ISO 50001 Energy Management System – Case Study

2023 United States of America

HARBEC, Inc.

ISO- 50001
21% improvement in energy performance over 6 years

HARBEC Manufacturing Facility and Wind Turbines

Case Study Snapshot	
Industry	Plastics Manufacturing and Machining
Product/Service	Precision metal and polymer components and sub-assemblies
Location	Ontario, NY
Energy performance improvement percentage (over the improvement period)	21 % improvement over 6 years
Total energy cost savings (over the improvement period)	US $126,187.32
Cost to implement Energy Management System (EnMS)	US $104,000.00
Total energy savings (over the improvement period)	6,160 MWh
Total CO_2-e emission reduction (over the improvement period)	508 Metric Tons

Organization Profile / Business Case

HARBEC started in 1977 as a general-purpose machine shop and grew to become a manufacturing company that uses state of the art processes and equipment to produce solutions for complicated and high precision modern manufacturing requirements in mostly medical, aerospace and high end industrial systems and products. Due to the nature of this work we are substantial energy and resource users.

As our requirements for increased control of our work environment grew, so did the cost of providing these improvements. Our dilemma then was to find ways to keep our manufacturing plant conditioned, without raising our cost of doing business and reducing our ability to be competitive. Our initial investigations using standard 'just plug it in' solutions like air conditioning and dehumidification were just too expensive.

Our efforts led to implementing an energy management system that would include a combination of Combined Heat and Power (CHP) along with onsite renewable wind energy. The plan was to blend the low and fixed cost of renewable energy with the high level of efficiency from CHP. While this proved difficult to finance in those days especially for a small business, we were eventually able to implement it in two phases, CHP followed by onsite wind.

Within 8 years we had paid off the initial projects, and had substantially reduced our energy cost and its impact on our product cost.

The next major phase was to upgrade our CHP plant, to efficiently generate more thermal energy. As a result of the upgrade were able to remove our remaining gas fired furnaces, standard A/C units, and one boiler. These units were recycled and today our facility maintains premium environmental requirements with no standard heating or A/C equipment. Our indoor air quality and comfort requirements are being met with thermal from our microturbine CHP generators.

During the 20 plus years of developing and implementing our Energy Management System (EnMS), at the same time, explored every way we could learn, to reduce energy consumption requirements. We constantly try to remind ourselves that the greenest energy is that which is not used. From soft starts to inverter drives on all our equipment, to over 40 all electric injection molding machines and energy efficient machine tools and compressors, to highest efficiency LED lighting, along with insulated molding barrels, etc. Today, our 82,000 square foot state of the art high efficiency manufacturing facility includes high efficiency insulation, day lighting, and radiant floor heating.

During the second phase of our experience we were introduced to ISO 50001. At the time were looking for a way to third party validate our energy and carbon numbers that we were hoping to be able to promote our efforts with. Not only were we able to accomplish that goal but the experience, knowledge, metrics, tools, systems, etc. that we found, far surpassed our initial goal. Today it continues to serve as our guide and assistant to constant improvement and the belief that “less energy per widget…forever”, is totally possible and realistic.

Another significant opportunity in the past for us to learn about energy efficiency in equipment came from NYSERDA which was the Energy Efficiency Program (IEP). During the years they offered it we learned a great deal about determining equipment energy efficiency’s impact on the bottom line.

“ISO 50001 continues to sustain itself as more people see that it works—and saves money. Third-party verification of our energy-management practices and results provides proof positive of our achievements."
— Robert Bechtold, president of HARBEC

Business Benefits

For HARBEC, managing energy is fundamental to our efforts to manage climate impacts. We started by measuring our energy use and the resulting carbon emissions. We now track the carbon embodied in every unique part that it produces, and this is reflected on the invoices we send to our customers. Our ISO 50001 energy management system enables HARBEC to track and realize continued reductions in embodied carbon that our customers see every month. We see a significant benefit in the sustainable practice of continuously managing our energy performance, although it is not easily quantified. We promote ourselves to new customers with this as an advantage of engaging with HARBEC as their supplier of systems and products.

