Policy Matters Ohio

Energy Policy
March 2012

Capturing energy waste in Ohio

Using combined heat and power to upgrade electric system

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Executive Summary

In 2009, Ohioans spent nearly $41 billion to fuel cars, to run our homes and businesses, and to power industry. This amounted to about 9 percent of Ohio's gross product that year. Because we use energy very inefficiently, however, billions of dollars are wasted. As a result, Ohio ranks 28th in the nation for energy productivity, which is the economic value achieved from the energy we use.

The biggest source of Ohio's energy waste comes from inefficiencies in the electric power industry itself. In 2009, we lost more than one quadrillion British thermal units (Btus) of energy in Ohio's electricity-generation system, worth an estimated $17.6 billion.

Combined heat and power (CHP) technologies, which generate power from heat that is normally wasted, can help transform this inefficient system and cut energy losses.

The overall energy efficiency of a factory is typically in the range of 50 to 55 percent. By using a single fuel source to produce both heat and power, CHP technologies achieve much higher industrial plant efficiencies than separate heat and power systems, result in significantly lower utility bills, and cut related emissions. Recovery and use of all the heat typically rejected in the electric generation process can achieve industrial plant efficiencies as high as 75 to 85 percent.

Key findings

- Ohio ranks 28th in nation for energy productivity—the bang we get for our energy buck
- Nearly 1/3 of all energy consumed in Ohio, worth an estimated $17 billion, is lost in our outdated electric system
- Ohio ranks 44th in nation for adoption of CHP technology designed to capture energy traditionally wasted
- Increasing CHP share of total electric power capacity by 10 percent would generate $1.3 billion in energy savings annually, reduce emissions by 13 million metric tons

There are two types of combined heat and power. Conventional CHP uses fuel to generate electricity, normally through an engine, turbine, or fuel cell; heat generated during the production of electricity is captured and recycled to meet the thermal needs of the facility. Waste heat recovery (WHR) captures and recycles, from an already occurring industrial process, heat that is normally released to the atmosphere. (Together, these CHP technologies are also known as cogeneration.) Generating electricity on-site or near energy consumers, particularly manufacturers, would allow us to capture heat energy typically wasted, save billions of dollars spent on polluting fossil fuels, and significantly reduce emissions.

Ohio has great CHP potential. The state currently ranks in the top five for potential use of CHP technology, but we rank 44th in the nation for actual adoption. While Ohio has a technical potential to generate 25 percent of its electricity from CHP, current capacity is less than 2 percent of total electric

power capacity. If we were to increase CHP's share of total electric power capacity by 10 percent in Ohio (an increase of 3.6 gigawatts), we would see $1.3 billion in annual energy savings. This would also reduce emissions by 13 million metric tons, the equivalent of taking 2.3 million cars – nearly percent of passenger vehicles registered in Ohio – off the road.

Ohio's manufacturing sector is a prime for target for CHP development. Early candidates for CHP/WHR investments include manufacturers that use large quantities of both electric and heat energy at the same time. Industry, made up largely of manufacturing, accounts for one-third of our state's energy use. Manufacturers burn fuels on-site, largely to heat chemicals, metals, wood, and glass in various industrial processes, and they access the electric power grid to run electric motors that drive things like metal cutting and forming tools, power welding tools, electric furnaces, and electric forklifts. Ohio manufacturers spent an estimated $5.9 billion on energy in 2008, and $4.4 billion in 2009 (more than one quarter the amount of their payroll costs). Ohio already has 552 megawatts (MW) of combined heat and power capacity, approximately 80 percent of which can be found in the manufacturing sector. For perspective, if that energy were used in the residential sector, it would be enough to power more than 450,000 homes.

There are many barriers to greater CHP adoption in Ohio. A lack of cooperation from electric utilities, along with complicated rate structures that discourage CHP adoption, has been a major impediment to greater adoption of these technologies. At the same time, achieving energy savings from CHP technologies has not been a priority for manufacturers or state and local economic development officials.

Recommendations

To overcome these barriers, the state of Ohio and local governments can implement policies that promote CHP development. The state should support local CHP efforts by creating an implementation schedule for existing CHP/WHR requirements under Ohio's alternative energy standard, with specific annual targets (a CHP/WHR "carve-out" within Ohio's alternative energy standard, similar to the renewable energy and solar requirements).

Ohio cities can provide "green incentives" to manufacturers as an economic development tool. Ohio manufacturers pay seven times more for energy than they do for state and local taxes. Green incentives – access to cheap and clean light, heat, and power – can help improve a company's energy productivity without the negative impact tax incentives would have on already strained state and local budgets. Cities can offer manufacturers green incentives by arranging long-term power purchasing agreements for affordable clean energy; co-locating industries within eco-industrial parks where heat and power energy resources can be shared cheaply; or by purchasing excess power generated by manufacturers that have invested in on-site CHP or WHR facilities.

Introduction

In 2009, Ohioans spent nearly $41 billion to fuel our cars, run our homes and businesses, and power our industry. This was approximately 9 percent of our state's gross product that year. Because of inefficiencies in the way we use energy, Ohio is slightly below the national average and far below top performers in energy productivity, ranking 28th in the nation for the level of gross economic activity we achieve for the amount of energy we consume (2009).[1] Among states, fifteen are at least 30 percent more energy productive than Ohio, and the state of New York gets more than twice as much output from the energy it consumes. Globally, Ohio and the rest of the nation fall behind other industrialized nations — with Japan being more than twice as energy productive as the U.S. and Ohio. Northwestern Europe is 23 percent more productive than the U.S.[2] In a global economy, this is a competitive race we cannot afford to lose.

The biggest source of Ohio's energy waste comes from inefficiencies in the electric power industry itself. Nearly 70 percent of all energy contained in fossil fuels used at electric plants, or nearly 1/3 of all energy consumed in Ohio (29 percent), is lost during generation and transmission on our outdated grid.[3] At the same time our electric industry discards large amounts of heat energy produced during conventional electricity production, however, energy consumers are purchasing fuel to create heat on-site. This is a waste of both scarce resources and money, and results in large amounts of unnecessary toxic and carbon emissions. In 2009, more than one quadrillion Btus of energy, an estimated $17.6 billion worth, was lost in Ohio's electrical system during generation and transmission.[4] That same year, Ohio's electric power industry ranked third in the nation for carbon dioxide (CO_2) emissions, first for sulfur dioxide (SO_2), and fifth for nitrous oxide (NO_X). Roughly half of all carbon emissions in Ohio come from the electric power sector.

By distributing electricity generation closer to the end user and capturing heat typically wasted, using combined heat and power (CHP) and waste heat recovery (WHR) technologies, we can slash the billions of dollars we spend on polluting fossil fuels and significantly reduce related emissions. Ohio ranks in the top five states for potential use of CHP technology, with Ohio's technical CHP potential estimated to be greater than 9 gigawatts in capacity, roughly 25 percent of Ohio's total electric capacity.[5] Table 1 shows we currently rank 44th in the nation, however, for actual adoption (with CHP representing just 1.5 percent of total generation capacity).

[1] "Table C12. Total Energy Consumption, Gross Domestic Product (GDP), Energy Consumption per Real Dollar of GDP, Ranked by State, 2009," US Energy Information Administration (EIA) at http://bit.ly/t3EgWH.
[2] See McKinsey & Co., *Wasted Energy: How the U.S. can reach its Energy Productivity Potential*, July 2007 at http://www.mckinsey.com/Insights/MGI/Research/Natural_Resources/How_US_can_reach_its_energy_potential .
[3] EIA consumption estimates at http://www.eia.gov/state/seds/hf.jsp?incfile=sep_sum/plain_html/sum_use_tx.html.
[4] EIA 2009 Consumption Estimates including electrical system losses at http://bit.ly/wxBpQD; EIA Price per Btu at http://bit.ly/yf1AU6 (calculation based on Ohio's average price of $16.78 per million Btus).
[5] See Oak Ridge National Laboratory, *Combined Heat and Power: Effective Energy Solutions for a Sustainable Future,* at http://bit.ly/wxXKcY. Technical potential based on report by ICF International at http://bit.ly/xIZqbs.

