ISO 50001 Energy Management System – Case Study

2024 United States of America

US AIR FORCE OKLAHOMA CITY AIR LOGISTICS COMPLEX

The first US Government organization to be certified to ISO 50001

The OC-ALC Energy team and SEU personnel gather to present the ISO 50001 recertification plaque to OC-ALC Command.

Case Study Snapshot	
Industry	US Federal Government – Dept. of Defense
Product/Service	Air Logistics Complex, U.S. Air Force (aircraft maintenance)
Location	Tinker Air Force Base Oklahoma City, Oklahoma USA
Energy performance improvement percentage (over the improvement period)	>35% improvement over 8 years
Total energy cost savings (over the improvement period)	USD 8,300,000 annually / USD 66.4 million since 2015
Cost to implement Energy Management System (EnMS)	USD 563,000 (more than ½ of cost part of ESPC contract)
Total energy savings (over the improvement period)	**1,461,283** MWh
Total CO_2-e emission reduction (over the improvement period)	**289,160** Metric Tons (through FY2023)

Organization Profile / Business Case

PROFILE AND BUSINESS CASE

The Oklahoma City Air Logistics Complex (OC-ALC), at Tinker Air Force Base, Oklahoma, is the largest aerospace Maintenance, Repair and Overhaul unit in the Department of Defense with a team of over 9,300 military and civilian professionals delivering combat ready air power for America. The complex performs programmed depot maintenance and modifications on KC-46, KC-135, B-1B, B-52, E-3 and Navy E-6 aircraft. The OC-ALC also provides maintenance, repair and overhaul for F100, F101, F108, F110, F117, F118, F119, F135, TF33 engines. Finally, the OC-ALC conducts maintenance and repair on a wide variety of aircraft components, systems, and parts for the Air Force, Navy, Marine Corps, and foreign military sales. The complex is responsible for the development and sustainment of a diverse portfolio of mission-critical software for the Air Force and diverse other customers, as well as world-wide aircraft battle damage repair capability for multiple weapon systems.

The US Department of Defense (DoD) recognizes threats to its operations that did not exist ten years ago. Climate breakdown, in particular the increased frequency and severity of weather phenomena (hurricanes, tornadoes, droughts, flooding, etc.), could impact mission critical DoD operations. In addition, the emerging threat of cyber attacks that could interrupt services from local utilities must be considered and countered. OC-ALC operations are critical to US national security, and energy resiliency is critical to OC-ALC operations. This exigency drove the ALC to be more disciplined about its energy management. In this light, implementing ISO 50001 was an obvious choice.

After the OC-ALC implemented ISO 50001, the ALC's parent organization, the Air Force Sustainment Center (AFSC), ratified the strategy by mandating ISO 50001 certification for the other Air Force Air Logistics Complexes, the Software Maintenance Directorate, and the hosting Air Force installations.

MOTIVATION FOR ENERGY MANAGEMENT

The U.S. Department of Defense (DOD) consumes more energy than any other federal agency—77% of the entire federal government's energy consumption. Energy management is integral to DOD operations. From running bases and training facilities to powering jets and ships, DOD relies on energy to maintain readiness and resiliency for mission operations. Energy efficiency—providing the same or an improved level of service with less energy—over time can reduce agency expenses, particularly at an agency like DOD, where energy represents roughly 2% of the department's annual budget. In light of this, the OC-ALC's parent organization, the Air Force Sustainment Center (AFSC) mandated in 2015 that the ALC be ISO 50001 certified.

ENERGY RELATED GOALS

The U.S. Congress has mandated energy goals for federal agencies like DOD since the 1970s. Legislation required reductions in fossil fuel consumption, increases in renewable energy use and efficiency targets for government fleets and buildings.

