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## DEFINITIONS

**Greenhouse Gases (GHG's):** Atmospheric gases that contribute to the greenhouse effect by trapping heat in the atmosphere. Major greenhouse gases include carbon dioxide (CO2), methane (CH4), nitrous oxide (N20), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF6).

**Watt:** A unit of power in the International System of Units which measures the rate of energy conversion. One watt is equal to one joule per second.

**Kilowatt (kw):** A unit of power equal to 1,000 watts.

**Megawatt (mw):** A unit of power equal to 1,000 kilowatts.

**Gigawatt (gw):** A unit of power equal to 1,000 megawatts.

**British Thermal Unit (BTU):** A unit of energy used in the power and heating and cooling industries.

**MBTU:** A unit of energy equal to 1,000,000 BTU.

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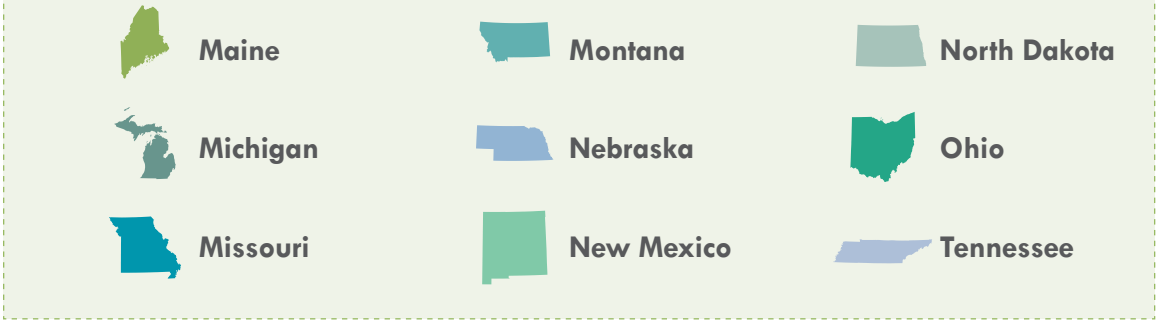
# GETTING PREPARED

## Economic Development in a Transforming Energy Economy

Now more than ever, economic development has to adapt to a volatile energy market and policies that are emerging to shape that market, a process that holds both opportunities and challenges. While the specifics of the transition to a low-carbon economy are still being deliberated both nationally and internationally, it appears likely that some type of cap and trade or carbon pricing will emerge. A price on carbon will hold significant implications for U.S industries, regions and the nation as a whole. This document is intended to help economic developers and those in related fields think about how they can prepare and position their local economies to benefit from such a transition.

To understand how states are preparing for this changing policy paradigm, IEDC convened a group of state economic development leaders in the fall of 2009. The meeting was intended to explore the opportunities and challenges presented by a regional or economy-wide move toward carbon pricing. The states represented diverse geographies and economic circumstances.

Following the meeting, IEDC engaged in case study research on each of the states, plus others, to better understand how they are transitioning to the low-carbon economy and working to reduce their greenhouse gas (GHG) emissions. This report includes case studies on the following nine states:



## Purpose of the Report

A carbon cap and trade system, on the federal policy agenda over the past nine months, has been viewed as a grave concern by some and a budding opportunity by others. Given this, IEDC wanted to better understand:

- What cap and trade is;
- What opportunities and challenges it could present to economic development; and
- How current economic development efforts are preparing states for the potential opportunities and pitfalls that could stem from carbon pricing on the national level.

***Defining the Clean Tech Industry***

Throughout this report we refer to the clean energy industry. For the purposes of this report, this includes businesses developing, supplying, generating, or storing energy, in areas such as: renewable energy sources, nonrenewable energy technologies (e.g. carbon capture and sequestration), efficiency technologies, and advanced energy storage technologies (e.g. batteries).

Preceding this study, IEDC published "What Is Carbon Cap and Trade? A primer for economic developers," in the fall of 2009. The document outlines how a carbon cap and trade system functions, how cap and trade systems are working in other parts of the world, and how the challenges and opportunities of a cap and trade system might impact economic development activities.

## WHAT IS DRIVING THE MOVEMENT TOWARDS CARBON PRICING?

Spurred by the desire for greater energy security, climate change mitigation, long-term energy affordability, and the transition to a clean energy economy, we are starting to see the federal government, Congress, the international community and the global business community move toward putting a price on carbon. Outlined below are the primary factors energizing this shift.

### Changing Policy Environment

In December of 2009, the United Nations Framework Convention on Climate Change took place in Copenhagen, Denmark, bringing together key nations with the goal of reaching an agreement to replace the expiring Kyoto Protocol. While the conference did not achieve a binding agreement for long-term action, a 'political accord' was negotiated by approximately 25 countries, including the U.S. and China. Notable within the accord was an agreement among developed countries to commit U.S. $30 billion in new resources toward reducing carbon over the next 3 years, and $100 billion by 2020.

Nationally, after the American Clean Energy and Security Act passed the House in June of 2009, comprehensive legislation addressing clean energy stalled in the Senate. Senators Barbara Boxer and John Kerry released the Clean Energy and American Power Act in September 2009; however, it did not garner enough political support to move forward. More recently, Senator Kerry has worked with Senators Lindsey Graham and Joe Lieberman to craft a bipartisan bill that includes provisions that are favorable to traditional energy industries, such as an expansion of offshore oil drilling, in addition to placing a price on carbon. Political wrangling and the uncertainty emanating from the recent oil spill in the Gulf of Mexico are repositioning political support for the current bill. Thus, the outcome of national U.S. politics on this issue remains uncertain.

While the Congress remains in flux on the issue of GHG mitigation, federal agencies are moving forward. In 2009, the Environmental Protection Agency determined that carbon is a pollutant, thus giving them more power to regulate its emission. In addition, the Securities and Exchange Commission has mandated that companies disclose their carbon usage and risk. The carbon disclosure guidance areas include the impacts of legislation and regulation; the impact

of international accords; the indirect consequences of regulation or business trends; and the physical impacts of climate change. Moreover, the American Reinvestment and Recovery Act and the President's 2010 and proposed 2011 budgets prioritize investment in clean energy research, greater energy efficiency and the promotion of green jobs.

## Sub National Activity Focused on Climate Change Mitigation

While national and global agreements are still being formulated, much activity focused on reducing carbon and incenting the emergence of cleaner energy and greater energy efficiency is taking place at the regional, state and local levels. Cap and trade programs are in place at the regional level, such as the Regional Greenhouse Gas Initiative, the Western Climate Initiative, and the Midwest Greenhouse Gas Accord. State and local governments have become laboratories of innovation, leading the charge in this area.

## Global Business Community Forging Ahead

The global business community also has been moving rapidly to position itself at the forefront of green and clean energy investments. According to McKinsey Quarterly, the $45 billion private-equity purchase of the energy utility TXU hinged on the insistence of the buyer that TXU reduce its plan to build several new coal-powered plants, and instead make investments in clean coal, energy efficiency and renewable energy.[1] Further, we now see numerous large corporations forming coalitions to create a business-led response to climate change. Consortia of major businesses – such as Business for Innovative Climate and Energy Policy (BICEP), which includes such corporations as Starbucks, Sun Microsystems, Levi Strauss, Nike and Timberland; and the United States Climate Action Partnership (USCAP), which includes members such as Alcoa, John Deere, Duke Energy, and Dow Chemical Company – function under the belief that a proactive business response to climate change will create more economic opportunities than risks for the U.S. economy.

## Changing Economic Competitiveness

Volatile energy prices are changing the location and competitiveness factors of businesses, and thus of communities. In some cases, businesses are returning to the U.S. to be closer to consumer markets or inputs to product development. Other corporations are relocating overseas for the same reasons.

Additionally, there is an overall sense that the U.S. is falling behind other countries in the energy market, which is projected to be one of the largest growth areas in the world – especially as the BRIC countries (Brazil, Russia, India and China), which are huge in both land mass and population, start demanding more and more energy to fuel growth. Further, the current policy gridlock on energy and carbon emissions provides mixed signals to the market, inhibiting investments in energy of all types.

Lastly, investment in clean tech sectors is growing globally. How those sectors develop and what policies steer their evolution can influence where jobs grow and the quality of those jobs. Understanding these changes and tapping into them is one of the reasons for this research.

It is clear that changes are on the horizon, and it is most visible in the current Federal policy arena. The implementation of a cap and trade or some type of carbon pricing would create opportunities and challenges for local economies. Opportunities include: 1) the establishment of a transparent price on carbon, enabling energy investments, which have slowed for both traditional and renewable sources, due to the current uncertain and dynamic policy and market environment; 2) new resources through carbon offsets, allowances and overall increased public and private funding in this realm; 3) emerging markets for new energy sources, energy efficient technologies, etc; 4) emerging new industries that can create new jobs, diversify local economies, and new economic opportunities; 5) opportunities to reposition struggling industries such as manufacturing to access new opportunities (e.g. wind turbine production) and 6) stimulating innovation by creating new demands and providing resources for research and development.

The challenges that communities face include: 1) higher energy prices; 2) transition costs for firms that have to adapt to carbon pricing through emission reductions, investing in energy efficient technologies or adapting to higher energy costs; 3) variation in dependence upon energy intensive industries, requiring greater transition costs and job losses in some places; 4) transitioning the workforce to access jobs in new industries; and 5) leakage whereby some economic activity moves to countries with laxer policies.

The ability for states and communities to position their economies to benefit from these changes depends to a certain extent to how they prepare for them. As our research shows,

states have already started down this path. In what follows, we offer a framework for preparedness. The strategies that states are using look to both tap into the emerging opportunities that this changing policy and market environment present, but also have started to assist with the transitions which also will occur.

## WHAT IS PREPAREDNESS?

Regardless of personal beliefs regarding global warming and the GHG mitigation debate, trends are pointing toward a future in which low-carbon economies will be rewarded. Changes to energy cost, delivery and availability are certain, whether those changes result from increased global demand, geopolitical forces and volatile prices, or whether carbon pricing is implemented on a national level. With this change as the only certainty, how states and localities prepare for this paradigm will impact their future opportunities and challenges. Preparedness in the face of a shifting global energy market and increasing pressures to reduce GHG emissions is essential for capitalizing on an economy's assets, while buffering and bolstering its weaknesses. In the transition to a low-carbon economy, the following elements contribute to preparedness.

### Implementing Energy Efficiency Measures throughout the Economy

Policies that encourage energy efficiency on the part of government, institutions and firms will lead to consumers to lower energy costs, which will act as a net return to the economy. According to the McKinsey Global Institute, implementing energy efficiency activities will abate a significant proportion of carbon emissions and provide positive economic returns through energy cost savings.[2] This is the "low hanging fruit" that many governments and firms have already begun to reap.

### Strengthening the Demand for Cleaner Sources of Energy and Energy Efficiency

Demand-side policies that encourage the purchase and use of clean sources of energy, as well as energy-efficient products, will help end users afford to make the shift.

## Developing Clean Energy Options

As demand for low-carbon solutions grows, this will lead to the emergence of new energy options, and new value chains that disrupt existing industries and create new ones.[3] As a result, we are witnessing investment opportunities increase globally, new businesses being created, and the emergence of entrepreneurial leaders in these industries. We also are seeing the emergence of new markets for traditional industries, such as the transition of manufacturers from making products such as automobile parts to fabricating wind turbine components.

## Tapping Into and Strengthening Existing Resources

Each state and region has different assets and vulnerabilities in the face of shifting energy markets and potential carbon pricing. These will be determined by a state's existing industry mix, their dependence on low energy prices, and the degree to which their industry base is integrated into the global economy. States that will be better prepared to manage this shifting market are acting in the following three areas:

***Helping existing businesses meet new demands (e.g. energy efficiency, utilities):*** While large corporations can do this on their own, and many are, small businesses are still struggling to adapt. Asthey are the drivers of the U.S. economy, aiding their transition to changing energy costs and greater energy efficiency is imperative.

***Targeting industries with potential to prosper under these conditions (e.g. manufacturing):*** While manufacturing has been declining in the U.S. for over 20 years, there is still a significant manufacturing base present in many states. These assets can be retooled into emerging areas that would be favored in a low-carbon economy – building wind and solar facilities, for example, requires significant manufacturing inputs.

***Training workers for new opportunities:*** Many workers in traditional fields such as manufacturing have skills parallel to those required for clean tech manufacturing, but retraining will be required. Moreover, in face of a carbon price, job losses will likely occur in some industries such as coal mining, oil and gas extraction and petroleum refining, requiring retraining for new opportunities.[4] Finally, the need for clean tech may reignite interest in nuclear energy, which faces a significant skilled worker shortage. Consequently, many states and regions are implementing training systems and degree programs that complement their targeted clean tech sectors.

### Developing New Resources, New Partnerships, and New Ways of Working to Accomplish All of the Above.

Preparedness demands new partnerships across government agencies and with the private and community sectors in order to accomplish the complex tasks required to shift to a low-carbon economy.

## A FRAMEWORK OF PREPAREDNESS

In this report are nine case studies that highlight the assets in each state (**Maine, Michigan, Missouri, Montana, Nebraska, New Mexico, North Dakota, Ohio, Tennessee**), along with a profile of their energy economy and their preparations for a low-carbon economy. Specifically, it examines energy generation in each state; the nature of each state's industry mix, particularly the importance of energy-intensive industries in that mix; and the policies each state has undertaken to reduce GHG emissions , promote clean technology, and transition its industries and workers in face of energy policy and market changes.

### The Energy Economy Snapshot

The energy economy snapshot looks at the energy generated in each state to assess its dependence on cheaper, fossil fuel-driven energy generation, and the degree to which cleaner energy options are emerging. This snapshot suggests areas of vulnerability – particularly if a state is highly dependent on low energy prices – as well as areas of opportunity, such as the ability to export cleaner energy sources.

