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Ohio Coal Development Agenda for Fiscal Years 2017–2018

Ohio

**Development
Services Agency**

John R. Kasich, Governor

David Goodman, Director

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A coal barge transports coal up the Ohio River near Bridgeport.

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IMPACT OF COAL IN OHIO



**IN THE NATION FOR
TOTAL PRODUCTION OF COAL**
9.3 MILLION TONS OF COAL PRODUCED
A REDUCTION OF 45% SINCE 2015

Source: Reference 1



21.7 BILLION TONS OF COAL
REMAIN WITHIN ALL OF OHIO

2018

11.9 BILLION TONS
IN MIDDLE KITTANING

7.0 BILLION TONS
IN LOWER KITTANNING

Source: Reference 2



1,272
TOTAL EMPLOYEES

Source: Reference 4



961
EMPLOYEES
IN PRODUCTION

Source: Reference 4



\$49,210
AVERAGE PRODUCTION
SALARY

Source: Reference 4

2016

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 14,605 megawatts.

Source: Reference 4



COAL SOLD 2016

\$541 MILLION
TOTAL VALUE

\$44.23 PER TON
AVERAGE

Source: Reference 5



12.5
MILLION TONS
OF OHIO COAL CONSUMED IN 2017
BY ELECTRIC GENERATION UNITS

Source: Reference 8



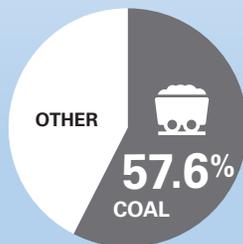
26.1%
OF COAL CONSUMED FOR
ELECTRIC GENERATION IN
OHIO WAS PRODUCED IN OHIO

Source: Reference 6



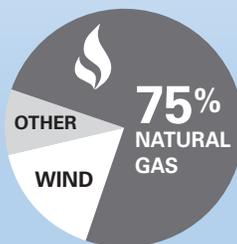
4%
FORECAST U.S. COAL
PRODUCTION DECREASE IN 2018

Source: Reference 7



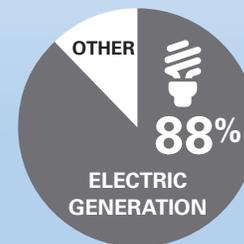
Electricity generation fuel sources in Ohio in 2017, down from 92% in 2003

Source: Reference 8



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

Source: Reference 4



Coal consumption in Ohio end use

Source: Reference 9

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 needs of the Ohio coal industry. Research and Development projects supported by the office develop technology that will utilize Ohio coal in an environmentally sound manner and will:

- Help meet new and existing federal regulations.
- Allow fuel and electricity prices to remain low and stable.
- 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 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.”



A tugboat moves barges filled with coal on the Ohio River.

Established under Section 1551.35 of the Ohio Revised Code, the Ohio Coal Technical Advisory Committee is an 11-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. Six 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:

- Larry Ward, United Mine Workers of America
- Commissioner Thomas Johnson, 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
- Representative Al Landis, Ohio House of Representatives
- Representative Jack Cera, Ohio House of Representatives
- Craig Butler, Director, Ohio EPA, Ex-Officio
- Vacant, Ohio Senate
- Senator Troy Balderson, Ohio Senate

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.

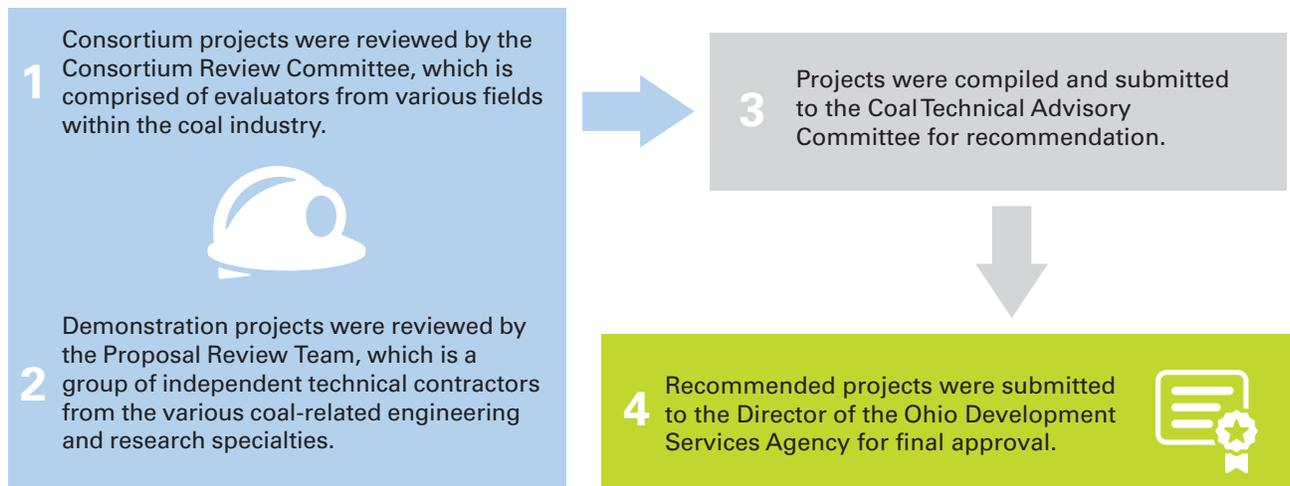
Funding priority was given to projects that provide:

