

ISO 50001 Energy Management System Case Study

2021

USA

Lawrence Berkeley National Laboratory

Leveraging the rigor of ISO 50001 to ensure energy and water management activities are strategic, effective, and persistent.



Berkeley Lab's Shyh Wang Hall is a LEED-certified gold building that houses the National Energy Research Scientific Computing Center (NERSC).

Organization Profile & Business Case

Lawrence Berkeley National Laboratory (Berkeley Lab or the Lab) conducts a wide variety of unclassified scientific research for the U.S. Department of Energy. Located in the San Francisco Bay Area, the Lab includes approximately 2.3 million gross square feet of research and support space and has an annual operating budget of approximately USD \$1B. The Lab was founded in 1931 by Ernest Orlando Lawrence, who won the 1939 Nobel Prize in physics, and whose “team science” philosophy still lives on at Berkeley Lab today. A deep commitment to diversity and inclusion continues to inspire innovative solutions.

Organized into six research areas (Biosciences, Computing Sciences, Earth and Environmental Sciences, Energy Sciences, Energy Technologies, and Physical Sciences), Berkeley Lab addresses the world’s most urgent scientific challenges, advancing sustainable energy, protecting human health, creating new materials, and revealing the origin and fate of the universe. The Lab is associated with 14 Nobel prizes and has over 3,000 full-time-equivalent employees and thousands of affiliates and annual facility users from around the world. It is operated by the University of California.

Case Study Snapshot

Industry	Other, Government
Product/Service	Research
Location	Berkeley and Emeryville, CA
Energy management system	ISO 50001
Energy performance improvement period, in years	5.5 years
Energy Performance Improvement (%) over improvement period	26%
Total energy cost savings over improvement period	USD \$2.17M
Cost to implement EnMS	USD \$277,000
Total Energy Savings over improvement period	77,600 GJ
Total CO₂-e emission reduction over improvement period	4,400 MT CO ₂ e

The Case for ISO 50001

Berkeley Lab has a wide range of aggressive [sustainability goals](#) set by the U.S. government, California state government, and the University of California. These include targets to

- improve energy intensity by 2% year over year,
- keep the overhead cooling energy consumption of its high-performance computing facility (NERSC) below 10% of the consumption used by the computers, and
- reduce water consumption intensity 36% by 2025 from a 2007 baseline.

The Lab's broad mission also drives a commitment to sustainability, stewardship, and leading by example. While pursuing ISO 50001 was voluntary, managing energy and water performance fits squarely with the Lab's business strategy. For this reason, the Lab has implemented the ISO 50001 for both energy and water performance improvement.

Saving money on utility bills supports the Lab's stewardship of taxpayer dollars. For the high-performance computing facility (NERSC), the Lab's significant energy (and water) use, it also contributes to NERSC's status as one of most efficient high-performance computing centers in the world. And through implementing 50001, the Lab has affirmed that when buildings operate efficiently, they also run more effectively and comfortably -- supporting the people, equipment, and scientific mission of the organization

Business Benefits

As of 1 April 2021, weather-corrected energy performance intensity at Berkeley Lab has improved 28% and weather-corrected total energy consumption has decreased by 22% from a fiscal year 2015 baseline. The Lab also tracks modified intensity and consumption metrics that exclude process consumption (loads that are switched on and off according to an operating schedule, such as high-performance computing and particle accelerators). The metrics that exclude process