Table 1

Ohio ranks 44th in the nation in adoption of CHP technology

(Percent CHP capacity as share of electric power generation capacity, 2010)

	CHP capacity		Electric power capacity		Percent CHP	State ranking	
State	Number of producers	Capacity (MW)	Number of producers	Capacity (MW)	CHP share of total Capacity	Rank CHP capacity	Rank CHP as share of total capacity
US-Total	3,589	83,519	6,417	1,138,640	7.3%		
ME	30	1,131	111	4,754	23.8%	21	1
LA	63	6,770	88	31,169	21.7%	3	2
AK	109	466	138	2,261	20.6%	32	3
HI	32	546	42	2,776	19.7%	29	4
OR	60	2,544	120	14,790	17.2%	10	5
NJ	210	2,969	104	20,038	14.8%	9	6
TX	125	16,672	347	117,734	14.2%	1	7
NY	436	5,882	353	42,842	13.7%	4	8
MA	145	1,922	136	15,378	12.5%	13	9
CA	961	8,590	803	72,570	11.8%	2	10
DE	4	394	20	3,514	11.2%	33	11
MI	89	3,101	239	32,992	9.4%	8	12
AL	37	3,183	81	35,288	9.0%	7	13
VA	51	2,189	132	25,912	8.5%	12	14
WI	80	1,527	199	19,050	8.0%	14	15
CT	153	689	75	8,990	7.7%	25	16
IN	37	2,323	103	30,928	7.5%	11	17
PA	53	3,301	193	49,650	6.7%	6	18
MD	21	837	58	13,611	6.2%	23	19
CO	32	936	134	15,578	6.0%	22	20
OK	19	1,344	78	23,063	5.8%	17	21
ID	19	218	100	4,013	5.4%	39	22
FL	71	3,490	172	67,780	5.2%	5	23
RI	24	104	15	2,022	5.1%	46	24
NC	61	1,504	161	30,197	5.0%	15	25
MN	51	765	279	16,608	4.6%	24	26
SC	22	1,150	97	25,878	4.4%	20	27
WA	34	1,265	135	31,063	4.1%	18	28
VT	28	43	60	1,108	3.9%	49	29
IA	34	585	213	15,757	3.7%	26	30
MS	22	570	48	17,606	3.2%	27	31
GA	38	1,190	132	39,665	3.0%	19	32
AR	16	497	60	17,242	2.9%	30	33
UT	20	220	64	7,860	2.8%	38	34
IL	139	1,367	223	50,092	2.7%	16	35
NV	12	337	60	13,177	2.6%	35	36
NM	16	227	44	9,015	2.5%	37	37
WV	11	381	37	17,350	2.2%	34	38
NH	22	98	66	4,501	2.2%	47	39
TN	28	495	64	23,847	2.1%	31	40
WY	13	170	62	8,379	2.0%	40	41
MT	19	113	40	5,992	1.9%	44	42
DC	2	14	2	850	1.7%	51	43
OH	48	552	148	36,018	1.5%	28	44
NE	16	104	103	8,380	1.2%	45	45
ND	11	68	44	6,518	1.0%	48	46
KS	17	134	144	13,600	1.0%	42	47
MO	19	227	140	23,499	1.0%	36	48
SD	5	24	34	3,809	0.6%	50	49
AZ	16	169	67	29,623	0.6%	41	50
KY	7	122	49	24,303	0.5%	43	51

Source: CHP data from ICF International: http://www.eea-inc.com/chpdata/index.html. Total Electric Power Capacity data from the Energy Information Administration: http://www.eia.gov/cneaf/electricity/epa/existing_capacity_state.xls

What is combined heat and power?

There are two types of combined heat and power (CHP), also known as cogeneration. Conventional CHP uses fuel to generate electricity (normally through an engine, turbine, or fuel cell); heat generated during the production of electricity is captured and recycled to meet the thermal needs of the facility. The second type, waste heat recovery (WHR), captures and recycles heat already being created from an existing industrial process that is normally released to the atmosphere. WHR requires no additional fuel to be used on site. This is "free energy" that would otherwise be lost in the industrial process.

CHP versus generating heat and power separately

Electricity was first generated from falling water. Once most of the easily exploited hydroelectric sources had been tapped, utilities began generating electricity by burning fossil fuels like coal, natural gas, and oil. In these power plants, the heat from burning fossil fuel boils water into steam, which then drives a steam turbine connected to an electric generator. Rather than funneling the spent (low-pressure) steam created in the electricity-generation process toward a useful purpose, our existing centralized electric power system uses a river, lake, or ocean to cool the hot exhaust or large cooling towers to disburse it into the ambient air.

A typical electricity-generating plant is only 30 to 40 percent efficient – that means that less than half of the energy in the fossil fuel ends up generating electricity for consumer use. It also means more fossil fuels are burned than necessary, and needless toxic and carbon emissions are produced. Due to low efficiency rates of electric generation, the overall energy efficiency of a factory is typically in the range of 50 to 55 percent, even for those with relatively efficient on-site boilers (at an 80 percent efficiency level or above) for supplying their thermal energy needs.

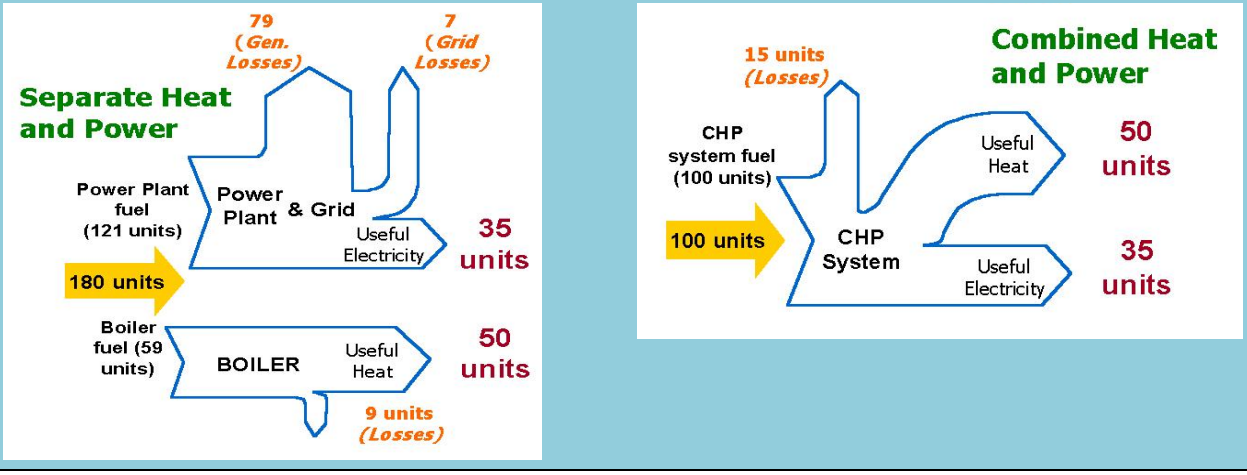
If we could transfer the heat lost from the electric power sector to our manufacturers and others, we could reduce enormous amounts of waste heat, while also reducing the need for manufacturers to purchase additional fuel for heating and cooling purposes. Transporting heat requires the use of expensive heavily insulated pipes, with great losses over any distance, and so becomes impractical beyond three miles. Our centralized electrical power system, located at the far corners of the state, means most existing power plants are far too remote to transfer heat to urban industrial centers.

Combined heat and power technology, sometimes referred to as distributed generation or co-generation, is typically located in facilities on site or near end users who are in need of both electric and heat energy.[6] The CHP system provides at least a portion of the electric load of the customer and the heat generated during the production of electricity is recycled and used to meet thermal needs of the facility (such as industrial process heating and cooling, space heating and cooling, and dehumidification). By using a single fuel source, CHP achieves much higher industrial plant efficiencies than separate heat and power systems, resulting in significantly lower utility bills and related emissions. If all the heat typically rejected in the electric generation process is recovered and used, efficiencies as high as 75 to 85 percent can be achieved. Figure 1 demonstrates how separate heat and power systems require more fossil fuel inputs than combined heat and power technology to produce the same amount of useful energy.

[6] Combined Heat and Power Partnership, US Environmental Protection Agency at http://www.epa.gov/chp/

Figure 1

The diagram shows separate heat and power systems require 180 units of fossil fuels to produce 85 units of useful energy (35 units of electricity, 50 units of heat), while a typical CHP system requires only 100, saving the expense of purchasing 80 fossil fuel units.



Source: Energy Solutions Center (ESC) slideshow "Natural Gas Cooling Solutions" at: http://bit.ly/z4XpV9.

Benefits of combined heat and power to the consumer:

- Decreases the overall amount of fuel required, particularly fuels purchased from out of state;
- Promotes cost savings from more efficient use of energy, and greater energy productivity (amount of economic output per energy input);
- Can offset the need for a company to purchase electricity at retail prices. In some cases, generates a second revenue stream for firms selling excess electricity to an electric utility;[7]
- Acts as an efficient and cost-effective substitute for back-up power generators in facilities like hospitals and disaster management centers that must have assured power;
- Offers firms greater control over their electricity source for industries in which assured power is desirable, especially during peak-use times (typically hot summer afternoons).

