A Renewable America

POWERING UP OHIO

A REPORT ON THE ECONOMIC BENEFITS OF RENEWABLE ELECTRICITY DEVELOPMENT

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EXECUTIVE SUMMARY

Economic growth, energy independence, and new job creation are just a few of the many reasons that a significant majority of Americans consistently support developing renewable electricity.[1] Technological innovations continue to lower costs, and in recent years, several of the renewable electricity sectors have experienced significant growth, attracting billions in new private investment.

Solar, wind, hydroelectric power, biomass, geothermal and waste-to-energy already provide more than 13 percent of U.S. electricity, and renewables are capturing an increasing share of the power grid every year.[2] In 2013, the major renewable electricity technologies provided well over 527 million megawatt hours of electricity to the utility grid – enough to supply the equivalent of over 43 million average American homes.[3] The renewable electricity industries also represent an important source of American jobs, directly employing over half a million people.

This report examines the current and potential economic benefits from developing renewable electricity in Ohio. The Buckeye State's existing deployment of renewable energy is already delivering significant economic benefits, as the sector has attracted $3.7 billion in new investment to bring projects online through 2013.[4]

The state also has considerable untapped renewable electricity potential, and this analysis finds that developing these resources can deliver significant economic gains.

Renewable electricity is **driving economic growth** and creating jobs in communities across Ohio. The state is already home to more than 25,000 jobs in renewable power industries and energy efficiency.[5]

Renewable electricity offers an **affordable source of power**, as the cost of renewable electricity has declined dramatically in recent years. Renewable power purchase agreements are typically long-term, fixed cost agreements, helping protect ratepayers from price spikes associated with other energy sources. Wind power costs have fallen over 50 percent in the last five years.[6] Solar installation costs have fallen nearly 40 percent since 2010.[7]

A **reliable source of power**, renewable electricity can displace the most expensive, least efficient power sources on the utility grid.

While there are many examples of successful Ohio renewable electricity projects, this report features four case studies that are representative of the current and future potential for the state's renewable power industries. Projects by large institutions, including an off-site wind farm powering The Ohio State University, on-site solar arrays installed by General Motors, on-site wind turbines powering Honda North America, and a solar array installed at Pilkington Glass, are featured in greater detail below. The case studies demonstrate that renewable energy is delivering low cost, reliable electricity, and creating jobs, while also saving businesses and other institutions money.

This report also builds on a scenario from the U.S. Department of Energy's (DOE) 2012 *Renewable Electricity Futures* study, which demonstrates that the U.S. is able to reliably and affordably meet 80 percent of its electricity use by 2050.

In a **"High Renewables" scenario**, Ohio has the potential to deploy as much as 18,823 megawatts (MW) of additional installed renewable electricity capacity by 2030 - enough to supply over 40 percent of overall state electricity use. Our report finds that this deployment would:

- Create nearly 100,000 additional local jobs and over $5 billion more in wages and benefits during construction.
- After construction and during its operation, these new renewable energy projects would create 6,225 additional annual jobs and nearly $330 million in annual wages and benefits. The projects would generate $396 million in annual tax revenue and $52 million in annual land leasing revenue.

Even in a **"Low Renewables" scenario**, characterized by low growth in electricity demand and 'Business-As-Usual' with no new policies, about 4,335 MW of additional renewable electricity capacity would be added by 2030. These additions would be driven by Ohio's Renewable Portfolio Standard (RPS) and the increasing competitiveness of renewable energy technologies. It should be noted that this analysis does not account for the recent decision to "freeze" the Ohio RPS for two years. Our report finds that this deployment would:

- Create over 31,000 additional local jobs and $1.8 billion more in wages and benefits during construction.
- After construction and during operation, these new renewable electricity facilities would create nearly 2,400 annual jobs and $123 million in annual wages and benefits. The projects would generate $73 million in annual tax revenue and $9.6 million in annual land leasing revenue.

