



Ohio Coal Development Office Strategic Plan

Core Objectives and Priorities for Action, 2008-09

Background

In 1984, Ohio legislators established the Ohio Coal Development Office (OCDO) to promote the increased use of Ohio coal. Specifically, OCDO was created to

“provide for the comfort, health, safety and general welfare of all employees and other inhabitants of this state through research and development (R&D) directed toward the discovery of new technologies or the demonstration or application of existing technologies to enable the conversion or use of Ohio coal as a fuel or chemical feedstock in an environmentally acceptable manner.”

OCDO was endowed by a 1985 Constitutional amendment authorizing the issuance of General Obligation bonds and creation of the Ohio Coal Research and Development Fund. Supplemented by General Revenue Appropriations for administrative costs, this fund supports OCDO work, which includes projects along the full research, demonstration and deployment (RD&D) spectrum, from basic research through pilot-scale test facilities to commercial-scale demonstration units. Since its inception, OCDO has awarded more than \$170 million for clean-coal technology research and development, leveraging an additional \$540 million in funds from other sources.

On July 1, 2003, the Ohio General Assembly transferred OCDO from the Ohio Department of Development to the Ohio Air Quality Development Authority (OAQDA). OCDO’s work to support the development and implementation of technologies that enable Ohio’s vast reserves of high-sulfur coal to be used in an economically and environmentally sound manner was viewed as complementary to OAQDA’s historic mission to improve the environment and drive economic development in Ohio by helping businesses comply with clean-air regulations and by supporting new clean-air technologies and energy sources.

One of OAQDA’s first actions was to commission an independent, third-party review of OCDO’s work to date. The purpose of the review was to highlight program successes,

identify existing and emerging challenges, and assess OCDO's ability to adapt its mission and activities to a rapidly changing energy landscape.

One of the major recommendations to emerge from the third-party review was that OCDO needed to engage in a strategic planning process that included (a) updating clear statement of OCDO's mission, and (b) development and implementation of a formal strategic plan with clear objectives, priorities, success indicators and timelines. The purpose of the plan is to guide OCDO's activities and provide a set of expected outcomes against which to evaluate the program's effectiveness. The third-party review also recommended that the plan be developed in collaboration with stakeholders and outside experts in relevant fields, with special focus on soliciting input from members of OCDO's Technical Advisory Committee.

Strategic Plan Development Process

Key components of the stakeholder engagement process culminating in the creation of this strategic plan document include the following:

- Telephone interviews with a select group of national and state leaders in the energy arena to help define the parameters of an effective survey instrument for soliciting input from a broad range of stakeholders
- Survey of a targeted and diverse list of stakeholders (coal industry, electric utility industry, research community, technology developers, environmental advocates, legislative and regulatory audiences) to solicit input on issues, needs and priorities to be considered in defining and focusing OCDO's future work
- Follow-up telephone or in-person interviews with selected survey respondents, as needed, to clarify their input
- Review and discussion of interview and survey feedback with members of the OCDO's Technical Advisory Committee (TAC)
- Joint work session involving OAQDA members, TAC members and staff to identify and prioritize issues shaping OCDO's future strategic direction
- Direct input from OAQDA members and staff

It should be noted that while most stakeholders agree that the OCDO program has generally been successful in its work, there clearly also exists a widespread concurrence with the third-party review's finding that the program's mission, objectives and activities need to be updated, clarified and prioritized.

Mission & Vision

OCDO's strategic planning process has clarified and affirmed that the **consensus mission, or purpose**, of the Ohio Coal Development Office is as follows:

To promote and assist in the development and commercialization of technologies and other advancements that enable the economic, efficient and environmentally

compatible use of Ohio coal for a broad range of public benefits within changing economic, political and regulatory conditions.

In executing this mission, OCDO will realize the following **vision** for the program, for Ohio coal and for the state and its citizens:

OCDO will lead state efforts to maximize the use of Ohio coal in an environmentally responsible manner, ensuring that coal continues to be a vital component of Ohio's energy resource portfolio and delivering optimal value to the state, its citizens and its business enterprises.

