Ford Cleveland: Inside-Out Analysis Identifies Energy and Cost Savings Opportunities at Metal Casting Plant

Benefits

- Identified potential cost savings of $3.3 million annually
- Found potential annual energy savings of nearly 18 million kWh and 139,000 MMBtu
- Identified opportunity for further savings of $9.5 million per year if the company installs a high-capacity cupola and lighting upgrade (more than 600,000 MMBtu in fuel savings and more than 8 million kWh in electricity savings)
- Found opportunities that could reduce CO_2 production by 63 million pounds per year
- Can achieve a payback period of slightly more than 2 years for all projects

Application

An inside-out analysis approach uses manufacturers' knowledge of their products and processes as an essential part of the energy-efficiency analysis. It utilizes the expertise of the plant designers, schedulers, managers, equipment operators, and maintenance staff to reduce resource use and costs. The Ford Cleveland Casting Plant used this approach to identify 16 projects among many industrial systems that can save energy and money. Many of these projects, and accompanying savings, can be replicated throughout the company and throughout industry.

Summary

The Ford Cleveland Casting Plant (CCP) in Cleveland, Ohio, used a two-part assessment methodology: characterization, to identify the components of the production processes that had the greatest savings potential, and inside-out analysis to identify specific savings opportunities that maximized savings while minimizing capital costs.

Assessment staff identified 16 energy- and cost-saving projects for short-term consideration that addressed a variety of issues, including combustion, compressed air, water, steam, motor drive, and lighting system efficiency. These projects represent a total of $3.3 million per year in savings with corresponding annual energy savings of almost 18 million kilowatt hours (kWh) in electricity and nearly 139,000 million British thermal units (MMBtu) in fuel. In addition, two long-term projects were identified that would together represent another $9.5 million in cost savings, with energy savings of more than 600,000 MMBtu in fuel and more than 8 million kWh in electricity.

DOE-Industry Partnership

The U.S. Department of Energy's (DOE) Industrial Technologies Program (ITP) cosponsored the assessment through a competitive process. DOE promotes plant-wide energy-efficiency assessments that will lead to improvements in industrial energy efficiency, productivity, and global competitiveness, and will reduce waste and environmental emissions. In this case, DOE contributed $100,000 of the total $300,000 assessment cost.

Company Background

Ford Motor Company revolutionized manufacturing with its mass production assembly lines in the early 1900s. Ford is now the second largest automobile manufacturer in the world. The company manufactures and markets a wide variety of passenger cars, trucks, and sport utility vehicles through franchised automobile dealerships.

The Ford CCP produces cast iron engine blocks and engine components for Ford plants throughout North America. The plant is part of a complex that includes two engine plants, an aluminum casting plant, and a central power plant. The central power plant distributes steam, compressed air, and electricity to the four production plants—the core shop, mold shop, melt shop, and finish shop. Annual production is about 300,000 tons of finished iron products. The plant purchases electricity, natural gas, water, coke, and steam. The production process is shown schematically in Figure 1.

The primary raw materials for the melt shop are scrap iron, scrap steel, coke, and limestone. Raw materials are fed into scaled-down blast furnaces called cupolas. The plant has four operational cupolas, and typically operates three of the four at any one time. Generally, two of the cupolas produce gray iron and one produces nodular iron.