The snapshot also provides an overview of each state's major industries and the percentage of its employment and GDP that is composed of energy-intensive industries. Energy-intensive industries are those highly dependent on energy and thus highly sensitive to energy prices; heavy emitters (e.g., some manufacturing); or both. This vulnerability is enhanced when the industry or sub-industry trades in a global market, driven by price competition, thus with little margin to absorb increased energy costs. These industries also face the prospect of "carbon leakage," whereby companies move their production or buy from producers in countries with looser laws governing carbon emissions. For this study, we define energy-intensive industries to include agriculture, mining, utilities, construction, and manufacturing.[5]

These energy economy snapshots suggest how each state stands in light of an emerging policy environment of which carbon pricing or cap and trade is part, and helps to determine a state's assets and opportunities as well as its dependence on non-renewables. It also helps to provide a deeper picture of how the state's economic base might be affected by the need to reduce GHG emissions.

### *Identifying Vulnerabilities within Energy- Intensive Industries*

While unprecedented opportunities will come from the switch to a lower-carbon economy, transition pains and significant investments will, without a doubt, be required to make it happen. Energy-intensive industries and the communities that host them will feel the pinch as they adapt to a changing energy environment. Some of the vulnerabilities inherent to energy-intensive industries are listed below.

- **Mining and Extractive Industries**: According to the Congressional Budget Office, coal mining would be one of industries heaviest hit by a carbon price, because it is the highest GHG emitter per unit of energy. However, carbon capture and sequestration technologies may reenergize and redefine the industry, thus possibly mitigating these impacts. Other mining, for materials such as metals and chemical inputs, will also be impacted because of the energy expended in the process, but that decline is predicted to be small.

  Similarly, oil and gas extraction will see demand decline as prices increase and other, cleaner options enter the marketplace; thus, job losses may occur. However, as oil is traded in the global marketplace, some of these impacts may be mitigated by increasing demand from other countries. Finally, the impacts on natural gas are mixed. On one hand, overall energy price increases may reduce demand, as natural gas emits more GHGs than renewables; but as gas currently has lower emissions than coal, it may pick up some of that market.[6]

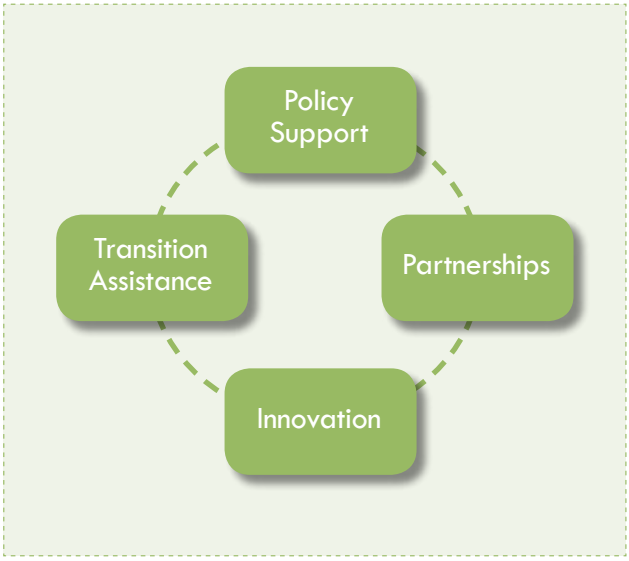
- **Agriculture:** For this industry, the economic challenge emerges from increased energy costs. This challenge may be mitigated by new opportunities and additional resources that directly benefit agriculture, such as land rent from wind turbines, new and growing markets for biomass products, and income from land management offset projects.

- **Utilities:** Utilities will be challenged to manage their costs without relying heavily on the ability to pass cost increases to consumers.

- **Construction and Manufacturing:** Both of these sectors represent a mix of vulnerabilities and opportunities. On one hand, both are vulnerable to increased energy costs, especially within their supply chains; higher costs will lead to reduced demand, and thus the potential for job loss and firm closure. However, carbon pricing may also reenergize these industries and create growth opportunities for emerging subsectors that complement the growth of energy efficiency and clean tech sectors. For example, glass manufacturers are finding new opportunities in solar panel manufacturing, and insulation manufacturers and installers are responding to demands for greater energy efficiency. Equally important, investments in energy efficiency and other transition support measures can help mitigate the challenges and better enable these industries to tap into the opportunities from a growing cleaner energy market.

## Preparing for the Low-Carbon Economy

Across the majority of states examined for this report, we found a significant amount of GHG mitigation activity, much of which is linked to economic development or is in the process of developing such linkages. Policies such as renewable energy standards, state and local energy efficiency strategies, new building codes, as well as clean tech development and deployment have tremendous implications for economic development. While some policies stand alone, others are part of a set of complementary policies that are capable of transitioning economies over the long term.




If national and local economies are to maintain and increase competitiveness, reduction of GHGs must be understood as beneficial to the future health of the economy, not just the environment. Almost all states are now taking steps toward changing their energy profiles and

incorporating sustainability into their economies. As such, the case studies examine not only what each state is doing to mitigate GHGs but also how they are using those mitigation efforts as economic drivers. The challenge of transitioning will be to employ and connect all of these pieces in a synergistic way. Despite their diversity of assets and differences, all of the states indicated some movement toward greater preparedness. That preparedness emerged in four areas detailed below: policy drivers; investments in innovation; transition assistance, and new partnership development.

### *Policy Drivers: leadership and financial stimulus*

In all states, we saw the development of policy initiatives and financial incentives that aimed to catalyze clean energy development and energy efficiency by stimulating demand and supply. In many cases, the state would lead by example, such as with energy-efficiency commitments. In Montana, for example, the state designed the State Building Energy Conservation Bond program to finance energy improvement projects on state owned buildings. Similarly, North Dakota offers the State Facility Energy Improvement Program which also uses state bonding to finance energy efficiency in state agencies and institutions.

Equally important but evident only in some states were efforts to address the development of the electricity grid, and its ability to absorb and deliver new forms of energy developed in diverse locations. For example, New Mexico created the Renewable Energy Transmission Authority to develop new transmission projects to enable renewable energy to get to the market. In Nebraska, as another example, Recovery Act funding is being used to implement smart grid technologies in two power districts.

The biggest policy driver is the adoption of renewable portfolio standards (RPS), which are now legislated in 30 states and account for more than half of the electricity sales in the United States. These targets allow private industry to adjust and adapt to a regulatory framework by providing stability for alternative energy investment. Without a regulatory guide with reasonable benchmarks, the private sector will not invest in alternative energy technologies. In addition, states are employing both supply- and demand-side incentives, such as tax rebates to clean tech energy suppliers, revolving loan funds for firms to transition to more energy-efficient practices, and rebate programs for consumers to purchase energy-efficient products.

Further, regional-level carbon pricing policies and programs are moving forward, the most notable of which is the Regional Greenhouse Gas Initiatve (RGGI), of which one of the case study states in this report, Maine, is a participant. RGGI, a mandatory cap and trade program addressing carbon dioxide emissions from power plants, is the first such program in the United States. The goal is to reduce $CO_2$ emissions from the power sector 10 percent by 2018. The RGGI encourages power producers in ten northeastern states (representing over 50 million people) to cut greenhouse gas pollution by requiring them to buy allowances, which decrease annually, to offset their emissions. States sell emission allowances through auctions and invest proceeds in consumer benefits such as energy efficiency, renewable energy, and other clean energy technologies.

RGGI has already made progress in financing and expanding energy efficiency programs in participating states and in generating revenue. The RGGI stipulates that states may allocate their auction revenue freely, as long as at least 25 percent is used for consumer benefit or strategic energy purposes. However, most states have gone far beyond the 25 percent requirement, placing a much higher percentage of revenue toward these objectives. As of spring 2009, 71 percent of the revenue has been used for clean energy initiatives.

RGGI is not the only regional carbon reduction initiative. New Mexico and Montana, two case studies covered, are part of the Western Climate Initiative (WCI), a collaborative effort of Western U.S. states and two Canadian provinces to reduce greenhouse gas emissions, and includes a regional cap and trade program. Michigan is a member and Ohio is an observer in the Midwestern Regional Greenhouse Gas Reduction Accord (MGGA), which looks to establish GHG reduction goals and timelines that are consistent with each state's goals.

In addition to these burgeoning regional policy initiatives, the case studies display a range of state policy activity to reduce GHG emissions and invest in solutions that stimulate economic growth. Common across the states are incentives to stimulate the production of and demand for cleaner energy options. Missouri for example offers the Linked Deposit program which offers low-interest loan programs to cover operational costs for any Missouri-based firm producing or selling power that is not generated by fossil fuels. Missouri also created the Biodiesel Producer Incentive fund to support biodiesel production. As another example, Nebraska offers a Renewable energy tax credit for electricity generated at a new zero-emission facility that is

powered by wind, moving water, solar, geothermal, fuel cells, methane or photovoltaics and the Rural Community-based Energy Development Act Wind Legislation to support the development of community wind energy. Tennessee offers the Small Business Energy Loan Program which offers low-interest loans, to a maximum of $300,000 to Tennessee-based businesses to increase energy efficiency in buildings, plants or manufacturing processes.

### *Transition Assistance*

Helping businesses retool to reduce energy use and emissions, as well as to find new opportunities in a shifting global marketplace, is a critical state activity. These efforts also include supportive mechanisms to help the workforce prepare and retrain for new and emerging industries. While large companies are largely leading this pathway, assistance is especially important for small and medium-sized businesses, as they drive job creation but also often compete at the economic margins, with insufficient resources to make transition investments (e.g. workforce training, energy-efficient heating and lighting systems, etc.).

In all cases, we saw a variety of initiatives to promote the transition of industries and workers. In Michigan, for example, the Michigan Economic Development Corporation, working with NEXTEnergy and a consortium of non-profits, suppliers, and government agencies, are linking component manufacturing to opportunities in alternative energy supply chains, especially wind energy. In Ohio, the Department of Development partnered with the Edison Materials Technology Center Alternative Energy Technology Group to build up the fuel cell supply chain. Similarly, the Missouri Partnership is working with the Missouri Department of Economic development and the Missouri Department of Natural resources to develop clean energy supply chains.

In New Mexico, the Mesalands Community College established the North American Wind Research and Training Center to deliver training for operations, maintenance and management of wind farms. Similarly, Lake Region State College in North Dakota worked with the wind industry to develop certificate and degree programs for Wind Turbine Technicians.

### *Investing in Innovation*

New technologies and innovation are critical for the economy to transition. Innovations can help reduce prices for cleaner fuels; enable high emitters to better control or capture emissions; increase the overall efficient use of energy; and better store energy for later or longer use. Currently, many states are investing in innovation through pilot projects and through research and development in alternative energies to reduce their costs, and helping high-emitting industries and firms adapt to this new economic environment. In each state, we see very different types of investments and pilots across a range of issues.

Across the case studies, we see the states aggressively supporting innovation in existing assets to meet GHG reduction goals while stimulating new economic opportunities. Ohio's Third Frontier Program, for example, is a 10 year $1.6 billion research and development funding program that is supporting innovation in alternative energy industries such as fuel cells and photovoltaics among others. In Tennessee, the University of Tennessee is partnering with DuPont to build a pilot plant and process development center to push innovation in biofuels. In North Dakota, the state is an active member of the Plains $CO_2$ Reduction partnership, a collaboration of 80 U.S. and Canadian stakeholders, investing in innovations in carbon capture and sequestration. Similarly, research activities within the University of Nebraska system includes the potential of dryland and irrigated cropping system for carbon sequestration and solar energy production. In Missouri, the Donald Danforth Plant Science Center is focusing its research efforts on the potential of algae for biomass development and the commercialization for biodiesel. In Maine, the Advanced Structures and Composites Center at the University of Maine has received $15 million from the Department of Energy to test and evaluate floating platform designs for offshore wind farms.

### *Partnerships*

States are not going it alone but are relying more and more on unique partnerships – both across state agencies and among businesses, governments, and non-profits – as part of the transition to a lower-carbon economy. This demands that agencies that may never have had reason to collaborate before learn how to do so, and in ways that may require a fundamental reorganization of responsibilities.

One of the premier examples of this approach is Michigan's merger of its former state departments of labor, economic growth and energy into one combined department, the Department of Energy, Labor, and Economic Growth (DELEG) – a clear sign that the state recognized the importance of alternative and renewable energy technology to its economy.

Further, instances of multi-jurisdictional cooperation are taking place in some states, as issues of energy almost always cross jurisdictional borders. Whether the aim is to export energy or to coordinate a statewide energy planning effort, support between multiple levels and jurisdictions of government is becoming an increasingly critical success factor. In Montana, the Department of Commerce is partnering with local economic development organizations to use the Job and Economic Development Impact Model, developed by the Department of Energy's National Renewable Energy Laboratory, to understand the economic impacts of developing and then deploying wind power plants, particularly their job and tax development implications. The purpose is to provide local economic development organizations with practical data to help the community understand the economic potential for such projects.

Partnerships with the private sector also emerge in the case studies. In Tennessee, for example, the state is building a partnership with Nissan and the Tennessee Valley Authority to develop electric cars and electric charging capacity.

What follows in the rest of this report are focused case studies, showing how various states are managing a variety of economic challenges with different resources and assets.

ENDNOTES

1 Nick Hoffman and James Twining, "Profiting from the low carbon economy," McKinsey Quarterly, August 2009, http://www.mckinseyquarterly.com/Profiting_from_the_ low_ carbon_ economy_2412 (Accessed September 3, 2009).

2 McKinsey Global Institute, "The Carbon Productivity Challenge: curbing climate change and sustaining economic growth," (June 2008).

3 Per-Anders Enkvist, Tomas Naucler, and Jens Riese, "What countries can do about cutting carbon emissions," The McKinsey Quarterly, no. 2 (2008), 38.

4 Congressional Budget Office, "How Policies to Reduce Greenhouse Gas Emissions Could Affect Employment" (May 5, 2010).

5 Not all subsectors within each of these broad industry sectors are energy intensive. But for the purpose of comparison and data availability, we use these broad categories for our analysis.

