



Did you know?

Ohio has the largest manufacturing facility of thin-film solar panels in the country.

Ohio is the #2 state in potential for manufacturing wind turbines and components.

Ohio is one of the few places where all phases of fuel cell development take place.

Ohio has the third most aggressive Renewable Energy Portfolio Standard that requires up to 6,000 megawatts (MW) of new renewable energy capacity by 2025 and is expected to create more than 30,000 jobs by 2030.

The Ohio School Facilities Commission is making more than \$4 billion available to partner with local districts to make sustainable and responsible facility construction of new schools a priority.

Ohio's innovative spirit and world-class advanced manufacturing infrastructure develops the products to meet the global energy needs of the future. Ohio-based companies are producing an increasing array of cleaner, greener and high tech energy solutions that the world is counting on. Ohio's advanced energy economy is leading the way.

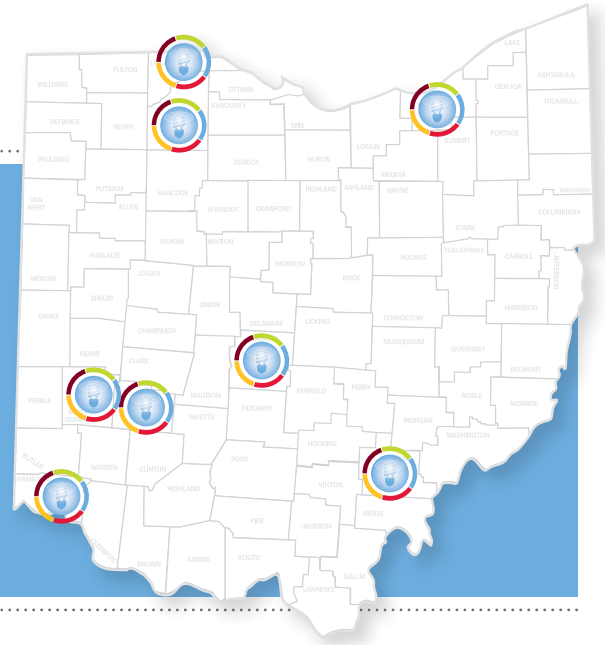
Ohio has invested more than \$150 million in energy technology development through the Ohio Third Frontier, bringing in more renewable energy facility projects than any other state. Ohio ranks #1 for renewable and advanced energy manufacturing, helping Ohio manufacturing companies create products for a globally competitive market. Ohio also ranks in the Top 5 in the U.S. for clean energy, energy efficiency and environmentally friendly production jobs and is ranked #1 in the Midwest for clean jobs and clean businesses.

The state is within 1000 kilometers of more than 63 percent of all U.S. and Canadian manufacturing facilities. Ohio-based manufacturers have maximized the state's manufacturing heritage and proximity to profitable markets to successfully shift from past inventions to tomorrow's innovations. New energy businesses can utilize these resources, combined with the Midwest's lowest taxes to grow and prosper.

A strong and prosperous business community requires an equally thriving system of colleges and universities. The University System of Ohio is the largest comprehensive public system of higher education in the nation. The system invests \$2 billion annually in research and development and is dedicated to training its workforce with the high-level knowledge, problem-solving, creative thinking and technology skills needed to be a leader in the innovation-based global economy.

Ohio also has two of the nation's top independent research universities, and combined with the University System of Ohio, eight schools are recognized as Centers of Excellence in advanced energy – Bowling Green State University, Case Western Reserve University, Central State University, University of Cincinnati, University of Dayton, The Ohio State University, Ohio University, and The University of Toledo.

Driving these universities' commitment to advanced energy is Governor Strickland's Senate Bill 221, a landmark energy reform bill that will ensure predictability of affordable energy prices and serve as a catalyst to enhance energy industries in Ohio, bringing new jobs while protecting existing jobs. The law requires that 25 percent of the energy sold in Ohio must come from advanced and renewable energy technologies—from clean coal to wind turbines—by 2025. These colleges and universities are dedicated to train "green collar" workers and invest significantly in research and development so that Ohio emerges as a national leader in sustainable energy.



