Global Energy Management System Implementation: Case Study

United States of America

FCA US LLC – Dundee Engine Plant

Dundee Engine Plant saves $690,000 in Energy Costs in the last two years.

FCA US LLC – Dundee Engine Plant, Dundee, Michigan

Case Study Snapshot	
Industry	Automotive
Product/Service	- 2.4-liter I-4 naturally aspirated engines for the Dodge Journey and Jeep Renegade - 2.4-liter I-4 Tigershark Dual Overhead Cam (DOHC) for the Jeep Cherokee
Location	Dundee, Michigan, USA
Energy Management System	ISO 50001
Energy Performance Improvement Period	2
Energy Performance Improvement (%) over improvement period	10%
Total energy cost savings over improvement period	$690,000 (over a 2 year period)
Cost to implement EnMS	$500,000 (over a 2 year period)
Payback period on EnMS implementation (years)	0.7
Total Energy Savings over improvement period (GJ)	27,000
Total CO_2-e emission reduction over improvement period (metric ton)	6,000

Business Case for Energy Management

Fiat Chrysler Automobiles

FCA US LLC is a North American automaker with a new name and a long history. Headquartered in Auburn Hills, Michigan, FCA US is a member of the Fiat Chrysler Automobiles N.V. (FCA) family of companies. FCA US designs, engineers, manufactures and sells vehicles under the Chrysler, Dodge, Jeep, Ram and FIAT brands, as well as the SRT performance vehicle designation. The company also distributes the Alfa Romeo brand vehicles and Mopar products.

Dundee Engine Plant (DEP)

The plant started as a joint venture between Mitsubishi Motors Corporation, Hyundai Motor Company and DaimlerChrysler Corporation in 2004 and was called Global Engine Manufacturing Alliance (GEMA). In December 2009, the Company became fully owned by a/the collaboration between Chrysler Group, now FCA US, and Fiat, now Fiat Chrysler Automobiles N.V., powertrain groups. GEMA became the Dundee Engine Plant in January 2012. The plant makes 4-cylinder engines, which are used in Dodge Journey, Jeep Cherokee and Jeep Renegade.

One of FCA's sustainability goals is to reduce energy consumption in the plants worldwide by 30% from 2010 to 2020. FCA utilizes World Class Manufacturing (WCM) methodology for achieving continual improvement and reducing overall operational cost. WCM has been a very effective tool to improve performance by focusing on the highest losses. Dundee Engine Plant was selected by the Company as one of the three pilot plants in North America in 2013 to implement ISO 50001. The principles of WCM were used as the framework to create the energy management system, which supported the implementation of the standard. Use of the ISO standard has helped to further standardize the process to manage energy systems.

"The efforts at the Dundee Engine Plant are a reflection of FCA's continuing commitment to reduce the environmental impact from our global operations. We have set a target to reduce energy consumption at our plants worldwide by 30 percent from 2010 to 2020. Achievements such as those at our Dundee Engine Plant contribute significantly to these objectives."

— Greg Rose, Director of Environment, Health and Safety - FCA US

Business Benefits Achieved

DEP became the first FCA powertrain plant to be certified with ISO 50001 and the second in North America. The plant has improved its energy performance by 10% in the last two years and saved $690,000 in energy cost and has reduced more than 6,000 metric tons of $CO_{2\text{-}e}$ through energy improvements. DEP achieved silver status in World Class Manufacturing audit and was the first North American powertrain plant to achieve a score of 4 (5 being World Class) in the environment and energy pillar. DEP also received FCA US Environmental, Health and Safety (EHS) award for best energy project in FCA North America in 2015 for the coolant filter system optimization.

DEP Energy Team Receiving FCA EHS Award for Best Energy Project North America in 2015

EnMS Development and Implementation

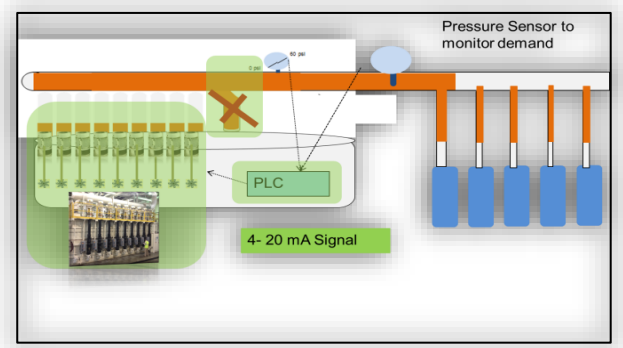
The WCM Energy Management System was first established at DEP in 2009 and it continues to focus on reducing energy loss to zero. Presently, energy loss at DEP is about 40% of the total energy cost. In 2013, with implementation of ISO 50001, DEP strengthened its energy management process and took on more projects by standardizing the way energy is managed.