6 Op. cit.


# Diversification Through Research and Innovation

Tennessee sits at an interesting crossroads between the traditional energy economy and a newer, low-carbon economy. Tennessee is making progress to leverage the research and innovation capacity already present in the state especially in the fields of energy efficiency, biofuels and solar energy. The state is also pursuing a diverse portfolio of renewable energy companies, in areas such as solar, electric vehicles, and biofuels.

The federally administered Tennessee Valley Authority (TVA), a public power company and regional economic development agency, owns virtually all of the state's electricity generation assets. Tennessee does not currently have a renewable portfolio standard; TVA is federally chartered and thus cannot follow state mandates. TVA currently generates 60 percent of its wholesale power via fossil fuels. Because TVA is the nation's largest public power company, serving 9 million people, it is thought to be an excellent test case for the adoption of cleaner energy. Thus far, TVA's current renewable energy portfolio includes 3,889 megawatts from hydro, wind, solar and methane sources in the Valley.[1]

The Governor's Task Force on Energy Policy, a 16-member panel of clean energy business, government, science and conservation leaders, has developed key goals to drive forward the state's competitiveness in the energy arena. Their goals included identifying opportunities for state government to lead by example; prospective policies to encourage energy efficiency and conservation; possible public-private partnerships encouraging research and development; and strategies for expanding the use of alternative fuels and renewable energy.

Further, in 2009, Governor Bredesen signed into law the Tennessee Clean Energy Future Act. The law includes financial commitments to new solar energy and electric vehicle initiatives; requires the state government to lead by example in managing its buildings and vehicle fleet; makes the clean-energy technology sector eligible for Tennessee's emerging industry tax credit; and promotes residential energy efficiency by streamlining the distribution of federal funds for weatherizing low-income homes and establishing a limited statewide residential building code for new construction.[2]

This legislation complements a diverse array of incentives, partnerships, and innovation to deepen Tennessee's role in the low-carbon economy and broaden its economic competitiveness.

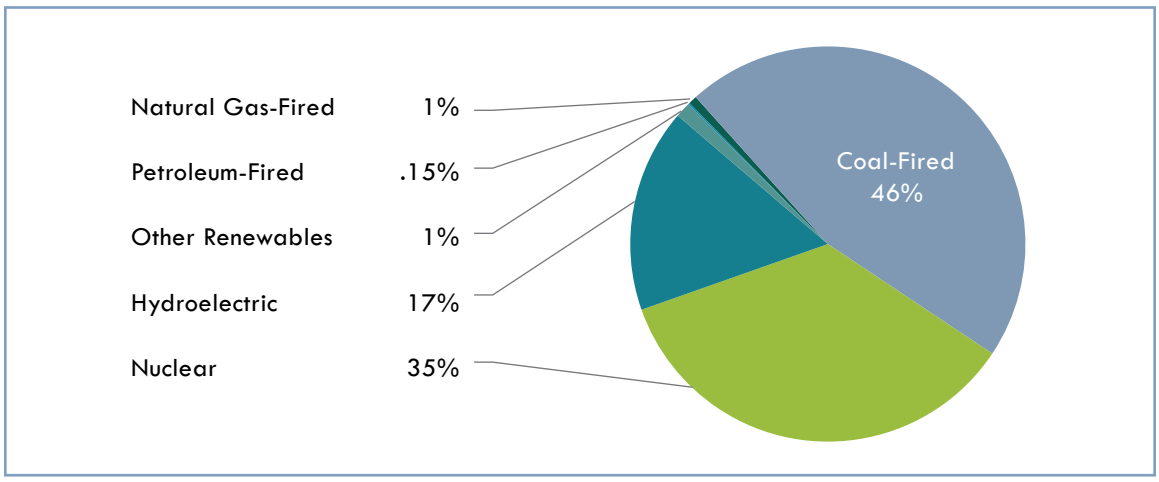
## Energy Economy Snapshot

Tennessee has few fossil fuel reserves, but has some of the highest hydroelectric power potential in the United States. Tennessee also has minor coal reserves in the Appalachian Basin in the eastern part of the state.[3] Tennessee's three nuclear reactors provide nearly triple the power of all the dams in the state. The state's single-unit Watts Bar Nuclear Plant began commercial operation in 1996 and was the last new nuclear reactor to be brought online in the country.[4]

In 2009, total electricity generation in Tennessee was 46 percent coal-fired, 17 percent hydroelectric, over one third nuclear, and 1 percent natural gas and renewables.

Renewables are growing as a proportion of total electricity generation. Biomass is the largest renewable energy resource in the Tennessee Valley,[5] allowing for the production of biofuels in the state. Further, approximately 800 MW of wind energy capacity is available within five miles of the TVA service area, and about 400 MW of solar photovoltaic capacity exists in the state.[6]

### TENNESSEE ELECTRIC GENERATION BY FUEL SOURCE, 2009

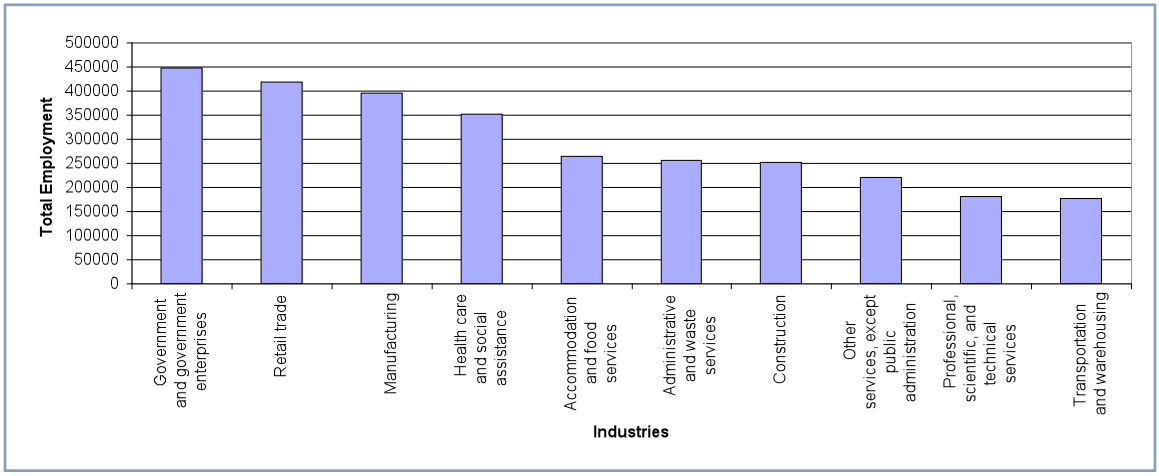



Source: U.S. DOE, Energy Information Administration, State Energy Profile, 2009

## Industry Overview of Tennessee

Government, retail trade, healthcare and social services, and manufacturing combined account for over 1.6 million employees in Tennessee. Accommodation and food services, construction, and administrative and waste services employ approximately 750,000 workers. Other services except public administration, professional, scientific, and technical services, and transportation and warehousing employ approximately 500,000 workers.

### TOP 10 INDUSTRIES BY EMPLOYMENT IN TENNESSEE: 2007

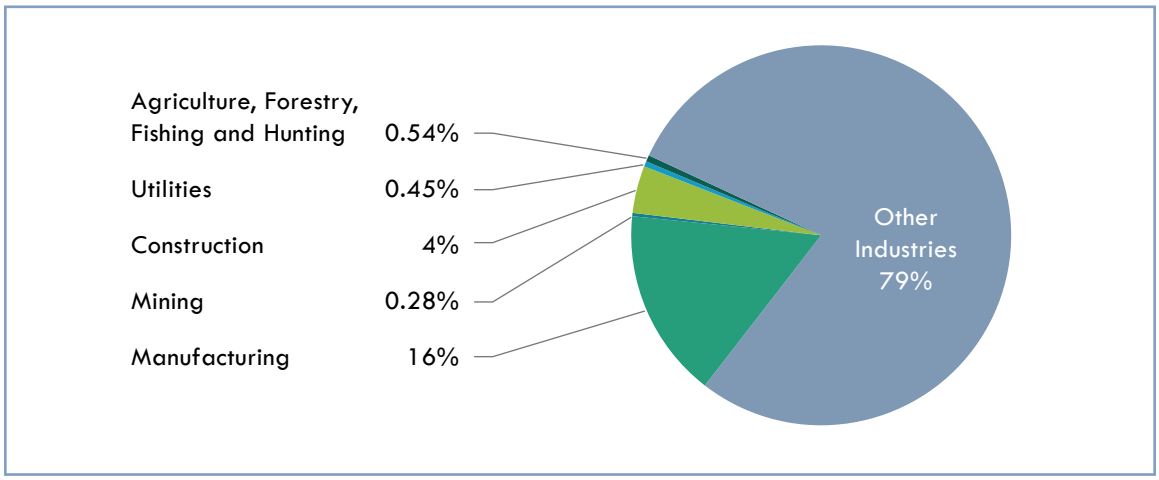



Source: BEA, 2007

Energy-intensive industries make up 22 percent of the total gross domestic product in Tennessee and 20 percent of the state's employment. From the five energy-intensive industries, manufacturing (16 percent) and construction (4 percent) represent the largest share of total GDP. Mining (.28 percent), utilities (.45 percent) and agriculture make up less than two percent of total GDP in the state. In regards to employment, manufacturing and construction again represent the highest share among the energy-intensive sectors (11 percent and 7 percent, respectively), while utilities, mining and agriculture, forestry, fishing and related activities total less than 3 percent of the total working population.

Looking at location quotients to understand the state's economic advantages, manufacturing stands out as a specialization for Tennessee, in terms of GDP, especially in motor vehicle body and parts manufacturing; electrical equipment and appliance manufacturing; wood products manufacturing; and paper manufacturing.[7] Employment specializations include manufacturing, agriculture, and construction. Sub-industry specializations include electrical equipment and appliance manufacturing; wood product manufacturing; paper manufacturing; and plastics and rubber products manufacturing.

**ENERGY INTENSIVE INDUSTRIES BY GDP IN TENNESSEE, 2007**



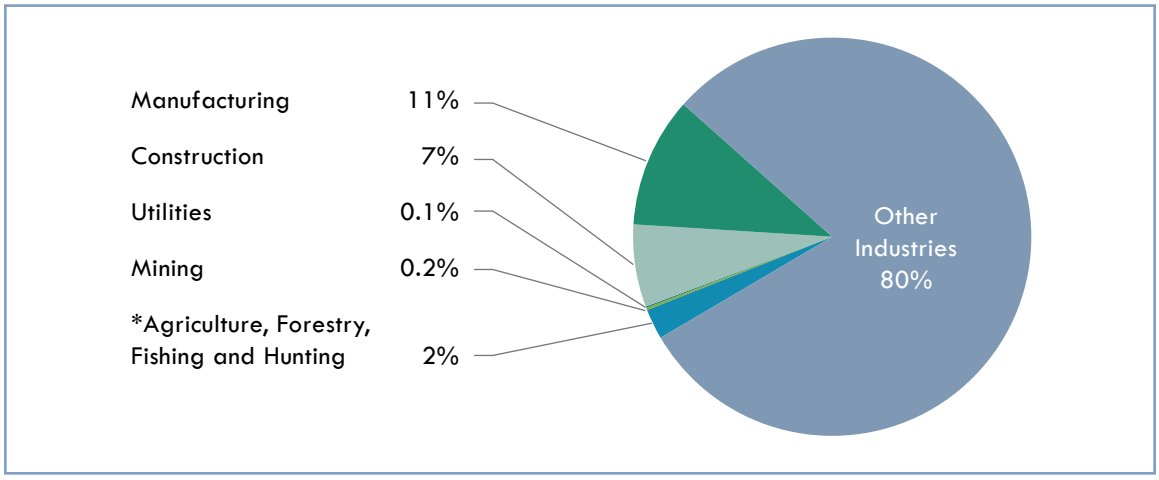

Source: BEA, 2007

## LOCATION QUOTIENT (COMPARATIVE TO THE U.S.) FOR ENERGY-INTENSIVE INDUSTRIES BY GDP

| Industry | Total: All Industries | Mining | Utilities | Agriculture. Forestry and Fishing | Construction | Manufacturing |
|---|---|---|---|---|---|---|
| LOCATION QUOTIENT | | .13 | .22 | .44 | .92 | 1.38 |
| Total GDP by Industry | $245,162 | $680 | $1,111 | $1,329 | $10,152 | $39,949 |
| Percentage of State GDP | 100% | .28% | .45% | .54% | 4% | 16% |

Source: BEA, 2007 (In millions of dollars) Shaded areas represent location quotients over 1.0

## ENERGY INTENSIVE INDUSTRIES BY EMPLOYMENT IN TENNESSEE, 2007




*Includes farm employment Source: BEA, 2007

**LOCATION QUOTIENT (COMPARATIVE TO THE U.S.) FOR ENERGY-INTENSIVE INDUSTRIES BY EMPLOYMENT**

| Industry | Total: All Industries | Mining | Utilities | Construction | Agriculture, Forestry, and Fishing | Manufacturing |
|---|---|---|---|---|---|---|
| LOCATION QUOTIENT | | .34 | .34 | 1.04 | 1.16 | 1.32 |
| Total Employment by Industry | 3,632,959 | 7,018 | 4,084 | 249,828 | 92,366 | 395,152 |
| Percentage of State Employment | 100% | .2% | .1% | 7% | 2% | 11% |

Source: BEA, 2007 Shaded areas represent location quotients over 1.0

## Preparing for the Low-Carbon Economy

TVA announced in 2007 its commitment to be a leader in energy efficiency and according to the Energy Information Administration, Tennessee utilities spent $10 million on energy efficiency in 2007, saving 63,547 MWh.[8] In May 2008, the TVA board approved a suite of pilot energy efficiency programs, including in-home energy auditing programs and prescriptive incentive programs for HVAC technologies.[9]

As part of the TVA's strategy, it created a renewable energy initiative that offers consumers a choice in the type of power they buy. "Green Power Switch" was created through the collaboration of local public power companies working with input from the environmental community. The TVA generates electricity through renewable resources such as solar, wind, and methane gas, adds it to the power mix and sells it to residential consumers in 150-kilowatt-hour blocks (approximately 12 percent of a typical household's monthly energy use). Each block adds $4 to customers' monthly power bills; consumers can buy as many blocks as they like. Green Power Switch is also marketed to commercial and industrial customers, who are asked to buy blocks based on the amount of energy they use.[10]

In addition to TVA's extensive role in the state's energy activities, the state government has a large slew of activity in this area. In March of 2008, the Governor established the Governor's Task Force on Energy Policy. The Task Force was charged with developing a state energy plan to help state government lead by example and to make recommendations to help the state become a leader in energy efficiency and renewable energy sources, and the development of clean-energy technology. The Task Force includes representatives of four state agencies and members representing business, environmental, legislative, and other interests.