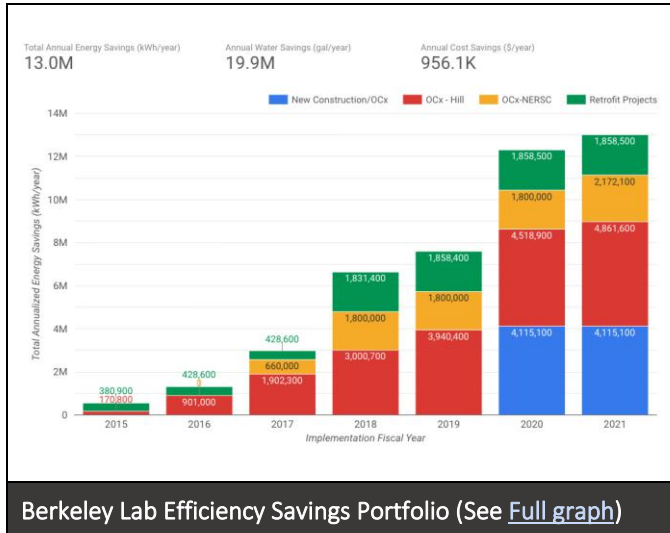
loads represent the change in energy intensity and consumption across the general building stock included within the management system scope. For the same performance period with process loads excluded, the weather-corrected energy performance intensity at Berkeley Lab has improved 26% and weather-corrected total energy consumption has decreased by 19% from a fiscal year 2015 baseline. The metrics excluding process loads are presented in the snapshot and used for the calculation of cost savings.

Direct costs for the implementation and maintenance of the ISO 50001 management system included in-house labor of an ISO 50001 Core Team, an approximately 24-month consulting engagement with Georgia Institute of Technology, and third-party certification. The ten-person Core Team met monthly with the consultant to review elements of the standard and convened for four intensive, two-day training and work sessions to develop processes inspired by the ISO standard. In the interim, the team worked in subgroups to tackle individual parts of standard, such as documentation, internal audit, and operational planning and control. Following certification, the Core team continues to meet quarterly to maintain and improve the management system. Costs over the 5.5-year performance improvement period totaled USD \$277,000. Energy savings over that same period totaled USD \$2.17M (7.8 times the cost).

Energy savings have been driven primarily through building operational improvements which are enhancing building services and occupant comfort while reducing reactive work orders. These improvements directly support the research mission of the Lab. In the area of water performance improvement, as of 1 October 2020, water use intensity has decreased 2.5% from a fiscal year 2015 baseline. Over the 5.5-year performance period, the Lab has discovered and fixed issues resulting in an annualized water savings of 19.9M gallons and USD \$252,000.

Overall, the ISO 50001 management system has allowed the Lab to develop a portfolio of maintained energy

savings totaling 13.0 million kWh/year (across electricity and natural gas) and saving over USD \$950K in utility costs per year.



- **Leveraging existing tools, systems, and strategies** avoided reinventing the wheel and helped with integration.
- **Developing and maintaining an overarching program manual** delivered consistency and provided a crucial guide for the team. The manual links to the essential documents, procedures, data, and tools for the team’s day-to-day work, and is continually referenced, updated, and improved.
- **Planning ahead for full implementation**, including determining long-term roles, responsibilities, and activities, allowed a seamless transition from planning to implementation and helped establish a sustained program.

Plan

Berkeley Lab’s implementation aims to 1) maintain transparency and a spirit of cooperation, 2) keep the implementation scope broad and consistent with the Lab’s greenhouse gas inventory, 3) maintain alignment with the Lab’s existing ISO 14001 program, and 4) develop procedures that meet the standard while also benefiting the organization. The team has found creative ways to adapt ISO 50001, with its origins in manufacturing, to work well for a large research laboratory.

Planning

Several strategies were crucial for a successful planning phase:

- **Setting a reasonable implementation timeframe** of 24 months allowed for requirements to become integrated into business operations.
- **Fostering a cross-functional team** with members from across the organization contributed to innovation, surfacing potential risks and issues, and creative problem-solving.

“Implementing ISO 50001 has significantly improved our documentation of data processing steps and weather normalization. A new analyst in our group was able to quickly get up-to-speed with all our energy and water management approaches just by reading our systems manual.”

— Deirdre Carter, Energy Manager

Top Management Support

The Lab’s sustainability team had built a track record of demonstrating results and communicating them. Prior to implementation, top management already provided strong vocal and financial support of the sustainability program. Top management also valued the rigor of an international standard like ISO 50001. To further strengthen support, the team worked to ensure that the program provided business value, and was innovative, transparent, and integrated with operations.