DEP received rebate checks of $200,000 and $88,000 from the energy provider for energy projects improving the coolant filter system and chiller.

Organizational

Dundee Engine Plant already had existing management systems certified to ISO 9001 (Quality), ISO 14001 (Environment) and OHSAS 18001 (Safety) in place prior to the implementation of ISO 50001 energy management system. Also, since the plant was already utilizing World Class Manufacturing to achieve continuous improvement, implementing ISO 50001 was smooth and the system established was very advanced. With the commitment and support from senior management the overall process to implement ISO 50001 was completed in six months. A full-time Energy Champion was appointed and a team assigned, who developed the system focused to benefit the company by improving energy efficiency and reducing cost. The energy team comprised of a powerhouse lead, facilities manager, maintenance manager, controls engineers, HVAC specialist and many others. Within two years of implementation, the plant completed several projects that were recognized by the Company, some of them are mentioned below.

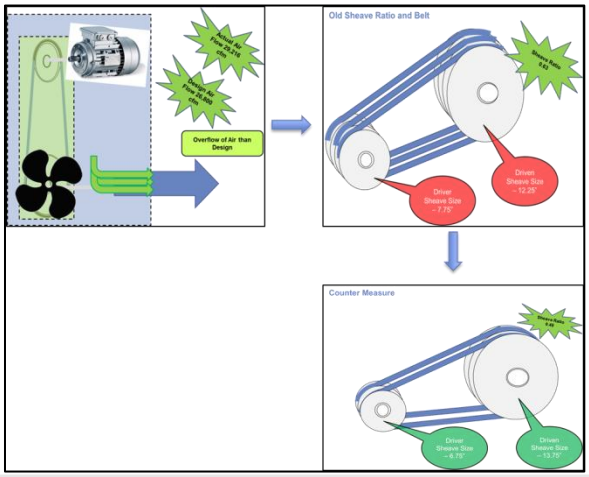
Coolant Filter System Optimization – DEP has 14 coolant filters that provide clean coolant to the machining lines at a pressure of 55-60 psi. Each system ranges from a 9-pump system to a 3-pump system, each using 75 hp motors. This system uses pneumatic by-pass valve control to regulate header pressure creating energy loss by sending already filtered coolant (volume and pressure) back to the supply tank.



Pictorial Representation of Coolant Filter System Project

To eliminate this loss, the by-pass control was eliminated and the motors were upgraded with Variable Frequency Drives that vary the pump speed to achieve the required pressure. Further pressure reduction was specified on each coolant line to maintain pressure at 54 psi on each system, further increasing the energy savings. This project annually saved 3,000,000 kWh, resulting in energy savings of $194,000.

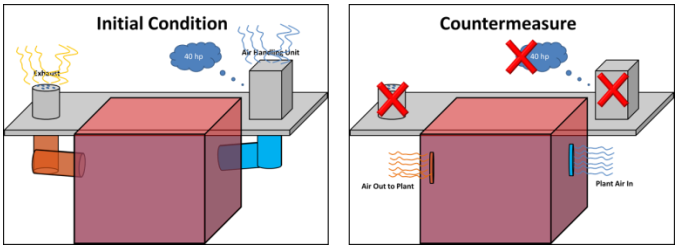
Air Handling Unit (AHU) Sheave Ratio project – DEP has 64 roof top units providing conditioned air to the plant. Air monitoring performed on individual units showed that each of these units were providing 10% more air than designed. In order to return these units to basic conditions, the team implemented a countermeasure, Sheave Ratio Reduction (driver/drive ratio), to achieve flow reduction. This in turn reduced energy consumption on the blowers.