- The National Energy Conservation Policy Act (NECPA, P.L. 95-619) requires federal agencies to report annually on energy management activities.
- The Energy Policy Act of 2005 (EPAct05, P.L. 109-58) and the Energy Independence and Security Act of 2007 (EISA, P.L. 110-140) amended and addressed additional energy management targets for the federal government, including 3% annual energy intensity reduction with an overall 30% reduction by 2015.
- Throughout several administrations, Presidents have issued executive orders to establish energy management, renewables and GHG guidelines and targets for the federal government. Several agencies, including DOD, did not reach the targeted goals. One of the challenges DOD faced in meeting these targets is implementing appropriate financing mechanisms.
- The Energy Policy Act of 1992 (EPAct92, P.L. 102-486) amended NECPA and authorized alternative financing methods for federal energy projects, including energy savings performance contracts (ESPCs) and utility energy service contracts (UESCs). These contracts make use of third-party financing by the energy service company (ESCO) to implement energy performance improvement projects at the given location. The third party is then paid back out of the organization's energy cost savings. ESPCs have become a preferred means of making energy efficiency improvements because, in part, funds do not have to be directly appropriated (or programmed).

OC-ALC INNOVATION SET THE PRECEDENT FOR THE US DoD

The OC-ALC took advantage of ESPC financing mechanism and was awarded the largest ESPC in US Government history - $243 million – in energy performance improvement projects.

In addition, the OC-ALC integrated the implementation of an ISO 50001 Energy Management System (EnMS) into the ESPC. ***This was the first time this arrangement had been implemented****. This means that there was no front-end cost to the OC-ALC for implementing ISO 50001. The implementation effort was paid for out of the energy cost savings from the ESPC energy performance improvement projects. The US DoD now recommends the inclusion of an ISO 50001 implementation into all relevant ESPC contracts.*

"Our ISO 50001 energy management system is a remarkable achievement that demonstrates our commitment to excellence, innovation, and sustainability," said Col. Jeffrey Anderson, the deputy commander of the OC-ALC. "Together, we can make a difference for our organization, our nation and our planet."

Finally, in 2024, the OC-ALC was awarded Superior Energy Performance (SEP) Gold certification for its air compressor operations and energy performance improvement in facility B210. *This was the first US Government SEP certification ever.*

Business Benefits

The EnMS based on ISO 50001 provides a more sustained program structure and imposes a rigorous international energy management standard centered on continual improvement, enhancing energy performance, controlling costs, operations and maintenance savings and safety. Since adopting ISO 50001, the OC-ALC has seen the following organizational benefits:

1. COMMUNICATIONS – The OC-ALC has realized improvement in cross-organization communications because communications channels are established when energy issues span organizational boundaries;
2. CONTRACTOR MANAGEMENT & COORDINATION – The OC-ALC's ISO 50001 EnMS acts as a 'container' for coordinating actions amongst the OC-ALC Energy Team, the energy performance contractor, the Tinker AFB Civil Engineering Energy team, and the local utility. In addition, the ESPC is not disrupted when personnel changes occur on either side of the contract. The EnMS maintains continuity.
3. LOW COST/NO COST ENERGY PERFORMANCE IMPROVEMENTS – Increased energy awareness has led to the identification and execution of process changes, generally at little or no cost to the ALC, that save significant amounts of energy.
4. SENIOR LEADERSHIP SUPPORT – Since implementing ISO 50001, senior leadership has been engaged in making energy performance improvement efforts successful and often taking highly visible and proactive actions to support the energy team's efforts.

The OC-ALC was recertified in 2020 and 2023. Recertification is extremely valuable to the organization. Command personnel rotate into and out of office roughly every two years. When new Command arrives, they recognize that certification is an accomplishment that had served previous commanders well, and they are motivated to engage in energy management and ensure that certification does not lapse during their time in command. It is due to this continued certification that the EnMS has continued receiving senior level support from four commanding officers for over seven years.

As for direct energy benefits, Tinker AFB was the largest energy consumer in the Air Force in 2012. With the help of a Honeywell team ensuring ISO 50001 conformance, and the support of base civil engineering, Tinker has since dropped to fourth place. This decrease happened while the OC-ALC's operational workload increased.

Since 2015, the OC-ALC has reduced their energy consumption by more than 35% and saved the Air Force an estimated $8.3 million a year in energy costs, $66.4 million total so far. The OC-ALC energy management system was

recertified for a second time in 2023 and continues to deliver results. Tinker AFB has now exceeded its energy efficiency targets and will continue to provide ongoing energy efficiency and GHG emission reductions.

