

3M

Case Study

Energy Efficiency as a 3M Competitive Advantage



3M Science. Applied to Life.

Business Case for Energy Management

Company Profile/Business Case- 3M is a global innovation company that never stops inventing. Over the years, our innovations have improved daily life for hundreds of millions of people all over the world. We have made driving at night easier, made buildings safer, and made consumer electronics lighter, less energy-intensive and less harmful to the environment. We even helped put a man on the moon. At 3M, we recognize the importance of sustainably-driven operations on a global scale and are committed to developing a sustainable future for our company as we continue to grow. We've been recognized as an industry-leader by Dow Jones Sustainability Index (selected for inclusion for 17 consecutive years), Energy Star (10 time partner of the year award from 2004-2014), the U.S. DOE's Better Buildings Better Plants (achieved goal of 25% reduction of energy intensity in U.S. operations from 2005-2015; new goal to improve 30% by 2025), and Carbon Disclosure Project (ranking of A- in climate change for 2016).

'The implementation of a management systems approach for energy management has provided great value to our organization. The proven performance of our ISO 50001 certified facilities has led 3M to include ISO 50001 and Superior Energy Performance as one of our strategies to meet our next set of corporate energy efficiency goals.'

-Jean Bennington Sweeney, Chief Sustainability Officer, 3M

Case Study Snapshot

Industry	Manufacturing
Product/Service	Multiple
Location	5 US Locations
Energy Management System	ISO 50001 and Superior Energy Performance (ISO 50021)
Energy Performance Improvement Period	2012-2015
Energy Performance Improvement (%) over improvement period	Average of 7.7%
Total energy cost savings over improvement period	\$2.4 million per year
Cost to implement EnMS	\$312,600
Payback period on EnMS implementation (years)	0.13 years
Total Energy Savings over improvement period	485,000 GJ
Total CO ₂ -e emission reduction over improvement period	94,800 Metric Tons

Energy plays a big part in our sustainable actions, as 3M recognizes the value of managing energy within our operations. Our energy management program began in

1973, with over 40 years of commitment to a “continuous improvement” and global cross-functional engagement. Recognizing that we utilize a large energy profile on a global scale offers an opportunity for 3M to make a meaningful difference with effective energy management. With that, we lower operational costs, reduce our carbon footprint, increase the reliability of our energy supply, improve our reputation and relations with businesses and communities that surround us, and optimize manufacturing processes by managing our energy efficiently. Always looking ahead to “what’s next,” 3M continues to be a driver of innovation in sustainability and impact-reducing initiatives on a global scale. Over the years, 3M has set some fairly aggressive targets in energy efficiency and our 2025 Corporate Sustainability Goals demonstrate our commitment to continuously improve upon our past accomplishments.

- Improve energy efficiency by 30% measured by Btu’s per unit of product produced
- Increase renewable energy to 25% of total electricity use
- Ensure GHG emissions at least 50% below our 2002 baseline, while growing our business

Business Benefits Achieved

Business Benefits (Summary)- Offering certification and recognition from a reputable third party led 3M to participate in the development of the ISO 50001 and 50021 standards through an industry collaborative led by the U.S. Department of Energy beginning in 2007. 3M facilities were among the first to pilot ISO 50001 implementation in 2011. 3M facilities in many countries support government initiatives to implement ISO 50001 as demonstrated by our partnerships with Natural Resources Canada, the Korean Energy Management Agency, and others. By integrating the systematic ISO-based framework of plan-do-check-act for the management of energy in on-site operations, our facilities have seen savings in energy costs and consumption, expansion of employee engagement, and increased visibility to the tracking of site energy performance. During the most recent five year internal goal period, 3M global operations improved their energy performance by 14.1%. Facilities that are participating in ISO 50001 and Superior Energy Performance are outpacing other 3M facilities, providing energy efficiency improvements 60% greater

than the 3M average. Due to the clear benefit, 3M has been busy increasing its ISO 50001 certified profile, with 28 global facilities that are certified or are working towards certification to ISO 50001 at the end of 2016.

