

Capturing the Emerging Market for Climate-Friendly Technologies: Opportunities for Ohio

Executive Summary

Increasing certainty that humans are changing the earth's climate through emissions of greenhouse gases is creating a new market for climate-friendly products and services. As states and nations begin to address climate change by regulating greenhouse gas emissions and encouraging the use of clean energy, demand is growing for technologies such as wind power, biofuels, and cleaner coal power plants. Ohio's manufacturing and agriculture sectors are already providing some of these solutions, and the state's economy stands to benefit as a supplier of the technologies and strategies to tackle climate change. This paper briefly describes the factors driving the growing demand for climate-friendly technologies, some of the key existing companies, organizations, and resources in Ohio, and the potential for Ohio to become a leading supplier of climate solutions. These solutions include a new generation of lower-emitting coal technologies, components for wind turbines, and the feedstocks and facilities to produce biofuels. The paper concludes with recommendations for how Ohio can capitalize on these emerging opportunities. These recommendations include focusing and coordinating state funding of climate technology programs, promoting the development of climate-related industry clusters, and exploring export opportunities to states and countries with existing carbon constraints.

Introduction

The U.S. National Academy of Sciences, and the science academies of the other G8 nations and Brazil, China, and India have concluded that the global climate is warming in large part as the result of emissions of carbon dioxide and other greenhouse gases (GHG) from human activities, mainly the burning of coal and oil. Scientists predict that the world will continue to warm in the century ahead, with significant impacts on sea levels and weather patterns, and adverse consequences for human health, ecosystems, and the economy. According to experts, avoiding the most severe impacts will require substantial reductions in greenhouse gas emissions. Based on this scientific consensus, a growing number of GHG emission reduction policies and strategies, briefly described in the first section of this paper, have been implemented worldwide, both in the public and the private sectors.

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The emergence of GHG emission reduction and emission trading initiatives at the international, national, and sub-national levels has given rise to a fast-growing “cleantech” industry and to a strong demand for climate-friendly technologies. As discussed in this paper, this emerging market presents a number of economic development opportunities for the state of Ohio.

The Ohio economy has the opportunity to gain a competitive advantage in the development and commercialization of GHG emission reduction technologies and services. Ohio’s economic base – especially manufacturing, coal power, and agriculture – could potentially become a major supplier of climate-friendly technologies. Ohio businesses have developed extensive expertise in these sectors of the economy.

Ohio has the research facilities, human capital, and resources to develop emissions-reducing technologies and products. Ohio is already home to significant activity in climate-related technologies and several in-state businesses are developing technologies for the rapidly growing renewable energy market. However, further efforts are needed to make Ohio a leader in the development and commercialization of climate-friendly technology. Several public-private partnerships have been established in Ohio to conduct innovative research, translate scientific discoveries into applicable technologies, as well as to commercialize products. Some of these partnerships have focused on low-GHG technology.

This paper discusses the main characteristics and the limits of these initiatives, and concludes with a series of policy recommendations that would strengthen the technological backbone of Ohio’s economy and revitalize its manufacturing sector through leadership in the provision of GHG reduction technology.

International, Regional, and Voluntary GHG Emission Reduction Efforts

In the last decade, governments and businesses have begun to address GHG emissions in an effort to mitigate climate change. Both the public and private sectors have implemented GHG emission reduction policies and strategies, and these efforts have accelerated in the last few years.

In 1997, the Parties to the United Nations Framework Convention on Global Climate Change agreed to the Kyoto Protocol, which requires developed countries to reduce their GHG emissions by an average of 5 percent below 1990 levels by 2012. The Protocol entered into force in 163 countries in February 2005, prompting emission reduction commitments in all of the most industrialized countries, with the exception of the United States and Australia.

In order to meet its Kyoto target – reducing GHG emissions 8 percent below 1990 levels by 2008-2012 – the European Union established the European Union Emissions Trading System (EU-ETS). This system represents the world’s first large-scale greenhouse gas trading program, covering six major industrial sectors and over 12,000 installations in the 25 member countries of the EU, for a total of \$37 billion of estimated value of annual emission allowances allocation.¹ Mandatory GHG emission trading

¹ Thomson, V.E. 2006. *Early Observations on the European Union’s Greenhouse Gas Emission Trading Scheme: Insights for United States Policymakers*. Pew Center on Global Climate Change: Arlington, VA. <http://www.pewclimate.org/docUploads/Early%5FObservations%5Fon%5FEUETS%5FThomson%2Epdf>
Last visited: 07/18/2006.

systems have been implemented or are under consideration in other industrialized countries as well, such as Japan, Canada, and New Zealand.

Despite the withdrawal of the United States from the Kyoto Protocol and the lack of a national climate policy, almost every U.S. state has adopted one or more policies that reduce GHG emissions, either directly by adopting explicit targets and policies for reducing GHG emission, or indirectly by expanding clean energy and energy efficiency.