Finally, in June 2014, the U.S. Environmental Protection Agency (EPA) proposed a rule, known as the Clean Power Plan, to reduce carbon dioxide emissions from existing power plants. The rule aims to cut national emissions 30 percent from 2005 emissions by 2030, with an interim target of 25 percent on average between 2020 and 2029.[8] In developing emission reduction targets for each state, EPA assumed a certain level of renewable energy development, energy efficiency improvement, and increased natural gas use in each state.

EPA's proposed rule calls for Ohio to reduce carbon dioxide emissions by 28 percent by 2030.[9] Based on our "High Renewables" case, Ohio could produce four times as much renewable energy as projected by EPA.[10] Even in the "Low Renewables" case, Ohio would exceed the EPA assumption of renewable energy development given expected growth in a business-as-usual scenario. As demonstrated in greater detail below, these results imply that the state should be able to easily meet or exceed its emission reduction target.

OHIO RENEWABLE ENERGY SUCCESS STORIES

Ohio is home to hundreds of companies that either produce renewable electricity or supply the components to build and maintain new projects. These companies employ thousands of workers and contribute billions to the state's economy.

Ohio's existing deployment of renewable energy is already delivering significant economic benefits, as the sector has attracted $3.7 billion in new investment to bring projects online through 2013.[11]

This section features an overview of current renewable electricity generation in Ohio and includes four examples that illustrate the benefits of renewable power development. Projects by large institutions, including an off-site wind farm powering The Ohio State University, on-site solar arrays installed by General Motors, on-site wind turbines powering a Honda North America manufacturing facility, and a solar array installed at Pilkington Glass, are featured in greater detail below.

DRIVING ECONOMIC GROWTH

Renewable electricity is helping fuel Ohio's economy.

- The state is home to more than an estimated 25,000 jobs in renewable power industries and energy efficiency.[12]
- There are more than 200 in-state solar companies and suppliers, employing 3,800 people.[13] One quarter of these companies have manufacturing facilities in the state.
- There has been $890 million in capital investments in Ohio wind energy projects. These projects generate $3 million in annual land lease payments to farmers and landowners, and $3.6 million in annual taxes to schools and local government.[14]

AFFORDABLE SOURCE OF POWER

The cost of renewable electricity has declined dramatically in recent years. Renewable power purchase agreements are typically long-term, fixed cost agreements, helping to protect ratepayers from price spikes associated with other energy sources. In many cases, renewable electricity is now cost competitive with traditional electricity sources. For example:

- According to analysis by the Public Utilities Commission of Ohio, currently operating renewable resources in the state will save Ohio's investor-owned utilities $8.4 million in 2014. This figure increases to $30 million, if currently approved facilities begin operation.[15]
- According to analysis by a researcher at The Ohio State University, Ohio's Renewable Portfolio Standard and Energy Efficiency Resource Standard have saved ratepayers 1.4 percent in electricity bills since 2008.[16]
- Wind power costs have fallen over 50 percent in the last five years.[17]
- Solar installation costs have fallen nearly 40 percent since 2010.[18]

RELIABLE SOURCE OF POWER

Renewable electricity can displace the most expensive, least efficient power sources on the utility grid.

- Every year in Ohio, hydroelectric power generates enough electricity to power over 34,500 households.[19]

WIND POWER PRODUCING COST SAVINGS FOR THE OHIO STATE UNIVERSITY

> "We invested in this project for five reasons: one is economics, two is because it's the right thing to do, three is economics, four is because we are the most comprehensive energy research center in the world, and five is economics."
>
> ***SCOTT POTTER***
> *SENIOR ENERGY ADVISOR, OFFICE OF ENERGY AND ENVIRONMENT, THE OHIO STATE UNIVERSITY*

EXECUTIVE SUMMARY:

In late 2012, The Ohio State University (Ohio State) entered into a 20-year power purchase agreement with Iberdrola Renewables to purchase 50 megawatts of wind power from the Blue Creek Wind Farm in Ohio, the largest wind farm in the state. Originally estimated to save Ohio State $1 million per year in energy expenses, the wind project is exceeding expectations and has delivered more than $4.2 million in savings to date. On average, the wind farm provides 20-25 percent of the University's main campus annual electricity. However, for 1100 hours during the first twelve months of the contract, Ohio State was powered 100 percent by wind – on occasion during critical grid times – most notably during the 2014 polar vortex, keeping electricity costs in check during the storms.