Relevant Trends, Projections and Other Strategic Considerations

At the time OCDO was established in 1984, achieving the goal of promoting the increased use of Ohio coal was primarily dependent on finding means to mitigate challenges associated with Ohio coal's physical/chemical, production and market constraints. Principal among these was the ability to burn Ohio coal within existing and proposed air-quality emissions restrictions.

Twenty-plus years later, a broader range of evolving and emerging considerations must be factored into OCDO's strategic planning. Three areas in particular are especially relevant:

Projected trends for energy supply and demand

Energy supply and demand trends are affected by a number of factors, including energy prices, economic conditions and advances in technology. All indications are that the next several decades will be marked by sustained higher prices for oil and natural gas, and that these price trends will force fundamental changes in the energy market. For example, economic considerations will affect fuel choice decisions in both the transportation and industrial sectors. Higher oil prices will increase the demand for unconventional fuels such as ethanol and bio-diesel, and are projected to stimulate coal-to-liquid fuel production. Higher natural gas prices are expected to reduce its use as a fuel for power generation and to stimulate the conversion of industrial boilers to coal as well as the development of renewable generation sources.

In contrast, factors such as the slow but continued improvement in coal mine productivity, the expected expansion of production capability, and competition from renewable and nuclear generation are expected to exert downward pressure on coal prices. Counterbalancing upward price pressure is expected from the need for additional base load generation, which will continue to be mostly coal-fired; from the deployment of a significant number of coal-to-liquid facilities; and from coal's capture of market share from natural gas.

These fundamental shifts will result in expansion of old markets and development of new markets for coal. Eastern coals will be used as feedstock to produce liquid fuels, synthetic natural gas and a myriad of industrial chemicals. Ohio coal will become a more valuable resource as a chemical feedstock. As more and more premium bituminous coals are used for higher-value end uses, lower-valued and generally lower-priced coals will be imported into the region to heat water for power production. Sub-bituminous coals will fall between these two in usage.

It is clear that coal will continue to play a significant role in meeting Ohio's power needs. Coal-fired power plants will continue to be the primary resource for meeting the expanding need for additional power generation. It is therefore anticipated that coal production will grow rapidly towards the end of the next two decades and that coal prices will remain relatively stable.

New environmental initiatives, including the imminent likelihood of greenhouse gas mitigation rules

The Clean Air Interstate Act (CAIR), which is intended to reduce interstate transport of fine particulate matter and ozone, will require further reductions of both SO₂ and NO_x emissions in two phases, beginning in 2009. (SO₂ and NO_x are precursors to particulate matter and ground-level ozone.) The Clean Air Mercury Rule (CAMR) will impose new limits on mercury emissions from new and existing coal-fired power plants with at least 25 Mw capacity and Combined Heat and Power (CHP) units larger than 25 Mw that sell at least one-third of their capacity. These mercury capture requirements will be implemented in two phases, beginning in 2010.

No environmental issue is more pressing, however, than carbon mitigation. A strong possibility exists that the United States will adopt a major global climate change initiative, including first-ever standards for CO₂ emissions, during the next decade. While the focus of such an initiative will be the control of greenhouse gases, it is likely also to include higher renewable energy standards and also policy incentives to encourage investments in clean coal and nuclear power as well as increased use of bio-fuel. This reality represents a potentially huge impact on Ohio with its substantial coal reserves and heavy reliance on coal-fired generation.

Evolution of existing technologies and the development of new technologies affecting the energy sector

A major dimension of the new vision for OCDO's role in promoting the use of Ohio coal is that the program will assert focused leadership in strategically vital areas of technology development. The program's near-term strategic direction must, therefore, be sensitive to the evolving technology landscape, both with regard to the evolution of existing technologies and the development of new technologies. It also must reflect thoughtful choices about which technologies offer the most promising pathways to a more vibrant future for Ohio coal and the greatest potential for alignment with state energy, environmental and economic development goals.

