A brief from THE PEW CHARITABLE TRUSTS | Jan 2015

Clean Economy Rising

Manufacturing powers clean energy in Ohio

Overview

Ohio has built upon its rich manufacturing legacy to become a leader in the production of wind, solar, and industrial energy efficiency technologies. Until recently, state and federal policies also spurred renewable energy projects throughout Ohio—but uncertainty over the future of these measures is dampening investment. This brief explores the drivers of Ohio's clean energy economy and the choices the state faces about its future competitiveness in the industry.

Clean energy policies

In 2008, the Ohio General Assembly passed legislation establishing two major clean energy requirements, modified in 2012 and 2014. One is an alternative energy portfolio standard that calls for investor-owned utilities and power retailers to obtain 25 percent of their electricity from advanced sources by 2024—half of which must come from renewable technologies, including 0.5 percent from solar power. The remainder can come from other advanced energy sources, defined as "any new, retrofitted, refueled, or repowered generating facility," including those using fossil energy. The second is an energy efficiency portfolio standard that requires utilities to reduce electricity use by 22 percent by 2025.[1]

After an intense legislative and public debate about whether these measures are increasing or reducing electricity prices, Ohio became the first state to weaken its clean energy requirements. In June 2014, the Assembly enacted a two-year freeze and modification of the two standards—a compromise from earlier legislation that would have repealed them.[2] The modifications, which clean energy businesses in the state say create uncertainty and will dampen investment,[3] include:

- Freezing the annual targets at 2014 levels until 2016.
- Extending the deadlines by two years.
- Eliminating the advanced energy requirement.
- Removing a requirement for the amount of renewable electricity that must be generated in-state.
- Requiring a commission to review the standards and consider additional modifications.[4]

> "Freezing the [renewable power and energy efficiency] standards for two years creates a start-stop effect that will confuse the marketplace, disrupt investment, and reduce energy savings for customers."
>
> — letter to Ohio Gov. John Kasich in June 2014 from more than 70 businesses, manufacturers, and other organizations

Key State Policies

✓	Renewable portfolio standard*	✓	Tax incentives		Green power purchasing
✓	Net metering and interconnection standards	✓	Bonds/loans/rebates/other financing	✓	Nonutility sales of renewable electricity allowed

* The renewable portfolio standard is frozen through 2016.

Source: North Carolina State University, Database of State Incentives for Renewables and Efficiency

Beyond the now-frozen provisions, Ohio offers a range of financing assistance for clean energy projects, including property and sales tax exemptions, rebates, and loans. The state also has a generous net metering policy, which allows owners of renewable energy projects at their homes or businesses to receive a credit on their utility bills for the power they generate on-site with no caps on project size.[5] Finally, the state has invested in clean manufacturing, helping businesses commercialize new advanced energy products and helping factories install renewable power and energy efficiency projects.[6] Ohio researchers and businesses have also received over $100 million in funding from the U.S. Department of Energy for clean energy-related projects over the past decade.[7]

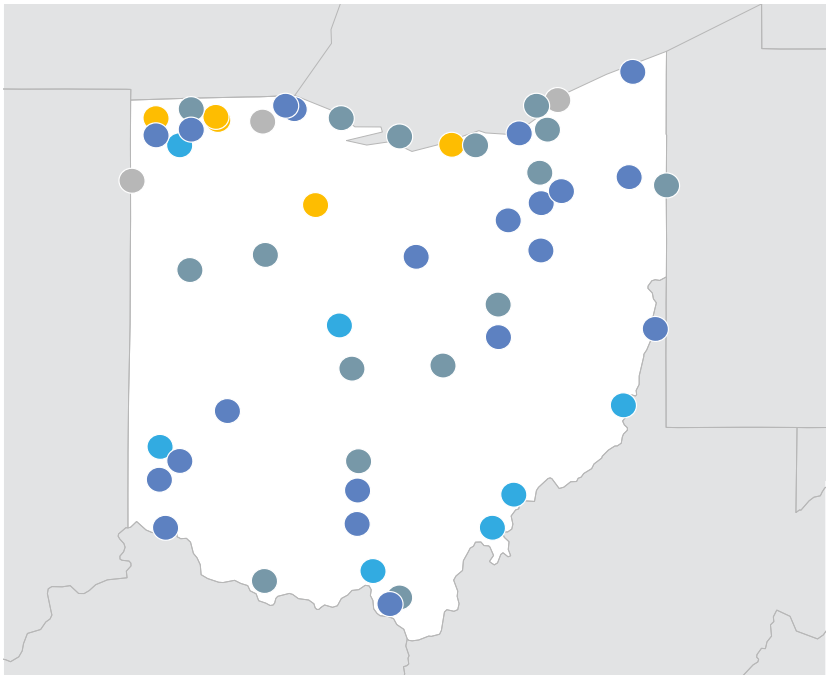
Installations and economy

Coal accounted for nearly 70 percent of electricity generation in Ohio in 2013.[8] Even though the state is the 10th-largest coal provider in the nation, its demand for that fuel source exceeds its supply. As a result, Ohio imports nearly twice as much coal as it produces,[9] at a net cost of approximately $490 million a year.[10]

Ohio's clean energy sector is dominated by wind power, which in 2013 totaled 426 megawatts—62 percent of installed renewable capacity. Hydropower and solar each accounted for 15 percent, with 101 and 100 MW, respectively. Biomass totaled 64 MW.[11]

These clean energy installations are spurring economic activity in the state. Ohio attracted $1.3 billion in private investment in clean energy over the five-year period between 2009 and 2013 and is expected to generate an additional $3.3 billion over the next decade, according to Navigant Research. Installations and revenue in most sectors, particularly wind, are expected to stall over the next two years, because of the freeze of the renewable portfolio standard, and begin picking up again after 2016. However, future investment may be significantly less than projected if the suspension is maintained indefinitely or if clean energy project developers redirect investment to other states because of policy uncertainty in Ohio.

