



## Ohio Coal Development Agenda for Fiscal Years 2014–2016

**Ohio**

**Development  
Services Agency**

**John R. Kasich**, Governor

**David Goodman**, Director

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A coal barge travels the Ohio River

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# IMPACT OF COAL IN OHIO



**IN THE NATION FOR  
TOTAL PRODUCTION OF COAL**  
**17.2** MILLION TONS OF COAL PRODUCED  
 A REDUCTION OF 31% SINCE 2013

Source: reference 1



**23.3** BILLION TONS OF COAL  
REMAIN WITHIN ALL OF OHIO

**2013**

**5.8** BILLION TONS  
IN LOWER FREEPORT

**4.5** BILLION TONS  
IN PITTSBURGH

Source: reference 2



**2,783**  
TOTAL EMPLOYEES



**2,163**  
EMPLOYEES  
IN PRODUCTION

**2014**



**\$70,000**  
AVERAGE PRODUCTION  
SALARY

Coal is a dependable and affordable energy source.

Prices have remained stable and remain vital to ensure low-cost electricity is available to Ohio's commercial, residential, manufacturing and agriculture sectors.

Source: reference 3

Ohio still maintains the **3rd largest operable fleet of coal-fired electricity generation units** in the U.S. with a combined net summer capacity of 15,428 megawatts.

Source: reference 4



**COAL SOLD 2014**

**\$1.1 BILLION**  
TOTAL VALUE

**\$49.14** PER TON  
AVERAGE

Source: reference 5



**13.4**  
MILLION TONS  
OF OHIO COAL CONSUMED IN 2015  
BY ELECTRIC GENERATION UNITS



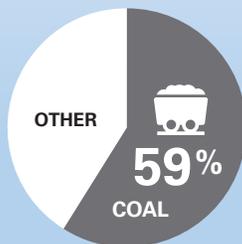
**42.4%**  
OF COAL CONSUMED FOR  
ELECTRIC GENERATION IN  
OHIO WAS PRODUCED IN OHIO

Source: reference 6



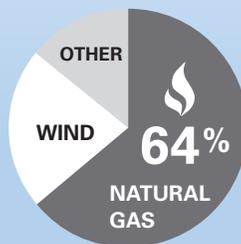
**19%**  
FORECAST U.S. COAL  
PRODUCTION DECREASE IN 2016

Source: reference 7



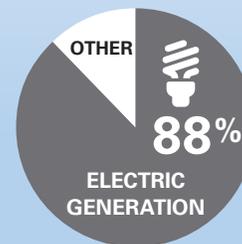
Electricity generation fuel sources in Ohio in 2015, down from 92% in 2003

Source: reference 8



Newly installed Ohio electric generator capacity in the last 10 years, 0% from coal

Source: reference 9



Coal consumption in Ohio end use



A coal train crosses the Flats Viaduct in Cleveland and passes under the Innerbelt Bridge spans



## Purpose

The Ohio Coal Development Office was established in 1984 to address the environmental impediments to Ohio coal utilization. The office provides support for research projects that address the short-term and long-term needs of the Ohio coal industry. Research and Development projects supported by the office will develop technology that will utilize Ohio coal in an environmentally sound manner, which will:

- help meet new and existing federal regulations;
- allow fuel and electricity prices to remain low and stable; and
- ensure that infrastructure and investments are not stranded and retired early, helping to ensure that Ohio's electric generation fleet remains diversified.

Governor John Kasich, working with energy stakeholders — from energy producers to environmentalists to energy consumers, developed a comprehensive energy policy for Ohio. One of the 10 pillars specifically addresses coal. It says:

“Ohio is rich with coal, and it’s a critical resource for our state’s energy needs. However, it’s important that we pursue new technologies that reduce coal’s impact on the environment.”

Established under Section 1551.35 of the Ohio Revised Code, the Ohio Coal Technical Advisory Committee is a 13-member group that reviews and makes recommendations concerning Ohio coal research and development project proposals, governance matters, and other topics related to Ohio coal development. Eight of the members are appointed by and serve indefinitely at the pleasure of the Director of the Ohio Development Services Agency, four members are appointed by the General Assembly, serving for the duration of the term in office and one ex officio member is from the Ohio Environmental Protection Agency.

### The current members of the Ohio Coal Technical Advisory Committee are:

- **Babe Erdos**, United Mine Workers of America
- **Commissioner Lynn Slaby**, Public Utilities Commission of Ohio
- **James J. Reuther**, Former Battelle employee, Non-university Research and Development
- **Timothy Riordan**, American Electric Power, Electric Utilities
- **Joseph Shields**, Ohio University, State University Research and Development
- **Michael Carey**, Murray Energy Corporation, Coal Production Company
- **Vacant**, Environmental organization
- **Representative Al Landis**, Ohio House of Representatives
- **Representative Jack Cera**, Ohio House of Representatives
- **Craig Butler**, Director, Ohio EPA, Ex-Officio
- **Senator Lou Gentile**, Ohio Senate
- **Senator Troy Balderson**, Ohio Senate
- **Vacant**, Manufacturers that use Ohio coal

## Programs

Article VIII, Section 15 of the Ohio Constitution authorizes the state to issue bonds and other obligations to support coal research and industry development. Additionally, the state may take an equity position and accept royalty payments for funded technology that reaches commercialization.