In 2024, the OC-ALC received Superior Energy Performance 50001™ (SEP 50001) certification for its compressed air facility located in building B210. This program, developed by the US Department of Energy, validates energy performance improvement using 3rd party auditors. Utilizing the SEP 50001 Measurement & Verification Protocol, auditors validated a greater than 40% energy performance improvement, which was calculated with a linear regression-based energy performance indicator for the whole facility. These top-down results were then compared to the implemented energy conservation measures, verifying the bottom-up actions produced the desired energy performance improvement.

The cost to implement the EnMS was included in the ESPC contract. There was no direct cost to the OC-ALC other than staff time (no new hires required). The ISO 50001 implementation represented approximately 0.07% of the ESPC contract value. The ISO 50001 implementation as well as ongoing EnMS support are paid for out of ongoing energy cost savings. A team of ISO 50001 implementation experts partnered with the energy team at OC-ALC to implement the EnMS in 10 months. The total man-hours included in this effort was approximately 3,600.

GHG emissions were greatly reduced due to the energy savings achieved. Reducing these emissions is a high priority for OC-ALC and, as of 2023, part of their annual, mandated goals. From 2015 to 2023, total GHG emissions for all energy sources were reduced by 289,160 metric tonnes (CO_2 equivalent). The table below shows these results which were based on the eGrid2022 data (U.S. EPA).

Annual Tier 1 Greenhouse Gas Emmision Reductions for OC-ALC

				GREENHOUSE GAS EMISSIONS *CO2e values are in metric tonnes (MT)*					
	ELECTRIC			GAS			TOTAL ENERGY		
FY	CO2e Actual	CO2e Model,FY15	EPI	CO2e Actual	CO2e Model,FY15	EPI	CO2e Actual	CO2e Model,FY15	EPI
2015	120,363	120,363	1.00	49,591	49,590	1.00	169,954	169,953	1.00
2016	122,093	120,863	1.01	41,016	44,400	0.92	163,109	165,262	0.99
2017	118,271	120,902	0.98	34,581	43,686	0.79	152,851	164,588	0.93
2018	109,429	121,389	0.90	38,488	48,765	0.79	147,917	170,154	0.87
2019	98,412	120,677	0.82	37,005	51,181	0.72	135,418	171,859	0.79
2020	92,373	119,484	0.77	25,070	48,540	0.52	117,443	168,024	0.70
2021	88,029	119,580	0.74	29,123	49,730	0.59	117,152	169,310	0.69
2022	84,373	123,378	0.68	26,410	46,568	0.57	110,783	169,946	0.65
2023	86,311	122,418	0.71	29,423	48,008	0.61	115,734	170,426	0.68
							1,230,361	1,519,522	
							Total Savings	**289,160**	**MT**

Plan

Obtaining commitment from top decision makers in the OC-ALC was advanced by the ESPC contract mechanism which allowed Tinker to pay for energy efficiency retrofits and the implementation of the ISO 50001 EnMS through energy savings. By not directly spending from the Air Force budget, the decision to proceed was greatly facilitated.

Top management was involved in the implementation process. Top management (Command) at the time of implementation recognized the risk to national security posed by poor energy performance and was a strong advocate for energy efficiency. While he was unaware of ISO 50001 at the time, he immediately saw the logic of it. Top management established a monthly reporting cadence throughout implementation. (This reporting cadence continues today and is the basis for top management review)

The OC-ALC had to obtain financial commitments and resources. In 2017, the OC-ALC already had an Energy Manager. Consequently, staff time was already committed to improving energy performance. This staff time was simply directed to implementing ISO 50001. It was only required that the ESCO, Honeywell, be willing to include ISO 50001 implementation as part of their costs. Given the size of the ESPC ($243M), the importance of this customer to the ESCO, and the relatively small outlay required for ISO 50001 implementation, Honeywell quickly agreed.