Renewable Electricity Power Plants, >1 Megawatt Capacity

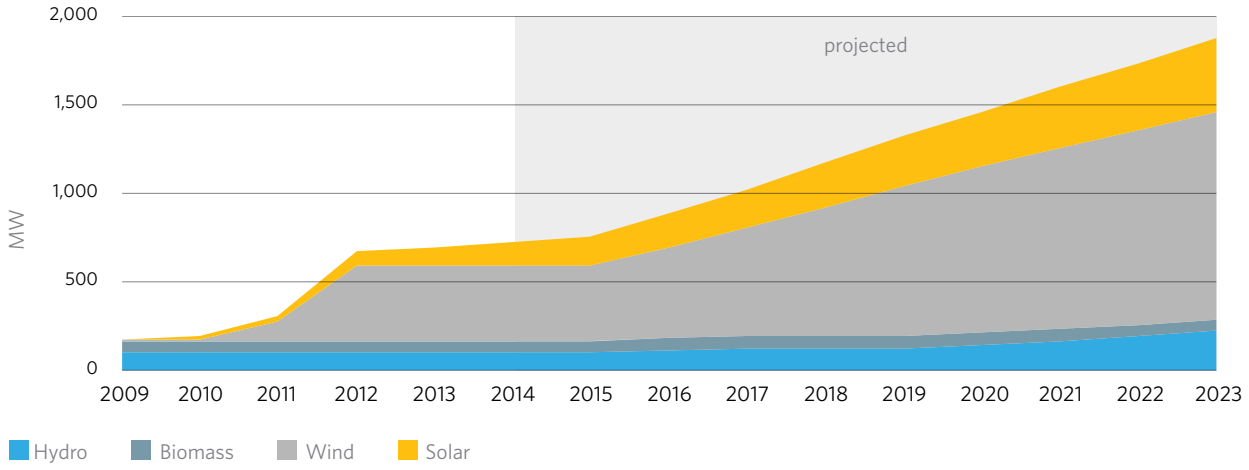


Source: Energy Information Administration, U.S. Department of Energy, state combined heat and power data

Snapshot: Ohio's clean energy economy

Clean Energy Capacity, by Sector and Year

Actual (2009–13) and projected (2014–23) growth in cumulative capacity

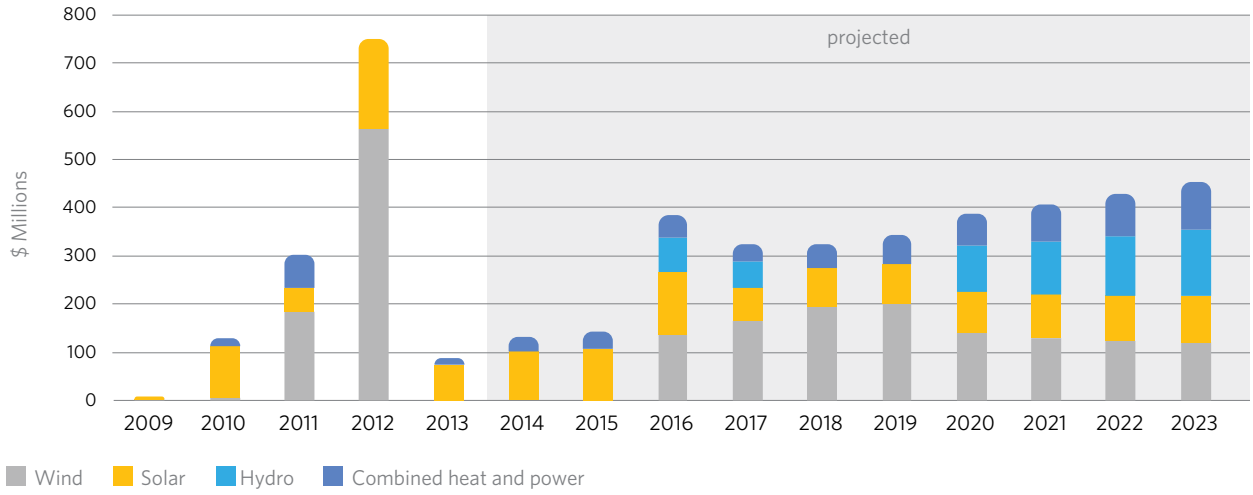


Note: Navigant Research provided data and projections of annual capacity additions from 2009 to 2023. These figures were added to baseline 2008 cumulative capacity data from the Energy Information Administration (except for wind and solar, for which cumulative data were available from Navigant). Navigant's methodology is described at the end of this brief, and that of the Energy Information Administration is available in Table 3, at http://www.eia.gov/renewable/state/ohio.

Sources: Navigant Research, Energy Information Administration

Clean Energy Investment, by Sector and Year

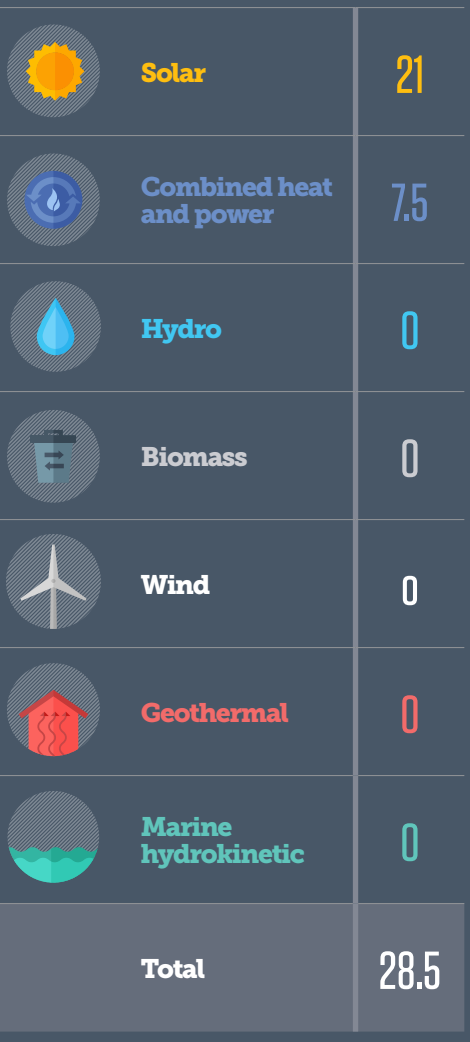
Actual (2009-13) and projected (2014-23) annual investment



Source: Navigant Research

New Clean Energy Capacity Installed in 2013 (MW)

Solar accounted for majority of new projects



Source: Navigant Research

> Ohio is a national leader in wind-related manufacturing, with more facilities producing products for the wind industry than any other state."
>
> — American Wind Energy Association

National Rankings and Key Statistics

Rank	
6th	in energy- and environment-related jobs, 2011 (103,917)
28th	in private investment, 2013 ($87 million)
29th	in new renewable capacity installations, 2013 (29 MW)

Sources: Navigant Research, Bureau of Labor Statistics

Geographic Spotlight

Cleveland: A Clean Energy Hub

Cleveland has worked to become a destination for clean energy projects and companies. The city adopted an advanced energy portfolio standard in 2008, requiring 25 percent of electricity produced by its municipal utility, Cleveland Public Power, to come from renewable or advanced energy sources by 2025 and strongly supported creation of the statewide standard that year.[*] Cleveland has also initiated energy conservation programs in city buildings and vehicle fleets, including requiring the energy efficient Leadership in Energy and Environmental Design (LEED) Silver certification for any newly constructed municipal facilities and efficiency upgrades for some older buildings.[†]

The city offers a variety of incentives to encourage clean energy deployment, including a municipal aggregation program that allows customers to purchase 100 percent of their electricity from clean energy sources.[‡] It also provides a property tax abatement for homes and multifamily buildings constructed according to specified green building requirements.[§]

Cleveland has partnered with local industry on numerous clean energy projects, including a proposed offshore wind project, an onshore wind resource assessment, several solar electricity and water-heating projects, and a biomass project developed by Cleveland-based quasar energy group on the site of a former General Motors factory.[**]

The 1-MW Collinwood BioEnergy facility, which converts sewage and food waste into electricity.