Funding priority is given to projects that provide:

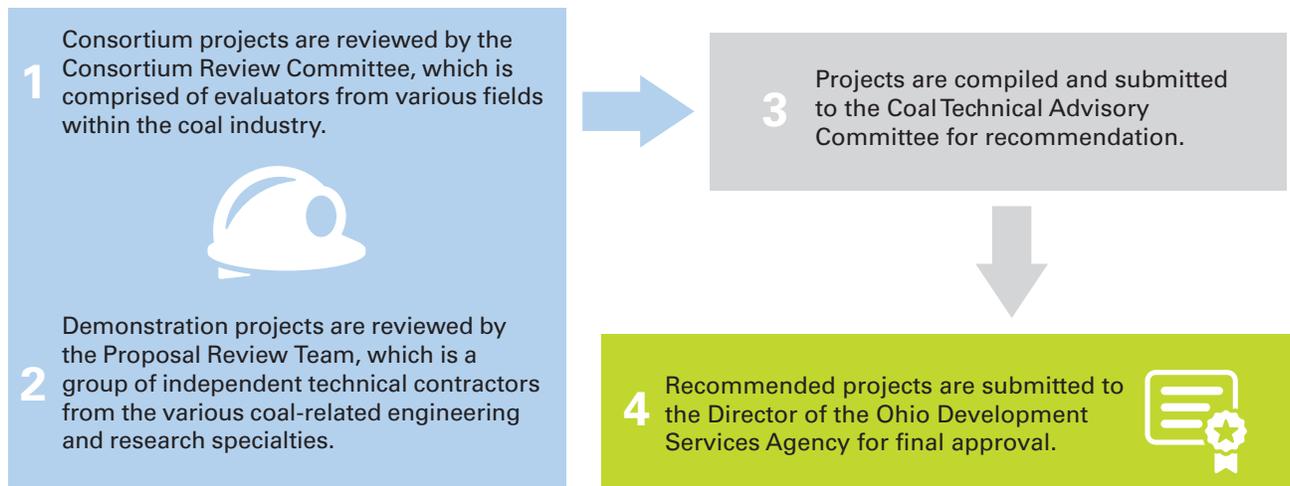
- Improvements or reconstruction of existing facilities and equipment;
- Construction and operation of commercial-scale clean coal demonstration facilities; and
- Technologies, equipment and other techniques that maximize the use of Ohio coal in an environmentally acceptable and cost-effective manner.

The Ohio Coal Development Office encumbered more than \$37 million through the Ohio Coal Research and Development Program during Fiscal Years 2014–2016, \$25 million of which was encumbered between Fiscal Years 2015–2016. This program provides funding for research and development of technology that results in the maximum conversion or use of Ohio coal as a fuel or chemical feedstock in a cost-effective manner. Projects in the program are divided into two initiatives, the Coal Demonstration and Pilot grants and the Coal Research Consortium grants.

For both initiatives, projects are received through a Request for Proposal process. Once projects are received, they are reviewed by a third party evaluator. Qualified proposals are submitted to the Ohio Coal Technical Advisory Committee for recommendation. The Ohio Coal Technical Advisory Committee then recommends projects for funding to the Ohio Development Services Agency Director.

Ohio Coal Demonstration and Pilot Program provides grants to utility power producers, clean coal technology developers, research and development firms and universities for the discovery and implementation of new technologies. Funding can be applied toward research or the demonstration of technologies that enable better, more cost-effective utilization of Ohio coal under current and anticipated environmental regulations.

Ohio Coal Research Consortium provides grants to Ohio colleges and universities to study mechanisms critical to emission formation and methods of control. Additionally, funding can be used for researching feasible uses of coal as a chemical feedstock or for other purposes.



## Market Opportunities and Constraints

As environmental regulations place constraints on the use of Ohio coal, new technologies are being deployed to reduce the environmental impact of coal.

The U.S. Environmental Protection Agency’s carbon emission standards for new, modified and reconstructed power plants were finalized and existing plants’ standards were stayed by the U.S. Supreme Court. However, current carbon regulations for electric generation, along with low-priced natural gas are impacting coal consumption, and halting new construction of coal-fired generation units without carbon capture technologies. This leads to early unit retirements and fuel switching for existing coal fleets.

In 2014, the U.S. generated 34 percent more electricity than it did in 1990, but with 77 percent less tons of sulfur dioxide, and 73 percent less tons of nitrous oxide being emitted.<sup>10</sup> These declines in emissions are due in part to an increasing number of coal-fired units with retrofitted flu-gas desulfurization units or scrubbers, and the increased installation of selective catalytic reduction units, or low nitrous oxide burners.<sup>11</sup> Regulations like the U.S. EPA’s Mercury and Air Toxics Standards has led to units in Ohio and nearby states that burn Ohio coal to be shut down or announce plans to shut down operations. Between 2013 and 2015, 19 percent of Ohio’s net summer coal capacity was retired.<sup>12</sup>

The Ohio Coal Development Office continues to invest in innovative technologies that will balance today’s energy needs with economic and environmental health. Investments through the office focus on technologies that provide affordable solutions to capturing and reducing pollutants, so that power plants can operate longer, and electricity can be less expensive, more diversified and more stable.



## New Technology for Ohio Coal

The Ohio Coal Development Office invests in technology to create new markets for Ohio coal (Graphene production), cost-effectively capture carbon dioxide (Membrane technologies), reduce emissions from coal-fired generation (Advanced Ultra-Super Critical), generate electricity that separates out carbon dioxide for storage (Chemical Looping), and addresses CO<sub>2</sub> storage options. The time scale for these outcomes varies and is vulnerable to market changes. However, the long-term goal of the office is the commercialization of these technologies and adoption of these technologies by the market.

The Ohio Coal Development Office works to ensure Ohio coal continues to be utilized as a low-cost fuel source or as a chemical feedstock for materials production. The following are some projects in which the office invested.

## Advanced Materials

Energy Industries of Ohio has recently completed two coal projects that qualified and demonstrated for use, welding, fabrication, and nickel-based super alloys for Advanced Ultra-Super Critical (A-USC) power plant conditions. A-USC power plants require new materials that can operate at high temperatures and pressures to increase efficiency and reduce CO<sub>2</sub> emissions. The project has conducted tests at the world's first high temperature (1,400 degrees Fahrenheit) steam-cooled fireside corrosion test loop and obtained American Society of Mechanical Engineers (ASME) code approval. This means U.S. manufacturers now have access to an alloy with the requisite strength needed for next generation power plants. An Ohio-based manufacturing cluster was developed under the program for producing components for these new materials. Many Ohio resources, such as the Edison Welding Institute, were used on the project. The final development phase of "live fire" component testing will include front end engineering design work along with the detailed design phase, where cost estimates for component fabrication and construction will be finalized. Site preparation needs and facility enhancements will be determined along with infrastructure upgrades provide jobs for Ohio's manufacturing base. The OCDO leveraged its funds for cost share with the U.S. Department of Energy's National Energy Technology Laboratory and an industrial consortium that included Babcock & Wilcox, the Electric Power Research Institute, General Electric, Babcock Riley, Foster Wheeler, Siemens, and Alstom Power. The current project includes many of these firms along with AECOM, Thermal Engineering Group, and Youngstown Thermal.