Energy and Water Data, Use, and Consumption

The Lab’s management system and action planning is strongly informed by data collection and analysis. Every month, the Lab processes a large amount of billing and

interval data that is automatically loaded into a powerful data analytics platform (called Skyspark) and a series of custom reports (developed in off-the-shelf online reporting tools Tableau and Google Data Studio). Categorizing and assessing the Lab’s energy and water sources and uses helped identify the biggest improvement opportunities, such as cooling towers. And the streamlined analysis of consumption data within an ever-improving set of online reports allows the Lab to focus on the tasks of identifying and prioritizing savings opportunities. In addition, the team has evaluated and progressively improved submeter function, testing, and interval data quality as well as enhanced sensor calibration efforts.

The Lab ISO 50001 scope includes all buildings under its operational control, with particular attention paid to key facilities that account for most of its energy and water consumption. The facilities operate an extensive range of highly sophisticated laboratory and research equipment, such as particle accelerators and nanoscale instruments. The Lab’s high performing computer center, NERSC, was determined to be both the significant energy and significant water use, and is projected to grow appreciably with the planned expansion of its computing capacity. As a result, the team put special focus on expanding energy and water saving activities at NERSC, strengthened existing collaboration efforts, and added one of its staff to the team.

Supporting Berkeley Lab Mission & Targets

Prioritizing value to both the Lab and the team was a strategy to ensure the 50001 program would persist. The team found creative ways to implement the ISO 50001 standard that went beyond “checking the box” and created value by supporting day-to-day work. Establishing a goal to be “strategic, effective, and persistent,” with an emphasis on maintaining savings, provided a touchstone to maintain alignment with the

Lab’s mission. Energy and Water Performance Indicators are explicitly linked to the Lab’s sustainability targets, which helps ensure alignment between the ISO 50001 management system and the Lab’s strategic objectives.



A multidisciplinary team works to improve building operations and efficiency at Berkeley Lab.

Reviewing, Analyzing, and Prioritizing

The team developed several complementary processes to examine and continually improve its management system and progress toward targets. These include:

- Monthly reviews of energy and water data;
- Monthly work sprints where improvement opportunities are identified, evaluated, selected, and allocated resources;
- Quarterly team meetings to review the system and energy/water performance and identify needed actions;
- Annual internal audits; and
- Management reviews that are conducted jointly with the ISO 14001 program and cover the breadth of the Lab’s sustainability targets.

Issues and improvement opportunities are encouraged from anyone at any time and are logged into a tracking system. Opportunities are prioritized based on an evaluation of feasibility, effort, and cost-effectiveness.

Do, Check, Act

Implementation

A unique and diverse core team planned and implemented ISO 50001 at Berkeley Lab. The team was led by the Lab’s sustainability group, and also included researchers and staff from Energy Technologies; Environment, Health, & Safety; Lab Operations; and the National Energy Research Scientific Computing Center (NERSC). This “team science” approach afforded diverse ideas and expertise, and helped expand visibility and support for the ISO 50001 program across the organization.

The Lab hired a consultant to “coach” the core team through the implementation process, which helped the team fully understand the vocabulary of the standard, and to transform the requirements into processes that created value within the Lab’s working environment. The team followed a learn-by-doing approach, which allowed a phased implementation to happen concurrently with the planning stage. With this method, the team could focus efforts on enacting discrete sections of the standard without getting overwhelmed, which facilitated course-corrections and ensured integration of ISO 50001 into business operations. These interim results were communicated with top management, whose growing support and enthusiasm provided motivation for the team.

Once implementation was complete, the team underwent a rigorous “readiness review,” essentially a dry run of a full compliance audit. The team then had time to correct findings and fine-tune the program in preparation for the actual certification audit.