Advanced Energy

Ohio's Centers of Excellence in Advanced Energy leverage the state's world-class advanced manufacturing infrastructure by stimulating innovations that produce an increasing array of cleaner, greener and high-tech energy solutions, helping Ohio meet its advanced energy goals.



Institution	Center of Excellence
Bowling Green State University	Sustainability and the Environment
Case Western Reserve University	Great Lakes Energy Institute
Central State University	Emerging Technologies
University of Cincinnati	Sustaining the Urban Environment
University of Dayton	von Ohain Fuels & Combustion Center
University of Dayton	Emerging Center of Excellence in Strategic Energy and Environmental Informatics
The Ohio State University	Climate, Energy and the Environment
Ohio University	Energy and the Environment
The University of Toledo	Advanced Renewable Energy and the Environment



Benchmarks

- Nationally recognized Center for Photochemical Sciences
- Major wind energy project in collaboration with The University of Toledo
- Leader in the application of geospatial technology to the solution to environmental problems
- BGSU Center for Regional Development engaged in economic development with regional governments and agencies
- Largest STEM education program in the state

Goals

Five-year period

- 1 Become the leading Center for Ohio in organic photovoltaics and other photonic materials
- 2 Gain statewide recognition for environmental impact of wind energy and algal-based fuels
- 3 Disseminate STEM Education best practices in Ohio schools
- 4 Impact transformation of manufacturing base to alternative energy industry

Metrics

- Commercialization of intellectual property
- Ohio STEM graduates retained in Ohio
- Number of MS and PhD graduates in STEM areas
- External funding (grants and contracts) in alternative energy, environmental quality, biodiversity conservation, and global change

Bowling Green State University's Center of Excellence in Sustainability and the Environment develops new strategies and technologies related to renewable, sustainable resources that maintain or improve environmental quality. Through basic and applied research, partnering with the external community, and STEM education, the Center contributes to the economic development of the state in alternative energy, environmental quality, biodiversity conservation, and global change. BGSU's efforts in alternative energy focus on organic photovoltaics for solar conversion and internal lighting, wind energy production, and the environmental impact of wind energy and algal fuels specific to the Ohio agricultural environment.

Driving Economic Advancement

BGSU has formed start-up companies, such as Blue Water Satellite, Inc. and CTI, Inc. focused on environmental monitoring. Patent applications in FY09 address new photonic materials to improve the efficiency of solar devices and new methods of environmental monitoring and bioremediation. Licenses related to work in the Center have been issued to three Ohio companies. Intellectual property for improved wind turbine design has been disclosed to BGSU. The Center provides consulting services for a number of government agencies and private companies. In collaboration with the BGSU Center for Regional Development, economic analysis of supply chain support of manufacturing related to alternative energy has been performed.



Great Lakes Energy Institute

Benchmarks

- \$5 million in energy research funding

Goals

- Be recognized by students and researchers worldwide as a key energy program
- Double the Case School of Engineering research funding in energy
- Support technology applications needed around the world and work on energy projects of significance

Metrics

- Number of faculty focused on energy and ratio of faculty researches in School of Engineering
- Number of PhD graduates
- Number of researchers hired within the industry

Case Western Reserve University's (CWRU) Great Lakes Energy Institute (GLEI) is a multi-million dollar research center focused on renewable energy, energy storage, and energy efficiency. The GLEI builds on 80 years of groundbreaking discoveries in energy research at the Case School of Engineering and has a mission to enable the transition to advanced sustainable energy generation, storage, and distribution and utilization through coordinated research, development and education.

The distinctive feature of GLEI is its ability to translate results from cutting-edge research into the next generation of energy technologies. Core research areas within GLEI include: wind, energy storage, grid and sensors, fuel cells, solar energy materials, energy efficiency, and carbon capture and clean combustion.

