ISO 50001 Energy Management System
Case Study

2021 United States of America

Des Moines Water Works

Over 10% reduction in energy intensity in 4 years.

Fleur Drive Treatment Plant

Organization Profile & Business Case

Des Moines Water Works (DMWW) is an independently operated, public utility providing drinking water to approximately 500,000 people through three treatment plants in the Greater Des Moines area. DMWW is the largest water utility in Iowa, among the largest 100 utilities in the country, and is recognized as an industry leader. DMWW is overseen by the Board of Water Works Trustees who make policy, appraisal, and evaluation decisions.

DMWW is managed by a team including the Chief Executive, Financial & Operations Officers, and department directors, all of whom are members of the Senior Management Team.

DMWW is committed to being good stewards of natural resources and realized reducing energy intensity plays a major role in that endeavor.

All areas of the utility are driven by the Mission Statement: *Des Moines Water Works is a regional utility that protects public health by delivering quality water in reliable quantities. Operating with fiscal discipline, DMWW offers dynamic and responsive services that provide high value to our customers.*

Case Study Snapshot	
Industry	Water Treatment
Product/Service	Public water supply
Location	Des Moines, IA USA
Energy management system	ISO 50001
Energy performance improvement period, in years	4
Energy Performance Improvement (%) over improvement period	10.2%
Total energy cost savings over improvement period	US$830,387
Cost to implement EnMS	US$196,004
Total Energy Savings over improvement period	147,748 GJ
Total CO_2-e emission reduction over improvement period	25,952 metric tons

DMWW's Core Values include: … *being mindful of our responsibility to protect and improve the limited natural resources for the benefit and use of future generations*

through challenging traditional approaches, developing best in class practices, and seeking opportunities to apply emerging technologies.

Energy management is an important part of DMWW's overall business strategy and rationale; so much so, the Board of Trustees created Policy 621. The policy drives the EnMS. It is presented here in its entirety.

621 Energy Policy. Des Moines Water Works is committed to continual improvement in its energy performance by using energy cost-effectively and efficiently, while being environmentally responsible. To achieve this, we are committed to:

621.1 Improving energy performance by implementing and continually improving an effective energy management system that supports all operations and customer satisfaction.

621.2 Measuring and continuously endeavoring to reduce energy consumption.

621.3 Purchasing energy efficient products and services.

621.4 Complying with applicable legal and other requirements related to energy use, consumption, and efficiency.

621.5 Considering energy performance in long-term planning, engineering design, and modifications to facilities, equipment, systems, and processes.

621.6 Providing the resources and information needed to set and achieve the energy objectives and targets with regular review.

621.7 Advocating for energy performance through efforts to educate, engage and raise awareness about energy performance improvement across stakeholder groups including agencies, non-governmental organizations, utilities, and policymakers.

Our goal was very simple: Continually improve our energy intensity through financially viable projects and operational adjustments.

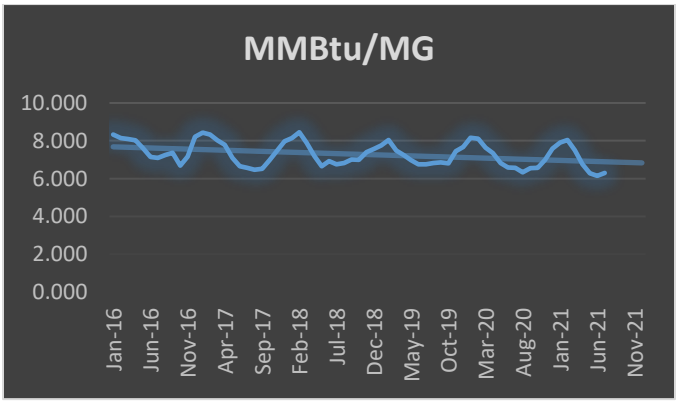
"ISO 50001 has helped Des Moines Water Works create and follow a systematic approach to reducing energy intensity. As a result, we continue to enjoy significant energy cost savings and reduced CO_2 emissions."

—Ted Corrigan, CEO

Business Benefits

DMWW has three major energy sources: Electricity is the major production energy source; natural gas is used for heating; and gasoline is used in the fleet of 110 vehicles.

Combining the three energy sources for 2017-2020, the annual improvement in energy intensity was 5.12%, 1.88%, 1.95% and 1.23% respectively. Overall energy intensity improvement was 10.18% over the four years. The combined annual improvements resulted in energy savings of US$830,387. The 2021 global average cost of electricity for business is US$0.127 per kWh. DMWW's average cost is US$0.052 per kWh. At the global average, DMWW would have saved US$1,873,794.



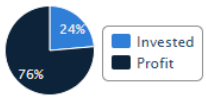
Avoided CO_2 emissions totaled 25,952 metric tons.

Non-energy benefits include:

- Critical equipment reliability.
- Wire-to-water efficiency of 38 pumps totaling over 18,000 electric hp is monitored and analyzed monthly to flag equipment issues. This allows MRO staff to investigate and make needed repairs before catastrophic failure occurs.
- Employee awareness has led to efficiency suggestions and reduced idling of fleet vehicles.
- Public awareness of our EnMS and subsequent positive financial and environmental impacts have improved public opinion of DMWW.