Benefits of CHP/WHR to society as a whole:

- Reduces waste of scarce energy resources, as well as smokestack and thermal pollution;
- Supports development of the biomass industry;[8] creates skilled design and construction jobs (to specify and install the CHP/WHR equipment) and maintenance jobs (to service the CHP/WHR equipment); develops a local supply chain for CHP/WHR equipment and servicing;
- Reduces the need for electric utilities to build expensive and difficult-to-site transmission lines and power plants. Compared to central power plants, CHP requires less investment in transmission and distribution infrastructure and has fewer associated expenses.

[7] Types of CHP Systems include: Gas turbines; microturbines; steam turbines; reciprocating engines — either spark-ignition or compression-ignition (diesel); and fuel cells.

[8] "Biomass CHP," Combined Heat and Power Partnership, US Environmental Protection Agency at: http://www.epa.gov/chp/basic/renewable.html.

Prime candidates for CHP investments

Early targets for CHP/WHR investments include entities that use large quantities of both electric and heat energy at the same time (their use loads are "coincident"). Other good candidates use heat energy throughout the year (for steam, hot or chilled water, process heat, refrigeration, dehumidification), produce waste heat, or demand power reliability.[9] Table 2 lists industries that make good potential first candidates for combined heat and power technologies due to their relatively consistent use of heat throughout the year. Most large commercial and residential buildings can also use CHP and WHR for space heating and cooling. As far back as 1882, Thomas Edison piped the steam left over from electricity generation at his power plant to warm surrounding buildings.

Table 2

Heat- and electricity-intensive industries that may benefit from CHP and WHR

Utilities: Making electricity; compressing natural gas; pumping water, sewage
Manufacturing **Paper:** Pulping, drying paper **Metals:** Refining, melting iron, steel, other metals; making coke; hot pickling/galvanizing, tempering, annealing steel; heat treating metals; cleaning metals **Chemicals and plastics:** Refining oil; promoting chemical reactions; melting plastics, resin; heating glue; drying paint; pumping oil **Ceramics**: Drying, firing pottery; melting, firing glass; drying, baking limestone; melting silicon, growing crystalline boules
Food Preparation and Preservation: Cleaning, drying, cooking, baking, canning foodstuffs; refining food oil
Farming: Heating barns and greenhouses, keeping animals and plants warm
Waste Management: Drying sludge
Health Care and Social Assistance: CHP in lieu of back-up generators for reliable power for emergency equipment; heating residential facilities; laundering clothes, sterilizing equipment
Educational, Human Services: Heating large residential facilities (dormitories, residential care, prisons)
Accommodation and Food Service: Washing, drying dishes; laundering linens; cooking food

Ohio's manufacturing sector is a prime first target for CHP development opportunities. Industry, made up of manufacturing, agricultural activities, construction, and mining, is Ohio's largest energy-consuming sector, accounting for 1/3 of our state's energy use. Manufacturers consume 90 percent of that industrial energy use in two primary ways: they burn fuels on site, largely to heat chemicals, metals, wood, and glass in various industrial processes, but also to heat and cool buildings and to power vehicles; and they access the electric power grid largely to run electric motors that drive metal cutting and forming tools, power welding tools, electric furnaces, and electric forklifts. Electricity is also used to light, heat, and cool buildings. Ohio manufacturers spent an estimated $5.9 billion on energy in 2008, and $4.4 billion in 2009 (more than one quarter the amount of their payroll costs). Nearly half of that was spent to purchase fuels for onsite heating and cooling purposes, while slightly more than half was spent on electricity to meet power needs.

Ohio examples. Table 3 shows Ohio has 552 MW of combined heat and power capacity already in existence, approximately 80 percent of which can be found in the manufacturing sector. For perspective, if the 552 MW were to be used in the residential sector, it would be enough to power more than 450,000 homes. Appendix 1 provides greater detail on several of these projects. Examples of CHP adopters include manufacturers of steel and other primary metals, automobiles,

[9] See the CHP Project Development Handbook from the U.S. EPA and CHP Partnership at http://1.usa.gov/y81EXK.

tires, food and wood products, pulp and paper, and petroleum refineries. Other CHP adopters are found in the agricultural sector; the public sector, including wastewater treatment facilities; at universities; and in the commercial sector, such as hospitals. While many interesting projects are already in existence, much more can be done.

Table 3

Ohio combined heat and power (CHP) systems, 2010

City	Organization	Facility	Application	NAICS	Op year	Capacity (KW)	Fuel Type
Agriculture							
Montpelier	Bridgewater Dairy	Bridgewater Dairy	Agriculture	11212	2008	800	BIOMASS
Ft Recovery	Wenning Poultry Farm	Wenning Poultry Farm	Agriculture	11231	2008	600	BIOMASS
Total agriculture CHP capacity						**1,400**	
Percent existing CHP capacity found in agricultural sector						**0.3%**	
Manufacturing							
Ashtabula	Energy Development Services	Bygen Corporation	Chemicals	325	1991	3,300	NG
Cleveland	Synthetic Products Co	Synthetic Products Co	Chemicals	325	1986	650	NG
Ashtabula	Trigen-Cinergy Solutions LLC	Millennium Inorganic Chemicals	Chemicals	325131	2001	28,000	NG
Cincinnati	Procter & Gamble Co	Ivorydale	Chemicals	325611	1965	12,500	COAL
Rittman	Morton Salt Co.	Morton Salt	Chemicals	325998	1986	1,875	COAL
Akron	Diamond Crystal Salt Company	Diamond Crystal Salt Company	Chemicals	325998	1960	1,100	COAL
Waverly	Mill's Pride LP	Mills Pride	Furniture	337112	1988	1,000	WOOD
Cleveland	Resource Capital	Empire Industries	Machinery	333	1987	700	NG
Mansfield	Broshco Fabricated Products	Broshco Fabricated Products	Primary Metals	331	2000	4,550	NG
Cleveland	ArcelorMittal-Cleveland	Cleveland	Primary Metals	331111	1950	45,000	WAST
Mingo Junction	RG Steel-Wheeling	Wheeling	Primary Metals	331111	1997	32,000	WAST
Warren	RG Steel-Warren	Warren	Primary Metals	331111	1934	20,500	NG
Chillicothe	Mead Corporation	Mead Corporation	Pulp and Paper	322121	1952	81,000	COAL
Hamilton	Smart Papers	Smart Papers Hamilton Plant	Pulp and Paper	322121	2009	40,000	COAL
Hamilton	Smart Paper/ Champion International Corporation	Hamilton Mill	Pulp and Paper	322121	1991	26,280	COAL
Coshocton	Smurfit Stone Container Corporation	Stone Container Corporation	Pulp and Paper	32213	1982	15,600	NG
Lockland	Jefferson Smurfit Corporation	Jefferson Smurfit Corporation	Pulp and Paper	32213	1935	8,000	COAL
Rittman	Packaging Corporation Of America	Packaging Corporation Of America	Pulp and Paper	32213	1928	14,000	COAL
Massillon	Greif Board Corporation	Warmington Road Facility	Pulp and Paper	32213	1998	6,850	NG
Oregon	Toledo	Toledo	Refining	32411	1986	6,000	WAST
Haverhill	Haverhill Coke / SunCoke Energy	Haverhill Facility	Refining	324199	2008	46,000	WAST
Akron	Goodyear Tire & Rubber	Goodyear Tire & Rubber	Rubber/Plastics	326211	1953	40,000	COAL
Mansfield	Jay Plastics	Jay Plastics	Rubber/Plastics	326199	1997	1,900	NG
Cincinnati	International Cogeneration Corporation	Clarke Gm Diesel	Transportation Equip.	336	1990	75	NG
Archbold	Sauder Woodworking	Sauder Woodworks Plt	Wood Products	321113	1993	7,200	WOOD
New Knoxville	Hoge Lumber Co	Hoge Lumber Co	Wood Products	321113	1972	3,700	WOOD
Total manufacturing CHP capacity (KW)						**447,780**	
Percent of Ohio CHP capacity that is in the manufacturing sector						**81.1%**	