The University also has the CWRU Campus Sustainability Initiative that leads the everyday effort of energy and environment consciousness, and ensures that new campus building projects meet criteria required for certification from the Leadership in Energy and Environmental Design.

Driving Economic Advancement

Case Western Reserve University's forward-looking energy initiatives, coupled with Ohio's advanced manufacturing infrastructure and highly-skilled workforce, can position the state to emerge as a national leader in sustainable energy. The GLEI offers a collaborative, translational research model that rapidly filters innovative ideas, nurtures them through to technological developments, and integrates them into the marketplace. Among the most important resources being developed at CWRU, is the next generation of engineers and scientists, who promote energy exploration and discovery in today's most important fields, including energy storage, wind energy and solar energy materials.



Emerging Technologies

Benchmarks

- The International Center for Water Resources Management offers the only interdisciplinary curriculum in water resources management at the baccalaureate level and is listed in the Gale's International Research Centers.
- Designated by the U.S. Congress as the lead institution in applied remote sensing technologies research for solving water management problems for the arid western U.S. for the U.S. Department of Interior.
- The Manufacturing Engineering Program is one of 22 ABET accredited programs in the U.S. The program has maintained accreditation since 1991.

Goals

Five-year period

- Increase enrollment of STEM students by 5% per year
- Increase number of graduates by 50%
- Increase the number of start-up companies affiliated with NETI by 100% and the number graduating by 50%
- Create a minimum of 150 jobs
- Increase external funding by 25%
- 100% of students affiliated with the Center will participate in internships/research activities
- 100% of graduates associated with the Center will be employed or matriculate to graduate school

Metrics

- External Funding
- Student and faculty industrial affiliation
- Start-up companies graduated from the incubator
- Internship/research activities for students
- Number of graduates in STEM areas
- Job and graduate school placement of graduates
- Applied research activities for faculty and staff
- Companies in and graduating from incubator
- Jobs created by commercialization
- Collaborations with external partners (industry, non profit and government)

The mission of **Central State University's** Center of Excellence in Emerging Technologies is to graduate a diverse workforce that is highly skilled and prepared for future jobs in emerging technologies in the Miami Valley and throughout Ohio. The Center integrates CSU'S core competencies in manufacturing engineering, environmental engineering, mathematics and computer sciences, natural sciences, and technology transfer and commercialization through the National Environmental Technology Incubator. The Center will offer expertise in the integration of renewable and alternative energy supporting manufacturing and environmental protection areas.

Driving Economic Advancement

The Center will enable technology transfer and commercialization in targeted industries and small businesses by leveraging university and industry research into best practices, as well as build a competitive workforce for future jobs.



Sustaining the Urban Environment

Benchmarks

- **Program Rankings** — *Environmental Engineering* — top-ranked PhD program at UC and ranked 3rd nationally among 130 programs by NRC (2010), 24th by *US News & World Report*, 6th by Academic Analytics, and 1st by OH College of Engineering Deans Report (May 2009); *Architecture* — 2nd by *Design Intelligence Magazine*; *Environmental Health* — 1st in NIH Funding of Public Institutions; *Construction* — 14th by *C-School Blog: Construction Management Education*; *Planning* — 20th by *Planetizen Guide*
- **Research Funding** (FY 2008) \$30,907,466 Total Research Awards; \$25,677,993 Federal Research Awards
- **Campus Sustainability** — *Princeton Review* named UC among the nation's top "green" universities in its first-ever list of schools leading in environmental practices and in preparing the next generation of green professionals; five LEED-certified buildings on campus (most recent received gold-level).