Many of these states participate in regional initiatives on climate change or clean energy. In December 2005, seven New England and Mid-Atlantic States (Connecticut, Delaware, Maine, New Hampshire, New Jersey, New York, and Vermont) established the Regional Greenhouse Gas Initiative (RGGI). Maryland committed to join RGGI in April 2006. RGGI will cap and trade carbon dioxide emissions from power plants of at least 25 megawatts that burn more than 50 percent fossil fuel. RGGI sets a cap on power plant emissions at approximately current levels of 120 million tons of carbon dioxide between 2009 and 2015, which then declines 10 percent by 2019, and it allows sources to trade GHG emissions allowances.

Other regional initiatives aimed at advancing clean energy and/or reducing GHG emissions include:

- the West Coast Governors' Global Warming Initiative;
- the Southwest Climate Change Initiative - launched in February 2006 by governors of Arizona and New Mexico;
- Powering the Plains, which involve participants from the Dakotas, Minnesota, Iowa, Wisconsin, and the Canadian Province of Manitoba;
- the Western Governors' Association Clean and Diversified Energy Initiative involving 18 western states.

Furthermore, several recent signs seem to suggest that a federal mandatory GHG emission reduction system might be established in the United States in the next few years. For instance, the number of legislative proposals that specifically address climate change has continued to grow in the last couple of years; over one hundred such bills have been introduced so far in the current two-year session of Congress.

Private actors have also established GHG emissions trading schemes, such as the Chicago Climate Exchange (CCX), a voluntary GHG emission registry, reduction and trading system that applies to members' emission sources in the United States, Canada, Mexico, Brazil, and other countries. CCX members make a voluntary – but contractually binding – commitment to reduce emissions of these GHG gases below 1998-2001 levels by 4 percent by December 2006 and by 6 percent by 2010.

Furthermore, an increasing number of companies have taken significant steps to reduce their emissions by implementing targets and other innovative programs in areas such as energy, carbon storage, and waste management. Wal-Mart CEO Lee Scott has committed his company to invest approximately \$500 million annually in technologies that will reduce Wal-Mart's global GHG emissions by 20 percent over the next 7 years. DuPont, which runs a major plant in Circleville, Ohio, has committed to reduce its GHG emissions by 65 percent from 1990 levels by 2010. BP, owner of Ohio's largest oil refineries (located in Toledo), has committed to reduce its GHG emissions by 10 percent over the same period. Companies have also emerged with aggressive strategies to capture a significant share of the surging clean energy market. GE recently announced that it

would double its yearly investment in cleaner technologies from \$700 million in 2004 to \$1.5 billion in 2010, while BP Alternative Energy estimates that BP's current and future investments in solar, wind, gas, hydrogen and combined-cycle-gas-turbine (CCGT) power generation could amount to \$8 billion over the next ten years.

The Emerging Market for Climate-Friendly Technologies: New Business Opportunities

The emergence of GHG emission reduction initiatives and emission trading schemes at the international, national, and sub-national levels, and the expectation that the rest of the world will follow suit, have given rise to a fast-growing cleantech industry and to a strong demand for climate-friendly technologies. Venture capital investment in U.S. cleantech startups totaled \$1.4 billion in 2005, representing the sixth largest investment sector for venture capitalists. Total investment (government and private, including venture capital) in renewable energy (the largest subset of cleantech) totaled \$7 billion in 2004, the most recent year for which figures are available².

The demand for climate-friendly technologies and products and the emergence of a carbon-constrained economy, provide a number of economic development and business opportunities. U.S. businesses could gain a considerable competitive advantage in the development and commercialization of GHG emission reduction technologies, products, and services.

Active business engagement in this high-tech market could be extremely beneficial to the U.S. economy, due to the typically high-skill/high-wage jobs associated with high-tech firms and the innovation in products and processes generated by the high-tech industry. These efforts would also help the United States prepare for potential domestic GHG regulations, building the know-how that businesses will need to meet such regulations in a cost-effective way, thus significantly reducing future compliance costs.

Risks and Opportunities for the Ohio Economy in a Carbon-Constrained World

As a carbon-constrained economy begins to emerge, it is especially important that Ohio begin strategic planning toward a more climate-friendly production system, as a means to protect the long-term vitality and competitiveness of its energy-intensive and manufacturing-based economy, especially in the face of potential domestic GHG regulations.

At the same time, the emergence of a market for climate-friendly technologies and carbon reductions provides the Ohio economy with a number of opportunities to gain a considerable competitive advantage in the development and commercialization of GHG emission reduction technologies and services, a market with strong growth potential.

Climate-Friendly Industry: Opportunities for the Traditional Sectors of the Ohio Economy

² Burtis, P.R., B. Epstein, and N. Parker. 2006. Creating Cleantech Clusters: 2006 Update. How Innovation and Investment Can Promote Job Growth and a Healthy Environment. <http://www.e2.org/ext/doc/2006%20National%20Cleantech%20FORMATTED%20FINAL.pdf>. Last visited: September 15, 2006.

Ohio's economic base – manufacturing, coal, and agriculture – could potentially supply significant climate-friendly technologies and GHG emission reductions.

