Components and Units for Air Conditioning Systems
Superior Energy Performance Level: Platinum | Current Certification: 3/13/2018 | Re-certification Due: 3/13/2021
SEP00277
Superior Energy Performance
Advanced Waste Management Systems, Inc.

Cost-benefit analysis

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

- Pilot program for the implementation of EMS in North America.
- Sub-measure infrastructure (Boomerang Energy).
- Skill building.
- Third-party auditing (AWMS).

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 terms of knowledge innovation, teamwork, and synergy aligned with the values of Ingersoll Rand.

Illustration 6. Energy consumption behavior and energy saving 2013-2017.

The energy improvement achieved up to 2018 was consolidated with the implementation of the ISO 50001 EMS, yielding over $785,000 in savings, in addition to lower energy consumption and greenhouse gas emissions.

As part of NAEMPP, We received statistical training to and tools needed to demonstrate energy performance improvement in compliance with the Superior Energy Performance Measurement and Verification Protocol (SEP M&V Protocol). We did some statistical regressions.

We use GT EnPI Tool from GTech and Energy Performance Indicator Tool from U.S. Department of energy to demonstrate our energy performance improvement.

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

—Rigoberto Mena Alanís, Maintenance Manager

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 to the importance of operational control among persons directly responsible for or involved in significant levels of energy use (USEn).

Intensive communication concerning the goals, objectives, and gains made with the EMS and the importance of their participation in order to achieve these.

Keys to success

- Continually advocate for a system focus.
- Call for constant leadership and commitment.
- Involvement of EMS in activities under the control of the organization.
- Benefit all departments involved, all types and spheres of support for the manufacturing operation.
- Ensure that all members of the organization understand the optimal energy performance that is being implemented.

Transparency

We participated in President´s awards: Ingersoll Rand recognizes people efforts through President's Awards. And those are send to all organization. That way is to recognize outstanding employee contributions in key areas of the company's vision. This is a prestigious honor within our organization. Also we communicated the achievement and the certificates through an email and different meetings at **Ingersoll-Rand Manufactura S. de R.L. de C.V.**

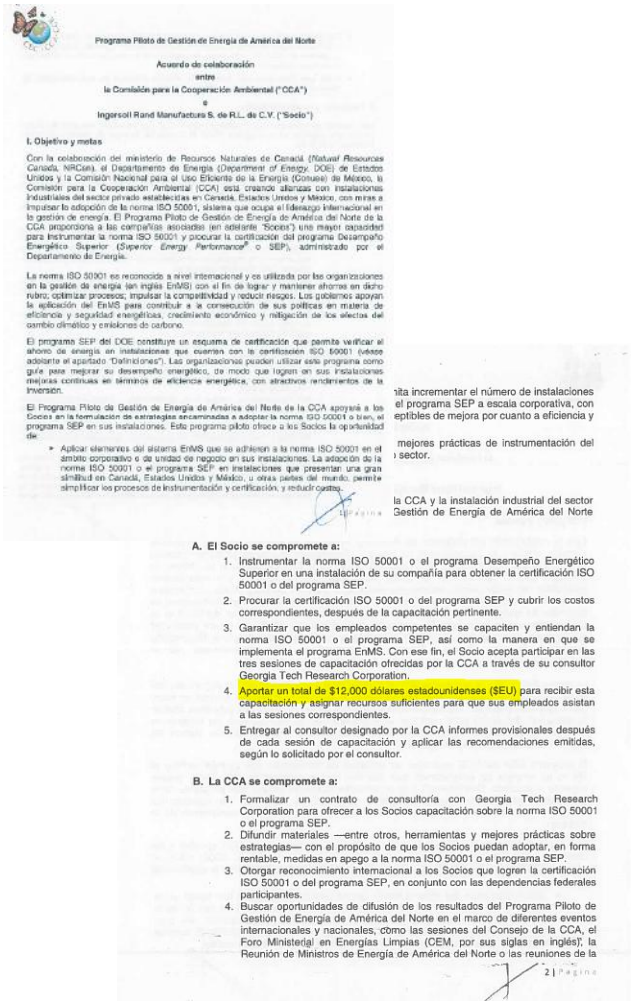
As well as on different websites like LinkedIn and Yammer.

Lessons Learned

- Understand and implement a standard based on performance compliance.
- Build skills for demonstration of continuous improvement through energy performance indicators and auditing of energy goals and objectives.
- Long-term strategic focus in order to ensure sufficient projects to achieve the energy goals and objectives.
- Understanding of possible instances of noncompliance caused by failure to achieve anticipated energy performance.
- Energy planning and monitoring/measurement/analysis.
- Development and maintenance of an energy review.
- Establishment of baseline indicators and energy performance.
- Setting and auditing of goals and objectives.
- Monitoring of significant deviations and acting to resolve them.
- Improved monitoring, measurement, and calibration.