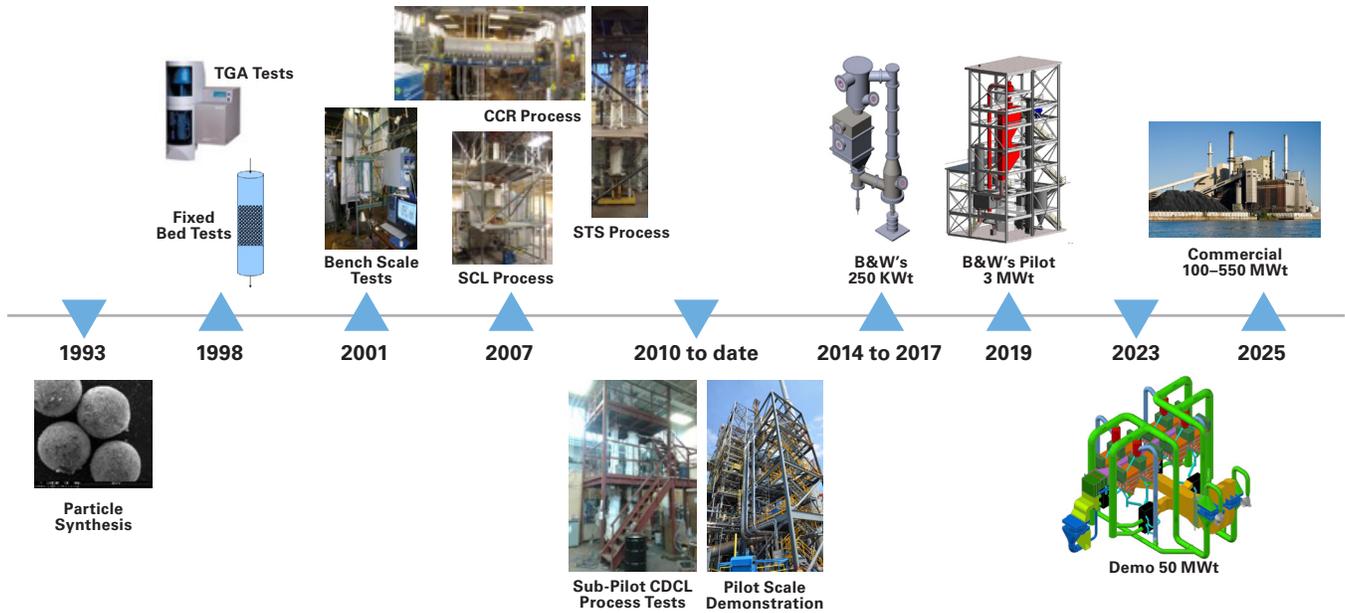
*Plant Barry steam-cooled fireside corrosion test loop*

## Membrane for CO<sub>2</sub> Capture

The Ohio State University (OSU) has been developing a prototype membrane for a cost-effective process to capture CO<sub>2</sub> from flue gas in coal-fired power plants. This technology is much cheaper and uses much less energy to capture CO<sub>2</sub> than the current state-of-the-art technology. This project will fabricate the prototype membrane, conduct a techno-economic analysis and design and construct and test the membrane at a pilot-scale unit. OSU will be teaming up with American Electric Power to construct the pilot unit and conduct these tests. Cost reductions for CO<sub>2</sub> capture are needed now more than ever for coal to be a competitive source for electricity generation in the face of federal CO<sub>2</sub> emission standards.



*Cooling towers at an Ohio coal-fired electric generating facility*



### Advanced Power Generation

The Babcock & Wilcox Company (B&W) and The Ohio State University (OSU) have been developing the chemical looping process for electric power generation with CO<sub>2</sub> capture for numerous years. Chemical looping is an advanced oxy-combustion process that utilizes an iron-based oxygen carrier to supply the oxidant to combust coal. Since no air is used during the combustion of coal, the chemical looping process produces a pure stream of CO<sub>2</sub> that can be compressed for permanent storage or used for enhanced oil recovery or for other beneficial purposes. The chemical looping technology holds the promise of lower costs and higher efficiencies when compared to other oxy-combustion processes. The new project will test Ohio coals in B&W's pilot facility to close additional technology gaps and bring this technology closer to commercialization. This technology promotes coal usage both for power and conversion to chemicals and liquid fuels. This technology shows promise to produce electricity with low-cost CO<sub>2</sub> capture and Ohio has the potential to become a national leader in this technology for energy and chemicals production.



Emission reduction facilities at an Ohio coal-fired electric generating facility



### Conversion of Ohio Coal to a High Value Product

Graphene continues to emerge as a most promising nano-material, which opens the way for its exploitation in a wide spectrum of applications, with uses for many Ohio industries. Currently, graphene is being produced from graphite, an expensive process that has contributed to the limited production and use of graphene. Additionally, there are limited sources for graphite in the United States, with 70–80 percent coming from China. The objective of the current project with Ohio University, the patent pending holder of this technology, is to build upon the proof-on-concept-project, in order to scale up this process using Ohio coal. Ohio University wants to demonstrate the operation of the process, increase the yield of coal to graphene, and evaluate the commercial applications for the synthesized product. Ohio University will be working on the design, construction and operation of a pilot facility to better estimate the manufacturing costs and working with commercialization partners like Lockheed Martin to further refine the characteristics of the graphene required for commercial use. This project brings an exciting and potentially highly profitable new market for Ohio coal which could help drive new Ohio coal production/sales. This innovation also disrupts and replaces an energy-intensive and expensive material process using foreign-sourced graphite, and instead uses a process that requires less energy and uses Ohio coal as a feedstock, thereby reducing graphene production's impact on the environment.