BACKGROUND AND CONTEXT

Ohio State is among the largest universities in America and one of the largest employers in Ohio. In that spirit of superlatives, Ohio State is now powered by the largest wind farm in Ohio, located in Van Wert County, after making one of the single largest purchases of renewable energy by any university in the country.

Ohio State had an interest to acquire renewable energy as soon as it became economically competitive. In 2011, it was deemed an appropriate time to explore the opportunity, due to the alignment of market availability of in-state wind capacity and competitive pricing. Ohio State had three core objectives: (1) the project had to deliver competitively price Ohio-based energy; (2) at a scale of at least 25 megawatts (MW); and (3) over a long-term period. Ultimately, Iberdrola Renewables, developer of the Blue Creek wind farm, and AEP Energy, the competitive retail electricity supplier to Ohio State's main campus, collaborated with Ohio State to develop two unique power purchase agreements that together provided for the delivery of 50 MW of Blue Creek wind energy over a 20-year contract.

Ohio State is a member of the American College and University Presidents' Climate Commitment and has established a public commitment to be carbon neutral by 2050. The contract to purchase wind from Blue Creek reduced Ohio State's carbon footprint by approximately 13 percent.

COST SAVINGS

Ohio State's contract with Blue Creek Wind Farm is exceeding expectations and has delivered more than $4.2 million in savings to date.

RELIABLE POWER

The Blue Creek Wind Farm provides 20-25 percent of the university's annual electricity.

The Blue Creek Wind Farm provides 20-25 percent of Ohio State's total electricity. Photo courtesy of The Ohio State University.

MAKING THE INVESTMENT

The Ohio State wind power purchase agreement is a long-term, fixed cost agreement, helping to protect the university from price spikes associated with other energy sources. This long-term price stability is critical to a public institution with a $100 million utility bill and a fiduciary duty to state taxpayers.

Under the original terms of the contract, the university initially expected to save $1 million per year in energy expenses. The wind project is exceeding expectations and has delivered $4.2 million in savings to date between late 2011 and 2014. The savings were a combination of an upgrade to the wind capacity factor at Blue Creek and a change in the utility tariff rate and capacity charges issued by the Public Utilities Commission of Ohio.

Over the course of a year, the Blue Creek wind farm represents roughly 20-25 percent of Ohio State's annual electricity. At some non-peak load times, when the wind farm is at maximum production, it delivers enough power to account for 100 percent of the main campus electricity. For approximately 1100 hours during the first twelve months of the contract, Ohio State was powered 100 percent by wind – on occasion during critical grid times – most notably during the 2014 polar vortex, helping to keep Ohio State's energy costs in check. For the entire month of January 2014, approximately 44 percent of the Ohio State campus electricity needs were met by wind.

The partnership between Ohio State and Iberdrola Renewables allows for unique new research opportunities. Through the agreement, Ohio State researchers have access to extremely proprietary data from operational data to market data. The expectation is that this agreement will lead to multi-disciplinary research projects of mutual interest to Iberdrola, Ohio State, and other research partners on issues such as rotor blade design and optimization, ecological preservation and restoration, wind modeling, wind energy markets, and policy analysis.

TECHNOLOGY SPOTLIGHT: BLUE CREEK WIND FARM

Completed in 2012, Blue Creek Wind Farm is the single largest utility-scale wind project in Ohio, generating 304 MW of renewable electricity. Blue Creek represents a $600 million investment in Ohio. The project required 500 construction jobs. The project pays approximately $2 million in annual lease payments to local landowners and $2.7 million in annual payments to local taxing bodies. In Van Wert County, Iberdrola Renewables is the largest single taxpayer – larger than the next 11 businesses combined.[20] Blue Creek produces enough electricity to power 76,000 homes annually.

