Clean Energy Economic Development Series

COLORADO'S CLEANTECH JOURNEY

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Prepared by Collaborative Economics
for Environmental Defense Fund

Report prepared for

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Collaborative Economics works with senior executives from business, foundations, government, education and community sectors - helping them create breakthroughs in how people think and act regarding their region. Collaborative Economics' clients have the passion, vision and commitment to blaze a new pathway for their community. They understand that a new kind of leadership is required to create great places, with thriving economies and world-class quality of life.

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ABOUT THIS REPORT

Collaborative Economics has analyzed the clean energy economy in all 50 states for the Pew Charitable Trusts and National Governors Association, and for many states and communities from California to Delaware, from Silicon Valley to St. Louis. Collaborative Economics published the country's only Green Innovation Index, focusing on changes in jobs, companies, financing, and other indicators of innovation in California. As importantly, we have worked directly with practitioners at the state and local levels all across the country to develop strategies to encourage development of clean energy sectors.

We have been struck by the determination with which public and private sector leaders are working together to turn the clean energy opportunity into an economic development "win" for their state or community. They focus on the basic "blocking and tackling" of job creation – encouraging market growth, streamlining permitting processes, making strategic investments, training workers, and helping companies find places to grow.

Through tracking the experience of individual firms in the clean energy sector (see LessCarbonMoreJobs.org), Environmental Defense Fund research continues to show that job creation in the clean energy sector – as in all sectors – must begin with creating customers. A focus on job training that ignores the need to simultaneously create customers may see trained job seekers, but little actual hiring. In contrast, regions that focus on nuts and bolts efforts, particularly in the key areas of market demand (notably creating customers now), seeding innovation, company recruitment and workforce development, are most likely to succeed.

The clean energy economy is growing, state by state, community by community, across the country. Job creation and private investment in manufacturing, installation, R&D, and other services are signs that the market is rewarding innovative, competitive companies. The reason for this success goes well beyond any single public policy, investment, or training program. Indeed, the formula that is working is a mix of federal, state, and local government initiatives, private sector economic development efforts, and industry associations and collaborations. It is also the result of bipartisan efforts to help stimulate market demand, seed innovation, then capture the economic benefits for people and places in these states. While these actions can occur independently, economic growth can be more successful with a multi-faceted approach that involves collaboration across sectors and stakeholders.

Every state and community that has experienced the benefits of a growing clean energy economy has blazed its own trail. Each one has a distinctive energy mix, set of natural assets, and existing industry strengths in manufacturing, agriculture, research, or other areas. What they have in common is the recognition that clean energy is a tangible opportunity for economic growth, just as it was biotechnology, information technology, or other opportunities in years past. In these states and communities, leaders find more reasons to work together on practical steps to promote job creation, than oppose one another to gain political advantage.

Their stories – their journeys – are clearly in the early stages. They would be the first to say they have a long way to go. But, as Colorado, Iowa, Ohio, and others have shown, states and communities can take action and get results in the form of new jobs, companies, and innovation that helps meet immediate needs and set the stage for future economic growth.

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OVERVIEW OF COLORADO'S ECONOMIC JOURNEY INTO CLEANTECH

Colorado has demonstrated that the clean technology (cleantech[1]) industry has tremendous potential to contribute to local economies. In recent years, Colorado's cleantech economic activity has surged, establishing the region as a leader in the cleantech industry.

- **Colorado has become a national hub for cleantech innovation**, with robust cleantech research and development (R&D) activities spearheaded by the National Renewable Energy Laboratory (NREL), Colorado universities, and private companies. These stakeholders have leveraged the presence of NREL to establish specialized research centers that drive cleantech innovation in the state. NREL alone creates a $714 million annual economic impact in the state (Development Research Partners, 2012).

- **Cleantech startups and established companies are increasingly choosing to locate and expand in Colorado**, creating job opportunities for workers across the skills-spectrum. The Metro Denver region alone had about 1500 companies and 18,000 workers in the cleantech sector in 2011 and achieved a 35 percent increase in direct employment growth since 2006. The Metro Denver region ranked 6th of the 50 largest metro areas in cleantech employment concentration in 2011 (7th in total number of workers). Cleantech companies employ about one percent of the region's employment base, which is nearly twice the national average. These jobs generated more than $1.3 billion from wages in 2010 (Development Research Partners, 2012).[2]

- **Renewable energy installations have increased sharply to meet local demand**, with total installations of solar and wind nearly doubling between 2007 and 2011 (AWEA, 2012b; Solar Energy Industry Association, 2012).

- **Colorado's leadership in cleantech has been achieved through collaboration.** Colorado stakeholders have worked across party lines and with public and private organizations to advance Colorado's cleantech economy. This supportive environment has been reinforced by the attitudes and behaviors of the people in Colorado.

How has Colorado achieved this cleantech economic activity? Colorado's success in clean technology cannot be attributed to any single effort; stakeholders have worked across jurisdictions, companies, and political party lines to collectively build a robust, diverse clean technology economy. Stakeholders have worked collaboratively to implement actions to stimulate demand for cleantech products and services, foster cleantech innovation, and help the region capture economic benefits from the sector's growth. Building off the state's history as a fossil fuel producer, its talented workforce, and strong energy research expertise, Colorado has successfully diversified its economy and become a leader in the cleantech industry.

Colorado's cleantech economy includes companies across the value chain, ranging from clean technology startups to wind component manufacturers, to solar panel installers. Workers in the cleantech sector are even more varied than the companies themselves; installers, technicians, sales representatives, engineers and scientists all contribute to the cleantech economy. This report will highlight a sampling of activities across the sector to demonstrate the evolution of Colorado's strong cleantech economy.

Given the depth and breadth of activities occurring in cleantech throughout Colorado, this report will focus primarily on the Metro Denver region, which includes the nine county metropolitan area of Denver and Northern Colorado, to illustrate the types of activities occurring in Colorado. This report will first discuss the actions Colorado stakeholders have taken to stimulate market demand, seed innovation, and capture the economic benefits, then show the results of those actions to date.

[1] Note that Colorado uses the term "cleantech" to describe its energy industry subsector. According to Colorado Cleantech Industry Association: Clean technology includes renewable energy manufacturers and providers as well as products and services that make our current energy production and distribution systems more efficient. The sector also includes products and technologies that help consumers and industries use natural resources such as energy, water and waste more efficiently.

[2] Development Research Partners identifies cleantech companies and workers as those directly related to the energy industry. For a full list of SIC and NAICS codes evaluated for inclusion in the cleantech sector view the full report: http://www.metrodenver.org/files/documents/industries-companies/industries/Energy_2011_9C_012212.pdf

COLORADO'S CLEANTECH ECONOMY ACTIONS

A robust cleantech economy is based on strong customer demand for cleantech products and services with ongoing innovation to advance the sector.

A region can develop all or part of this economy locally through focused actions in three different categories: stimulating demand, seeding innovation, and capturing economic benefits. These types of actions may be focused in just one category, but sector growth can be more successful with a multi-faceted approach that involves collaboration across sectors and stakeholders.

A diverse set of stakeholders play roles in building a strong cleantech economy. These stakeholders can include local, regional, state, and federal government, as well as private companies, academic institutions, and organizations. Colorado stakeholders have worked across sectors to create a unique atmosphere that fosters a growing clean energy economy. The Colorado Action Timeline in Figure 1 exhibits a sample of actions that have helped stimulate demand, seed innovation, and capture the economic benefits in the region of the cleantech industry. Colorado's stakeholders consistently employed strategic actions across all three categories, attracting customers to build a new market as well as pushing local firms to adopt new innovations and incentivizing other firms to locate in their region. These actions are explained in greater detail in the following sections.

ACTIONS TO BUILD THE CLEANTECH ECONOMY

Stimulating Demand – Initiatives that increase consumer demand for clean energy by increasing affordability, removing barriers, or setting standards for clean energy.

Seeding Innovation – Actions to increase local cleantech innovation by investing in research and development, funding new startup companies, or creating supportive networks.

Capturing Economic Benefits – Actions to recruit and support cleantech companies while also promoting and aligning job creation and workforce development.

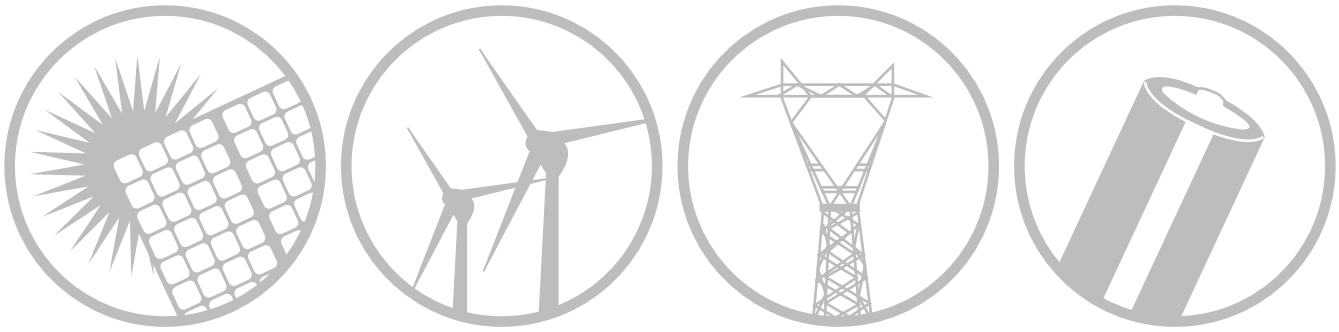
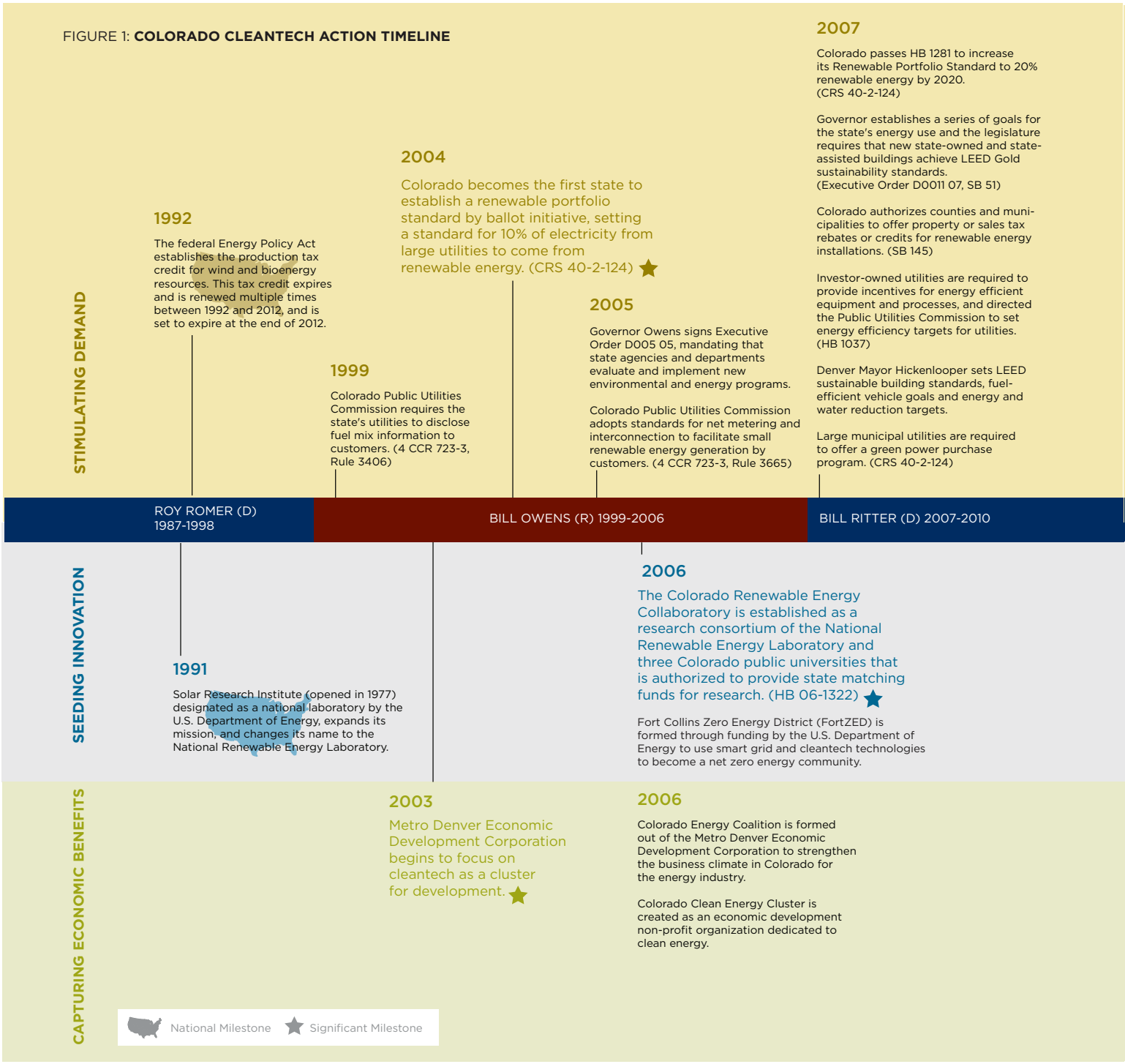


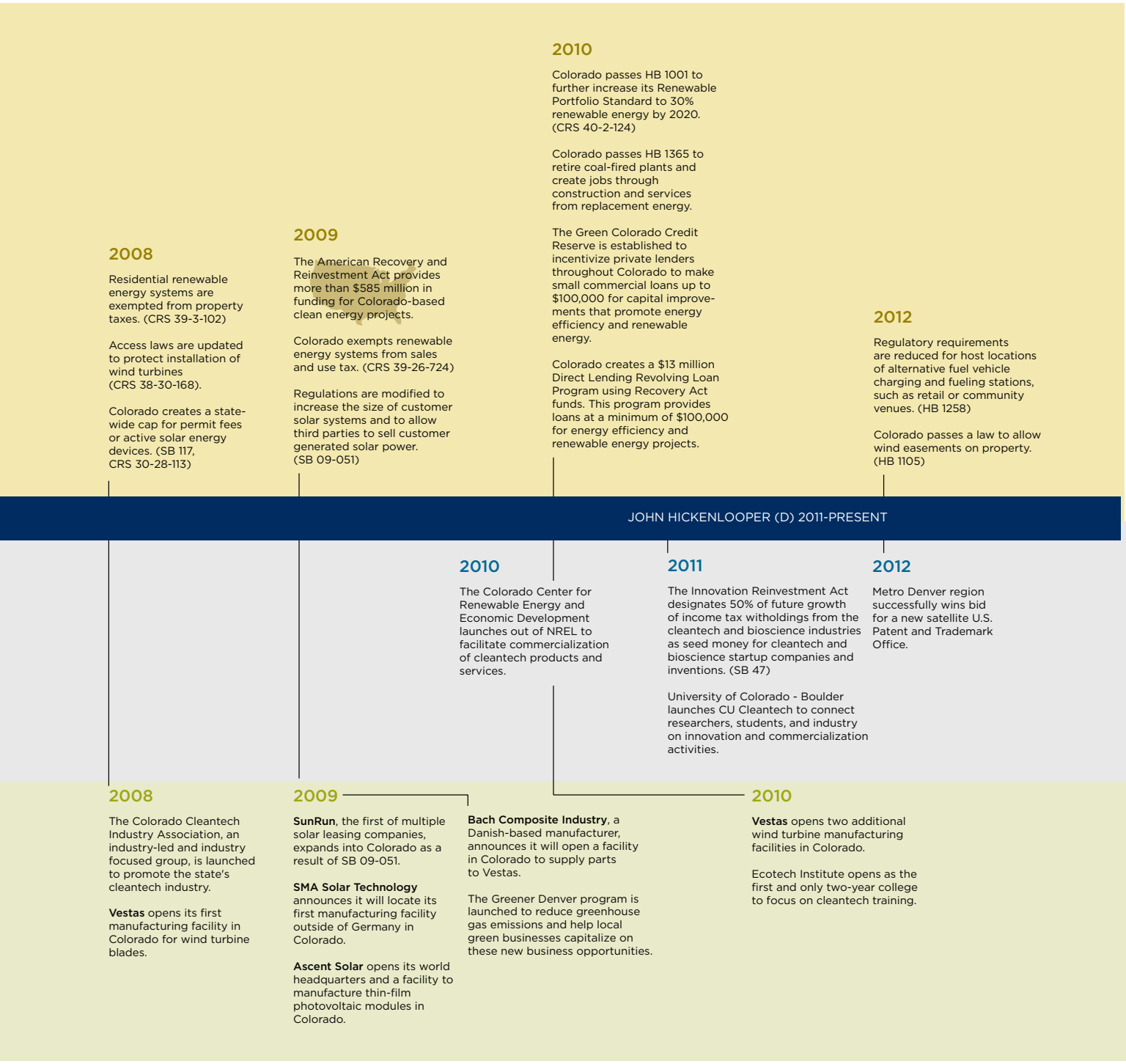
FIGURE 1: **COLORADO CLEANTECH ACTION TIMELINE**



STIMULATING DEMAND

Stakeholders can increase the cleantech customer base by stimulating demand for products and services. Policymakers could remove regulatory barriers to expand access to clean energy, create financial incentives to increase affordability, or set standards for increased clean energy use. These actions send a market signal to cleantech companies that there will be a local demand for products. Many companies opt to ramp up production of goods and services in response. Colorado's policymakers and organizations have implemented a number of these actions in the past decade to stimulate consumer demand and expand the cleantech market.

Cleantech policies in Colorado have been implemented under both Republican and Democratic administrations. Top-level leaders in the Colorado General Assembly from both parties, as well as the state's U.S. senators and representatives, have helped reduce regulatory hurdles and create incentives to increase cleantech economic development. Republican Governor Bill Owens oversaw a kick start in the state's cleantech economy with actions such as the 2005 Executive Order to mandate government purchasing of cleantech products and services where feasible. Democratic Governor Bill Ritter was instrumental in accelerating cleantech activity through his plan for the



New Energy Economy launched in 2007, which included actions to support companies and create new jobs in cleantech. Democratic Governor John Hickenlooper spearheaded a number of cleantech initiatives while Mayor of Denver and since becoming governor has supported other energy sectors as well as cleantech.

Colorado established regulatory standards that has helped stimulate demand for renewable energy by sending a market signal to businesses that there will be local customers for such products and that the state is supportive of the sector's efforts. Colorado became the first state to pass a renewable portfolio standard (RPS) by voters in a 2004 ballot initiative, which was a major milestone for Colorado's cleantech economy. The state has since increased the level twice by legislative actions to the current standard of 30 percent renewable energy by 2020 and has created energy efficiency standards. Eligible technologies under the state's RPS include solar thermal electric, photovoltaics (PVs), landfill gas, wind, biomass, hydroelectric, geothermal electric, recycled energy, anaerobic digestion, and fuel cells using renewable fuels. Governors Owens and Ritter and Mayor Hickenlooper also stimulated demand for purchasing cleantech products with their executive orders to implement energy efficiency, sustainable building, and fuel-efficiency programs. (NC State, 2012).