Since 2013, five of our U.S. manufacturing facilities had been engaged with the U.S DOE’s Better Buildings Industrial SEP Accelerator program for a multi-facility, enterprise-wide certification. In May of 2016, it was announced that all five 3M locations not only completed the certification process to ISO 50001, but each facility also met the supplementary requirements and performance improvement goals of the SEP program. Upon this announcement, an additional facility in the U.S. that had been recently recertified in 2015 was merged into the enterprise. The achievement was a culmination of a significant level of effort for a number of individuals, both at each location and in St. Paul. The determination and collaboration of the energy champions and teams at these five locations have resulted in this remarkable accomplishment. The energy savings from these locations over the 3 year certification improvement period resulted in:

- An average energy performance improvement of 7.7% during the 3 years of certification
- 460,000 MMBtu of primary energy savings
- \$2.4M in annual energy cost reductions
- Reduced greenhouse gas emissions of 94,800 metric tons CO₂e.

As calculated by the DOE’s Enterprise-Wide Accelerator (EWA) Case Study, operational changes implemented at these sites accounted for 69%, or \$1.7M, of the energy cost savings. A breakdown of the total energy saved is shown in figure 1 (in units of primary energy). Collectively, the five sites saved 21.8 million kWh of electricity and 237 billion Btu of natural gas, which total to savings of 460 billion Btu in primary energy. Along with this, the non-financial benefits of implementation have proven to provide the genuine benefits of increased cross functional team engagement,

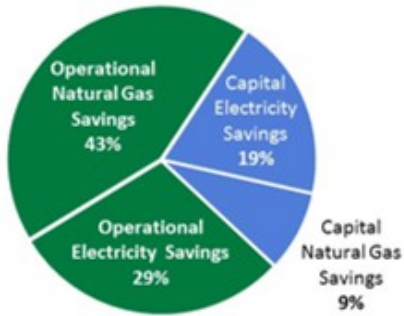


Figure 1: DOE EWA Energy Savings Breakdown for 3M

Site Name	Perf. Improvement (%) ¹	Annual Energy Cost Savings (\$) ²	Operational Energy Savings in Total (%)	SEP Implementation Cost (\$) ³	SEP Implementation Labor (FTE-yr.) ⁴
Manufacturing Site A	11.0%	\$473,000	89%	\$20,000	1.8
Manufacturing Site B	6.9%	\$250,000	92%	\$183,000	2.2
Manufacturing Site C	5.2%	\$580,000	87%	\$13,500	1.5
Manufacturing Site D	10.0%	\$941,000	46%	\$73,000	0.7
Manufacturing Site E	5.2%	\$154,000	76%	\$23,000	2.3

¹SEP certified performance improvement was achieved in 3 years (including reporting period) for all sites.
²Annual energy cost savings (rounded to thousand dollars) reflect SEP certified performance improvement, which included results from both capital and operational projects.
³SEP implementation costs (rounded to thousand dollars) contains significant, non-requisite metering equipment investment for site B and D.
⁴SEP implementation labor included both site and Central Office staff time.

Figure 2: DOE's EWA Case Study analysis

higher awareness and program participation by all employees on location, tangible management support, and data-driven project implementation. 3M also participated in external benchmarking with peer companies pursuing ISO 50001 certification, including Cummins Inc. These conversations yielded beneficial outcomes for both parties; with increases in applicable knowledge and comparison of best practices utilized for achievement in the requirements of the standard. Finally, certification of ISO 50001 and SEP has become an internal and external demonstration to 3M's continued commitment to energy efficiency in our global operations.

EnMS Development and Implementation

Establishing the corporate-level, central office to develop the 3M-defined course for ISO 50001 & SEP implementation in conjunction with the U.S DOE's Better Buildings SEP Enterprise-Wide Accelerator program streamlined the efforts required by our locations throughout the process. The enterprise-wide implementation creates the opportunity for all cohort facilities to share a common EnMS defined and maintained at the Central Office level. In doing this, the processes are consistent and on a common schedule.