In 2021, The U.S. Department of Energy (DOE) recognized HARBEC Inc. of Ontario, NY, for its recertification to the Superior Energy Performance 50001™ (SEP 50001) program and additional Platinum-level achievements. SEP 50001 offers ISO 50001 certification and elevated levels of recognition to facilities that achieve sustained excellence in energy management. Using elevated levels of recognition (Silver, Gold and Platinum), SEP 50001 employs a scorecard which scores a facility on the basis of improvements in energy performance as well as implementing actions, processes, procedures, or advanced technologies beyond the requirements for ISO 50001. HARBEC touts

this achievement in our marketing materials provided to customers and conversations with them as well as others, as evidence of HARBEC's energy management system and its impacts on your energy performance and carbon footprint.

Since its first certification in 2013, HARBEC has steadily improved its energy and carbon performance. Independent third-party audits confirmed that HARBEC improved its energy performance by 44.1% over the 11 years, an average of over 5% improvement each year. In 2023, HARBEC continued its energy performance excellence, and in its latest recertification again achieved the platinum level of performance.

HARBEC believes the business case for its EnMS is substantiated by its energy savings, but that's just part of the overall benefits. Energy cost reductions alone have averaged $21K annually, and HARBEC estimates the cost of maintaining the system at $17K per year. This demonstrates that the EnMS pays for itself. The non-quantified benefits of showing customers the reduced carbon impact from using HARBEC as their supplier, along with promoting ourselves as a sustainable manufacturer are strong benefits too. When considering all of these factors, HARBEC's management has never waivered on its commitment to maintaining its EnMS, and believes strongly that the benefits far outweigh the costs.

Plan

HARBEC's top management has embraced its partnership with the U. S. Department of Energy's Better Plants program, and in 2015 set a target of a 25% improvement in energy performance over 10 years, or an average of 2.5% annually. In addition, HARBEC's management has made a commitment to continuing its certification of ISO 50001, as well as verifying its energy performance as part of the DOE SEP 50001 program.

To maintain their certification of their EnMS, every three years HARBEC undergoes recertification, and examines energy performance as well as conformance with ISO 50001. Each year in between, HARBEC undergoes a surveillance audit to review the EnMS status and how its functioning. Its not just these annual checks for HARBEC, as their leadership meets with its energy team monthly to establish and monitor energy performance issues, including upcoming recertification timelines and commitments.

For example, HARBEC's efforts to meet its annual 2.5% reduction target has led it to examine more closely its significant energy uses, as they drive its use of energy. HARBEC has built an understanding of the impact of cooling degree days on its energy performance. Its entire facility is space cooled as well as its highly sensitive plastic injection molding processes, and all of its machines create heat that drives up cooling load. HARBEC has recently installed a heat exchanger and loop piping into its water pond used to store water for fire protection, and has been able to perform process cooling with this cooling loop. HARBEC also found that during periods when the building needed cooling, but the pond was below 50 degree chiller temperatures, it could feed its building air handlers with cooling water from the pond, and provide space cooling during non-summer months.

This "free cooling" is depicted on Figure 1, showing the pond geo loop system providing 45 degree water during a day in March 2023. HARBEC has extensive plant dashboard through its Webcontrol system, which it uses to monitor energy performance of all its significant end uses, such as plant cooling and heating

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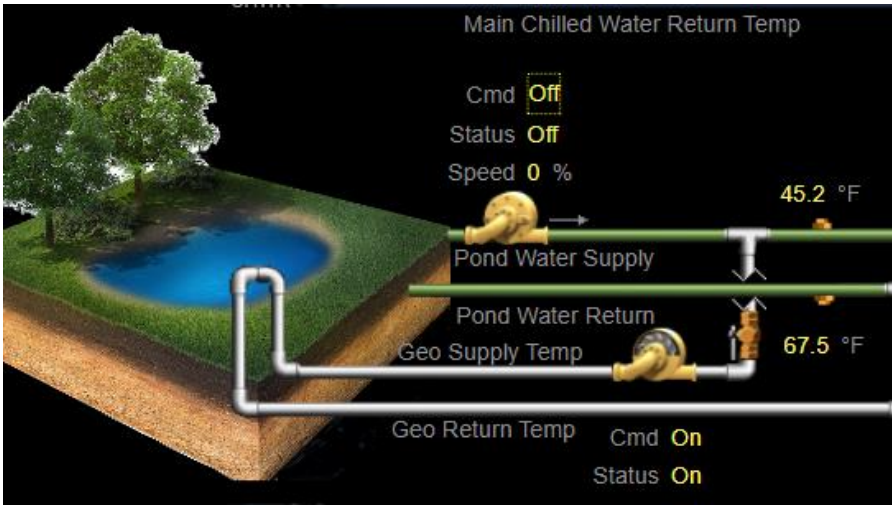