Colorado has also removed regulatory barriers that limit cleantech market growth. At the state level, energy is

integrated into the mission of state organizations such as the Colorado Office of Economic Development & International Trade and the Colorado Energy Office. State officials work closely with local public and private stakeholders to understand and remove regulatory barriers and stimulate industry growth. The Colorado General Assembly has also removed barriers through legislation. For example, legislators passed a rule to allow third parties to sell customer generated power (SB-091), which led to the expansion of solar leasing companies and solar installations on individual homes (NC State, 2012). More recently, the General Assembly implemented a rule that makes it easier for facilities in the community, such as retail stores or public libraries, to host alternative fuel vehicle charging stations (Colorado Cleantech Industry Association, 2012).

Colorado stakeholders have implemented financial incentives to stimulate consumer demand for clean energy products and services, including a property tax exemption and a sales and use tax exemption for renewable energy systems. The Federal Government has also helped stimulate demand through the American Recovery and Reinvestment Act, which provided the Colorado government and private companies with more than $585 million in funding for clean energy projects (U.S. Department of Energy, 2010). In addition to cleantech specific policies and actions, Colorado has created other business incentives that have drawn in cleantech companies. For example, Colorado revised its income tax rules to incentivize companies to locate facilities and create jobs in Colorado. The large utility Xcel Energy also provides incentives for customers to install renewable energy systems, including upfront subsidies and generation credits, through its Solar Rewards program. Since 2006, Xcel has provided $256 million in rebates and credits for about 10,500 commercial and residential solar arrays. These funds came from a two percent renewable energy charge on customer bills (Jaffe, 2012).

Colorado Cleantech Industry Association convenes private sector and public institutions to identify and work toward solutions to expand and strengthen the cleantech economic engine in Colorado. The cleantech industry is recognized in Colorado as an economic development opportunity, not a political one.

Christine Shapard, Colorado Cleantech Industry Association

SEEDING INNOVATION

Colorado has become a leader in cleantech innovation by funding R&D projects, providing mentorship and investment in cleantech startups, and establishing collaborative networks to share R&D resources. The Metro Denver region is home to NREL, which began operating in Colorado in 1977 as the Solar Research Institute and is the only federal laboratory to focus on renewable energy and energy efficiency technologies. The state of Colorado and universities have leveraged NREL's location to build cleantech research capabilities and economic opportunities throughout the region. By leveraging strong local research assets, Colorado has cultivated an atmosphere that fosters innovative technologies and new cleantech companies.

Colorado's innovation activities are led by stakeholders such as:

- **NREL** – which has created organizations including the Colorado Center for Renewable Energy Economic Development (CREED), and is a partner in the Colorado Renewable Energy Collaboratory and Solar Technology Acceleration Center (SolarTAC)
- **State of Colorado** – which passed legislation to create the Collaboratory and to launch an innovation fund, is a partner in CREED, and has state agencies targeting the cleantech industry
- **Colorado Universities** – which are partners in the Collaboratory, CREED, and SolarTAC, in addition to having strong cleantech research programs at each university
- **Business incubators** – which support new startup companies in the cleantech industry

The **Solar Technology Acceleration Center** (SolarTAC) opened in 2011 and is the largest test facility for solar technologies in the nation. SolarTAC allows members to collaborate in solar energy research and testing for proprietary and public projects. SolarTAC formed under a public-private partnership involving utilities, the city of Aurora, private companies, and universities. The city of Aurora helped ease regulatory hurdles in establishing this center and does not require demolition or other burdensome permits, which makes it easier for companies to test industrial sized devices at the site.

The **Colorado Renewable Energy Collaboratory** was created by legislation in 2006 as a research partnership among the University of Colorado-Boulder, the Colorado School of Mines, Colorado State University, and NREL. The Collaboratory leverages the research strengths and different cleantech perspectives of each institution. The Collaboratory focuses on supporting economic growth in the cleantech market, cultivating commercialization efforts, and educating researchers and technicians to enhance the workforce.

The Collaboratory is built on a foundation of teamwork and trust among institutions, with a scientific director from one institution and administrative lead from another, and researchers from others. The Collaboratory facilitates research with industry partners and among institutions through research centers. Research projects may be funded by industry member fees and matched by the state of Colorado, or sponsored by industry in partnership with one or more institutions.

The Collaboratory currently has three research centers in place and two in development.

- Colorado Center for Biorefining and Biofuels (2007)
- Center for Revolutionary Solar Photoconversion (2008)
- Center for Research and Education in Wind (2010)
- Carbon Management Center (in development)
- Energy Systems and Energy Efficiency Center (in development)

Partners in the Collaboratory have received a total of $8 million from the state of Colorado over the past five years and have spent over $6 million to date. This funding has been leveraged to bring in an additional $37 million into the state in second stage research, in addition to more in further research (Hiller, 2012; Colorado Renewable Energy Collaboratory, 2011).

Colorado got a head start by establishing a clean energy research collaboration in 2007, before most states were looking at clean energy as an economic opportunity. That early start helped the state attract existing clean energy companies, investors to support Colorado startups, and top researchers and students to our labs and universities, laying the groundwork for a self-sustaining cleantech industry.

David Hiller, Executive Director, Colorado Renewable Energy Collaboratory

In 2006, the Colorado General Assembly took a significant step in seeding innovation by creating the Colorado Renewable Energy Collaboratory, a research consortium of NREL and three Colorado public universities. The legislation also authorized state matching funds for cleantech research. Since its inception, the Collaboratory has been a driver of innovation in the state and is a key player in coordinating cleantech R&D efforts. This new consortium provides a venue for researchers from different institutions to work together on research projects and focus on technology transfer to facilitate innovation and commercialization. The Collaboratory also helps incentivize companies to locate in the region by providing a one-stop shop where companies can find researchers and leverage the strengths of multiple institutions.

In addition to the Collaboratory's own research efforts, Collaboratory partners also provide research capabilities to other organizations and research centers, such as the SolarTAC. The Collaboratory has also partnered with other research institutions, such as the National Center for Atmospheric Research and the National Oceanic and Atmospheric Administration, to combine research expertise and support joint projects. In addition to being a partner in the Collaboratory, NREL leads other programs that support industry innovation through research, commercialization, and entrepreneur training to make Colorado a cleantech leader. For example, NREL launched CREED in 2010 in partnership with the state. CREED coordinates resources to provide opportunities for entrepreneurs and cleantech companies, open access to capital from investors, and facilitate networking among the public and stakeholders.

NREL also has internal programs such as the Innovation and Entrepreneur Center to facilitate connections within NREL and with outside stakeholders. For example, the Center can help an entrepreneur obtain a license for NREL technology, talk to an NREL expert or create a contract to work with NREL staff. NREL also hosts an annual Industry Growth Forum, which is a cleantech investment event. The Forum includes a business planning competition from emerging cleantech companies in which participants are judged by professional investors (NREL, 2011).

Colorado universities are also creating their own programs to focus on cleantech R&D activities in addition to being partners in the Collaboratory. For example, the University of Colorado (CU) – Boulder launched CU Cleantech in 2011 to connect researchers, students, and industry to spur innovation and commercialization. CU Cleantech assists with market assessment programs, public-private research partnerships, placing students in cleantech companies, and supporting entrepreneurs.

The strong innovation and R&D activity in Colorado has spawned dozens of new startup companies in the cleantech industry. Organizations and incubators have emerged to shepherd those companies through the early stages of company development to become successful. CleanLaunch Technology Incubator and Rocky Mountain Innosphere are two examples of incubators in the Metro Denver region. These incubators can provide a range of support to startups. Rocky Mountain Innosphere, for example helps technology-based startup companies gain access to academic and government researchers, assist with raising capital, build a network of advisors, and other activities to accelerate the development of the new company.

The Colorado Department of Labor and Employment has also started specifically targeting cleantech startups. They developed a program to train, mentor, and support cleantech entrepreneurs through the American Recovery and Reinvestment Act State Energy Sector Partnership grant. The Department gathered industry leaders to analyze existing programs and created training specifically designed for cleantech startups. They are currently training more than 100 participants to be small business owners in the cleantech industry through incubators and other programs (Colorado Department of Labor and Employment, 2011).

The Colorado General Assembly invested in cleantech industry innovation by passing the Innovation Reinvestment Act of 2011, making it one of the few states with an energy specific innovation fund. This legislation diverts 50 percent of future growth of income tax withholding from the cleantech and bioscience industries to be used as seed money for cleantech and bioscience startup companies and inventions. This new fund will be an important source of financing for cleantech startups to pass early stage commercialization hurdles and will provide seed money for proof of concept stage in business development (Colorado Cleantech Industry Association, 2011).

The region has drawn additional business to support its R&D activity as well. For example, the U.S. Department of Commerce announced in 2012 that they will open a U.S. Patent and Trademark satellite Office in the Metro Denver area. This is expected to create 1000 new jobs and generate $440 million for the local economy (Sherry, 2012).

Colorado Center for Renewable Energy Economic Development (CREED) is a partnership among NREL, state and local governments, and industry stakeholders. The idea for the center originated in the 2008 proposal to manage the NREL facility. The proposed NREL team wanted to create a center to help speed up the commercialization and deployment of clean technologies to spur economic development.

CREED launched in 2010 and the organization created a facility to co-locate stakeholders ranging from incubators and industry associations to research organizations like the Collaboratory. The stakeholder organizations now have offices in one building to facilitate relationships among stakeholders. CREED provides a conduit for interested parties to have only one spot to find industry associations, research partners, and financing information to support entrepreneurs.

CleanLaunch is a business incubator that supports the creation and growth of cleantech companies in Colorado. CleanLaunch is a hub for researchers, engineers, entrepreneurs, and investors to connect, share resources, and spur the growth of early-stage clean technology ventures. In collaboration with pro bono advisors, CleanLaunch clients develop and refine business plans and go-to-market strategies, address legal issues, and connect with investors in order to position their ventures for growth into market-stage operations. CleanLaunch has seen a significant increase in the cleantech startup community in recent years and have had interest from about 300 early stage companies over the past three years (Miller, 2012).

CAPTURING ECONOMIC BENEFITS

In order to help the region capture the benefits of the growing cleantech economy, public and private stakeholders have worked collaboratively to align job creation and workforce development activities with company recruitment and support. This alignment is a critical strategy to ensure that there are both job opportunities and trained workers in an area, and to capitalize on the positive cleantech business environment created from the stimulating demand and seeding innovation actions. Actions to capture the economic benefits include training a skilled cleantech workforce, recruiting companies to locate and grow in the region, and encouraging the deployment of cleantech products. State and local organizations are working across jurisdictions and with multiple stakeholders to promote cleantech economic development in Colorado and the Metro Denver region.

Colorado has numerous organizations dedicated to supporting the cleantech industry, ranging from economic development organizations to associations focused on increasing cleantech education and awareness. These organizations help create an economic environment in which cleantech companies want to locate and grow. Colorado's cleantech-related organizations include:

- **Local and regional economic development organizations** – such as the Metro Denver Economic Development Corporation (EDC) and Aurora Economic Development Council
- **Private and nonprofit organizations** – such as the Colorado Cleantech Industry Association (CCIA), Colorado Clean Energy Cluster (CCEC), Colorado Renewable Energy Society, and the Colorado Solar Energy Industries Association

Local economic development organizations have demonstrated their commitment to the cleantech sector by targeting it as an industry for development. The Metro Denver EDC has been a critical player in expanding the region's cleantech economy and recruiting national and international companies. Within the Metro Denver EDC, the Colorado Energy Coalition is an advocacy group that represents all sectors within the energy industry, including fossil fuels and renewable resources, and is dedicated to strengthening the energy business climate in Colorado. City organizations, such as the Aurora Economic Development Council, are also targeting the cleantech industry and working with Metro Denver EDC to negotiate a permitting and financial incentives package for the cleantech company to locate in their city.

The **Metro Denver Economic Development Corporation** (EDC), an affiliate of the Metro Denver Chamber of Commerce, focuses on developing the cleantech sector. The Metro Denver EDC has been in place for over 20 years and includes 70 partner cities, counties, and economic development organizations in nine counties in Metro Denver and Northern Colorado (Metro Denver EDC, 2012).

In 2003, the EDC identified nine innovation clusters, of which cleantech was one, to focus economic activity. The EDC focus on the cleantech cluster enabled them to target companies to cultivate a robust cleantech economy in the region.

The cities and counties in the EDC decided to compete as a region, rather than against each other, to bring cleantech companies to the area and be more responsive to the company's needs. EDC brings together state and local entities to create a recruitment package with tax rebates and financial incentives for companies. EDC has been a critical player in promoting the region, communicating a consistent message, and leveraging local assets to market the region nationally and internationally (Clark, 2012).

The Metro Denver EDC strategy has been to build a cluster of economic activity around cleantech - rather than chasing hot companies we focus on recruiting companies that build the region's supply chain.

Tom Clark, Metro Denver EDC

The **Colorado Cleantech Industry Association** (CCIA) is an industry-led, industry-focused cleantech organization founded in 2008. The organization focuses on common industry issues and is dedicated to advancing the cleantech industry through advocacy, public policy leadership, development, and education. CCIA worked with the industry to develop a Cleantech Action Plan to identify areas where stakeholder time and effort would have the most impact and where resources were needed. CCIA has also had significant policy success, including the 2011 Senate Bill 47 that provides seed funding to commercialize technologies and startups. CCIA also started the Cleantech Fellows Institute to train leaders of cleantech companies or companies looking to make the transition into the cleantech industry (CCIA, 2012).

Private and nonprofit organizations are also helping Colorado capture the economic benefits of growth in the cleantech industry. For example, CCEC is a nonprofit economic development organization with a mission to grow clean energy jobs in Colorado. Another example is CCIA, which is a unique organization that unites all industry players in the cleantech field. CCIA has dozens of member companies and organizations and a board of directors representing diverse segments of the cleantech industry, from venture capitalists to the Collaboratory.

The Colorado Renewable Energy Society is an organization whose members work to increase awareness of the economic and environmental benefits of renewable energy and energy efficiency technology. The Society hosts a number of educational events and also supports policy initiatives to advance renewable energy and energy efficiency projects in the state. Colorado also has technology-specific organizations, such as the Colorado Solar Energy Industries Association, which was founded in 1989. This association is focused on expanding solar markets and generating jobs and prosperity for the people of Colorado. They work with solar business members to advance solar policy, remove market barriers, highlight emerging trends, and promote solar outreach and education.

In addition to building a favorable business environment and enhancing networks, preparing Colorado's workforce for cleantech jobs has also been important to capturing economic benefits of the sector. Across Colorado there have been initiatives undertaken at the regional, academic and state levels in collaboration with colleges and universities to ensure that local workers are equipped for jobs ranging from cleantech R&D to maintenance and installation in the cleantech sector.

Companies are partnering with academic institutions and local and state governments to ensure that they have a trained local workforce to be able to expand their operations. For example, Spirae, a smart-grid company based in Fort Collins, developed relationships with Colorado State University, the Larimer County Workforce Investment Board, Fort Collins Utilities, Front Range Community College, and others to identify training needs and capabilities. As a result of these collaborations, Spirae received funds from the Governor's Energy Office, Colorado Workforce Development Council, and the U.S. Department of Energy to develop a three-course smart grid training program for technicians through the community college and a three-course smart grid training program for engineers through Colorado State University. Spirae and the university are offering their laboratories for hands-on experience, and a Colorado State Energy Sector Partnership grant is enabling more than 750 Colorado students to attend these courses in 2012 (Pfannkuch, 2012).

Colorado colleges and universities are developing specialized classes and programs in cleantech. The three Colorado universities involved in the Collaboratory, for example, offer a range of classes and programs to prepare students for cleantech R&D. The Colorado School of Mines, for example, offers classes in energy economics, engineering, and policy.

Ecotech Institute opened in Aurora in 2010 as the first and only college focused on training students in careers in cleantech. Ecotech offers two-year associate's degrees in renewable energy technology, solar and wind energy technology, electrical engineering and environmental technology, and other programs related to developing the cleantech workforce. Ecotech Institute graduated its first class of 42 students in June 2012 and currently has more than 500 students.

Community colleges are also playing an important role in educating the Colorado workforce. Red Rocks Community College's Renewable Energy Program, for example, offers degrees and certificates in solar, wind, and energy efficiency technologies. Redstone College offers certificates and degree programs for a variety of cleantech careers, including energy specific degrees in wind energy technology and an industrial service training program in heating/ventilation/air conditioning. Arapahoe Community College also offers energy technology programs, including solar technician, energy analyst, and construction supervision programs.

Northern Colorado is an ideal location for Spirae and the Center for Smart Grid Advancement. We enjoy a uniquely synergistic and collaborative environment here in Fort Collins, which contributes to Spirae's ability to develop and deliver smart-grid solutions, as well as educated smart-grid stakeholders and workforce.

Sunil Cherian, Spirae's CEO, upon announcing it was expanding operations into the Rocky Mountain Innosphere building (NCBR, 2011)

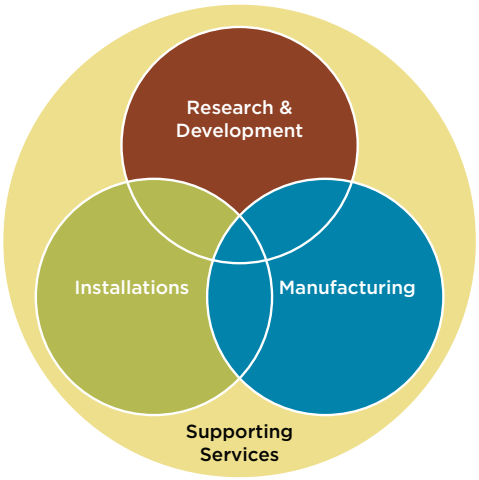
The **Colorado Clean Energy Cluster** (CCEC) is a nonprofit economic development organization with a mission to grow the clean energy jobs in Colorado. CCEC was founded in 2006, and now has over 30 member companies. CCEC focuses on actionable initiatives to build infrastructure to support the industry. For example, through their Clean Energy Supply Chain Initiative they identified four main categories of gaps in the cleantech supply chain, including technology, marketing, workforce, and supply chain specific issues, and are now working with partners on actions to fill those gaps and connect industry players (CCEC, 2012).

CLEANTECH ECONOMY RESULTS

The actions that Colorado stakeholders have taken to build an active cleantech economy have led to impressive results. The region has emerged as a leader in cleantech innovation and has demonstrated strong customer demand for cleantech products and services. In addition, cleantech companies are increasingly choosing the Metro Denver region as a place to locate and grow, bringing significant economic benefits to the area.

COLORADO'S ENERGY TECHNOLOGY VALUE CHAIN

FIGURE 2
ENERGY TECHNOLOGY VALUE CHAIN



The investment and work to stimulate demand, seed innovation, recruit companies, and develop a new workforce has paid dividends across the value chain. Colorado has built a cleantech economy that includes a variety of companies and activities, all of which operate across the energy technology value chain. The segments of the value chain may exist independently, but provide a more robust economic cluster when all segments are developed and work together. Figure 2 illustrates the interaction of the energy technology value chain segments. Colorado now boosts companies that provide each of these activities:

Research & Development (R&D): R&D activities are carried out primarily by research institutions, such as federal laboratories, universities, or private company research divisions. R&D activities foster an environment centered on developing new products and processes so that the region can become a leader in innovation.