Based on the Task Force's recommendations, in July 2009, the Governor signed into law the Tennessee Clean Energy Future Act of 2009 as the cornerstone for all future energy policy in the state. The legislation requires state government to do a better job of leading by example and makes the clean-energy technology sector eligible for Tennessee's emerging industry tax credit. It further promotes residential energy efficiency by streamlining the distribution of federal funds for weatherization of low-income homes and establishing a limited statewide residential building code for new construction.[11]

## State and Local Incentives

Tennessee offers state and local incentives that support the transition to a low-carbon economy by encouraging production of and demand for alternative and renewable energy, and by spurring the growth of clean tech industries and energy efficiency.

### *Incentives to encourage production:*

Tennessee offers the **Green Energy Tax Credit** to certified green energy supply chain manufacturers. The credit must be used to offset the certified manufacturer's franchise and excise tax liability. Any tax credit that cannot be used to benefit a certified manufacturer during a fiscal year may be returned to the taxpayer in the form of a cash overpayment. TVA has agreed to supply necessary information to the commissioner of revenue to verify the amount of the credit.[12]

***Incentives to encourage demand:***

The **Green Island Corridor Grant Program,** which is administered by the Tennessee Department of Transportation (TDOT), assists retail vehicle fuel stations and farm co-ops with up to 80 percent of the cost to convert or install storage and fuel dispensing equipment for E85 (*motor fuel blends of up to 85 percent ethanol and 15 percent gasoline*) and B20 (biodiesel) pumps, with a cap of $45,000 per pump. TDOT advertises biofuel station locations on the official state map and provides interstate signage at exits with participating biofuel stations. This program is working to establish a statewide network of E85 and B20 pumps alongside interstate and major highway corridors to make these fuels available to citizens, travelers and fleets.[13]

**The Small Business Energy Loan Program** provides low-interest loans of up to $300,000 to qualified Tennessee-based businesses to improve energy efficiency in their buildings, plants and manufacturing processes.[14]

The Tennessee Department of Economic and Community Development offers **Tennessee Clean Energy Technology Grants** to businesses to offset the cost of installing clean energy technologies such as solar electric generating equipment, wind energy systems, solar thermal systems, hydrogen fuel cells and hybrid solar lighting.[15]

Further, the Tennessee Department of Economic and Community Development offers **low-interest loans to municipal and county governments to fund energy-related improvements** to courthouses, administration buildings, schools, maintenance facilities and other buildings owned by local government. Even if a local government doesn't apply for the loan program, the Energy Office will arrange for an energy audit to provide technical assistance to communities interested in lowering their energy costs. The loan maximum for each community is $500,000 annually.

To help local governments keep up with rising energy costs and help schools save money on utility bills, a portion of lottery funds were used to establish an **Energy Efficient Schools Program** in 2008. The program is expected to reduce energy bills by 18.5 percent if the schools implement the upgrades and utilize best practices for energy conservation, saving an estimated $29 million in energy costs for Tennessee schools annually.[16]

Under the **Pollution Control Equipment Tax Credit,** the purchase of equipment that is mandated by state, federal or local law and that results in the reduction of water and/or air pollution, or the elimination of hazardous waste, may qualify for tax credits such as exemption from sales and use taxes, among other incentives.[17]

In 2007, the state passed legislation that requires at least 30 percent of the motor vehicles purchased for the state fleet each fiscal year be energy-efficient. In a separate bill, the state required that state agencies, universities, and community colleges develop and begin implementing plans to reduce motor fleet use of petroleum products by 20 percent beginning in January 2009.[18]

## Transition Assistance

With Tennessee's strong history in manufacturing and its emerging focus on biofuels and energy efficiency, the state is beginning to embark on initiatives that support the transition of its industries and its workforce.

### *Transitioning Industry*

#### *Energy Efficiency*

Tennessee received $42 million in federal stimulus funds through the Energy Efficiency and Conservation Block Grant Program. Most of the funds will go directly to small- and medium-sized cities and counties to provide assistance in conserving energy and reducing fossil fuel emissions. Areas of funding that will be given priority include: developing an overall energy efficiency and conservation strategy; retrofitting existing buildings with cost-effective energy efficiency measures; implementing renewable energy technologies on government buildings; and replacing traffic signals and street lighting with energy-efficient technologies. Of the remaining funds, $13.8 million will go to the Department of Economic and Community Development, which will issue $9.3 million in grants and use $4.5 million for public education and worker training.[19]

The public education campaign will be targeted to help Tennesseans improve the energy efficiency of their homes, and will use various channels to disseminate information, including workshops and print media. The training initiative will provide worker skills in a variety of green sectors, including weatherization, advanced energy codes, and solar installation. These programs will better position Tennessee's workforce to take advantage of the clean energy economy.

With one of the highest per capita rates of residential electricity consumption in the U.S., Tennessee recently announced its State Energy and Efficiency Appliance Rebate Program (SEEARP), also funded through the American Recovery and Reinvestment Act (AARA). Tennessee is receiving $5.9 million for the program's rebates and administrative costs. The program will provide residential rebates of $250 for air source heat pumps and central air conditioners, and $40 for room air conditioners with the Energy Star designation. Consumers receiving rebates may be eligible for additional financial assistance through TVA's existing residential efficiency programs.

In July 2009, the governor announced a $9.3 million grant program – also funded by the Recovery Act – for small- and medium-sized cities and counties seeking cost savings through energy-efficiency upgrades at local government facilities.[20] The funds (up to $100,000 per local government) are subject to approval by the U.S. Department of Energy (DOE), and preference is given to local governments that commit to promoting community-wide energy efficiency efforts, including minimum standards for new home construction.

***Biofuels***

Beyond encouraging energy efficiency in the built environment, Tennessee also is investing in biofuels. In 2006, Governor Bredesen formed the Alternative Fuels Working Group as a first step in developing an alternative fuels strategy for Tennessee. In 2007, the governor and the General Assembly set aside more than $72 million to position Tennessee to be a national leader in the production of biomass ethanol and related research.[21] See more on biofuels research taking place in Tennessee in the innovation section of this chapter.

### *Wind*

Wind development is an ongoing target for the state; about half of TVA's current renewable energy is generated from wind. Wind Prospecting in the Tennessee Valley Region is a two-year joint project of the Tennessee Energy Policy Office, Tennessee Valley Authority and Appalachian State University, funded by the DOE. The project aims to assess the wind-generating potential of various high altitude sites in eastern Tennessee. Several sites have been surveyed and identified as potential generating sites; physical inspections have been conducted at some sites and monitoring towers and equipment have been installed. The project will support the TVA's Green Power Switch program.[22]

### *Solar*

Tennessee is a participant in the Million Solar Roofs program, a DOE initiative to promote the use of solar energy. The initiative focuses on two solar technologies: photovoltaics (solar electric cells), which produce electricity from sunlight, and solar thermal panels, which produce heat for domestic hot water, space heating or heating swimming pools. The initiative establishes state and community partnerships that bring together business, government, the energy industry and community organizations to coordinate national and state resources and eliminate barriers to the use of solar energy.

### *Electric Cars*

The state is also pursuing an aggressive agenda to make electric vehicles part of its economy. Tennessee is one of five states participating in what is described as "the largest deployment of electric vehicles and charging infrastructure ever undertaken." The multistate project is being funded through a $99.8 million DOE grant to Electric Transportation Engineering Corp. The project will install electric vehicle charging infrastructure and deploy up to 5,000 Nissan battery electric vehicles in strategic markets in Tennessee, Arizona, California, Oregon and Washington.

### *Transitioning the Workforce*

In November 2008, the state Department of Labor and Workforce Development's Employment Security Division–Labor Market Information Section published a report outlining the state's potential in green job growth, "Growing Green: the potential for green job growth in Tennessee." The report also discusses how the state's assets could be used to support such growth.

Education and training programs forming or already in place that complement the state's focus areas in energy efficiency and clean tech industries are detailed below.

To prepare the biorefinery workforce, the Biosucceed program is developing a new curriculum of a complete Master of Science degree program that can be delivered by any of three university partners and via distance education. It will develop six graduate-level classes, two classes aimed at undergraduates, and modules that can be inserted in individual classes. Ultimately, these classes will be offered at no cost for customization by any institution around the country. The program is funded by a U.S. Department of Agriculture Higher Education Grant and is a partnership between North Carolina State University, North Carolina A&T, and the University of Tennessee Agricultural Experiment Station.

The Tennessee Energy, Industry and Construction Consortium, which includes a range of private and public sector employers and unions, is planning recruiting and training strategies for skilled trades workers that could be linked with energy efficiency projects. The state also offers comprehensive energy auditor training on performing inspections, surveys, and collecting diagnostic information on homes as part of the state's Weatherization Assistance Program.

Other green workforce assets in the state include:

- A Sustainability MBA at David Lipscomb University;
- Training in energy efficiency and solar power installation for residential construction at Cleveland State Community College, as part of an associate's degree program (which, with experience, can lead to solar PV installer certification); and
- Project Lead the Way, a pre-engineering program in 33 school sites in the state which introduces students to concepts related to energy efficiency. [23]

## Investing in Innovation

Innovation is key to enabling the transition to a low-carbon economy. Research and development in alternative energies and energy efficiencies aims to reduce their costs and help high emitting industries and firms in adapting to this new economic environment. Tennessee's innovation efforts are focused in energy efficiency, biofuels, and solar technologies. They are detailed below.

### *Energy Efficiency*

Tennessee has a world-class research facility in Oak Ridge National Laboratory (ORNL). ORNL is the largest of DOE's science and energy labs and houses the Bioenergy Science Center, Buildings Technology Center, High Temperature Materials Laboratory, and the National Transportation Research Center. The lab's activities now complement the state's extensive efforts in the area of energy efficiency through its series of "deep energy retrofit" research projects. (The lab defines *deep energy retrofits* as renovations to existing structures that use the latest energy-efficient materials and technologies and result in significant energy reductions.)[24] The projects are being supported by DOE's Building America Program, which has received additional funding from the Recovery Act. At least 10 homes across the region will be sought to participate. It is expected that data on savings from energy efficiency resulting from the project may be used to encourage more deep retrofits across the region.

### *Biofuels*

The University of Tennessee Biofuels Initiative (UTBI) is a five-year, $70 million commitment funded by the state. In 2007, the legislature appropriated $40.7 million for capital construction and $8.25 million for research, farmer incentives, and operating incentives for the biofuels initiative. The goal is to produce switchgrass, a non-food crop not previously grown commercially in Tennessee, through a farmer incentive program, and to construct and operate a pilot biorefinery with the capacity to produce 5 million gallons of cellulosic ethanol per year (about the amount the state currently uses annually for the state fleet). The plant in Vonore had its official grand opening in January 2010 and is now in production.

***Solar***

In September 2009, DOE confirmed Recovery Act funding to support the Volunteer State Solar Initiative in Tennessee. Under DOE's State Energy Program, the governor has proposed a statewide plan that prioritizes energy savings, creates or retains jobs, increases the use of renewable energy, and reduces carbon pollution. After demonstrating successful implementation of its plan, the state will receive $31 million in additional funding, for a total of nearly $62.5 million.[25]

The Volunteer State Solar Initiative is a comprehensive solar energy and economic development program focusing on job creation, education, renewable power production, and technology commercialization. The goal is to stimulate short-term economic growth while positioning the state to support long-term expansion of the solar industry. The initiative focuses on two projects:

> **The Tennessee Solar Institute** at the University of Tennessee and Oak Ridge National Laboratory, which will focus on industry partnerships to improve the affordability and efficiency of solar products; and
>
> **The West Tennessee Solar Farm**, a five-megawatt, 20-acre power generation facility that will be one of the largest installations in the Southeast and serve as a demonstration project for education and economic development.

The Solar Institute will create a "Solar Opportunity Fund" to underwrite a series of new innovation and installation grants, helping to establish relationships with industry and leverage ARRA funding. Over the next three years, approximately $23.5 million in grants will be distributed to solar industry firms looking to strengthen or expand their operations, as well as businesses looking to install solar-energy generation systems.[26] Moreover, Innovation Grants will provide funds to the state's solar industry firms for technical assistance, facility or process improvements, and workforce development. Installation Grants also will be issued to accelerate the deployment of solar energy statewide, providing grants to businesses to fund the purchase and installation of small-scale solar photovoltaic systems.

The Solar Farm will serve as an educational demonstration site for the public and students to learn about the benefits of renewable energy, showcasing commercially available solar

techniques and technologies. The Tennessee Department of Transportation will control the property for the farm in order to develop a pull-through interstate welcome center that encourages greater access to the site for educational purposes. In addition to its education mission, the farm will serve as a showcase for Tennessee-made solar products and components. Land acquisition and construction will be funded outside the Recovery Act.

## Partnerships

Many noteworthy partnerships are growing in Tennessee to drive forth the low-carbon economy as a greenhouse gas mitigation initiative as well as an economic driver. In addition to those already noted in this chapter, the partnerships highlighted below show successful coordination among state and quasi-state agencies.

**The Tennessee Department of Community and Economic Development** (ECD) is the lead economic development agency for the state, working to recruit and expand businesses in Tennessee. Recruiting a diverse portfolio of renewable energy companies to Tennessee is one of the ECD's focus areas. Additionally, ECD Commissioner Matt Kisber serves on the Governor's Task Force on Energy Policy, which is leading the state's energy plan.