Commercial sector							
Toledo	St. Charles Hospital	St. Charles Hospital	Hospitals	62211	1999	1,100	NG
Cleveland	Cogeneration Partners Of America	Deaconess Hospital	Hospitals	62211	1987	665	NG
Beachwood	EUA/Highland Energy Partners, L.P.	Radisson Beachwood Inn	Hotels	72111	1989	100	NG
Toledo	BHP Energy Solution	Toledo Art Museum	Museums/Zoos	71211	2004	240	NG
Mansfield	Mansfield Area YMCA	Mansfield YMCA	Amusement/ Recreation	71394	2000	150	NG
Total commercial sector CHP capacity (KW)						**2,255**	
Percent Ohio CHP capacity in the commercial sector						**0.4%**	
Universities and colleges							
Cincinnati	Univ. of Cincinnati	Univ. of Cincinnati	Colleges/Univ.	62231	2004	48,000	NG
Kent	Kent State University	Kent State University	Colleges/Univ.	61131	2003	12,400	NG
Toledo	Medical Coll. of OH	Medical Coll. of OH	Colleges/Univ.	61131	1989	8,900	NG
Columbus	Ohio State University	Mccracken Power Pt	Colleges/Univ.	61131	1988	3,125	COAL
Oberlin	Oberlin College	Oberlin College	Colleges/Univ.	61131	1984	773	COAL
Wooster	College of Wooster	College of Wooster	Colleges/Univ.	61131	1992	375	COAL
Total universities and colleges CHP capacity (KW)						**73,573**	
Total universities and colleges CHP capacity (%)						**13.3%**	
Local government							
Akron	Akron City Of	Akron Recycle Energy Plant	Solid Waste Facilities	562212	1979	2,000	WOOD
Akron	KB Composting Services, Inc.	Department of Public Services Composting Facility	Solid Waste Facilities	562212	2008	335	BIOMASS
Lima	Lima Wastewater Treatment Plant	Lima Wastewater Treatment Plant	Wastewater Treatment	562111	2003	90	BIOMASS
Toledo	City of Toledo	Toledo Wastewater Treatment Plant	Wastewater Treatment	11231	2008	6,200	BIOMASS
Hamilton	City of Hamilton	City Building	General Gov't	92119	1971	16,000	NG
Wooster	City of Wooster	City of Wooster	General Gov't	92119	2006	375	BIOMASS
Toledo	SeaGate Convention Centre	SeaGate Convention Centre	General Gov't	92119	2005	240	NG
Total local government (KW)						**25,240**	
Total local government (%)						**4.6%**	
Military/national security							
Fairborn	Wright Patterson AFB	Wright Patterson AFB	Nat. Security	92811	2002	2,075	WAST
Total military/national security (KW)						2,075	
Total military/national security (%)						0.4%	
Residential							
Paris	Private Residence	Private Residence	Private Homes	81411	1992	115	NG
Total Residential CHP Capacity						**115**	
Percent CHP Capacity that is in the Residential Sector						**0.0%**	
Total Ohio CHP capacity (KW)						**552,438**	

Data from CFI: http://www.eea-inc.com/chpdata/index.html; B/ST=Boiler/Steam Turbine; CT=Combustion Turbine; NG=Natural Gas; MT=Microturbine; WAST=Waste Heat; ERENG= Reciprocating Engine; OTR=Other

Barriers to greater CHP adoption

If Ohio were increase its CHP and WHR capacity by an additional 10 percent, we would see $1.3 billion in annual energy savings and reduce emissions by 13 million metric tons, the equivalent of taking 2.3 million cars, or nearly 30 percent of passenger vehicles registered in the state, off the road. The $5.4 billion capital investment needed to make this transition would create more than 20,000 jobs.[10] Ohio, with its strong manufacturing base, could also be a leader in producing gas and steam turbines, high-pressure steam lines, valves, and the other essential components of CHP systems. Furthermore, CHP technologies can use biomass or biogas for fuel, so CHP could be a boon to Ohio's agricultural sector. As this section shows, however, there are obstacles to reaching that target.

Ohio's clean energy laws do not effectively promote CHP. Aggressive alternative energy and energy efficiency requirements for our electric utilities helped jumpstart renewable energy and efficiency industries in Ohio, but have been less effective in promoting CHP development.[11] Ohio law requires 25 percent of the electricity generated in Ohio to come from alternative energy by 2025, at least 12.5 percent of which must come from renewable energy sources like solar, wind, geothermal, and biomass.[12] The other half can be procured from renewable energy or advanced energy technologies, the latter of which is defined to include combined heat and power. The renewable energy requirement includes annual benchmarks to ensure utilities make continual progress in the development of renewable energy between now and 2025. There are no equivalent benchmarks for the other half of the alternative energy standard for any of the advanced energy technologies like CHP. As a result, there is no incentive for utilities to secure CHP resources before 2025. Ohio also has an energy efficiency standard that requires electric utilities to become 22 percent more efficient by 2025, but it does not specifically allow for combined heat and power as a way to meet that standard.

The CHP incentive program under Ohio's Advanced Energy Fund was discontinued. At one point, an incentive program housed in the Ohio Department of Development's Energy Office used grants from Ohio's Advanced Energy Fund to encourage adoption of CHP technology. The program was small to begin with, has since expired, the Advanced Energy Fund has been depleted, and collections for the fund have stopped (there used to be a small clean energy surcharge on our electric bills).

Manufacturers are not in the energy business. Manufacturers are not energy experts and reducing operating costs from energy use tends to be less of a priority than increasing revenues from product sales. Plus, historically low gas prices and relatively low electricity prices, in part due to special arrangements, economic development side deals, and ratepayer cross subsidies that make industrial electricity rates artificially low, have further hindered adoption of this technology.

Ohio's municipal utilities and rural cooperatives often do not have the technical capacity to enable direct investments in combined heat and power. Even Ohio's investor-owned utilities have not developed the skills needed for thermal energy production, distribution or integration into industrial facilities. Ohio's municipal utilities largely rely on American Municipal Power-Ohio to

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[10] Amanda Woodrum, Policy Matters Ohio, *Greening Ohio Industry (2009)* at http://bit.ly/x4Bwpx.
[11] *See* Policy Matters Ohio, *Energy Standards at Work: Ohio Senate Bill 221 Creates a Cleaner Economy* (2010), at http://www.policymattersohio.org/energy-standards-at-work-ohio-senate-bill-221-creates-a-cleaner-economy.
[12] See ORC § 4928.64 *Electric distribution utility to provide electricity from alternative energy resources* at http://codes.ohio.gov/orc/4928.64.

develop, manage, and supply their electric power. In the past, AMP-Ohio has depended heavily on centralized coal-fired power, but more recently has begun exploring CHP opportunities.

The Ohio Constitution may limit the state's ability to directly finance CHP projects. Article VIII, Section 13 of the Ohio Constitution reads, in part: "Except for facilities for pollution control or solid waste disposal, as determined by law, no guarantees or loans and no lending of aid or credit shall be made under the laws enacted pursuant to this section of the constitution for facilities to be constructed for the purpose of providing electric or gas utility service to the public." This has historically been interpreted to mean the state cannot finance power projects, including combined heat and power, unless they are determined to be a facility for pollution control**.**

Heat and power are considered separately. Two energy systems have evolved to meet heat and power needs separately, via gas and electric utilities. It requires unconventional thinking across two systems to realize the economic efficiencies created by combined heat and power.

Recommendations

To counter these barriers, state and local governments can implement policies to promote CHP development.

The state of Ohio should support local CHP development efforts by encouraging Ohio's investor-owned utilities to become willing partners. By creating an implementation schedule for existing CHP/WHR requirements under Ohio's alternative energy standard, with specific annual targets, we can encourage Ohio's investor-owned utilities to become more cooperative partners in promoting CHP/WHR development opportunities in the near term. Essentially, we would be creating a CHP/WHR "carve-out" within Ohio's alternative energy standard, similar to the renewable energy and solar requirements.

Cities in Ohio can provide "green incentives" to manufacturers as an economic development tool. Ohio manufacturers pay seven times more for energy than they do for state and local taxes. However, manufacturers are not in the energy business and may not have the awareness, time, technical capacity, or motivation it takes to sort out energy-saving opportunities. Local economic development officials, however, working with energy, technical, and financing partners, can help manufacturers take advantage of CHP/WHR opportunities. Green incentives – access to cheap and clean light, heat, and power – can help improve a company's energy productivity without the negative impact tax incentives would have on already strained state and local budgets. This strategy is better for the environment (and community) than existing economic development approaches. Cities can offer manufacturers green incentives by arranging long-term power purchasing agreements for affordable clean energy; co-locating industries within eco-industrial parks where heat and power energy resources can be shared cheaply; or by purchasing excess power generated by manufacturers that have invested in on-site CHP or WHR facilities (via CLEAN contracts discussed further below).

1. **Help arrange long-term Power Purchase Agreements (PPAs) with manufacturers and other businesses for affordable and clean light, heat, and power.** Long-term power purchase agreements reduce the risk to manufacturers from the volatility of fossil fuel energy prices, while also assuring utilities a guaranteed rate of return. To ensure access to clean energy at low rates, cities could use PPAs as a development tool, working with Ohio's investor-owned utilities (IOUs), investigating the use of municipal power authority to "acquire, construct, own, lease, and operate" light, heat, and power facilities (there are some

federal limitations here), or joining others to form a CHP buying group to make the purchase.[13] For example, as part of a legal settlement at the Public Utilities Commission of Ohio, the investor-owned utility American Electric Power set an aggressive goal for CHP development within its service territory of 350 MW (although that settlement has been rejected by the PUCO for other reasons which puts the goal in question). Duke Ohio has proposed to conduct a CHP feasibility study as part of its three-year efficiency plan. Other IOUs might be encouraged to undertake similar programs if a CHP/WHR "carve-out" were created within Ohio's existing alternative energy standard for electric utilities (as mentioned above). Cities can also employ their municipal power authority in lieu of working with investor-owned utilities in order to undertake these projects and offer green incentives. To do so, cities can work with CHP and WHR development companies or consultants with the technical expertise to develop these projects such as the local companies Middough Inc., BHP Energy, Echogen Power Systems, and PSI engineering, or the Chicago-based company Recycled Energy Development. The Energy Resources Center at the University of Illinois at Chicago is also an excellent source for unbiased information for cities in the early stages of exploring opportunities.