- Improvements or reconstruction of existing facilities and equipment.
- Construction and operation of commercial-scale demonstration facilities.
- 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 \$8.1 million through the Ohio Coal Research and Development Program during Fiscal Years 2017–2018. This program provided 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 were divided into two initiatives: the Coal Demonstration and Pilot grants and the Coal Research Consortium grants.

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

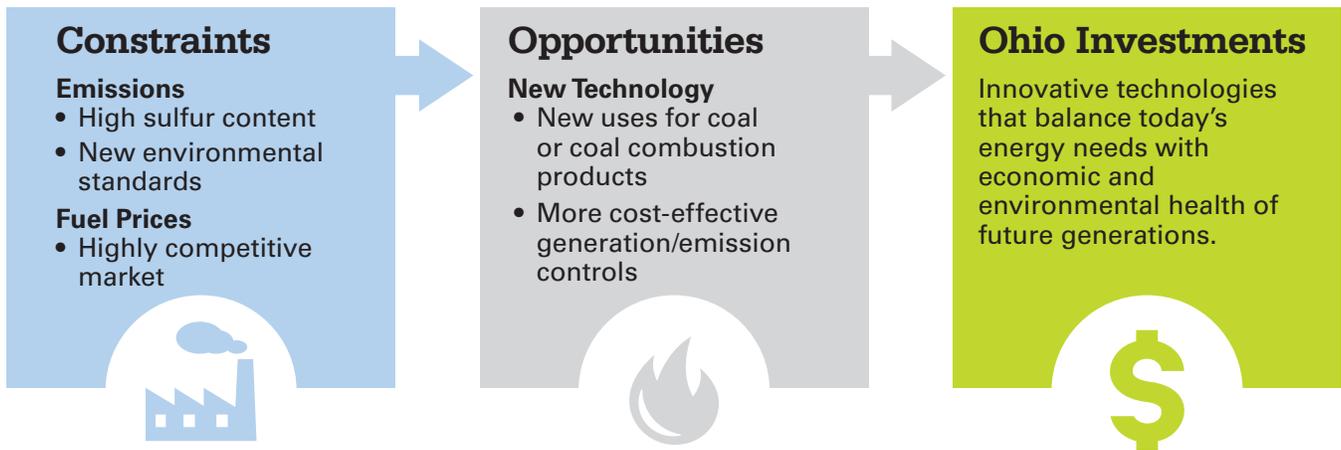
- Ohio Coal Demonstration and Pilot Program provided grants for the discovery and implementation of new technologies to utility power producers, technology developers, research and development firms, and Ohio colleges and universities. Funding can be applied toward research or the demonstration of technologies that enable better, more cost-effective utilization of Ohio coal under current and anticipated environmental regulations.
- Ohio Coal Research Consortium provided grants to Ohio colleges and universities to study mechanisms related 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 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 (Ohio Coal-based Composite Plastics), cost-effectively reduce carbon dioxide emissions (Coal-to-Liquids for Jet Fuel), capture emissions from coal-fired generation (Capture of Heavy Metals and Wastewater Recovery), and address CO₂ storage options. The goal of the program is the commercialization of technologies and adoption of technologies by the market. The following are projects in which the office invested over the past two years.

Recovery of Rare Earth Elements from Coal

Rare earth elements are required for many modern applications including semiconductors, sensors, rechargeable batteries, catalysts and magnets. There are currently no mines or production facilities for rare earth elements in the United States. This leaves the U.S. wholly dependent on foreign sources for these strategic and critical materials. Approximately 80 percent of rare earth production occurs in China. Battelle Memorial Institute developed a process to recover rare earth elements from coal ash generated by power generation facilities using acid digestion.



Residual coal ash prior to rare earth extraction testing.

Reclamation of Ohio Coal Mine Sites Using Coal Combustion Products

Flue gas at most Ohio electric generation units are scrubbed to remove sulfur dioxide. This produces a large amount of byproduct material that needs to be placed in a landfill. The Ohio State University sought to show that this material and fly ash (that is produced during the combustion of coal for electric generation) could be used to improve the environmental quality, land use and safety of previously disturbed mined lands located in Ohio. One portion of the project was conducted at American Electric Power's (AEP) Conesville coal-fired power plant and demonstrated the beneficial use of 1.7 million tons of coal combustion materials to help reclaim abandoned mine land. The project also conducted multi-year tests at AEP's Cardinal power plant for mine reclamation and conducted tests at AEP's Gavin Plant using coal combustion material to reduce acid mine drainage impacts. Water quality was found to be similar to background levels and environmentally benign for these demonstrations. The project showed that coal combustion materials could be used to provide an economically feasible and environmentally viable alternative to landfill disposal, which promotes the continued use of Ohio coal.