Goals

- Win an NSF Engineering Research Center and/or NIH Center in Sustainability
- Promote sustainable energy industrial development in Ohio
- Promote inclusion of energy-related metrics, policies and technologies in sustainability research conducted across campus
- Leverage campus-wide minor in Sustainability and baccalaureate program in Energy and Materials to increase the number of graduates prepared for "green collar" jobs

Metrics

- 3 new faculty hires with expertise in photovoltaics, biomass energy production and water resource analysis and development
- Research grants to study "Algae growth and utilization for wastewater cleanup (Hamilton County Metropolitan Sewer District); "A novel method of separating carbon dioxide gas from power plant flue gases for subsequent sequestration" (U.S. Dept of Energy); and the "Impact of climate change on meteorology and the subsequent impacts on energy production methods" (U.S. EPA)

University of Cincinnati's Sustaining the Urban Environment Center of Excellence focuses on improving the health and wealth of Ohio's urban dwellers through development and dissemination of engineering and scientific metrics, policies, and technologies that promote the evolution of economically and environmentally sustainable urban regions. According to the *2008 World Energy Outlook* published by the International Energy Agency, cities are responsible for 67 percent of the world's energy demand and contribute 71 percent of global energy-related CO₂ emissions. Efficient energy management and development of renewable advanced energy technologies with small carbon footprints are key drivers in the evolution of sustainable urban regions. Close ties between energy, environment, and economy are deliberately fostered in the home of the Center, the newly formed School of Energy, Environmental, Biological and Medical Engineering, which houses both a first-of-its-kind undergraduate degree program in Energy and Materials Engineering and an established, highly-rated Environmental Engineering graduate program. Faculty members affiliated with the Center conduct research in bio-fuel, fuel cell, wind turbine and solar technologies as well as in energy-related environmental areas such as CO₂ mitigation technologies, building energy efficiency, sustainable water infrastructure technologies, and sustainable industrial development.

Driving Economic Advancement

The Center is well positioned to produce graduates who are highly skilled "green collar" workers — the fastest growing economic sector. Vital partnerships with organizations such as the U.S. Environmental Protection Agency; GE Aviation; Algaeventure Systems Corporation; the National Institute for Occupational Safety & Health; Pegasus Technology Services, Inc.; Battelle; AGENDA 360; Green Cincinnati Plan; and the Hamilton County Climate Initiative explore energy and sustainability solutions that also lead to job growth in Ohio.



von Ohain Fuels & Combustion Center

Benchmarks

- Ranked among the top three fuels and combustion programs among national universities by NASA, the Center has been compared to schools including Penn State and Georgia Institute of Technology

Goals

- 1 Achieve an annual growth in expenditures of at least four percent
- 2 Perform ground-breaking fundamental research using the nation's first research scale Fischer-Tropsch fuel synthesis facility
- 3 Increase collaboration with the industry as measured by research agreements and partnerships

Metrics

Over the past five-years

- Number of peer reviewed publications: **108 Journal Publications**
- Annual research expenditures: **\$10.4 million**
- Number of researchers: **60 professionals (24 Ph.D.'s) and 30 graduate students**
- Number of Ohio based industrial collaborations: **11 industries**
- Number of awards (state, national, international), invited talks, and fellows: **61**

The University of Dayton's von Ohain Fuels & Combustion Center is an award winning academic and research center with an international reputation and more than 25 years of history in achievement and sustained growth. Nationally ranked by NASA and GE Aviation, and currently conducting research deemed a top three priority for the US Air Force, the center is committed to the development and application of alternative and conventional fuels and fuel additives with complementary emphasis on understanding and optimizing fuel combustion processes and decreasing emissions, development of environmentally friendly algae and bio fuels, determining fuels and materials compatibility, investigating greenhouse gas emissions, and understanding and mitigating the environmental impacts of fuel use. The Center has an ongoing six year, \$49.47 million award that is enabling the program's continued growth, while continuing to build upon its impressive record of accomplishments.

Driving Economic Advancement

The Center maintains a strong relationship with key companies and institutions that strengthen Ohio's economy, such as GE Aviation, Parker, Battelle, Lubrizol, Velocys, Graftech, AFRL, and NASA GRC. In partnership with Beard Energy and other Ohio companies, the Center will work to establish an environmentally-acceptable coal, biomass, and gas-to-liquid fuel industry in Ohio.