2. **Redevelop industrial parks into eco-industrial parks and ensure manufacturers have access to efficient light, heat and power resources at a low cost.** An eco-industrial park is a community of manufacturers and other businesses that collaborate to manage energy, water and materials in a way that jointly improves efficiency.[14] Existing eco-industrial parks include one that converts landfill gas into the park's energy system, one that runs a biomass electricity generation plant for a manufacturing company, and one that co-locates firms with a gas-fired power plant. Some cities recruit new industry by offering infrastructure and lower overhead costs (such as green incentives). Some develop green industry networks around an anchor power plant. Nearby eco-industrial parks help identify where one industry's waste can be another industry's raw material, such as waste heat recovery opportunities.

3. **Work with municipal utilities, investor-owned utilities, or rural electric cooperatives to purchase excess power generated by manufacturers via CLEAN contracts** and distributed power on the grid (CLEAN stands for Clean Local Energy Accessible Now). The CLEAN contract program in Ontario, Canada serves as a good model.[15] The Ontario Power Authority has engaged in numerous 20-year CLEAN contracts for a total of nearly 400 megawatts of community-owned, renewable energy projects within the province. The CLEAN contract program pays a predetermined rate for clean energy generated. The rate paid varies according

[13] Article 18, Section 4 of the Ohio Constitution states "Any municipality may acquire, construct, own, lease and operate within or without its corporate limits, any public utility the product or service of which is or is to be supplied to the municipality or its inhabitants, and may contract with other for any such product or service." See also Ohio Revised Code, Section 4933.02, http://www.legislature.state.oh.us/constitution.cfm?Part=18&Section=0, which says gas or electric utilities may manufacture and supply both electricity and gas: "every corporation organized under the laws of this state to manufacture and supply artificial gas for light, heat, or power purposes and every corporation organized under the laws of this state to manufacture and supply electricity for light, heat, or power purposes, subject to statutory provisions relating to the granting of franchises by municipal corporations for any such purpose in force at the time of granting the franchise, may manufacture and supply electricity and artificial gas, respectively, for light, heat, or power purposes. Such corporations may make all contracts and do all things necessary and convenient for furnishing electricity and artificial gas for both public and private objects." http://law.onecle.com/ohio/public-utilities/ch4933.html

[14] "Eco-Industrial Parks (EIP)," Indigo Development at http://www.indigodev.com/index.html

[15] Often referred to as a feed-in tariff.

to the technology employed (*i.e.,* solar, wind, etc.). They also include a per kilowatt-hour bonus for community-owned projects. Most recently, Ontario Power Authority launched a program for capturing waste heat (200 MW, $90/MWH). Within a few years, Ontario is expected to have the largest installation of community-owned renewable resources outside Denmark and Germany. This program is successful due to the predetermined rate guaranteed to developers of clean energy projects over long-term contracts (CLEAN contracts). CLEAN contracts will also serve to make the electricity sector more competitive, sustainable, and innovative. See Appendix 2 for more information on Ohio's municipal utilities, rural electric cooperatives, and investor-owned utilities.

4. **Enlist the Ohio Air Quality Development Authority for help accessing lower-interest bond financing** such as the $120 million in Qualified Energy Conservation Bonds (QECBs) allocated to Ohio from the 2009 federal stimulus (sub-allocations were made to cities with populations over 100,000)**.** For local economic development officials interested in pursuing CHP/WHR, these bonds can be a cheap way to raise capital for financing. They are taxable bonds very similar to the highly successful Build America bonds, issued at very low interest rates (2 percent over 15 years). For the most part, these bonds are designed for use in public projects. So, a municipal power authority could easily take advantage of them if willing to take on debt directly, as could a public hospital, school, or university. On the other hand, 30 percent of the bonds can be used to finance privately-owned projects, so it is possible that a municipality could help arrange financing for a private energy partner or manufacturer to invest in their own facilities, if structured properly. The Ohio Air Quality Development Authority has the financial expertise to help sort out the financing package. To date, these bonds have gone largely unused throughout the country because they are poorly understood by state and local officials (nationally only something like 15 percent of the bonds have been employed). Fortunately, the bonds do not expire so there is ample opportunity remaining.

More information

Local guide to implementing CLEAN contracts: http://bit.ly/z88TMc
The Ontario program for waste heat recovery: http://bit.ly/jRx0qz
Read about Quality Energy Conservation Bonds: http://1.usa.gov/yZ06Eo

Conclusion

The biggest source of Ohio's energy waste comes from inefficiencies in the electric power industry itself. By distributing electricity generation closer to the end user and capturing heat typically wasted, using combined heat and power (CHP) and waste heat recovery (WHR) technologies, we could slash the billions of dollars we spend on polluting fossil fuels and significantly reduce related emissions. Ohio ranks in the top five states for potential use of CHP technology, but 44th in the nation for actual adoption. Achieving energy savings from combined heat and power technologies, in the past, however, has not been a priority among state and local economic development officials and the lack of cooperation from electric utilities has been a major impediment. But the state of Ohio can change that by encouraging Ohio's investor-owned utilities to become willing partners by adopting timelines under Ohio's alternative energy standard for CHP, and Ohio's cities can provide "green incentives" to manufacturers as an economic development tool.

Appendix 1

Steel manufacturers, other primary metals

SunCoke Energy / AK Steel — Middletown, Ohio (between Cincinnati and Dayton).[16] In 2010, SunCoke Energy began construction of a $390 million heat-recovery coke battery capable of producing about 550,000 tons of metallurgical-grade coke and 50 MW of electrical power annually for the adjacent AK Steel Middletown plant. The plant has generated about 500 temporary construction jobs and will create about 75 permanent operation and maintenance jobs.

SunCoke Energy Haverhill North Coke Company / AK Steel — Franklin Furnace, Ohio (near Portsmouth)[17] In 2009, SunCoke Energy began selling 550,000 tons of metallurgical coke annually to the adjacent AK Steel plant for its blast furnace steelmaking process. The SunCoke plant will also produce 46 MW of electricity that will be sold to the power grid.

Air Products and Chemicals / AK Steel — Middletown, Ohio[18] Air Products and Chemicals plan to build a $315 million, 105-MW combined-cycle WHR unit at the AK Steel blast furnace in Middletown, Ohio that would save an estimated 2.7 trillion Btu annually and cut their electricity purchase (from Duke Energy) in half. The project would replace an existing air separator that produces oxygen (700 tons/day) and a hydrogen production unit — PRISM Hydrogen Generator steam methane reformer — that would add additional hydrogen production and produce more than one million cubic feet per day of hydrogen. Oxygen is used by AK Steel for making steel and hydrogen is used in the steel annealing process. They received a federal stimulus grant of $30 million for the project and the project would have generated 220 construction jobs over two years. In April 2011, the project was put on hold because of the recession. Air Products and Chemicals was the prime designer and contractor on this project, and General Electric would have supplied the turbine and generator. A current bill in the legislature, if passed, would qualify the project as a renewable energy source and allow the project to earn additional financing through Ohio's renewable energy credit market.

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[16] "AK Steel Board Approves Long-Term Agreement For Coke and Electrical Power," AK Steel press release, March 24, 2008 at http://www.aksteel.com/news/press_release.aspx?doc_id=634&year=2008; See also Jessica Heffner, "SunCoke gets final permit, can start construction: Ohio Gov. Ted Strickland touts project as a 'major job creation investment,' " *The Oxford (Ohio) Press*, February 9, 2010 at http://bit.ly/zuxQhU; and "SunCoke plant getting final touches, *Cincinnati Business Courier*, August 22, 2011 at http://bit.ly/zgfNh2.

[17] Jessica Heffner, "AK signs coke deal purchase from SunCoke Haverhill plant: Steelmaker, SunCoke ink 12-year agreement; AK says it still needs coke from local project," *Dayton Daily News*, September 4, 2009. http://bit.ly/wAHeSY; See also Combined Heat and Power Installation Database, ICF International on behalf of the Department of Energy and Oak Ridge National Laboratory, accessed August 2011 at http://bit.ly/yP4Yl0; and "SunCoke Energy Design," SunCoke Energy website at http://www.suncoke.com/our-innovation/suncoke-design.php, as well as "History," SunCoke Energy website at http://www.suncoke.com/about-us/history.php.