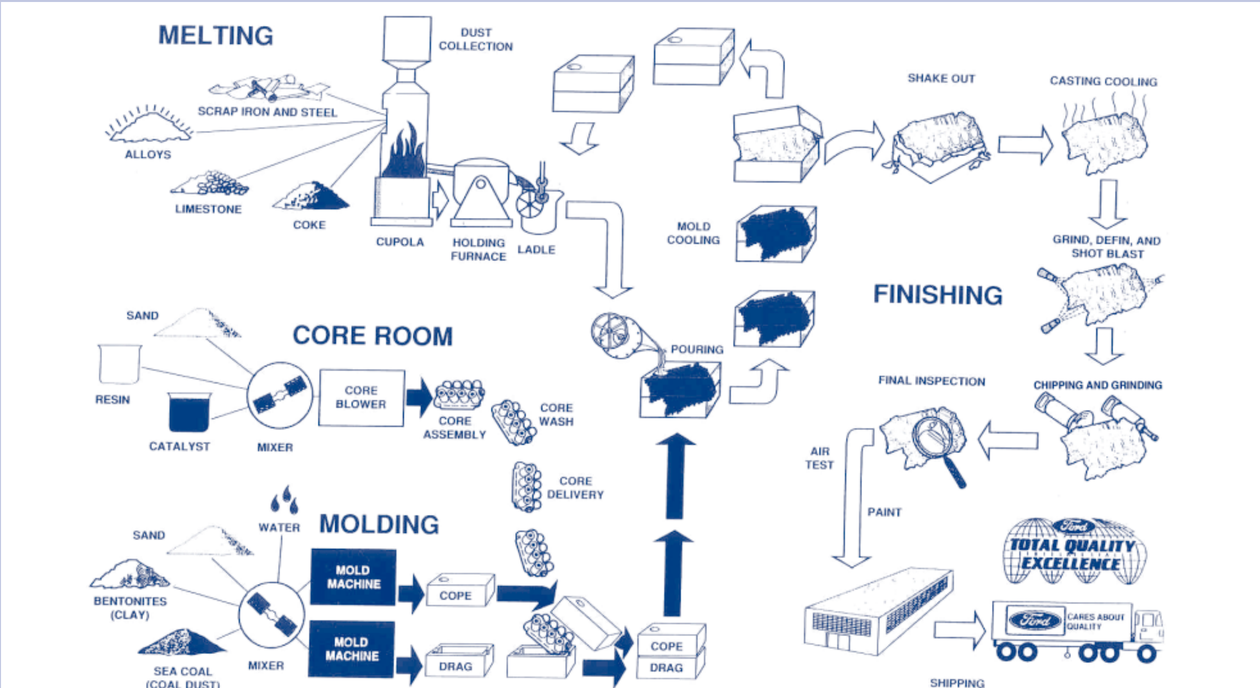

Figure 1. Production Process at the Ford Cleveland Casting Plant

In the mold shop, sand is formed into molds that form the outer surfaces of the castings. Sand cores that are made in the core shop create hollow areas in the castings.

The molten iron is poured into molds moving along a conveyor. There are currently four mold lines operating two shifts per day. Here the molds are cooled, knocked out, and cleaned.

Finishing is accomplished with shot blasters, vibratory shakers, and manual air chipping hammers. After finishing and dry painting, the castings are inspected and shipped.

Assessment Approach

The goals of the plant-wide assessment were to reduce energy use, waste, and production costs through a series of specifically targeted initiatives. The approach consisted of two phases:

1. Characterization—to identify the components of the production process that have the greatest savings potential

2. Inside-out analysis—to identify specific opportunities that maximized savings while minimizing capital costs. In this approach, the analysis begins with the equipment that actually manufactures the product, then works outward.

The assessment team employed the principles of lean production to analyze the core, mold, and finishing shops. In the melt shop, the focus was on improving cupola design and performance, as well as improving the material handling, air-pollution control, pumping, fan, cooling, and compressed air systems.

During the characterization phase of the assessment, the team used flow diagrams to indicate the magnitude and location of energy-use, waste generation, and production costs during the manufacturing processes. Using these maps, specific systems, equipment, and processes were targeted for detailed analysis to identify the most attractive savings opportunities.

After systems had been identified and prioritized according to savings potential, the assessment team used an inside-out approach to analyze each system for savings opportunities. When seeking to reduce energy costs, the assessment team analyzed the manufacturing equipment and processes, the energy distribution systems, the primary energy conversion equipment, and the utility services in sequence. To optimize waste reduction, the team also began the analysis at the manufacturing processes, worked outward to waste treatment equipment, and ended at the waste disposal services. By first looking for savings opportunities at the heart of the manufacturing process and then working out toward the plant boundary, savings are multiplied because distribution systems, energy conversion equipment, and waste treatment processes can be downsized or eliminated. Applying the inside-out approach yields significant savings at minimal initial cost. The advantage of this approach is that it capitalizes on manufacturers' knowledge of their products and processes. It utilizes the expertise of the plant designers, schedulers, managers, equipment operators, and maintenance staff to reduce resource use and costs.

Results and Projects Identified

Table 1 lists the project recommendations identified during the Ford CCP plant-wide assessment.