### CO<sub>2</sub> Utilization for Enhanced Oil Recovery and Geologic Storage

Battelle Memorial Institute's project seeks to make carbon capture, utilization, and storage (CCUS) implementation in Ohio a reality. Battelle would improve CO<sub>2</sub> storage characterization through geologic data, modeling, and field testing. The goal of the project is to improve storage performance and increase predictability of enhanced oil recovery and storage that uses CO<sub>2</sub> from coal. CCUS is needed to provide viable options for reducing CO<sub>2</sub> emissions from coal-fired power plants or other industrial sources while increasing domestic oil production.

### Remediation of Coal Ash Ponds and Reclamation at Coal Mines

The focus of the Ohio State University (OSU) project is on the beneficial use and disposal of coal combustion residues, especially fly ash and flue-gas desulfurization products in the vicinity of Ohio generating stations. OSU has partnered with American Electric Power (AEP) to promote the safe and cost-effective closure and remediation of coal ash impoundments in Ohio and constructing landfills over them, which promotes the high volume beneficial use of Ohio flue-gas desulfurization combustion products in reclamation of abandoned Ohio coal mine sites. The project will take place at AEP's Gavin power plant to test the coal ash pond portions of the project; water quality monitoring will occur at AEP's Conesville and Cardinal power plants. The project will result in reduced coal combustion liability and disposal costs for Ohio coal-fired utilities in a manner that is beneficial to the environment, the public's health and safety, and the generating companies.



*Coal combustion products to be used at a reclaimed coal mine*

## ***Future Investment***

The Demonstration and Pilot Program targets investment in clean coal related technologies. The priorities are listed below. Persons (individuals and businesses) doing business in Ohio or educational or scientific institutions that are located in Ohio are eligible to receive funding through this program.

### **Demonstration and Pilot Program RFP Priorities:**

1. Development/deployment of advanced coal-based power and fuel producing systems (e.g., integrated gasification combined cycle, oxy-combustion, ultra-supercritical, chemical looping, etc.);
2. Improved retrofit technologies applicable to existing coal-fired generating units: to increase generating efficiency to significantly reduce carbon dioxide emissions; to reduce parasitic loads of pollution control technologies; to reduce emissions of conventional pollutants, including hazardous air pollutants; and to develop methods for capture and sequestration of carbon dioxide;
3. Improved technologies/processes that enable the more efficient conversion of Ohio coal to a chemical feedstock, liquid or gas;
4. Cost effective carbon dioxide capture and sequestration through improving capture technology and development of carbon dioxide transport mechanisms that can meet the ever evolving U.S. EPA CO<sub>2</sub> carbon regulations;
5. Coal technologies/processes that lower the cost of supplying the energy needs of Ohio's industrial complex;
6. High volume fly ash and flue gas desulfurization coal combustion products in mine remediation/reclamation, captured CO<sub>2</sub> from coal combustion or a chemical reaction, that provide a benefit/revenue stream to the Ohio coal industry or that reduces coal combustion liability/disposal costs;
7. Economic and effective mercury and other hazardous air pollutant capture technologies; and
8. Analysis of the costs of retrofitting existing power plants with CO<sub>2</sub> capture technologies compared to the costs of retrofitting new facilities that have been constructed "CO<sub>2</sub> capture ready" units.

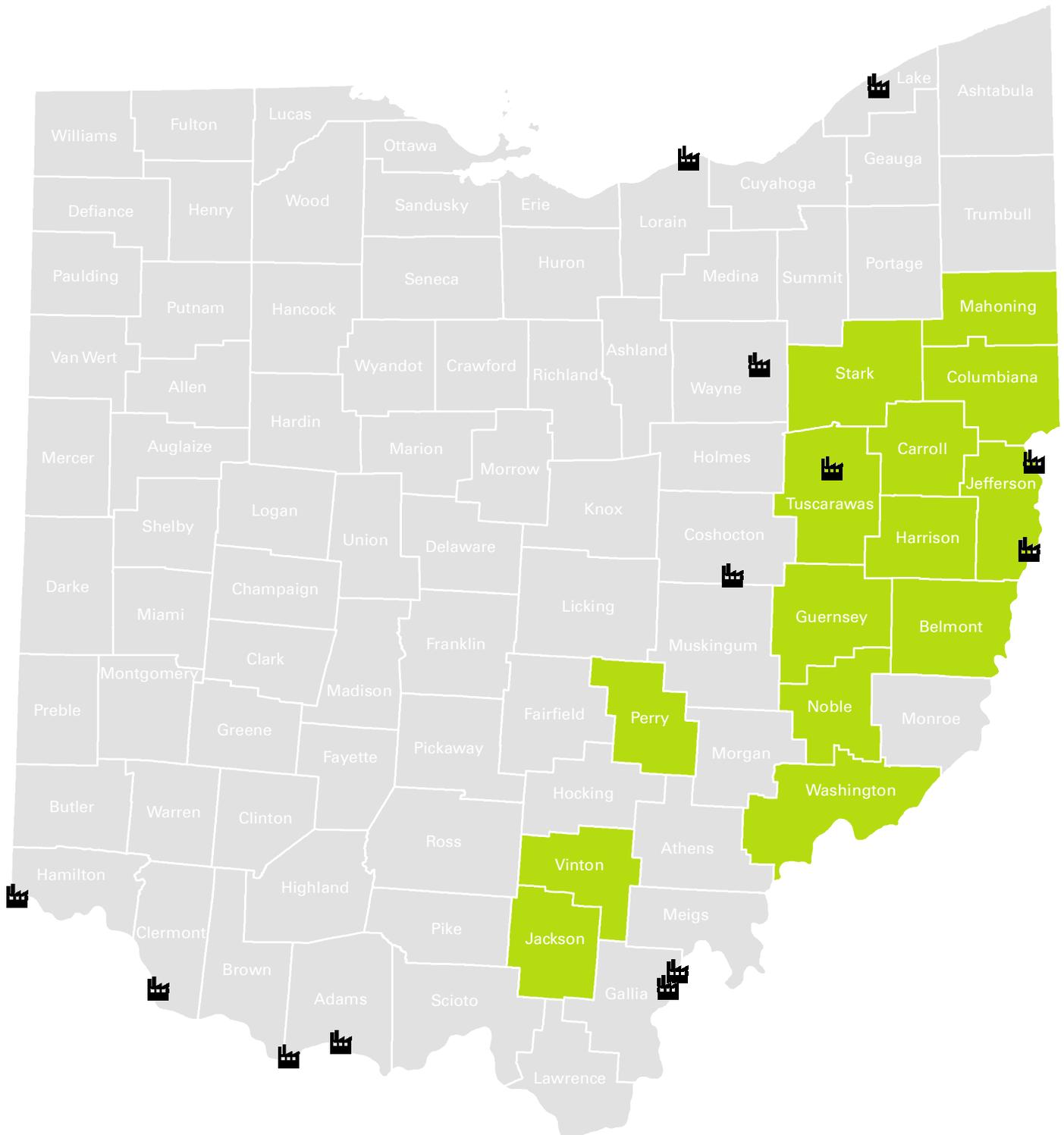
The Ohio Coal Research Consortium priorities will target the technical issues facing Ohio coal producers and end users and are listed below. These projects must improve or lower the cost of technologies and/or expand the use of Ohio coal.