Manufacturing: Manufacturing involves production of a technology and includes companies throughout the supply chain, ranging from component suppliers to those assembling complete units for sale to consumers.

Installation: Installation of clean energy technologies, such as developing wind turbine farms, will occur in response to market demand. Companies involved in activities such as site assessment, logistics, transportation, and construction play an important role in installation.

Supporting Activities: A variety of other activities are critical to supporting clean energy technology. These supporting organizations facilitate interactions among players, provide funding, educate consumers, advocate for business friendly policies, or provide technical support and product maintenance services.

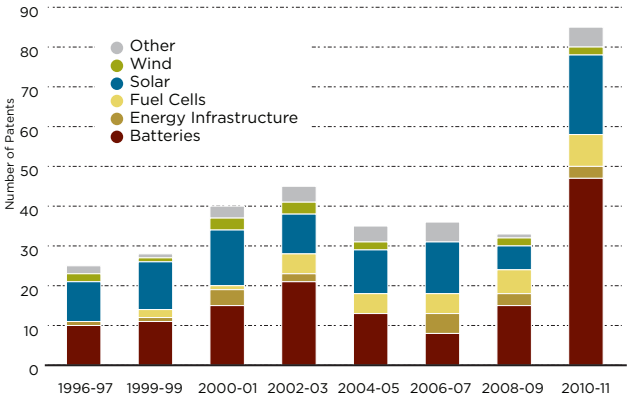
DRIVING INNOVATION THROUGH WORLD-CLASS R&D EXPERTISE

Colorado's increased R&D-related activities demonstrate that the state is solidifying its role as a leader in cleantech innovation. These results have been driven by actions that seed innovation and support all segments of Colorado's cleantech economy.

Colorado has some of the highest levels of federally-funded science, research, and engineering laboratories, which have contributed to its R&D activities and the local economy as a whole. The state estimates that its 24 federal laboratories have collectively contributed $1.5 billion to Colorado's economy in 2010 and employed nearly 16,500 people directly or indirectly. NREL alone has a $714 million annual economic impact in the state. The Metro Denver region is also home to the National Center for Atmospheric Research, Western Power Administration, and National Institute of Standards and Technology (Development Research Partners, 2012).

Colorado's support for innovation is also demonstrated by the strong cleantech R&D activity at academic institutions. The University of Colorado-Boulder, the Colorado School of Mines, and Colorado State University have a long history in energy R&D and have expanded their activities into cleantech. Colorado ranked 16th in the nation for overall R&D expenditures at academic institutions in fiscal year 2009 (Development Research Partners, 2012).

FIGURE 3
CLEAN TECH PATENTS
COLORADO



Data Source: 1790 Analytics, Patents by Technology; USPTO Patent File
Analysis: Collaborative Economics
Note: "Other" category includes electric vehicles, geothermal, hybrid systems, and hydro power

TABLE 1
COLORADO NATIONAL RANKING IN CLEAN ENERGY PATENTS

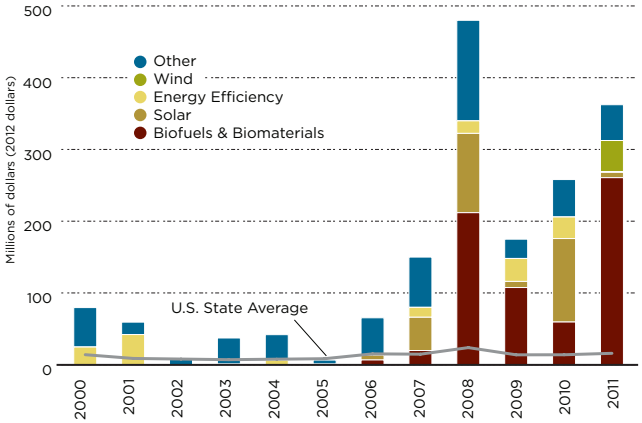
	1996-97	2010-11
Batteries	21	13
Energy Infrastructure	27	18
Fuel Cells	50*	16
Solar	4	7
Wind	6	25**
Other	18	15

* CO had zero fuel cell patents in 1996-97, therefore tied for last in national rank.
** CO has maintained roughly the same number of wind patents over the years, though some states such as New York and South Carolina have drastically increased wind patent activity over this time.
DataSource - Table 1: 1790 Analytics, Patents by Technology; USPTO Patent File
DataSource - Table 2: Clean Tech Investments from August 6, 2012, Bureau of Labor Statistics

Colorado's R&D and innovation activity can be demonstrated by the number of patents registered. Figure 3 shows the total number of cleantech patents in Colorado in various technologies. Patent activity has steadily increased over the past 15 years, more than tripling between 1996 and 2011 and significantly jumping in the past two years. Colorado has also increased its cleantech patent activity relative to other states. Table 1 shows Colorado's national ranking in clean energy patents. In 1996, Colorado had no fuel cell patents and is now ranked 16th in the country. Additionally, Colorado has remained strong in solar patents and has remained ranked in the top ten states.

Colorado has cultivated a skilled cleantech workforce, with the second-most highly-educated adult population in the nation (Development Research Partners, 2012). This workforce expertise and concentration of R&D activity is also leading to new cleantech companies. Figure 4 shows the increase in cleantech venture capital investments in the past ten years has increased dramatically. Funding for cleantech companies in Colorado more than tripled over the last decade, with Colorado companies receiving nearly $80 million in 2000 and over $362 million in 2011 (in 2012 dollars). Table 2 shows that Colorado has consistently been a leader in cleantech venture capital investments over the last decade, maintaining a position in the top ten states nearly every year, and was ranked third in total investments in 2011. Colorado has also consistently ranked in the top five states for investment per capita since 2000 (CleanTech Group, 2012).

FIGURE 4
VENTURE CAPITAL INVESTMENTS IN CLEAN TECHNOLOGY
COLORADO AND THE U.S. STATE AVERAGE (2012 REAL DOLLARS)



Note: Other includes energy storage, air & environment, smart grid, advanced materials, recycling & waste, transportaiton, agriculture, and 'other.'
Data Source: CleanTech Investments from August 6, 2012 and Bureau of Labor Statistics
Analysis: Collaborative Economics

TABLE 2
COLORADO NATIONAL RANKING IN CLEAN TECH VC INVESTMENTS

	2000	2011
1	California	California
2	Washington	Massachusetts
3	Massachusetts	Colorado
4	Connecticut	Texas
5	Colorado	Oregon

MANUFACTURING COMPANIES RESPONDING AND GROWING

Cleantech companies are increasingly choosing to locate and expand in the Metro Denver region because of the area's collaborative actions to advance the economy. Colorado has become home to a variety of cleantech manufacturing companies ranging from those that produce wind turbines to those that specialize in biofuels. Cleantech companies have been actively recruited by economic development organizations. These organizations help companies realize the benefits of Colorado's many local assets including, world class research and testing capabilities, collaborative environment, political support, financial incentives, and workers with skills ranging from research experts and plant managers to assemblers and welders.

Manufacturing in the cleantech industry has increased in recent years with new startups and international companies locating in the region. Colorado's wind manufacturing industry is centered on the major international wind company Vestas. Vestas opened its first manufacturing facility in the Metro Denver region in 2008 and now has four manufacturing facilities on three campuses. A variety of factors attracted Vestas to Colorado, including the nearby testing facilities and experts at NREL, focused support from the state and regional governments, proximity to the wind corridor, and an international airport with flights to Denmark. Vestas has created a market for other companies in the wind supply chain that have moved to the region, such as Danish manufacturing companies Aluwind and Bach Composite Industry, Connecticut-based Hexcel Corporation, and distributed generation wind turbine manufacturer Southwest Windpower. The American Wind Energy Association (AWEA) estimates that there are 3,000 jobs in wind manufacturing and 4,000-5,000 direct and indirect jobs in Colorado's wind supply chain in 2011 (AWEA, 2012a). While Colorado has attracted a number of wind companies, the uncertainty about the renewal of the federal Production Tax Credit has impacted the entire wind industry and has caused slowing across the board.

The Metro Denver region is also home to solar manufacturing companies that span a variety of unique technologies. Germany-based SMA America, for example, is the world's largest solar inverter manufacturer that opened its domestic branch in the area in 2010. Other solar manufacturers, such as SkyFuel, Inc and Ascent Solar, are creating products ranging from large utility-scale solar thermal systems to consumer products like cell phone solar chargers.

Colorado has a variety of other cleantech companies producing at small and large scales, including energy efficient product companies such as Coolerado, smart grid companies such as Spirae, and biofuel companies such as Gevo. The entrepreneurial and innovative environment is also starting to produce dozens of new cleantech companies every year.

Coolerado manufactures and markets innovative, high-efficiency air conditioners that use up to 90% less energy than traditional AC units. Based in Colorado, the company sells its air conditioners across the US and in 26 countries around the world. Federal tax credits as well as strategic venture capital investments have helped Coolerado increase production capacity to meet growing domestic and international demand for efficient air conditioning (White, 2010).

SMA Solar Technology, the world's largest manufacturer of solar panel inverters, opened its first manufacturing facility outside of Germany in Denver in 2010. The plant is the largest solar inverter production facility in the US, supplying inverters to the growing US market. The decision to locate in Denver was motivated by its proximity to key transportation hubs as well as the region's strengths in clean energy research. Economic incentives from state and local governments also helped Denver beat twenty other cities across the country that also competed for the SMA plant (Svaldi, 2009).

The **Federal Production Tax Credit**, which provides an income tax credit for the production of electricity from utility-scale wind turbines, is set to expire at the end of 2012. As of October 2012, uncertainty about its renewal still loomed, and Martha Wyrsh, head of Vestas-American Wind Technology, Inc., stated that "The U.S. wind industry has slowed, largely due to the uncertainty surrounding the Federal Production Tax Credit extension" (Reuters, 2012). In consequence, Vestas has decreased its Colorado manufacturing workforce by about 500 employees in 2012 through layoffs, attrition, and relocations, bringing its total Colorado workforce to about 1,200 employees (Longeteig, 2012).

The forward thinking environment, spirit of innovation and general support for renewable energy in the area made Broomfield attractive to us as a company. There's also tremendous potential for collaboration with nearby institutions such as NREL, University of Colorado at Boulder and the Colorado School of Mines.

Scott Brown, Interim CEO of Southwest Windpower, on opening an additional facility for its distributed generation wind turbines in Broomfield, Colorado (Southwest Windpower, 2011).

CLEAN ENERGY INSTALLATIONS

Actions to stimulate demand for renewable energy system installations have helped Colorado companies dramatically increase deployment of cleantech products and services in recent years. For example, the state's RPS, which mandates 30 percent renewable energy by 2020, has incentivized installation of solar and wind power in the state to meet that goal. Figure 5 shows that at the end of 2011 Colorado had more than 200 megawatts (MW) of solar PV power installed, compared to only 12 MW in 2007. By the end of 2011, Colorado became fifth in the nation in installed solar capacity and continues to have more cumulative installations than the average U.S. state (Solar Energy Industry Association, 2012).

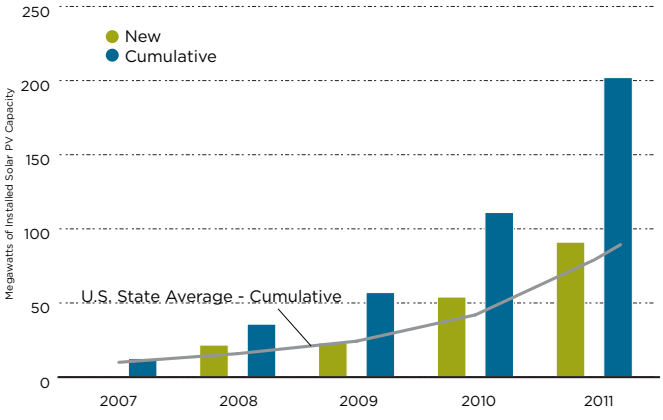
Wind installations have also increased in recent years. Colorado is the 12th windiest state in the U.S. and is currently 9th in installed wind capacity. Figure 6 displays Colorado's growth in wind capacity, which reached 1,805 MW by the end of 2011 (AWEA, 2012b).

Colorado is one of only six states that have exceeded 10 percent of state generated electricity coming from wind (Wiser and Bolinger, 2012).

Colorado has achieved this installation activity without sacrificing overall economic progress. Figure 7 shows that Colorado's electricity bill compared to gross domestic product (GDP) has continued to decline. Colorado's GDP has continued to outpace changes in electricity bills even while renewable energy installations increased.

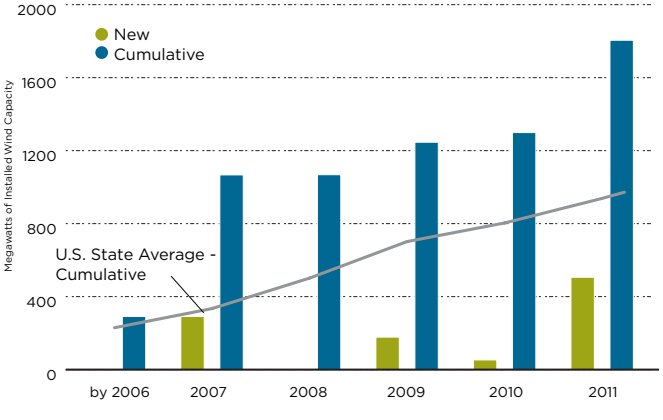
Utilities are actively involved in clean energy installations, stimulating the local economy and creating installation jobs. The large utility Xcel Energy has become an active supporter of cleantech, even going so far as supporting the legislation to increase the state's RPS. Xcel Energy is meeting its renewable energy goals by pursuing large utility-scale installations as well as smaller distributed

FIGURE 5
INSTALLED GRID-CONNECTED SOLAR PV CAPACITY
COLORADO



Data Source: Solar Energy Industry Association
Analysis: Collaborative Economics

FIGURE 6
INSTALLED WIND CAPACITY
COLORADO



Data Source: American Wind Energy Association
Analysis: Collaborative Economics

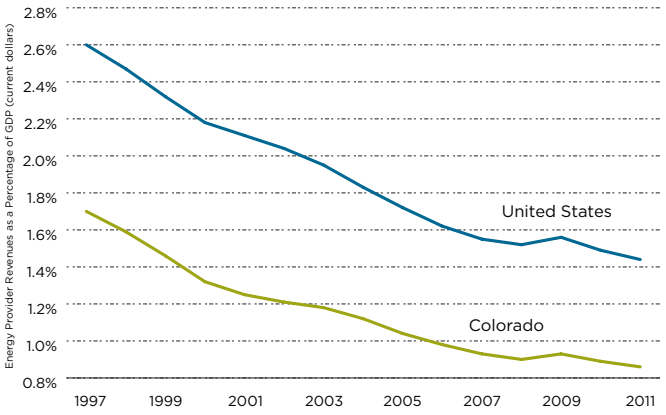
generation projects such as rooftop solar panels. Xcel Energy currently uses a majority of the wind power in Colorado and achieved a national benchmark in 2012 when they used wind to supply 57 percent of their total electricity use for a few hours (Hargreaves, 2012). Xcel Energy has been adding large wind farms in Colorado to take advantage of the cost-competitive price of wind compared to other energy sources (Xcel Energy, 2011).

Private companies are also helping stimulate demand for cleantech installations. Many of Colorado's ski resorts, for example, have installed wind and solar energy systems to generate energy at the resort or purchase off-site renewable power for the resorts. The resorts are also reducing their energy use by upgrading to energy efficient technologies for building operations. Steamboat Ski & Resort and Park City Mountain Resort, for example, are upgrading resort equipment to more efficient units and purchasing renewable energy certificates to offset electricity use.

Many companies have moved to the region to support the increase in clean energy installations. For example, solar leasing companies, including SunRun, SolarCity, and Sungevity, have expanded into Colorado as a result of the policy revisions from Senate Bill 09-051, which allowed third parties to sell customer generated solar power. These companies offer homeowners the opportunity to install solar panels though alternative financing and minimal upfront costs.

Renewable energy installations are often installed in rural areas, which adds economic value to the landowners and counties that opt to participate in the market. The wind industry, for example, contributes $10 million in annual property tax payments by wind project owners and $5.4 million in annual land lease payments for wind turbines (AWEA, 2012a).

FIGURE 7
ELECTRICITY BILL AS A PERCENTAGE OF GDP
COLORADO



Data Source: U.S. Department of Energy, Energy Information Administration; U.S. Department of Commerce, Bureau of Economic Analysis
Analysis: Collaborative Economics

COLORADO'S CLEANTECH ECONOMY RESULTS SUMMARY

In summary, Colorado's value chain segments (R&D, manufacturing, installation, and supporting services) have grown substantially in response to collaborative efforts to expand the sector. Table 3 shows the nine-county region's cleantech economy as determined by Development Research Partners for Metro Denver EDC. Most of Colorado's cleantech employment is located in this region, including 18,000 jobs and 1,500 companies directly involved in cleantech in 2011, making the region 6th of the 50 largest metro areas in cleantech employment concentration (7th in absolute employment). Table 4 shows the top seven metro regional areas in total cleantech employment.

- **Metro Denver** ranks on par with large metro areas such as New York City and San Francisco in total number of cleantech workers.
- **Metro Denver** had a 35 percent increase in direct employment from 2006-2011, compared to an average 11 percent increase in the U.S.
- **Cleantech companies** employ about one percent of the region's total employment base, nearly twice as much as the national average of 0.5 percent.
- **In 2010,** the average annual salary for a cleantech job in the Metro Denver area was nearly $75,000 for a total regional annual payroll of nearly $1.3 billion (Development Research Partners, 2012).

These outcomes show the growth and strength of Colorado and the Metro Denver region's cleantech economy.

TABLE 3
METRO DENVER CLEANTECH ECONOMY

Direct Jobs (2011)	18,000
Direct Companies (2011)	1,500
Average annual salary (2010)	$74,410
Regional annual payroll (2010)	$1.3 billion
Five-Year Direct Employment Growth (2006-11)	35%

DataSource: Development Research Partners, 2012

CONCLUSION

Colorado's cleantech economy has grown as a result of collaborative, multi-stakeholder actions to stimulate demand for cleantech products and services, foster cleantech innovation, and help the region capture economic benefits from the sector's growth. R&D activity, cleantech manufacturing, and renewable energy installations have all substantially increased in Colorado. This progress demonstrates Colorado's success in creating a diverse, robust cleantech economy and establishing the region as a leader in the cleantech industry.

- **Colorado has pioneered actions to help stimulate consumer demand for cleantech products and services**. Colorado voters made the state the first to pass an RPS by ballot initiative and policymakers created financial incentives for cleantech, which helped show the state is supportive of the cleantech industry.

- **Colorado has become a hub for cleantech innovation.** Research institutions and private companies are working together to advance cleantech R&D and commercialization through organizations such as the Collaboratory. In addition, programs to foster new cleantech companies, such as efforts by CREED, are helping those innovative technologies reach consumers.

- **Colorado stakeholders have taken action to capture the economic benefits of the cleantech industry growth locally.** Organizations such as the Metro Denver EDC and CCIA have worked with companies to help them locate and grow in the region. These efforts have created job opportunities for workers across the skills-spectrum, resulting in 35 percent increase in direct employment growth in cleantech between 2006 and 2011.