Determination of OCDO's strategic direction has taken into consideration a number of technology realities:

- Advanced coal power systems, such as the Integrated Gasification Combined Cycle (IGCC) and Ultra-supercritical (USC) pulverized coal boilers, which can increase conversion efficiency by as much as 20 percent, appear to be primed for short-term commercial deployment.
- Existing commercial clean coal technologies such as Pulverized Coal Combustion (PC) and Circulating Fluidized Bed (CFB) technologies, using sub-critical and supercritical steam conditions, are expected to remain the mainstays of the generation fleet. Technologies that improve environmental performance and that can be cost-effectively applied to existing generation will be at a premium.
- While the separation of CO₂ from flue gas and disposal of CO₂ in geologic formations is a relatively new area of research, projects like FutureGen are moving toward construction and could demonstrate large scale CO₂ sequestration in the early part of the next decade. Meanwhile, other carbon capture and sequestration options are being pursued under current OCDO grants, such as CCP sorbents and oxy-combustion. In addition, the Midwest Regional Carbon Sequestration Partnership is aggressively pursuing the characterization of Ohio geologic formations in terms of potential for CO₂ sequestration and will likely demonstrate CO₂ injection in Ohio within three years. A clearer understanding of geologic sequestration and the impact of CO₂ and other combustion gases in various geologic formations will be critical for the safe, effective, long-term use of sequestration. (Geologic sequestration includes sequestration for enhanced oil and gas recovery as well as sequestration in deep formations.)
- While the current favored technology for converting coal to liquid fuel is indirect coal liquefaction, there are significant issues associated with coal liquefaction that must be addressed to hasten deployment of the technology and to guide related RD&D efforts. For example, does Ohio coal offer advantages over other coals in this application? Do Ohio coal and Western coal blends offer advantages over unblended coal streams in this process? It is expected that OCDO will participate in development of coal-to-liquid technologies in the intermediate term; meanwhile, other government entities will continue to support the development of other energy sources such as ethanol and biofuels. (OCDO will cooperate with these efforts, particularly with feedstock blending opportunities.)
- Various types of fuel cells are under development on an intermediate time frame, as well as many other promising technologies with longer-term potential, including (a) chemical looping coal combustion, (b) production of syn-gas with the ideal ratio for the Fischer-Tropsch chemical process, (c) catalysts suitable for solid oxide fuel cells, (d) sorbents for mercury capture, and (e) direct coal fuel cells.

Key Opportunities & Challenges

Projected global energy market trends, new and anticipated environmental initiatives, and the evolution of existing and new technologies can be expected to create significant opportunities – and challenges – for Ohio coal. Primary among them are the following:

- There will be an imperative to maintain and expand Ohio's existing fleet of coal-fired power plants. Even if IGCC and/or other advanced technology plants are built in Ohio within the next 15 to 20 years, the majority of Ohio's power generation will come from continued and expanded use of PC coal-fired power plants over a transition period of many years.
- Because the most effective, and probably the most cost-effective, means of reducing greenhouse gas emissions is to reduce the levels that initially are generated during the conversion process, there will be significant incentives for optimizing generating efficiency through power cycle innovations to reduce both generating costs and emissions.
- While Pulverized Coal Combustion (PC) and Circulating Fluidized Bed (CFB) technologies will remain the mainstays of Ohio's existing generation fleet, there will be a keener focus on the application of clean-coal technologies in building new coal-fired generation.
- With ever-growing concerns about global warming and climate change, there will continue to be increasingly strong interest in demonstrating carbon capture and sequestration technologies, including oxy-combustion technologies that are effective and economic. In particular, the long-term life of PC coal-fired plants would be greatly enhanced if the existing fleet could be retrofitted with economical CO₂ management systems and new plants were designed with CO₂ management systems.
- To help mitigate high oil and natural gas prices, there will be a growing demand for alternate liquid fuels. While some of the demands for alternate fuels will be addressed by the use of ethanol and biofuels, the need for additional liquid fuels will require viable commercial coal-to-liquid fuel conversion technologies. Coal-to-liquid technology has the potential to become a major source of high-value coal usage for Ohio.
- As emissions from industrial boilers become more significant, leading to increased emission standards on smaller industrial boilers, there will be a need to either develop smaller industrial boilers or to cost-effectively apply existing technologies at the smaller scale.