### **Ohio Coal Research Consortium Priorities:**

1. Addressing technical problems being experienced by Ohio coal producers and end users to improve and/or lower the cost of technologies and/or emission controls enabling continued or expanded use of Ohio coal;
2. Improving the environmental performance of coal-based technologies and/or lowering their cost of operation;
3. Generating innovative research in the field of coal use;
4. Training a future supply of Ohio-based scientists and technologists in clean coal and emission control technologies;
5. Finding novel and more economical ways to convert Ohio coal to a liquid, a gas, or chemical feedstock;
6. Improving the efficiency of the coal to electricity conversion process for Ohio coal; and
7. Accelerating development and supporting early stage deployment of processes or technologies that can enhance or improve the use of Ohio coal in an environmentally acceptable manner.

These program priorities take into consideration the long-term and short-term needs of the Ohio coal industry in the face of existing and proposed environmental regulations, including the market realities of competing fuel sources, with input from Ohio Technical Advisory Committee members and industry stakeholders.

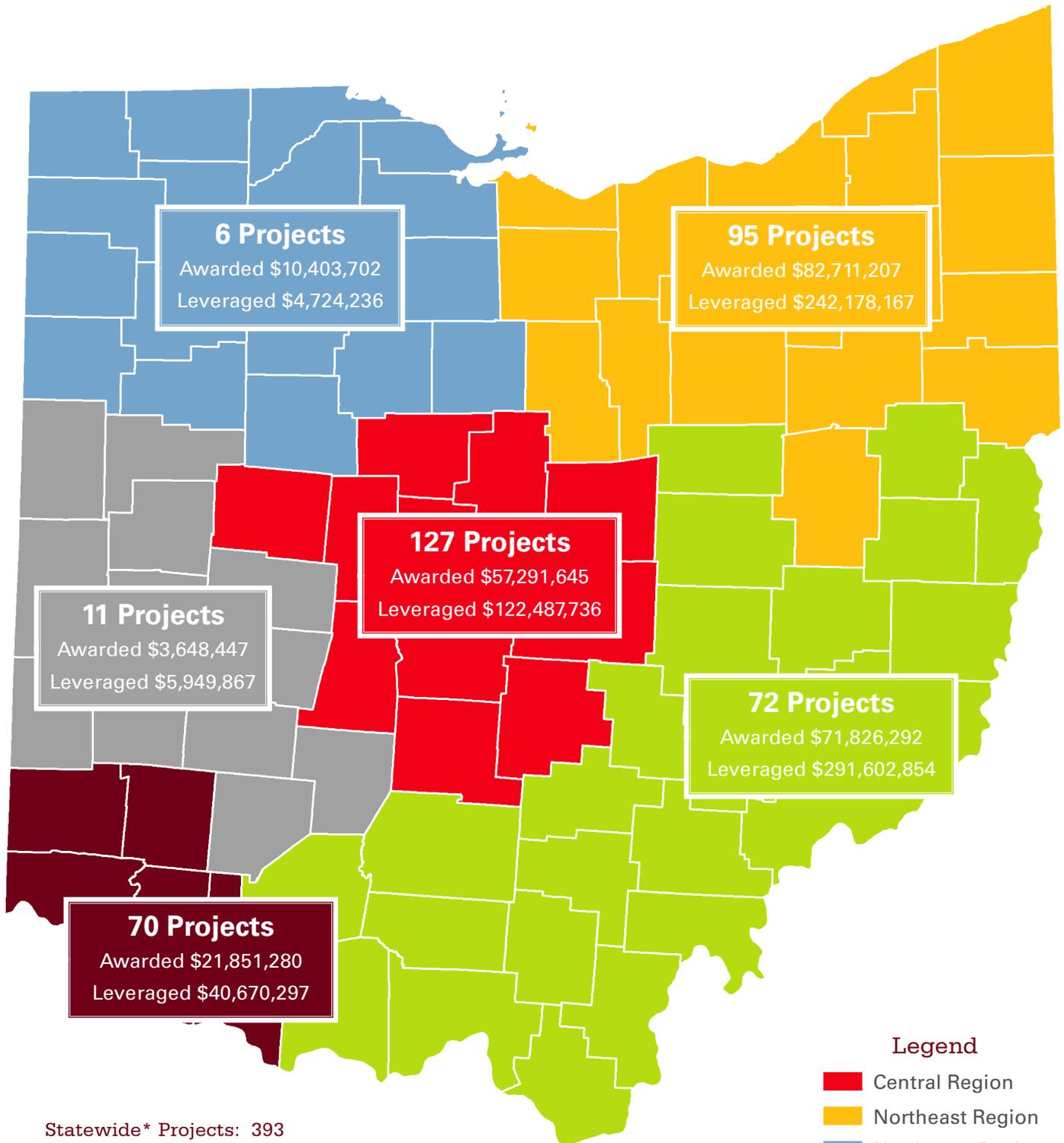
# Coal-Fired Power Plants and Counties with Active Coal Mines