Colorado, like other states, is vulnerable to market uncertainties such as those surrounding the federal wind production tax credit. However, stakeholders are confident that the robust cleantech sector activity will continue through collaboration and support from local, state, and federal stakeholders. The time is ripe for Colorado to lead cleantech innovation and foster strong economic activity to support the cleantech sector.

ACRONYMS

AWEA – American Wind Energy Association

CCIA – Colorado Cleantech Industry Association

CCEC – Colorado Clean Energy Cluster

CREED – Center for Renewable Energy and Economic Development

EDC – (Metro Denver) Economic Development Corporation

GDP – Gross Domestic Product

MW – Megawatts

NREL – National Renewable Energy Laboratory

PV – Photovoltaic

R&D – Research and Development

RPS – Renewable portfolio standard

SolarTAC – Solar Technology Acceleration Center

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Collaborative Economics would like to thank the following individuals for taking the time to speak with the team and share their insights about Colorado's cleantech economy:

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Tom Clark – Metro Denver EDC

Richard Adams – NREL

David Hiller – Collaboratory

Drew Bolin - CO Clean Energy Cluster

Stephen Miller – CleanLaunch Technology Incubator

Tom Morgan and Carol Craig – CO Department of Labor and Employment

Tracee Bentley – CO Energy Office Legislative and Policy Director

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Clean Energy Economic Development Series

IOWA'S WIND ENERGY JOURNEY

NOVEMBER 2012

Prepared by Collaborative Economics
for Environmental Defense Fund

Report prepared for

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ABOUT THIS REPORT

Collaborative Economics has analyzed the clean energy economy in all 50 states for the Pew Charitable Trusts and National Governors Association, and for many states and communities from California to Delaware, from Silicon Valley to St. Louis. Collaborative Economics published the country's only Green Innovation Index, focusing on changes in jobs, companies, financing, and other indicators of innovation in California. As importantly, we have worked directly with practitioners at the state and local levels all across the country to develop strategies to encourage development of clean energy sectors.

We have been struck by the determination with which public and private sector leaders are working together to turn the clean energy opportunity into an economic development "win" for their state or community. They focus on the basic "blocking and tackling" of job creation – encouraging market growth, streamlining permitting processes, making strategic investments, training workers, and helping companies find places to grow.

Through tracking the experience of individual firms in the clean energy sector (see LessCarbonMoreJobs.org), Environmental Defense Fund research continues to show that job creation in the clean energy sector – as in all sectors – must begin with creating customers. A focus on job training that ignores the need to simultaneously create customers may see trained job seekers, but little actual hiring. In contrast, regions that focus on nuts and bolts efforts, particularly in the key areas of market demand (notably creating customers now), seeding innovation, company recruitment and workforce development, are most likely to succeed.

The clean energy economy is growing, state by state, community by community, across the country. Job creation and private investment in manufacturing, installation, R&D, and other services are signs that the market is rewarding innovative, competitive companies. The reason for this success goes well beyond any single public policy, investment, or training program. Indeed, the formula that is working is a mix of federal, state, and local government initiatives, private sector economic development efforts, and industry associations and collaborations. It is also the result of bipartisan efforts to help stimulate market demand, seed innovation, then capture the economic benefits for people and places in these states. While these actions can occur independently, economic growth can be more successful with a multi-faceted approach that involves collaboration across sectors and stakeholders.

Every state and community that has experienced the benefits of a growing clean energy economy has blazed its own trail. Each one has a distinctive energy mix, set of natural assets, and existing industry strengths in manufacturing, agriculture, research, or other areas. What they have in common is the recognition that clean energy is a tangible opportunity for economic growth, just as it was biotechnology, information technology, or other opportunities in years past. In these states and communities, leaders find more reasons to work together on practical steps to promote job creation, than oppose one another to gain political advantage.

Their stories – their journeys – are clearly in the early stages. They would be the first to say they have a long way to go. But, as Colorado, Iowa, Ohio, and others have shown, states and communities can take action and get results in the form of new jobs, companies, and innovation that helps meet immediate needs and set the stage for future economic growth.

John Melville
President and COO
Collaborative Economics

Jackie Roberts
Director of Sustainable Technologies
Environmental Defense Fund

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OVERVIEW OF IOWA'S ECONOMIC JOURNEY INTO WIND ENERGY

Iowa has demonstrated that the wind energy industry has tremendous potential to contribute to local economies. In recent years, Iowa's wind energy activity has surged and the state is now one of the nation's top wind employers with more than 6,000 jobs (AWEA, 2012a).

- **Iowa is a leader in wind installations** with the second highest installed wind capacity in the nation and is one of only two states that receive over 20 percent of electricity from wind power (AWEA, 2012a; and Wiser and Bolinger, 2012). Iowa's growth was kick-started by the nation's first renewable portfolio standard passed in 1983.

- **Iowa is an epicenter of wind activity because it is the state where supply meets demand and is home to world leaders in the wind industry.** Iowa has leveraged its historical manufacturing strength to flex capacity into wind component manufacturing and has attracted more major wind industry manufacturers than any other state (AWEA, 2012a). Companies have been drawn to Iowa by its skilled workforce, transportation infrastructure, availability of industrial suppliers, local customer base, and bipartisan support from Iowa leaders. Iowa's strong wind manufacturing supply chain is boosted by the aggressive pace of installations in the state and surrounding areas. Iowa is ready to continue to expand wind installation and business opportunities throughout the value chain.

- **Iowa community colleges and universities are leading the way in terms of training the wind industry workforce.** Iowa's community colleges are aggressively training wind energy technicians and analysts, and nearly all of Iowa's 15 colleges have wind training courses. Iowa Lakes Community College had one of the first wind technician training programs approved by the American Wind Energy Association (AWEA, 2012c). Iowa universities are increasingly expanding into wind-related programs and research in collaboration with industry partners.

How has Iowa built its wind energy economic sector? Iowa's success cannot be attributed to any single effort; stakeholders have worked across jurisdictions, companies, and political party lines to collectively build a robust, diverse wind energy economy.

Stakeholders have worked collaboratively to stimulate demand for wind energy products and services, foster wind energy innovation, and help the state capture economic benefits from the sector's growth. Building off the state's history in manufacturing, its talented workforce, and rich renewable energy resources, Iowa has successfully diversified its economy and become a leader in the wind energy industry.

Iowa's clean energy economy is centered on the wind, biofuels, and energy efficiency sectors and includes companies across the value chain, ranging from wind component manufacturers and biofuel producers to energy efficient construction. Workers in the renewable energy sector are even more varied than the companies; installers, technicians, sales representatives, engineers and scientists all contribute to the renewable energy economy.

Given the depth and breadth of activities occurring throughout Iowa, this report will focus primarily on the wind industry to demonstrate how Iowa has developed a strong clean energy economy. This report will first discuss the actions Iowa stakeholders have taken to stimulate market demand, seed innovation, and capture the economic benefits, and then show the results of those actions to date.

IOWA'S WIND ENERGY ECONOMY ACTIONS

A robust clean energy economy is based on strong customer demand for products and services with ongoing innovation to advance the sector.

A region can develop all or part of this economy locally through focused actions in three different categories: stimulating demand, seeding innovation, and capturing economic benefits. These types of actions may be focused in just one category, but sector growth can be more successful with a multi-faceted approach that involves collaboration across sectors and stakeholders.

A diverse set of stakeholders play roles in building a strong wind energy economy. These stakeholders can include local, state, and federal government, as well as private companies, academic institutions, and organizations. Iowa stakeholders have worked across sectors to create a unique atmosphere that fosters a growing wind energy economy. The Iowa Action Timeline in Figure 1 exhibits a sample of actions that have helped stimulate demand, seed innovation, and capture the economic benefits of the wind energy industry. Iowa's stakeholders consistently employed strategic actions across all three categories, pulling forward end market growth as well as pushing markets into new innovations and local production and installation since the 1980s. These actions are explained in greater detail in the following sections.

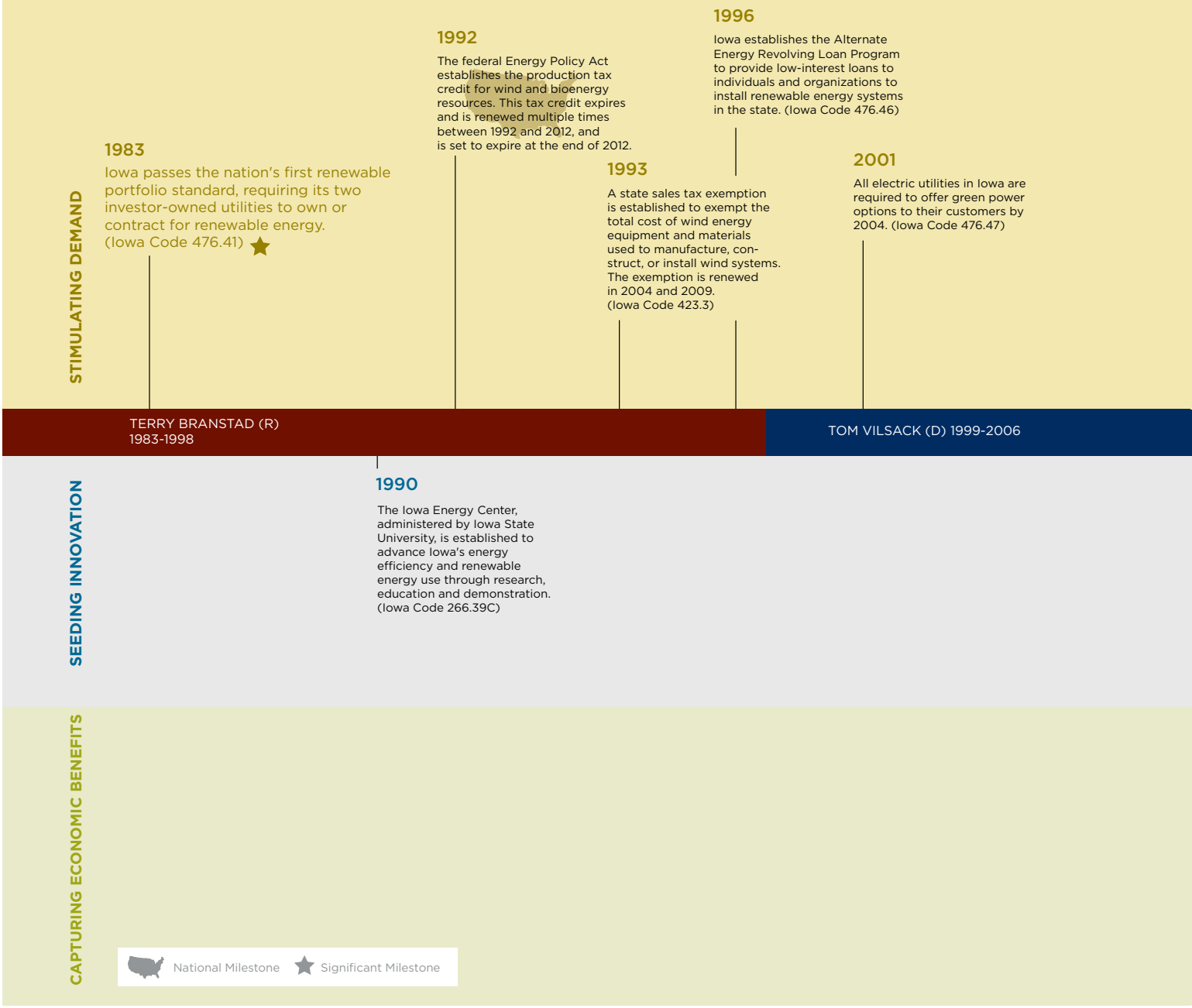
ACTIONS TO BUILD THE WIND ENERGY ECONOMY

Stimulating Demand – Initiatives that increase consumer demand for wind energy by increasing affordability, removing barriers, or setting standards for clean energy.

Seeding Innovation - Actions to increase local wind energy innovation by investing in research and development, funding new startup companies, or creating supportive networks.

Capturing Economic Benefits – Actions to recruit and support wind-related companies while also promoting and aligning job creation and workforce development.

FIGURE 1: **IOWA WIND ENERGY ACTION TIMELINE**

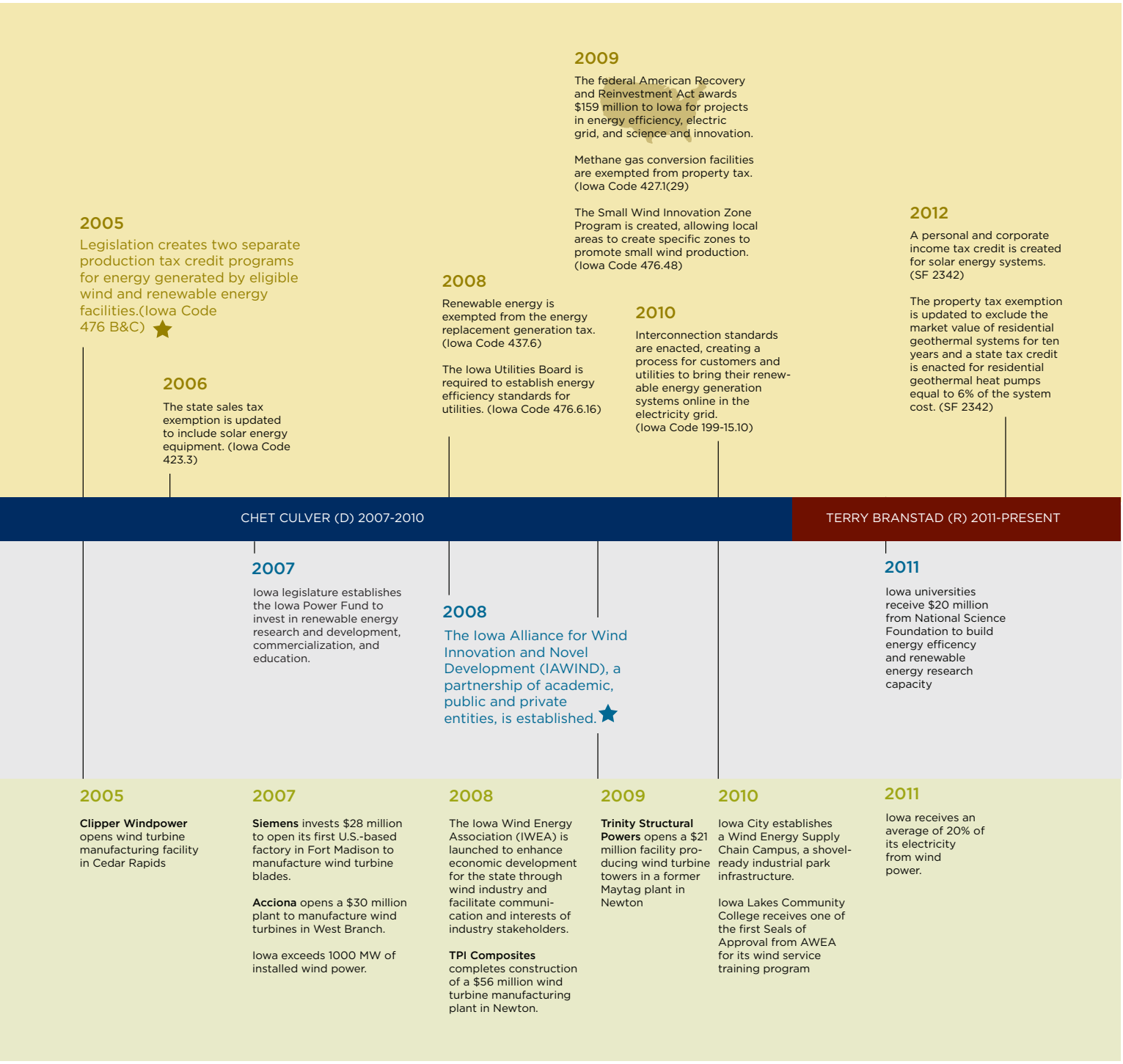


STIMULATING DEMAND

Stimulating demand for wind energy products and services increases the wind energy customer base. Policymakers could remove regulatory barriers to expand access to renewable energy, create financial incentives to increase affordability, or set standards for increased renewable energy use. These actions send a market signal to wind companies that there will be local demand for products. Many companies opt to ramp up production of goods and services in response. Iowa's policymakers and organizations have implemented a number of these actions in the past decade to stimulate consumer demand and expand the wind energy market.

Iowa was one of the first states to promote wind energy and has shown consistent support for the wind industry across political parties, organizations, and geographic boundaries. Renewable energy policies in Iowa have been implemented under both Republican and Democratic administrations. Top-level leaders in the Iowa General Assembly, as well as the state's U.S. senators and representatives, have helped reduce regulatory hurdles and create incentives to increase renewable energy economic development.

Iowa governors have repeatedly prioritized expansion of the wind industry as well. Republican Governor Terry



Branstad, during his first term, oversaw a kick start in the state's renewable energy economy with the passage of the nation's first renewable portfolio standard (RPS) in 1983. Democratic Governor Tom Vilsack signed a key state law in 2005 to provide a tax credit for renewable energy production. Democratic Governor Chet Culver helped bolster the renewable energy sector by creating the Iowa Power Fund in 2007 to invest in renewable energy research and development projects in the state (NC State, 2012). Governor Branstad has demonstrated continued support for the industry in his current term by speaking out in support of extending the Federal wind production tax credit (Henderson, 2012).

Regulatory standards can help stimulate demand for renewable energy by providing a market signal to businesses that there will be local customers for wind products and services, and that the state is supportive of the sector's efforts. Iowa's landmark 1983 RPS requires the state's two investor-owned utilities to own or contract for a combined total of 105 megawatts (MW) of renewable energy. Eligible resources include solar, wind, waste management, resource recovery, refuse-derived fuel, agricultural crops or residues, woodburning facilities, or small hydropower facilities. While the utilities have long surpassed this standard, it set an early precedent for the state's leadership in renewable energy and gave the state a head start in reducing hurdles for renewable energy installations. For example, the state has since allowed utilities to receive

approval on revised electricity rates before installing new renewable energy generation, reducing the financial risk of new installations.

Iowa stakeholders have implemented a range of financial incentives to stimulate consumer demand for wind energy products and services, including a property tax exemption and a sales tax exemption for wind and solar equipment and materials. Iowa is one of the few states with a state renewable energy production tax credit, providing 1-1.5 cents per kilowatt hour, which is a significant benefit to local renewable energy producers. The Iowa Energy Center administers the Alternative Energy Revolving Loan Program, which was created in 1996 and is funded by the state's investor-owned utilities and state bonds. This loan program provides a zero percent interest loan to an individual or business for 50 percent of the cost of a renewable energy system (NC State, 2012). The Federal Government has also helped stimulate demand for a variety of clean energy projects through the American Recovery and Reinvestment Act, which provided the Iowa government and private companies with $159 million in funding for clean energy projects ranging from energy efficient upgrades and weatherization to funds for the state energy program (U.S. Department of Energy, 2010).