**The Southern Alliance for Clean Energy (SACE)** is the contractor for ECD's Million Solar Roofs initiative. SACE has been involved in a variety of activities since 2003 designed to increase the acceptance and utilization of solar energy. A statewide stakeholders meeting has been held, drawing approximately 175 representatives from academia, the solar and utility industries and the general public who are interested in furthering the use of renewable energy technologies.[27]

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7 *Location Quotients: A location quotient is a useful economic base analysis tool to determine which industries have a high percentage of GDP or employment compared to a comparison area, such as the nation. Location quotients with results of 1 or higher are determined to be specialized industries.

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## Supply Chain Advancement to Retool the Manufacturing Base

In May 2008, Ohio became one of the first states in the country to pass a renewable portfolio standard (RPS) which mandates that by 2025, at least 25 percent of the electricity sold in Ohio must be generated from advanced energy technology – with a minimum of 12.5 percent from alternative sources such as third-generation nuclear power plants, fuel cells, energy-efficiency programs, and clean coal technology. Additionally, Ohio created a renewable energy credit tracking system, which allows utilities to buy, sell, and trade credits to comply with the renewable energy and solar energy requirements. Furthermore, electric utilities will be required to achieve energy savings of 22.5 percent by the end of 2025 through energy efficiency programs. Utilities must also implement programs to reduce peak energy demand by one percent beginning in 2009, and an additional .75 percent per year through 2018. Since public utilities are the largest emitters of greenhouse gases (GHG's), this state-mandated cap on emissions is expected to provide the stimulus for significant investment in the alternative energy industry.[1]

Further, Governor Ted Strickland has made advanced energy technology a centerpiece of his economic development policy. The Ohio Energy Office's Business and Industry team manages a portfolio of technical and financial resources, and works with partners to improve the competitiveness of Ohio manufacturers and to foster emerging energy technologies. Executive goals for Ohio include:

- Improving the Competitiveness of Ohio Business;
- Fostering New and Emerging Energy Technologies;
- Assisting Businesses to Connect to Financial Resources;
- Assisting Businesses Connect with Partners; and
- Assisting Businesses Connect to other Resources.

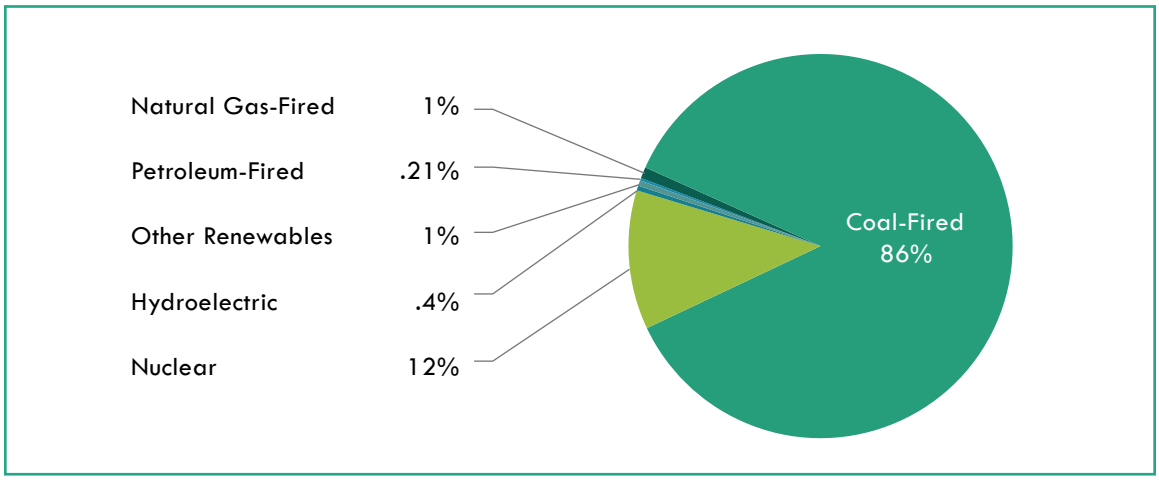
Regionally, Ohio joined the Midwestern Regional Greenhouse Gas Reduction Accord (MGGA), as an observer in November 2007. The MGGA is a regional agreement between six Midwestern states including: Iowa, Illinois, Kansas, Michigan, Minnesota, Wisconsin and one Canadian Province (Manitoba) to reduce GHG's. The MGGA program has four main goals: to establish GHG reduction targets in time frames consistent with signing states' targets; to develop a market-based and multi-sector cap-and-trade mechanism to help achieve those reduction targets; establish a system to enable tracking, management, and crediting for entities that reduce GHG emissions; and to develop and implement additional steps as needed to achieve the reduction targets, such as a low-carbon fuel standards and regional incentives and funding mechanisms.[2]

According to the American Council for an Energy-Efficient Economy[3], Ohio could save over $19 billion by using energy efficiency strategies. The state could also create more than 32,000 new jobs by 2025, including trade and professional jobs needed to design, install, and operate energy efficiency measures. By 2007, 2,513 businesses had generated more than 35,000 Ohio jobs in the clean energy economy, and venture capitalists are investing nearly $75 million in Ohio's clean energy businesses.[4]

## Energy Economy Snapshot

Ohio is rich in coal which constitutes 86 percent of its electricity generation. With a large population and a heavily industrial economy, Ohio is among the top states in total energy consumption. Other sources of electric generation in Ohio are nuclear (12 percent), natural gas (1 percent), renewable (other than hydroelectric, 1 percent), and petroleum (less than 1 percent). Of note, energy consumption in Ohio's industrial sector ranks among the highest in the nation, yet its energy costs are below the national average.

### OHIO ELECTRIC GENERATION BY FUEL SOURCE, 2009




Source: US DOE, Energy Information Administration, State Energy Profiles, 2009

Existing renewable energy facilities in Ohio include, but are not limited to the following:

***Wind***

- Four 1.8 megawatt (mw) wind turbines in Bowling Green operated by the municipal utility
- 225 kilowatt (kw) wind turbine at the Great Lakes Science Center in Cleveland

***Solar***

- 783 kw solar photovoltaic array on seven acres at the Ohio Air National Guard 180th Fighter Wing headquarters in Toledo (facility will eventually generate more than 1 mw).
- 159 kw and 60 kw solar photovoltaic arrays located at the at Oberlin College
- 42 solar panels at the Cleveland Indians Progressive Field provide 8.4 kw of solar power

***Hydro***

- 130 mw hydroelectric capacity statewide, plus a 42 mw hydroelectric plant located in West Virginia on the Ohio River as a joint venture of American Municipal Power-Ohio member communities

***Other***

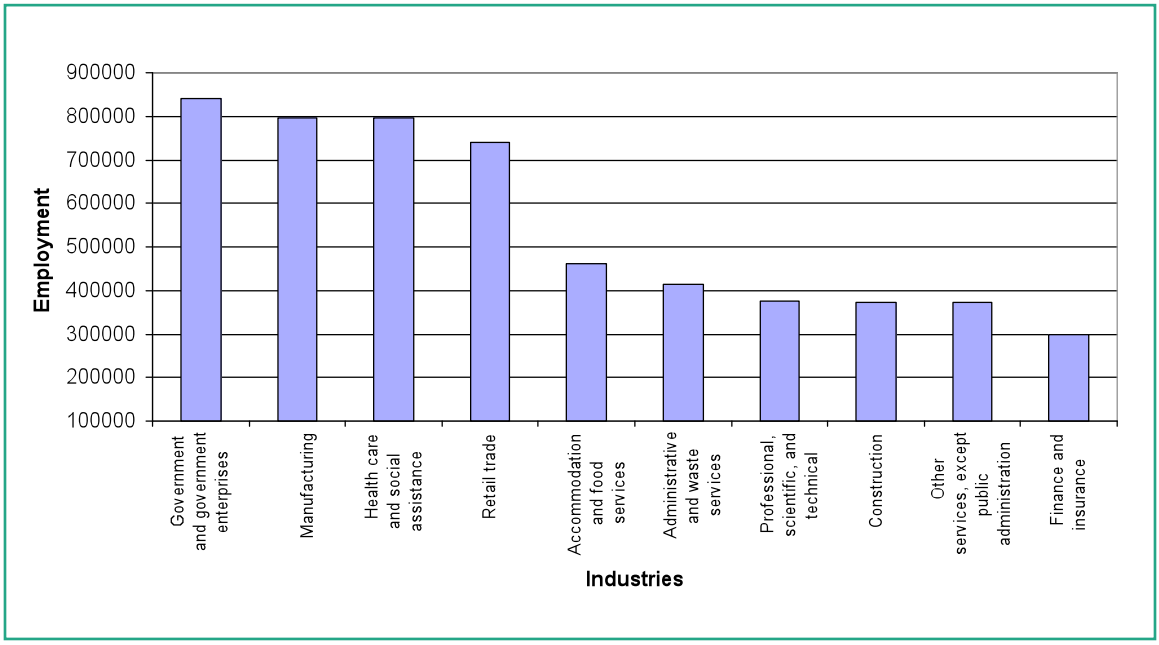
- 17 landfill gas projects of which seven generate electricity for a total capacity of 37 mw
- Biomass generation using waste residue to generate heat and power onsite in the wood manufacturing and paper industries

## Industry Overview of Ohio

Identifying the opportunities and challenges emerging from the move to a low-carbon economy requires and understanding of the state's current vulnerabilities and areas of resilience in their current industry mix. Ohio's industry mix is focused in government, manufacturing, health care and retail trade. These four industries combined employ over 3,000,000 employees. Accommodation and food services; administrative and waste services; professional, scientific and technical services; construction; and other services except public administration employ over 1,750,000 employees in the state.

Energy intensive industries make up 25 percent of the total gross domestic product (GDP) in Ohio and 19 percent of the total employment. From the five energy intensive industries, manufacturing (18 percent), construction (4 percent), and utilities (2 percent) make up 24 percent of the total GDP. Mining (.49 percent) and agricultural, forestry, fishing and hunting (.73 percent) only make up a little more than 1 percent of the total GDP in the State.

**TOP 10 INDUSTRIES BY EMPLOYMENT IN OHIO: 2007**

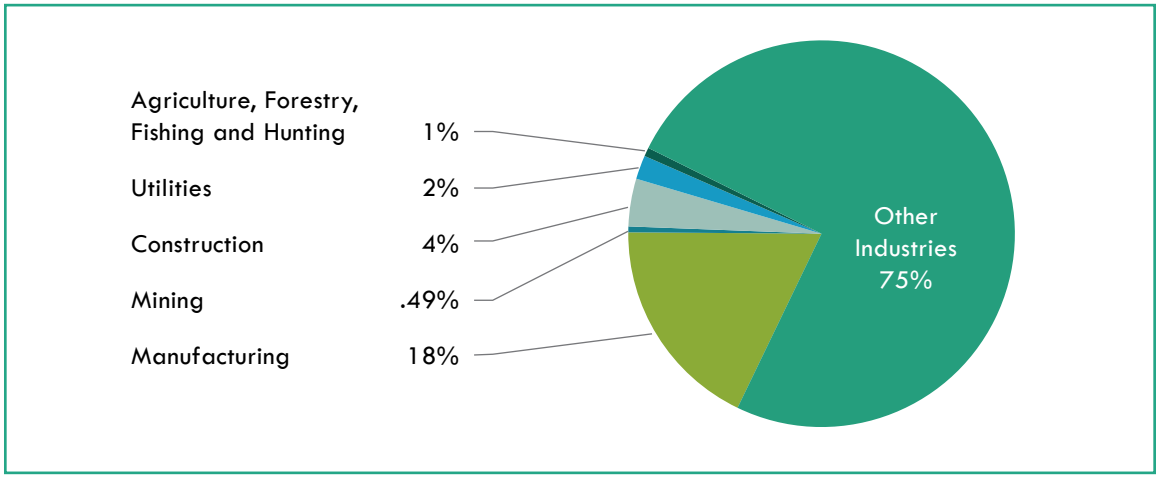



Source: BEA, 2007

Energy Intensive Industries make up 19 percent of the total working population in Ohio. Both manufacturing (12 percent) and construction (5 percent) make up the highest number of employment by energy intensive sectors in the state, followed by agriculture (2 percent).

Looking at location quotients[5] to understand the state's economic advantages, utilities and manufacturing stand out as specializations for Ohio, in terms of GDP and employment. The following are sub industry specializations within Ohio's manufacturing industry: motor vehicle, body trailer, and parts manufacturing; primary metal manufacturing; product manufacturing; fabricated metal product manufacturing; electrical equipment and appliance manufacturing; and plastics and rubber products. Note that there are no sub industry specializations denoted within the utilities industry.