## Legend

-  Coal-Fired Power Plant
-  County with Active Coal Mines (as of 2014)

# 30 Years of Projects



- Legend**
- Central Region
  - Northeast Region
  - Northwest Region
  - Southeast Region
  - Southwest Region
  - Western Region

Statewide\* Projects: 393  
 Awarded: \$249,188,253  
 Leveraged: \$709,591,751  
 Total Value: \$958,780,004

\*Regional figures do not match statewide totals due to some statewide and out-of-state projects

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***Appendix A***  
***Awarded Projects between FY 14 and FY 16***  
***(July 1, 2014 – June 30, 2016)***

Appendix A - Demonstration and Pilot Program Project Descriptions & Research Consortium Project Descriptions

Grantee	Title	amount
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**Advanced Coal-based Power Generation**

Grantee	Title	Grant Amount
The Ohio State University	Advanced Control Architecture and Sensor Information Development for Process Automation, Optimization, and Imaging of Chemical Looping Systems	\$500,000
The Ohio State University	Calcium Looping Processes for Clean Coal Conversion: Investigation of High Pressure	\$157,968
The Ohio State University	Chemical Looping Coal Gasification Sub-Pilot Unit Demonstration and Economic Assessment for IGCC Application	\$1,000,000
The Babcock and Wilcox Company	Commercialization of an Atmospheric Iron-Based CDCL Process for Power Production	\$1,583,191
The Ohio State University	Commercialization of an Atmospheric Iron-based Coal Direct Chemical Looping Process for Power Production, Phase II	\$2,499,894
The Ohio State University	Effect of coal mineral matter on oxygen cycle in the Ohio State coal direct chemical looping process	\$159,999
The Ohio State University	Pilot Scale Testing of the Carbon Negative, Product-Flexible Syngas Chemical Looping Process	\$1,350,000
The Ohio State University	Redox Mechanism Study of Iron-Based Oxygen Carriers in Coal-Direct Chemical Looping Reactions	\$160,000
The Ohio State University	Study of Physical and chemical interactions between coal and oxygen carrier particles in the OSU coal-direct chemical looping process	\$159,999

**Coal Combustion Products**

The Ohio State University	Coal Combustion Products Program	\$434,128
Ohio University	Ohio Coal Conversion to High Value Graphene: Pilot Scale-up	\$835,293
Ohio University	Production of Asphalt Binder Iron Ohio Coal Resources	\$160,000
The Ohio State University	Remediation of Coal Ash Ponds with Landfill Overfills & Reclamation at Coal Mines Using FGD Byproducts Phase IV	\$2,399,159

**Carbon Management**

University Of Akron	A hierarchical platform for amine sorbent for post-combustion CO2 capture	\$160,000
Battelle	CO2 Utilization for Enhanced Oil Recovery in Geologic Storage in Ohio	\$2,294,754
The Ohio State University	Cost effective CO2 capture with polymer-supported porous graphene membranes	\$160,000
The Ohio State University	Electrochemical pump for high-efficiency oxygen production	\$160,000
Battelle	Geo-mechanical Framework for Secure CO2 Storage in Fractured Reservoirs and Caprocks for Sedimentary Basins in the Midwest United States	\$300,000
University of Cincinnati	High Efficiency Pre-Combustion CO2 Capture Membrane Reactor during gasification of Ohio Coals	\$250,000
University of Cincinnati	Integrating H2 perm-selective WGS membrane reactor with CO2 membrane separator for efficient Pre-Combustion Carbon Capture	\$249,998
The Ohio State University	Mixed-conducting, nanocrystalline ceria membrane for oxygen separation	\$160,000
Ohio University	Novel direct heat recovery and integration strategy to reduce CO2 capture costs	\$160,000
The University of Akron	Novel NOx and SOx Resistant Polyvinyl alcohol-Amine Sorbents for Post-Combustion CO2 Capture	\$159,860
The Ohio State University	Novel Prototype Membrane for CO2 Capture	\$1,000,000
The Ohio State University	Techno-economic analysis of the carbonation calcination reaction (CCR) process for CO2 capture from coal combustion power plants	\$159,960

Appendix A - Demonstration and Pilot Program Project Descriptions & Research Consortium Project Descriptions

**Coal Advancement/Mine Productivity**

Ohio Department of Natural Resources	A Resource Evaluation of the Kittanning Coal Seams of Ohio	\$250,000
The Ohio State University	Mitigating impacts of acid mine drainage from legacy mining through secondary coal mining and reclamation	\$99,946

**Coal as a Chemical Feedstock**

University of Cincinnati	Carbon Dioxide as Feedstock in Selective Oxidation of Lower Alkanes	\$160,000
Battelle	Direct Coal-to-Liquids (CTL) for Jet Fuel Production Using Biomass-Derived Solvents	\$600,000
Battelle	Economic Recovery of Rare Earth Elements from Ohio Coal	\$190,014
University of Cincinnati	Multi-Scale Catalytic Membrane Reactors for Hydrogen Production in Coal Gasification Systems	\$160,000
University of Cincinnati	Novel Catalysts for Direct Conversion of Ohio Coals Syngas into Oxygenates: Continuation	\$160,000
Ohio University	Ohio coal-based composite plastics	\$160,000
The Ohio State University	Production of functionalized carbon-nanostructures from coal gas	\$159,984