In addition to renewable energy-specific policies and actions, Iowa has attracted wind energy companies through business incentives and policies that lower the cost of doing business in Iowa. For example, Iowa revised its income tax rules to incentivize companies to locate facilities and create jobs in Iowa. These tax advantages include a 50 percent deductibility of federal taxes from Iowa corporate income and only taxing based on the percentage of sales income in the state (Iowa Economic Development Authority, 2012a). Iowa also has a New Jobs Training Program to provide customized training and employee development to new or expanding businesses through the Iowa community college network (Iowa Economic Development Authority, 2012b).

Iowa was the first in the nation to exceed 20 percent wind generation. Much of our success stems from the leadership of Iowa's Governors, Congressional Delegation and the Iowa Legislature, all of whom have recognized the job creation and economic development impact of the wind energy industry. As the rest of the nation looks to follow our example, Iowa businesses and communities support the wind energy industry and are poised to meet the national demand for wind turbine components and services.

Harold Prior, Iowa Wind Energy Association Executive Director

SEEDING INNOVATION

Iowa has increased activity in wind energy innovation by funding research and development (R&D) projects and establishing collaborative networks to share R&D resources. Iowa stakeholders, particularly universities and companies, have leveraged local installation and manufacturing activity to cultivate an atmosphere that fosters innovative technologies and processes.

The Iowa Alliance for Wind Innovation and Novel Development (IAWIND) was founded in 2008 to stimulate collaboration among and within universities and industry partners on wind-related research, testing, and training. IAWIND partners experts at Iowa's three public universities with private companies to help support and facilitate research needs. For example, academic researchers are working with Siemens Energy to develop a low-cost carbon fiber derived from biorenewable feedstock to be used in turbine blades.

Iowa stakeholders have established a variety of other wind R&D programs. Iowa is part of the Experimental Program to Stimulate Competitive Research (EPSCoR) program to help the state improve research capacity in a variety of areas. In 2011, Iowa received funding from the National Science Foundation (total $20 million over five years) to build renewable energy and energy efficiency research capacity at Iowa's three public universities. The project includes a wind specific component, led by the University of Iowa, to help Iowa establish laboratories and be a leader in topics such as wind speed modeling and wind turbine blade performance and reliability (Iowa EPSCoR, 2012). Iowa State University administers the Iowa Energy Center, which includes a research grant program for Iowa-based nonprofit groups to conduct renewable energy and energy efficiency R&D projects.

Governor Chet Culver worked with the Iowa General Assembly to invest in renewable energy and energy efficiency industry innovation by establishing the Iowa Power Fund in 2007. The fund is designed to support R&D, commercialization, and implementation of early stage technologies that will reduce the state's dependence on fossil fuels and establish Iowa as a leader in the energy industry. The fund has invested more than $71 million in 50 competitive projects, leveraging over $604 million in matching industry funds and activities (Iowa Office of Energy Independence, 2012).

Iowa also utilizes general programs for promoting innovation in renewable energy. The Research Activities Credit, for example, provides a refundable tax credit for up to 6.5 percent of R&D investment made in Iowa by private companies. This program includes a specific program for research on innovative renewable energy generation components manufactured or assembled in Iowa.

IAWIND provides the mechanism to connect talented faculty and Iowa's universities and community colleges with the Iowa wind industry. The research funding program provided by IAWIND benefits both industry and the faculty.

P. Barry Butler, IAWIND principal investigator and Provost of University of Iowa

Iowa Alliance for Wind Industry Novel Development (IAWIND) is a partnership with state and local governments, community colleges, Regents Universities, the private sector, and the Federal Government. IAWIND was formed in 2008 when it was awarded a $3 million grant from the Iowa Power Fund to support training and research projects, and established a board of directors that awards the project funds. IAWIND is designed to coordinate and implement research, training, and education to meet the demand of local wind companies and enhance relationships among wind stakeholders. Iowa's academic researchers are now increasingly engaging in partnerships and discussions on common wind research problems and are sharing testing resources with other universities and wind companies.

IAWIND's activities are focused around three main programs to provide a full spectrum of support to the wind industry: research, internships, and training.

- **Research** – IAWIND provides funding for Iowa university professors to work with Iowa companies to solve common research problems. Each participating company is required to match research funds for the project.
- **Internship** – IAWIND helps fund an internship program for Iowa students to work with wind energy companies in Iowa. This program has proven successful in opening dialogue with wind companies and providing Iowa students with hands on experience in the wind industry.
- **Technical Training** – IAWIND works with community colleges to help them purchase equipment to expand their wind-related training programs. This program increases the preparedness of Iowa's workforce in the latest wind energy technologies.

CAPTURING ECONOMIC BENEFITS

In order to help the region capture the benefits of the growing wind energy economy, public and private stakeholders have worked collaboratively to align job creation and workforce development activities with recruiting and supporting companies. This alignment is a critical strategy to ensure that there are both job opportunities and trained workers in an area, and to capitalize on the positive business environment created from the stimulating demand and seeding innovation actions. Actions to capture the economic benefits include training a skilled wind energy workforce, recruiting companies to locate and grow in the region, and encouraging the deployment of wind products. State and local organizations are working across jurisdictions and with multiple stakeholders to promote wind energy economic development in Iowa. Iowa has numerous organizations to support the renewable energy industry, ranging from economic development organizations to associations that build networks among industry partners. These organizations help create an economic environment in which renewable energy companies want to locate and grow.

State and local organizations have demonstrated their commitment to the renewable energy sector by targeting it as an industry for development. The Iowa Economic Development Authority (IEDA), for example, has identified the wind energy industry as a targeted industry for Iowa to grow. The IEDA leverages Iowa strengths of a strong wind market, a central location with convenient transportation routes, a highly educated and productive workforce, and a pro-business state government to attract new companies in the Iowa wind supply chain.

Local economic development organizations are also taking the initiative to expand and support the wind industry. For example, Iowa City, with its Iowa City Area Development Group, created a Wind Energy Supply Chain Campus on 173 acres of city-owned property. It is envisioned as an industrial park equidistant from nearby large wind manufacturers Acciona and Clipper Windpower. The area has been certified as "shovel ready" to facilitate the development process for wind-related companies. The Eastern Iowa Economic Development Alliance also has a focus on the wind industry. The alliance works to attract business and investment, helps with site selection, and facilitates access to workforce training and recruitment resources. The Greater Des Moines Partnership also supports wind industry expansion and targets advanced manufacturing industry, which includes wind component manufacturing.

The **Iowa Economic Development Authority (IEDA)** actively recruits wind component manufacturers, service companies, and wind farms to make Iowa an epicenter for wind-related companies. IEDA connects potential companies with key members of the industry in Iowa to learn firsthand about the benefits of locating there. IEDA works with communities and businesses to create a recruitment package that includes assistance such as direct financial assistance, tax credits, job training funds, technical assistance, site location reviews, or regulatory process assistance.

IEDA also works with stakeholders to create a responsive environment that meets wind industry needs. For example, when the industry started expanding in Iowa, IEDA reached out to community colleges for training support for the industry. Since then, nearly all of Iowa's community colleges offer wind training courses.

The Iowa Wind Energy Association (IWEA) is a unique organization that unites all players in the wind energy field. IWEA has dozens of member companies and organizations and a board of directors representing diverse segments of the wind industry. IWEA networks various members of the wind industry and provides a unified voice for legislative efforts.

The Iowa Energy Center, established by the Iowa General Assembly in 1990, also supports the renewable energy industry in Iowa. The Energy Center is designed to serve Iowans by providing reliable, objective tools and information, as well as educational resources for Iowa residents and businesses. For example, the Iowa Energy Center funded and hosts a wind assessment study and calculator to help individuals and developers evaluate the potential for wind turbines in their town.

In addition to building a favorable business environment and enhancing networks, preparing Iowa's workforce for wind energy jobs has also been important to capturing economic benefits of the sector. Iowa has implemented a variety of training programs to ensure that local workers are equipped for wind sector jobs ranging from R&D to maintenance and installation.

The Iowa universities involved in IAWIND offer a range of classes and programs to prepare students for renewable energy R&D and management. The University of Iowa, for example, has a Wind Power Management track in the school of Mechanical and Industrial Engineering to educate students in the design, operations, and maintenance of wind farms. The University of Northern Iowa also offers bachelor and graduate degree programs in engineering that focus on applied renewable energy R&D in addition to a manufacturing technology program.

Iowa State University recently launched the Wind Energy Initiative in the College of Engineering. The goal of the program is to combine research and education to make wind energy competitive with other energy sources. The program includes a new wind energy minor for undergraduates starting in the Fall 2012, a 10-week intensive wind research and training experience for undergraduates, and a new PhD program launching in Fall 2012 in Wind Energy Science, Engineering, and Policy that will graduate at least 30 U.S. students in five years (Engineering Research Institute, 2012).

Iowa community colleges are working with wind industry stakeholders to design training programs for new and incumbent workers. Iowa Lakes Community College is a national leader among community colleges and had one of the first American Wind Energy Association (AWEA) approved wind turbine service technician programs (AWEA, 2012c). Iowa Lakes' Wind Energy & Turbine Technology program has five training labs and is training about 200 students a year in construction, operations and maintenance of wind turbines (Prior, 2012). Nearly all of Iowa's 15 community colleges have training classes related to renewable energy systems, and many have either full associate's degree programs or certificate programs for wind energy technicians. For example, Des Moines Area Community College has a Wind Turbine Technician program and Iowa Western Community College has a Sustainable Energy Technology: Renewable Energy program.

The Iowa Workforce Development office is also helping prepare workers through an American Recovery and Reinvestment Act State Energy Sector Partnership grant to train and place workers in the renewable energy and energy efficiency sectors. The project is designed to serve businesses, dislocated workers, and underemployed and unemployed Iowans with training funds in industries such as wind energy and energy efficient construction and retrofits. For example, this grant allowed Kirkwood Community College to develop its Energy Production and Distribution Technologies program. Through this grant, Kirkwood works collaboratively with local wind manufacturing companies Acciona and Clipper Windpower to train workers for jobs in the sector (Iowa Workforce Development, 2012).

Iowa Wind Energy Association (IWEA) is a nonprofit organization designed to support the growth of the wind industry in Iowa, including supply chain companies and wind turbine installations. Established in 2008, IWEA now has over 150 members representing all aspects of the wind industry, ranging from universities, governments and manufacturing companies, to developers and utilities.

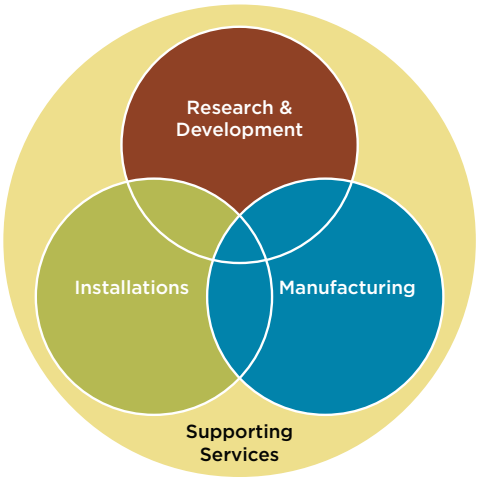
IWEA hosts events and webinars, and provides a unified industry voice on legislative efforts. Each year, IWEA conducts an Annual Membership Meeting and Wind Conference in Iowa. The conference attracts industry experts, community and federal representatives, and hundreds of attendees. The meetings are an opportunity for industry partners to connect with each other and further expand the wind industry in Iowa.

WIND ENERGY ECONOMY RESULTS

Iowa has embraced the wind industry, which has allowed the state to diversify its economy while maintaining its rural roots and manufacturing strengths. The actions that Iowa stakeholders have taken to build a robust wind energy economy have led to impressive results. The state has emerged as a leader in wind component manufacturing and has demonstrated strong customer demand for wind energy products and services. In addition, as shown in the action timeline (Figure 1), wind-related companies are increasingly choosing Iowa as a place to locate and grow, bringing significant economic benefits to the state.

IOWA'S ENERGY TECHNOLOGY VALUE CHAIN

FIGURE 2
ENERGY TECHNOLOGY VALUE CHAIN



The investment and work to stimulate demand, seed innovation, recruit companies, and develop a new workforce has paid dividends across the value chain. Iowa has built a wind energy economy that includes a variety of companies and activities, all of which operate across the energy technology value chain. The segments of the value chain may exist independently, but provide a more robust economic cluster when all segments are developed and work together. Figure 2 illustrates the interaction of the energy technology value chain segments. Iowa now boosts companies that provide each of these activities:

Research & Development: R&D activities are carried out primarily by research institutions, such as federal laboratories, universities, or private company research divisions. R&D activities foster an environment centered on developing new products and processes so that the state can become a leader in innovation.

Manufacturing: Manufacturing involves production of a technology and includes companies throughout the supply chain, ranging from component suppliers to those assembling complete units for sale to consumers.

Installation: Installation of clean energy technologies, such as developing wind turbine farms, will occur in response to market demand. Companies involved in activities such as site assessment, logistics, transportation, and construction play an important role in installation.

Supporting Activities: A variety of other activities are critical to supporting clean energy technology. These supporting organizations facilitate interactions among players, provide funding, educate consumers, advocate for business friendly policies, or provide technical support and product maintenance services.

WORKING WITH INDUSTRY TO DRIVE INNOVATION

Iowa's wind energy R&D-related activities are focused on universities working directly with companies to improve processes and create innovative technologies. These industry partnerships are helping manufacturers make better, more reliable wind turbines and leading to cheaper wind energy. Research projects range from improving wind measurements and analysis to examining fiberglass blade performance during construction and operation. A few recent examples include:

- **Acciona,** a major wind manufacturer, is working with Iowa State University researchers to design a 100-meter concrete wind turbine tower and install it in Cedar County, Iowa. The research project leverages $16 million from Acciona and $3 million from the Iowa Power Fund. The research will help commercialize the new AW-3000 turbine and will include a new type of concrete turbine tower that has the potential to cut the cost of wind power and create more local jobs. Turbines built on concrete towers are significantly taller than traditional steel towers, increasing efficiency and productivity. These towers will be constructed on-site, which also provides the potential to create more local jobs in wind installation (Ford, 2011).

- **Anemometry Specialists** recently announced it would match a $300,000 grant from IAWIND for a professor at Iowa State University to develop a buoy-mounted measurement platform that would make offshore wind energy assessment more cost-effective. This new technology has the potential to reduce the costs of offshore wind production by four percent (Anemometry Specialists, 2012).

Iowa's progress in renewable energy innovation can also be demonstrated by patents. Figure 3 shows that Iowa has increased patents for clean energy over the last decade. Iowa continues to have significant strength in biotechnology innovation building from its agricultural expertise, but is also an increasingly notable player in wind innovation with six patents in 2010-2011. Table 1 shows that Iowa had no wind patents in the 1992-1993 period and then jumped to 12th in the nation in the 2010-2011 period. Given the increase in academic R&D programs and partnerships with wind manufacturing companies, Iowa is well positioned to maintain a leadership role in wind patents and innovation.

Iowa's actions to seed innovation also have significant economic impacts. For example, Iowa commissioned an analysis of the first 31 projects invested in through the Iowa Power Fund. Of the $38.3 million invested, the study found that, even in a low scenario estimate, the 20-year economic impact will be an additional 8,500 jobs with a total payroll of $3.8 billion, and the activities could generate more than $475 million in state revenue and more than $390 million in local property taxes. The impact during the life of the projects (eight years, from 2007-2014) is also significant, with a cumulative $181 million economic output, nearly $63 million in workers earnings, and average annual employment of about 200 (Impact DataSource, 2010). Iowa also estimated that IAWIND, which includes research and training activities, will lead to $3.4 million in economic activities, 1,350 jobs, and $176 million in worker earnings over the next 20 years (Iowa Office of Energy Independence, 2010).

TABLE 1

IOWA NATIONAL RANKING IN CLEAN ENERGY PATENTS

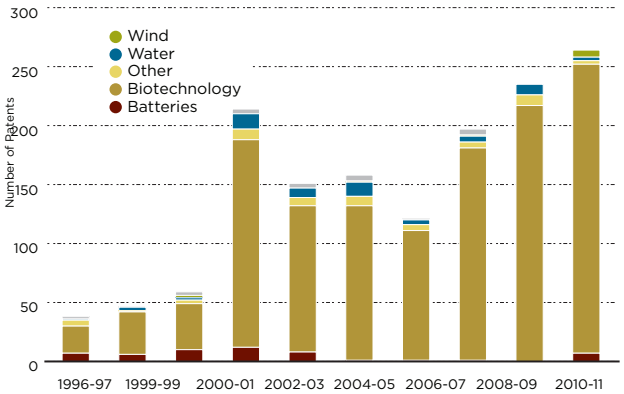
	1992-93	2010-11
Biotechnology	22	7
Wind	50	12
Overall	25	17

Note: Iowa had zero wind patents in 1992-1993 and therefore tied for last in national rank.
DataSource: 1790 Analytics, Patents by Technology; USPTO Patent File

FIGURE 3

CLEAN ENERGY PATENTS

IOWA



Data Source: 1790 Analytics, Patents by Technology; USPTO Patent File
Analysis: Collaborative Economics
Note: "Other" category includes electric vehicles, energy infrastructure, hybrid systems, hydro power, fuel cells, and solar; "Biotechnology" includes biofuels and biochemicals

MANUFACTURING COMPANIES RESPONDING AND GROWING

Iowa is one of the few states with manufacturing companies that produce all of the main components of a wind turbine — turbines, blades and towers – and has attracted more major wind manufacturers than any other state. Wind-related companies have chosen to locate and expand in Iowa because of stakeholder's actions to stimulate demand, seed innovation, and capture economic benefits of the wind industry. Wind-related companies take advantage of Iowa's collaborative environment, political support, financial incentives, and workers with skills ranging from plant managers to assemblers and welders.

Iowa has leveraged its manufacturing strength to expand into wind component parts. Iowa receives 17.8 percent of its gross domestic product (GDP) from manufacturing, ranking it sixth in the nation among states dependent on manufacturing, and more than 10 percent of Iowa jobs were in manufacturing as of 2010 (CIRAS, 2011). Iowa manufacturers have used their experience with large equipment production to expand into wind components. Iowa's large machinery manufacturing companies are an ideal fit for producing the large components for wind turbines. Companies such as John Deere and Caterpillar have capitalized on this opportunity and have flexed their manufacturing capacity to also produce wind turbine components. In the past ten years, Iowa has increasingly become a center for international wind industry leaders, including two turbine manufacturers, two blade manufacturers, and a tower manufacturer. In 2005, Clipper Windpower became one of the first major manufacturers to locate in Iowa. Clipper chose Iowa because of the state's proximity to wind resources, availability of suppliers, and support from Iowa's leaders, among other reasons (Iowa Department of Economic Development, 2008).

Acciona Windpower North America LLC invested over $30 million to open its first U.S. wind turbine facility in West Branch, Iowa in 2007 (Acciona, 2012). The Iowa Department of Economic Development noted that, according to Adrian LaTrace (Acciona's North American vice president of manufacturing), "Acciona looked at sites throughout the upper Midwest. Iowa was selected due to its excellent logistical proximity to a large number of Acciona wind power projects in the United States, and also due to factors such as the nearby industrial supplier base, an available and skilled workforce, technical training centers, and support from state and local governments." Acciona also received an incentive package from the state that included a loan, infrastructure assistance, and tax benefits from programs like the High Quality Job Creation program (Iowa Department of Economic Development, 2008).