(Pictured left to right) Professor Tarunjit Butalia (OSU), John Massy-Norton (AEP), OSU President Michael Drake, and State Representative Al Landis during a tour of AEP's former surface mine that used coal combustion products to help reclaim the land.

Ohio Coal-based Composite Plastics

Ohio University had previously demonstrated that a combination of Ohio coal and thermoplastic resin has similar physical properties to commercially available wood plastic composites. Now the team at Ohio University is improving the performance of the product to meet commercial decking composite specifications, increasing its opportunity for commercialization, and creating a new market for Ohio coal.



Ohio University coal plastic composite materials; including source coal, compounded coal plastic composite material, and specimens for testing.



Lakin Phillips, a graduate student, works on the Ohio Coal based Composite Plastics project. Phillips received a Master's degree from Ohio University in Fall 2017.

Coal-to-Liquids for Jet Fuel

Battelle Memorial Institute has demonstrated a direct coal-to-liquids process for producing jet fuel from biomass-derived coal solvents. The new process offers a significant reduction in capital and operating costs and a substantial reduction in greenhouse gas emissions compared to coal-to-liquid production using the Fischer-Tropsch process. Furthermore, a detailed economic analysis showed that the jet-fuel selling cost at the refinery using the Battelle coal-to-liquids process is \$61/bbl (\$1.45/gallon), and it produces less greenhouse gas emissions compared to jet fuel that is produced from petroleum.



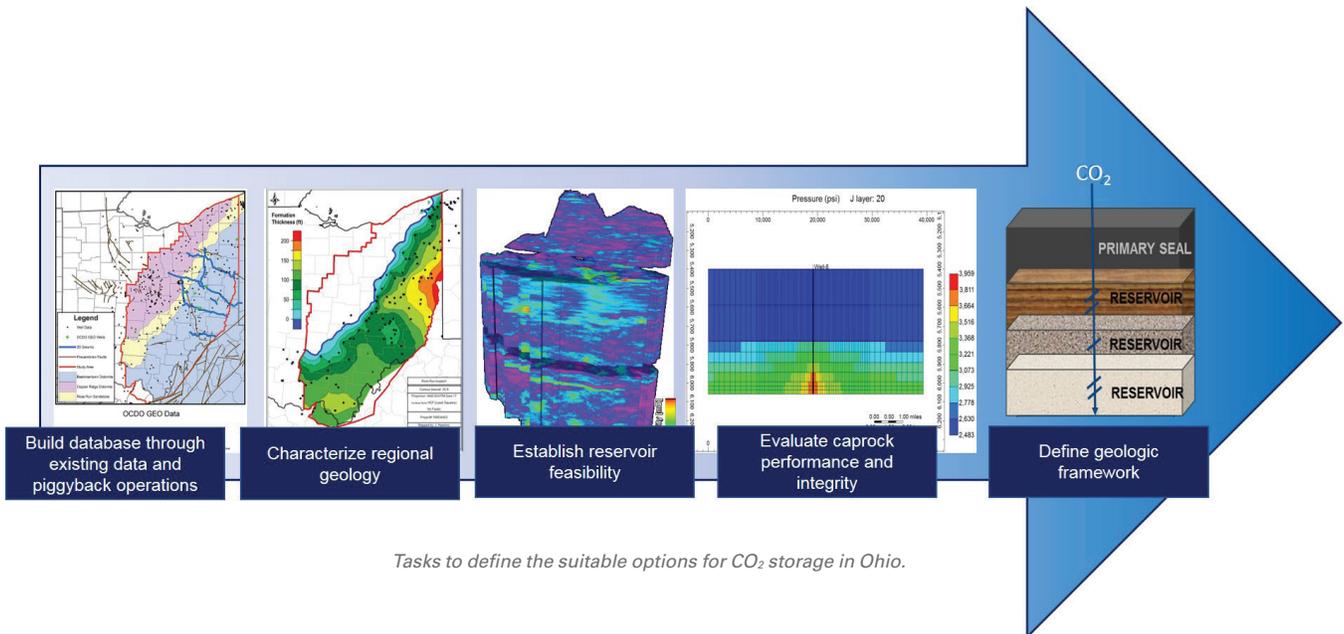
Quantex pre-pilot plant facility used to produce liquefied coal (syncrude) for Coal-to-Liquids for Jet Fuel project.

Capture of Heavy Metals and Wastewater Recovery

The University of Cincinnati tested the feasibility of a membrane technology to recover coal-fired power plant wastewater while also removing heavy metals. The project showed the ability of the membrane to recover 90 percent of clean water from wastewater while simultaneously concentrating residual heavy metals 10-fold so that it could be captured, reducing the impact of these heavy metals on the environment.