Coal is the primary fuel for Ohio's abundant and relatively inexpensive electrical supply, with coal-fired plants producing 86.5 percent of the state's electricity. Ohio businesses and utilities have been leaders in deploying clean coal technology since the mid-1980s³. The state is actively involved in the development of this technology, mainly through the Ohio Coal Development Office⁴ (OCDO), which co-funds the development and implementation of technologies that can use Ohio's vast reserves of high sulfur coal in an environmentally friendly manner. Since 1984, OCDO has provided \$170 million in funding or co-funding for 288 projects. Furthermore, Ohio has the subterranean capacity to “sequester” carbon in underground geologic formations. This technology allows coal plants to store captured carbon emissions underground, where the gases do not contribute to climate change.

Beyond coal, other key sectors of Ohio's economy, such as manufacturing and agriculture, have the potential to become major suppliers of GHG emission reduction technologies and processes. Historically, Ohio has derived economic strength from a large manufacturing industry. Despite the steady decline of this industry in the last few decades, manufacturing remains the largest sector of the Ohio economy, accounting for 20 percent of the Gross State Product. Ohio is the second largest auto manufacturing state and leads the nation in production of electrical equipment and appliances (9.3 percent of the national industry total) and plastic and rubber products (7.9% of the national industry total)⁵. Ohio also is the seventh largest exporting state. In 2005, Ohio merchandise exports had a total dollar value of \$34.8 billion; four product categories combined (machinery, vehicles, electrical machinery, and plastics) accounted for \$21.6 billion in exports⁶.

The advanced manufacturing skills of the Ohio workforce could help create successful low-GHG products for export to regions in need of such technologies to satisfy emission regulations. Within the automotive sector in particular, investment in the development of advanced engine technologies, such as hybrid electric vehicles and computer controlled combustion, would help Ohio maintain its economic strength in this important industry (OEC, 2005). The development and commercialization of climate-friendly technologies and products for the automotive sector would also help reduce GHG emissions from the transportation sector, which accounts for almost one third of total U.S. CO₂ emissions.

Agriculture has always represented another important economic sector of the Ohio economy and currently accounts for nearly \$1.5 billion of Ohio's economy.⁷ Agriculture can play a key role in reducing greenhouse gas emissions. For example, less productive agricultural lands can be reforested with carbon-dioxide consuming trees; and farming practices can be altered to absorb and retain carbon in agricultural soils. These actions would also help improve soil, water and air quality, increase wildlife habitat, and

³ Ohio Coal Development Office, *Ohio Coal Development Agenda*, March 2001.

⁴ This office is located within the Ohio Air Quality Development Authority (OAQDA).

⁵ Larrick, Don, “Ohio's Gross State Product,” March 2005, p. 11.

⁶ Ohio Department of Development, Office of Strategic Research. 2006. *Ohio Exports 2005*. <http://www.odod.state.oh.us/research/files/b000000001.pdf> Last visited: 07/17/2006.

⁷ Ohio Department of Development: Office of Strategic Research, “Ohio's Gross State Product,” March 2005, available at: <<http://www.odod.state.oh.us/research/files/e100.pdf>>, p. 12)

provide additional recreational opportunities. In addition, biomass from agricultural sources could be used to produce biofuels for transportation and power generation.

Ohio's agricultural sector is well suited for the development of advanced clean energy technologies, which can create development opportunities for Ohio's rural economies. Many of these opportunities arise from the rapidly growing biofuel industry. According to Urbanchuk and Kapell (2002⁸), an ethanol plant producing 40 million gallons per year creates \$142 million in local economic activity during the construction phase and buys \$56 million in goods and services annually, 71 percent of which goes to farmers for grain. According to the same study, corn-based ethanol plants typically raise crop prices five to ten cents per bushel in a 50-mile radius around the plant.

Production of ethanol from dedicated cellulosic feedstocks such as switch grass, wood, agricultural residues and municipal refuse has even greater potential to reduce GHG emissions and create value from waste streams. Cellulosic ethanol results in substantially lower life-cycle GHG emissions than corn-based ethanol, since it requires much less energy and much less fertilizer than ethanol from corn.⁹ The production of ethanol derived from cellulose may provide a significant opportunity for Ohio, and more work will be required to develop this potential. The Ohio Agricultural Research and Development Authority could provide the research required for the development and commercialization of this technology.

The Economic Benefits of Investments in the Clean-Tech Industry

Two of the most promising sectors of the clean-tech industry are represented by renewable energy (the largest subset of cleantech) and energy efficiency technologies.