Strategic Objectives and Priority Actions

OCDO has outlined a limited set of strategic objectives and priority actions designed to seize evolving and emerging market opportunities. These objectives and actions will support attainment of the central goal of reducing Ohio's and the nation's reliance on foreign energy sources by creating in Ohio the ability to maximize the use of coal both

(a) as an industrial energy source and (b) to produce electricity, transportation fuels and chemicals – all while minimizing environmental impact.

To attain this goal, OCDO will focus its efforts in 2008 and 2009 on four strategic objectives and corresponding priority actions:

1. **Maximize the use of coal, including expanding the use of coal beyond electricity generation, to supply Ohio's energy needs.**

- a. Support the development of improved retrofit technologies applicable to existing coal-fired generating units. The focus of these technologies would be (i) to increase generating efficiency to significantly reduce CO₂ emissions; (ii) to reduce emissions of conventional pollutants to negligible levels; and (iii) to develop methods for capture and sequestration of CO₂.
- b. Provide incentives to upgrade Ohio's existing fleet of coal-fired electric generation plants. Work with appropriate government agencies to facilitate modification of existing units through the use of advanced technology.
- c. Support the development of coal-fired technologies capable of cost-effectively supplying the energy needs of Ohio's industrial complex.
- d. Support development of advanced coal-based power- and fuel-producing systems. These could include IGCC, Oxy-combustion systems, Ultra-supercritical pulverized coal units, chemical looping systems, etc.
- e. Support coal-to-liquid fuels conversion technologies.

2. **Reduce the environmental impact of continued, as well as additional, coal usage.**

- a. Support development of cost-effective CO₂ capture and sequestration technologies.
 - i. Provide support to continually improve CO₂ capture technology.
 - ii. Support surveying and cataloging Ohio's candidate CO₂ reservoirs.
 - iii. Support research addressing CO₂ purity requirements for saline aquifer sequestration.
 - iv. Support work aimed at addressing the challenges of CO₂ transport.
- b. Support development of effective mercury capture technologies.
- c. Provide incentives for upgrading existing industrial and generating facilities.
- d. Support high-volume fly ash and flue gas de-sulfurization byproduct utilization in mine remediation.

3. **Support university research through the Ohio Coal Research Consortium.**

- a. Explore novel approaches to increased coal conversion efficiency.
- b. Explore novel and less costly approaches to the capture of coal plant pollutants.
- c. Support research projects through bench-scale demonstration phase.

4. Advocacy

- a. Work with legislators and regulators, and through properly targeted media outreach and public education initiatives to help create (i) a regulatory environment that enhances the competitiveness of Ohio coal, and (ii) a climate of informed and supportive public opinion that understands coal's vital role in meeting Ohio's energy needs and powering the state's economy.

Guiding Principles for Project Funding Decisions

Guiding principles for project selection should be developed by the Technical Advisory Committee with assistance of the staff within funding cycles to allow for maximum flexibility and consideration of the specific details of a proposed project. However, both the Third Party Review and this strategic planning process identified key elements that should be considered, better defined and weighted in funding decisions.