Table 1. Summary of Assessment Recommendations (A.R.) from Plant-Wide Energy Assessment at Ford Cleveland Casting Plant

A.R. No.	Description	Annual Savings				Project Cost	Simple Payback (yr)
		Resource			Cost Savings		
	Recommendations for Short-Term Considerations	**Elextricity (kWh)**	**Natural Gas (MMBtu)**	**Other Fuel (MMBtu)**			
1	Reduce excess air in cupola blast air preheaters		64,000		$361,000	None	Immediate
2	Inspect, repair, and maintain steam traps			11,000	$54,581	None	Immediate
3	Use supersonic oxygen lancing to improve temperature profile in cupola	2,707,000		49,000	$465,509	$10,000	.08
4	Optimize riser and gating sizes				$101,099	$5,500	.08
5	Install adjustable flow vortex nozzles to reduce compressed air use	911,000			$396,908	$63,070	.17
6	Insulate bare pipes				$54,417	$7,323	.17
7	Replace 400-watt with 360-watt metal halide lamps	1,484,000			$57,867	$16,000	.25
8	Fix leaks and repair insulation in preheated combustion air ducting	369,000	11,000		$115,800	$47,000	.42
9	Upgrade ladle heating system		24,000		$132,000	$70,000	.5
10	Use notched V-belts on belt-driven equipment	2,724,000			$106,225	$52,428	.5
11	Oxy-fuel injection system for one cupola		-17,000	-27,000	$328,900	$186,000	.58
12	Install cooling tower to eliminate once-through cooling for air conditioning units	-164,000			$468,119	$368,000	.83
13	Install isolation valves and automatic moisture traps to reduce air leaks on weekends and shutdowns	318,000			$138,764	$154,550	1.08
14	Install a cover and heat recovery system at ladle dry/preheat stations		11,000		$59,000	$100,000	1.75
15	Install VFDs on cupola forced-draft blowers	4,492,000	13,000		$246,800	$609,000	2.5
16	Install VFDs on cupola induced-draft blowers	4,922,000			$192,000	$624,000	3.25
	Total for short-term projects	**17,763,000**	**106,000**	**33,000**	**$3,278,989**	**$2,312,871**	**0.71**
	Recommendations for Long-Term Consideration						
17	Install a high-capacity cupola	8,000,000	365,000	239,000	$9,465,659	$24,800,000	2.58
18	Replace 400-watt mercury lights with 360-watt metal halide lights	282,000			$11,508	$42,468	3.67
	Total for long-term projects	**8,282,000**	**365,000**	**239,000**	**$9,477,167**	**$24,842,468**	**2.62**
	Total for all projects	**26,045,000**	**471,000**	**272,000**	**$12,756,156**	**$27,155,339**	**2.13**

Working with plant personnel, the assessment team identified 16 energy- and cost-saving projects for short-term consideration. These projects addressed a variety of issues, including combustion, compressed air, water, steam, motor drive, and lighting system efficiency. Together, these projects comprised \$3.3 million per year in cost savings, with an estimated implementation cost of \$2.3 million. The overall simple payback was less than 1 year. Implementing the short-term projects could save about 18 million kWh and nearly 139,000 MMBtu per year, plus reduce carbon dioxide (CO_2) emissions by about 63 million pounds per year (lb/yr). In addition, the assessment team identified two projects for long-term consideration, including installation of a high-capacity cupola. Implementing these projects could save another \$9.5 million per year and produce energy savings of more than 8 million kWh in electricity and more than 600,000 MMBtu in fuel.

BestPractices is part of the Industrial Technologies Program, and it supports the Industries of the Future strategy. This strategy helps the country's most energy-intensive industries improve their competitiveness. BestPractices brings together emerging technologies and energy-management best practices to help companies begin improving energy efficiency, environmental performance, and productivity right now.

BestPractices emphasizes plant systems, where significant efficiency improvements and savings can be achieved. Industry gains easy access to near-term and long-term solutions for improving the performance of motor, steam, compressed air, and process heating systems. In addition, the Industrial Assessment Centers provide comprehensive industrial energy evaluations to small- and medium-size manufacturers.

Project Partners

Ford Motor Company

- Cleveland Casting Plant, Cleveland, OH
- Advanced Manufacturing Development, Redford, MI
- Global Engineering Alignment, Livonia, MI

Energy Information Systems, Dayton, OH

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