CO₂ Storage Assessment

Battelle Memorial Institute completed a multi-year study of Ohio’s carbon dioxide capture utilization and storage potential. It concluded that Ohio has the geologic storage capacity for several decades worth of CO₂ emissions from all fossil-fueled power plants located in Ohio. Detailed mapping and capacity estimates have narrowed down potential geologic storage areas and have primed the pump for future site-specific investigations.



Tasks to define the suitable options for CO₂ storage in Ohio.

Future Investment

The Demonstration and Pilot Program targets investment in 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:

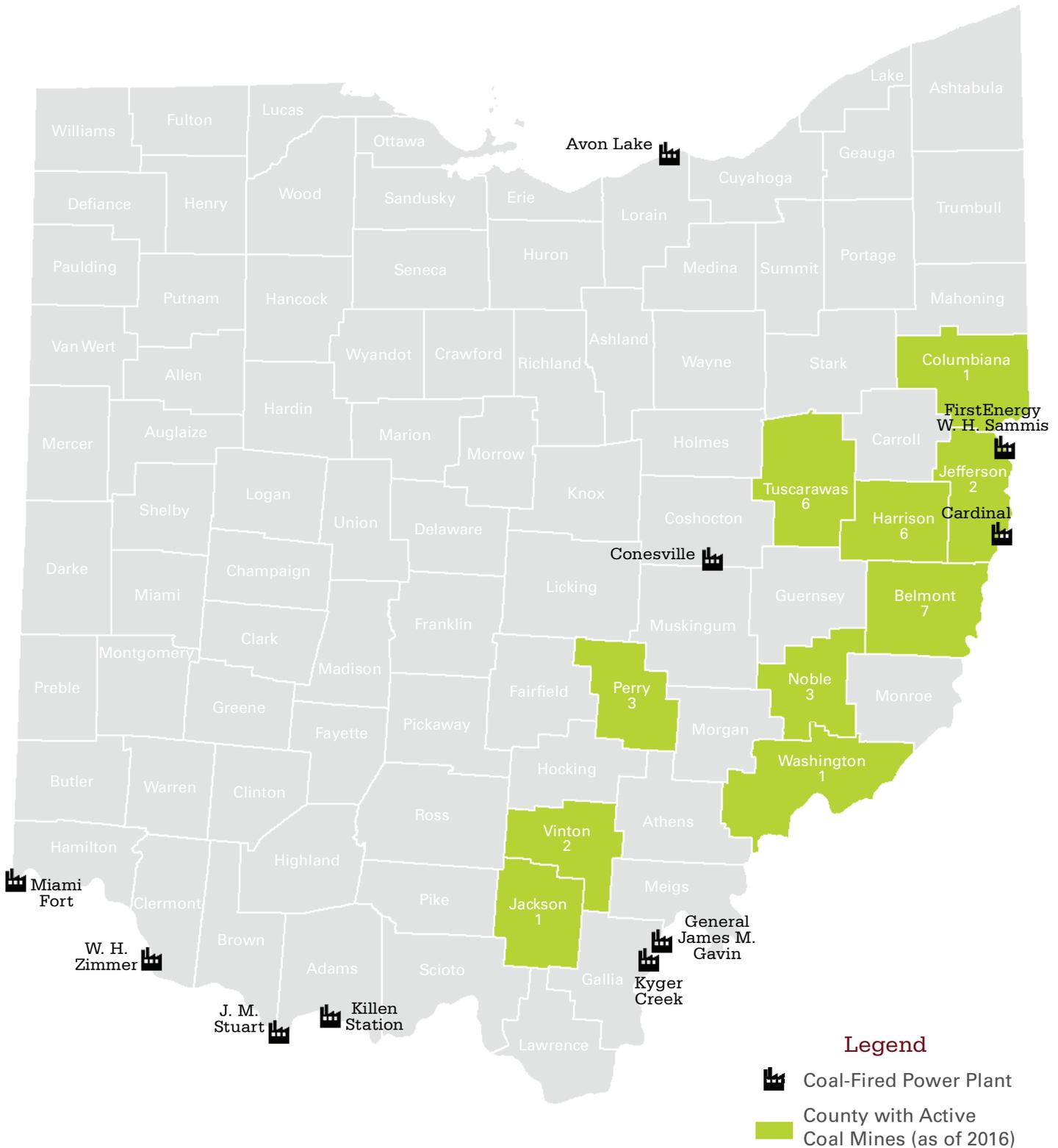
1. Development/deployment of advanced coal-based power and fuel producing systems (e.g. integrated gasification combined cycle, oxy-combustion systems, chemical looping systems, etc.) that will reduce carbon and other emissions and/or lower their cost of operation.
2. Improved technologies applicable to coal combustion technology systems: to increase generating efficiency in order to significantly reduce carbon dioxide emissions that also reduces the fixed costs and/or variable operating costs, maintenance costs, or other means for existing and new systems; and to reduce parasitic loads of pollution control technologies.
3. Cost-effective carbon dioxide capture and sequestration through improving capture technology and development of carbon dioxide transport mechanisms.
4. Analysis of the costs of retrofitting existing power plants with carbon dioxide capture technologies that are not “carbon capture ready”, compared to the costs of retrofitting facilities that are “carbon dioxide capture-ready.” Must include a commitment of data support from a major Ohio electric utility.
5. Coal technologies/processes that lower the cost of supplying the energy needs of Ohio’s industrial complex.
6. Cost-effective improved retrofit technologies to reduce emissions of criteria air pollutants, including sulfur dioxide, nitrogen dioxides/oxides, mercury and air toxins.
7. Improved technologies/processes that enable the more efficient conversion of Ohio coal to a chemical feedstock, liquid, or gas.
8. Coal combustion products: High volume fly ash and flue gas desulfurization utilization that reduces liability/disposal costs (excluding projects related to agricultural augmentation with FGD gypsum). These projects must clearly show the economic and annual usage volume advantages over current end uses.
9. Analysis of the potential impact on the Ohio coal industry of increased electrification of the ground transportation sector and identification of opportunities to advance Ohio coal so that the state can optimize environmental and economic benefits.

