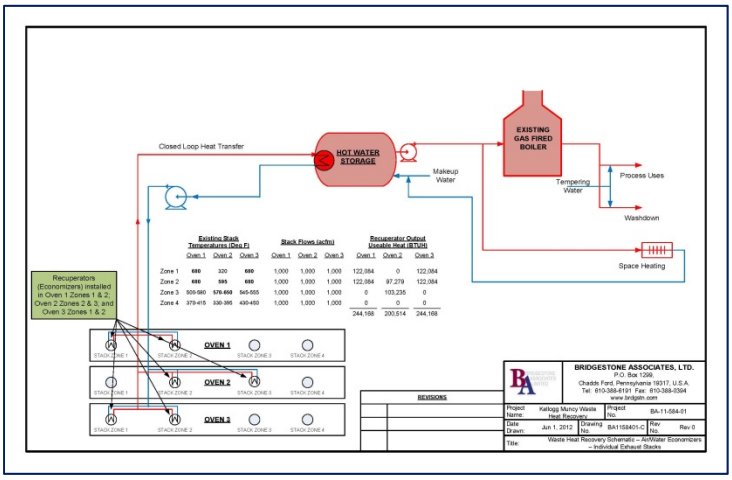
PROJECT SUMMARY

KELLOGG'S CORPORATION WASTE HEAT RECOVERY PROJECT

PROJECT SUMMARY



Bridgestone Associates was engaged by Kellogg's Corporation to study waste heat recovery from three large bakery ovens at Kellogg's plant in Muncy, Pennsylvania. These three gas fired ovens exhaust to atmosphere a total of approximately 1.5 MMBtu/hour of 350 – 680 °F waste heat. The ovens operate 24/7 baking Pop-Tarts and Nutri Grain bars for consumer use. In addition to the energy used in the ovens, the plant uses energy for various cooling requirements and for space heating and production hot water. The use of the waste heat to replace one or more of these other energy uses was the primary focus of the study. Bridgestone evaluated waste heat production availability and quality, developed a number of alternative recovery designs and uses, and prepared a comprehensive technical and economic model to evaluate between alternatives.

PROJECT STATISTICS

Client:	Kellogg's Corporation
Project Type:	Waste heat recovery from bakery ovens
Estimated Project Cost:	US$106,000 – 1,260,000 depending on project implemented
Plant Location:	Muncy, Pennsylvania, USA
Energy Used:	91,600 mcf/yr natural gas in ovens, 104,187 mcf/yr total 18,143 MWh/yr
Waste Heat Sources:	Three ovens each with four zones with separate exhaust stacks
Waste Heat Temperature:	350 – 680 °F depending on oven zone
Primary Fuel:	Natural gas

PROJECT DESCRIPTION

Bridgestone Associates conducted a detailed study on the utilization of waste heat from Kellogg's three bakery ovens at their Muncy plant. This waste heat, a total of approximately 1.5 MMBtu/hr is exhausted from the bakery's three ovens from four separate zone exhaust stacks on each oven.

Bridgestone's analysis evaluated the following uses of waste heat:

- Production of washdown and product hot water
- Production of washdown, product hot water and space heating hot water
- Absorption chilling producing chilled water
- Organic Rankine Cycle production of electricity
- Combustion air pre-heating
- Combustion air pre-heating and washdown and product hot water

Estimated Economizer Output				
	OVEN 1	OVEN 2	OVEN 3	TOTAL
	Zones 1 & 2	Zones 2 & 3	Zones 1 & 2	Combined
Exhaust Flow in Economizers	914 SCFM	980 SCFM	914 SCFM	2,808 SCFM
Economizer Exhaust Gas Inlet Temperature	680 °F	605 °F (avg)	680 °F	
Economizer Exhaust Gas Exit Temperature	350 °F	350 °F	350 °F	
Economizer Efficiency [1]	75%	75%	75%	
Available Waste Heat Energy Out of Economizer	244,169 BTUH	200,515 BTUH	244,169 BTUH	688,853 BTUH
Annual Waste Heat Energy Out of Economizer [2]	1,733.6 MMBTU/yr	1,423.7 MMBTU/yr	1,733.6 MMBTU/yr	4,890.9 MMBTU/yr
Notes: 1. Assumes 75% economizer efficiency. 2. Assumes 7,100 hours per year				

Detailed analysis of each of these included evaluating current costs versus costs utilizing waste heat generated energy, changes in operation and maintenance costs, selection of equipment alternatives, capital costs associated with implementing each alternative, impact (if any) of waste heat recovery on existing operations and oven production, and an overall analysis of savings and simple payback.

Potential Measure	Estimated Annual Savings	Estimated Capital Costs	Simple Payback
Washdown and Product Hot Water Production	$8,270	$106,250	12.8 years
Washdown, Product Hot Water Production and Space Heating	$28,581	$280,500	9.8 years
Absorption Chiller	$49,906	$554,677	11.1 years
Organic Rankine Cycle	$71,495	$1,265,000	17.8 years
Combustion Air Pre-Heating	$22,988	$414,750	18 years
Combustion Air Pre-Heating and Washdown and Product Hot Water Production	$28,582	$438,450	15 years

Based on the analysis conducted, none of the proposed uses of waste heat proved to have a reasonable payback that would meet the client's investment criteria.