The clean energy industry has grown significantly in the last few years and is expected to expand further over the medium term. For instance, according to a study prepared for the United Nations Environment Program, global sales in the renewable energy market will reach \$234 billion to \$625 billion by 2010, and as much as \$1.9 trillion by 2020. The market in the United States alone is expected to grow 34 percent by 2020 (Innovest Strategic Value Advisors, 2002).¹⁰ According to a recent study by the Union of Concerned Scientists, the Renewable Portfolio Standards that have been introduced in 22 states and the District of Columbia in the last few years will drive 32,000 MW of new renewable power production by 2017 – \$32 billion in new investments.¹¹

The hypothesis that investments in renewable energy and energy efficiency measures have a positive impact on the economy has been corroborated by numerous

⁸ Urbanchuk, J.M., J. Kapell. 2002. *Ethanol and the Local Community*.

http://www.ethanolrfa.org/objects/documents/120/ethanol_local_community.pdf. Last visited: 06/01/2006.

⁹ Greene, D.L., A. Schafer. 2003. *Reducing Greenhouse Gas Emissions from U.S. Transportation*. Pew Center on Global Climate Change: Arlington, VA.

¹⁰ Innovest Strategic Value Advisors. 2002. *Climate Change and the Financial Services Industry: Module I-Threats and Opportunities*. Prepared for the UN Environmental Program Finance Initiatives Climate Change Working Group.

¹¹ The Union of Concerned Scientists. 2005. Fact Sheet: Renewable Electricity Standards at Work in the States. http://www.ucsusa.org/clean_energy/clean_energy_policies/res-at-work-in-the-states.html. Last visited: 06/01/2006.

economic studies worldwide. A White Paper of the European Commission,¹² published in 1997, concluded: “the development of renewable energy sources can actively contribute to job creation, predominantly among [...] small and medium sized enterprises” (European Commission, 1997, 4). The model used in this White Paper predicted the creation of 500,000 new jobs in the renewable energy sector in Europe by 2010. The White Paper also concluded that the expected growth in energy consumption in many developing countries – which can be satisfied, at least in part, using renewable energy – offers interesting business opportunities for the European renewable energy sector.

In a more recent study, Burtis et al. (2006¹³) tried to assess the positive impacts on the U.S. economy of the cleantech industry, including renewable energy and energy efficiency technologies. Modeling by the authors (based on thirty years of data from the National Venture Capital Association) suggests that investments in renewable energy generation create more jobs per unit of generation capacity than investments in traditional (non-renewable energy) projects. According to Burtis et al. (2006), every \$100 million of venture capital money “could help spur the creation of 2,700 direct jobs at venture-backed companies, many more indirect jobs, and \$500 million in incremental annual revenue over the subsequent two decades” (Burtis et al., 2006, 10).

Kammen et al. (2004¹⁴) reviewed 13 independent reports and studies that analyzed the economic and employment impacts of the clean energy industry in the United States and in Europe. Although these studies employ a wide range of methods, making a direct comparison of the numbers difficult, clear general conclusions can be drawn:

- “the renewable energy sector generates more jobs per megawatt of power installed, per unity of energy produced, and per dollar of investment, than the fossil fuel-based energy sector” (Kammen et al., 2004, 3). For instance, according to a REPP study,¹⁵ the wind industry and the solar PV industry generate, respectively, 5.7 and 5.65 person-years of employment per million dollars in investment (over 10 years), while every million dollars invested in the coal industry generates only 3.96 person-years of employment, over the same period.
- “embedding support for renewables in a larger policy context of support for energy efficiency, green building standards, and sustainable transportation will greatly enhance net positive impacts on the economy” (Kammen et al., 2004, 3).

¹² European Commission. 1997. *Energy for the Future: Renewable Sources of Energy. White Paper for a Community Strategy and Action Plan*. http://ec.europa.eu/energy/library/599fi_en.pdf. Last visited: 06/01/2006.

¹³ Burtis, P.R., B. Epstein, and N. Parker. 2006. *Creating Cleantech Clusters: 2006 Update. How Innovation and Investment Can Promote Job Growth and a Healthy Environment*. <http://www.e2.org/ext/doc/2006%20National%20Cleantech%20FORMATTED%20FINAL.pdf>. Last visited: 06/01/2006.

¹⁴ Kammen, D.M., K. Kapadia, and M. Fripp. 2004. *Putting Renewables to Work: How Many Jobs Can the Clean Energy Industry Generate?* Renewable and Appropriate Energy Laboratory, UC Berkeley. <http://rael.berkeley.edu/files/2006/Kammen-Renewable-Jobs-2006.pdf>. Last visited: 06/01/2006.

¹⁵ Singh, V., J. Fehrs. 2001. “The Work that Goes into Renewable Energy”. http://www.crest.org/articles/static/1/binaries/LABOR_FINAL_REV.pdf. Last visited: 06/01/2006.

A vigorous cleantech industry could be particularly beneficial to two sectors of the economy: manufacturing and agriculture.