> In tandem with energy efficiency, advanced and renewable energy are vital to the revitalization of Cleveland's economy. The city is becoming a leader in advanced energy generation by collaborating with public, private, and institutional leaders to develop wind, solar, municipal solid waste-to-energy and co-generation capabilities."
>
> — Cleveland Office of Sustainability

* City of Cleveland, "Advanced and Renewable Energy," http://www.city.cleveland.oh.us/CityofCleveland/Home/Government/CityAgencies/OfficeOfSustainability/AdvancedAndRenewableEnergy?_pref34_1132432_34_1122469_1122469.tabstring=Tab1.

† City of Cleveland, Office of Sustainability, http://webapp.cleveland-oh.gov.

‡ City of Cleveland, "Advanced and Renewable Energy."

§ North Carolina State University, Database of Incentives for Renewables and Efficiency, last reviewed April 30, 2012, http://dsireusa.org/incentives/incentive.cfm?Incentive_Code=OH55F&re=0&ee=0.

** City of Cleveland, "Advanced and Renewable Energy."

Wind industry highlights

Ohio's manufacturing industry ranks fifth in the nation for the value of goods it produces ($80 billion) and is the largest sector of the state's economy.[12] The Buckeye State has leveraged this to become the nationwide leader in wind-related manufacturing, with more facilities producing components for the industry than in any other state. The materials produced in Ohio include blades, towers, nacelles (the covers that sit atop the turbine and enclose the machinery), steel, and fiberglass. At the industry's peak, 62 facilities produced wind components in the state,[13] but many manufacturers are now leaving the industry or redirecting investment to other states because policy uncertainty has dampened the local market for their products.[14]

The wind energy sector also presents an export opportunity for Ohio and the United States. U.S. manufacturers have demonstrated leadership in producing high-margin specialty materials such as fiberglass, sensitive electronics, and controls, which are used by other nations in producing finished wind turbines. As a result, U.S. wind-related exports to China in 2011 exceeded U.S. imports of such technologies from that country by $146 million.[15]

Turbine blades produced in the United States are less expensive than those made in China and Germany, according to a 2013 study by the Global Wind Network. In addition, U.S.-made towers and other components are more cost-effective for domestic wind projects, because purchasing these materials from a source near the installation site reduces transportation costs and avoids import tariffs.

However, the United States is not ready to compete in producing the larger, next-generation wind turbines that will be the future of the industry. The Global Wind Network concluded that robust investments are needed to modernize and expand U.S. wind manufacturing capabilities.[16] Ohio could be a hub for future development in the wind energy sector with its coastline on Lake Erie creating opportunities for offshore wind development and for shipping products throughout the Great Lakes region.

Company Spotlight

Molded Fiber Glass Cos.

Headquartered in Ashtabula with locations around the nation,[*] Molded Fiber Glass Cos. produces reinforced plastics and composite materials for the clean energy, automotive, and other industries.[†]

The company's big break came in 1953 when it was selected by Chevrolet to produce the fiberglass for the automaker's innovative Corvette. As part of its efforts to continually diversify its offerings and stay abreast of market trends, the company expanded into the wind industry.[‡] Its products for wind power include blades, structural materials, and other components, which are sold to General Electric Co.[§]

Molded Fiber Glass' Ohio factory once produced spinners for wind turbines but the company has since moved those operations into other states with more favorable clean energy policies and abundant wind resources, such as California and Texas. Should the local market expand again, the company is well-positioned to ramp up its operations in Ashtabula.[**]

[*] Molded Fiber Glass Cos., "10 Strategically Located Factories in North America," http://www.moldedfiberglass.com/locations.

[†] Global Wind Network, "Wind Industry Supply Chain Map," http://maps.glwn.org/default.aspx#. Information available at the Molded Fiber Glass Cos. dot on the map in Ashtabula.

[‡] Heide Aungst, "2014 Business Hall of Fame: Richard Morrison" (November 2014), *Inside Business*, http://ibmag.com/main/Archive/2014_Business_Hall_of_Fame_Richard_Morrison_12706.aspx.

[§] Molded Fiber Glass Cos., "Wind Energy and Renewable Energy Products," http://www.moldedfiberglass.com/markets/wind-and-other-renewable-energy-products.

[**] Carl LaFrance, Molded Fiber Glass Cos., pers. comm., November 25, 1014.

Despite its leadership in wind-related manufacturing, Ohio lags in installed wind capacity. The state has wind resources to support 55 GW of wind power capacity,[17] enough to meet nearly all of the state's current electricity demand.[18] However, it has developed less than 1 percent of this amount, 426 MW—ranking 25th in the nation.[19]

> Wind power is capable of meeting more than 98 percent of [Ohio's] current electricity needs."
>
> — American Wind Energy Association

In 2013, the American Wind Energy Association estimated that of the states that had not yet fulfilled their renewable portfolio standards, Ohio would drive the most wind installations.[20] This is consistent with the state's performance during 2011 and 2012, when it added nearly 416 MW, 97 percent of its total installed wind capacity, according to data from Navigant Research. This rapid growth was largely due to falling material costs nationwide, the rush to complete projects before the expiration of the federal production tax credit, and the demand driven by the state's renewable portfolio standard.[21] By the end of 2012, Ohio had soared to a rank of 13th nationally for new capacity (312.9 MW) and private investment ($563.2 million) in wind.

The following year, however, Ohio installed no new wind projects because of uncertainty created by the legislative debate over the renewable portfolio standard and the expiration of the federal tax credit.[22] Then 2014 brought enactment of the two-year freeze on the standard and another law requiring wind projects to maintain wider setbacks from property lines. The setback requirement could exclude approximately 90 percent of farmland from wind turbine installation,[23] which could cost the state at least $2.5 billion worth of projects that were in progress at the time of enactment.[24] Some industry experts have warned that these two laws will mean the end of new wind development in Ohio.[25]

According to Navigant Research, wind power installations in Ohio attracted $755 million from 2009 to 2013 and are projected to add $1.2 billion between 2014 and 2023. However, this amount could drop if the state fails to reinstate its renewable portfolio standard. Conversely, if Ohio takes the initiative to fully harness its wind resources, it could attract more private capital, create new businesses and jobs, and generate additional demand for its manufacturing capabilities.