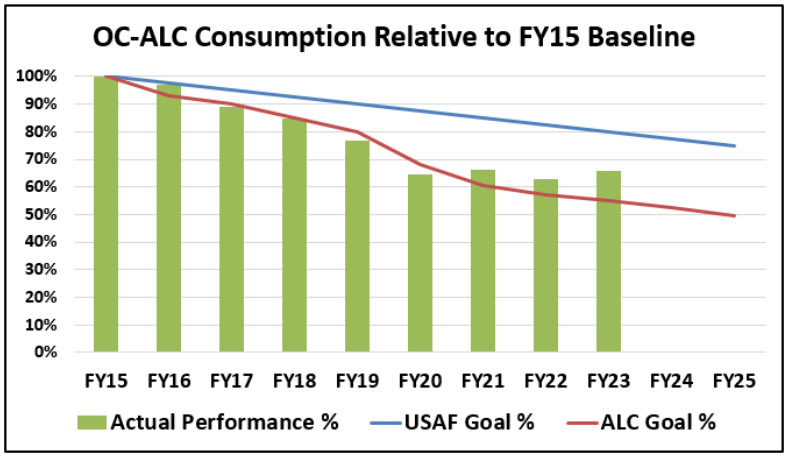
We need to mention here that, while the ESCO was initially skeptical of ISO 50001, they have become one of its strongest advocates and they now include ISO 50001 implementation as an offering to their industrial ESPC clients.

From the beginning, energy assessments were conducted by Honeywell energy engineers that determined the energy consumption and the energy performance of the facilities and major equipment at the OC-ALC. A deep dive into the daily utility energy consumption data and the additional data from meters installed by the ESCO facilitated these assessments. Based on the analysis, energy retrofit projects were prioritized that would deliver energy performance improvements and energy cost savings that would allow Tinker AFB to meet its mandated energy targets. Other priorities like aging infrastructure and equipment that used the most energy at the OC-ALC helped to focus the many opportunities identified.

Federal energy and sustainability goals were integrated into the EnMS objectives and targets. Specifically, Executive Order 13693 Planning for Federal Sustainability in the Next Decade required federal agencies to reduce energy consumption by 25% from a 2015 baseline by 2025. Adopted by the USAF, the ALC Energy Team was held accountable for achieving this goal at the OC-ALC. Having achieved the 25% goal in 2020, the Energy team took a more aggressive position and doubled the savings goal to 50%. Progress toward this goal is reviewed by the energy team on a monthly basis and by top management annually. In FY 2023 the ALC had reached a 35% reduction from the FY 2015 baseline.

"The benefit [of the ESPC] is that it better connects the government operations with the investments and guaranteed savings that the contractor is bringing to the table. That partnership is better enabling communication and collaboration by providing a common perspective and shared goals."

Joseph Cecrle, OC-ALC Energy Manager



OC-ALC Progress Toward Goal

Comparison of annual % reduction in energy consumption versus goals represented as glide paths

Do, Check, and Act

Top management approved the inclusion of ISO 50001 implementation and certification within the scope of the ESPC contract. They realized that this would elevate the profile of energy management, help the OC-ALC achieve its federal energy goals, and also institutionalize an energy management system with regular reviews by top management.

The ESPC set about to upgrade aging infrastructure and equipment that used the most energy within the OC-ALC at the time. The project included

- adding two new 2,000-ton chillers to the cooling system,
- 10 million square feet of more efficient LED lighting,
- smart meters to monitor and track energy consumption,
- compressed air retrofits,
- Replacing an old high-pressure gas distribution system and centralized steam heating plant with distributed heating systems to reduce energy consumption,
- Building envelope and HVAC upgrades throughout.

These improvements, made in more than 50 buildings, enabled reduced annual energy costs by $8.3 million from five years ago.

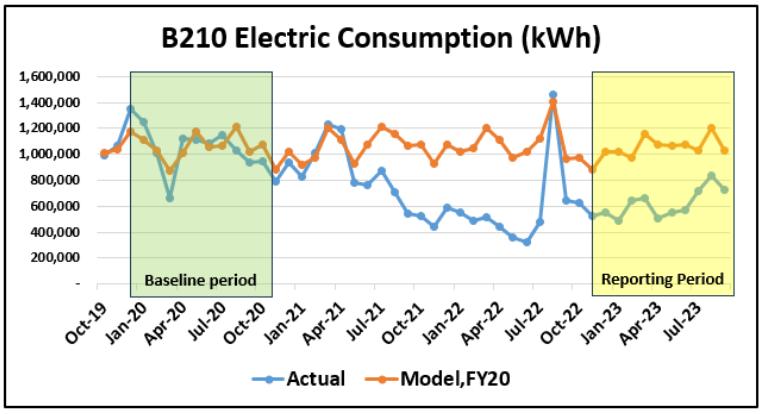
“This was a massive project that happened while needing to sustain production,” said Cecrle. “All the construction was completed on time, and in fully occupied buildings — that’s huge.”