These program priorities take into consideration the 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. Moving forward the Ohio Coal Development Office will focus its resources on demonstration and pilot projects that have potential for commercialization and adoption by the market.



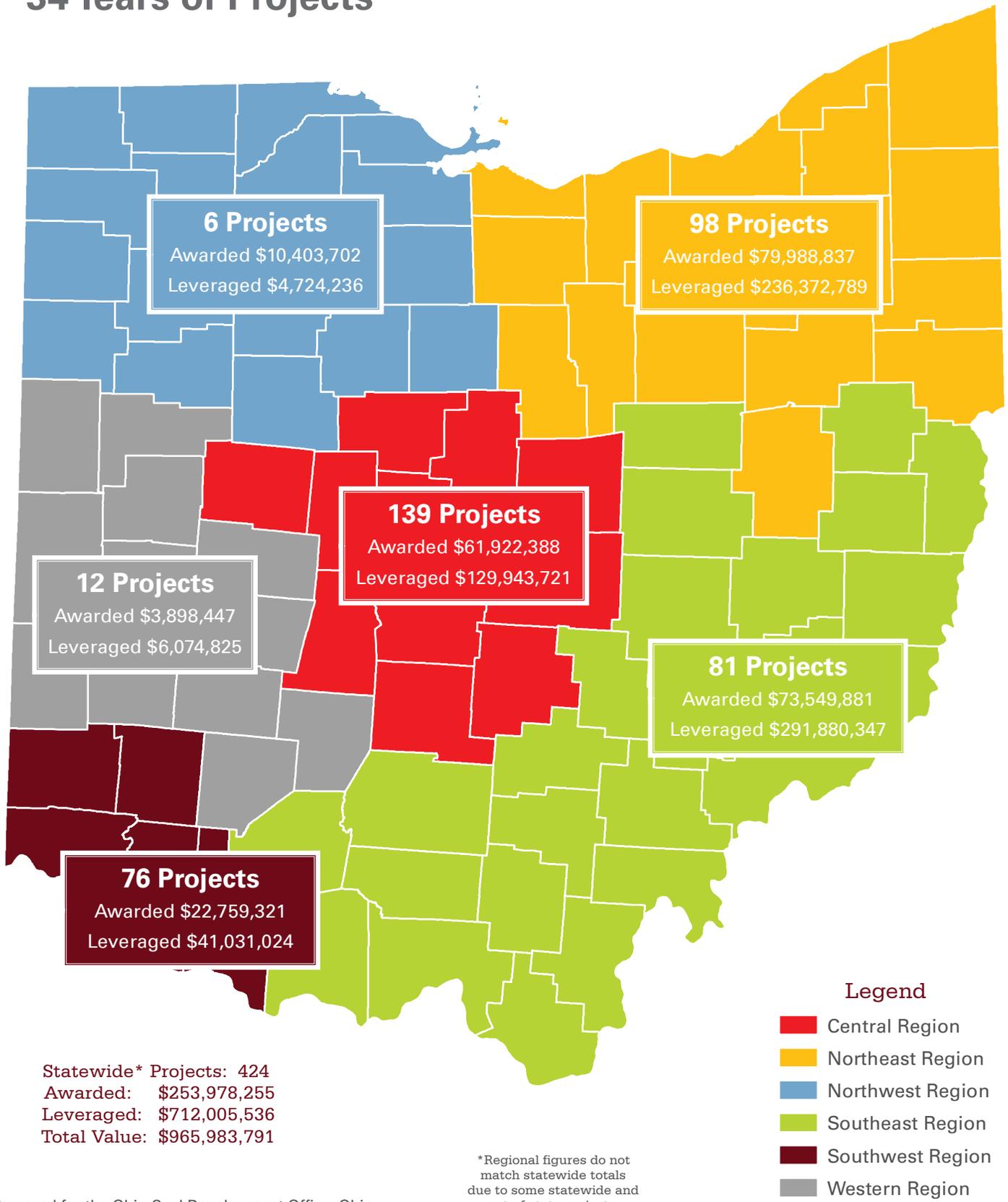
A river barge with loads of coal passes under the Daniel Carter Beard Bridge on the Ohio River in Cincinnati.