Ohio Wind
National rankings and statistics, 2013

Key Statistics	
1st	in wind-related manufacturing facilities (62 have worked in this sector)
12th	in wind-related jobs (over 2,000)
19th	in wind resource potential (54.9 GW)
25th	in total capacity (426 MW)
100,000	homes powered by wind

Sources: American Wind Energy Association, National Renewable Energy Laboratory, Navigant Research

Project Spotlight

Blue Creek: Ohio's Largest Wind Farm

The Blue Creek Wind Farm in western Ohio, constructed in 2012, is the largest in the state. The 304-MW project includes 152 Gamesa wind turbines, the majority of which were manufactured and assembled in the United States. The farm produces enough electricity to serve approximately 76,000 homes and sells this power to FirstEnergy (a large investor-owned utility operating in Ohio and throughout the eastern United States), American Municipal Power (a nonprofit wholesale energy provider in seven states), and Ohio State University in Columbus.

During construction, Blue Creek provided more than 500 jobs, generated $25 million in local economic activity, and involved more than 30 Ohio companies. The project now provides $2 million in annual lease payments to landowners and generates $2.7 million in tax revenue for Van Wert County, where it is the largest taxpayer, and Paulding County.[*] The Crestview Local School District receives $850,000 of this total.[†]

Project developer Iberdrola Renewables, a Spanish energy company with U.S. operations based in Oregon, was attracted by Ohio's clean energy policies. Federal policies also played a major role in this project, as they have for others throughout the United States. The company has indicated that uncertainty over the future of state and federal policies may jeopardize its future investment in Ohio.[‡]

The Blue Creek Wind Farm in Van Wert and Paulding counties.

[*] Iberdrola Renewables, "Blue Creek Wind Farm," http://iberdrolarenewables.us.files.s3.amazonaws.com/pdf/blue-creek-fact-sheet.pdf.

[†] Mark Del Franco, "Wind Farm Exemplifies Why Ohio Policy Matters" (June 2014), *North American Wind Power*, http://www.nawindpower.com/issues/NAW1406/FEAT_02_Wind-Farm-Exemplifies-Why-Ohio-Policy-Matters.html#.

[‡] Iberdrola Renewables, "Landowner News" (2012), 2, http://iberdrolarenewables.us.files.s3.amazonaws.com/pdf/Landowner-News-March2012-final.pdf; and Ibid.

Solar industry highlights

Installed solar capacity in Ohio (100 MW) is roughly one-quarter that of wind power but is increasing rapidly. Installations grew nearly 90 percent and generated $421 million in private investment from 2009 to 2013, and they are expected to increase by 223 percent and generate $935 million between 2014 and 2023.

Until recently, this growth was fueled in part by requirements that 50 percent of the clean electricity needed to fulfill the renewable portfolio standard be generated in-state and that 0.5 percent come from solar energy.[26] However, the 2014 law that froze the standard and eliminated the in-state rule has put downward pressure on the prices of marketable renewable energy certificates—credits that solar project owners sell to utilities that need to fulfill the mandate. This may make financing more difficult, reducing the number of installations in Ohio and even affecting the market in neighboring states.[27]

Ohio's leadership in solar manufacturing is even more notable. The state ranks second in the nation for the number of solar-related manufacturers (86)[28] and is home to several companies producing components for export to China.[29] This industry offers a strong economic opportunity for Ohio and the nation: In 2011, Chinese manufacturers led exports of photovoltaic cells and modules, but the United States maintained a $913 million trade advantage in solar technologies due to its leadership in producing high-tech components.[30]

Ohio Solar
National rankings and statistics, 2013

Key Statistics	
2nd	in solar-related manufacturers (86)
8th	in jobs (3,800)
15th	in homes powered by solar (8,498)
16th	in total capacity (100 MW)
20th	in new capacity (21 MW)
20th	in private investment ($75.3 million)

Sources: Navigant Research, Solar Energy Industries Association, Solar Foundation

Geographic Spotlight

Toledo: 'Solar Valley'

The port city of Toledo has become a hub for manufacturers of solar panels and components because of its long association with the glass industry and strong research institutions.[*] The city was hard-hit by the 2008 recession, with declines in the automotive and construction industries, but has since repurposed some of its workforce and manufacturing facilities to become Ohio's "Solar Valley."[†] Three major solar energy innovators in the region are highlighted below.

The Wright Center for Photovoltaics Innovation and Commercialization

Established in 2007, the Wright Center for Photovoltaics Innovation and Commercialization is a partnership among the University of Toledo, Bowling Green State University, Ohio State University, and a number of businesses—many of which are in the Toledo area. These participants, along with the Ohio Department of Development and federal agencies, contributed a combined $48.6 million to launch the center. It serves as a clearinghouse for research to address technical challenges and market barriers facing the solar photovoltaics industry and to encourage the commercialization of new technologies developed by local researchers.[‡] Over the past eight years, the initiative has secured $32 million in grants and contracts from the U.S. Department of Energy, U.S. Air Force, Ohio Department of Development, and other entities. Research conducted at the laboratory has resulted in 35 inventions, 42 patent applications, and two spinoff companies.[§]

First Solar

First Solar, one of the world's largest solar panel manufacturers and utility-scale project developers, maintains its U.S. manufacturing facility in Perrysburg, a suburb of Toledo.

The plant produces "thin film" solar panels by depositing a layer of cadmium telluride—a light-absorbing crystalline compound—onto glass, resulting in a highly efficient, lightweight system. First Solar recently announced plans to expand its Ohio facility to meet growing demand. The company will add four production lines to manufacture approximately 2 million solar panels annually, enough to provide electricity to 19,600 average Ohio homes. The expansion will add 120 employees to the plant's existing 1,100 workers.[**]

Nextronex Power Systems

Nextronex Power Systems developed a patented solar inverter system, which changes the direct current produced by solar panels to alternating current that can be connected to the grid. The unique configuration of the firm's technology uses multiple inverters that are

Continued on next page

switched on and off as needed to improve electricity generation during low-light conditions, increase efficiency, and enhance product longevity. The company's system produces 4 to 8 percent more electricity than a typical inverter and is especially cost-effective when coupled with batteries to store solar power for later use.[††]

The company has furthered its product development through partnerships with federal agencies and universities. In 2011, Nextronex moved from a private facility in Millbury to the University of Toledo campus to take advantage of the school's energy research and its proximity to a number of companies working in the solar sector.[‡‡] In 2014, the company won a competition to receive technical assistance from NASA to accelerate technology transfer between the government and private sector.[§§]

Nextronex has worked on more than 30 projects around the nation—predominantly in Ohio—for clients that include municipal utilities, industrial facilities, airports, the Ohio Air National Guard, and the U.S. Department of Agriculture. The company's inverter is enabling increased power production at these facilities, resulting in a shorter payback period.[***] One of Nextronex's 2014 projects, the Anthony Wayne Solar Array at the Toledo Zoo, developed by Ohio-based GEM Energy, was named project of the year by *Solar Builder* magazine.[†††]

[*] Ashley Craig et al., *The Solar and Wind Supply Chain in Ohio*, 1 (January 2012), Environmental Law and Policy Center, http://elpc.org/wp-content/uploads/2013/02/OhioWindSupply-0218.pdf.