Detailed financial records relating to the implementation of the EnMS show the total cost of implementation including certification audits was $196,004. Staff time was 686 hours and consultant hours totaled 689 for a combined total of 1,375 hours. The DOE pilot project training added 1,184 staff hours.

Investment Gain	$634,383.00
ROI	323.66%
Annualized ROI	43.47%
Investment Length	4.00 years



Plan

DMWW has been implementing energy efficiency projects since at least 1992. By 2013, most of the low-hanging fruit had been picked. In 2014, the CEO directed and empowered staff to reach higher and do better.

Top Management Commitment

Fortunately for DMWW, the CEO championed energy management with the Senior Management Team (SMT). The CEO was a powerful force and super-salesman. The SMT voted unanimously to proceed with ISO 50001 as did the Board of Water Works Trustees.

Board Policy 621.6 committed resources, both financial and labor, to achieve energy intensity improvement goals and objectives.

Energy Consumption and Use

DMWW had a few sub-meters, tracked gasoline use manually by fleet vehicle, and had access to historical energy related invoices. Heeding the adage, “You can’t manage what you don’t measure.”, a plan was quickly put into place to purchase and install about 70 networked electric sub-meters, 110 fleet vehicle GPS tracking modules, natural gas sub-meters, flow meters, and pressure transducers. In the meantime, we would calculate consumption and where energy was being used by tracking runtime and applying nameplate energy data.

Historical energy bills had long been entered into a spreadsheet so it would be easy to pull that data for use in the EnMS.

Department of Energy’s Pilot Program and eGuide

Ensuring that the EnMS would support DMWW’s goals, objectives, and targets for implementation relied heavily on the CP EnMS and additional training.

The US Department of Energy’s Advanced Manufacturing Office of Energy Efficiency & Renewable Energy sponsored a pilot program for water/wastewater facilities. DMWW was fortunate to be one of the participating utilities, using it as the foundation to build our system on. The Energy Team logged 1,184 hours of live training at select locations around the country.

The emphasis of the pilot program was intensive training on ISO 50001 and Superior Energy Performance™ (ANSI/MSE 50021) and how to implement the energy management system.

Included in the training material was the eGuide (replaced by 50001 Ready Program), a collection of 136 templates, worksheets, and examples of how to plan and implement the standards. These resources were used heavily in the planning stages of implementation.

Collect Data, Review, Analyze, Prioritize

Data was collected back to 2015 and included utility bills, production units, weather, motor nameplate, pump nameplate, run times, financials, and building characteristics.

Using the data, an energy balance spreadsheet was created broken down by systems. Within each system, equipment was identified along with its nameplate kW. Annual energy consumption was calculated for each piece of equipment by applying the load factor (actual percent loaded) and duty factor (percent annual run time). The energy balance was calculated by dividing the total calculated energy consumption by the actual energy purchased. The balance was 98.73%.

From this data, we identified the significant energy users we would focus on. In several cases, pumps with throttled discharge valves were given high priority.

Top Management Involvement

As mentioned earlier in this case study, top management directed staff to manage energy. Throughout the implementation process, the CP EnMS was invited to senior management team meetings once a month where progress reports were presented, and senior management would provide direction, suggestions, and motivational support.

Resources

With full support of the management team and Board of Water Works Trustees, obtaining financial and human resources was written into Board Policy. See 621.6 on page 2.

"ISO 50001 Energy Management System provides best route navigation to manage energy on the same level as finance, personnel, and processes."

—Douglas Oscarson, Energy Manager

Do, Check, Act

Timeline

In late 2014, realizing energy should be managed much like finance, treatment processes, personnel and construction projects, the CEO made the decision to obtain an in-house Certified Practitioner in Energy Management Systems (CP EnMS). The CP EnMS would lead energy management efforts, assess progress, and ensure continual improvement based on ISO 50001.

Soon thereafter, DMWW was recruited by the US Department of Energy (DOE) to participate in a pilot program for the water/wastewater sector to implement ISO 50001 as an energy management system and work towards the DOE's Superior Energy Performance® companion certification. The pilot program was successfully completed in the Summer of 2016.

Also in 2016, DMWW joined the Department of Energy's Better Plants Challenge and set a goal of reducing energy intensity by 25% over ten years.

In November 2017, DMWW became the first water utility in the USA to certify to both ISO 50001 and Superior Energy Performance® at the Fleur Drive Treatment Plant Campus. The campus includes administrative offices, fleet, fabrication, engineering, water treatment/distribution and management of over 3000 acres of watershed parklands.

The other two treatment plants will become certified to ISO 50001 and Superior Energy Performance® in 2021.

Energy Team

The CP EnMS recruited staff from the Engineering and Water Production (WP) departments to form the Energy Team. Water Production MRO staff control nearly 80% of all energy used from all sources so it was important to have them represented. The WP department is also home to the electricians, control system specialists and operational staff, all of whom would play a major role during implementation of the ISO 50001 and associated projects.

