

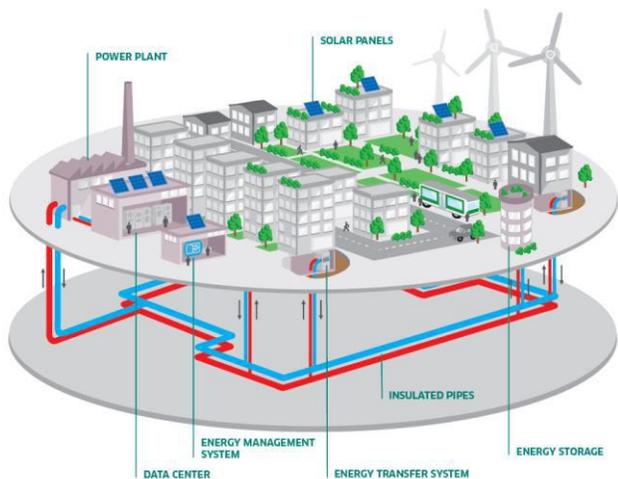
ISO 50001 Energy Management System Case Study

2021

Canada

Energy Services Acquisition Program (ESAP)

ESAP will reduce GHG emissions by providing clean heating and cooling energy while promoting continual energy performance improvement.



Top – View of the Cliff Central Heating and Cooling Plant (CHCP) from the public meeting area.

Bottom – Diagram of a typical four-pipe urban District Energy System (DES).

Case Study Snapshot	
Industry	Public Buildings
Product/Service	Heating and Cooling
Location	National Capital Region, Canada
Energy management system	ISO 50001
Energy performance improvement period, in years	3
Energy Performance Improvement (%) over improvement period	4.2%
Total energy cost savings over improvement period	\$420,000 USD
Cost to implement EnMS	\$365,000 USD
Total Energy Savings over improvement period	54,000 GJ
Total CO ₂ -e emission reduction over improvement period	2,350 Metric Tons

Organization Profile & Business Case

The Energy Services Acquisition Program (ESAP) was launched by Public Services and Procurement Canada (PSPC), a department of the Government of Canada, in 2009 to modernize four existing district energy system (DES) networks in the National Capital Area. In 2019, ESAP assumed responsibility for managing a contract with Innovate Energy, a Public Private Partnership (P3),

to complete a \$950 million USD six year construction project and a \$2.1 billion USD 35 year operations and maintenance agreement. The scope of the ESAP project includes 2 new CHCPs, 12 new boilers, 12 new electric chillers, 38 kilometers of district energy pipes, thermal storage, and 2 heat pumps. Since the emission baseline period (FY 05/06) ESAP has successfully reduced emissions from its DES networks by 52%. Key factors that have contributed towards this milestone include: transitioning towards efficient equipment such as electric chillers (from steam-driven chillers), reduced use of fuel oil, use of river water for free cooling, and promoting a culture of energy efficiency within the organization. In addition, ESAP is in the process of transitioning from a high pressure steam to a low-temperature hot water (LTHW) heating system that will reduce greenhouse gas (GHG) emissions even further. The implementation of ISO 50001 by ESAP was packaged with the LTHW capital renewal project to ensure continual energy performance improvement over the next 35 years.

The commitment to energy management at ESAP is demonstrated in its P3 contract, which includes a requirement of ISO 50001 certification for the 4 DES networks under ESAP's jurisdiction and well-defined energy and emission performance targets. Energy management is one of the cornerstones of the ESAP business model and is essential to achieving the contractually-defined performance metrics. This enables ESAP to market the heating and cooling energy supplied to the connected buildings as some of the greenest and best-value energy on the market over the life cycle of the buildings.

ESAP is motivated to reduce energy use and GHG emissions to align with Canada's goals established under the Paris Agreement (2015), the Pan-Canadian Framework on Clean Growth and Climate Change (2016), Canada's Greening Government Strategy, and the proposed Canadian Net-Zero Emissions Accountability Act to achieve net-zero emissions by 2050.

Business Benefits

ESAP's Energy Management System (EnMS) has enabled the organization to identify opportunities to improve energy performance, reduce GHG emissions from operations, and to build internal energy management capacity as an organization. ESAP's Energy Management Team has successfully achieved its objectives by monitoring factors such as the monthly consumption of electricity, natural gas, and loading conditions. The operational criteria and procedures are seamlessly integrated with on-site plant operations to achieve optimum efficiencies at the Central Heating and Cooling Plants (CHCPs).

