

Freescal Semiconductor Successfully Implements an Energy Management System

The Superior Energy Performance (SEP) plant certification program is being tested through pilot projects, and one of the earliest participants was the Freescal Semiconductor Oak Hill Fab plant in Austin, Texas. Working with the Department of Energy's (DOE's) Industrial Technologies Program, the Oak Hill site implemented an energy management system in accordance with American National Standards Institute Management System for Energy (ANSI/MSE 2000:2008), had two of its major energy-using systems assessed for energy efficiency, and implemented projects that would improve the plant's energy efficiency and produce substantial energy and cost savings. As a result, Freescal's Oak Hill plant reduced its annual energy consumption by 28 million kilowatt hours (kWh) of electricity and 26,000 million British thermal units (Btu) of natural gas between 2006 and 2009, saving more than \$2 million each year. Freescal's Oak Hill plant is now certified at the SEP silver level, and has a management system in place to proactively manage the facility's energy resources in the future.

Superior Energy Performance

SEP is a market-based, ANSI-accredited plant certification program that provides industrial facilities with a roadmap for achieving continual improvement in energy performance while boosting competitiveness. To become certified, an industrial plant must implement an energy management system in conformance with International Organization for Standardization (ISO) 50001 (which is replacing ANSI/MSE 2000:2008) and make energy performance improvements.

Freescal Semiconductor

Freescal makes microcontrollers, processors, and other electronic parts used in products like automobiles, media players, mobile phones, household appliances, and networking infrastructures. An independent company spun-off from Motorola, Freescal operates in 24 countries with more than 20,000 employees. Freescal is headquartered in Austin, Texas, generates \$5 billion in annual sales revenue, and supplies more than 10,000 firms with electronic parts. The company has manufacturing sites in the United States, France, Malaysia, and China.

Freescal Oak Hill Fab is Freescal's 8-inch silicon wafer manufacturing facility in Austin, Texas. The factory—with 80,000-square-feet of ISO 3 cleanroom—makes microcontrollers, as well as power management and radio frequency products for the wireless and networking markets. When the factory started production in 1991, Freescal Oak Hill Fab was the first 200



Freescal's clean room and data monitoring systems.

Courtesy of SEP

The Department of Energy's Industrial Technologies Program partnered with the U.S. Council for Energy-Efficient Manufacturing (U.S. CEEM), states, and regional teams to conduct energy management demonstrations to help industrial manufacturing plants achieve ambitious energy intensity reduction objectives through strategic energy management.

Companies that participate in the demonstrations test the elements of Superior Energy Performance (SEP) and a forthcoming American National Standards Institute-accredited plant certification program, developed by U.S. CEEM. The regional teams help industrial facilities and manufacturing plants implement an energy management system to improve energy performance and reduce energy costs. As a demonstration site, facilities receive training and support to

- Implement International Organization for Standardization (ISO) 50001 and energy management strategies that lead to continual energy performance and energy intensity improvement
- Reduce energy and other operational costs and carbon emissions
- Monitor and verify energy performance improvements.

At the close of the demonstration project, plants pursue certification through SEP and are prepared to meet the requirements of ISO 50001.

millimeter commercial facility in the world. It has technology capabilities to the 0.25-micron technology node. The plant consumes about 200 million kWh of electricity and 0.2 trillion Btu of natural gas annually.

Energy Management System Project Objectives and Implementation

Freescale established a core engineering team from the Oak Hill plant's facilities, environmental, health, and safety staff to integrate the new management system for energy into its existing management system for environmental, health, and safety (ISO 14001 and Occupational Health and Safety Assessment Series [OHSAS] 18001 based). Freescale then developed an energy management policy and set energy goals. Freescale also developed an energy profile for the Oak Hill site, and calculated the energy reductions that resulted from energy efficiency improvements that had been made over the past three years. Finally, Freescale conducted a self audit and management review prior to the third-party audit.

Energy Management System

Freescale has a global environmental, health, and safety management system (EHSMS) that contains the following elements:

- General/Plan
- Management Commitment
- Planning
- Implementation
- Checking
- Management Review.

The management system governs all manufacturing sites worldwide and has ISO 14001 and OHSAS 18001 Enterprise Certification.

To integrate energy management into the EHSMS, Oak Hill developed high-level documents that incorporate elements of ISO 14001, OHSAS 18001, and ANSI/MSE 2000:2008, and have procedure-level documents that pertain to either EHS or energy management. The EHSMS and energy management system is electronic and server-based.

The energy management system helped Freescale shift emphasis from energy efficiency at the project level to a much broader focus, such as improving key performance indexes and looking at the overall operation of each major energy-using sub-system.