[†] Chris Bury, "Toledo's Makeover: Glass City to Solar Valley" (Dec. 18, 2008), ABC News, http://abcnews.go.com/Technology/JustOneThing/story?id=6475809.

[‡] University of Toledo, "Wright Center for Photovoltaics Innovation and Commercialization," last updated Sept. 29, 2013, 5, 7, http://www.utoledo.edu/research/pvic/about.html.

[§] Diane Miller, "The University of Toledo Solar Research Update" (March 2013), http://www.utoledo.edu/offices/government_relations/pdfs/UT%20solar%20research%20update%202013.pdf.

[**] Jon Chavez, "First Solar to Add 120 Workers at Perrysburg Twp. Plant," *The Blade*, Nov. 13, 2014, http://www.toledoblade.com/Energy/2014/11/13/First-Solar-to-add-120-employees-at-local-plant.html.

[††] Gene Monteith, "Nextronex Commercializes New Solar Power Conversion System," HiVelocity (Aug. 26, 2010), http://www.hivelocitymedia.com/innovationnews/Nextronex8_26_10.aspx; and Rudy Magasrevy, Nextronex, pers. comm., November 24, 2014.

[‡‡] Sheena Harrison, "Solar Incubator Spreads Wings," *The Blade*, July 3, 2011, http://www.toledoblade.com/Energy/2011/07/03/Solar-incubator-spreads-wings.html.

[§§] Jon Chavez, "NASA's Advice Aimed Toward Area Businesses," *The Blade*, May 24, 2014, http://www.toledoblade.com/business/2014/05/24/NASA-s-advice-aimed-toward-area-businesses.html.

[***] Nextronex, "Project Portfolio" (2013), http://nextronex.com/projects; Nextronex, "Nextronex Inc. Announces USDA Photovoltaic Solar Farm Project" (Oct. 17, 2014), http://nextronex.com/nextronex-inc-announces-usda-photovoltaic-solar-farm-project; and Rudy Magasrevy, Nextronex, pers. comm.

[†††] Nextronex, "November 2014 Nextronex News" (Nov. 21, 2014); and Kelly Pickerel, "2014 Ground-Mount Project of the Year Winner: Anthony Wayne Solar Array" (Oct. 21, 2014), http://solarbuildermag.com/featured/2014-ground-mount-project-year-winner-anthony-wayne-solar-array.

Industrial energy efficiency highlights

Ohio's substantial manufacturing activity comes at a price: Its industrial energy use is larger than that of any other end-use category in the state (one-third of the total) and is the sixth-greatest in the nation.[31] Ohio manufacturers can save money and reduce their energy consumption by using technologies such as combined heat and power, which simultaneously generates electricity and heat from a single fuel source; and waste heat to power, which captures wasted heat from an industrial process—which otherwise would be vented—and uses it to generate electricity. Compared with traditional central-station power generation, these efficient systems can cut fuel use by nearly half.[32]

Ohio has the greatest potential for industrial energy efficiency of any state in the Midwest (nearly 6 gigawatts)[33] and has installed 514 MW of power generation capacity using this technology.[34] Installations of combined heat and power in the industrial sector alone generated $97 million in private investment from 2009 to 2013 and such facilities are expected to provide an additional $585 million between 2014 and 2023, according to Navigant Research.

When designed with a switch allowing the facility to operate independent of the local grid, combined heat and power systems increase a facility's resilience and keep the lights on during power disruptions. This additional benefit is important because for the past three years, Ohio has ranked seventh nationally in the number of reported power outages.[35] A 2003 transmission line failure in the state also precipitated the largest blackout ever in North America.[36]

A variety of state and federal policies encourage the deployment of combined heat and power and waste heat to power. A state law, passed in 2012, made both technologies eligible for complying with the "advanced energy" requirement of Ohio's advanced energy portfolio standard, an initiative that has since been frozen.[37] Combined heat and power is also eligible for a state sales tax exemption[38] and a federal investment tax credit.[39] However, the federal credit is relatively small compared with credits for other energy-generating technologies and there are limitations to the size of eligible systems that exclude many projects.[40] Industrial energy efficiency technologies are also not eligible for the state's net metering program, adding to the challenge some facilities have in making these projects economically feasible.[41]

Likewise, several state policies have created barriers to the expansion of industrial energy efficiency in Ohio. Customers who generate significant electricity on site and rely on the utility for backup power are often required to pay hefty standby rates, which are fees for connection to the grid and other services,[42] while others seeking to implement new generating projects have faced long lead times for permitting and additional utility fees.[43] Removing obstacles to the use of industrial energy efficiency technologies would create additional market opportunities in Ohio.

Ohio Industrial Energy Efficiency

National rankings and statistics, 2013

Key Statistics	
6th	in new capacity (7.5 MW)
6th	in private investment ($11.3 million)
27th	in total capacity (514 MW)
53	projects statewide

Sources: Navigant Research, U.S. Department of Energy state combined heat and power data

The Blue Creek Wind Farm in Van Wert and Paulding counties.

Company Spotlights

Harnessing Heat to Generate Business Opportunities

The waste heat to power market is expected to grow globally to $53 billion by 2018.[*] Ohio is poised to capitalize on this opportunity because it is home to companies innovating and manufacturing this technology.