Development and use of professional expertise- Beginning in 2013, 3M teamed with U.S DOE's Better Buildings Industrial SEP Enterprise-Wide Accelerator program. An essential component of the implementation process was attending in-person, structured training sessions, organized by the DOE and Georgia Tech in order to gain industry-experienced expertise in ISO 50001 processes in manufacturing companies and work through the enterprise-building process. Throughout the implementation period, members of our central office team and site energy teams collaborated with various experts and consultants, including: external benchmarking with industry partners with an ISO 50001 certification profile, internal ISO 90001 & 140001 experts, and internal ISO 50001 certified locations (i.e. sites in Canada, Germany, and U.S.).

Organizational- First, it was important that the development of the EnMS engaged all levels of employees in the organizational structure; from the site to the corporate functions. As our network of global Energy Champions continuously seek validated best practices, it quite simply made sense for our corporate-level Energy Management team to take on the role of an EnMS Central Office. With this in mind, a two-tiered communication flow was developed in order to assure awareness and accountability, meeting requirements, and allocation of resources. As can be seen in figure 3, the "Management Representative/ EnMS Team leader" is defined at both the facility and corporate level. "Top Management" is similar, with the Plant Manager representing facility-level of EnMS oversight; whereas the corporate level consists of a cross-functional committee (with leadership from Engineering, Environmental Health and Safety, and Supply Chain). The wide-ranging inclusion of key team members across department lines within both levels of the two-tiered approach provided great benefit to the implementation process. This included increased EnMS awareness and leverage of EHS team members already-engaged with ISO 9001 and 140001. The 3M EnMS Central Office consists of 3 full time Energy Management employees (including the Corporate Energy Manager, a Senior Energy Project Leader, and an Energy Analyst), tasked with dividing responsibilities in the development of an ISO 50001 & SEP implementation system that would be

maintained at the corporate level and could be utilized for replication across numerous locations.

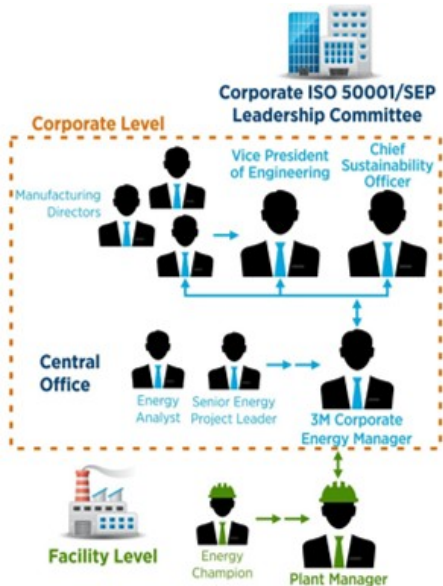


Figure 3: 3M Enterprise Communication Flow

Each of the 5 Energy Champions (the site energy and ISO 50001 implementation lead) and energy teams worked collectively with the Central Office throughout for a collaborative, feedback-driven development process of all EnMS materials and processes. In this regard, implementation was customized to 3M needs, but allowed for consistency in practice.

Tools & Resources- Over the course of implementation, an Enterprise-Wide SharePoint system was developed to house the EnMS tools & resources that meet standard requirements, providing easily-accessed and document-controlled versions (figure 4).

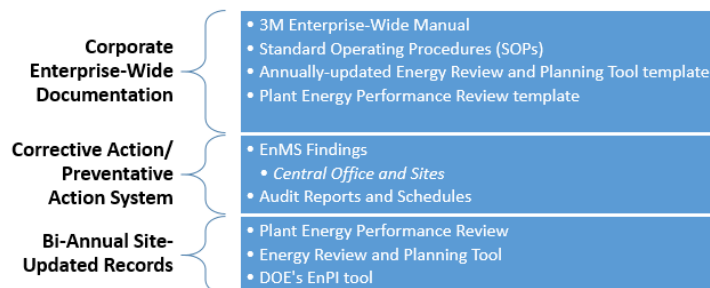


Figure 4: EnMS Tools and Resources

Each site utilizes the components of the EnMS as defined by the Central Office to meet the requirements of the standard, but is also free to customize the means

for completion on an individual site scale. In this way, consistency in process is provided, while each location is given the flexibility to individualize to the locations' existing procedures and practices. It was of benefit to the 3M teams to leverage existing corporate tools and resources; including location's Management of Change documentation, 9001 and 14001 processes and systems, our corporate energy data and projects databases, among others.