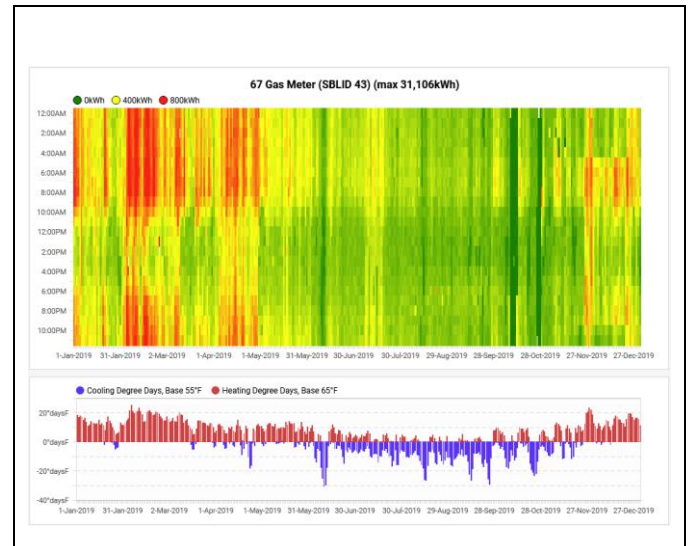
Activities and Performance

A key activity driving energy performance is an ongoing commissioning (OCx) process (see ocx.lbl.gov) applied to both the general building stock and the high-performance computing facility (NERSC, the Lab’s significant energy use). Through repeated monthly work cycles since late 2017, this team has been identifying, prioritizing, selecting, and fixing building deficiencies, and then verifying and maintaining those savings going

forward. In the Lab’s high performance computing center (NERSC), ongoing commissioning work reduced the non-compute, overhead energy of the data center (mostly cooling) by 37 percent. Overall, ISO 50001 targets - derived from the federal government, state of California, and University of California - have been achieved. However, continual improvement is needed to continue to deliver and maintain savings.

Tools, Resources, and Data Analysis

The Skyspark analytics platform is a key tool used to identify savings opportunities, perform analyses, and track performance. Also important to the management of the Lab’s ISO 50001 system is a comprehensive systems manual and an ecosystem of related (Google) documents and online reporting. Consistent funding from the Lab’s management has been critical to the development of tools and expertise over the performance period.



Visualization of energy consumption in Skyspark over one year (x-axis) through the 24 hours in a day (y-axis) with tracking of heating degree days helps identify waste (red areas to the left) and helps to maintain savings over time.

Reported energy savings use metered data normalized using weather regression, which is performed using linear regression with heating or cooling degree days normalized to 2012-2020 weather (collected by an on-site, calibrated weather station). Regressions, calculated

with the Skyspark analytics platform, are performed every 6 months for a rolling 12-month performance period. The baseline period is fiscal year 2015 (October 2014 through September 2015) and the performance period is the 12-month period from April 2020 through March 2021. In addition to weather normalization for all energy metrics, the Lab tracks certain metrics normalized by square footage (an average of monthly values during the performance period).

Transparency

The certification report called Berkeley Lab’s innovative approach to applying the standard “best in class” and also stated:

“This is clearly one of the more robust and well thought out energy/water management systems and should be a model for other complex organizations implementing ISO 50001.”

Berkeley Lab has been very open and has actively shared about its implementation, certification, and sustainability data. In particular:

- Certification was announced publicly in the Lab’s [daily newsletter](#), [sustainability website](#), and several U.S. Department of Energy articles, as well as through an email blast to a broad range of internal and external stakeholders.
- Throughout implementation, the Lab communicated regularly via meetings and presentations both internally and externally.
- Graphs of the Lab’s sustainability data, including for ISO 50001, are available at sbl.lbl.gov/data.

- Information on Berkeley Lab’s ISO 50001 program, including its comprehensive online manual, is publicly available (iso50001.lbl.gov) to serve as a resource for other organizations.

The Lab’s ISO 50001 Implementation was selected for a 2021 U.S. Department of Energy Sustainability Award for its Innovative Approach to Sustainability.

What We Would Have Done Differently

- We would have paid closer attention to over-designing new processes. We have found ourselves revising some processes that had become cumbersome to maintain. By contrast, for those processes that were extra-streamlined, it has been easy to add a bit more rigor later, if needed.
- We would have emphasized development of a strong internal audit program earlier in implementation. We have found that comprehensive internal audits are a uniquely valuable approach to continual improvement of the management system.

“I’m impressed by the extent to which the ISO 50001 Standard has harmonized communication within our team and improved the rigor of our energy and water management. We are now adapting processes inspired by our ISO 50001 management system in many other areas of our sustainability work.”

— John Elliott, Chief Sustainability Officer

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.