Cecrle said the biggest savings came when base personnel were able to shut off the last of the steam boilers. Adding, with the old boilers off for all of fiscal year 2020, the cost savings are very noticeable.

OC-ALC also focuses on operational controls that do not require new hardware to realize energy savings. A major example was in the 76th Maintenance Support Group’s compressor shop (building B210). The air compressor bank provides massive amounts of compressed air to CMXG’s Air Accessories Maintenance Facility next door. It is the largest compressed air user across all of Tinker.

“Patrick Duff, who was a MXSG Building supervisor at the time, suggested we tailor compressed air production to the anticipated schedule on the other side of the wall in CMXG’s air accessory maintenance operation,” Cecrle said. “When we asked how to do this, Duff said, ‘Why don’t we just make a phone call once a day to find out what the schedule is.’”

Duff ultimately implemented a “phone call protocol” that improved air compressor energy performance by 40% and saved the ALC roughly $30,000 per month in electric bills. These savings will continue forever because Duff incorporated the phone call protocol into the work control documents for the facility.



Energy Consumption Reduction B210 (SEP Facility)
Comparison of actual consumption vs. normalized consumption which is represented by a linear regression model for the SEP facility, building B210 during certification period.

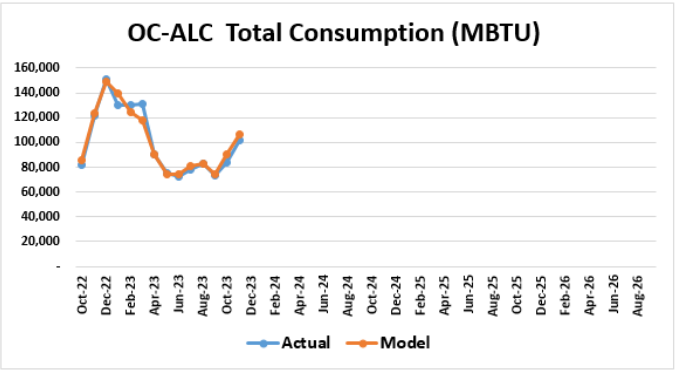
"This is real energy management," Cecrle said. "And these kinds of improvements will become even more critical as we work to make the ALC more energy resilient." From the beginning of the EnMS implementation, the energy team and its energy management consultants followed the US DOE's SEP Measurement & Verification Protocol (https://betterbuildingssolutioncenter.energy.gov/iso-50001/sep-50001/resources/sep-50001-measurement-and-verification-protocol) to ensure an accurate and technically rigorous analysis. They utilized linear regression models for developing its energy performance indicators (EnPI). These robust EnPIs covered both the whole OC-ALC complex as well as each of the significant energy uses (SEUs). Energy consumption data obtained from utility-grade meters was utilized to ensure integrity. Relevant variables related to operational and industrial activities as well as weather conditions were utilized. These EnPIs were calculated and reviewed on a monthly basis by the energy team to track progress. MS Excel was the tool used to track and develop the EnPIs.

The OC-ALC also aggressively selected five (5) Significant Energy Uses (SEUs). These included aircraft strip and paint hangars, compressed air plants, plating facilities, and chemical cleaning facilities. The ALC used the above-mentioned SEP M&V Protocol to determine relevant variables for each. Depending upon the facility, those variables included Heating Degree Days (HDD), Cooling Degree Days (CDD), Number of Days in the meter read period (NOD), and the number of days that different types of aircraft were in the docks.