According to Sterzinger and Svrcek (2004¹⁶), the cleantech industry could help offset the decline of the traditional U.S. manufacturing base. A state's ability to capture these markets and create new jobs may depend in large part on whether it can participate in a significant portion of the supply chain. The Union of Concerned Scientists projects that a 20 percent market share of renewable energy by 2020 in the United States would create more than 350,000 new jobs, most of which would be concentrated in the manufacturing sector (The Union of Concerned Scientists, 2005a).¹⁷ While this type of analysis may be on the high end of the range of possible job creation numbers, further study of the opportunities for growth in these sectors is warranted, especially for states that are already involved in markets for intermediary renewables components. An analysis of the potential supply chain for wind turbine components indicates that the U.S. states that have lost the most traditional manufacturing jobs in recent years are those best positioned to capture the new manufacturing jobs that will be needed as the renewable energy industry expands (Sterzinger, G., M. Svrcek. 2004). A report by the same authors ranked Ohio's potential for job creation from the expansion of the wind industry as second only to California.¹⁸ While the cost of wind power has fallen dramatically as the technology matures and manufacturers realize economies of scale, electricity from wind power is not yet competitive in all markets.

Another study (The Energy Foundation, 2005)¹⁹ focused on the development opportunities created by the biofuel and windpower industries for rural economies. According to this report, "advanced clean energy technologies can make the Ag-Energy sector a new engine of economic growth, tipping rural economies from economic stress to prosperity" (The Energy Foundation, 2005, 5).

The windpower industry, with its high growth rate,²⁰ appears to yield the highest economic benefits for rural economies. A report prepared by Northwest Economic Associates for the National Wind Coordinating Committee²¹ showed total local annual economic impacts of three working wind farms in Minnesota, Oregon, and Texas. Annual landowner revenues, after taxes, ranged from \$50,000 to \$500,000, while annual tax

¹⁶ Sterzinger, G., M. Svrcek. 2004. *Wind Turbine Development: Location of Manufacturing Activity*. <http://www.crest.org/articles/static/1/binaries/WindLocator.pdf>. Last visited: 06/01/2006.

¹⁷ The Union of Concerned Scientists. 2005a. *Renewing America's Economy*. http://www.ucsusa.org/assets/documents/clean_energy/Renewing-Americas-Economy-2005.pdf. Last visited: 06/01/2006.

¹⁸ Sterzinger, G., M. Svrcek, 2005. *Component Manufacturing: Ohio's Future in the Renewable Energy Industry*. Renewable Energy Policy Project.

¹⁹ The Energy Foundation. 2005. *The New Harvest: Biofuels and Windpower for Rural Revitalization and National Energy Security*. <http://www.eesi.org/programs/Agriculture/reports/NewHarvestExecSum.pdf>. Last visited: 06/01/2006.

²⁰ According to a study prepared for UNEP, wind power generation should be producing sales of \$150 billion to \$400 billion worldwide by 2020 (Innovest Strategic Value Advisors. 2002. *Climate Change and the Financial Services Industry: Module 1-Threats and Opportunities*. Prepared for the UN Environmental Program Finance Initiatives Climate Change Working Group).

²¹ Northwest Economic Associates. 2003. *Assessing the Economic Development Impacts of Wind Power*. Prepared for National Wind Coordinating Committee. http://www.nationalwind.org/publications/economic/econ_final_report.pdf. Last visited: 06/01/2006.

revenues ranged from \$242,000 to \$611,000. As pointed out by Hopkins (2003²²), for a 250-acre farm, with income from wind at approximately \$55 per acre, the annual income from a wind lease would be \$14,000, with very few acres removed from production.

However, “the flow of benefits to agriculture would be particularly strong to the extent that biomass became a more important energy source” (Dumas, 2006, 22).²³ Urbanchuk and Kapell (2002)²⁴ found that an ethanol plant producing 40 million gallons per year adds \$110 million to the local economic base and at least \$1.2 million to local and state tax revenues.

Another economic benefit associated with cleantech, and especially with renewable energy, is represented by the tax revenue. Generating power from renewable resources contributes more tax revenue than generating the same amount of power from conventional energy sources. As an example, the California Energy Commission has found that solar thermal power plants yield twice as much tax revenue as conventional, gas-fired plants (U.S. DoE, 1997).²⁵

Ohio Businesses in the Climate-Friendly High-Tech Market

Ohio is currently home to significant activity in the realm of climate-related technologies and several instate businesses are developing technologies for the renewable energy market. Wind energy represents one of the fastest growing segments of this market. In the United States, electricity produced from wind sources increased by more than 35 percent in 2005, surpassing 9,200 MW by the end of that year.²⁶

Historically, Ohio has been the center of innovation for many of the major developments in wind technology. The first large windmill for the production of electricity was built in Cleveland in 1888, while modern commercial wind turbines are direct descendants of the first two-bladed wind turbine for electric power production that was produced in the 1970s by NASA at its Cleveland Research Center.²⁷ In part due to these early technological developments, Ohio has become a leading U.S. manufacturer of wind turbine components. Several Ohio-based firms, including Parker Hannifin, Owens Corning, and Timken Steel, are among the leading suppliers for this industry. As the demand for wind technologies increases, it is crucial that these businesses continue to

²² Hopkins, B. 2003. *Renewable Energy and State Economies*. The Council of State Governments: Lexington, KY.