2.2. **Quotes and Visuals**

Following images demonstrate NAEMPP Cost:



Programa Piloto de Gestión de Energía de América del Norte

Acuerdo de colaboración
entre
la Comisión para la Cooperación Ambiental ("CCA")
e
Ingersoll Rand Manufactura S. de R.L. de C.V. ("Socio")

I. Objetivo y metas

Con la colaboración del ministerio de Recursos Naturales de Canadá (*Natural Resources Canada*, NRCan), el Departamento de Energía (*Department of Energy*, DOE) de Estados Unidos y la Comisión Nacional para el Uso Eficiente de la Energía (Conuee) de México, la Comisión para la Cooperación Ambiental (CCA) está creando alianzas con instalaciones industriales del sector privado establecidas en Canadá, Estados Unidos y México, con miras a impulsar la adopción de la norma ISO 50001, sistema que ocupa el liderazgo internacional en la gestión de energía. El Programa Piloto de Gestión de Energía de América del Norte de la CCA proporciona a las compañías asociadas (en adelante "Socios") una mayor capacidad para instrumentar la norma ISO 50001 y procurar la certificación del programa Desempeño Energético Superior (*Superior Energy Performance*® o SEP), administrado por el Departamento de Energía.

La norma ISO 50001 es reconocida a nivel internacional y es utilizada por las organizaciones en la gestión de energía (en inglés EnMS) con el fin de lograr y mantener ahorros en dicho rubro; optimizar procesos; impulsar la competitividad y reducir riesgos. Los gobiernos apoyan la aplicación del EnMS para contribuir a la consecución de sus políticas en materia de eficiencia y seguridad energéticas, crecimiento económico y mitigación de los efectos del cambio climático y emisiones de carbono.

El programa SEP del DOE constituye un esquema de certificación que permite verificar el ahorro de energía en instalaciones que cuentan con la certificación ISO 50001 (véase adelante el apartado "Definiciones"). Las organizaciones pueden utilizar este programa como guía para mejorar su desempeño energético, de modo que logren en sus instalaciones mejoras continuas en términos de eficiencia energética, con atractivos rendimientos de la inversión.

El Programa Piloto de Gestión de Energía de América del Norte de la CCA apoyará a los Socios en la formulación de estrategias encaminadas a adoptar la norma ISO 50001 o bien, el programa SEP en sus instalaciones. Este programa piloto ofrece a los Socios la oportunidad de:

- Aplicar elementos del sistema EnMS que se adhieren a la norma ISO 50001 en el ámbito corporativo o de unidad de negocio en sus instalaciones. La adopción de la norma ISO 50001 o el programa SEP en instalaciones que presentan una gran similitud en Canadá, Estados Unidos y México, u otras partes del mundo, permite simplificar los procesos de instrumentación y certificación, y reducir costos.

ita incrementar el número de instalaciones
el programa SEP a escala corporativa, con
eptibles de mejora por cuanto a eficiencia y

mejores prácticas de instrumentación del
sector.

la CCA y la instalación industrial del sector
Gestión de Energía de América del Norte

A. El Socio se compromete a:

1. Instrumentar la norma ISO 50001 o el programa Desempeño Energético Superior en una instalación de su compañía para obtener la certificación ISO 50001 o del programa SEP.
2. Procurar la certificación ISO 50001 o del programa SEP y cubrir los costos correspondientes, después de la capacitación pertinente.
3. Garantizar que los empleados competentes se capaciten y entiendan la norma ISO 50001 o el programa SEP, así como la manera en que se implementa el programa EnMS. Con ese fin, el Socio acepta participar en las tres sesiones de capacitación ofrecidas por la CCA a través de su consultor Georgia Tech Research Corporation.
4. Aportar un total de $12,000 dólares estadounidenses ($EU) para recibir esta capacitación y asignar recursos suficientes para que sus empleados asistan a las sesiones correspondientes.
5. Entregar al consultor designado por la CCA informes provisionales después de cada sesión de capacitación y aplicar las recomendaciones emitidas, según lo solicitado por el consultor.

B. La CCA se compromete a:

1. Formalizar un contrato de consultoría con Georgia Tech Research Corporation para ofrecer a los Socios capacitación sobre la norma ISO 50001 o el programa SEP.
2. Difundir materiales —entre otros, herramientas y mejores prácticas sobre estrategias— con el propósito de que los Socios puedan adoptar, en forma rentable, medidas en apego a la norma ISO 50001 o el programa SEP.
3. Otorgar reconocimiento internacional a los Socios que logren la certificación ISO 50001 o del programa SEP, en conjunto con las dependencias federales participantes.
4. Buscar oportunidades de difusión de los resultados del Programa Piloto de Gestión de Energía de América del Norte en el marco de diferentes eventos internacionales y nacionales, como las sesiones del Consejo de la CCA, el Foro Ministerial en Energías Limpias (CEM, por sus siglas en inglés); la Reunión de Ministros de Energía de América del Norte o las reuniones de la

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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.

CLEAN ENERGY MINISTERIAL
Accelerating the Transition to Clean Energy Technologies

ipeec