Energy Profile and Energy Reduction Goal

Developing an energy performance indicator (EnPI¹) that meets SEP measurement and verification requirements necessitates a thorough understanding of the factors that impact a plant's energy intensity, as well as the ability to use statistics to normalize the data using techniques such as linear regression analysis. Freescale staff received training from SEP on how to develop an energy profile using these methods, and then developed historical EnPIs for the Oak Hill plant, which is a requirement for SEP certification.

Freescale developed an energy profile that included information about the Oak Hill plant's energy consumption and energy intensity. Freescale set the energy reduction goal of 1.25 million kWh in sustained project savings for 2010 at the Oak Hill facility.

¹ Ratio of current energy usage to baseline usage that would have occurred in the absence of energy efficiency improvements.

Freescale's Energy Management Policy

It is the policy of Freescale Austin sites to conduct all activities related to energy use and energy efficiency consistent with the integrated Austin environmental, health, and safety (EHS) and energy management system and in full support of the Freescale Corporate EHS policy and goals and global site service goals.

Freescale Austin sites will comply with all legal requirements and other commitments associated with energy management as applicable.

Freescale Austin sites are committed to the continual improvement of the Austin EHS and energy management system and improvement in energy performance.

Freescale exceeded the set goal, completing projects that will save the plant 2.55 million kWh on an annual basis.

Freescale's corporate goal is to reduce the company's carbon footprint by 50% by 2015, which includes a 10% reduction in electricity consumption.

Energy Savings Assessments

Two energy savings assessments were performed at the Freescale Oak Hill Fab plant in Austin, Texas. The first assessment focused on the pumps serving the facility's chilled water system. A number of energy savings opportunities were identified, which included achieving better control of the plant's chilled glycol pumps and chilled water secondary pumps, adjusting the number of chillers operating during different times of the day, lowering differential pressure in air handlers, and running fewer condenser water pumps. The second assessment focused on the facility's

ASME Energy System Assessment Standards

In 2010, the American Society of Mechanical Engineers (ASME) published four new standards that establish requirements for conducting energy system assessments at industrial facilities. Many industrial facilities have the potential to increase the efficiency of their systems, but have difficulty doing so because there is no market definition for energy system assessment services. The absence of an accepted definition makes it difficult for service providers to establish market value for their services and for consumers to determine the relative quality of assessment services. The four standards cover process heating, pumping, steam, and compressed air systems. The energy assessment standards are intended to assist plant personnel in identifying cost-effective projects that often have short payback periods. The standards address the topics and requirements for organizing and conducting assessments, analyzing the data collected, and reporting and documentation. As part of this effort, accompanying guidance documents, which provide technical background and application details for utilizing the standards, are also available from ASME.

compressed air system. Improvement opportunities identified included replacing restrictive local piping and valves so that the air pressure could be reduced, adjusting a flow controller and storage that were not being used to the fullest, and addressing a pressure dewpoint setting that was too low.

As a result of applying the assessment standards to the plant's pumping and compressed air systems, DOE Energy Experts worked with plant staff to identify energy savings opportunities of 1.1 million kWh and 0.4 million kWh, respectively, and found ways to enhance the compressed air system's reliability.

Self Audit

Freescale conducted a self audit on all of the elements of the Oak Hill site's energy management system. Independent auditors were not part of the core team. The self audit included a review of plans, procedures, and records. Interviews with facilities and manufacturing personnel were conducted. The energy profile was also reviewed.

The self audit showed no major non-conformances to the system. All required corrective actions were completed and suggestions for improvements were also tracked and addressed. An independent review of the energy data was provided by Georgia Tech, showing no non-conformances.



Courtesy of SEP

Freescale SEP team members, Laura Mendicino, Mark Krawczyk, and James Belle, collaborate on the incorporation of the energy program into the corporate EHS program.

Third-Party Audit and Certification

A third-party audit was conducted onsite at Freescale's Oak Hill facility over four days. Five auditors, along with three ANSI staff who were "auditing the auditors," conducted the audit. The audit's objectives were to confirm the facility's effective implementation of the ANSI/MSE standard and conformance to SEP requirements.

Fifteen overall processes were audited, numerous documents were reviewed, and several employees and contractors were interviewed. The audit showed no major non-compliances, and five minor non-compliances were issued. Seven strengths and eight opportunities were identified. Freescale was recommended for SEP Silver-level certification.

Freescale developed and submitted corrective action plans for the five minor non-compliances identified during the certification audit; plans were accepted by the auditor. The auditor issued a certificate after ANSI certified them as a registrar. Certification requires surveillance audits each subsequent year (an ISO 50001 requirement) for a three-year period, and then re-certification. Once the SEP program is mainstreamed, Freescale will seek certification for its other sites.

Finding New Ways to Save Energy

The economic downturn (which resulted in a production downturn) presented a challenge for Freescale to find new ways to reduce energy use. Freescale's energy use was not correlated with production because many of its process tools were left on even when production was shutdown. Typical of a silicon wafer fabrication facility, the company had many expensive semiconductor process tools that were always left on in order to ensure they did not degrade and could be easily switched to production. The team developed a methodology for testing the shutdown of process tools. Freescale was successful in using this methodology to shutdown the idle tools and save a significant amount of energy. This had never been done at the Oak Hill Fab facility before, and stretched the boundaries of what plant staff considered possible to control energy costs.