[18] Chelsey Levingston, "Air Products to modernize Middletown operations: Company also proposes $315M facility at AK Steel," *Dayton Daily News*, February 19, 2011 at http://bit.ly/ghYnif; See also Jessica Heffner, "Company awarded $30M for 'green' energy project at AK Steel: Air Products awarded $30 million from feds to build 'green' power plant at Works," *Hamilton (Ohio) Journal-News*, November 4, 2009 at http://bit.ly/xhWw3H; "Final Environmental Assessment for the Air Products and Chemicals, Inc. Waste Energy Project at the AK Steel Corporation Middletown Works, Middletown, Ohio," U.S. Department of Energy, National Energy Technology Laboratory, DOE/EA-1743, July 2010 at http://www.netl.doe.gov/publications/others/nepa/EA-1743.pdf; Chelsey Levingston, "Air Products' waste-gas project at AK Steel on hold," *Dayton Daily News*, April 22, 2011 at http://bit.ly/gpheY8; Jessica Heffner, "Mom becomes activist to take on coke plant," *Middletown Journal*, September 10, 2009 at http://bit.ly/CG5HN.

Cokenergy / ArcelorMittal — East Chicago, Indiana.[19] ArcelorMittal, the world's largest steelmaker, has operations in 22 countries including facilities in Ohio and Indiana. In the Indiana facility, a 1998 waste heat recovery system uses waste heat from the industrial coke production process to generate 95 MW of electricity for use on-site. In 2002, an additional WHR system was installed using waste heat from the blast furnace to generate 50 MW. Now the CHP/WHR totals 220 MW, saving ArcelorMittal $100 million per year.

Ohio has many other steelmaking and coke plants that might be candidates for CHP/WHR systems:[20] AK Steel (formerly Armco)[21] with Ohio facilities in Coshocton, Mansfield, and Zanesville; AK Tube LLC (AK Steel Subsidiary) in Walbridge, OH; ArcelorMittal[22] with Ohio facilities in Cleveland, Columbus, and Warren (coal to coke); ArcelorMittal Tubular Products[23] (ArcelorMittal Subsidiary) in Shelby (near Mansfield) and Marion (north of Columbus); Charter Steel Company[24] in Cuyahoga Heights (Cleveland) and Fostoria (south of Toledo); Nucor Steel — Marion (north of Columbus)[25]; North Star BlueScope Steel[26] Delta (west of Toledo); Republic Engineered Products LLC (owned by ICH, Mexico City),[27] in Lorain, Canton, and Massillon; Timken Co.,[28] in Canton (Faircrest and Harrison facilities); V&M Star[29], Youngstown; Severstal Wheeling[30] in Mingo Junction, Yorkville, and Martins Ferry (all near Steubenville); and Severstal Warren[31] in

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[19] Primary Energy Recycling Corporation website at http://primaryenergy.com/projects/cokenergy/default.aspx http://primaryenergy.com/projects/ironside/default.aspx; See also September 2010 slideshow: http://www.chpcentermw.org/wasteheat2010/CokenergyTourInfo.pdf; and JAD Environmental website at http://www.jadenvironmental.com/projects-jad.php; and MetalMiner website: http://bit.ly/diQGA2.

[20] U.S. Environmental Protection Agency, "Available and Emerging Technologies for Reducing Greenhouse Gas Emissions from the Iron and Steel Industry," October 2010, pp 42–46 at http://www.epa.gov/nsr/ghgdocs/ironsteel.pdf; See also Ernst Worrell, et al., "Energy Efficiency Improvement and Cost Saving Opportunities for the U.S. Iron and Steel Industry," Energy Analysis Department, Lawrence Berkeley National Laboratory, University of California, October 2010, pp. 131–135 at http://1.usa.gov/wsTd7C.

[21] "AK Steel Facilities," AK Steel website at http://www.aksteel.com/production_facilities/.

[22] ArcelorMittal Facilities in Cleveland formerly Jones & Laughlin, Republic Steel, LTV Steel, and International Steel Group); Columbus formerly L-S II Electro-Galvanizing Co. and Ohio Kanpoh Steel, and Warren formerly International Steel Group.

[23] Formerly known as Dofasco Copperweld.

[24] "About Our Company – Facilities," Charter Steel website at http://www.chartersteel.com/about/facilities.php;

[25] "Location - Marion, Inc.," Nucor website at http://www.nucorbar.com/locations.aspx?i=11.

[26] Joint venture between BlueScope Steel, Australia and Cargill. North Star BlueScope Steel website at http://www.northstarbluescope.com/.

[27] "About Republic Steel," Republic Steel website at http://www.republicengineered.com/about.php.

[28] "Timken increases steel output, jobs," CantonRep.com, April 19, 2011, at http://bit.ly/A7RAQk. See also, Mike Seifert and Nathan Abboud, "Energy Savings Initiatives: The Timken Company's Steel Business," Timken slideshow, March 24, 2010 at http://www.forging.org/fierf/pdf/Timken.pdf.

[29] Owned by Vallourec, France; formerly Brier Hill Works, Youngstown Sheet & Tube, Jones & Laughlin Steel, LTV Steel, and North Star Steel), "Production," V&M Star website at https://www.vmstar.com/PublicWebsite/index.html; See also Bill Toland, "$650 million plant to transform Youngstown: Steel mill, expected to bring 350 jobs, atop natural-gas fields," *Toledo Blade*, April 19, 2011 at http://bit.ly/ezhcxN.

[30] Owned by Severstal, Russia; formerly Wheeling-Pittsburgh Steel, Esmark. "Severstal Wheeling: A manufacturer and distributor of flat rolled and other steel products." Severstal website at http://bit.ly/Af91xN; See also Paul Giannamore, "Severstal idling Mingo Junction furnace," *The Intelligencer / Wheeling News Register*, January 23, 2009 at http://www.news-register.net/page/content.detail/id/519869/Severstal-idling-Mingo-Junction-furnace.html?nav=515; and Paul Giannamore, "Talks between Severstal, union begin next week: Meeting held to discuss Mingo Junction plant," *The Herald Star*, January 30, 2010 at http://www.hsconnect.com/page/content.detail/id/531606.html?nav=5010.

[31] Formerly WCI Steel Inc. "Severstal Company Profile," Severstal website at http://bit.ly/xqmOXa.

Warren; and FDS Coke Plant LLC[32] in Toledo (this plant is still getting permits, but if built, it will also produce 135 MW of electricity).

Auto industry

Broshco Fabricating Products — Mansfield, Ohio.[33] Automobile seat frame manufacturer Broshco Fabricating Products has a CHP system that generates 4.55 MW of electricity and 8 million Btu per hour of hot water to supplement building and process heat loads. The system has three 1,150 kW Waukesha 7100 GSI natural gas-fired engine generator units (installed in 2000) and a fourth 1,100 kW Waukesha APG natural gas-fired engine generator (added in 2005) that is a test unit for the ARES DOE program.

Food industry

Shearer's Foods — Massillon, Ohio.[34] In the spring of 2010, Shearer's Food opened the first platinum-certified Leadership in Energy and Environmental Design (LEED) snack-food manufacturing facility in the world. This manufacturing plant in Massillon, Ohio makes tortilla and potato chips and uses 47 percent less natural gas for its oven, 30 percent less energy overall, and 30 percent less water than similar plants. When the second phase of construction is finished in spring 2011, the $22 million, 110,000 square-foot building will employ 180 people and have invested $40 million in equipment. PSI Engineering, a local company based in Fremont, Ohio, designed Shearer's chimney which captures heat typically discarded in the oven and fryer stack waste and uses it to preheat the corn cook water, supply hot water for sanitation cleaning, and supply nearly all of the heating needs of the building, thus saving over 22 percent of the energy normally used for these processes. The total energy saved by this waste heat recovery (WHR) system will reduce greenhouse gas emissions by more than 1,066 metric tons annually.

The building also has 22 percent recycled content and nearly 29 percent locally harvested and manufactured materials. All wood products used are certified by the Forestry Stewardship Council. The building has extensive insulation and large windows and skylights that provide natural light. In addition, the roof collects 17,000 gallons of rainwater each month, reducing the need to acquire water from outside sources by 21 percent over similar facilities. Also, over 75 percent of the electricity used by the facility will be purchased from wind farms (via the renewable energy credit market).