Energy Review and Planning- With our existing 3M reporting systems, we were well-set up for the development of an energy review and planning process. The corporate-level Energy Management group has been tracking energy costs and consumption by facility for decades, and furthermore analyzing this data for trends, areas for opportunities in improvement, new technologies, upgrades in existing equipment, and process optimization opportunities. After benchmarking with an external industry partner, an Energy Review and Planning Tool (ER&PT) was developed for 3M facilities to house all the requirements of the standard-defined energy review process (figure 5).



Figure 5: Screen shot of the ER&PT menu tab

Within the Microsoft Excel®-based tool, all the standard's requirements for section 4.4 are documented. This template is organized in a way to effectively streamline action items in a systematic manner, with a tab for each requirement step. The utilization of the ER&PT proved to be essential during the internal and external audit processes, providing a

consistent, easy to navigate display that decreases audit time dramatically.

Approach used to determine whether energy performance improved- Within the ER&PT process, the approach used to determine energy performance improvement is defined through the collective utilization of the DOE’s EnPI Microsoft Excel® -add-in tool and features of our ER&PT to expand upon the model’s outputs with data displays and documentation. Utilizing the EnPI tool has provided the ISO 50001 & SEP enterprise locations a statistically-analyzed, normalized view of energy performance, where each site is able to account for impacts due to weather, variations in production, and other factors that cause deviations in data. Our enterprise utilized the performance improvement period defined at their locations between 2012-2016, the relevant variables applicable, and most-sensible method of modeling to their site’s analysis.

Approach used to validate results- Once the performance improvement of the site has been established through the data-driven analysis, the sites utilize the Bottom-Up Sanity Check tab within the ER&PT to validate results. The performance improvement % and the MMBtu saved from the EnPI analysis is “worked up to” in a process utilizing all documented energy projects and their associated energy savings. A list of ISO 50001-related energy projects delivered on site during the implantation period is stepped through, summing the MMBtu savings delivered along the way. Calculations associated with the savings are validated, and site walk-throughs to physically view the project results is standard practice.

To maintain operational control and sustain energy performance improvements - Multiple practices to institutionalize continuous improvement in energy management have been established. A defined schedule of “checkpoints” has been established within our enterprise, where milestones are required by both the ISO 50001 locations and the Central Office (figure 6). With this structure, both individual sites and the enterprise are voicing EnMS standings with the decision- makers, who have the ability to provide additional resources, hold teams accountable, and impact the achievement of performance goals. Also, the CA/PA system, SharePoint documentation system, the

EnMS manual, and SOPs, guides the program with continuous improvement in mind.

	Q1			Q2		
	January	February	March	April	May	June
Central Office	Annual update of tools - Review & Planning Tool/Management Review Workbook, etc. Training on updated tools provided to plants.	External Stage I audits		External stage II audits or surveillance audits	New plants to join enterprise	
Plants					PEPR's take place. PEPR Workbook and Review & Planning Tool saved and uploaded to SharePoint.	
	Q3			Q4		
	July	August	September	October	November	December
Central Office		Internal audits completed		Participate in PEPR's as appropriate	Schedule internal/external audits for upcoming year - Plant, Corporate, DEKRA	Top Management Review
Plants		Internal audits completed		PEPR's take place. PEPR Workbook and Review & Planning Tool saved and uploaded to SharePoint.	Schedule internal/external audits for upcoming year - Plant, Corporate, DEKRA	

Figure 6: 3M's Enterprise-Wide Bi-Annual schedule

Communication- As process optimization continues to occur, the enterprise locations also utilize a documentation process called the Management of Change (MOCs). In this regard, updates made the site energy system to be more effective are comprehensively documented within the facility and communicated to all employees. Sites utilize multiple methods of communication to motivated employee awareness and engagement; energy-specific suggestion box, energy fairs, visual communication materials around sites, informational cards held within badges, as well as introductions to the importance of ISO 50001 & SEP in site visitor welcome and safety videos. At the Central Office level, the Corporate Energy Manager takes on the role of deciding when to communicate internally and externally.