²³ Dumas, L.J. 2006. *Seeds of Opportunity: Climate Change Challenges and Solutions*. Prepared for the Civil Society Institute. <http://www.resultsforamerica.org/calendar/files/041906%20Seeds%20of%20Oppty%20Dumas%20report%20FINAL.pdf>. Last visited: 06/04/2006.

²⁴ Urbanchuk, J.M., J. Kapell. 2002. *Ethanol and the Local Community*. http://www.ethanolrfa.org/objects/documents/120/ethanol_local_community.pdf. Last visited: 06/01/2006.

²⁵ U.S. Department of Energy, National Renewable Energy Laboratory. 1997. *Dollars from Sense. The Economic Benefits of Renewable Energy*. <http://www.nrel.gov/docs/legosti/fy97/20505.pdf>. Last visited: 06/01/2006.

²⁶ American Wind Energy Association. 2005. “U.S. Wind Industry to Break Installation Records”. November.

²⁷ Sterzinger, G., Svrcek. 2004. *Wind Turbine Development: Location of manufacturing Activity*. <http://www.repp.org/articles/static/1/binaries/WindLocator.pdf>. Last visited: 08/18/2006.

play a leading role in this expanding market, and that the Ohio economy is able to attract foreign investments in this sector, as is its neighbor state Pennsylvania.²⁸

Ohio businesses are playing a role in the growing solar energy market as well. First Solar, headquartered in Arizona but with significant operations in Ohio, is a leader in the development and manufacturing of solar collection systems. Parker Hannifin, headquartered in Cleveland, is developing a hydraulic drive system that can precisely position solar collectors, thereby increasing their efficiency.

Ohio also has the potential to become a leader in the production and commercialization of fuel cell technology, which produces electricity through the combination of hydrogen and oxygen. This technology can provide a carbon-free fuel source for vehicles, as long as the process that produces the hydrogen is carbon-free (for example, electrolysis powered through renewable energy sources). Fuel cell technology research and development has been supported by several state-funded programs described in the next section.

Business development on and around the initiatives described above could boost Ohio's productivity and competitiveness and foster industry "clusters." Clusters are generally defined as groups of companies and institutions located in a specific geographic region that are linked through interdependencies and competitiveness because they provide related products and/or services.²⁹ These industry clusters hold the potential to promote sustained economic growth. However, this potential can be fully exploited only through the coordination of public and private institutions and resources.

Ohio's Institutional Support for Climate-Friendly Technology

In order to adequately address the challenges that an increasingly carbon-constrained economy poses and to take advantage of all the opportunities that the rapidly growing market for low-GHG technologies and products offers, strong coordination and support at the institutional level is needed. According to a report prepared in 2002 by the Battelle Memorial Institute for the Ohio Department of Development, both the government and the private sector should work together to make the transition to a technology-based economy successful. Further, at a more general level, a stronger coordination of state government and industry R&D and investment activities would be necessary.

Based in part on these recommendations, several public-private partnerships and initiatives have been established in Ohio. These efforts have encouraged the development of numerous federal- and state-funded projects and attracted major private investments in two increasingly strategic sectors of the Ohio economy: clean-coal technology and alternative energy technology, with a focus on fuel cells.

Several major clean-coal projects have been recently initiated in Ohio. In April 2006, the Public Utilities Commission of Ohio approved American Electric Power's (AEP) plan to build a 600 MW clean-coal plant along the Ohio River in Meigs County.

²⁸ Spanish company Gamesa Energy, the world's third-largest wind-turbine manufacturer, recently announced its decision to headquarter and conduct major investments in Pennsylvania.

²⁹ Ketels, Christian, "The Development of the Cluster Concept – Present Experiences and Further Developments," Prepared for the NRW Convergence on Clusters, Duisburg, Germany, December 5, 2003, p. 3.

The plant will use Integrated Gasification Combined Cycle (IGCC) technology which makes it easier to capture carbon dioxide for sequestration. Three other potential coal gasification facilities are being considered in Ohio: a combination IGCC and synthetic natural gas plant in Allen County by Global Energy/Lima Energy; a coal-to-fuels facility in Lawrence County by Beard Energy, and a coal-to-fuels facility in Scioto County by CME North American Merchant Energy.

• **R&D Initiatives**

Several initiatives have been established in Ohio to support research and development of climate-friendly technologies, such as clean-coal and renewable energy technologies.

The Ohio Air Quality Development Authority and its Ohio Coal Development Office³⁰ are participating in the Midwest Regional Carbon Sequestration Project, a program sponsored by the U.S. Department of Energy whose goal is to advance the research and development of carbon sequestration through small initial test projects in the region. The Ohio Universities Research Consortium is a program of the Ohio Coal Development Office administered by Ohio University. This consortium is a joint research effort by major universities in Ohio to develop advanced coal technologies, including climate-friendly technologies, such as advanced carbon capture techniques. Another important institution involved in the development of clean technologies is the Ohio State University's Carbon Management & Sequestration Center, which focuses on understanding and enhancing the science, management, and policy of carbon within terrestrial soils, crops, trees, and wetlands (OEC, 2006 forthcoming).

