

Energy Recycling Opportunities for Ohio: An Industrial Analysis

By: Recycled Energy Development (RED)

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A viable energy recycling project has the following benefits:

Internal (to the host facility):

- Reduced operating costs (translates to ↑ profitability, ↑ competitiveness)**
- Reduced exposure to energy price volatility**
- Reduced environmental footprint/GHG emissions and associated compliance costs**

External (to society):

- A more viable and market-competitive local economy**
- Reduced regional electricity transmission congestion**
- Increased electricity capacity supply to match rising demand**
- New capacity additions from industrial energy recycling are cleaner, cheaper, and more quickly deployable than most central generation options**

Shared Characteristics of Target Industries:

- Stable/growing industry**
- Three-shift/day operations**
- Significant consumer of fuel, electric and/or thermal energy**
- Attractive waste heat or fuel streams**
- High/rising electrical rate environment**

Below we have taken the opportunity to examine several industries in Ohio that RED believes there is significant recyclable energy present.

We have broken our analysis down by two distinct areas of energy recycling:

- 1. Combined Heat & Power (CHP)**
- 2. Waste Heat Recovery**

The FOUR industries included in each section (per energy recycling technique) will have typical project size ranges listed. Additionally, we included specific facilities that qualify for these opportunities, citing researched energy uses and other confirmatory tools based on EPA emission records.

Summary of Findings:

	Electric Power Potential (MW) <i>(per project, on average)</i>	Number of Major Facilities Identified in Ohio	Total Electric Power Potential (MW)
Combined Heat & Power (CHP)			
Petrochemical Refining	50 - 200	4	200 - 800
Ethanol	50 - 100	7	350 - 700
Chemicals	40 - 70	5	200 - 350
Pulp & Paper Mills	20 - 30	4	80 - 120
Total:			850- 2000 MW
Waste Heat Recovery			
Metals Production ~ Steel			
a. Integrated mill	100 - 200	4	400 - 800
b. Mini-mill	10 - 20	4	40 - 80
Natural Gas Compressor Stations	10 - 15	18	180 - 270
Lime & Cement	5 - 15	9	45 - 135
Glass	5 - 15	4	20 - 60
Total:			650 - 1350 MW

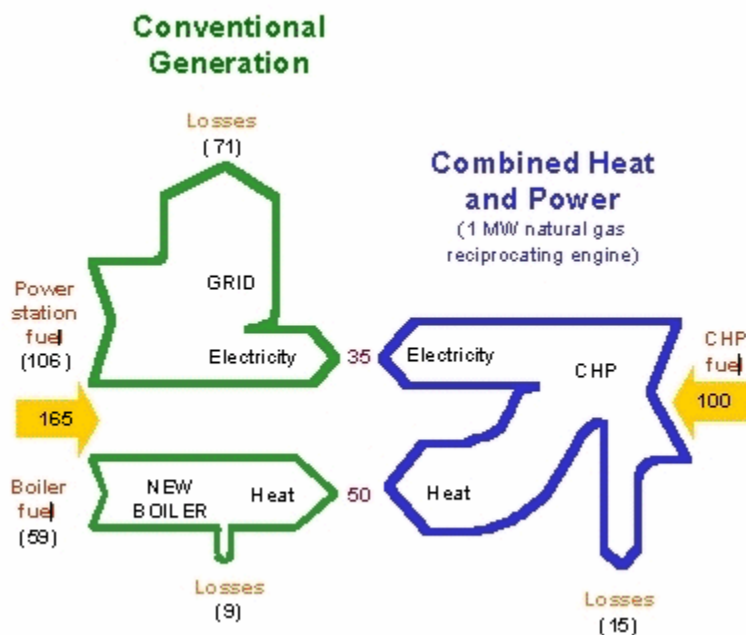
Combined Heat & Power: In just four of Ohio's industrial sectors, the thermal load requirements at the just the few largest facilities couple be optimally-matched to generate between **850-2000 MW** of electricity. These CHP systems would operate between 80-90% efficiency, and would require less build time and capital cost than traditional central generation technologies.

Waste Heat Recovery: The four representative industries chosen for this analysis have strong importance to the Ohio economy. Through waste heat recovery efforts, between **650-1350 MW** of *fuel-free power* can be generated at these industrial facilities.