Canada was amongst the first countries in the world to adopt the voluntary ISO 50001 standard in 2011. In addition, PSPC is the first public sector organization in North America to achieve the ISO 50001 certification. Another ESAP accomplishment is the planning and implementation of an extensive energy data collection plan with more than 1,000 metering points to ensure accurate daily and monthly energy consumption data (for electricity, natural gas, steam, and hot water). ESAP can monitor the energy performance of its heating and cooling plants in real time, which has proven to be beneficial when identifying sources of inefficiency or when solving problems located within the plants. ESAP has made energy performance improvement information accessible to the energy plant operation personnel. During regular meetings, the Energy Management Information System (EMIS) allows the energy team to get a better understanding of its operations and to standardize operating practices that lead to consistent energy efficiency in operations.

“ISO 50001 provides the best internationally-recognized framework for an energy management system to track and verify the energy performance of a private partner for a period of 35 years.”

– Michael Burke, Senior Energy Engineer, ESAP

ISO 50001 has allowed ESAP to establish a culture of energy responsibility in alignment with the environmental performance goals of the Government of Canada. The EnMS has allowed ESAP to make better decisions related to energy performance improvement through availability of real time data and input from plant chiefs. This process has been instrumental in helping to reduce ESAP’s GHG emissions by 52% compared to the 2005 emission baseline.

ESAP has achieved an energy performance improvement of 4.2% compared to the weather normalized baseline since it implemented ISO 50001. In addition to this energy use reduction, ESAP has also reduced emissions by 2,350 metric tons of CO₂-e compared to the baseline. Implementing the ISO 50001 EnMS for ESAP took three years of using a combination of full time staff and external consultants.

All of the energy savings claimed by ESAP’s ISO 50001 implementation were operational. Due to the nature of the 5-year modernization project, ESAP’s ISO 50001 certification was obtained on legacy equipment that will be almost entirely replaced by 2025. The majority of this equipment is near the end of its life cycle, rendering capital projects unappealing except in extremely rapid payback scenarios (e.g., steam trap replacement).

The EnMS cost approximately \$365,000 to implement (over three years) and achieves annual energy savings of approximately \$420,000 due to a reduction of energy use of 54,000 GJ per year. All cost savings were the result of more efficient actions by CHCP operational personnel. Ongoing internal support of the EnMS requires between 0.5 – 1 full-time equivalent staff, at a rough annual salary of \$50k - \$100k per year (variations depend on the level of audit preparation required). The energy savings value is generated using normalization and validated with a “sanity check” which is performed with the bottom-up estimates (energy savings calculated for specific energy management actions) as discussed further in the “Do, Check, Act” portion of this case study.

Implementation of the EnMS brought the challenge of metering accuracy and reliability to the forefront. A focus on reliable metering was a great asset to PSPC in structuring its P3 agreement. Operations by the P3 have resulted in more precise monitoring of energy use and, as a result, more reliable invoicing of clients for energy use. In addition, the frequent dialogue and working relationships formed for ISO 50001 between PSPC and the P3 have been very beneficial to non-energy activities and improving the overall business efficiency of ESAP due to the streamlining of other processes. As a result of the communication and strong working relationship, a culture of energy performance is emerging amongst personnel of both PSPC and the P3.



Figure 1 – Overview of the EMIS Dashboard for Confederation Heights CHCP

Plan

ESAP gained the commitment to modernization by putting forward a compelling business case that identified three key benefits: reduction in GHGs, cost savings, and improved health and safety. The commitment included requiring the private partner to design, build, operate and maintain the LTHW DES. Given the long duration of the contract with the unforeseeable escalation rates for energy supply, energy is a flow through cost to the Government of Canada. On this basis, and given that energy is the single largest operating cost, ESAP senior management were convinced that requiring the private partner to comply with ISO 50001 would be a valuable approach to

ensure continual energy performance improvement over the 35-year period.

ISO 50001 EnMS planning was initiated with an assessment of the level of effort required, timeline, cost for implementation, and projected energy savings.