## ENERGY INTENSIVE INDUSTRIES BY GDP IN OHIO, 2007



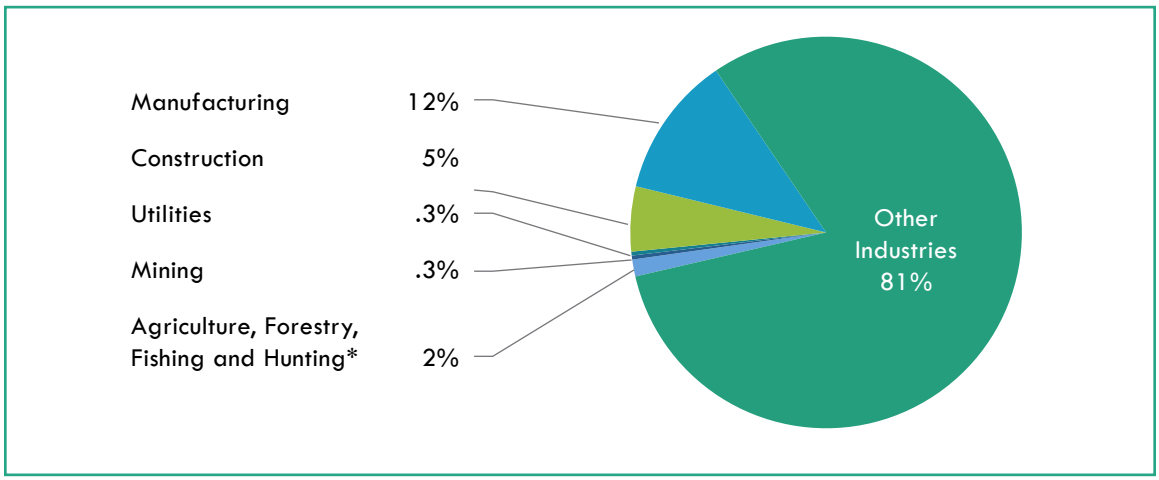

Source: BEA, 2007

## LOCATION QUOTIENT (COMPARATIVE TO THE U.S.) FOR ENERGY-INTENSIVE INDUSTRIES BY GDP

| Industry | Total: All Industries | Agriculture, Forestry and Fishing | Mining | Construction | Utilities | Manufacturing |
|---|---|---|---|---|---|---|
| Location Quotient | | .59 | .24 | .83 | 1.02 | 1.55 |
| Total GDP by Industry | $462,506 | $3,367 | $2,245 | $17,195 | $9,766 | $84,986 |
| Percentage of State GDP | 100% | 1% | .49% | 4% | 2% | 18% |

Source: BEA, 2007 (In millions of dollars) Shaded areas represent location quotients over 1.0

## ENERGY INTENSIVE INDUSTRIES BY EMPLOYMENT IN OHIO, 2007




*Includes farm employment Source: BEA, 2007

## LOCATION QUOTIENT (COMPARATIVE TO THE U.S.) FOR ENERGY-INTENSIVE INDUSTRIES BY EMPLOYMENT

| Industry | Total: All Industries | Mining | Agriculture, Forestry and Fishing | Construction | Utilities | Manufacturing |
|---|---|---|---|---|---|---|
| Location Quotient | | .59 | .65 | .83 | 1.01 | 1.45 |
| Total Employment by Industry | 6,812,623 | 22,193 | 95,186 | 365,455 | 21,952 | 796,758 |
| Percentage of State Employment | 100% | .3% | 2% | 5% | .3% | 12% |

Source: BEA, 2007 Shaded areas represent location quotients over 1.0

## Preparing for the Low-Carbon Economy

In May 2008, Ohio Governor Strickland signed Senate Bill 221 into law, enacting an alternative energy portfolio standard that requires that 25 percent of electricity sold by Ohio's electric distribution utilities or electric services companies must be generated from alternative energy sources by 2025. At least half of this energy must come from renewable energy sources, such as solar, wind, biomass and hydro with a minimum of 0.5 percent coming from solar resources. One half of the renewable energy facilities must be located in Ohio.

In addition to the renewable sources requirement, the remainder of the alternative energy required to meet the standard may be generated from advanced energy resources, such as clean coal, nuclear, fuel cells, customer cogeneration, and solid waste. The law sets annual benchmarks, or incremental percentage requirements for renewable energy, through 2025. Each utility and electric services company is subject to compliance payments if the annual benchmarks are not met. Utilities and electric services companies may purchase renewable energy credits to meet the renewable portion of the standard. Moreover, the state government offers the industrial sector funding opportunities along with business and technical services in order to help Ohio manufacturers became more competitive and to foster emerging energy technologies.[6]

In 2007 the Governor announced an Energy, Jobs and Progress plan to address the threat of climate change in the state. The objectives included:

- Ensuring affordable and stable energy prices to protect Ohio consumers and jobs;
- Attracting energy jobs of the future through an Ohio advanced energy portfolio standard;
- Safeguarding Ohio families by empowering consumers and modernizing Ohio's energy infrastructure.

## State and Local Support Programs and Incentives

Ohio offers state and local incentives that support the transition to a lower-carbon economy by encouraging production of and demand for alternative and renewable energy, and by spurring the growth of clean tech industries and energy efficiency.

### *Incentives to encourage production:*

**The Ohio Third Frontier** is a 10-year, $1.6 billion research and development funding program, which has leveraged an additional $6 billion in federal and private sector support for emerging industries and technologies. As of June 30, 2009, Ohio Third Frontier had awarded more than $970 million for energy related research, development and product commercialization.[7] There are several divisions devoted to alternative energy industries including the Advanced Energy Program, Advanced Materials Program, Fuel Cell Program, Innovation Ohio Loan Fund, Ohio Research Commercialization Grant Fund, Photovoltaic Program, and Targeted Industry Attraction Grants.[8] SRI International, Inc. recently concluded that investment from Ohio Third Frontier has resulted in $6.6 billion of economic impact and the creation of 41,300 jobs.[9]

The Ohio Department of Development operates the **Advanced Energy Fund**, which provides incentives for both commercial and utility-scale projects and manufacturing. The fund began with a $307 million contribution from the State of Ohio.[10]

**The Advanced Energy Job Stimulus Fund** is a $150 million fund that provides grants for development of clean energy. Forty four percent of the funds are to be used for clean coal technology projects, the remainder will be for non-coal-related projects. The Fund is being administered by the Ohio Air Quality Development Authority.[11]

### *Incentives to encourage demand:*

The Ohio Department of Development's Ohio Energy Office is administering the **Targeting Industry Efficiency grant program.** These grants will help manufacturers in Ohio make improvements in energy efficiency, create long-term jobs, and improve the environment by reducing carbon emissions. Targeted industries include advanced energy, aerospace and aviation, agriculture and food processing, bioscience and bio-products, instruments, controls and electronics, motor vehicles and parts manufacturing, and polymers and advanced materials. Technologies

may include combined heat and power, demand reduction, assessments for carbon mitigation opportunities, improvements in process heat applications, motors and other industrial systems. Awards will range between $250,000 and $1 million and will be selected through a competitive process.[12]

**The Advanced Energy Fund** provides two residential solar energy incentive programs, the Solar Thermal Energy Incentive for Residential Housing Units and the Residential Solar Photovoltaic Energy Incentive. The programs provide grants of up to $3 per watt, up to $25,000, and go towards solar systems at least 2,000 watts. The grants, when combined with current Federal tax credits for solar reduce the payback for installation from 30 to 11 years.[13] The Edison Materials Technology Center (EMTEC) Alternative Energy Technology Group has developed a solar supply chain database with 113 companies in Ohio.[14]

**The Energy Efficiency Loan Program** was established to provide low-interest loans to residents and businesses wishing to invest in energy efficiency and renewable energy projects. It is financed through a rider on electric bills in the state and is authorized to collect $100 million over a 10-year period with the purpose of promoting economic development and to improve environmental quality.[15]

In June 2009, the Ohio House of Representatives passed **Ohio's Solar Schools Bill.** The bill institutes a pilot program for solar schools which would install solar electricity panels in the 70 largest school districts around the state and install solar panels on all public schools within five years. The solar initiative for schools offers tax credits and other incentives to investors.

## Transition Assistance and Market Forces

Much of the focus in Ohio is in increasing energy efficiency across residential, commercial and institutional users. The U.S. Department of Energy has set aside $84 million for Ohio's local governments to spend on energy efficiency and conservation projects. The money set aside for Ohio includes $25 million to the Ohio Department of Development's Energy Office. The office must award 60 percent of that, or $15 million, to smaller towns and counties across the state. The grant is part of $3 billion in the American Recovery and Reinvestment Act (ARRA) funds being distributed through the Department of Energy's Efficiency and Conservation Block Grant program. The effort is designed to help local governments, including Indian tribal governments,

pay for projects and upgrades, reduce energy use and cut combustion emissions[16]. Funds will be used to provide home energy audits and weatherization programs, replace inefficient appliances by providing rebates for new energy efficient appliances, and requiring that inefficient appliances are exchanged, upgrade commercial lighting and refrigeration, and provide incentives for manufacturers to replace inefficient equipment with more efficient technologies.

Prior to ARRA, Ohio was already beginning to focus on energy efficiency. In 2004, Ohio made the top 10 list of states with the highest share of Energy Star-qualified homes, with 12 percent of all homes built in Ohio receiving an Energy Star label. It is estimated that the investments made in Ohio through Energy Star could prevent the emissions of 14 million metric tons of GHG's, equivalent to eliminating the emissions from 9 million vehicles.[17] In 2006, the state ranked number 8 in terms of the total number of Energy Star homes built, and in Columbus alone 2,122 Energy Star certified homes were built in 2006.[18] Further, Ohio's manufactures are also becoming Energy Star certified and in February 2009 Honda's auto plants in Marysville and East Liberty, Ohio received Energy Star awards from the U.S. EPA for advances in curbing energy use during the production of passenger cars and light trucks. At the Marysville plant, associates significantly reduced electricity use by reprogramming plastic injection molding machines to run only during the production cycle, reducing $CO_2$ emissions by 80,000 pounds per year.[19]

### *Transitioning Industry*

In addition to spurring savings via energy efficiency, Ohio is also working to develop emerging clean tech industries that build off of the state's many assets in its manufacturing economy.

#### *Fuel Cells*

Ohio has coordinated state-level programs that are spurring the growth of its fuel cell supply chain.[20] The Edison Materials Technology Center (EMTEC) Alternative Energy Technology Group has partnered with the Ohio Department of Development to build the fuel cell supply chain.[21] EMTEC maintains a supply chain database, currently with 935 businesses that can leverage the on-line forum to develop their business model, receive constructive feedback, establish credibility, and identify where best to reside in the fuel cell supply chain.[22] The fuel cell supply chain is clustering around the Cleveland/Akron area, Cincinnati, Dayton and Columbus.

EMTEC developed their Fuel Cell Hierarchy (FCH) to map out the network of suppliers for this complex newly evolving technology.[23]

Further, the Ohio Fuel Cell Coalition (OFCC) consists of members from government, academia and the private sector, who are working towards building the networks necessary for the fuel cell supply chain to prosper in Ohio. Using grants from the Ohio Department of Development and Ohio Third Frontier, OFCC's website provides valuable information for companies looking to expand into Ohio's fuel cell supply chain.[24] The Fuel Cell Corridor Portal provides more detailed information for OFCC members.

### *Solar Energy*

Solar Energy is one of the Ohio Department of Development's targeted industries. There are more than 115 businesses and research institutions involved in the solar energy supply chain in Ohio. These companies range from mid-sized solar installation companies like Dovetail Solar and Wind to larger companies like First Solar in Perrysburg that employs nearly 700 people.[25] The automotive glass supply chain is providing a solid underpinning of a new solar clustering taking place around Toledo.[26] Wood County, OH, which encompasses Toledo, is seeing large scale investment by its solar cluster. First Solar, Inc., and Willard & Kelsey Solar Group, LLC are investing $241 million into Perrysburg that they anticipate will create 534 new jobs. Cabo USA, Inc. is expanding operations at its current facility.

### *Wind Energy*

Ohio's history with wind turbines and as an advanced manufacturing hub provides it with a solid base for capturing supply chain opportunities for wind turbines.[27] The world's first electric wind turbine was built in Ohio in 1888 in Cleveland, and the first megawatt-sized turbine was built in Cleveland in 1941. While the production processes of automobile manufacturing and wind turbine construction requires a certain amount of retooling (automobile manufacturing requires small parts at huge scales, and wind turbines manufacturing requires larger parts at typically lower volumes), the proximity of so many component manufacturers with decades of experience in castings, machining, bearings, gears, forging and fabricating parts is unparalleled in North America. More than 220 businesses and research institutions are involved in Ohio's wind energy supply chain, and more than 1,000 companies have been identified as eligible to transition into manufacturing components for the wind energy supply chain.[28]

Further, the Ohio Wind Working Group (OWWG), originally organized under an Ohio Energy Office Grant by Green Energy Ohio, is now operated by the Ohio Department of Development and is funded by the U.S. Department of Energy's Wind Powering America Program. OWWG continues to engage the nation's top wind developers, public utilities, state and local officials, researchers, landowners, nonprofit organizations, and other interested parties to identify issues, obstacles, and opportunities which impact wind energy development in Ohio. Drawing from the manufacturing, government, development and research sectors, as well as local landowners, OWWG members work collaboratively on information-sharing, education, and outreach on emerging wind energy issues relevant to Ohio. The results have been promising with 2006 alone representing $250 million in investment and the creation of 1,700 direct and indirect jobs.[29]

Further, the State of Ohio offers incentive programs to accelerate the wind energy supply chain:

- **The Wind Production and Manufacturing Incentive Program**, which offered a production-based incentive has not been funded since 2007, but included a $5 million grant to EverPower's Buckeye Wind Project and JW Great Lakes Wood County Wind Farm.
- **The Anemometer Loan Program** provides 100 percent of the cost and equipment for a non-profit entity to perform pre-development studies on wind energy potential.[30]
- The City of Cleveland passed new **wind turbine zoning legislation** in June 2009 that is expected to provide a transparent regulatory process for business and residential owners by establishing predictable guidelines for the installation of wind turbines.[31]

The Ohio Department of Development has provided approximately $100 million in research funds since 2002 for advanced energy systems including wind. Timken Company, Owens Corning and Parker Hannifin, three leading suppliers of wind turbine parts are located in Ohio, and all operate research facilities in the state.[32] Case Western Reserve University has partnered with seven regional companies, Parker Hannifin, Lubrizol Corporation, Rockwell Automation, Swiger Coil Systems, Cleveland Electric Laboratories, Phillips Group, and Wm. Sopko & Sons Company to establish an Ohio Wind Energy Research and Commercialization Center. The Ohio Controlling Board is providing a $500,000 grant towards the center which will be affiliated with the Case Western Energy Institute seeking ways to test and bring to market new wind turbine technologies.[33]

***Biofuels***

There are more than 60 Ohio businesses and research institutions involved in the biomass industry and over 1,300 wood manufacturing companies in the state that produce residues that are capable of being converted onto biomass energy.[34] Further, Ohio is one of seven states participating in the Great Lakes Biomass State and Regional Partnership. The Partnership is administered by the Council of Great Lakes Governors and receives grant funding from the U.S. Department of Energy.