Figure 1. HARBEC's Pond Water Loop

"What started as a pond to hold water for fire protection became a valuable energy asset. Our knowledge of how much our energy use is driven by cooling needs came out of our ISO 50001 process of identifying our significant end uses, and pointed us to use this asset effectively."
—Robert Bechtold, HARBEC President

Do, Check, and Act

In its partnership with the U. S. DOE Better Plants program, HARBEC has established its 2.5% annual energy performance target. It meets with their representatives to discuss energy performance monthly. These meetings usually check energy performance, and identify changes in energy use patterns, and discuss what drives them. Then, HARBEC takes action, and extracts and furnishes detailed data on renewable energy production, cogenerated electricity and thermal generation, facility energy consumption, production levels, weather data, and other variables which drive its energy performance. Together, they develop and maintain regression models to normalize HARBEC's energy performance, and satisfy ISO 50001 requirements. HARBEC then summarizes the meeting findings and any action items and shares them with its monthly energy team during their meetings, where they decide how best to act upon these items.

The regression models determine energy performance, but also identify which key variables drive energy performance. The models are developed using the U.S. Department of Energy's EnPI tool, which uses regression modelling techniques to normalize energy consumption data using weather and production variables. Currently, HARBEC's energy performance model has extremely strong R-squared and p-values, indicating the robustness of their data tracking, energy performance and their overall approach to EnMS.

Recently, HARBEC took a deeper look into what was driving their baseload energy use, as this is indicated in its energy performance model. HARBEC decided to focus on its weekend energy use. It found that one or more backup air compressors were kept on over the weekend, to support its sandblasting operation. Air compressors were another of HARBEC's significant energy uses. It also found these were active during the week as well, leading to a year-round load that could be better managed. HARBEC developed a new standard operating procedure (SOP) for the sandblasting process to schedule its operation over the weekend, but that its team would need to start an extra air compressor and also shut it off when the process is complete. This practice will save HARBEC thousands of hours of running air compressors in standby mode over a full year.

In the table below, HARBEC's energy management planning, checking, and acting over the 6 year period ending in 2021 has included a 21% improvement in energy performance. The energy performance indicator (EnPI) models have consistently included production and cooling degree days as variables, along with wind speed. During some periods, heating degree days or CHP capacity has played in to the model development.

Baseline Year	Performance Period	Energy Performance Improvement %	Cumulative Savings MMBTU	Independent Variables	Energy Performance Indicator (EnPI) Equation	Notes
2015	2016-2018	17.6%	9,149	Production hours, CDD, %CHP capacity, wind speed	0.05 x Production Hours + 2.8 x CDD + 439* CHP Capacity - 0.73 * %Wind Available x Wind Speed Cubed + 1853	New CHP system installed in baseline year
2018	2019-2021	3.6%	5,046	Production hours, HDD, CDD, wind speed	0.077 x Production Hours - 0.50 x HDD + 2.63 x CDD - 0.37 x Wind Speed Cubed + 1599	More operational improvements than capital projects, COVID impacts as well
Totals		21.2%	14,195			
Cumulative 6 Year Savings (MWh)			4,160			
CO2e Savings (MT)			508			
CO2e factor of .122 MT/MWh average, based on calculated CO2 emissions from electricity and natural gas, divided by energy used, in source MMBTU blend of natural gas, renewable electric, and grid electric (egrid NYUP region)						

The table provides details on HARBEC's two certification periods, one with a 2015 baseline year and a three year performance period ending in 2018, and another with a 2018 baseline year and a three year performance period ending in 2021. HARBEC found that its energy performance continues to be driven by its production hours, but also its cooling and heating of its facility, its availability of wind resources, and also its CHP system. When HARBEC is able to harness these factors efficiently, its energy efficiency improves and it realizes energy cost reductions as well as a reduced carbon footprint.