Coal-Fired Power Plants and Counties with Active Coal Mines



The number indicates how many active coal mines are in each county as of 2016.

34 Years of Projects



Statewide* Projects: 424
 Awarded: \$253,978,255
 Leveraged: \$712,005,536
 Total Value: \$965,983,791

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

Prepared for the Ohio Coal Development Office, Ohio Development Services Agency (Research; July 2018)

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5. "2016 Report on Ohio Mineral Industries: An Annual Summary of the State's Economic Geology," State of Ohio Department of Natural Resources Division of Geological Survey, Columbus 2017, http://geosurvey.ohiodnr.gov/portals/geosurvey/PDFs/Mineral_Industries_Reports/MinInd16.pdf
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9. U.S. Energy Information Administration Form EIA-923, 'Power Plant Operations Report,' Form EIA-3, 'Quarterly Coal Consumption and Quality Report, Manufacturing and Transformation/Processing Coal Plants and Commercial and Institutional Coal Users,' Form EIA-5, 'Quarterly Coal Consumption and Quality Report, Coke Plants,' and Form EIA-7A, 'Coal Production and Preparation Report.' <http://www.eia.gov/coal/annual/pdf/table26.pdf>
10. "2016 Report on Ohio Mineral Industries: An Annual Summary of the State's Economic Geology," J.D. Stucker, State of Ohio Department of Natural Resources Division of Geological Survey, Columbus 2017, http://geosurvey.ohiodnr.gov/portals/geosurvey/PDFs/Mineral_Industries_Reports/MinInd16.pdf

Appendix A
***Demonstration and Pilot Program Project Descriptions and
Research Consortium Project Descriptions***

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

| Grantee | Title | Grant Amount |
|---|---|---------------------|
| Advanced Coal-based Power Generation | | |
| The Ohio State University | 10 MWe Coal Direct Chemical Looping Large Pilot Plant- Pre-Front End Engineering and Design Study | \$1,450,000 |
| Ohio University | Determining the Corrosive Potential of Captured CO ₂ with Impurities from the Coal Direct Chemical Looping Process | \$159,841 |
| The Ohio State University | Fate of Sulfur from Bituminous Coal in the Coal Direct Chemical Looping Process | \$160,000 |
| The Ohio State University | Fluidization and Distribution Characteristic Studies of Coal Particles in Packed Moving-Bed of Oxygen Carrier Particles for the Coal Direct Chemical Looping System | \$160,000 |
| The Ohio State University | Heat Integration Optimization and Dynamic Modeling Investigation for Advancing the Coal Direct Chemical Looping Process | \$1,250,000 |
| Carbon Management | | |
| Battelle | Central Appalachian Basin CarbonSafe Integrated Pre-Feasibility Project | \$250,000 |
| The Ohio State University | Catalytic Combustion of Methane Emitted from Coal Mine Ventilation Air Systems | \$160,000 |
| The Ohio State University | Mineralizing Carbon Dioxide using Stabilized Flue Gas Desulfurization Material in the Presence of Acid Mine Drainage | \$249,913 |
| University of Cincinnati | Novel Catalysts for Total Combustion of Ventilation Air Methane Emitted in Underground Coal Mines | \$160,000 |
| Ohio University | Novel CO ₂ - SO ₂ Co-Capture Process by Deep Eutectic Solvents | \$92,103 |
| The Ohio State University | Sequestration of CO ₂ and Co-Contaminants into Geological Formations in Ohio | \$159,985 |
| Ohio University | Techno-Economic Assessment of Ohio Coal as a Source of Carbon Dioxide for use in Enhanced Ohio Recovery in the Utica-Point Pleasant Oil Window | \$159,562 |
| Coal as a Chemical Feedstock | | |
| University of Cincinnati | Cost-Effective Co-Production of H ₂ and Carbon Nanotubes from Coal-Gasifier Syngas by Membrane Reaction | \$249,999 |
| University of Cincinnati | Highly Selective Catalysts for the Direct Conversion of Ohio Coals derived Syngas to Oxygenates at High Pressures | \$50,000 |
| Applied Sciences, Inc | Nanocarbon Production Process Using Coal Syngas | \$250,000 |
| Ohio University | Ohio Coal-Based Composite Plastics | \$160,000 |
| Environmental Issues | | |
| The Ohio State University | Beneficial Use of Flue Gas Desulfurization Gypsum for Phosphorous Removal from Wastewater | \$249,945 |
| University of Cincinnati | Novel Chemical Absorbents for the Removal of Toxic Heavy Metals from Flue Gas Desulfurization Process Water | \$250,000 |
| Ohio University | Novel Hydrothermal Upgrading of Coal Refuse-Biomass Blend into High Quality Solid Fuel | \$156,804 |