Acciona is working with local companies to build a wind industry cluster in Iowa. The company is helping to expand the local supply chain with its goal to source 90 percent of its parts locally, and currently sources 80 percent of its completed turbine and tower from North American companies (U.S. Department of Energy, 2012). Acciona is also working with local researchers to build new innovative wind technologies, such as its new concrete tower design.

In 2007, **Siemens** opened a 600,000 square foot facility in Fort Madison, Iowa to manufactures wind turbine blades. Siemens is now the largest employer in Fort Madison, with 600 employees at the plant and an estimated 350 indirect jobs created from the plant's activities. Fort Madison was chosen for its strategic location for shipping turbine parts to wind power projects across the country. A rail yard was added to the facility in 2008, using existing railroad infrastructure to more efficiently transport the turbine parts (Siemens, 2010). In 2012, Siemens was selected by MidAmerican Energy, Iowa's largest energy company, to provide all 176 utility-scale turbines that will be installed this year, providing an additional 407 megawatts of wind power. This expansion will create even more Iowa jobs in the manufacturing, installation, and maintenance of turbines (DeFreitas, 2012).

Iowa's major wind manufacturers, manufacturing infrastructure, and skilled workers are drawing additional suppliers to the state. For example, Spanish-based Goian, which provides lifts for people and equipment inside support towers for wind turbines, followed its major customer Spanish-based Acciona's lead and also opened a location in Iowa (Bzdega, 2008). The Iowa Department of Economic Development, Greater Des Moines Partnership, and City of Ankeny worked collaboratively to win the new facility out of Goian's five candidate states (Moerman, 2008).

TPI Composites is another example of a company that worked with state and community leaders in Newton, Iowa to build a plant on the site of a former Maytag facility. The plant employs about 500 local workers, many of whom were laid off when the Maytag plant closed. TPI now manufactures turbine blades for GE Power, which sells turbines throughout the Great Plains. In addition to wind-specific manufacturing companies, numerous manufacturers are a part of the Iowa wind supply chain and provide parts to the major wind manufacturers (Iowa Department of Economic Development, 2008).

Iowa now has over 200 wind-related businesses (Terry Branstad, 2012). AWEA estimates that there are more than 3,000 jobs in wind manufacturing alone (out of the 6,000 total jobs), making Iowa a leading state in wind manufacturing employment (AWEA 2012a).

Goian is confident that our decision to place our first North American facility in the Des Moines area will be an excellent investment. We have easy access to the suppliers, customers and workforce that will grow our company well into the future.

Iñaki Sancho, General Manager of Goian North America LLC on the announcement of locating its facility in Iowa (Moerman, 2008)

The federal **Production Tax Credit**, which provides an income tax credit for the production of electricity from utility-scale wind turbines, is set to expire at the end of 2012. As of October 2012, uncertainty about its renewal still loomed, contributing to a slowdown in the U.S. market demand for new wind turbines. . Consequently, multiple Iowa wind manufacturers are laying off workers. For example, in August Clipper announced a 32 percent reduction in workforce (76 workers in Iowa) (Dewitt and Franzman, 2012) and in September Siemens announced a layoff of 407 workers in Fort Madison. Siemens noted that the difficult market conditions due to lack of congressional action on the tax credit contributed to its decision (Pitt, 2012).

WIND ENERGY INSTALLATIONS

Iowa's rich wind resources, combined with actions to stimulate demand for renewable energy installations, have allowed Iowa companies to dramatically increase their deployment of wind products and services in recent years. Iowa is the 7th windiest state and is currently ranked 2nd in installed wind capacity. Table 2 shows the top five states in wind installations. Texas has the most installations, but is also ranked first in wind resource potential. Iowa is narrowly ranked higher than California, but is far ahead of Illinois and Oregon. Figure 4 displays Iowa's growth in wind capacity, which reached 4,524 megawatts by the end of the second quarter 2012 (AWEA 2012b). This is nearly double the amount of wind power in five years and is over four times the national average. Iowa is one of only two states that have exceeded 20 percent of state generated electricity coming from wind (Wiser and Bolinger, 2012).

Utilities are actively involved in clean energy installations, stimulating the local economy and creating installation jobs. The large investor owned utility MidAmerican Energy has become an active supporter of wind energy and has played a leadership role in installations. MidAmerican is first in the nation in ownership of wind-powered capacity among rate regulated utilities and by the end of 2012 will own over 2,200 MW of wind generation, which will account for over 30 percent of its generation capacity powered by wind. MidAmerican began installing wind turbines in Iowa in 2004 and expanded to take advantage of the economic value in wind power (MidAmerican Energy, 2012). Iowa's policies, such as advanced approval of electricity rates before installing wind turbines, have facilitated this growth by reducing the risk of investment recovery.

Iowa also has many wind industry companies that were founded or have expanded in the state. These companies provide marketing, advertising, legal services, site assessment, and a range of other services to the wind industry. Anemometry Specialists, for example, is a full service wind assessment company that helps identify and assess potential installation locations, manages installation projects, and conducts inspections and maintenance on turbines.

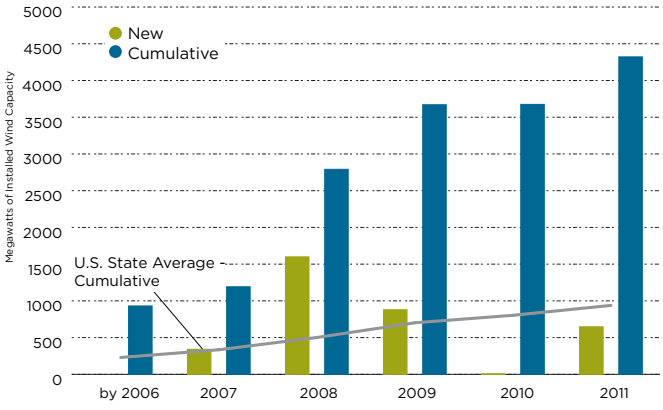
Iowa has achieved this installation activity without sacrificing overall economic progress. Figure 5 shows that Iowa's electricity bill compared to GDP is on par with the rest of the U.S. and Iowa's GDP has continued to outpace changes in electricity bills even while renewable energy installations increased.

TABLE 2
TOP STATES IN TOTAL WIND INSTALLATIONS*

1	Texas	10,648 MW
2	Iowa	4,524 MW
3	California	4,425 MW
4	Illinois	3,055 MW
5	Oregon	2,820 MW

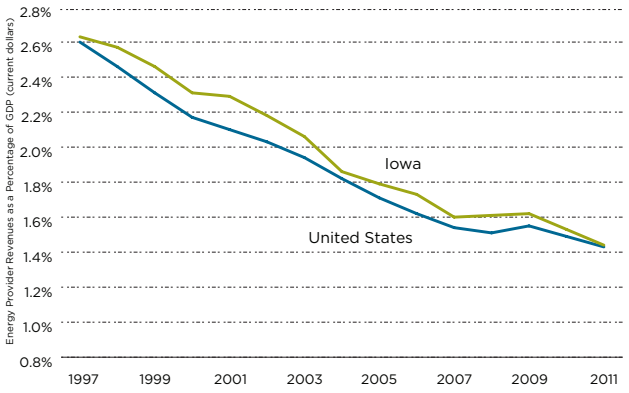
* Wind installations as of second quarter 2012
DataSource: AWEA, 2012a

FIGURE 4
WIND ENERGY INSTALLATIONS
IOWA



Data Source: American Wind Energy Association
Analysis: Collaborative Economics

FIGURE 5
ELECTRICITY BILL AS A PERCENTAGE OF GDP
IOWA



Data Source: U.S. Department of Energy, Energy Information Administration; U.S. Department of Commerce, Bureau of Economic Analysis
Analysis: Collaborative Economics

SUMMARY: IOWA'S WIND-RELATED ECONOMY

In summary, Iowa's value chain segments (R&D, manufacturing, installation, and supporting services) have demonstrated progress in response to stakeholder actions and market demand. Iowans across the state are seeing the benefits of the wind industry. Iowa farmers and landowners, for example, have embraced the wind industry as a partner through leasing land to installers, while still being able to farm the land around the turbines. A recent poll shows that 85 percent of Iowa voters see wind energy as a positive benefit to the state (Haberman, 2012).

Table 3 summarizes a few key economic benefits to Iowa from the wind energy industry. Iowa is one of the top employers in the wind industry, with more than 6,000 direct and indirect jobs in 2011. The manufacturing sector contributes jobs to workers generally in more urban areas, but installations also bring significant benefits to the state's rural economy. The wind industry, for example, contributes $19.5 million in annual property tax payments by wind project owners and $13 million in annual lease payments to land owners (AWEA 2012a). An Iowa farmer may receive an additional $6,000 per acre for each turbine annually. Rural Pocahontas County alone has over 200 wind turbines installed and has received over $3 million dollars in tax revenue from these wind turbines during the past three years (IWEA, 2012).

These outcomes show a robust and diverse wind energy economy in Iowa.

TABLE 3
IOWA WIND-RELATED ECONOMY

Workers	6000+
Companies	200+
Annual Payroll	$ 70+ million
Percent of Electricity Generated from Wind	20%
Annual Property Tax Contribution From Wind Project Owners	$19.5 million
Annual Lease Payments to Land Owners	$13 million

DataSource: Terry Branstad, 2012. AWEA, 2012a. Greater Des Moines Partnership

We've found an available and highly skilled workforce in Iowa. The Iowa Department of Economic Development, Alliant Energy, the Cedar Rapids Area Chamber of Commerce and the city of Cedar Rapids also provided significant support to help us launch our production facility.

Jim Dehlsen, former Clipper CEO, on expanding operations in Iowa (Iowa Department of Economic Development, 2006)

Founded in 2002, **Anemometry Specialists** provides comprehensive wind energy assessment services to utilities and developers in Iowa and around the world. Based in the small community of Alta, Iowa, Anemometry Specialists employs 27 full time employees and installs meteorological towers that collect data on conditions such as temperature, wind speed, and humidity to determine whether the site is appropriate for a wind farm. The company also conducts studies and analyses that help both large- and small-scale wind projects access financing. Anemometry Specialists has grown substantially with the rise of the wind industry in Iowa, doubling in size and revenue for six years and maintaining a 20 percent growth rate since the recession (Anemometry Specialists, 2011).

CONCLUSION

Iowa's wind energy economy has grown as a result of multi-stakeholder, bipartisan actions to stimulate demand for wind products and services, foster innovation, and help the state capture economic benefits from the industry's growth. R&D activity, wind manufacturing, and wind energy installations have all substantially increased in Iowa in recent years. This progress demonstrates Iowa's success in creating a diverse, robust wind energy economy and establishing the state as a leader in the wind energy industry.

- **Iowa policymakers have helped stimulate consumer demand for renewable energy products and services.** Iowa was the first state to pass an RPS and is one of the few states with a state renewable energy production tax credit, which helped show the state is supportive of the renewable energy industry.

- **Iowa is increasing its role in wind energy innovation and researchers are collaborating with industry partners to advance the wind energy industry.** New organizations such as IAWIND and university wind technology programs will help solidify Iowa's role in wind energy R&D.

- **Iowa state and local officials have made significant strides to capture the economic benefits of the wind energy industry growth.** Iowa is one of the few states that manufactures all major parts of the wind turbine and has dozens of companies throughout the wind supply chain, creating jobs across skills spectrum. Iowa is also taking a leading role in training the workforce for wind industry jobs through its strong community college wind training programs.

Iowa, like other states, is vulnerable to market uncertainties such as those surrounding the federal wind production tax credit. There is broad agreement among Iowa's U.S. Congressional delegation, Governor, and state legislators that the production tax credit would help the state maintain its economic momentum. However, Iowa's experience to date in creating a wind industry cluster will allow it to leverage opportunities in other clean energy industries, such as biochemicals or solar, as it moves towards a more diverse clean energy economy.

ACRONYMS

AWEA – American Wind Energy Association

GDP – Gross Domestic Product

IAWIND – Iowa Alliance for Wind Innovation and Novel Development

IEDA – Iowa Economic Development Authority

IWEA – Iowa Wind Energy Association

MW – Megawatts

R&D – Research and Development

RPS – Renewable portfolio standard

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Clean Energy Economic Development Series

OHIO'S ADVANCED ENERGY JOURNEY

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Prepared by Collaborative Economics
for Environmental Defense Fund

Report prepared for

Environmental Defense Fund - Environmental Defense Fund's mission is to preserve the natural systems on which all life depends. Guided by science and economics, we find practical and lasting solutions to the most serious environmental problems. What distinguishes Environmental Defense Fund is the combination of what we protect and how we protect it. We work to solve the most critical environmental problems facing the planet. This has drawn us to areas that span the biosphere: climate, oceans, ecosystems and health.

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Collaborative Economics works with senior executives from business, foundations, government, education and community sectors - helping them create breakthroughs in how people think and act regarding their region. Collaborative Economics' clients have the passion, vision and commitment to blaze a new pathway for their community. They understand that a new kind of leadership is required to create great places, with thriving economies and world-class quality of life.

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ABOUT THIS REPORT

Collaborative Economics has analyzed the clean energy economy in all 50 states for the Pew Charitable Trusts and National Governors Association, and for many states and communities from California to Delaware, from Silicon Valley to St. Louis. Collaborative Economics published the country's only Green Innovation Index, focusing on changes in jobs, companies, financing, and other indicators of innovation in California. As importantly, we have worked directly with practitioners at the state and local levels all across the country to develop strategies to encourage development of clean energy sectors.

We have been struck by the determination with which public and private sector leaders are working together to turn the clean energy opportunity into an economic development "win" for their state or community. They focus on the basic "blocking and tackling" of job creation – encouraging market growth, streamlining permitting processes, making strategic investments, training workers, and helping companies find places to grow.

Through tracking the experience of individual firms in the clean energy sector (see LessCarbonMoreJobs.org), Environmental Defense Fund research continues to show that job creation in the clean energy sector – as in all sectors – must begin with creating customers. A focus on job training that ignores the need to simultaneously create customers may see trained job seekers, but little actual hiring. In contrast, regions that focus on nuts and bolts efforts, particularly in the key areas of market demand (notably creating customers now), seeding innovation, company recruitment and workforce development, are most likely to succeed.

The clean energy economy is growing, state by state, community by community, across the country. Job creation and private investment in manufacturing, installation, R&D, and other services are signs that the market is rewarding innovative, competitive companies. The reason for this success goes well beyond any single public policy, investment, or training program. Indeed, the formula that is working is a mix of federal, state, and local government initiatives, private sector economic development efforts, and industry associations and collaborations. It is also the result of bipartisan efforts to help stimulate market demand, seed innovation, then capture the economic benefits for people and places in these states. While these actions can occur independently, economic growth can be more successful with a multi-faceted approach that involves collaboration across sectors and stakeholders.

Every state and community that has experienced the benefits of a growing clean energy economy has blazed its own trail. Each one has a distinctive energy mix, set of natural assets, and existing industry strengths in manufacturing, agriculture, research, or other areas. What they have in common is the recognition that clean energy is a tangible opportunity for economic growth, just as it was biotechnology, information technology, or other opportunities in years past. In these states and communities, leaders find more reasons to work together on practical steps to promote job creation, than oppose one another to gain political advantage.

Their stories – their journeys – are clearly in the early stages. They would be the first to say they have a long way to go. But, as Colorado, Iowa, Ohio, and others have shown, states and communities can take action and get results in the form of new jobs, companies, and innovation that helps meet immediate needs and set the stage for future economic growth.

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OVERVIEW OF OHIO'S ECONOMIC JOURNEY INTO ADVANCED ENERGY

Ohio has demonstrated that the advanced energy[1] technology industry has important potential to diversify and contribute to the state and local economy.

- **Ohio's public and private stakeholders work collaboratively to build strong advanced energy activity throughout the state economy.** Stakeholders from both sides of the political aisle have endorsed programs that support the commercialization of promising technology and stimulate demand for advanced energy products. The Advanced Energy Economy Institute estimated that more than 400 establishments and at least 25,000 workers are directly linked to the advanced energy industry, across the multitude of subsectors and professions (AEEI, 2012).

- **Ohio's manufacturers are diversifying to produce advanced energy products.** Ohio's manufacturing leaders like Timken Co., Parker Hannifin and Owens Corning have developed products that serve advanced energy end markets. New companies and smaller-scale manufacturing and machining businesses are also participating in the sector.

- **Ohio is a national leader in advanced energy research, stemming from the state's universities, as well as other public and private sector research efforts.** These stakeholders have established specialized research centers that encourage collaboration across institutions and connect researchers with private businesses. Ohio's patent registrations in advanced energy nearly doubled over the last decade and climbed in national rankings.

- **Ohio cultivates growth in diverse advanced energy technologies.** Ohio has one of the largest wind supply chain networks in the United States, is a national leader in research activity for fuel cells and batteries, developed a strong thin-film solar manufacturing cluster, and is home to the most energy efficiency product manufacturers in the Midwestern United States. Strategic economic development efforts are also targeting emerging sectors like industrial waste heat recovery and smart grid.

Ohio's rapid expansion across the advanced energy economy cannot be attributed to any single effort; stakeholders have worked across jurisdictions, sectors, and political party lines to collaboratively build multiple advanced energy technology clusters and opportunities for workers across the skills spectrum. Businesses, state and municipal government leaders and nonprofit organizations have taken action to strategically leverage the state's historical strengths in research and manufacturing. Stakeholder initiatives included stimulating local demand for advanced energy projects, investing in promising advanced energy technologies and capturing economic benefits locally by building industry networks and training the workforce. Taken together, these efforts propelled Ohio into national leadership in advanced energy technology innovation and production, and prompted strong growth in technology deployment. The efforts have cultivated business growth and employment opportunities for Ohioans with a range of skills, from specialized machinists to financial services professionals.

Although Ohio's definition of advanced energy includes many subsectors, this report will focus on developments in renewable energy, advanced storage, fuel cells, and energy efficiency technology, with a sampling of examples from emerging sectors such as smart grid and industrial waste heat recovery. It will specifically highlight the Northeastern region of Ohio (including Cleveland, Akron, Canton and Youngstown), to exemplify how multi-stakeholder collaborative efforts in Ohio have increased economic activity in the advanced energy industry.

[1] Ohio's definition of advanced energy encompasses a wide range of subsectors, including wind, solar, biomass, fuel cells, energy efficiency, advanced storage, nuclear, natural gas, smart grid, hydropower, industrial waste heat capture and clean coal

OHIO'S ADVANCED ENERGY ECONOMY ACTIONS

A robust advanced energy economy is based on strong customer demand for advanced energy products and services with ongoing innovation to advance the sector.

A region can develop all or part of this economy locally through focused actions in three different categories: stimulating demand, seeding innovation, and capturing economic benefits. These types of actions may be focused in just one category, but sector growth can be more successful with a multi-faceted approach that involves collaboration across sectors and stakeholders.

The Ohio Action Timeline exhibits a sample of advanced energy initiatives and milestones introduced by stakeholders that stimulated end markets, seeded innovation, and helped the region capture economic benefits in wind and solar technology, fuel cells, advanced storage and energy efficiency technology. Ohio's stakeholders are active at the local, regional and state level, from public agencies, private companies, academic institutions, and nonprofit organizations. These stakeholders have worked across sectors to foster innovation, entrepreneurship and job creation.