Freescale benefited from the data analysis requirements of the energy management system and SEP. The key performance indicators (KPI) monitoring told Freescale that some systems, like the facility's steam system, were not operating as designed. Freescale became aware of this due to the KPIs and monitoring system performance over time. Freescale's management was impressed, and since then, KPIs have been developed for a number of other systems in the plant, including chilled water, outside air make-up, and ultrapure water. This was a direct result of going through the energy management system implementation process. This shows that management system implementation is not just a "paperwork" exercise, but that if you apply the tools, real benefits can be seen.

Barriers

Freescale's biggest barrier to certification was demonstrating the energy performance improvements. SEP has a requirement to include adjustments for changes in production level, production mix, weather, and more, and developing an accurate model took time. There was also a challenge with correlating production levels to energy consumption.

Freescale considered using the SEP Mature Energy Pathway as a means for demonstrating program compliance. However, there were some gaps in data due to the pathway requiring plants to provide 10 years of historical data. Also, because of the nature of its production processes, Freescale could not obtain credit for some of the criteria being scored, such as implementing a combined heat and power (CHP) system, because the payback on CHP projects is too long due to Freescale's low demand for heat.

Implementing ANSI/MSE 2000:2008 proved to be less challenging for Freescale. It took some time for the plant to decide whether

it should completely integrate the energy management standard into its existing management systems. Ultimately, Freescale decided to integrate some elements, while keeping some parts separate from the existing management system.

Results and Keys to Success

The Freescale pilot project is a good example of how a company can leverage plant-level activities into a corporate-wide energy management program. When Freescale began the pilot program, the company already had ISO 9001 and 14001 certification in place; the company elected to add its energy management system to the existing environmental management system. Furthermore, Freescale is implementing the energy management program at a sister facility also located in Austin, Texas.

One key to Freescale's success was raising awareness of the Oak Hill site's certification throughout the entire organization. Once the equipment operators became aware of the importance of improving energy performance, they understood their role and took the appropriate actions to make improvements. Another key to success was getting buy-in from senior management. The Oak Hill plant manager was very hands-on, and he helped focus the overall effort on managing energy.

Freescale's Oak Hill plant qualified as an SEP Silver Certified Partner and achieved a 6.5% improvement in energy intensity over three years. Other benefits Freescale reaped from the SEP implementation include the following:

- Successfully incorporating energy management into a recognized company-wide management system, increasing the ease with which improved energy management practices can be adopted, advancing the potential of corporate sustainability efforts, and expanding the opportunities for such measures to be replicated throughout the company. Success of the sites' energy management programs is no longer dependent upon one person.
- Engaging more employees in energy management and energy efficiency. Non-engineer and energy-related staff, such as line or production workers, can provide valuable input and have specialized knowledge or ideas for how to reduce energy use.

Lessons Learned

"The pilot program provided an opportunity to integrate our energy conservation efforts into a comprehensive energy management system. It led us to review the plant operating procedures, which we modified to emphasize energy efficiency. We have developed key performance indicators and control charts at the system level to understand how various factors impact our energy use. These tools are now used to drive continual improvement in energy efficiency by evaluating the effectiveness of energy conservation projects and monitoring to ensure that improvements are sustainable," said Mark Krawczyk, plant services engineer.

Implementing an energy management system allowed Freescale to look at managing energy as a way of doing business, as opposed to only making improvements on a project-by-project basis, bringing the concept of managing energy to a higher level.



Mark Krawczyk, Freescale, (center) accepts an award for the plant's SEP achievement from Dub Taylor, Texas State Energy Conservation Office, (L) and Paul Scheihing, DOE Industrial Technologies Program (R)

Courtesy of SEP

As a result of the pilot project, six key activities have been identified that contribute to a timely, successful implementation of the SEP program:

1. Leverage existing environmental or quality management systems and staff.
2. Cross-train your energy and management system staff.
3. Create cross-functional teams.
4. Establish management commitment upfront and keep communicating to management on project status.
5. Hold regular team meetings during the implementation phase.
6. Take a structured look at data using statistical methods to realize immediate benefits.

Freescale has two plants in Austin (one being the Oak Hill facility), with one plant manager and one EHS management person. A Freescale energy engineer from the company's other plant in Austin participated in all of the energy management systems training at Oak Hill. Freescale has not fully developed KPIs and energy profiles for this other facility, but it does have the energy management system framework incorporated at the site. This is the site that Freescale wants to get certified next. From a cost of implementation perspective for Freescale, it will be relatively inexpensive for the company to get the second Austin plant certified.

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