\$5,778,152

Appendix B
Fiscal Report

Appendix B - FISCAL REPORT

| OPERATING BUDGET - Fund: GRF / ALI 195402 | | | |
|--|------------------|---------------------------|------------------|
| Budget Period | Beginning | Expensed/Obligated | Balance |
| Fiscal Year 2017 | \$ 234,400.00 | \$ 225,695.47 | \$ 8,704.53 |
| Fiscal Year 2018* | \$ 227,368.00 | \$ 227,368.00 | \$ - |
| Fiscal Year 2019 (Current) | \$ 227,368.00 | \$ - | \$ 227,368.00 |
| <i>* Balance Pending Final Reconciliation.</i> | | | |
| CAPITAL (PROJECT) BUDGET - Fund: 7046 / ALI C19505 | | | |
| Budget Period | Beginning | Expensed/Obligated | Balance |
| Fiscal Year 2017/2018 Biennium** | \$ 12,461,747.67 | | |
| Fiscal Year 2017 | | \$ 2,298,539.78 | \$ 10,163,207.89 |
| Fiscal Year 2018 | | \$ 5,873,206.73 | \$ 4,290,001.16 |
| Fiscal Year 2019/2020 Biennium (Current)*** | \$ 9,290,001.16 | | |
| <i>** \$10,000,000.00 New Appropriation + \$2,461,747.67 Re-appropriation from 2015/2016 Capital Biennium.</i> | | | |
| <i>*** \$5,000,000.00 New Appropriation + \$4,290,001.16 Re-appropriation from 2017/2018 Capital Biennium.</i> | | | |

| |
|---------------------------------------|
| Information Current as of 07.02.2018. |
|---------------------------------------|

Appendix C
Projects Completed Between Fiscal Years 2017–2018

Appendix C - Projects Completed between FY 17 and FY18 (July 1, 2016- June 30, 2018)

| Grantee | Title | Grant Amount |
|---|--|--------------|
| Advanced Coal-based Power Generation | | |
| The Ohio State University | Advanced Control Architecture and Sensor Information Development for Process Automation, Optimization, and Imaging of Chemical Looping Systems# | \$500,000 |
| Energy Industries of Ohio | Advanced Ultra Super Critical Component Demonstration* | \$1,818,255 |
| 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 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 | Electrochemical Pump for High-efficiency Oxygen Production* | \$160,000 |
| The Ohio State University | Mixed-conducting, Nanocrystalline Ceria Membrane for Oxygen Separation* | \$160,000 |
| 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 |
| Carbon Management | | |
| University of Akron | A Hierarchical Platform for Amine Sorbent for Post-combustion CO ₂ Capture* | \$160,000 |
| Ohio State University | Cost Effective CO ₂ Capture with Polymer-supported Porous Graphene Membranes* | \$160,000 |
| Battelle | Defining CO ₂ Storage Options in Upper Ohio Valley Region – Advanced Characterization of Geologic Reservoirs and Caprocks* | \$4,986,629 |
| Battelle | Geomechanical Framework for Secure CO ₂ Storage in Fractured Reservoirs and Caprocks for Sedimentary Basins in the Midwest United States* | \$300,000 |
| University of Cincinnati | Integrating H ₂ perm-selective WGS Membrane Reactor with CO ₂ Membrane Separator for Efficient Pre-Combustion Carbon Capture# | \$249,998 |
| Ohio University | Novel Direct Heat Recovery and Integration Strategy to Reduce CO ₂ Capture Costs* | \$160,000 |
| University of Akron | Novel NO _x and SO _x Resistant Polyvinyl Alcohol-Amine Sorbents for Post Combustion CO ₂ Capture* | \$159,860 |
| The Ohio State University | Techno-economic Analysis of the Carbonation Calcination Reaction Process for CO ₂ Capture from Coal Combustion Power Plants* | \$159,960 |
| Coal as a Chemical Feedstock | | |
| University of Cincinnati | Carbon Dioxide as a Feedstock in Selective Oxidation of Lower Alkanes* | \$160,000 |
| Battelle | Direct Coal-to-Liquids 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 Conversion to High Value Graphene: Pilot Scale-up* | \$835,293 |
| Ohio University | Ohio Coal-based Composite Plastics* | \$160,000 |
| Ohio University | Production of Asphalt Binder from Ohio Coal Resources* | \$160,000 |
| The Ohio State University | Production of Functionalized Carbon-nanostructures from Coal Gas* | \$159,984 |

Appendix C - Projects Completed between FY 17 and FY18 (July 1, 2016- June 30, 2018)

Coal Advancement/Mine Productivity

| | | |
|--------------------------------------|---|-----------|
| Ohio Department of Natural Resources | Evaluation of Available Resources of the Middle and Lower Kittanning Coal Beds in Ohio* | \$250,000 |
|--------------------------------------|---|-----------|