Echogen Power Systems

Akron-based Echogen Power Systems pioneered the development of a patented waste heat to power system that uses supercritical carbon dioxide (a liquid with a boiling point lower than water's) to capture heat and turn it into electricity. This design increases the range of temperatures and pressures beyond what is typical for other waste heat to power systems and reduces cost and size.[†]

The company got its start by licensing a NASA technology and modifying it to create a heat recovery engine. Echogen completed an early prototype in 2007 and, four years later, secured a partnership with turbo machinery giant Dresser-Rand to perfect and market the product.[‡] The firm's most recent commercial offering allows 8-MW units to be scalable for projects up to 50 MW by linking them together.[§]

To broaden its reach, Echogen is branching out into additional promising sectors that could benefit from capturing otherwise-wasted heat. It received a U.S. Department of Energy grant to apply its innovative technology to improve the efficiency of solar power. Similarly, the company is working with the Lawrence Berkeley National Laboratory and partners in Texas to develop geothermal energy applications. In 2011, it received funding from the U.S. Navy's Small Business Innovation Research program to use its technology to improve the efficiency of marine vessel engines, which led to a partnership with General Electric Marine two years later.[**]

WHE Generation

WHE Generation Corp., based in Lancaster, produces a waste heat to power engine that captures unused heat from industrial exhaust, methane or natural gas flares, and other sources to generate steam for electricity generation. The high-efficiency engine is geared toward applications under 250 kilowatts.[††] WHE Generation partnered with Ohio State University's Center for Automotive Research to perfect its technology[‡‡]—which is compatible with nearly any initial fuel source and was recognized by *Popular Science* magazine as its invention of the year in 2008.[§§] The company intends to begin mass production in Ohio in 2015.[***]

WHE Generation has had a promising entry into the market, with its initial stock offering closing at $1.8 million[†††] and purchase orders for its engine topping $1 million even before commercial release.[‡‡‡] One of its earliest market applications is an initial agreement to provide 6,500

Continued on next page

engines to Phoenix Power Group to create electricity from the combustion of waste motor oil collected at car dealerships and oil change shops.[§§§] Over the next five years, the company anticipates installing 100 MW of its technology and creating approximately 85 jobs in the Lancaster region.[****]

Waste heat to power system produced by Echogen Power Systems.

WHE Generation's waste heat to power engine.

[*] ReportsnReports.com, "Waste Heat Recovery Market by Application (Pre-Heating, Steam Generation, Electricity & Others), and Industry (Petroleum Refining, Heavy Metal, Cement, Chemical, Natural Gas Compression, Pulp/Paper Industry & Others)" (April 2014), http://www.reportsnreports.com/reports/280777-waste-heat-recovery-market-by-application-pre-heating-steam-generation-electricity-others-and-industry-petroleum-refining-heavy-metal-cement-chemical-natural-gas-compression-pulp-paper-industry-others-global-trends-forecast-to-2018.html.

[†] Alex Kacludis, "Supercritical CO2 Refines Cogeneration," *Cogeneration and On-Site Power Production* (Jan. 1, 2013), http://www.cospp.com/articles/print/volume-14/issue-01/features/supercritical-co2-refines-cogeneration.html.

[‡] Echogen Power Systems, "Our Story" (2014), http://www.echogen.com/about/our-story.

[§] *Renewable Energy From Waste*, "Dresser-Rand Demonstrates New Waste Heat Recovery System" (Oct. 1, 2014), http://www.rewmag.com/dress-rand-echogen-meeting.aspx; and Ibid.

[**] Echogen Power Systems, "Applications" (2014), http://www.echogen.com/our-solution/applications.

[††] WHE Generation Corp., "Overview," http://whegeneration.com/#overview.

[‡‡] Cyclone Power Technologies, "Cyclone Power Technologies Completes Build of Next Generation Waste Heat Engine With the Ohio State University's Center for Automotive Research" (Nov. 5, 2013), http://www.cyclonepower.com/2013/Press_Release_Cyclone_OSU-CAR_Engine_Build_11-4-13.pdf.

[§§] Cyclone Power Technologies, "Cyclone Power Technologies Receives $175,000 License Fee From Its Waste-Heat-to-Power License" (Oct. 21, 2014), http://www.cyclonepower.com/2014/Cyclone%20Press%20Release_License_fee10-21-2014.pdf.

[***] Cyclone Power Technologies, "Cyclone Signs Phase Two Commercialization Agreement for Its Waste Heat Engine With the Ohio State University's Center for Automotive Research" (March 12, 2014), http://www.cyclonepower.com/2014/Press_Release_Cyclone_OSU-CAR_Phase_Two_Agreement_3-12-14.pdf.

Continued on next page

[†††] Cyclone Power Technologies, "Cyclone Power Technologies' Waste Heat Subsidiary Completes $1.3 Million Round of Funding" (Oct. 7, 2014), http://www.cyclonepower.com/2014/Cyclone%20Press%20Release_A_Round_Closing_9-30-14.pdf; and Christopher Nelson, WHE Generation Corp., pers. comm., December 1, 2014.

[‡‡‡] Cyclone Power Technologies, "Cyclone Power Technologies Receives $175,000 License Fee."

[§§§] Cyclone Power Technologies, "Cyclone and Phoenix Power Group Sign Collaborative Agreement to Support Production of Waste Heat Engine" (March 18, 2014), http://www.cyclonepower.com/2014/Press_Release_Cyclone_PPG_3-18-14.pdf.

[****] Christopher Nelson, WHE Generation, pers. comm.

Project Spotlight

Combined Heat and Power Fuels an Ohio Manufacturer

When the Richard H. Gorsuch power plant near Marietta closed in 2010, Solvay Specialty Polymers USA LLC, a local plastics manufacturer, lost its source for steam generation and needed to find a new long-term replacement.

The solution came in the form of an 8-MW combined heat and power plant built in December 2014 by DTE Energy Co.'s facility in Marietta. The plant produces steam and electricity for Solvay at an 80 percent operating efficiency. Natural gas powers a turbine, and waste heat and gases otherwise lost are captured to make steam for Solvay's plastics manufacturing. The combined heat and power project also provides electricity to the manufacturing plant, helping reduce the load on the electrical grid and improving the reliability of Solvay's power supply.

The project also benefits the community. Approximately 75 percent of contractors working on the construction were local, and the plant is expected to employ 11 full-time workers.[*]

[*] Amanda Nicholson, "New Cogeneration Plant Nearing Completion Date," *Marietta Times*, Sept. 5, 2014, http://www.newsandsentinel.com/page/content.detail/id/595669/New-cogeneration-plant-nearing-completion-date.html?nav=5054.

Solar project at the community center in Athens, constructed by Dovetail Solar and Wind, one of the oldest and largest renewable energy firms in Ohio.

Emerging opportunities

Ohio was one of the first states to allow local communities to pool residents together and purchase electricity or natural gas at a lower price. Cincinnati was the first major U.S. city to pursue 100 percent renewable energy this way—and secured a two-year contract that will save 53,000 customers an estimated $133 a year.[44] Officials in the capital, Columbus, are considering a similar approach,[45] and more cities are expected to use it.

In addition to wind, solar, and industrial energy efficiency, other clean energy sectors also have the potential to emerge in Ohio.