The Energy Team is empowered to use the EnMS to support organizational goals, objectives, and targets with SMT oversite. Energy analysis is woven into the company's operations. Purchasing, engineering, operations, fleet, and distribution are all included in energy analysis to support Board Policy 621.

Objectives, Targets & Action Plans

To date, sixteen objectives have been created with twenty-three associated actions plans (activities). Some key activities identified and implemented that have contributed to improved energy performance are:

- 100% conversion to LED lighting
- Upgrade building management systems and insulation
- Fleet idling reduction
- Numerous VFDs to eliminate throttled valves
- Real-time energy monitors for control center
- Require steam/condensate leaks to be classified as urgent

Critical targets were achieved by utilizing the energy team's knowledge and skills and the resources provided by top management.

Measurement, Analysis & Performance Improvement

Energy Performance Indicators (EnPIs) were developed for each of the three energy sources. Energy units from all three sources were converted into MMBtu.

- The electric EnPI is MMBtu/Million gallons pumped.
- The natural gas EnPI is MMBtu/HDD
- The gasoline EnPI is MMBtu/fleet run hour.

Heeding the adage, "You can't manage what you don't measure.", an aggressive metering project saw the installation of over 180 networked sub-meters on distribution switchgear & panels, significant energy users (SEUs), and fleet vehicles. Numerous flow meters and pressure transducers were installed on SEUs to augment energy data. The data is brought into the SCADA system and is recorded in a historian database. From that database, trends are analyzed, and queries are run to develop detailed SEU performance.

Sub-meter data showed over 75% of all energy is consumed pumping water with electric motors (combined 18,000 horsepower). The most in-depth analysis is performed on these systems. Wire-to-water efficiency is calculated regularly with many larger systems programmed to display real-time efficiency in the Control Center.

Using results from analysis, objectives and associated targets and action plans were developed and prioritized based on Life Cycle Cost (LCC) analysis. On many projects, generous incentive rebates from the electric utility brought the cost down so the normal budget process could be bypassed.

Analysis also supports equipment reliability by flagging possible electric and mechanical issues that ultimately impact reliability and efficiency.

All energy related data is collected, summarized, and analyzed monthly by the CP EnMS.

Action plans are tracked on a Register of Implemented Actions where actual measured or calculated energy savings are balanced with actual energy consumption.

Performance improvement is calculated using the DOE's EnPI Tool within Excel. The tool uses regression analysis to establish a normalized baseline of energy consumption, track annual progress of intensity improvements, energy savings, and CO_2 emission reductions that account for variations in weather, production, and other variables.

DMWW's baseline is 2016 with reporting periods of 2017-2020.

The variables used are production, weather, fleet runtime, and main breaks.

The tools and resources used are extensive instrumentation, SCADA Historian, submeters, energy invoices, EAM, and a fleet tracking system.

Communication & Management Review

Throughout the EnMS implementation process and continuing today, the Energy Team keeps constant communication with senior management open with monthly energy reports, energy forecasts, SEU inefficiency flags, and weekly departmental fleet idling reports.

The annual management review of the EnMS, along with the regular communication ensure the Energy Team is focusing on top priorities and continually improving the EnMS to meet goals and objectives.

Training

Before the EnMS was fully implemented, a comprehensive training program was developed to help ensure goals and objectives would be met.

- Water Production operational staff was trained in selecting the most efficient pump combinations, electrical terminology, electrical time-of-use rates, electrical demand, and more.
- Water Production maintenance and repair staff were trained on SEU maintenance and repairs, instrument calibration and documentation, and recognition of possible electrical/mechanical issues that may affect efficiency and reliability.
- All employees had EnMS awareness training.
- All employees had fleet idling training.

Asset Management & Purchasing

The Enterprise Asset Management System (EAM) helps ensure goals and objectives are met. EAM was modified to track employee SEU training, SEU maintenance and repair documentation, and EnPIs. EAM tracks and interrogates/flags utility bills for review if they fall outside of the expected consumption.

All purchasing is done through EAM. The purchasing module was customized to require Energy Team approval when purchasing products or services that may impact energy efficiency.

Employee Engagement

Regular communication with employees is done using the company intranet and periodic EnMS presentations in video format so all employees on all shifts get the same information. New employee onboarding includes a video describing the EnMS and highlights what their roles may be in making the EnMS successful. An employee suggestion program is in place.

Third-party Audit Preparation

The DOE pilot program included an on-site audit of our energy management system by certified ISO 50001 auditors. The audit was used as our first internal audit and to prepare DMWW for the third-party audit.

Transparency

DMWW's ISO 50001 Certification was announced to the public through a press release, on social media, bill stuffers, and the company website, http://www.dmww.com/about-us/energy-management/. All suppliers and contractors were notified with a direct mailing.

What We Would Have Done Differently

- Included energy team members in writing the energy manual rather than just reviewing what the CP EnMS had written.
- Included the internal auditors in the DOE's pilot program.
- Used a contractor to install the sub-meters rather than internal electricians to speed up the process.
- Recruit an "energy efficiency champion" in each department to promote the EnMS.
- Certify all three treatment plants originally.