The HARBEC footprint expanded in 2021 to include additional square feet and a several more machines, but otherwise same footprint in terms of energy use. Although this increased space and machines added to its energy use during late 2021, no baseline adjustment was made as use of the addition was being phased in during second half of 2021. As a result, the recorded energy performance improvement for the 2019-2021 period is somewhat understated, and is actually higher but has not been quantified.

Transparency

HARBEC provides a model of transparency to its customers, stakeholders such at the U.S. Department of Energy and the New York State Energy Research and Development Authority (NYSERDA), and the general public through its access to its internal energy system. HARBEC's management decided to provide public access to its Webcontrol system (shown on the right depicting its wind power generation on site), and the system can be accessed at webcontrol.harbec.com by anyone using guest credentials. These guests can access a wide array of data on its wind power, CHP system, facility energy use, water use, and free cooling using its water pond, just to cite examples of the transparency HARBEC offers.

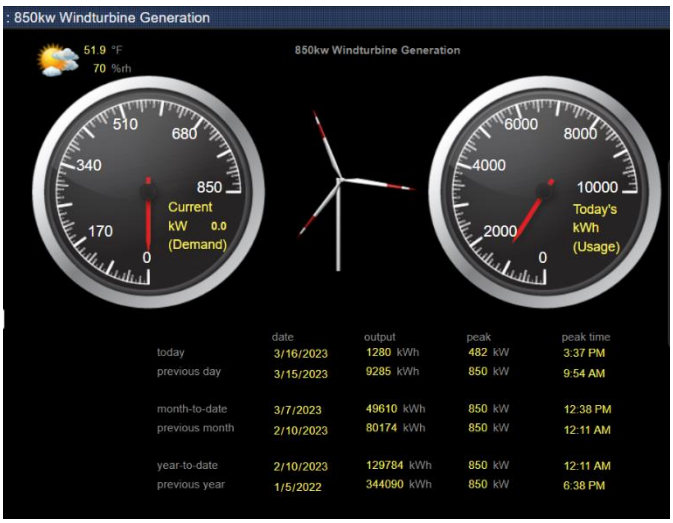

Figure 2. HARBEC's Transparent Webcontrol System Illustrating Wind Electricity Generation During March 2023

What We Can Do Differently

HARBEC is still learning much about its operations from its EnMS, and has dedicated much focus on efficiencies in its central plant, as it involved a more complex integration of renewables and combined heat and power as well as utility sources of energy. HARBEC is now shifting its focus to its manufacturing processes and where energy is used. HARBEC has machines for plastics injection molding, CNC machining, and additive manufacturing. HARBEC knew that machine process energy was a broad area of energy use, it was significant but it was not known which types of machines used the most energy. HARBEC sought to deepen its understanding of its significant energy uses, as it had not previously done so.

HARBEC installed energy loggers on a wide array of its machines, and found that its ancillary equipment supporting its plastics injection molding process consumed 25 percent of its facility electricity use. This equipment is used for heating water to heat the barrel of its machines, to aid in the melting of the plastic resins during the molding process. Not only do these small heaters consume a large portion of its energy use, but HARBEC believes it is possible to instead use waste heat from its CHP system to supplement or replace the electric heating done by these units. HARBEC has started planning on how to capture this opportunity, which will likely require an internal pilot effort, potentially followed by an R&D effort to fully capture these savings.

HARBEC realizes that there are many more opportunities to improve and reduce its energy use, and that their EnMS guides their approach by focusing efforts on areas that will most impact their bottom line, as well as their sustainability goals. HARBEC plans to explore in more depth its machine energy use and hopes to identify new areas of energy performance improvement by using its EnMS. The lesson learned here for HARBEC is that you can dig deeper into your energy use to better understand it, and it may lead you to more improvements.