To support construction of this manufacturing facility, Shearer's Food received a $291,879 award from the federal American Recovery and Reinvestment Act of 2009, $4 million in bonds from the Summit County Port Authority, a loan of $3.4 million from the Ohio Water Development Authority, a $2.5 million Ohio Chapter 166 direct loan, and a $8,425,000 Ohio Enterprise Bond Fund loan.[35]

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[32] "FDS Coke Plant," FDS Coke Plant website: http://fdscokeplant.com/nonrecovery.htm; See also "The FDS Co-Generation Facility." http://fdscokeplant.com/documents/fds_cogen_1pg.pdf.

[33] "Project Profile — Broshco Products," Midwest CHP Applications Center, Department of Energy, October 2, 2007 at http://www.chpcentermw.org/rac_profiles/Midwest/BroshcoProducts.pdf.

[34] Cindy Grahl, "Shearer's Snackfoods: Platinum chips," *Builder's Exchange Magazine*, Volume 9, Issue 12, December 2010 at http://www.bxmagazine.com/article.asp?ID=1150; See also Leslie Guevarra, "Shearer's Cuts the Ribbon on America's Greenest Snack Factory," GreenBiz.com, August 12, 2010 at http://bit.ly/wvQfRt. And Matt Tullis, "Manny Awards: Smart Chip," *IBmagazine*, May/June 2010 at http://bit.ly/wvTFCW; and Marina Mayer, "LEED-ing the Way," *Snack Food & Wholesale Bakery*, February 11, 2011 at http://bit.ly/wC4aaw.

[35] Council of Development Finance Agencies (CDFA) slideshow, pages 13–15: http://bit.ly/y7Tn4A; See also Ohio Development Department, "All Projects Funded By The Ohio Energy Resources Division, As of March 31, 2011," (federal ARRA stimulus money) at http://bit.ly/wpCslT; See also Ohio Department of Development press release, April 28, 2008 at http://development.ohio.gov/newsroom/2008PR/April/11.htm .

Wood products manufacturers

Sauder Woodworking — Archbold, Ohio (west of Toledo).[36] In 1993, Sauder Woodworking installed a 7.2 MW CHP system in its 4.5 million square feet facility in Archbold. The CHP system burns 1,000 tons of wood waste each week to supply its two steam turbines. In 2006, the system provided about half the electricity the facility uses. In addition to the energy savings from not having to purchase electricity off the grid, the company earned $50,000 from selling excess steam energy to nearby companies.

Other Wood Products Manufacturers in Ohio with CHP systems include:[37] Hoge Lumber Company, New Knoxville (north of Dayton) with 4 MW; and Mill's Pride LP, Waverly (south of Chillicothe) with 1 MW.

Pulp and paper manufacturers

SMART Papers — Hamilton, Ohio (near Cincinnati).[38] In 2009, SMART Papers upgraded its CHP system to burn biomass — primarily yard waste as well as industrial wood and fiber waste. With four steam turbines, the system generates 40 MW of electricity as well as steam to operate the mill that produces premium-coated magazine and uncoated printing papers. Honeywell International supplied the co-generation system. SMART Papers employs 550 people.

Other Pulp and Paper Manufacturers in Ohio[39] with CHP systems include: Mead Corporation, Chillicothe with 81 MW; Smurfit Stone Container Corporation, Coshocton with 16 MW; Packaging Corporation of America, Rittman (near Akron) with 14 MW; Jefferson Smurfit Corporation, Lockland (near Cincinnati) with 8 MW; and Greif Board Corporation, Massillon with 7 MW.

Tire manufacturers

Goodyear Tire & Rubber — Akron, Ohio.[40] In 1953, Goodyear Tire & Rubber built a coal-fired 40 MW CHP system.

Petroleum refineries

Nationally, petroleum refineries have been one of the leading industries using CHP systems. For example, there are 17,331 MW of CHP systems installed at refineries in Texas. Calpine Deer Park Energy Center in Houston, Texas[41] operates a 250 MW electricity generating plant that also produces steam used by the Shell Chemical Company nearby. In Ohio, BP-Husky Refinery of Oregon, Ohio (near Toledo)[42] installed a 6 MW CHP system in 1986.

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[36] Karen Koenig, "Sauder Woodworking Cleans up in the RTA Market," Woodworking Network, September 19, 2007 http://www.woodworkingnetwork.com/articles/sauder_woodworking_cleans_up_in_the_rta_market_127742198.html.
[37] Combined Heat and Power Installation Database, ICF International on behalf of the Department of Energy and Oak Ridge National Laboratory, accessed August 2011 at http://www.eea-inc.com/chpdata/index.html.
[38] "SMART Papers Breaks Ground on $30 Million Energy Project to Produce North Americas Most Environmentally Responsible Premium Printing Papers," SMART Papers press release, May 13, 2008 at http://bit.ly/wc1ejt.
[39] Combined Heat and Power Installation Database, ICF International on behalf of the Department of Energy and Oak Ridge National Laboratory, accessed August 2011 at http://www.eea-inc.com/chpdata/index.html.
[40] *Id.*
[41] *Id.* See also "Calpine Deer Park Energy Center Receives EnergyStar Award," Calpine press release, May 13, 2003 at http://phx.corporate-ir.net/phoenix.zhtml?c=103361&p=irol-newsArticle&ID=526760&highlight=.
[42] *Id*.

Agriculture

Bridgewater Dairy — Montpelier, Ohio (west of Toledo)[43] In 2008, Bridgewater Dairy installed an anaerobic methane digester to convert the manure from its 3,800 cows into methane (natural gas) that it then burns to generate 0.8 MW of electricity using a reciprocating engine/generator. The waste heat from this generator aids the manure digester process. The total cost was more than $2 million, but the USDA Rural Development program granted $500,000 for the digester. The dairy now sells the excess electricity, 30 percent of the total electricity generated, to its electric cooperative, which brings in additional revenue.

Wastewater treatment facilities

City of Toledo Waste Treatment Plant — Toledo, Ohio[44] has a 10.3 MW cogeneration system at its Bay View Wastewater Treatment Plant (WWTP) that burns landfill and digester gas and provides the power for the treatment plant. It includes a Solar Turbines Taurus 60 combustion turbine (5.2 MW), a heat recovery steam generator (HRSG), and a Dresser Rand (General Electric) steam turbine (6.9 MW). Excess heat is recovered and used to heat local buildings.

MUSH market and the commercial sector

(MUSH = Municipal government, Universities, Schools, Hospitals)

Toledo Museum of Art — Toledo, Ohio.[45] In 2004, the 230,000 square foot Toledo Museum of Art installed four Capstone C60-JCHP micro-turbines that produce 0.26 MW of electricity (up to 15 percent of demand) and produce 1.6 million Btu of hot water from the waste heat. The hot water is used with absorption cooling to control humidity in galleries and archives. The project cost $521,571, which was covered by a $75,000 grant from the Ohio Department of Development, Office of Energy Efficiency (OEE) and a low interest loan through the OEE for the remainder.

SeaGate Convention Center — Toledo, Ohio.[46] In 2005, the 360,000 square foot SeaGate Convention Center installed four Capstone C-60 CHP micro-turbines that produce 0.26 MW of electricity (which is about half their demand) and produce 1.6 million Btu of hot water and 100 tons of chilled water (most of their demand) from the waste heat. The project cost $596,097 and saves about $125,000 each year. The initial cost was covered by a $150,000 grant from the Ohio

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[43] Dan Toland "From Waste to Want: Northwest Ohio dairy is first in the state to produce electricity from manure," *Our Ohio*, January/February 2009 at http://ourohio.org/magazine/past-issues-2009/jan-feb-2009/from-waste-to-want-2/. See also "Renewable Power Opportunities for Rural Communities," United States Department of Agriculture, April 2011 at http://www.usda.gov/oce/reports/energy/RenewablePowerOpportunities-Final.pdf; and Combined Heat and Power Installation Database, ICF International on behalf of the Department of Energy and Oak Ridge National Laboratory, accessed August 2011 at http://www.eea-inc.com/chpdata/index.html.

[44] "Middough Inc Helps City of Toledo, Bay View WWTP Win Several Energy Awards," Middough, Inc. press release, February 17, 2011 at http://www.middough.com/Newsroom-Docs/COT-Press-Release-FINAL-2-17-11.aspx; See also Dean E. Karafa, "Bay View Wastewater Treatment Plant Electrical Power Cogeneration System," Middough, Inc. slideshow, March 3, 2009 at http://www.mi-wea.org/docs/Bayview%20WWTP%20Biogas%20to%20Energy.pdf; and "State-of-the-art Cogen at Bay View," *Combined Cycle Journal*, 3rd Quarter 2010 at http://bit.ly/AkE3Eo.

[45] "Toledo Museum of Art Installs Microturbines for Efficiency Gains," Ohio Department of Development at http://bit.ly/zlUTrj; See also "Projects," BHP Energy webpage at http://www.bhpenergy.com/Projects.html; and "2010 Ohio Solar Tour: Toledo Museum Of Art," Ohio Solar Tour at http://bit.ly/AeVMPt.