The state is home to several energy storage projects to collect excess energy when the sun is shining or the wind is blowing and later release electricity into the grid. Researchers at Case Western Reserve University's Great Lakes Energy Institute are developing storage technologies such as batteries and fuel cells.[46] Several of these projects have received grants from the U.S. Department of Energy's Advanced Research Project Agency-Energy.[47] Local companies are also working on pilot projects in communities across Ohio. One is being developed by Ashlawn Energy with the assistance of a $4.2 million grant from DOE and will be completed at a power plant in Painesville by 2015.[48]

Clean Fuels Ohio, a nonprofit organization that has received DOE funding, and investments by the state's Local Government Innovation Fund have also helped localities with clean and efficient transportation solutions.[49] Projects include installing infrastructure for electric vehicle charging, providing refueling stations for biofuel- and natural gas-powered automobiles, and improving vehicle efficiency. These efforts saved Ohio consumers 11.9 million gallons of petroleum in 2013.[50]

These are only a handful of the ways Ohio researchers and communities are transforming the state's energy infrastructure.

Conclusion

State and federal policies have spurred the growth of Ohio's clean energy installations, businesses, private investment, and manufacturing opportunities in recent years. However, an uncertain policy future—including a freeze on the state's renewable portfolio standard and expiration of federal tax incentives—is jeopardizing Ohio's leadership in the clean energy sector. Decisions by government leaders over the next few years will write the story of the state's ability to compete in the growing global clean energy economy.

Acknowledgments

This policy brief is one of a collection examining state clean energy economies. The states selected have demonstrated leadership in clean energy policies, installations, and economies, or are at a crossroads in their energy futures. The brief was prepared by The Pew Charitable Trusts' clean energy initiative, with Lynn Abramson as lead author. This research was funded in part by The 11th Hour Project.

Unless otherwise specified, data on capacity additions and investment were provided by Navigant Research, an energy market research firm, and include solar photovoltaics, industrial sector combined heat and power, geothermal power (excluding heat pumps), biomass power (excluding landfill-gas, anaerobic digesters, and biogas recovery), hydropower projects, permanently installed (not pilot) marine and hydrokinetic projects, and wind projects greater than 1 MW.

The Clean Energy Business Network

Pew's Clean Energy Business Network seeks to inform and engage clean energy business leaders in policy issues affecting the industry. For more information or to sign up for this free resource, visit pewtrusts.org/businessnetwork.

Endnotes

1 North Carolina State University, Database of State Incentives for Renewables and Efficiency, "Ohio Incentives/Policies for Renewables and Efficiency," last modified 2014, http://www.dsireusa.org/incentives/index.cfm?re=0&ee=0&spv=0&st=0&srp=1&state=OH.

2 Maria Gallucci, "Ohio Gov. Kasich to Sign 'Freeze' on State Clean Energy Mandate by Saturday," *International Business Times*, June 11, 2013, http://www.ibtimes.com/ohio-gov-kasich-sign-freeze-state-clean-energy-mandate-saturday-1598602.

3 Tom Knox, "51 Businesses, 21 Organizations in Letter to Kasich: S.B. 310 Will be Harmful to Ohioans' Electric Bills, Burgeoning Renewable Energy Industries" (January 4, 2014), *Columbia Business First*, http://www.bizjournals.com/columbus/news/2014/06/04/51-businesses-21-organizations-in-letter-to-kasich.html.

4 Ankit Saraf and Steve Fine, "Ohio Modifies Alternative Energy Portfolio Standard, Freezes Renewable Energy Standard for Two Years," ICF International (2014); and North Carolina State University, Database of State Incentives for Renewables and Efficiency, "Ohio Incentives/Policies."

5 North Carolina State University, Database of State Incentives for Renewables and Efficiency, "Net Metering," last modified November 18, 2014, http://dsireusa.org/incentives/incentive.cfm?Incentive_Code=OH02R&re=0&ee=0.

6 Ohio Development Services Agency, "Business Services," http://development.ohio.gov/businessservices.htm.

7 USASpending.gov, "Prime Award Spending Data," accessed March 11, 2014, http://www.usaspending.gov/search?form_fields=%7b%22recip_state%22:null,%22recip_congdist%22:null,%22recip_country%22:null,%22cfda_num%22:%5b%2281.087%22%5d,%22fyear%22:%5b%222013%22,%222012%22,%222011%22,%222010%22,%222009%22,%222008%22,%222007%22,%222006%22,%222005%22,%222004%22%5d%7d. Based on Ohio's share of funding from the U.S. Energy Department's Office of Energy Efficiency and Renewable Energy and the Advanced Research Projects Agency-Energy, fiscal years 2004–13.

8 Energy Information Administration, "Ohio: State Profile and Energy Estimates" (Dec. 18, 2013), http://www.eia.gov/state/analysis.cfm?sid=OH.

9 Ibid.

10 Union of Concerned Scientists, "Ohio's Dependence on Foreign Coal" (2014), http://www.ucsusa.org/sites/default/files/legacy/assets/documents/clean_energy/Ohio-Coal-Imports-BCBC-Update-2014.pdf.

11 Energy Information Administration, "Ohio Renewable Electricity Profile 2010" (March 8, 2012), Table 3: State Renewable Electric Power Industry Net Summer Capacity, by Energy Source, 2006–10 (MW), http://www.eia.gov/renewable/state/ohio. Data from 2008 were combined with capacity additions from Navigant Research, as explained in the second figure, "Clean Energy Capacity, by Sector and Year," in this brief.

12 Ohio Manufacturers' Association, *Ohio Manufacturing Counts: Facts About Ohio Manufacturing* (2012), http://www.themanufacturinginstitute.org/~/media/C4E028A38BE24F5E902CF696F9956C4C/Ohio_Manufacturing_Counts.pdf.

13 American Wind Energy Association, "Ohio Wind Energy" (April 25, 2014), http://www.awea.org/Resources/state.aspx?ItemNumber=5395.

14 Ed Weston, Global Wind Network, pers. comm., December 9, 2014; and Carl LaFrance, Molded Fiber Glass Cos., pers. comm., November 25, 2014.

15 The Pew Charitable Trusts, *Advantage America: The U.S.-China Clean Energy Technology Trade Relationship in 2011*, 20 (2013), http://www.pewtrusts.org/~/media/legacy/uploadedfiles/peg/publications/report/USChinaReportFINALpdf.pdf.

16 Global Wind Network, "U.S. Energy Manufacturing and Supply Chain: A Competitiveness Analysis" (June 15, 2014), http://www.glwn.org/USWindCompetitiveness.pdf.

17 National Renewable Energy Laboratory, "Estimates of Windy Land Area and Wind Energy Potential, by State, for Areas ≥ 30%: Capacity Factor at 80 m," last updated April 13, 2011, http://apps2.eere.energy.gov/wind/windexchange/docs/wind_potential_80m_30percent.xls.