Energy Recycling Opportunity #1: Combined Heat & Power

In FRONT of the process

Combined heat and power (also referred to as CHP, cogeneration) systems employ the heat by-product of electric generation units to satisfy a useful thermal load nearby. These 'double uses' of a single fuel input can achieve efficiencies of 85-90% (or, about 3X the efficiency of electric generation-only units). Industrial facilities are prime candidates for these CHP systems, because they require not only large amounts of thermal energy for their process, but also heavy electricity loads to operate their mechanical machinery.



1. Petrochemical Refining (50-200 MW CHP Systems per facility)

According the US Census Bureau, in 2006, the petroleum refining industry spent over \$11 billion in fuels and electricity purchases to run their operations. Almost every large refinery in the US will typically need over 500,000 lbs/hr steam to operate- which represents about 100 MW of optimal cogeneration per refinery.

Major Petroleum Refineries in Ohio:

Company	Location
BP PRODUCTS NORTH AMERICA INC	OREGON
MARATHON ASHLAND PETROLEUM	CANTON
PREMCOR REFINING GROUP	LIMA
SUNOCO INC (R&M)	OREGON/HAVERHILL

Below is an aerial image from BP's refinery in Oregon, OH.



2. Ethanol (50-100 MW CHP Systems per facility)

- Process Improvement: Optimized Cogeneration to match steady-state thermal load
- OPEX Improvement: \$0.06 - \$0.10/gallon
- Project size: **about 1 MW per million gallons per year (MPY) produced at the plant**

Company	Location	Current Capacity (MGY)	Under Construction/ Expansions (MGY)
Coshoctan Ethanol, OH	Coshoctan, OH	NA	60
Greater Ohio Ethanol, LLC	Lima, OH	NA	54
POET	Fostoria, OH	NA	65
POET	Leipsic, OH	NA	65
POET	Marion, OH	NA	65
The Andersons Marathon Ethanol, LLC	Greenville, OH	NA	110
VeraSun Energy Corporation	Bloomingsburg, OH	NA	110
Ohio Total		NA	529

The proposed ethanol facilities represent a combined heat and power (CHP) opportunity of greater than **500 MW**.

For example:

VeraSun’s Bloomingsburg Facility (under construction) is pictured below. This plant will have an annual capacity of 110 MGY when it is commissioned in mid 2008. The plant will consume roughly:

400 MMbtu/hr of natural gas & about 10 MW of electricity.

An optimal combined heat and power system with an electrical output of 100+ MW would be adequate for this location.

Below is an aerial image from the facility:



3. Chemicals (40-70 MW CHP Systems per facility)

'Chemical manufacturing' can refer to any number of industrial processes. A similar component that is present in nearly all these processes, however, is a significant thermal load that is employed to perform both physical and chemical alternations to the necessary raw materials.

For example:

Bayer Polymers LLC ~ ADDYSTON, OH

Below is an aerial image from the Bayer facility, which specializes in plastics manufacturing:



COGNIS CORP ~ Cincinnati, OH

Below is an aerial image from Cognis Corps' Cincinnati plant manufactures products made from renewable fats and oils



Others:

THE LUBRIZOL CORPORATION (2 plants ~ Painesville, Wickliffe)

MILLENNIUM INORGANIC CHEMICALS INC (2 plants ~ Ashtabula)

MORTON SALT DIVISION OF MORTON INTERNATIONAL INC (Rittman, OH)

4. Pulp & Paper Mills (20-30 MW CHP Systems per facility)

A. Pulp Mills—converts wood chips or other plant fiber source into a thick fiber board which can be shipped to a paper mill

Example: MW Custom Papers LLC ~ Chillicothe, OH



B. Paper Mills – reduce the fiber boards into a variety (color, size, quality variances) of paper products

Example: Smart Papers ~ Hamilton Mill in Hamilton, OH

The Hamilton Mill (pictured below) produces 93,000 tons of premium coated and uncoated printing papers:

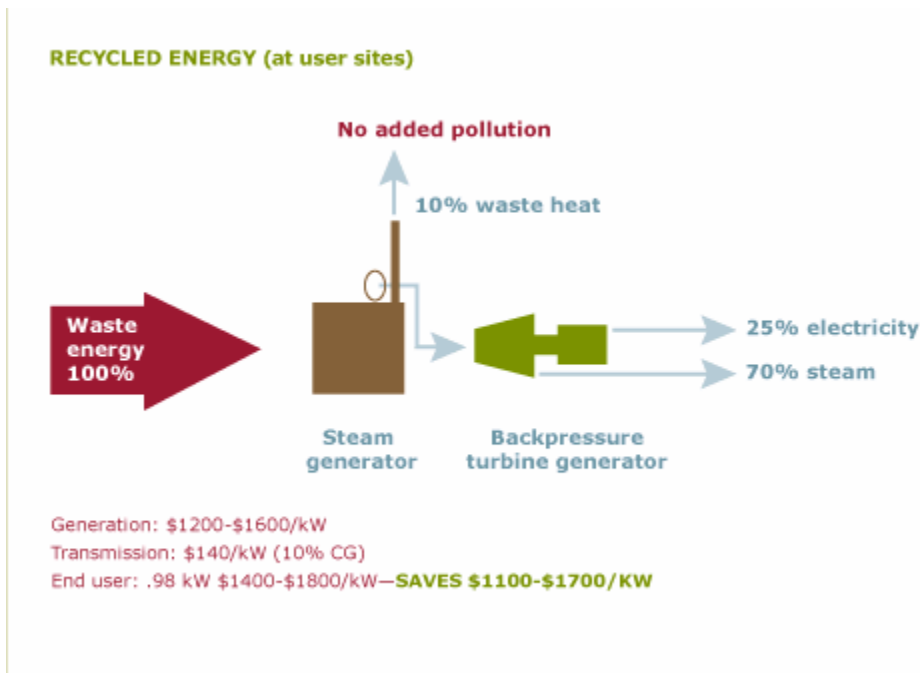


MOSINEE HOLDINGS INC ~ Middletown, OH
CRYSTAL TISSUE COMPANY ~ Middletown, OH

Energy Recycling Opportunity # 2: Waste Heat Recovery

AFTER the process

Another form of energy recycling will extract useful energy from the waste gas streams coming off the tail end of industrial processes. Typically, these streams will just be cooled (sprayed with water) enough so that they can pass through any pollution control devices and then simply be exhausted into the atmosphere. Heat recovery steam generators (HRSGs) allow the hot gases to contact water circulating in tubes, which converts that water to steam. The newly formed steam can then be used to generate additional electric power and/or satisfy another thermal load.



1. Metals Production ~ Steel

A. Integrated Steel Mills: (100-200 MW recovery per facility)

- **Process Improvement(s):** Cogeneration/ Waste Heat Recovery
- **Project size:** 50-200 MW

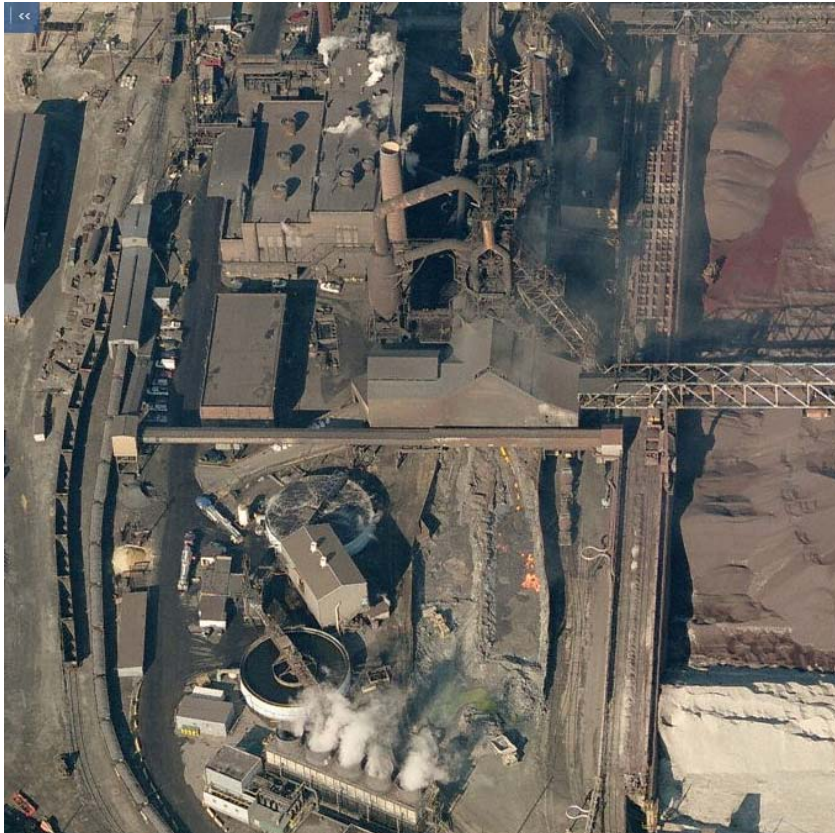
Integrated steel mills are characterized by their large blast furnace/basic oxygen furnace operations that transform raw materials (iron ore, limestone, and coal (or coke)) into a variety of iron and steel-related products. These large milling operations are extremely energy-intensive and represent a large energy-recycling opportunity.