[46] Anne Vazquez, "Combined Heat and Power Helps Fuel Convention Center: Convention center uses on-site power generation to produce clean energy that also reduces utility bills," *Today's Facility Manager*, May 2006 at http://www.todaysfacilitymanager.com/tfm_06_05_green.php. See also, "Projects," BHP Energy webpage at http://www.bhpenergy.com/Projects.html; See also "US EPA Honors BHP Energy for Green Projects," *Distributed Energy*, May 12, 2011 at http://www.distributedenergy.com/the-latest/bhp-epa-recognition.aspx.

Department of Development, Office of Energy Efficiency (OEE) and a low interest loan through the OEE for the remainder.

Huntington Center — Toledo, Ohio.[47] The Huntington Center arena is a 260,000-square-foot, three-story building with 8,000 seats, 22 suites, and 1,200 club seats. It was built in 2009 and is the home of the Toledo Walleye ice hockey team. The arena has a CHP system consisting of Capstone turbines that can produce 0.26 MW of electricity, 1.6 million BTU of hot water, and 100 tons of chilled water from the recovered exhaust heat.

University of Cincinnati — Cincinnati, Ohio.[48] In 2002, UC spent $62 million to expand its 28,000 square foot Central Utility facility by 33,000 square feet and add two Solar Titan gas-fired turbines (made by Solar Turbines, Inc. in San Diego, a subsidiary of Caterpillar), a Dresser-Rand (General Electric) steam turbine, and a diesel generator for generating a total of 47 MW of electric power. The exhaust heat from the gas turbines is used to heat over 100 buildings comprising 12 million square feet used by 40,000 students, faculty, and staff. The expansion saves UC about $4.5 million dollars a year in energy costs.

Kent State University — Kent, Ohio.[49] KSU's 880-acre main campus in Kent, with 115 buildings, has a $23 million CHP system consisting of a Solar Taurus 60 turbine (which can run on natural gas or fuel oil and produce 5.2 MW of electricity) and a Solar Taurus 70 generator (capable of generating 7.2 MW of electricity). Exhaust from the turbines is used to generate steam for heating and to drive chillers. The CHP system satisfies almost 90 percent of the university's electric power needs in the winter and 60 percent in the summer. In addition, the CHP system meets half of the university's need for steam. The plant is estimated to be 71 percent efficient overall and to reduce CO_2 emissions by 13,000 tons per year. Total annual savings are estimated to be more than $700,000.

College of Wooster — Wooster, Ohio[50] The College of Wooster has a coal-fired steam boiler that provides heating and absorption cooling for the 1.1 million square feet of campus buildings. In 1992, they added a 375 kW topping cycle, backpressure turbine and induction generator set at a cost of $233,000. The unit is estimated to produce 1.3 million kWhr per year by burning an additional 145 tons per year of coal. Overall, the plant saves about $50,000 per year.

Other Ohio Colleges with CHP units include: Medical College of Ohio, Toledo (9 MW); Ohio State University, Columbus (3 MW), and Oberlin College, Oberlin (0.7 MW).

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[47] "Projects," BHP Energy webpage at http://www.bhpenergy.com/Projects.html.
[48] Marianne Kunnen-Jones, "Plant Expansion Begins," University of Cincinnati news release, February 20, 2002 at http://www.uc.edu/news/utility.htm. *See also* Mary Bridget Reilly, "Expanded Utility Plant to Power UC's Future," University of Cincinnati news release, April 10 (2001) at http://www.uc.edu/news/cup.htm. Shook Construction, "University of Cincinnati Central Utility Plant" at http://www.shookconstruction.com/cup_plant.php. "Production Equipment," University of Cincinnati Utilities at http://www.uc.edu/af/utilities/production.html.
[49] "University District Heating and Cooling System Awarded Energy Star CHP Award February 28, 2007," http://www.epa.gov/chp/documents/past_award_winners.pdf See also Angela Neville, "CHP: Helping to Promote Sustainable Energy," *Power*, June 1, 2009 at http://bit.ly/wxPdok.
[50] District Energy Library, University of Rochester, NY at http://www.energy.rochester.edu/us/oh/wooster/.

District heating/cooling

Ohio has several district heating and cooling utilities that provide steam and chilled water to many businesses located near each other. Neither of these systems currently has CHP, but these kinds of facilities are readily converted to CHP.[51]

Akron Energy LLC (Thermal Ventures) — Akron, Ohio.[52] In downtown Akron, Akron Energy provides steam heat to a total of 17 million square feet of commercial buildings (including Akron Children's Hospital, Akron General Hospital, Summa Hospital, and the University of Akron) and chilled water to 2 million square feet of buildings (including the Akron Aeros baseball stadium and the Akron Civic Theater). Their boilers can burn natural gas, woodwaste, wood chips, coal, recycled tires, or natural gas.

Cleveland Thermal — Cleveland, Ohio.[53] Through 20 miles of pipe, Cleveland Thermal provides steam heat and chilled water to 30 million square feet of buildings in downtown Cleveland including the Anthony J. Celebrezze Federal Building, the Cleveland Public Library, the Cuyahoga County Justice Center Complex, Cleveland City Hall, Trinity Cathedral, the Huntington Bank Building, WKYC-TV, the Wyndham Hotel, the Winton Manor Apartments, and soon the new Cleveland Medical Mart & Convention Center. Currently they provide 30 percent of the energy used in the downtown area. They have one boiler that burns coal and one that uses fuel oil or natural gas.

[51] The Kendall Station CHP plant in Cambridge, MA provides an excellent model. See Martin LaMonica , "City power plant waste heat fuels district heating," CNET News, June 21, 2011 at http://cnet.co/jNYsWw.
[52] "About Akron Energy LLC," Akron Energy website at: http://www.akronenergyllc.com/overview.htm. See also Kelly M. Dodson, "Where the Rubber Meets the Road: Scrap tires viable fuel in Akron," *District Energy*, Second Quarter 2006 at http://www.tvii.biz/LINKS/ATideamag06article.pdf.
[53] Cleveland District Heat website at: http://www.clevelandthermal.com/about/facilities and http://www.clevelandthermal.com/services and http://www.clevelandthermal.com/about/history.

Appendix 2

Ohio Electric Utilities and Distributors/Ohio Investor-Owned Electric Utilities

- AEP Ohio (Ohio Power and Columbus Southern Power) www.aep.com/
- Duke Energy Ohio www.duke-energy.com/
- Dayton Power and Light Company www.waytogo.com/
- FirstEnergy Corp. (Ohio Edison Company, The Illuminating Company and Toledo Edison Company) www.firstenergycorp.com/

These utilities are members of the Ohio Electric Utility Institute www.oeui.org/profile.htm

Ohio Municipal Utilities

American Municipal Power (AMP) has 81 Ohio members (of the total of 129 member municipalities in five states). Cleveland Public Power, with 74,000 customers, is one of the larger. amppartners.org/members/member-list/

Ohio Rural Electric Distribution Cooperatives

There are 25 members of Ohio Rural Electric Cooperatives www.ohioruralelectric.coop/local-co-ops

Service Areas in Ohio

www.puc.state.oh.us/pucogis/statemap/congress_elecserveE1.pdf

Electricity Grid

Ohio electric utilities are connected to the national transmission grid through two independent system operators:

- MISO (formerly the Midwest Independent Transmission System Operator) www.midwestiso.org
- PJM (formerly the Pennsylvania-New Jersey-Maryland Interconnection) pjm.com

Here is a map showing the states they cover: www.miso-pjm.com/

Authors

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Acknowledgements

We would like to extend our gratitude for invaluable input we received from several experts in the field including: Lee Geisse of the Ohio Blue-Green Apollo Alliance; Mark Shanahan of Midwest Gateway Partners; John Cuttica of the DOE Midwest Clean Energy Application Center; Melissa Mullarkey of Recycled Energy Development; Nolan Moser of the Ohio Environmental Council; Ned Ford of the Sierra Club-Ohio Chapter; graduate intern Jamie Wilson; and Anne Hampson of ICF International. We are grateful for the support from the RE-AMP network, which made it possible to do this work. Any errors and omissions in the report are the sole responsibility of the authors.

Policy Matters Ohio is a non-profit, non-partisan research institute dedicated to researching an economy that works for all in Ohio. Policy Matters seeks to broaden debate about economic policy by providing research on issues that matter to Ohio's working people and their families. Areas of inquiry for Policy Matters include work, wages, and benefits; education; economic development; energy policy; and tax policy. Generous funding comes from the Ford, Joyce, Gund, Cleveland, Public Welfare, Annie E. Casey, Sisters of Charity and W.K. Kellogg Foundations, the Economic Policy Institute, and Greater Cleveland Community Shares. To those who want a more fair and prosperous economy… Policy Matters.

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