Strategic Energy and Environmental Informatics

Benchmarks

- The Center was the top-ranked center in 2003, the first year that the U.S. Department of Energy established rankings, and has been consistently ranked in the top ten since

Goals

- 1 Establish a sustainable research emphasis on carbon emission, analysis and tracking
- 2 Successfully demonstrate first generation large scale (large installation to small city) energy efficiency and carbon emissions assessment tools
- 3 Develop substantial and sustained relationships with major energy utilities in Ohio and throughout the U.S.

Metrics

- 1 Number of peer reviewed publications
- 2 Annual research expenditures
- 3 Number of utilities supporting research
- 4 Cumulative energy savings for Ohio based businesses and residents

The University of Dayton's emerging Center of Excellence in Strategic Energy & Environmental Informatics builds upon two distinguished hubs on its campus. The first hub, the Industrial Assessment Center (IAC), is funded by the University's Department of Energy and is one of a unique set of programs in the nation to continuously receive funding throughout its 30-year existence. Most notably, the Center was the top-ranked center in 2003, the first year that the U.S. Department of Energy established rankings, and has been consistently ranked in the top ten since.

The second hub is the University's award winning Air and Water Research Program. This program also boasts more than 30 years of continuous growth and achievement. Academically, the University offers one of only two Master of Renewable and Clean Energy Programs in the United States.

Driving Economic Advancement

The Industrial Assessment Center, combined with the Air and Water Research Program, provides the research and academic strengths that enable the University to be responsive to the increasingly critical areas of research in energy efficiency, environmental impact and carbon emissions. The IAC has specifically saved Ohio industry an estimated \$500 million over the past 15 years.



Climate, Energy and the Environment

Benchmarks

- Ohio State departments participating in this Center of Excellence are highly regarded nationally, as measured by *U.S. News & World Report* rankings:
 - agricultural engineering (8th)
 - industrial and manufacturing engineering (14th)
 - materials science and engineering (13th)
- Programs affiliated with this Center of Excellence have brought in over \$66 million of support over the past two years

Goals

- 1 Position Ohio as a strong competitor in new energy technologies and environmental sustainability processes
- 2 Increase strategic partnerships with industries in climate, energy, and the environment to move proposed solutions into the marketplace
- 3 Make Ohio a strong voice in the national debate on energy and environmental policy

Metrics

- Number of large research awards received in the relevant topic areas
- Number of PhD graduates in programs affiliated with the proposed center
- Peer-reviewed publications for each research area (*this number already exceeds 4,000*)
- Number of graduates who accept employment in Ohio's energy and environment industries

The issues at the intersection of climate, energy, and the environment are complex, and will require a breadth of perspectives to find sustainable solutions and create a viable energy future. As one of the nation's most comprehensive universities, **The Ohio State University** is uniquely poised to bring a wide range of expertise to bear on climate, energy, and environment interactions with a "systems-wide" approach. The Center of Excellence in Climate, Energy and the Environment includes more than 300 researchers from many of Ohio State's 18 colleges.

This comprehensive team leverages extensive expertise in engineering, physical sciences, agricultural biosciences, social sciences, business and law to sequester carbon, develop advanced solar materials, refine carbon-trading, generate cleaner, less expensive, and renewable power, create sustainable transportation solutions, track climate change, and protect natural resources—all issues that will shape national energy policy.

Driving Economic Advancement

New federal, state, and private investments into energy and environment initiatives will create a multitude of new jobs requiring a skilled, "green-collar" workforce. Ohio State's partnerships with companies such as Honda of America, GE Aviation, Ford Motor Company, and American Electric Power will provide its undergraduate and graduate students with the skills and knowledge necessary to enter the advanced energy and technology sectors and boost Ohio's economy. Ohio State's Center of Excellence in Climate, Energy, and the Environment has the potential to serve as the foundation of the state's energy future.



