

SHOWCASE PROJECT: WAUPACA FOUNDRY: CUPOLA WASTE HEAT RECOVERY UPGRADE DRIVES DEEPER ENERGY SAVINGS

SOLUTION OVERVIEW

Waupaca Foundry, a Hitachi Metals Group company, is a gray and ductile iron foundry that melts over 2.5 million tons of iron per year at seven plants across the country. At Plant 23 in Waupaca, Wisconsin, a high-volume cupola furnace technology is used to cast iron and other metals. With an average of 5,500 heating degree days per year, Plant 23 uses 60% of its annual natural gas consumption for building space heating. The plant melts 700,000 tons of gray iron annually, producing waste heat that is captured and used for space heating. Since 2004, Plant 23 has invested in capital improvements to maximize waste heat recovery as a strategy to reduce plant energy intensity. Incorporating new controls and heat recovery technologies, Waupaca implemented an upgrade and expansion of its existing heat recovery system and increased the amount of waste heat recovered by 42%.

The cupola furnace at Plant 23 consists of a vertical steel shell with a refractory brick lining. Fuel is burnt with air introduced by blast air blowers and oxygen injections, and the combustion gases are then evacuated through a side take-off duct into the emission control system. A two-stage cooling system reduces the combustion gas temperature from 1400°F to 350°F before it enters the baghouses. The first stage reduces the air temperature from 1400 °F to 950 °F, which provides blast air pre-heating to increase melting efficiency. The second stage reduces the temperature from 950°F to 350°F, using an air-to-oil heat exchanger. The hot oil loop concentrates the waste heat removed from the system, at a rate of 70 MMBTU per hour, to be used in the air makeup units for space heating, among other waste heat applications.

The existing waste heat recovery system was installed in 2004 and upgraded in 2010. It includes 14 air makeup units and a control system that only operated in on/off mode. In 2018, after an assessment of the system to investigate additional improvement opportunities, the Plant 23 team determined that the existing control system was obsolete and unreliable. Also, the initial design of the system considered the air makeup units connected in a series, which resulted in a large amount of recovered heat being concentrated in the first units of the furnace hot oil loop. This reduced the waste heat available for units at the end of the hot oil loop and impacted the system's thermal transfer efficiency. The team also discovered that based on the heat being generated, 3 additional air makeup units, with capacity for 75,000 cubic feet per minute (CFM) each, could be connected to take advantage of more exhaust heat.

SECTOR TYPE

Industrial

LOCATION

Waupaca, Wisconsin

PROJECT SIZE

665,850 Square Feet

FINANCIAL OVERVIEW

Project Cost \$442,188

SOLUTIONS

Waupaca’s heat recovery system upgrades were implemented as part of a collaborative effort between the Plant 23 engineering team, a mechanical contractor, and Focus on Energy—the statewide energy efficiency program in Wisconsin. The Focus on Energy program provided technical support to the engineering team and validated the waste heat calculations and energy savings. The program also awarded Waupaca Foundry with an incentive to complete the upgrades. The design and engineering analysis of the project, along with the Focus on Energy assessment, lasted approximately 3 months. At its conclusion, the team decided to move forward with the upgrades to the piping layout and control system, along with the addition of three new air makeup units to the heat recovery system.

After completing the engineering and assessment phase, the team began the procurement and fabrication of the upgrades. This involved putting together project costs and determining total energy savings. The team then installed the new control system and implemented the piping upgrades, followed by the system expansion to tie in the 3 new makeup air units. Installation concluded with a commissioning of the new system and the additional air units to ensure all operational requirements were met. The total project cost was \$442,188, which was offset by an incentive of \$177,178 from Focus on Energy. Annually, the plant reduced natural gas usage by 242,590 therms; energy costs by \$109,165; and CO₂ by 1,456 tons. With the utility incentive included, the project’s simple payback was 2.4 years.

Table 1: Plant 23 Heat Recovery System Upgrades Project Timeline

#	Activity	A 19	M 19	J 19	J 19	A 19	S 19	O 19	N 19
1	Engineering & FOE assessment								
2	Procurement & Fabrication								
3	Existing System Upgrade - Control System & Piping								
3.1	Existing System Commissioning								
4	System expansion – Tie in 3 new AMUs								
4.1	System expansion Commissioning								

OTHER BENEFITS

Plant 23’s project leveraged Waupaca’s experience implementing waste heat recovery upgrades at

other plants. At Plant 1 in Waupaca, WI, a waste heat recovery system provides 70% of plant space heating requirements and 100% of plant water heating needs. Plant 1's savings, combined with Plant 23, reduces Waupaca's natural gas usage by 1,200,000 therms per year. This is equivalent to \$540,000 in savings and an annual reduction of CO₂ equivalent by 72,000 tons. Based on Plant 1 and 23's upgrades, similar systems can be applied to other foundries and steel mills, as well as in industries that require seasonal building heat, but that generate substantial waste heat.

Waupaca Foundry, Inc. is committed to finding new technologies to achieve energy and emission reductions at its facilities and across the regions where it operates. In a combined effort with other state and industry leaders in Wisconsin, Waupaca Foundry contributed to the development of a new state regulation—SB144 / AB204, published on Aug 3, 2017—which “provides that heat that is a byproduct of a manufacturing process is considered a renewable resource for the purpose of the renewable portfolio standards law”.

Annual Energy Use

Baseline(2018 - No Waste Heat)



Actual(2020 - Upgraded Waste Heat)



Energy Savings

13.06%

Annual Energy Cost

Baseline(2018 - No Waste Heat)



Actual(2020)



Cost Savings

13.06%



Hot oil heat exchangers