Pictorial Representation of AHU Sheave Ratio

Substation HVAC optimization – There are 4 substations inside the plant that convert 13.8kV to 480V. These substations can reach temperatures of 150F and use air handlers on the roof containing 40 hp blowers each to cool the substations to 75F. The air after use in the substation is then exhausted through the roof to the atmosphere. With Michigan summers exceeding 75F most of the time, these blowers run continuously to cool the substations. As a countermeasures, the plant installed axial fans on the substations to take air from inside the plant and exhaust it back to the plant. This project saves energy by using a 2 hp fan instead of using a 40 hp blower to cool the substations. Exhausting the hot air from substations to the plant in winter, which is used as free heating, and the use of substations as a mechanical de-

humidifier in the summer (instead of using air conditioners to remove the humidity) resulted in $60,000 savings annually.



Pictorial Representation of Substation HVAC project

Chilled Water System Optimization – The chilled water system in DEP consists of three 600 ton Chillers, three chilled water pumps, and three 40 hp condenser pumps which provides chilled water at 50F to the plant. The system uses an obsolete controller and operates each element of the system independently. For each chiller unit running 1 Chilled water pump and 1 condenser pump would operate. To restrict flow and pressure, the valves on the condenser and chilled water side were partially closed, causing further inefficiency. The system ran at 0.91 kW/ton. As a countermeasure for this condition, the controller for the system was replaced with adaptive control algorithm which looks at pressure differential on the chilled / condenser water side and variable frequency drives were installed on every pump and fan. The entire system was integrated and the flow restrictors opened and operated at 0.57 kW/ton, saving 1,500,000 kWh annually at a cost savings of $95,000.

Infra-Red Heaters – The Material Handling docks at DEP are used to load/unload parts. As the doors are frequently open, 400,000 Btu/hr forced Air Heaters were used to maintain indoor dock temperatures. The heaters would run continuously in winter to heat the surrounding area. The heaters are now replaced with Infra-red heaters which are 140,000 Btu/hr each. The infra-red heaters transfer energy to a body with a lower temperature through electromagnetic radiation. Unlike forced air heaters which require air as a medium to transfer energy, no contact or medium between the two bodies is needed for the energy transfer, hence using less than half the energy of the forced air heaters.

"FCA Dundee Engine Plant puts a great deal of emphasis on energy efficiency, conservation and cost reductions, not only to comply with ISO 50001 but also in our continuous improvement efforts under World Class Manufacturing (WCM). We understand and believe in the critical nature of managing energy in the most efficient manner to not only save costs but to do the right things and not use more precious resources than necessary to operate the business."

— Tania M. Pratnicki Young, Plant Manager, Dundee Engine Plant

Energy Review and Planning

The energy sources entering the plant are monitored daily at the utility meter and use an Energy Monitoring System, where energy is tracked at the bus level to analyze departmental consumption. Compressed Air Usage is monitored by specialized software and comparison of the performance is done on a monthly basis with all the FCA plants. The primary energy sources entering the plant are stratified to 6 secondary vectors based on what the energy is transformed into. Process Electricity, building electricity, compressed air, chilled water, natural gas – heating and natural gas – process. Each vector is measured, monitored, performance goals and action plans set to meet the goals. Once projects are identified, a detailed benefit cost analysis is performed by the energy team using power monitoring devices. Projects are then reviewed with top management and finance. The projects with less than a two year benefit cost are funded.

Cost Benefit Analysis

Each energy project that involves a financial investment goes through intensive analysis. Only when the benefit cost analysis is accepted does the project go for submission for approval. Through WCM, each project goes through a 'Plan/Do/Check/Act' cycle. The planning stage involves a comprehensive study, where energy

data is monitored, along with relevant variables. The team with expertise on the system executes the analysis. After the project is implemented, the energy consumption and the relevant variables data are again collected for the final Benefit Cost Analysis. The final approval of the Benefit Cost is completed by the finance department.

Energy Performance Improvement Approach

Daily production data, cooling degree days, and heating degree days are used as variables to perform regression analysis for energy efficiency. This improves the accuracy and statistical significance of the model. The aim of the regression model analysis is twofold. It is used to reduce fixed energy consumption year-over-year and to reduce variable consumption by reducing slope of the linear regression model. This is a top-down approach to see overall plant performance.