The Ohio Biomass Energy Program provides information, resource referrals, business connections and periodic funding assistance to support the development and use of biomass energy resources in Ohio.[35] The mission of the Ohio Biomass Energy Program is to increase the development and utilization of biomass energy resources in Ohio in order to promote energy sustainability and a cleaner environment. To achieve this mission, their objectives are to:

- Acquire, develop, and promote information about biomass energy resources;
- Increase the production and use of biomass energy resources;
- Encourage Ohio investments in biomass energy technologies;
- Facilitate cooperative approaches among Ohio state agencies, industry, and organizations on biomass development;
- Promote the environmental benefits of renewable biomass energy resources; and
- Manage projects of the Great Lakes Biomass State and Regional Partnership.

Lastly, in August 2009, Ohio Edison Company, a subsidiary of FirstEnergy Corp., agreed in a consent decree to repower one of its coal-fired power plants - the R.E. Burger Units near Shadyside, Ohio - using primarily renewable biomass fuels. The agreement will reduce net GHG emissions by 1.3 million tons a year. Ohio is joined by the states of New York, New Jersey and Connecticut in this agreement.[36] The consent decree will also reduce emissions of $SO_2$ and NOx from Burger's current levels. This will be the largest coal-fired electric utility plant in the country to repower with renewable biomass fuels and the first such plant at which GHG will be reduced under a Clean Air Act consent decree.

***Transitioning the Workforce:***

Ohio is taking a proactive stance in developing its green workforce and in connecting people to green training and green jobs. In July 2009, the University System of Ohio partnered

with the Ohio Environmental Council to launch The Ohio Green Pathways (OGP) to develop the University System of Ohio's capacity to develop a green collar workforce[37]. This project directly links education and training opportunities available in the system with jobs in green industries across the state, with the goal of making Ohio's workforce a global leader in the green economy. The project developed a catalog of the University System of Ohio's green education and training programs targeted at prospective, students and employers.[38]

Additionally, the Ohio Green Workforce Training Partnership (led by the Corporation for Ohio Appalachian Development) is working to widen opportunities to workers participating in the Ohio Home Weatherization Assistance Program to pursue career opportunities beyond low-income residential weatherization programs. The program combines the knowledge and experience of Ohio's existing weatherization network, organized labor, environmental groups and local community and technical colleges. Partnership participants include the Central Ohio Technical College, Cuyahoga Community College, Electrical Trades Center of Central Ohio, Hocking College Logan Campus, Laborer's District Council of Ohio, Laborers' International Union of North America, Ohio Environmental Council, Ohio Apollo Alliance, Ohio Association of Community Action Agencies, Ohio Department of Development, Ohio Partners for Affordable Energy, Ohio State Building and Construction Trades, Ohio Urban Resources System (OURS), Policy Matters Ohio, Third-Sun Solar & Wind, Ltd., and the Cuyahoga Community College.[39]

Further, ARRA funds are supporting the transition towards green jobs in Ohio. The Ohio Department of Job and Family Services received two State Labor Market Information Improvement Grants from the U.S. Department of Labor as part of ARRA.[40] The Green Jobs Grant was awarded to develop a statewide infrastructure to support green jobs workforce development, education and training. Job and Family Services is partnering with the Governor's Workforce Policy Advisory Board, the Ohio Board of Regents and the University System of Ohio to identify the skills needed by green industries, so that curricula and training programs can be developed around those needs. Interested job seekers can then be connected with related workforce development services, training providers and job opportunities.

Additionally, the Auto Industry Grant is a $4 million shared grant with Indiana and Michigan to coordinate efforts to help dislocated auto industry workers pursue new career paths in green industries. Along with Michigan, Ohio's role will be to gather information from auto industry

manufacturers and parts suppliers about their changing business environments and labor force needs. Ohio also will conduct a green jobs survey of Ohio employers, to better identify the number of green jobs available in the state and the skills required to fill them.

## Investing in Innovation

Innovation will enable the economy to transition. Through proactive and cutting edge partnerships between state, quasi-state, and university partnerships, Ohio is targeting innovation in the areas that are complementary to their emerging clean tech supply chain areas. Some of the notable efforts are listed below. Much of Ohio's innovation efforts support their existing industrial assets to help position them for participation in this rapidly changing energy marketplace.

### *Fuel Cells*

Six companies were recently awarded a total of $6.38 million towards continued fuel cell research by Ohio Third Frontier and the Ohio Department of Development. The fuel cell awards are designed to focus on the technical and cost barriers for expanding the commercialization of fuel cell technology.[41] Further, researchers at the University of Dayton have demonstrated the use of carbon nanotubes as a catalyst in fuel cells, which could potentially lead to a significant reduction in the cost of fuel cells, which until now have primarily relied on platinum catalysts.[42]

### *Solar*

The Ohio Third Frontier also runs the Photovoltaic Program to fund research and commercialization of solar energy research in conjunction with Ohio's universities. The Program awarded six projects for Fiscal Year 2010 totaling slightly more than $6 million to six firms. The projects range from improving photovoltaic longevity, functionality, thickness, affordability.[43] Researchers at The Ohio State University are working on developing next generation solar energy materials that capture more of the sun's energy.[44] As example of the photovoltaic clustering around Toledo, Xunlight Corporation is a company specializing in the development of next generation solar modules. It was established in 2002, to commercialize solar technology that was developed at the University of Toledo's Thin Film Silicon Photovoltaic Laboratory.[45]

***Clean Coal***

Clean coal refers to the development and implementation of technology designed to mitigate the environmental effects of using burning coal. It can include anything from the gasification of coal, known as IGCC (Integrated Gasification Combined Cycle), to carbon sequestration, which buries the carbon dioxide released from the burning of coal. The Ohio Coal Development Office (OCDO) is a program within the larger Ohio Air Quality Development Authority[46], which co-funds the development and implementation of technologies that are attempting to find cost-effective and environmentally sustainable methods of leveraging Ohio's vast reserves of high-sulfur coal. To date, the Ohio Coal Development Office has funded approximately 300 projects. Further, The Third Frontier Commission awarded $10.5 million to The Ohio State University's Institute for Energy and the Environment to coordinate the Advanced Energy via Green Industrialization Ohio Research Program. This will enable The Ohio State University to staff a leading researcher in carbon sequestration, and to expand its partnership in clean coal research with Ohio University.[47]

Approximately $1.3 million was awarded in 2006 to seven universities in Ohio to fund research into improving the efficiency of converting coal into energy including improving GHG and mercury capture (byproducts of burning coal), and greatly increasing hydrogen yields (to be used for direct electricity generation and improving fuel cell technology). Of particular note is Demonstration Project D-06-02, which was given to The Ohio State University, in partnership with American Electric Power, Brookhaven National Laboratory, Oak Ridge National Laboratory, Oxford Mining and B&N Coal to improve management methods for carbon sequestration in reclaimed mine land soils. Included in this research will be the development of protocol for trading carbon credits on the Chicago Climate Exchange.[48]

***Geothermal***

A specific example of ARRA fund usage is Wright State University's research into the development of more advanced ground-based heat pumps (GHP's) for geothermal projects. The development of more accurate computer models that can determine the efficiency of GHP's, allowing owners of systems a more thorough analysis before installation of a new system should translate into a more transparent decision-making process, and speed up the commercialization of geothermal technologies.[49]

## Partnerships

In addition to many of the partnerships discussed earlier in this document, the key role of the Ohio Department of Development along with its energy office, as well as a diversity of non-profit and trade association partnerships have emerged in Ohio to further support the growth and development of the state's clean tech industries. Many of them are denoted below.

The **Ohio Department of Development (ODOD)** is the lead economic development agency for the state. The department has a deep agenda in supporting the growth of the advanced energy business sector with a robust supply chain. ODOD operates the Advanced Energy Fund, the Ohio Wind Working Group (OWWG) and is involved in numerous other partnerships that are driving forward the advanced energy sector within Ohio.

Within ODOD is the **Ohio Energy Office** which is focused on ensuring stable energy prices, modernizing Ohio's energy infrastructure, and attracting jobs through the growth of environmentally friendly industries. The OEO has a lead role in accomplishing the goals of Ohio's energy bill. Further, OEO funds projects related to the deployment of renewable energy technologies including wind, solar photovoltaic, solar thermal, and geothermal, as well as energy efficiency measures for industrial, commercial, and some consumer classes of residential. The Office has been involved in supporting energy-related components of ARRA, including the State Energy Program, the Energy Efficiency and Conservation Block Grant Program, and the Energy Efficient Appliance Rebate Program.

Formed in 2007, **Ohio Advanced Energy** is a non-profit business-trade association dedicated to the development of a vibrant advanced and renewable energy economy in Ohio.[50]

**Clean Fuels Ohio** is a non-profit based in Columbus whose stated goal is to increase public-private partnerships in building the biofuel supply chain in Ohio.[51]

**Green Energy Ohio** is a leading organization in Ohio with the goal of promoting environmentally and economically sustainable energy policies and practices. It maintains a valuable, continuously updated website providing a comprehensive snapshot of existing research, state programs and examples of successful commercialization of alternative energy technology.[52]

**WIRE-Net**, a membership organization of business professionals devoted to sharing ideas about economic growth and job creation,[53] created the **Great Lakes Wind Network (GLWN)** as an industry-based organization of manufacturers, suppliers and research organizations with a mission to serve this market by growing the supply chain. Their mission is to increase the domestic (North America) content of wind turbines. GLWN hosts local conferences and workshops around the U.S. and Canada to educate OEM's (original equipment manufacturers) on how they can enter the supply chain. A successful example of this is HPM America, which faced declining demand for its injection molding machines when its customer base shrank following a retrenchment in the domestic automobile industry that began in 2003. HPM America recognized that they needed to diversify their production base, and concluded that the alternative energy sector was an opportunity for high growth. They started a contract manufacturing unit, and were approached by a wind turbine manufacturer, which has led to resurgence in revenue and job creation.[54]

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# Transitioning to Wind while Advancing Carbon Capture and Sequestration

While staying true to its deep economic base in oil and coal, North Dakota is also expanding its economy by targeting wind energy and carbon capture and sequestration technologies.

Wind energy represents an enormous asset in North Dakota. It has the potential to produce more than 1.2 trillion kilowatt (kw) hours of electricity every year, enough to power over a quarter of the U.S.[1] As of December 2008, the state ranked first in the country for potential wind energy output, but 11th for actual wind energy output. Wind potential has not been fully exploited due to concerns over constraints on the transmission grid.[2] Even though North Dakota has further room to develop its wind assets, since 2000, its actual wind energy generation has grown from one-half megawatt (mw) to over 850 mw, in place or under construction.

Hydroelectric power also represents an important alternative energy source in North Dakota, accounting for 5 percent of the state's total electricity production, according to the U.S. Department of Energy in 2009.

The state is the largest U.S. producer of canola and is 11th in soybean production and 16th in corn production, providing great potential for producing biofuels such as diesel and ethanol.[3] With six ethanol plants in the state and one bio-diesel plant, North Dakota has considerable production capacity.

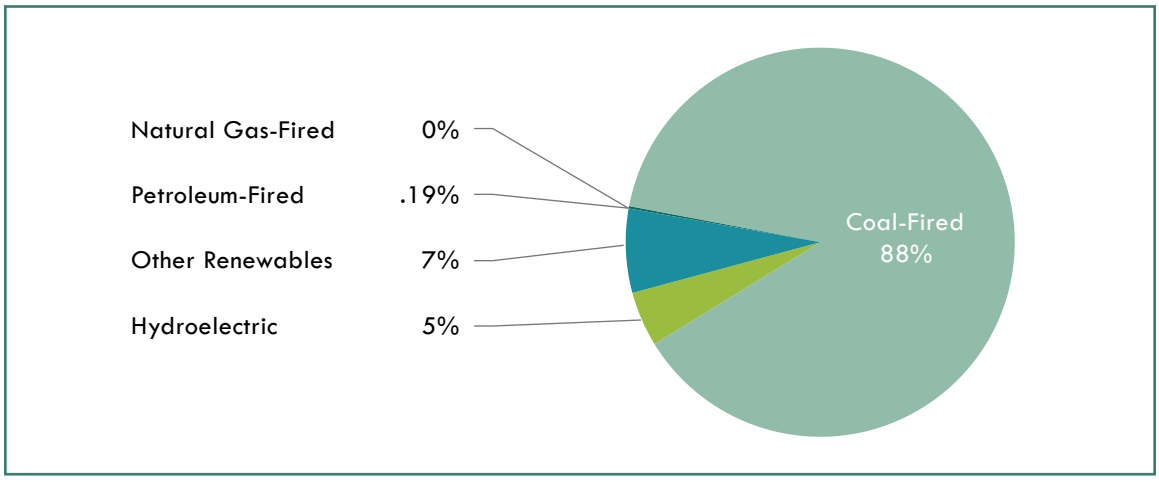
## Energy Economy Snapshot

North Dakota's per capita energy consumption is among the highest in the nation, which is due in part to heating demand in the winter.[4] However, given the small size of North Dakota's population, both electricity generation and demand are relatively low in raw numbers. Nearly all of the state's electricity is generated by coal-fired power plants that draw on the state's considerable fossil fuel reserves. Coal is extracted from large surface mines in the central part of the state, while the western part of the state has substantial crude oil and natural gas reserves.[5]

North Dakota is the fourth largest oil-producing state in the U.S.[6] The state's oil output accounts for about 2 percent of total U.S. crude oil production. The state is also an entry point for Canadian crude oil transported via pipeline to U.S. refining markets in the Midwest. The state also produces approximately 1 percent of the nation's annual natural gas production. The majority of the state's natural gas is transported via major pipelines originating in Montana and western Canada to markets in the U.S. Midwest for consumption.[7]

North Dakota generates 88 percent of its electricity from coal, 7 percent from renewable sources (other than hydroelectric), 5 percent from hydroelectric, and less than 1 percent from petroleum-fired and natural-gas fired plants.