Beside clean-coal technology, Ohio also has the potential to become a leader in the production and commercialization of fuel cell technology. However, private investors may not be able to bear the costs and the risks associated with this new technology. For this reason, substantial public resources have been committed by the State of Ohio for fuel cell technology research and development, including through the Third Frontier Project, a 10-year, \$ 1.6 billion initiative launched by Governor Bob Taft.³¹ This project has established partnerships among universities, research organizations and private industries, which are working together on innovative research, the application of scientific discoveries to new technologies, and product commercialization.³² One of the goals of this program is to develop a fuel cell industry cluster and make Ohio a national leader in the manufacturing of fuel cell systems, components, and balance-of-plant equipment. In support of this goal, Ohio is promoting in-state fuel cell research, technology development, and manufacturing system improvements, in addition to creating a supportive business environment for fuel cell companies.

Since 2002, the Third Frontier Project has provided \$335 million in grants. Part of this money has been offered to support research and development of climate-friendly

³⁰ The Ohio Coal Development Office (OCDO) was created within the Ohio Department of Development to provide strategies to use Ohio coal in an economical, clean, and efficient manner.

³¹ The Third Frontier Project is administered by the Third Frontier Commission, which was legislatively created in 2003. The Commission is responsible for the allocation of funds appropriated by the General Assembly to support programs and activities associated with the Third Frontier.

³² Battelle Memorial Institute, "Innovation – The Future of Ohio's Economy: An Ohio Technology-Based Economic Development Strategy," prepared for the Ohio Department of Development, May 2002.

technologies. For instance, Third Frontier has distributed \$39 million in strategic support of efforts to research and develop fuel cell technology in the state of Ohio. At the same time, the State has devoted another \$49 million to 128 research projects on fuel cell technology at nine academic institutions in Ohio.³³ The Third Frontier Project has also provided \$11 million to develop the Ohio Bioproducts Innovation Center at the Ohio Agricultural Research and Development Center. The center is focusing on research and development on a broad range of chemical industry products, including hydrogen production. Under the Third Frontier initiative, Ohio also established, in 2003, the Fuel Cell Initiative, a \$103 million program aimed at making Ohio the leader in fuel cell technology. From 2003 through 2005, the State awarded \$36 million in grants to 24 future cell projects involving academic researchers and small companies.

• **Application and Commercialization Programs**

Several other institutions and programs have been established in Ohio to promote a smooth transition toward a technology-based economy and to support the applications and commercialization of different kinds of technologies, including low-GHG technologies. For instance, the Thomas Edison Program was established to support the expansion of high-wage jobs and high-growth companies, and the creation and growth of early-stage technology ideas. The program funds a network of non-profit organizations around the state to provide services to new and existing businesses that will result in an increase in technology businesses in state, new and improved products brought to market by Ohio businesses, and improved and more efficient processes in existing Ohio businesses. In addition, the Program encourages regional and statewide collaborations with other economic development entities within and outside the network.³⁴ Seven Edison Technology Centers are located around the state and provide a variety of product and process innovation and commercialization services to both established and early-stage technology-based businesses such as: new product design; CAD/CAM; prototyping; materials selection and handling; plant layout and design; quality systems; information systems; machining; joining technology assistance; and biotechnology business consulting. One of these centers, the Dayton-based Edison Materials Technology Center, focuses on advanced materials and materials processing including Solid Oxide Fuel Cells.

Another important program aimed at making Ohio's economy more technology-focused is Jump Start. It was established in January of 2004 by Case Western Reserve University and NorTech to help accelerate the growth of early-stage (up to \$10 million in current revenues) companies and ideas in Northeast Ohio³⁵ that hold strong potential to become high-growth businesses (\$30 to \$50 million in annual revenues). One of the companies that have qualified for funding from JumpStart is ComSense Technology, a manufacturer of innovative high temperature pressure sensors for harsh environments that enable more precise control of diesel, gasoline, and turbine engines resulting in improved fuel efficiency and reduced emissions.

³³ Ohio Department of Development Technology Division, *Ohio's Fuel Cell Roadmap*, "Appendix C – Current Fuel Cell Related Projects Being Conducted by Ohio Academic Institutions," Page C1-C6.

³⁴ <http://www.odod.ohio.gov/tech/edison/>

³⁵ Northeast Ohio includes 16 counties: Ashland, Ashtabula, Columbiana, Cuyahoga, Geauga, Holmes, Lake, Lorain, Mahoning, Medina, Portage, Richland, Stark, Summit, Trumbull, and Wayne counties.

Future Directions and Policy Recommendations

The stage is set in Ohio for a transition to an economy bolstered by climate-friendly technologies. Both the government and the business community appear to be committed to the goal of creating a technology-based economy and both public and private investments in the research, development, and commercialization of high-tech products and services are ramping up.