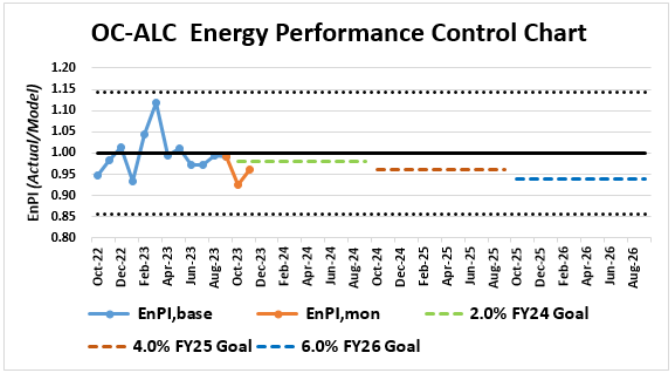
Using these relevant variables, the ALC developed a linear regression model for each SEU. The linear regression models were held to the SEP M&V Protocol standard which requires an R-squared > 0.5, F-test < 0.1, and all P-values <0.2, with at least one P-value < 0.1.

The Energy Performance Indicator (EnPI) for each SEU was defined as the Actual Energy Consumed divided by the Projected (modeled) Energy Consumed. Therefore, the EnPI is a non-dimensional indicator that has a value of 1.0 if the actual energy consumed was exactly equal to the projection from the model. The EnPI would be less than one if energy performance was better than projected that month, and greater than one if energy performance was worse than projected that month.

In addition to the SEU models, the ALC developed a Complex-wide model to track energy performance across the entire organization. This model was also developed using the SEP M&V Protocol. The ALC developed a model for electricity consumption (kWh) and a model for natural gas consumption (MBTU). Actual and projected consumption values were converted to millions of British Thermal Units (MBTU), as required for AF reporting, and summed. The resulting overall ALC Complex tracking tool is shown below.



Comparison of OC-ALC actual consumption vs. model



Plot of OC-ALC complex-wide EnPI with incremental goals of 2%, 4% and 6%

The linear regression equation for the overall complex was determined to be:

Projected Energy Consumption = [Electric Consumption] + [Gas Consumption]
= [(472403.98 * NOD) + (10273.01 * CDD)] kWh * 0.003412 MBTU/kWh + [(420.40 * NOD) + (113.33 * HDD)] MBTU

The result of this rigorous monitoring approach is that Top Management trusts the credibility of the energy savings estimates and has no reservations in supporting and expanding the EnMS. The OC-ALC Energy Team accrued significant Top Management good will due to the exceptionally data driven approach to monitoring and reporting energy performance.

Energy awareness training was conducted for all OC-ALC employees and is now part of the new hire orientation. In addition, special training for key individuals associated with the operation and maintenance of the significant energy uses (SEUs) was conducted to ensure that these important facilities and equipment were operated and maintained efficiently. These key individuals became part of the energy team and participate in energy team meetings.

A robust internal audit by a 2nd party consultant was utilized to ensure that the EnMS was implemented, and that it conformed to ISO 50001. This set the stage for 3rd party certification. Besides energy and costs, the OC-ALC tracked the number of personnel who received the energy awareness training and reported this at Management Review. (The number was typically over 99% of the workforce.)

Transparency

OC-ALC has used the Tinker AFB public relations department to publicize its successes on its publicly accessible website - www.tinker.af.mil. Upon initial certification to ISO 50001 in 2017 and on each recertification (2020 and 2023), Tinker published articles that touted its energy management program successes. In addition, OC-ALC reports annually to US Department of Defense to measure progress towards its energy and sustainability goals.

Likewise in 2024, Tinker publicized its Superior Energy Performance 50001™ (SEP 50001) certification for its compressed air facility in building B210. The SEP 50001 award ceremony was recently published on the Tinker public website.

What We Can Do Differently

The ALC currently relies upon the personnel at the SEUs to populate and maintain their Opportunities Lists. This is because the personnel at the SEUs are most familiar with their operations and challenges. However, SEU personnel also have other responsibilities and tasks, and opportunities lists are sometimes ignored for periods of time.

It would be valuable for the OC-ALC Energy Team to formalize the development of opportunities by holding periodic meetings, perhaps twice a year, to convene personnel from all of the SEUs and to facilitate a brainstorming session to identify opportunities. This would help focus the effort and make it more productive. It would also enable the Energy Team to drive toward a list that is balanced between projects that require capital and projects that can be done more immediately at low cost or no cost.