Ohio's story is compelling because local and state policies were implemented alongside private business and nonprofit collaborative efforts to accelerate the sector's growth. It is also important to note that Ohio's stakeholders consistently employed strategic actions across all three categories, pulling forward end market growth as well as pushing markets into new innovations and local production since the late 1990s.

ACTIONS TO BUILD THE ADVANCED ENERGY ECONOMY

Stimulating Demand – Initiatives that increase consumer demand for advanced energy by increasing affordability, removing barriers, or setting standards for advanced energy.

Seeding Innovation – Actions to increase local advanced energy innovation by investing in research and development, funding new startup companies, or creating supportive networks.

Capturing Economic Benefits – Actions to recruit and support advanced energy companies while also promoting and aligning job creation and workforce development

FIGURE 2: **OHIO CLEANTECH ACTION TIMELINE**

STIMULATING DEMAND

Ohio policymakers have stimulated demand for advanced energy through a mix of regulatory reform, incentives and an advanced energy portfolio standard. State, local, and federal governments often stimulate end markets for emerging technologies by setting standards for use, removing barriers to implementation, or creating incentives for customers to buy the technology. The advanced energy sector requires large amounts of capital investment to develop and bring the technology to market, and therefore represents a risk for private businesses. Market stimulus actions signal to businesses that the state is supportive of advanced energy technology, and that end market demand for the product will exist.

Ohio's state government has demonstrated consistent support for the advanced energy industry over the years and across political party lines. Former Governor and later Senator George Voinovich (R) advocated for low emissions electricity sources, focusing primarily on nuclear energy. Governor Bob Taft (R) supported diverse advanced energy technologies, including fuel cells and renewables, through a series of investment programs. Governor Ted Strickland (D) worked with

2008

The Energy Improvement and Extension Act of 2008 extends the federal business energy investment tax credit by increasing the duration of the credit by eight years, increasing the credit amount for fuel cells, and creating new credits for small wind systems, geothermal heat pumps, and combined heat and power systems. The credit was further expanded by the American Recovery and Reinvestment Act of 2009. (HR 1424)

2009

The American Recovery and Reinvestment Act awards $658M to Ohio for projects in energy efficiency, renewable energy, electric grid, transportation, and science and innovation.

Energy Conversation for Ohioans (ECO-Link) program offers Ohio homeowners reduced rate financing for energy efficiency and renewable energy home upgrades.

2011

First Energy Northeastern Ohio's Investor Owned Utility commits to purchasing 5,000 MWh Solar Renewable Energy Credits and 20,000 MWh Renewable Energy Credits in equal quantities each calendar year, from 2011 to 2020.

2012

Governor Kasich's energy plan establishes Waste Energy Recovery and Combined Heat and Power as energy sources that can contribute to meeting the renewable portfolio standard and also reaffirms support for alternative energies. (SB 315)

HOUSE (D) 2009-2010

HOUSE (R) 2011-PRESENT

JOHN KASICH (R) 2011-PRESENT

2008

Great Lakes Energy Institute launches at Case Western Reserve University to organize research, industry collaboration and student programs around energy

2010

Ohio Third Frontier program extended to 2015 by voters.

2011

Northeastern Ohio is awarded a $2M federal Jobs and Innovation Accelerator Challenge Grant to improve speed-to-market for near-production or pilot-production companies in the advanced energy and flexible electronics industry clusters.

US Department of Energy awards over $1.5M to three Northeastern Ohio groups to study impact and feasibility of deep offshore wind farms in Lake Erie.

2008

NorTech, a Northeastern Ohio cluster promotion group, identifies advanced energy as a focus area and lays groundwork for strategic cluster development in the sector.

Ohio Bipartisan Job Stimulus Plan (HB 554) which includes the Advanced Energy Job Stimulus Program to trains workers and encourage development, production and use of advanced energy projects from 2009 to 2011.

2009

Lake Erie Energy Development Corporation was developed and launched by NorTech Energy Enterprise, the Cleveland Foundation, City of Cleveland, Cuyahoga and Lorain Counties as a group to promote offshore wind in Lake Erie.

2010

Ohio Energy Gateway Fund created, which combines $40M in federal American Recovery and Reinvestment Act funds with state and private funds for investment in fuel cell, solar, wind, and energy storage industries in Ohio.

Northwestern Ohio is identified as Ohio's Solar Hub of Innovation and Opportunity by the state; receives a $250,000 state grant to help advertise the region as a hub and logical place for alternative energy investment.

2005-2012

Companies originated or expanded in the advanced energy sector in Ohio. Some examples: **Parker Hannifin**, **BASF** (acquired Novolyte Technologies), **LG Chem** (acquired Rolls Royce Fuel Cells), **GrafTech, Isofotón**, **Smashray** and **Tremont Electric**

the Republican-led legislature to build on those legacies to codify an inclusive electricity source standard to reduce Ohio's emissions. Current Governor John Kasich (R) has reaffirmed many of the tenets of past policies and broadened the electricity standard to include industrial waste heat recovery.

One of the earliest major milestones for Ohio's advanced energy economy was the creation of the Advanced Energy Fund in 1999 during the gubernatorial administration of Bob Taft (R) by the Republican-led legislature. This program supported renewable energy and energy efficiency projects across the state. Originally, the Advanced Energy Fund gained financing through a surcharge on ratepayer utility bills. In 2010, Ohio voters allowed the surcharge to expire, and the Fund now exists as a revolving loan fund for renewable energy and energy efficiency projects.

Another major market expansion action came as a result of the Ohio Senate Bill 221 (SB 221) in 2008, which established Ohio's Alternative Energy Portfolio Standard (AEPS) and Energy Efficiency Resources Standard (EERS). This legislation passed under the leadership of the Republican party with bipartisan support in the Ohio legislature, and Ted Strickland (D) as the governor. Ohio's AEPS and EERS established Ohio as not only a place to produce components and

perform research in advanced energy, it created predictable, mandatory end markets for local installation of these technologies as well.

The AEPS requires that Ohio's utilities generate 25 percent of total retail electricity from alternative energy sources by 2025. This standard is split into two main parts.

- 12.5 percent of Ohio's total retail electricity must be generated by renewable energy sources, including wind, solar, hydroelectric and biomass by 2024. This portion includes a mandatory solar-electric energy carve-out, which requires .05 percent of total electricity to be sourced from photovoltaic sources. Also, at least half of the renewable portion must be generated in Ohio, the equivalent of at least 6.25 percent of total electricity.

- 12.5 percent of total electricity must be sourced from what the legislation defines as advanced energy sources, which includes fuel cells, nuclear energy and clean coal by 2025 (DSIRE, 2012).

Although 12.5 percent sourced from renewables by 2024 is not an aggressive standard compared to many states' renewable portfolio standards today, it represented an ambitious goal from Ohio's 2007 baseline. Ohio's renewable energy (including hydroelectric) accounted for only 0.5 percent of total net electricity generated in 2007 (US EIA, 2012). The AEPS prompted Ohio's utility companies to incentivize deployment of advanced energy capacity, which resulted in a dramatic rise in installation of these technologies, especially in wind and solar. Ohio's cumulative wind energy capacity was more than 55 times higher in the second quarter of 2012 than in 2008 (DOE, 2012), and cumulative solar capacity was 35 times higher in the first quarter of 2012 than in 2008 (SEIA, 2012 and Sherwood, 2010). However, in 2012, the AEPS was modified to include industrial waste heat recovery as an eligible renewable technology, which may compete with installations of other renewable energy technology and lower demand going forward.

The Energy Efficiency Resource Standard (EERS) also helped build Ohio's advanced energy sector by spurring investments in energy efficiency technology, and encouraging weatherization of homes and facilities. The EERS mandates that investor owned utilities reduce demand for electricity by 22 percent by 2025 (DSIRE, 2012). Similar to the AEPS, as of 2012 industrial waste heat recovery is now included as an eligible technology in the EERS.

Subsequent state and local measures reinforced these major market expansions. In 2010, the state legislature passed a property tax exemption for utility scale and commercial renewable energy installations. At the local level, Ohio's largest cities (Cleveland, Columbus and Cincinnati) introduced tax abatement programs for energy efficient buildings (DSIRE, 2012). Each of these efforts further expanded local demand for associated technologies, such as high efficiency lighting and energy efficient appliances.

SEEDING INNOVATION

Purposeful actions by the state, universities and private sector have helped Ohio become a leader in advanced energy technology innovation, by leveraging Ohio's system of universities and research institutions. Although patent and research activity has occurred in this sector for several decades, recent collaborative initiatives accelerated activity and encouraged commercialization of new technologies.

One of the most instrumental policies to support the advanced energy sector has been the Ohio Third Frontier (OTF), which is a state program that promotes technology commercialization. Advanced energy technology was identified as a key strategic industry early on in the program, and every subsequent gubernatorial administration has invested in advanced energy technology projects, ranging from wind, advanced storage and biofuels technology companies to various testing facilities around the state.

Ohio's academic community has also worked together to forge connections among researchers, institutions and industry to promote innovation. Since 2007, the University Clean Energy Alliance of Ohio (UCEAO) has brought together researchers from Ohio's fifteen universities, as well as other public and private research facilities including NASA Glenn, to provide a platform for collaboration through annual events and working groups. UCEAO formed as a result of universities seeking additional collaboration in order to be competitive for grants in the advanced energy sector. Since its formation, the alliance has partnered with industry groups, various state agencies and the OTF to engage diverse stakeholders and promote innovation in advanced energy.

The Great Lakes Energy Institute (GLEI) based at Case Western Reserve University is another example of increased emphasis on cross-disciplinary, multi-stakeholder advanced energy research in the Northeastern Ohio region. GLEI has championed many initiatives, including providing technical assistance to emerging entrepreneurs, supporting private companies with special research projects, and connecting energy researchers in different departments on campus. GLEI formed in 2008, and since then, has quadrupled the amount of energy-related research occurring at the university (Anderson, 2012).

The Ohio Third Frontier program has helped take the fuel cell industry in Ohio to another level. It laid the foundation for the state's leadership in the industry by supporting applied R&D and thus commercialization; we also have the best quality fuel cell supply chain in the world, along with five fuel cell integrators developing technology to drive the industry forward.

Pat Valente, Executive Director of the Ohio Fuel Cell Coalition

The University Clean Energy Alliance of Ohio provides a platform for businesses and researchers to network; collaboration often grows organically and businesses are contacting universities directly for help with research and analysis.

Jane Harf, Director, University Clean Energy Alliance of Ohio

Wind Energy Research and Development Center - In 2011, Stark State College of Technology began construction on an $11.8 million testing and training facility for wind technology next to the Akron-Canton Airport in Northeastern Ohio. Stark State developed the project in collaboration with the Stark County Port Authority, Stark Development Board and Timken Company, which is a large manufacturing company that produces bearings and other components for wind turbines. Timken invested more than $6 million in the facility, and will use the space to test new products. It will also be used in wind technician training and hands-on research for students at the college. The project also received OTF funding and loans through Ohio's Advanced Energy Jobs Stimulus Program.

The Ohio Third Frontier (OTF) is a $2.3 billion state grant program that was enacted by the Ohio legislature in 2002 with bipartisan support. It provides funds to businesses, universities, nonprofit organizations and research centers to support the development and commercialization of promising Ohio-based startup companies and technologies. The program is strongly supported by voters and was re-funded through a ballot initiative in 2010.

Advanced energy has been an important strategic industry for OTF since its inception. For much of the past decade, OTF has devoted funds specifically to fuel cell and photovoltaic technology development, as well as advanced energy in general, which includes wind and advanced storage. The program funds advanced energy projects ranging from technology testing centers to startup company training programs.

OTF has invested roughly $140 million in advanced energy projects since 2002, nearly 12 percent of the program's total dispersed funds (Chagnon, 2012).

Key OTF investments in advanced energy innovation include:

- Stark State College of Technology's Fuel Cell Prototyping Center and Wind Energy Research and Commercialization Center
- Wright Center for Photovoltaics Innovation and Commercialization at the University of Toledo
- Start-up company accelerators like JumpStart in Northeastern Ohio

CAPTURING ECONOMIC BENEFITS

In order to help the region capture the benefits of the growing advanced energy economy, public and private stakeholders have worked collaboratively to align job creation and workforce development activities with recruiting and supporting companies. This alignment is a critical strategy to ensure that there are both job opportunities and trained workers in an area, and to capitalize on the auspicious business environment created from the stimulating demand and seeding innovation actions. Actions to capture the economic benefits include recruiting companies to locate and grow in the region, encouraging entrepreneurship and expansion of existing businesses and training a skilled advanced energy workforce. In Northeastern Ohio, chambers of commerce, industry organizations, local government and private businesses have been particularly successful in establishing a supportive business environment for advanced energy, developing and diversifying into new technologies, enhancing business networks and preparing the local workforce.

Northeastern Ohio's regional chamber of commerce, the Greater Cleveland Partnership (GCP), has been an influential voice of support for advanced energy, and a core regional development organization. The GCP has embraced an all-of-the-above advanced energy economy portfolio, reflecting its pragmatic goal to capture and create diverse economic benefits for the region through the development of a robust energy economy. The GCP represents over 15,000 members from the business community and local governments and works to connect its members with each other to cultivate a business-friendly environment (GCP, 2012). It has advocated in the state legislature for supportive policies towards all advanced energy subsectors, though focused on offshore wind development, nuclear energy and clean coal (GCP, 2011). The GCP also works closely with Cleveland Plus and Team NEO, the region's marketing and business recruiting organizations, which also identified advanced energy as one of the region's important strategic sectors, and worked to encourage local expansion of advanced energy businesses and draw new companies.

Isofotón North America's new Ohio manufacturing facility is an example of our commitment to the U.S. market, and benefits from the support of key partners, including Samsung, Mercedes AMG, Posco, as well as our highly productive R&D and economic development partnership with the University of Toledo, Ohio.

Ángel Luis Serrano, CEO, Isofotón (Beetz, 2012)

Ohio's development and diversification of local advanced energy businesses are supported by a variety of private and public organizations. NorTech is the GCP's economic development partner that promotes innovation, commercialization and emerging technology-based industry clusters, with a focus on advanced energy technology since 2009.

NorTech also collaborates with the Manufacturing Advocacy & Growth Network (MAGNET), Northeastern Ohio's manufacturing business development group, to help interested manufacturing companies expand into advanced energy end markets. MAGNET leads the Partnership for Regional Innovation Services to Manufacturers (PRISM) program, which helps businesses expand and improve their business models by offering technical assistance on lean manufacturing processes, product design and new markets. Roughly 20 to 25 percent of PRISM clients are related to the advanced energy sector (Schober, 2012). One client, Transformer Engineering, LLC (Trenco) is headquartered in Northeastern Ohio, and develops customized electromagnetic components for a variety of industries including wind and solar energy. Trenco participated in PRISM to learn lean manufacturing principles to improve processes and become more competitive (MAGNET, 2012).

Large Ohio-based companies have also taken a key leadership role in the sector by partnering on research and fueling demand for local suppliers, installers, engineers and affiliated services roles. In the wind industry, companies such as Timken Co., Owens Corning and Sherwin-Williams invested in local research and development, launched new products and forged partnerships with research institutions, suppliers and customers. Leading companies in fuel cells including GrafTech, LG Chem (formerly Rolls Royce Fuel Cells) and BASF Catalysts, have also prompted expansion of local research, workforce training and component supply chains. In Northwestern Ohio, First Solar served as an early anchor of a now substantial solar technology cluster, with several startup companies and a very active university research community.

In addition to homegrown development, the state of Ohio also works with regions to recruit advanced energy companies. One example is Spain-based Isofotón, a photovoltaic manufacturer which begins production in Northwestern Ohio with roughly 120 employees in November 2012.

As the Greater Cleveland Partnership's economic development partner specifically promoting advanced energy in the region, **NorTech** plays several key roles for the sector, including the following key examples.

First, it markets the region as an advanced energy hotspot for businesses and destination for investment. NorTech collaborated with the Manufacturing Advocacy & Growth Network (MAGNET) and other regional groups to secure a two million dollar federal White House Jobs and Innovation Accelerator Challenge grant in 2011 to push forward promising close-to-market advanced energy technology, and train the associated workforce. Northeastern Ohio was one of 20 regions in the nation to win.

Second, NorTech builds networks within and across subsectors to facilitate collaboration on regulatory and business improvements, as well as connect businesses across the value chain (suppliers, customers, project developers, financiers, etc). NorTech's advanced energy network directory contains more than 500 Northeastern Ohio businesses, organizations and research institutions, including over 170 that identify themselves as connected to the wind industry.

Third, NorTech drives strategic growth in the sector. It has also identified and "roadmapped" emerging advanced energy subsectors in Northeastern Ohio in collaboration with industry leaders, and compared Northeastern Ohio's strengths to other regions. Because resources are limited, the roadmaps help the region target support for specific subsectors that are most likely to succeed in the long term.

The Sherwin-Williams Company has developed industry leading coatings technologies at its Cleveland-based research and development center to support our nation's growing investment in alternative energy assets. With regional manufacturing strength in steel, fiberglass, resins, electronic control systems, and storage capabilities, Northeastern Ohio offers significant opportunities for partnerships in this fast growing market.

Christopher Connor, CEO, The Sherwin-Williams Company (Cleveland Plus, 2010)

Individual counties and cities have also taken steps to cultivate the local advanced energy economy. An example is Cleveland's home county, Cuyahoga, which created the Great Lakes Energy Development Task Force in 2006 to bring together stakeholders around a county energy strategy. This task force laid the groundwork for the Lake Erie Energy Development Corporation (LEEDCo), which now actively promotes an offshore wind pilot installation off the coast of Cleveland.

In addition to broad advanced energy sector efforts, subsector-specific organizations have deepened networks within specific advanced energy segments such as fuel cells and wind energy. The Ohio Fuel Cell Coalition, for example, formed in 2002 as an advocacy organization to educate policymakers about the fuel cell subsector and connect researchers, fuel cell integrators and suppliers across the state. The Great Lakes Wind Network (GLWN) is a similar organization that formed in 2007 to support the wind industry, and subsequently connected and mapped more than 300 wind-related businesses across the United States, as a means of helping Ohio manufacturers and businesses participate in the wind turbine supply chain.

In addition to building a favorable business environment, supporting company diversification and enhancing networks, preparing Ohio's workforce for advanced energy jobs has also been important to capturing economic benefits of the sector. Across Ohio, initiatives have been undertaken at the regional, academic and state levels to ensure that local workers are equipped for jobs in the advanced energy sectors.

Training programs at universities and colleges around the state are numerous, ranging from solar installer training to nuclear engineering programs. These have expanded rapidly in recent years to meet the wide range of skill levels required by the diverse advanced energy subsectors, such as Stark State's development of a Fuel Cell technician training program and University of Akron's College of Engineering research program in fuel cells and other advanced energy technologies. Private industry partners have also invested in cultivating a skilled workforce. For example, in 2011 wind developer Iberdrola Renewables donated $150,000 to an Ohio career center to create a wind technician training program (Bloomberg, 2011).