For example: Tom Casten, current Chairman for Recycled Energy Development and former Chairman of Primary Energy Ventures, has had previous success working with large integrated steel mills, such as Mittal Steel (formerly Ispat Inland Inc.) of East Chicago, IN.

Primary Energy successfully captured the waste heat exiting the coke oven batteries and the blast furnace operations and turn those streams into a combined 170 MW of electric power and over 900,000 lbs/hr of process steam. This recycling effort was achieved without any incremental fuel usage.

Here are several integrated steel mill operations in Ohio (The state of Ohio contains nearly a quarter of all the integrated steel mill operations in the US):

ArcelorMittal International (formerly ISG Cleveland Inc; LTV Steel) ~ **Cleveland, OH**



Others:

Wheeling-Pittsburg Steel Corp. ~ Steubenville, OH

AK Steel ~ Middletown, OH

WCI Steel ~ Warren, OH

B. Steel Mini-mill Operations (10-20 MW recovery per facility)

In addition to integrated steel mills, there is also another steel-production process called a 'mini-mill' operation. These operations rely on scrap steel/iron as their primary feed sources. Most mini-mills rely on electric arc furnaces to supply the heat necessary to melt down the scrap metals in a 'reduction' process that brings the metals back to their core constituents again. The electric power consumed and the corresponding intense thermal discharges make mini-mills a sizable energy recycling prospect.

Mini-mill operation examples:

V & M STAR's Youngstown, OH Plant



Others:

NORTH STAR BHP STEEL LLC ~ Delta, OH

REPUBLIC ENGINEERED PRODUCTS INC ~ Lorain, OH

MARION STEEL COMPANY ~ Marion, OH

2. Natural Gas Transmission ~ Compressor Stations (10-15 MW recovery per station)

Note: Natural gas pipelines install compressor stations every 100 miles or so, compressor stations are installed to re-pressurize the gas with gas turbines. Several major arteries run directly through Ohio.

- **Process Improvement(s):** Waste Heat Recovery
- **Project size:** 10-15 MW with advanced organic fluid technologies

Gas Transmission Company	# of OH Compressor Stations
Columbia Gas Transmission Corp	5
East Ohio Gas Company	3
Tennessee Gas Pipeline	3
Dominion Transmission Inc	3
Texas Eastern Transmission LP	3
ANR Pipeline Company	1

For example, Texas Eastern Transmission Company's (TETC's) compressor station in Athens, OH (pictured below) uses gas turbine to 'boost' the natural gas as it moves northward from the Gulf of Mexico to the Northeast via the TETC 36" diameter pipeline.



3. Lime & Cement (5 - 15 MW recovery per facility)

The lime and cement manufacturing industries have similar energy processes at work. Typically, these processes include a long, rotating tunnel (called a 'rotary kiln') that introduces the raw material at one end and a flame at the other side. This system requires a steady-state consumption of electricity (for the mechanical parts) and heat (to supply the kiln thermal load). Typically, for each rotary kiln there is about 2-3 MW of recoverable heat available to generate power from.

Ohio Lime Plants:

CARMEUSE LIME INC GRAND RIVER OPERATION	GRAND RIVER
CARMEUSE LIME INC MAPLE GROVE OPERATION	BETTSVILLE
CARMEUSE LIME INC MILLERSVILLE OPERATION	MILLERSVILLE
GRAYMONT DOLIME (OH) INC	GENOA
HURON LIME COMPANY	HURON
MARTIN MARIETTA MAGNESIA SPECIALTIES	WOODVILLE
NATIONAL LIME AND STONE COMPANY - CAREY	
OH LIME P	CAREY

Aerial image from Huron Lime Company's Huron Facility (3 kilns total):



Cemex Incorporated's XENIA, OH facility:



Also, there is another large cement plant: LaFarge in ~ Paulding, OH

4. Glass (5-15 MW recovery per facility)

Glass facilities, like the Libbey Glass Inc ~ Toledo, OH pressed glassware facility, required temperatures in excess of 1600°F in order to melt raw materials (silica sand, other raw materials such as lime, dolomite, soda, and cullet) into a variety of glass products.



Others:

OWENS BROCKWAY GLASS CONTAINERS - PLANT #12 ~ Zanesville, OH
LANCASTER GLASS CORP ~ Lancaster, OH
THOMSON INC ~ Circleville, OH