18 American Wind Energy Association, "Ohio Wind Energy."

19 Ibid. Installed capacity reported by source adjusted downward slightly based on Navigant Research data.

20 American Wind Energy Association, "AWEA State RPS Market Assessment 2013," http://www.awea.org/Resources/Content.aspx?ItemNumber=5669.

21 U.S. Department of Energy, "Revolution Now: The Future Arrives for Four Clean Energy Technologies" (Sept. 17, 2013), http://energy.gov/sites/prod/files/2013/09/f2/200130917-revolution-now.pdf.

22 According to data provided by Navigant Research. Data from the American Wind Energy Association show a very small amount (3.4 MW) of wind project installations in 2013; the difference is due to slight variations in when a project is considered to be installed.

23 Mark Shanahan, "Remember in November: John Kasich and Energy" (Oct. 10, 2014), Plunderbund, http://www.plunderbund.com/2014/10/10/remember-in-november-john-kasich-and-energy.

24 North American Windpower, "Ohio Gov. Kasich Green-Lights Tougher Wind Turbine Setbacks" (June 17, 2014), http://www.nawindpower.com/e107_plugins/content/content.php?content.13090.

25 Kathiann M. Kowalski, "Setback Changes Will End New Wind Farms in Ohio," Greentech Media (June 24, 2014), http://www.greentechmedia.com/articles/read/Setback-Changes-Will-End-New-Wind-Farms-in-Ohio.

26 Solar Energy Industries Association, "Ohio Solar," http://www.seia.org/state-solar-policy/ohio.

27 Sara Rafalson, "Chill From Ohio RPS Freeze Extends to Neighboring Solar Markets," Renewable Energy World, (Aug. 8, 2014), http://www.renewableenergyworld.com/rea/blog/post/2014/08/ohio-rps-freeze-causing-a-chill-in-more-than-just-the-ohio-srec-market.

28 Solar Energy Industries Association, "Ohio Solar."

29 Ashley Craig, Howard Learner, and Peter Gray, "The Solar and Wind Supply Chain in Ohio" (January 2012), Environmental Law and Policy Center, 8–9, http://elpc.org/wp-content/uploads/2013/02/OhioWindSupply-0218.pdf.

30 The Pew Charitable Trusts, *Advantage America*, 15.

31 Energy Information Administration, "Table C10: Energy Consumption by End-Use Sector, Ranked by State, 2012," http://www.eia.gov/state/seds/sep_sum/html/pdf/rank_use.pdf.

32 Oak Ridge National Laboratory, *Combined Heat and Power: Effective Energy Solutions for a Sustainable Future* (Dec. 1, 2008), 5–6, http://www.energy.gov/sites/prod/files/2013/11/f4/chp_report_12-08.pdf.

33 Midwestern Governors Association, *Midwestern Energy Opportunities Report: Low-Cost Energy in the Midwest*, 10, http://www.midwesterngovernors.org/2012Chair/Energy/EnergyActionPaper.pdf.

34 U.S. Department of Energy, "Combined Heat and Power Installation Database," http://www.eea-inc.com/chpdata.

35 Eaton, "Blackout Tracker: United States Annual Report 2013," http://powerquality.eaton.com/ppdn/LeadGenHandler.aspx?originalPath=%2fLG%2fBlackout-US.aspx.

36 Energy Information Administration, "Ohio: State Profile and Energy Estimates."

37 Amanda Woodrum and Randy Schutt, "Capturing Energy Waste in Ohio: Using Combined Heat and Power to Upgrade Electric System," Policy Matters Ohio (March 2012), 10, http://www.policymattersohio.org/wp-content/uploads/2012/03/OhioCHP_March2012.pdf.

38 American Council for an Energy-Efficient Economy, "State and Local Policy Database," updated October 2014, http://database.aceee.org/state/ohio.

39 North Carolina State University, Database of State Incentives for Renewables and Efficiency, "Business Energy Investment Tax Credit" (March 13, 2014), http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=US02F.

40 The Pew Charitable Trusts, "Harness the Heat to Save Money, Improve Competitiveness and Resiliency" (January 2014), http://www.pewtrusts.org/~/media/legacy/uploadedfiles/IndustrialEfficiencyFactSheetJan2014pdf.pdf.

41 American Council for an Energy-Efficient Economy, "State and Local Policy Database."

42 James Selecky, Kathryn Iverson, and Ali Al-Jabir, *Standby Rates for Combined Heat and Power Systems: Economic Analysis and Recommendations for Five States*, Brubaker & Associates Inc. and the Regulatory Assistance Project, 29–34, http://www.consultbai.com/images/stories/News/standbyrates_256206.pdf.

43 Anna Chittum and Nate Kaufman, *Challenges Facing Combined Heat and Power Today: A State-by-State Assessment* (Sept. 28, 2011), American Council for an Energy-Efficient Economy, 61, http://www.aceee.org/research-report/ie111.

44 Kari Lydersen, "Municipal Aggregation: A New Direction or the Same Old Thing?" (Dec. 12, 2012), Midwest Energy News, http://www.midwestenergynews.com/2012/12/17/municipal-aggregation-a-new-direction-or-the-same-old-thing.

45 Dan Gearino, "Columbus May Seek Energy Deal for Residents," The Columbus Dispatch, May 15, 2014, http://www.dispatch.com/content/stories/ business/2014/05/15/columbus-may-seek-energy-deal-for-residents.html.

46 Case Western Reserve University, "Great Lakes Energy Institute: Storage and Conversion" (2014), http://energy.case.edu/research/storage-conversion2.

47 Advanced Research Projects Agency-Energy, "Projects," http://arpa-e.energy.gov/?q=projects%2Fsearch-projects&field_program_tid=All&field_project_state_value=OH&term_node_tid_depth=All&=Apply+Filter.

48 Bill Hagstrand, "Vanadium Redox: Powering Up Local Communities," *Crain's Cleveland Business,* Aug. 23, 2013, http://www.crainscleveland.com/article/20130823/BLOGS05/308239999/-1/BLOGS.

49 Clean Fuels Ohio, "Incentives for Alternative Fuel Vehicles and Technologies," http://www.cleanfuelsohio.org/fleet-solutions/incentives.

50 Clean Fuels Ohio, "Clean Cities Hits Major Petroleum-Reduction Milestone" (Oct. 21, 2014), http://www.cleanfuelsohio.org/news-room/posts/clean-cities-billion-gallons.

For further information, please visit:

pewtrusts.org/cleanenergy

Contact: Lynn Abramson, senior associate, clean energy
Email: labramson@pewtrusts.org
Phone: 202-540-6474