Validation of Results

At Dundee Engine Plant, the success of the energy management system is not only based on energy performance improvements but on other metrics, including meeting forecasted energy cost, energy goals, number of suggestions for energy improvement by team members, number of energy projects completed, amount of savings generated year-to-date, level of project (basic/major/advance), tool usage etc. By measuring these parameters, team involvement is measured and reported in WCM audits. DEP has several audits year round, which include WCM audits, expansion audits, corporate audits, which keeps the plant ready all the time. Also, with several ISO internal audits throughout the year, any nonconformance or opportunity for improvements are caught regularly.

Operational Controls and Performance Sustenance

Several operational controls have been established on the HVAC, chillers, compressors and coolant filter system. The operational controls range from set-points on temperature on HVAC and chillers, pressure on compressed air, coolant filter system and frequency of the variable frequency drives on the chilled water and coolant system. These are logged by the operators daily to make sure the systems are run as required and to make sure projects are sustained. The operational controls are part of the standard work instructions (SWI) or visual aid or procedures that are updated as needed.

"Our energy efficiency planning efforts involve identifying and quantifying savings opportunities, followed by understanding how to access this potential. This is supported by World Class Manufacturing strategies and ISO 50001 Management Systems at Dundee Engine Plant where they have embraced the challenge to improve energy efficiency and they have done so with GREAT ENERGY!"

— Dawn Breznai, Senior Manager, EHS Powertrain Operations

Training, Development and Communication

The Energy Team at DEP comprises of members with expertise on different energy systems. The Energy Champion is a Certified Energy Manager (CEM), Certified Practitioner in Energy Management System (CPEnMS) and Qualified Specialist on Pumps System Assessment Tool (PSAT). The competence on the energy team is tracked through the WCM process by the People Development Team and the Energy Pillar Team. Required competence for the Energy Team is determined by the Energy Pillar Lead at the start of the year based on the projects planned for the year. Each project is assigned a lead, based on expertise, and is assigned a support team. Working through the project, the team member develops the skills necessary for the tools. Based on their learning and contribution, their skills are rated.

Expert training is provided for new hires operating advanced equipment. Operational controls also include all the preventive maintenance that need to be done on the equipment as recommended by the manufacturer. The PM's are tracked and shown in plant-wide software accessible by anyone within the plant.

At DEP, communication of success stories is shared across the corporation using FCA US newsletter, EHS newsletter and Energy Blog.

Tools & Resources

DEP uses several sophisticated tools to analyze the energy system. Use of advanced tools help simplify complex analysis and simplify decision making.

- AFT Fathom software is used to model the coolant filter system pumping system to accurately analyze the flow supply and demand.
- Powernet software from EATON is used for energy monitoring at the plant.
- Factory Talk software is used to control HVAC and Lighting system.
- EnPI V4.0, a tool developed by the U.S. Department of Energy, is used to do regression analysis to help establish a normalized baseline of energy consumption and track annual progress.

"Dundee Engine Plant is one of the top plants in terms of energy efficiency across North America. The Energy Team at the plant is dedicated to using the ISO 50001 system to not only track energy use, but also to develop projects that will help to reduce the overall energy usage at the plant. Combining both the WCM methodology and ISO 50001, DEP is able to reduce energy cost, which helps the overall bottom line"

- Kevin M. Dunbar, Corporate Energy Group Supervisor, Manufacturing Engineering

Lessons Learned

Over the past four years, DEP has maintained the energy management system with zero non-conformances. The team has learned a lot and is continuously improving. Some of the lessons learned include:

- Production, maintenance and engineering teams need to be actively engaged in implementing the energy management system. They are the best resources to understand inefficiency.
- It is okay to take best practices from other locations and implement them at the plant.
- Sometimes it can take several successful projects to be implemented before it becomes easier to get required resources.

Keys to Success

- Involve vendors and suppliers on energy projects and communicate the importance of energy performance when initiating work with them. At DEP, the vendors work with the internal team during analysis until the commissioning of the system during major energy projects.
- Expand projects and concepts to similar systems. When performing a retrofit on the coolant system, DEP took ideas from the adaptive controls project used on the chiller systems and expanded it to the coolant project, which resulted in an additional 15% savings on the system.
- Understanding energy usage in detail and all the variables impacting it is very important for executing projects with the best payback.

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.

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