Incorporating a focus on low-GHG technologies into the current strategic planning for the transition to a technology-based economy could significantly benefit Ohio's economic development. Ohio has the potential to leverage a competitive advantage in climate-friendly technologies for the growing GHG reduction and clean energy market, an opportunity that should be pursued while promoting the shift towards a technology-based economy.

The Pew Center on Global Climate Change recommends the following:

• Greater Coordination and Stronger Climate-Related Technology Focus, and New Emphasis on Commercialization of State-Funded Programs

A critical step in creating a rising tide of technological breakthroughs is having robust investment in basic and applied research. The programs described in this paper have been very effective in establishing strong partnerships among universities, research organizations and private industries, which are working together to conduct innovative research, translate scientific discoveries into applicable technologies, and commercialize products.

However, in order for Ohio to develop a competitive advantage in climate-friendly technologies, these programs should be part of a broader, overarching economic and technology policy aimed at developing a technology-focused and -oriented economy including specialization in climate-friendly products and services. As a first step, existing state-funded technology programs such as the Third Frontier Initiative should be broadened to include a focus on low-GHG technology. In addition, existing programs should move beyond research and development and begin promoting the actual commercialization of innovative technologies. This could be accomplished through a new initiative, by reforming existing programs, or both. In parallel to this effort, Third Frontier's climate-related technology strategies should be coordinated more closely with other programs like the Ohio Coal Development Office and Edison programs. This coordination should extend to private efforts as well, such as the Jump Start program. At the same time, more explicit efforts should be established, both within and beyond existing programs, to develop a skilled workforce for the highly competitive technology market.

• Promote the Development of Competitive Industry Clusters for Climate-Friendly Technologies

The development and commercialization of climate-friendly technologies could be pursued through specific industry "clusters."

Internationally competitive industries are generally clustered in geographic areas. Clusters have been identified with numerous benefits such as increased competitiveness, quicker pace of innovation, attracting new businesses in the cluster field to locate in the

area, encouraging a specialized skilled workforce, and enhanced productivity. Clusters are vertically and horizontally robust in terms of business participation, and their development is based on several factors that allow firms that “act first” to develop a market advantage. As the initial firm or group of firms develop, the cluster of businesses grows and become more competitive. In this initial phase, adequate financial incentives must be provided by the state in order for a cluster to succeed.

It is in within these cluster activities that entrepreneurs can exploit perceived opportunities. The economist Joseph Schumpeter argued that the entrepreneur does not invent things, but rather exploits what has been invented. National studies have shown that business in high-income states that are well positioned for global competition are members of innovative business networks or clusters that partner with research centers, institutions and universities.³⁶ Ohio needs to purposefully foster this type of activity, broadening its customer base, strengthening its capabilities in specific niches, and pursuing complex production capacity. At the outset, adequate financial support for collaborative activity is necessary in order for a cluster to succeed. For this reason, Ohio should establish an assistance program for industries that initiate collaborative cluster development efforts, especially in the area of climate-friendly technology.

Through the development of climate-friendly technology clusters, Ohio would have the opportunity to strengthen the technological character of its economy, revitalize its manufacturing sector, and become a leader in the production of GHG reduction technology.

- **Conduct research on changes in export markets due to GHG constraints**

As shown in this paper, Ohio is particularly well suited for the development of climate-friendly technology and Ohio’s economy has the opportunity to gain a considerable competitive advantage in the market for such technology. Given the rapidly growing demand for climate-friendly technologies in national and international markets, leadership in this sector could create new growth for Ohio’s economy. Specific programs and incentives should be established to develop this export strength. For instance, the State of Ohio and business trade associations should consider a research program to help Ohio’s exporting industries to take advantage of both existing and potential opportunities in foreign markets that face – or are expected to face in the future – greenhouse gas constraints. This research program would identify the markets for climate-friendly products with the highest growth potential, and would also help Ohio’s small and medium businesses adopt the most effective strategies to succeed in the highly competitive global market for climate-friendly technology.

³⁶ Kleinhenz, J. “Engineering Innovation; The Catalyst for Economic Development in Northeast Ohio”. Cleveland Engineering Society Conference, September 15,2004. See also Kleinhenz, J. “An Introduction to the Northeast Ohio Clusters Project,” Economic Development Quarterly, Vol. 14 No.1, February 2000.

About the Pew Center on Global Climate Change

The Pew Center on Global Climate Change was established in 1998 as a non-profit, non-partisan and independent organization. The Center's mission is to provide credible information, straight answers, and innovative solutions in the effort to address global climate change.

Working on an issue that is often polarized and politicized, the Pew Center provides a forum for objective research and analysis and for the development of pragmatic policies and solutions. In its first seven years, the Pew Center has become a leading voice for sensible action to address the most pressing global environmental problem of the 21st century.

The Pew Center's Business Environmental Leadership Council (BELC) is the largest U.S. based association of corporations focused on advancing technology and policy solutions to climate change. Its 40 members are mostly Fortune 500 multinationals and large utilities, with combined market capitalization over \$2 trillion and 3 million employees.

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