Energy and the Environment

Benchmarks

- Energy & Environmental Research Center, University of North Dakota
- RTI International Center For Energy Technologies
- Energy Dynamics Lab, Utah State

Goals

- Create spin-off companies based on clean coal, carbon dioxide sequestering, and alternate energy technologies
- Enhance education on 'Energy and Environment' issues to produce a skilled workforce and leadership for Ohio
- Support existing energy companies and recruit new ones through research collaborations and development partnerships
- Create and promote a sustainable and economically viable energy roadmap for Ohio

Metrics

- Growth in federal research support
- Increase in invention disclosures
- Number of degrees granted in energy and environmental fields
- Number of jobs created and retained by spinoffs connected to the Center
- Level of technical assistance and consulting provided by the Center to business and government

Accessible, environmentally sensitive, and economical energy is vital to the well being of Ohio and the security of our nation. Located in the heart of Ohio's coal and oil fields, and in the nation's electric power "breadbasket," **Ohio University** is known for research, demonstration, and development strengths focused on the production and delivery of energy and fuels, as well as the monitoring and control of associated pollution.

At Ohio University, excellence in energy and the environment stems from multi-disciplinary collaborations that include engineers, public policy and public health experts, plant biologists, economists, and chemists. The productivity of Ohio University researchers and students and the quality of their work is enhanced by internationally known research facilities such as the Institute for Corrosion and Multiphase Technology and the Institute for Sustainable Energy and the Environment.

Driving Economic Advancement

Through smart fuels Ohio University aims to create quality jobs. With the advent of a clean energy economy in the state, which Ohio University's Center of Excellence in Energy and the Environment will help to develop, close to a 1000 new jobs could be created in Appalachian Ohio alone and the establishment of a carbon management industry in the region has the potential to grow to \$1 billion by 2020.

With close to \$28.1 million in external funding and with a significant portion of the proceeds from the largest donation ever received by a public college of engineering—the \$95 million Russ gift—Ohio University colleges, scientists, and scholars will help the state leverage economic stability and prosperity through the significant contributions its Center will make in the advanced energy sector.



Advanced Renewable Energy and the Environment

Benchmarks

- Expertise in energy and the environment has been recognized in national and international publications, like *The Economist*, *Newsweek*, and the *Wall Street Journal*
- Winner of two of only 11 Solar Energy America awards in 2007
- Winner of one of only six projects funded by the U.S. Department of Energy for biofuels research in September 2008
- A UT environmental researcher led an expert delegation to assess the Three Gorges Dam for impact on water, land, wildlife, economics and society (reported in *Science Magazine*)

Goals

- Help Northwest Ohio become a national leader in alternative energy research, production, and use
- Increase industry employment in Northwest Ohio in advanced renewable energy and the environment at a 15% per year rate for the next 10 years
- Become an emerging national leader in environmental and ecosystems sciences, monitoring and remediation
- Identify a new dean for the newly created School of Solar and Advanced Renewable Energy by the 2010-2011 academic year
- Produce 10 post-incubation companies by 2011 through The Scott Park Campus of Energy and Innovation

Metrics

Over the past five-years

Economic Contribution Measures:

- Invention Disclosures: **54**
- Technology Licenses: **32**
- Industry Research funding: **\$4 million**
- UT Spinoff Companies: **Five spinoff companies**
- Industrial Collaborators: **30 companies**

Faculty Expertise Measures include:

- Publications: **924 publications** by the 59 core faculty members
- Citations per faculty member: **91.4**
- Grants and contracts: **\$54 million** (*past three years*)

The Center of Excellence in Advanced Renewable Energy and the Environment addresses the need for new clean-energy technologies and a better understanding of complex environmental systems necessary for solving global challenges that will demand decades of focused attention and interdisciplinary contributions. Over the past ten years, **The University of Toledo** has invested in faculty talent and the research infrastructure that are helping Northwest Ohio emerge as a global center for advanced renewable energy.

Driving Economic Advancement

The Center of Excellence in Advanced Renewable Energy and the Environment's core areas of research and technology development are focused around solar, biomass energy, wind, energy storage, conversion and management, and ecosystems. These efforts support local industrial growth in companies that are expanding their products to become competitive in the global markets.