Senior management approved the allocation of resources for an Energy Management Team to implement the EnMS and for financial expenditures related to external consultation and metering infrastructure to enable EnMS implementation.

The scope and boundary of the EnMS includes four DES networks consisting of boilers, chillers, and auxiliary equipment for the generation of heating and cooling energy in the CHCPs as well as distribution heating and cooling loops to deliver the energy to 80 buildings with a total floor area of 1.75 million square meters. The EnMS focuses on the efficient generation and distribution of energy. While there are energy utility supply meters for natural gas and electricity that feed the CHCPs which are highly accurate, there are still over 1,300 metering points within the scope and boundary for which metering was not well maintained.

Considerable effort went into understanding the accuracy and reliability of the existing energy metering infrastructure and data systems, and an investment was made into the energy metering system so it could be used to generate accurate energy performance indicators.

To ensure that the EnMS would support the strategy and targets for energy performance improvement, the Energy Management Team employed a systematic tool (the Energy Planning Tool) built using Microsoft Excel that concentrated the energy planning actions into a single document and procedure.

The Energy Planning Procedure provides guidance regarding the steps to be taken to conduct annual planning, support, and operation. For each of these activities there are defined inputs, planning activities, and planning outputs. Throughout the Energy Planning Process the review and analysis of energy use, allocation of EnMS resources, and priorities for action, are documented and tracked in the Energy Planning

Tool. The completion of energy planning using a tool that was easy to use (combined with a well-documented procedure) enabled the Energy Management Team to focus on the generation of an action plan that would support the organizational strategy and targets.

Based on energy planning, an analysis was developed to understand the quantities and types of energy that were consumed in each CHCP. PSPC undertook the development of the energy dashboards in collaboration with the National Research Council of Canada to display detailed energy performance indicators and make the information available to CHCP personnel and the Energy Management Team. Considerable work went into the development of this dashboard, starting with Energy Performance Indicators (EnPI) that included defining the detailed calculations behind the displayed values. Validation methods were developed for the data going into the calculations to flag anomalies and inaccurate metering values.

Based on energy planning, the Confederation Heights (Confed) DES network was selected as a “significant energy use” (SEU). The key criteria for the selection of Confed as the SEU were significant energy consumption and a CHCP Plant Chief who was eager to work closely with the Energy Management Team. Analysis of the operations of the Confed CHCP led to an observation that excess standby boiler capacity was left “idling” throughout most of the year to ensure reliability of energy supply. A standard operating procedure (SOP) was developed for the CHCP to only operate a specified number of standby boilers depending upon the total plant load. To support operation of the standby boilers vs. the SOP, a weekly report was developed and is now sent to the Plant Chief to validate compliance with the SOP.

Do, Check, Act

The process of implementing the EnMS occurred over a three year period. It started in 2017, with ESAP choosing to demonstrate leadership by implementing and certifying to ISO 50001. In 2019, it became a

requirement for the P3 responsible for operations to maintain ISO 50001 certification for the four DES networks over the 35 years period of the contract.

The ESAP leadership team provided the necessary investments in support of energy management and they took a highly visible and active leadership role within the organization.

A key focus in the action plan developed during energy planning was to implement “operational control” of the standby boilers in the CHCPs. The specific number of standby boilers required in different seasons was defined and a standard operating procedure (SOP) was developed. Furthermore, specific dashboards and reports were developed to monitor actual operation of the standby boilers vs. the criteria in the SOP.

A major strength of the energy management system is the integration of the operations team with energy management. Additionally, a process was implemented to review the overall system efficiency, individual equipment efficiencies, the operational control criteria, and to discuss any specific issues monthly with each DES Plant Chief and key members of the energy team on a regular basis. All energy performance metrics are compared against historical trends and targets to ensure optimal operation of the systems.

Other significant measures that were implemented to reduce energy use are the shut-off of the four steam-driven chillers, use of river water for free cooling, upgrade of the deaerator at one of the plants, implementation of more frequent steam trap surveys and repairs, and reduction of the operation of the least efficient boilers (when operationally possible).