**Environmental Issues**

The Ohio State University	An integrated forward osmosis-membrane distillation membrane process for flue gas desulfurization wastewater treatment	\$159,915
The Ohio State University	Catalytic Treatment of Water Contaminated by Coal Processing	\$160,000
University of Cincinnati	Novel regenerable adsorbents for waste water treatment from wet flue gas scrubbers	\$160,000
University of Cincinnati	Techno-economic feasibility study of novel process for simultaneous removal of heavy metals and recovery of FGD process water	\$250,000
The Ohio State University	Water recovery and capture of poisonous contaminants in flue gas desulfurization	\$160,000

**Improved Retrofit Technology Development**

Energy Industries of Ohio	AUSC Component Demonstration	\$5,000,000
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**Mercury Capture**

University of Cincinnati	Development of Elemental Mercury Oxidation Catalysts Highly Resistant to Ohio Coal Combustion Flue Gases	\$249,999
University of Cincinnati	Integrated Low-Temperature SCR, Mercury, and Trace Metal Capture for Power Plants Fired Using Ohio Coal	\$160,000

**\$24,854,061**

***Appendix B***  
***Fiscal Report***

Appendix B - Fiscal Report

	Budget	Total Expensed/ Obligated	Balance
Fiscal Year 2014 Administrative Expenses	\$261,205.00	\$200,169.07	\$61,035.93
Fiscal Year 2014 Coal Projects	\$37,064,743.06*	\$12,716,032.00	\$24,348,711.06#
Fiscal Year 2015 Administrative Expenses	\$261,405.00	\$215,720.54	\$45,684.46
Fiscal Year 2015 Coal Projects	\$27,348,711.67**	\$7,916,796.00	\$19,931,916.67##
Fiscal Year 2016 Administrative Expenses	\$234,400.00	\$234,400.00	\$0.00
Fiscal Year 2016 Coal Projects	\$19,431,915.67***	\$16,970,168.00	\$2,461,747.67
Fiscal Year 2017-2018 Coal Projects	\$12,461,747.67****	\$0.00	\$12,461,747.67###
Fiscal Year 2017 Administrative Expenses	\$234,400.00	\$0.00	\$234,400.00###
*Carryforward from FY13; Total FY 13/FY14 two-year budget \$40,312,537.73. two-year budget			
#End of two-year budget - FY13/FY14; FY14 Balance re-appropriated as part of the FY15/FY16			
**Two-year budget - FY15-FY16; \$3,000,000.00 new appropriation and \$24,348,711.67 re-appropriated Balance from FY13/FY14 two-year budget			
##Two-year budget - FY15/FY16; FY Balance carried forward into FY16			
***Carryforward from FY15			
****Two-year budget - FY 17-FY18; \$10,000,000.00 in new appropriation and \$2,461,747.67 re-appropriated Balance from FY15/FY16			
###As of July 1, 2016			

***Appendix C***  
***Projects completed between Fiscal Years 2014–2016***

Appendix C - Projects Completed between FY 14 and FY16 (July 1, 2013- June 30, 2016)

Grantee	Title	Grant Amount
<b>Advanced Coal-based Power Generation</b>		
Energy Industries of Ohio	Boiler Materials for Ultra Supercritical Coal Power Plant#	\$7,756,168
Energy Industries of Ohio	Materials for Advanced Ultra Supercritical Steam Turbines*	\$2,541,492
Energy Industries of Ohio	A Supplier Development Program for Clean Coal and Nuclear Energy Components*	\$636,503
The Ohio State University	Electro-catalytic Separation of Oxygen from Air*	\$100,000
The Ohio State University	Nano-composite Supported Membranes for Cost Effective O2 Separation*	\$100,000

<b>Coal Combustion Products</b>		
The Ohio State University	Reclamation of Ohio Coal Mine Sites Using FGD By-Products: Phase II Demonstration*	\$1,436,035

<b>Carbon Management</b>		
The Ohio State University	Pilot Scale Testing of Carbon Negative, Product Flexible Syngas Chemical Looping#	\$4,999,997
Battelle Memorial Institute	Systematic Assessment of Wellbore Integrity for Geologic Carbon Storage Projects Using Regulatory and Industry Information*	\$199,999
Battelle Memorial Institute	Simplified Predictive Models for CO2 Sequestration Performance Assessment*	\$150,000
The Ohio State University	Novel Inorganic/Polymer Composite Membranes for CO2 Capture*	\$500,000
Battelle Memorial Institute	CO2 Utilization for Enhanced Oil Recovery and Geologic Storage in Ohio#	\$1,739,660
University of Cincinnati	High Efficiency Pre-Combustion CO2 Capture Membrane Reactor during Gasification of Ohio Coals#	\$250,000
University of Akron	Novel NOx and SOx Resistant Polyethylene Glycol-Amine Sorbents for Post-Combustion CO2 Capture*	\$100,000
The Ohio State University	Calcium Looping Process (CLP) for Clean Coal Conversion to Hydrogen and Electricity: Fate of Sulfur*	\$100,000
The Ohio State University	Affordable CO2-selective Membranes for Post Combustion Capture*	\$100,000
University of Cincinnati	Metal-Organic Framework-Based Membranes for Highly Selective Gas Separations*	\$100,000
The Ohio State University	Study of Physical and Chemical Interaction between Coal and Oxygen Carrier Particles in the OSU Coal-Direct Chemical Looping Process*	\$100,000

<b>Coal Advancement/Mine Productivity</b>		
Ohio Department of Natural Resources	A Resource Evaluation of the Pittsburg (No. 8) and the Lower Freeport (No. 6a) Coal Seams of Ohio*	\$300,000