Coal Combustion Products

| | | |
|---------------------------|--|-------------|
| The Ohio State University | Beneficial Uses of Flue Gas Desulfurization Gypsum in Ohio: Agricultural and Environmental applications* | \$406,181 |
| The Ohio State University | Reclamation of Ohio Coal Mine Sites Using Flue Gas Desulfurization Byproducts: Phase III Demonstration Projects* | \$1,643,820 |

Environmental Issues

| | | |
|---------------------------|---|-----------|
| The Ohio State University | An Integrated Forward Osmosis-membrane Distillation Membrane Process for Flue Gas Desulfurization Wastewater Treatment* | \$159,915 |
| Ohio State University | Catalytic Treatment of Water Contaminated by Coal Processing* | \$160,000 |
| 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 |
| The Ohio State University | Mitigating Impacts of Acid Mine Drainage from Legacy Mining through Secondary Coal Mining and Reclamation* | \$99,946 |
| 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 Flue Gas Desulfurization Process Water# | \$250,000 |
| Ohio State University | Water Recovery and Capture of Poisonous Contaminants in Flue Gas Desulfurization* | \$160,000 |

\$20,747,714

*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 |
|-------|--|------------------|--|----------------|---------------|
|-------|--|------------------|--|----------------|---------------|

Technical (32.5 Points)

| | | | | | | | |
|----|---|--|---|-----|---|--|-----|
| 1. | Clarity and specificity of objective(s) | | x | 1.0 | = | | 5 |
| 2. | Technical merit | | x | 2.0 | = | | 10 |
| 3. | Statement of work | | x | 1.5 | = | | 7.5 |
| 4. | Environmental performance | | x | 2.0 | = | | 10 |

Financial/Experience (30 Points)

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

Marketability (37.5 Points)

| | | | | | | | |
|-----|----------------------------|--|---|-----|---|--|-----|
| 8. | Applicability to Ohio | | x | 2.0 | = | | 10 |
| 9. | Cost-effectiveness | | x | 1.0 | = | | 5 |
| 10. | Business/marketing plan | | x | 1.5 | = | | 7.5 |
| 11. | Increased use of Ohio coal | | x | 2.0 | = | | 10 |
| 12. | Impacted Ohio communities | | x | 1.0 | = | | 5 |

Weighted Total Score

100

Ohio Coal Research Consortium Program Proposal Evaluation Sheet

Criterion 1: Overall merit

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 improvement from state-of-the-art approaches to the described problem and has the potential to significantly increase the use of Ohio coal while reducing environmental impact and increasing cost effectiveness. The proposal demonstrates an awareness of the current state-of-the-art in related areas of coal research and current environmental demands placed on the Ohio coal industry.

Criterion 2: Capital and total annual cost analysis

The proposal contains a preliminary capital and total annual cost analysis of the process as currently configured (0 to 5 points). The basis shall be 7,446 hours of operation per year, 500 MW net 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: Objective feasibility

The clarity in stated objectives and feasibility of achieving those objectives (0 to 5 points). The application clearly addresses a problem, concept or question described within one or more of the areas of interest. 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).

Criterion 4: Leveraging

Leveraging of cost sharing funds from industry or government sources (0 to 4 points). One goal of the OCDO is that OCRC funds 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. Scores will be assigned using the following criterion:

| 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 direct funding from other government sources |
| 4 | Project has received direct funding from industry |

Criterion 5: Equipment and techniques availability

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 and patent applications

Publication of relevant research in peer-reviewed journals and applications for relevant patents (0 to 2 points). Reviewers will assign scores on this criterion as follows: one for the filing of a relevant patent application; one for peer-reviewed relevant paper submissions for publication; and two for filing both a relevant patent application and submitting a relevant peer-reviewed paper.

Criterion 7: Relevance

Relevance (0 to 5 points). The project demonstrates a high transferability to consumers of Ohio coal, which will lead to increases in the use of Ohio coal in an environmentally acceptable manner and be economically competitive with either existing technology or preferably competitive with natural gas combined cycle plants and has the potential to improve Ohio’s economy.

Criterion 8: Collaboration

Collaboration (0 to 4 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.

| Points | Criteria Description |
|--------|---|
| 0 | No effort was made to collaborate |
| 2 | Project demonstrates existence of a strategic partnership with industry/end-user partners that provides an advisory role for the project |
| 3 | Project demonstrates existence of a financial partnership with industry/end-user partners that provides use of their facilities, direct cast support, or other signs of significant collaboration |
| +1 | Project demonstrates existence of a partnership with industry/end-user partners that are located and operate in communities that have experienced the closure of an Ohio electric coal-fired generation unit, or closure of an Ohio coal mine within the past ten years |

Final Scoring

| | |
|---|-----------------------------|
| 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 4 Points) |
| 5. Equipment and techniques availability | ___ (0 to 2 Points) |
| 6. Publication and patent applications | ___ (0 to 2 Points) |
| 7. Relevance | ___ (0 to 5 Points) |
| 8. Collaboration | ___ (0 to 4 Points) |
| Total Score | ___ (0 to 32 Points) |