### NORTH DAKOTA ELECTRIC GENERATION BY FUEL SOURCE, 2009

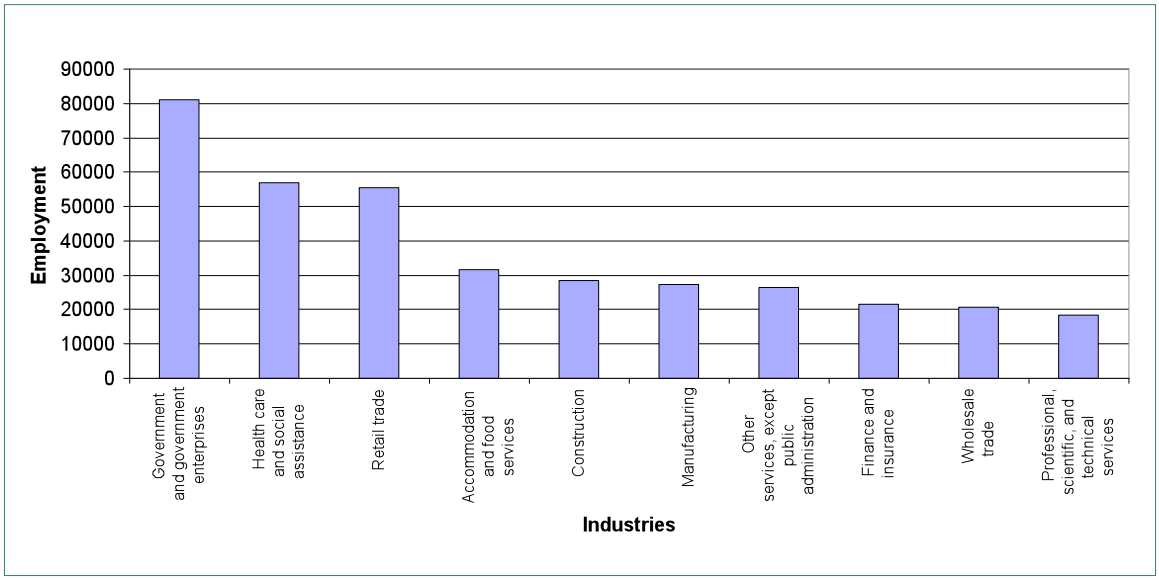



Source: US DOE, Energy Information Administration, State Energy Profiles, 2009

## Industry Overview of North Dakota

Understanding the vulnerabilities and areas of resilience in the state's current industry mix will help identify the challenges and opportunities of moving to a low-carbon economy. Government, healthcare and social services, and retail trade account for the highest number of employees in North Dakota, approximately 190,000 people. Accommodation and food services, construction, manufacturing, and other services (except public administration) employ approximately 90,000 workers, while finance and insurance, wholesale trade, and professional, scientific and technical services employ approximately 60,000 workers.

### TOP 10 INDUSTRIES IN NORTH DAKOTA BY EMPLOYMENT 2007



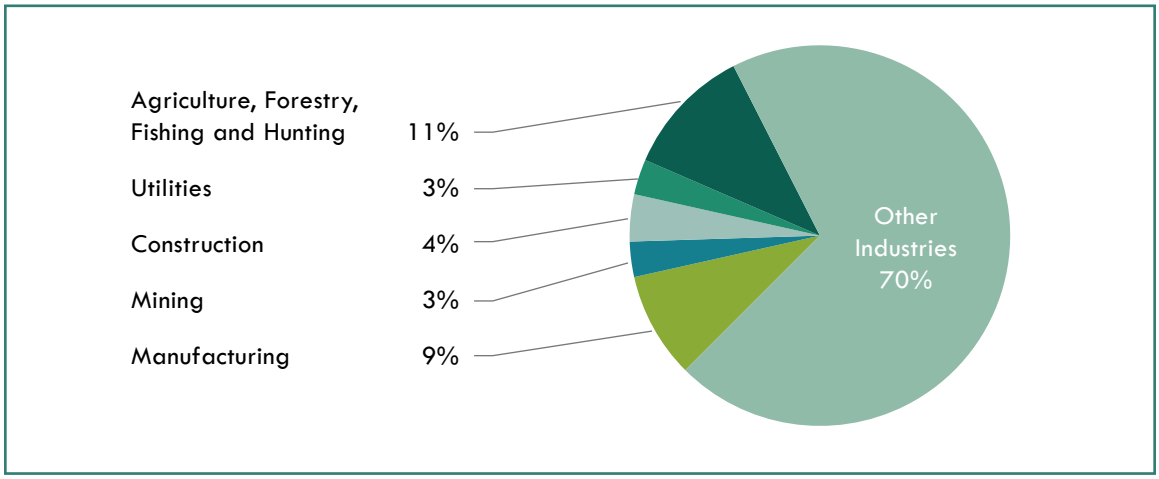

Source: BEA, 2007

Energy-intensive industries make up 30 percent of the state's gross domestic product (GDP) and 21 percent of total employment in North Dakota. From the five energy-intensive industries, manufacturing (9 percent), construction (4 percent), and agriculture, forestry, fishing, and hunting (11 percent) make up 24 percent of total GDP. Mining (3 percent) and utilities (3 percent) comprise 6 percent of GDP in the state. Agriculture (7 percent) is the largest employment sector among the energy-intensive industries, followed by construction and manufacturing (both 6 percent). Mining and utilities comprise 1 percent each of North Dakota employment.

Looking at location quotients[8] to understand the state's economic advantages, agriculture, mining, and utilities stand out as specializations for North Dakota in terms of GDP. Especially strong are crop and animal production for agriculture, as well as support activities for mining, except oil and gas. Utilities do not have sub industry classifications.

Additionally, North Dakota has employment specializations in the areas of agriculture, mining, and utilities. Sub industry specialization include: agriculture and forestry support activities; oil and gas extraction, mining (except oil and gas); and support activities for mining.

### ENERGY INTENSIVE INDUSTRIES BY GDP IN NORTH DAKOTA, 2007



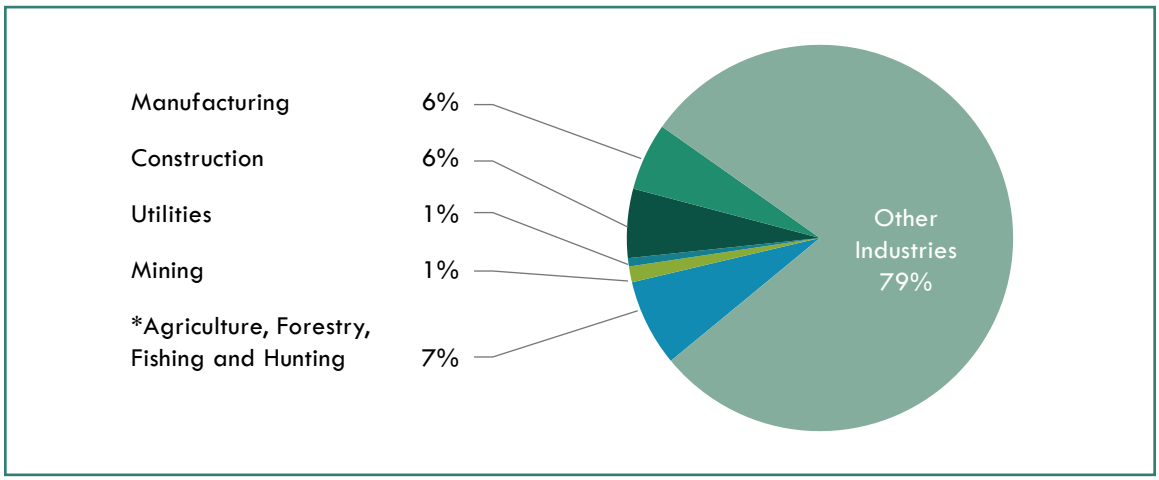

Source: BEA, 2007

### LOCATION QUOTIENT (COMPARATIVE TO THE U.S.) FOR ENERGY-INTENSIVE INDUSTRIES BY GDP

| Industry | Total: All Industries | Manufacturing | Construction | Utilities | Mining | Agriculture. Forestry and Fishing |
|---|---|---|---|---|---|---|
| LOCATION QUOTIENT | | .78 | .96 | 1.29 | 1.60 | 8.72 |
| Total GDP by Industry | $28,518 | $2,638 | $1,227 | $760 | $918 | $3,046 |
| Percentage of State GDP | 100% | 9% | 4% | 3% | 3% | 11% |

Source: BEA, 2007 (In millions of dollars) Shaded areas represent location quotients over 1.0

## ENERGY INTENSIVE INDUSTRIES BY EMPLOYMENT IN NORTH DAKOTA, 2007




*Includes farm employment Source: BEA, 2007

## LOCATION QUOTIENT (COMPARATIVE TO THE U.S.) FOR ENERGY-INTENSIVE INDUSTRIES BY EMPLOYMENT

| Industry | Total: All Industries | Manufacturing | Construction | Utilities | Mining | Agriculture, forestry, fishing, related activities, and other |
|---|---|---|---|---|---|---|
| LOCATION QUOTIENT | | .70 | .89 | 2.17 | 2.43 | 3.42 |
| Total Employment by Industry | 483,868 | 27,422 | 27,971 | 3,360 | 6,401 | 35,261 |
| Percentage of State Employment | 100% | 6% | 6% | 1 % | 1% | 7% |

Source: BEA, 2007 Shaded areas represent location quotients over 1.0

## Preparing for the Low-Carbon Economy

In 2005, North Dakota's Governor Hoeven signed comprehensive legislation designed to accelerate production of wind energy and biofuels, as well as to enhance the transmission infrastructure necessary to get both renewable and conventional energy to market.[9] The legislation also created an Office of Renewable Energy and Energy Efficiency within the Division of Community Services at the state Commerce Department to assist in the development of renewable energy and promote energy conservation in both the public and private sectors. The office administers programs and advances information pertaining to state and federal incentives available for the full range of renewable energy sources.

In March 2007, North Dakota adopted a voluntary renewable portfolio standard with the objective of having 10 percent of all retail electricity sold in the state be obtained from renewable energy and recycled energy by 2015.

## State and Local Incentives

North Dakota offers state and local incentives that support the transition to a low-carbon economy by encouraging production of and demand for alternative and renewable energy, and by spurring the growth of clean tech industries and energy efficiency.

### *Incentives to encourage production:*

The North Dakota **Renewable Energy Corporate Tax Credit** allows any taxpayer - individual or corporation - to claim an income tax credit of (3 percent per year for five years) for the cost of equipment and installation of a system that uses geothermal, solar, biomass or wind energy and that is installed after December 31, 2000.[10]

**The Renewable Energy Property Tax Incentive** exempts from local property taxes any locally assessed solar, wind, or geothermal energy device serving a new or existing building or structure. Stand-alone systems and those that are part of conventional systems are eligible. For solar, wind or geothermal systems that are part of a conventional energy system, only the renewable energy portion of the total system is eligible.[11]

**The Large Wind Property Tax Reduction** offers property tax reductions for commercial wind turbines constructed before 2011. Originally, the law reduced the taxable value of centrally assessed wind turbines with capacity of 100 kw or greater from 10 percent to 3 percent of their assessed value, a property tax savings of 70 percent. However, this law has been amended, resulting in slightly different tax valuation procedures for some installations.[12]

A **100 percent sales and use tax exemption** is available for purchasing building materials, production equipment and other tangible personal property used in the construction or expansion of wind-powered electrical generation facilities.

***Incentives to encourage demand:***

**The State Facility Energy Improvement Program,** delivered by the Office of Renewable Energy and Energy Efficiency, utilizes state bonding to finance energy improvement projects. This program has provided over $10 million to state agencies and institutions for energy efficiency improvements, resulting in $1.5 million of annual energy savings.

Performance contracting is a second mechanism for state agencies and institutions to finance energy efficiency improvements. Performance contracting uses an energy services company to provide a detailed energy audit of a state-owned facility and then defines projects for energy savings. Since 2001, over $22.3 million in energy efficiency upgrades have been implemented though performance contracts, resulting in $2.2 million in energy savings annually.[13]

The **Biofuels Partnership in Assisting Community Expansion (PACE) Loan Program** provides an interest buy-down of 5 percent below the note rate to biodiesel and ethanol production facilities; livestock operations that use byproducts from biodiesel or ethanol facilities for feed; and facilities that provide storage of grain used in biofuels production.[14]

**The Ethanol Production Incentive** provides qualified ethanol producers who meet certain eligibility requirements with quarterly incentive payments based on the number of gallons produced during adverse times. The incentive amount is based on the average North Dakota wholesale ethanol price for the preceding quarter and the average North Dakota corn price for the preceding quarter.[15]

**The State Energy Efficient Appliance Rebate Program (SEEARP),** funded by $615,000 from the Recovery Act, provides rebates to purchase new energy-efficient refrigerators. The state will be issuing $150 rebates for full-size refrigerators that replace an old full-size refrigerator.[16]

## Transition Assistance

North Dakota is focusing on supporting industry transition in the areas of energy efficiency, wind, and carbon capture, all of which are detailed below.

### *Transitioning Industry:*

#### *Energy Efficiency*

The State Energy Program, funded by the Recovery Act, is designed to promote energy conservation and efficiency and reduce the growth of energy demand. The state is presently accepting applications for the following activities within the program:[17]

- **Wind Monitoring:** This initiative provides grants to North Dakota communities for activities that promote and advance the use of wind resources. Possible activities include wind resource monitoring, demonstration projects and feasibility studies. The initiative provides opportunities for North Dakota communities and job development authorities to investigate developing their wind energy potential. Grant funds have been used to conduct over 40 wind energy assessments around the state.
- **Landfill Gas Feasibility Studies:** This activity proposes to fund six landfill gas utilization studies for cities and counties. Grants will be limited to $15,000.
- **Electric Vehicles:** This will provide cost-sharing grants to state agencies and institutions for the purchase of Global Electric Motocar electric vehicles for use in state campuses, state parks, and other appropriate venues.

#### *Wind*

As noted above, North Dakota has been identified as having the greatest wind resources of any of the lower 48 states by the Department of Energy's National Renewable Energy Laboratory. The state also has few environmental constraints regarding land availability.[18] The governor is supporting further development of wind and has signed legislation promoting new