It is important for the academic world to play a role in economic development. As experts in our subject matter, we offer research capabilities to the community. We also are responsible to prepare students for careers in advanced energy, as they are our future entrepreneurs and innovators.

Dianne Anderson, Executive Director, Great Lakes Energy Institute

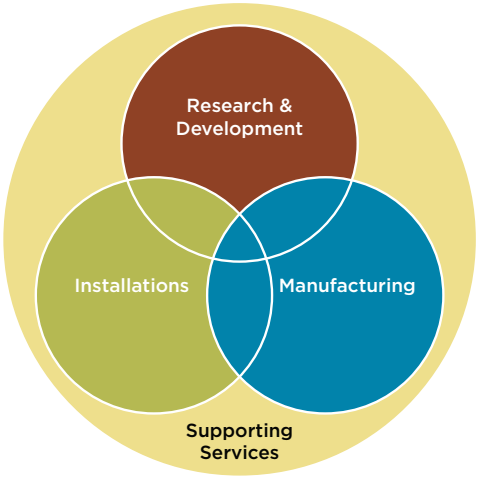
LEEDCo is a nonprofit development corporation working to build an offshore wind industry cluster of activity in Northeastern Ohio. LEEDCo was developed by public and private partners, including NorTech, four counties, the City of Cleveland, the Cleveland Foundation and the private developer Freshwater Wind, LLC. Researchers from universities and the private sector have also supported LEEDCo's efforts to evaluate offshore wind feasibility. The organization sought and received federal support for the project as well, including a U.S. Department of Energy award of $500,000 specifically to study cost reduction strategies for the pilot offshore project.

ADVANCED ENERGY ECONOMY CREATING RESULTS

The actions that Ohio stakeholders have taken to build a robust advanced energy economy have created impressive results. The region has emerged as a leader in advanced energy product manufacturing and innovation, and demonstrated a growing customer demand for advanced energy products and services.

OHIO'S ENERGY TECHNOLOGY VALUE CHAIN

FIGURE 1
ENERGY TECHNOLOGY VALUE CHAIN



The investment and work in Ohio to stimulate demand, seed innovation and capture economic benefits locally has paid dividends across the value chain. The segments of the value chain may exist independently, but provide a more robust economic cluster when all segments are fully developed and working together. Figure 1 illustrates the interaction of the energy technology value chain segments. Ohio now boasts companies that provide each of these activities:

Research & Development (R&D): R&D activities are carried out primarily by research institutions, such as federal laboratories, universities, or private company research divisions. R&D activities foster an environment centered on developing new products and processes so that the region can become a leader in innovation.

Manufacturing: Manufacturing involves production of a technology and includes companies throughout the supply chain, ranging from component suppliers to those assembling complete units for sale to consumers.

Installation: Installation of clean energy technologies, such as developing wind turbine farms, will occur in response to market demand. Companies involved in activities such as site assessment, logistics, transportation, and construction play an important role in installation.

Supporting Activities: A variety of other activities are critical to supporting clean energy technology. These supporting organizations facilitate interactions among players, provide funding, educate consumers, advocate for business friendly policies, or provide technical support and product maintenance services.

STRONG RESEARCH ACTIVITY

Ohio's research expertise has helped position it as a driver in the advanced energy sector for several decades. Ohio has fifteen research universities throughout the state, along with the NASA Glenn research facility, Battelle and the Air Force Research Laboratory at Wright-Patterson Air Force Base. Many private companies active in the advanced energy economy conduct research and development in Ohio as well, including Rockwell Automation, First Solar and Lockheed Martin, amongst many others. Collectively these entities have encouraged a thriving research community, as evidenced by the extensive patent registrations in the state, across a range of subsectors.

Ohio has exhibited remarkable growth in innovation over the past decade (Figure 2). Since 1996, total advanced energy patent registrations nearly doubled, increasing by 94 percent. Over the same period, Ohio's fuel cell, solar and electric vehicle patent registrations roughly doubled, and wind-related patents tripled. Ohio consistently ranks among the top ten states for patent registrations in the advanced energy sector, as shown in Table 1. In addition to being a leader in advanced energy patents overall, Ohio also remains strong within individual patent segments. Ohio climbed in state rankings for patent registrations in batteries, fuel cells and wind over the past decade (Table 2).

Capital investment is important to furthering research and development efforts in the advanced energy sector. Venture capital, private equity investments and majority stake acquisitions may infuse capital into an organization, or companies can increase their research capabilities and product offerings through acquisition of other companies. Private and corporate investments in advanced energy in Ohio have changed shape over the past ten years (Figure 3). In the early 2000s, venture funding lead investment deals in Ohio. However, as the sector matured, other forms of private equity and more merger and acquisition deals have been announced. Ohio's large manufacturing companies have been particularly active in acquisition of advanced energy product technologies since 2009, led by Eaton Corporation and Parker Hannifin.

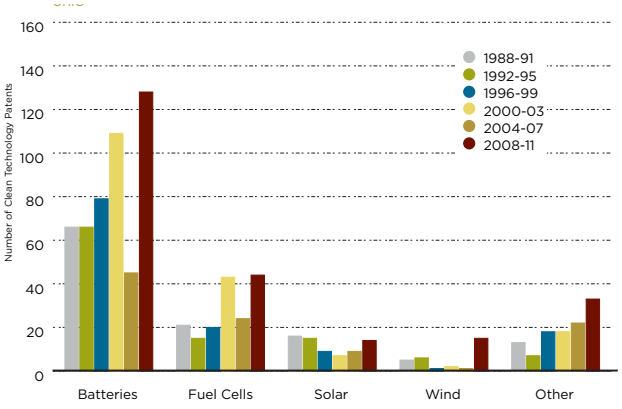
TABLE 1
TOTAL ADVANCED TECHNOLOGY ENERGY PATENTS
Top Ranking States in Patents Registered

	1996-99	2008-11
1	California	California
2	New York	New York
3	Michigan	Michigan
4	Texas	Texas
5	Michigan	Massachusetts
6	Massachusetts	Ohio
7	Ohio	Minnesota
8	Georgia	Pennsylvania
9	Florida	Illinois
10	Pennsylvania	Connecticut

TABLE 2
OHIO'S ADVANCED ENERGY PATENTS
National Rank in Patents Registered

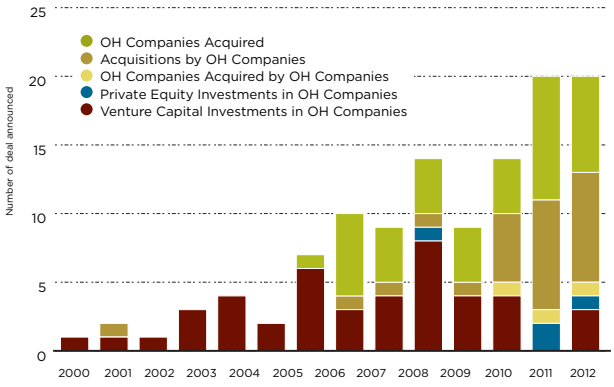
	1996-99	2008-11
Batteries	7	5
Fuel Cells	8	7
Wind	18	7
Solar	13	13
Electric Vehicles	3	3
Total Advanced Energy	7	6

FIGURE 2
ADVANCED ENERGY PATENTS TRENDS
BY TECHNOLOGY TYPE OVER TIME
OHIO



Note: Other includes Electric Vehicles, Hybrid Systems, Geothermal, Energy Infrastructure, Hydropower
Data Source: 1790 Analytics, Patents by Technology; USPTO Patent File
Analysis: Collaborative Economics

FIGURE 3
ADVANCED ENERGY INVESTMENTS AND MERGERS AND ACQUISITIONS
ANNOUNCED DEALS INVOLVING OHIO ADVANCED ENERGY FIRMS



Data Source: CleanTech Investments through August 6, 2012
Analysis: Collaborative Economics

Ohio's Fuel Cell Research Leading to Economic Expansion - Fuel cell research has been strong in Ohio for many decades, with universities like Case Western Reserve and Ohio State, and research institutions such as Battelle, along with many private companies leading the way. This research leadership has lead to extensive economic expansion, both through investments in research and component supply chains.

Investments in the sector gained momentum throughout the 2000s and into the present. The Ohio Third Frontier had a specific Fuel Cell Program from 2002 to 2011, which drew private and other public investment to the sector with a leverage ratio of 4:1 (Ohio Third Frontier, 2009). A recent corporate acquisition suggests the private sector is increasingly keen on investing in promising Ohio-based fuel cell technology. LG Chem acquired a majority stake in Rolls Royce Fuel Cells for $45 million in June 2012 (Bloomberg, 2012). The technology is still under development.

From 2004 to 2008, the number of businesses participating in the cluster expanded 75 percent (Ohio Third Frontier, 2009), many of them in the fuel cell supply chain. Pat Valente of the Ohio Fuel Cell Coalition notes, "there is not a fuel cell manufactured in the United States that does not have Ohio components."

MAINTAINING MANUFACTURING LEADERSHIP BY EXPANDING INTO ADVANCED ENERGY

Advanced energy manufacturing activity in Northeast Ohio has gained momentum in recent years, helping the state diversify its customer base to maintain its leadership role in manufacturing and attracting new firms. Ohio's manufacturing activity has grown from its historical strengths of specialized businesses, a skilled workforce, and key location for transportation logistics.

Because Ohio's advanced energy sector is diverse, the sector offers opportunities for workers with varying levels of education and skills. There are job concentrations in multiple subsectors, ranging from wind to batteries, as well as in various stages of production, including final products, machining, component parts, raw materials and many others. Both existing and startup businesses are opting to participate in the sector. The Advanced Energy Economy Institute conservatively estimated that more than 400 establishments and over 25,000 workers were linked to the Ohio advanced energy industry in 2010, across the multitude of subsectors and professions (AEEI, 2012).

For example, The Great Lakes Wind Network has gathered information about Ohio's wind suppliers and in November 2011 reported that 174 manufacturers around the state have sold their products into the wind market (Weston, 2011). The majority of those suppliers are machine shops and metal fabricators. Direct employment in the subsector was at least 640 workers in 2010, which includes only the employees of establishments that install, fabricate or develop technology for the wind industry as a major part of their business (AEEI, 2012). Estimates that include direct jobs and jobs farther down the supply chain are significantly higher. The American Wind Energy Association (AWEA) estimates that the wind industry employed over 5,000 people in 2011, the 4th highest state for wind employment in the United States (AWEA, 2012).

Diverse Advanced Energy Business Opportunities - Ohio's advanced energy establishments are coming from many parts of the manufacturing sector.

Several leaders in advanced energy subsectors have facilities located in Ohio. Manufacturing giants like Timken Co., Rockwell Automation, Parker Hannifin, Eaton Corporation and Owens Corning have developed or acquired products that serve advanced energy end markets like wind, smart grid and energy efficiency technology.

At the same time, many small to medium manufacturers have opted to diversify their product offerings into the sector. A study led by a Case Western Reserve University professor suggested that roughly 37 percent of small automotive suppliers attributed more than ten percent of their sales to "environmentally-friendly products"(Helper et al, 2011). This suggests that a solid portion of existing automotive supply chain businesses have diversified their customer base by participating in the advanced energy sector, even if not as their primary activity.

New companies have also emerged in Ohio, in some cases aided by regional early-stage business accelerators like Jumpstart or low-interest loans. Some examples are Catacel, which is commercializing fuel cell technology, Tremont Electric, which sells a movement-powered charger for electronic devices and Smashray, which offers high efficiency LED products.

In the fuel cell subsector there has been substantial growth in component manufacturing and integration of units. Between 2004 and 2008, the number of businesses and research institutions participating in the sector increased by 75 percent (OTF, 2009). At present, the Ohio Fuel Cell Coalition identifies roughly 40 Ohio manufacturers of fuel cell components or units and nearly 20 research and training facilities involved in the sector in the state (OFCC, 2012). Fuel cell industry employment in Ohio accounted for 9.8 percent of total national industry employment in 2010 (Valente, 2012).

The Solar Energy Industries Association (SEIA) noted that 55 solar manufacturing facilities are active in Ohio, and 160 businesses total when including installers, developers and other segments of the value chain (SEIA, 2012). Advanced Energy Economy Institute estimates that 1,350 people are employed by the photovoltaic industry in Ohio (AEEI, 2012). Although many of the manufacturing facilities are clustered around industry leaders First Solar and Xunlight in the Northwestern corner of the state, Energy Law and Policy Center's supply chain research suggests a strong presence of component part suppliers in the Northeastern part of Ohio as well (ELPC, 2011).

Energy storage is another key subsector in Northeastern Ohio, and accounted for approximately $105 million in revenues in 2009 (NorTech, 2011). There are roughly 27 organizations in the region involved in research, development and manufacturing. NorTech projects that Northeastern Ohio has potential become a domestic leader in emerging redox flow batteries and distributed energy storage systems technologies, because no other U.S. region has demonstrated comparable activity or strategic local assets (NorTech, 2011).

Ohio also has the highest number energy efficiency technology manufacturers in the Midwest. The state has 69 manufacturers of ENERGY STAR energy efficient products, including lighting and fans, home building materials and heating and cooling products, roughly double the number of businesses in neighboring Michigan (Energy Star, 2012).

Ohio's Robust Wind Energy Supply Chain - According to the Great Lakes Wind Network (GLWN), in 2011 Ohio had the highest number of wind supply chain manufacturers in the United States (Weston, 2011), many of them existing businesses that identified wind as a new opportunity. An example is Norlake Manufacturing Company, an electromagnetic component part supplier that worked with GLWN to improve efficiency and identify new customers. In 2011, Norlake leveraged GLWN's network to secure a contract with Ingeteam, an electrical systems company working with major companies in the wind industry, such as Siemens (WIRE-net, 2012).

Current market conditions for wind are worrisome for many Ohio suppliers given the uncertainty on the future of the federal wind Production Tax Credit (PTC). The PTC provides an income tax credit for the production of electricity from utility-scale wind turbines, and is set to expire at the end of 2012. As of October 2012, uncertainty about its renewal still loomed, contributing to a slowdown in the U.S. market demand for new wind turbines. According to a GLWN poll in the summer of 2012, there was "overarching pessimism" about the U.S. market among wind suppliers in light of the uncertainty around the PTC (GLWN, 2012). In Ohio, this has lead many companies that have previously worked in the wind supply chain to seek out opportunities in other industries.

Despite the uncertainty, Ohio's wind sector has laid infrastructure to branch out strongly into different parts of the wind energy technology value chain. In addition to the many Ohio firms with the capacity to participate in wind manufacturing, there is also strong growth in onshore wind installations, potential for Lake Erie offshore installations, and new technology testing centers including the Wind Energy Research and Commercialization Center at Case Western Reserve University in Cleveland to advance and improve wind technology.

Echogen Power Systems is an Akron-based company launched in 2007 that develops industrial waste heat recovery technology. In light of Ohio's shift to include waste heat recovery into its AEPS and EERS, Echogen is poised to feed a growing demand for this technology.

Echogen's signature product was conceived at the NASA's Jet Propulsion Laboratory. Echogen licensed NASA's patented absorption heat pump technology, and then developed additional patent-pending innovations to arrive at the company's Thermafficient® Waste Heat Engine. The product is in beta-testing, and a large Midwest utility installed a demonstration product in 2009.

As a promising start-up company, Echogen has tapped into Ohio's commercialization support infrastructure. JumpStart, the Greater Cleveland Partnership's business accelerator partner, has invested in the company since 2007.

INSTALLATIONS RAMPING UP

Ohio's natural resources are numerous, including untapped wind and solar assets, offering opportunities for installers, technicians, developers and financiers to participate in the advanced energy sector. Although installations have increased significantly in the past few years, many experts believe there is a large gap between Ohio's potential for installations and what has been deployed to date.

In recent years, there has been a significant increase in wind turbine installations, though Ohio remains behind leading states in installations. AWEA reported that as of the second quarter of 2012, over 400 megawatts of cumulative wind capacity has been installed in Ohio, nearly triple the prior year. Although a significant increase, Ohio still has considerable potential to expand installations. It continues to lag behind the national average of installed capacity, though it has a total onshore wind resource potential of 54,920 megawatts (AWEA, 2012).

Offshore wind installations in Lake Erie have also been discussed widely in Northeastern Ohio, with extensive planning around a pilot offshore wind project. Offshore winds are more consistent than onshore ones, and Lake Erie is shallower than the other Great Lakes, offering potential access to an emerging market in the United States.

Solar deployment has also increased substantially. SEIA estimates that Ohio has installed 49 megawatts of solar power, had the 14th highest installed solar capacity level in the nation as of the first quarter of 2012, and was the leading Midwestern state for solar installations (SEIA, 2012). Since 2010, the amount of solar power installed in Ohio has more than tripled (SEIA, 2012).

CONCLUSION

Ohio's advanced energy economy has grown as a result of multi-stakeholder actions to stimulate demand for advanced energy products and services, foster advanced energy innovation, and help the region capture economic benefits from the sector's growth. R&D activity, advanced energy manufacturing, and renewable energy installations have all substantially increased in Ohio. This progress demonstrates Ohio's success in creating a diverse, robust advanced energy economy and establishing the region as a leader in the advanced energy industry.

- **Ohio policymakers from both sides of the aisle have worked together to stimulate consumer demand for advanced energy products and services.** Ohio's advanced energy portfolio standard and energy efficiency resources standard encouraged customers to purchase advanced energy technology, and indicated that the state is supportive of the advanced energy industry.

- **Ohio is a hub for advanced energy innovation in many subsectors**. Research institutions and private companies are working together to develop advanced energy R&D and commercialize promising technology through programs such as the Ohio Third Frontier. These programs are helping innovative technologies reach the consumer market.

- **Ohio's stakeholders have taken action to capture the economic benefits of the advanced energy industry growth locally.** Organizations such as NorTech and the Great Lakes Wind Network have worked with companies to help them locate and grow in the region. These efforts have created job opportunities for workers across the skills-spectrum.

Ohio, like other states, is vulnerable to market uncertainties such as those surrounding the federal wind production tax credit. However, stakeholders are confident that diverse advanced energy sector activity will continue through collaboration and support from local, state, and federal stakeholders. The time is ripe for Ohio to lead advanced energy innovation and foster strong economic activity to support the advanced energy sector.

ACRONYMS

AWEA – American Wind Energy Association

AEPS – Advanced energy portfolio standard

EERS – Energy Efficiency Resources Standard

GCP – Greater Cleveland Partnership

GLEI – Great Lakes Energy Institute

GLWN – Great Lakes Wind Network

LEEDCo – Lake Erie Energy Development Corporation

MAGNET – Manufacturing Advocacy & Growth Ntwrk

MW – Megawatts

OTF – Ohio Third Frontier

PRISM – Partnership for Regional Innovation Services

PV – Photovoltaic

R&D – Research and Development

SEIA – Solar Energy Industries Association

UCEAO – University Clean Energy Alliance of Ohio

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- **Dave Karpinski**, NorTech
- **Michael McKay**, Ohio Third Frontier
- **John Schober**, Manufacturing Advocacy & Growth Network
- **Mark Shanahan**, Midwest Gateway Partners
- **Richard Stuebi**, Early Stage Partners
- **Pat Valente**, Ohio Fuel Cell Coalition
- **Ed Weston**, Great Lakes Wind Network

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