<b>Coal/CO2 as a Chemical Feedstock</b>		
Touchstone Research Laboratory	Re-Utilization of Industrial CO2 for Algae Production Using a Phase Change*	\$391,302
Ohio University	Ohio Coal Conversion to High Value Graphene*	\$249,991
The Ohio State University	Thin Film Solid Oxide Fuel Cell for Coal Syngas*	\$100,000
University of Cincinnati	Multi-Scale Catalytic Membrane Reactors for Hydrogen Production in Coal Gasification Systems*	\$100,000
University of Cincinnati	Novel Catalysts for Direct Conversion of Ohio Coals Derived SYNGAS into Ethanol*	\$100,000
The Ohio State University	Production of Functionalized Carbon Nanostructures from Coal Gas*	\$100,000

<b>Environmental Issues</b>		
University of Cincinnati	Novel Regenerable Adsorbents for Waste Water Treatment from Wet Flue Gas Scrubbers*	\$100,000

**\$22,351,147**

\*Final report accepted and available upon request

#Draft report pending, available upon request once final report is accepted

***Appendix D***  
***Criteria Used to Select Office's Specific Types of Projects***

**Ohio Coal Demonstration and Pilot Program Proposal Evaluation Sheet**

Each section of scoring is based on a scale of 0 to 5, where 0=unacceptable, 3=average, and 5=excellent. For the total score, the weighting factors for each of the individual sections are combined out of a total of 100 points.

Score		Weighting Factor		Weighted Score	Maximum Score
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**Technical (40 Points)**

1.	Clarity and specificity of objective(s)		x	1.5	=		7.5
2.	Technical merit		x	3.0	=		15
3.	Statement of Work		x	1.5	=		7.5
4.	Addressing of environmental issues		x	2.0	=		10

**Financial/Experience (35 Points)**

5.	Reasonableness of the budget		x	2.0	=		10
6.	Cost-share		x	2.0	=		10
7.	Technical and management competence		x	3.0	=		15

**Marketability (25 Points)**

8.	Applicability to Ohio coal/likelihood of market		x	2.0	=		10
9.	Identification of issues/cost effectiveness		x	1.0	=		5
10.	Marketing plan		x	1.0	=		5
11.	Use of Ohio coal		x	1.0	=		5

**Weighted Total Score**

**100**

**Ohio Coal Research Consortium Program Proposal Evaluation Sheet**

**Criterion 1:**

The overall merit of the proposed project (0 to 5 points). The research represents a significant contribution to expanding the base of knowledge in the defined focus area. The proposed approach is innovative and represents a significant departure from state-of-the-art approaches to the described problem and has the potential to significantly increase the use of Ohio coal in an environmentally acceptable manner. An awareness of the current state-of-the-art in related areas of coal research is demonstrated.

**Criterion 2:**

The proposal contains a preliminary capital and total annual cost analysis of the process as configured (0 to 5 points). The basis shall be 7,446 hours of operation per year, 500 MW equivalent if electric generation is the purpose or 250 tons of coal per hour if a byproduct or other product is the objective.

**Criterion 3:**

The stated objectives and feasibility of achieving those objectives (0 to 5 points). The application clearly addresses a problem, concept or question described within the research areas defined above. A well-defined, logical statement of work is provided to effectively address the technical issues. An approach is described that is scientifically sound, well planned and uses current methods (or methods adequate to solve the problem) in the investigation.

**Criterion 4:**

Leveraging of cost sharing funds from industry or government sources (0 to 3 points). One goal of the OCRC program is that OCRC support will be used as cost share in proposals submitted to other sources of government and industrial funding. The college/university would be expected to maintain its cost share at 20 percent (or greater) of ODSA's contribution to the project. The outside funds would be used to either expand the program or reduce ODSA's contribution to the project. Executive summaries of companion proposals must be attached as an appendix to demonstrate the attempt to leverage third party funding. ODSA staff will assign scores on this criterion as follows:

Points	Criteria Description
0	No effort was made to obtain outside funding
1	Project can demonstrate attempt(s) were made to receive outside funding, but were declined
1	Project can demonstrate attempt(s) were made to receive outside funding, but have not received a decision
3	Project has received outside funding

**Criterion 5:**

The facilities or specialized equipment and techniques are available to the PIs to meet the project objectives (0 to 2 points). Zero if key equipment or techniques are not available or not included in the list of equipment to be purchased by the project. Two points if equipment is available.

**Criterion 6:**

Publication of research in peer-reviewed journals and applications for patents (0 to 2 points). For projects that have received OCRC funding for a number of years, it is expected that by the end of the third year that a paper has been submitted to a peer-reviewed journal for publication and/or a patent application has been filed. Reviewers will assign scores on this criterion as follows: two for the filing of a patent application; or two for peer-reviewed paper submissions for publication; and zero if after completion of three years of work, no patent application has been filed and a peer-reviewed paper has not been submitted for publication.

**Criterion 7:**

Relevance (0 to 3 points). The project has a high transferability to consumers of Ohio coal, will lead to increases in the use of Ohio coal in an environmentally acceptable manner and has the potential to improve Ohio’s economy.

**Criterion 8:**

Applicability (0 to 2 points). Overall how well the project relates to each the four purposes of the OCRC listed on page 2 and 3 of the RFP.

**Criterion 9:**

Collaboration (0 to 2 points). Demonstrated financial and/or strategic partnerships with industry producers and/or end users that will increase the likelihood that the technology/results of the project will have a pathway towards further development and eventual field deployment.

<b>Final Scoring – based upon completeness of proposal and supporting documentation provided</b>	
1. Overall merit	___ (0 to 5 Points)
2. Capital and total annual cost analysis	___ (0 to 5 Points)
3. Objective feasibility	___ (0 to 5 Points)
4. Leveraging	___ (0 to 3 Points)
5. Equipment and techniques availability	___ (0 to 2 Points)
6. Publication and patent applications	___ (0 to 2 Points)
7. Relevance	___ (0 to 3 Points)
8. Applicability	___ (0 to 2 Points)
9. Collaboration	___ (0 to 2 Points)
<b>Total Score</b>	<b>___ (0 to 29 Points)</b>