These include:

- Mission impact (clear and strong fit with mission and stated OCDO objectives)
- Technical risk (potential for technical success and moving to the next stage of development or commercialization)
- Commercial risk (likelihood of near-term commercial success, both the competitive performance of the technology and the capability of the applicant commercialize the technology)
- Exclusivity – (projects that would not otherwise be pursued in private sector without OCDO support)
- Leveraging potential (ability to leverage federal and private research dollars for specific projects)
- Direct financial return (likelihood of commercial licensing and associated royalty revenue streams)
- Immediacy of benefits (time frame within non-financial benefits will be realized)
- Research portfolio balance (contribution to a balanced research portfolio of basic research, technology development and both pilot-scale and full-scale demonstration)

Administrative Implications

In the past, the areas considered for OCDO funding were dictated by the projects proposed as responses to broadly framed OCDO requests for proposals. While there may have been common threads in the varied project proposals, and a great number of “continuation” projects, there was no clearly defined direction or overall goal for the body of R&D being conducted. OCDO selected those projects deemed generally most worthy rather than those projects best aligned with any specific strategic direction or focus.

OCDO will solicit proposals that are consistent with the objectives and priorities identified in this Strategic Plan. In addition, approved projects should follow a logical development chain within specific technology areas. Proactively *leading* technology development in this manner will require OCDO to have access, either through permanent staffing or through consultant services, to greater technical, analytical and financial expertise than the program has required in the past.

Metrics/Timelines for Evaluating Success

The Strategic Objectives and Priority Actions section above identifies areas of study to pursue. In general all projects will have the ultimate goal of the demonstration of technologies that reduce the cost of compliance of usage of Ohio coal with current and anticipated environmental regulations and/or increases in efficiency in conversion of coal to energy or chemicals. Therefore, metrics will be developed and applied on a project by project basis within the following parameters:

- 1) Demonstration Projects – a successful project will demonstrate use of Ohio coal in a system that is equal to or better than the state of the art in terms of reliable operation, process energy efficiency, cost of operation and cost of emission control. Although not all demonstration projects must have cost share by DOE or other governmental agencies, however, the overall goal of the OCDO program is 50% or more cost share from federal government sources for demonstration projects. In addition, a substantial match will be expected from entities directly benefiting from the grant. Metrics for evaluation of a given project will be established at the beginning of a project with specific targets for increased efficiency, reliability, cost reduction, etc. The OCDO goal will be that about 50% of these projects will be considered successful based upon the goals established at the beginning of the project.
- 2) Pilot Scale Projects – these projects range in scale from the first step beyond the university laboratory to as large as 1/10 of a commercial process. Risks in this stage are high especially in the attempt to build a first of a kind model of a process based upon data from the laboratory where many details of stream flow, heat exchange and temperature control, materials of construction, etc. are considered for the first time. Again, metrics for evaluation of a given project will be established at the beginning of a project with

specific targets for increased efficiency, reliability, cost reduction, etc. The OCDO goal will be that about 25% of these projects will be considered successful based upon the goals established at the beginning of the project.

3) University Consortium Projects and Proof of Concept projects – these are very high risk projects in terms of those likely to lead to a demonstration scale project and commercially adopted concepts. Still, this is the area of the OCDO program that generates new ideas with the potential to dramatically change methods for conversion of coal to energy and chemicals and reduction in costs of emission controls. The success of this level of work is judged by the number of students trained for research in coal issues, patents filed and awarded for novel concepts, and peer reviewed papers published. The OCDO goal would be that one in ten of these projects would be considered worthy of scale up and testing at the pilot plant level.

It is important to identify two elements that, while providing some measure of accomplishment, may not be appropriate as stand-alone indicators of the program's success. The first is the volume of coal mined in Ohio. Annual tonnage numbers and mining sector employment figures are important. But they are determined by economic and technology factors beyond the control or influence of OCDO research and development work. At best, these numbers can provide some indication of the impact of clean coal technology on the long term trends of Ohio coal production. Secondly, counting "successful" projects may provide a distorted view of a program intended to push the development of advanced technologies. That development process entails, and may actually require, a number of "failures" in order to advance both knowledge and application of new technologies.