Cost-benefit analysis- Within the partnership of the DOE’s EW SEP acceleration initiative, a detailed Cost-benefit analysis was provided. The cost to implement was greatly offset by having an already established energy management program at each location and by the leadership provided by the corporate team, saving up to one full time equivalent (FTE/yr) for each site. The cost to implement was \$7,600 less per site than the cost to implement SEP individually. According to the EWA Case Study provided, implementing at the five 3M sites cost about \$63,000 per site on average (figure 7).

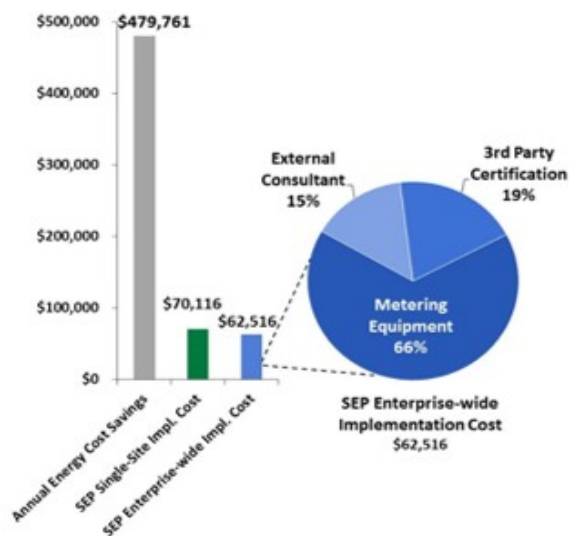


Figure 7: DOE's EW SEP Costs and Benefits

Major components of this investment were the expansion in metering by 2 of the 5 sites, 3rd party certification costs, external consultant fees, and efforts and worktime focused by full-time 3M internal staff, equating to about 1.7 FTE/yr per site over the course of implementation. The enterprise-wide versus the traditional site-based approach yielded savings with reduced 3rd party auditing and certification costs by due to shortened audit time, as each site had consistent processes and documentation. In total, 3M saved \$18,000 on the initial certification audits and projects savings of \$56,000 on audit costs over a three year cycle (including the initial audit and two surveillance audits) compared to standalone site audit costs.

Lessons Learned

Lessons Learned: The management systems approach provides a proven methodology to achieve a culture of continuous improvement in energy performance. The

opportunities to streamline the implementation process through corporate leadership and with multiple plants working as cohorts through our enterprise-wide certification provided significant benefits in terms of time savings, cost savings, and sharing of best practices. Having leadership within the organization with ISO 50001 and 50021 training and experience is a definite advantage, as is the ability to call upon outside resources as needed. The time and resource commitment within a facility seeking to become certified must be understood and supported by management, as leveraging and maintaining management support is critical. The momentum needs to continue, with a process for integrating new energy team members maintaining forward motion, assuring system maintenance, engaging cross functional team members, and offering development opportunities. 3M aims to expand our ISO 50001 & SEP enterprise-certified profile globally, with these locations being the pace-setters.

Keys to Success

- Leverage of the Central Office manual, standard operating procedures, CA/PA reporting system, and data analysis tools
- Reduction in future audit costs through sampling-based audits
- Strengthening benchmarking and information sharing through networking & internal auditing
- Reinforcement of systematic management of energy at our top-consuming locations, with empowered energy leaders at each facility

Through the Energy Management Working Group (EMWG), government officials worldwide share best practices and leverage their collective knowledge and experience to create high-impact national programs that accelerate the use of energy management systems in industry and commercial buildings. The EMWG was launched in 2010 by the Clean Energy Ministerial (CEM) and International Partnership for Energy Efficiency Cooperation (IPEEC).

For more information, please visit www.cleanenergyministerial.org/energymanagement.