The team compares total energy consumption for the system against total normalized energy consumption derived from energy baseline regressions calculated for electricity and natural gas independently for each CHCP. The electricity and natural gas data is derived from calibrated utility supply meters. The relevant variables used for normalization of the energy baselines are heating and cooling degree days derived from a local

Environment Canada (Federal Government) weather service. The energy baselines were constructed to meet the statistical requirements of the International Measurement and Verification Protocol (IPMVP). The difference between actual and normalized total energy consumption is calculated as a percentage and compared against the target. Actual vs. normalized energy consumption are compared monthly and annually to determine energy performance vs. target. The energy savings are further validated by doing a “Bottom-Up” sanity check, where individual energy conservation measures are quantified and verified against the energy performance improvement value.

The timeframe for the energy baselines is twelve months (annual) based on monthly energy data from Fiscal Year (FY) 2017/18. Energy performance improvement is reported annually, based on the FY (from April 1st to March 31st). There have been three annual reporting periods since the end of the energy baseline, FY 18/19, FY 19/20, and FY 20/21 (See Table 1 below).

Static factors, such as the number of buildings connected to the DESs, are also tracked between the baseline period and the reporting period.

Fiscal Year	Total Actual Energy Consumption / EnMS Boundary (GJ)	Modeled & Non-Modeled Cons. (GJ)	Actual Cumulative Energy Performance Improvement (GJ)	Actual Cumulative Energy Performance Improvement against the Baseline (%)	Target Cumulative Energy Performance Improvement (GJ)	Target Cumulative Energy Performance Improvement (%)
FY 18/19	1,366,000	1,403,000	36,600	2.6%	28,100	2.0%
FY 19/20	1,269,000	1,298,000	29,100	2.2%	59,900	4.6%
FY 20/21	1,231,000	1,285,000	54,300	4.2%	54,500	4.2%

Table 1 - Actual energy performance improvement vs. target

Transparency

In August 2020 ESAP achieved ISO 50001 certification. This success was communicated through organization-wide emails, posts on the internal and external websites, and employee engagement presentations. Performance results were validated using the same processes that helped ESAP become ISO 50001

certified. Portfolio-wide performance is evaluated monthly, and energy savings cumulative sums (CUSUMs) are generated for each plant to validate performance relative to the weather-normalized energy baselines. Energy performance results are communicated quarterly to the relevant parties and input from anyone doing work for ESAP is solicited regularly for review by the Energy Management Team.

What We Would Have Done Differently

ESAP would have done the following differently:

- Ensured that energy meters were properly selected, maintained, and calibrated on a consistent basis far in advance of ISO 50001 implementation. Over the course of many years there were a multitude of issues related to meter accuracy, calibration, location, and intended purpose. As a result, years of effort were required before the metering provided credible data for analysis.
- Engaged operations staff earlier in the process. They have a wealth of knowledge about the equipment and their proper and optimal operations. It is highly probable that their participation in the development of the EnMS at the initial stages would have resulted in a quicker implementation and have helped the EnMS achieve positive results sooner.
- Expanded the energy team earlier in the implementation phase. Onboarding and retirement of senior staff responsible for the EnMS likely delayed the implementation and successful utilization of the EnMS. Ultimately, for the EnMS to be successful, there must be an active champion

who has an understanding of all facets of the system and ensures the completion of critical tasks.

“The private partner will deliver efficient heating and cooling services to the 80 Government of Canada buildings connected to the district energy system in the National Capital Area. Their compliance with ISO 50001 will help Canada to meet international and domestic commitments for emission reductions by ensuring continual energy performance improvement.”

—Tomasz Smetny-Sowa, Senior Director, ESAP

“Our firm has helped many private sector firms to implement and certify ISO 50001, however this was the first time working with a public sector organization to implement ISO 50001. This process of working with PSPC to implement ISO 50001 helped me realize that the fundamental benefits that I had seen ISO 50001 bring to private sector organizations were equally applicable to a large public sector organization. It has been particularly rewarding to work with an organization that is so committed to CO2 reduction and is formalizing ISO 50001 as part of its strategy to drive continuous improvement in energy performance.”

—Peter Bassett, President, Energy Performance Services (EPS) Inc.

The Energy Management Leadership Awards is an international competition that recognizes leading organizations for sharing high-quality, replicable descriptions of their ISO 50001 implementation and certification experiences. The Clean Energy Ministerial (CEM) began offering these Awards in 2016. For more information, please visit www.cleanenergyministerial.org/EMAwards.