GENERAL MOTORS CHARGES UP IN OHIO WITH SOLAR POWER INVESTMENT

"We choose to invest in biomass, solar, and waste-to-energy because of the financial benefits to General Motors. We only purchase renewable energy that is on par or beats non-renewable energy options - that is the number one priority when we evaluate projects. Renewable energy delivers direct daily savings and offers us the ability to control energy costs in the future as a hedge. Investing in renewable energy offers an opportunity to educate our customers, employees and the community that these technologies are cost competitive with traditional power."

ROB THRELKELD
MANAGER, RENEWABLE ENERGY, GENERAL MOTORS

EXECUTIVE SUMMARY:

In 2013, General Motors (GM) flipped the switch on a 1.8 megawatt (MW) solar array at its Toledo Transmission plant. The project supported 25 construction jobs in the Toledo area and currently saves the facility $40,000 per year. The solar array was the largest rooftop array in Ohio at the time of its completion and provides enough renewable electricity to power 150 homes. This investment has been so successful that in 2014, GM chose to install a 2.2 MW solar array at its Lordstown plant, home of the Chevrolet Cruze. The company has set a corporate goal to promote the use of 125 MW of renewable energy by 2020 globally across it manufacturing facilities.

BACKGROUND AND CONTEXT

GM supports a diversified energy portfolio, as it does with its products. The company has set a corporate commitment to promote the use of 125 megawatts (MW) of renewable energy by 2020 globally across its manufacturing facilities. As of December 2014, GM has installed or sourced more than 100 MW of renewable energy globally – well on its way to meeting this ambitious target. In the United States, GM has installed 9.4 MW of solar across four states – California, Maryland, Michigan, and Ohio.

In Ohio, a total of nearly $9 million has been invested to support on-site renewable projects at GM facilities in the last two years.

In 2013, GM installed a 1.8 megawatt (MW) solar array at its Toledo Transmission plant. The solar array was the largest rooftop array in Ohio at the time of its completion and provides enough renewable electricity to power 150 homes. The Toledo solar array generates roughly three percent of the plant's overall electricity consumption. The Lordstown solar array is GM's fifth largest solar installation in the world. GM has installed electric-vehicle charging stations at its Lordstown and Parma facilities, locations to demonstrate how renewable energy can help power the next generation of cars.

MAKING THE INVESTMENT

GM partnered with a local solar developer, Solscient Energy, to install the 1.8 MW rooftop solar array in 2013 at its Toledo Transmission plant. Solscient owns and operates the array and sells all the generated power back to GM. This $4 million investment supported 25 jobs, including equipment, engineering, and construction positions. Using more than 20,000 First Solar modules, the Toledo solar array generates enough electricity to power 150 homes and was the largest rooftop solar array in Ohio at the time of its completion. The power purchase agreement was financed through low-interest bonds issued by the Toledo Port Authority designed to spur local renewable electricity investment and development. The Toledo solar array saves the GM facility an estimated $40,000 per year.

Capitalizing on the benefits of solar power in Ohio, GM completed a second major investment in renewable electricity, completing a 2.2 MW ground-mounted solar array at its Lordstown plant at the end of 2014. This 10 acre ground-mounted solar array sits on a previously abandoned parking lot and is visible to the millions who drive along the Ohio Turnpike each year and will serve to highlight GM's ongoing commitment to renewable electricity in the state. The $4.4 million investment is comprised of 8,500 panels. GM worked with Ohio manufacturer Northern States Metals of Youngstown to build the steel solar racks for the array and other local manufacturers, technicians, and electricians on the installation. GM owns and operates the Lordstown solar array and completed the construction of this solar array in less than 60 days.

COST SAVINGS

The solar array at the Toledo Transmission plant is currently saving the facility $40,000 a year in electricity costs.

LOCAL INVESTMENT

The Toledo solar project supported 25 construction jobs, and used panels from First Solar, an Ohio-based manufacturer.

The General Motors Toledo Transmission plant will save $40,000 annually as a result of its investment in a 1.8 MW rooftop solar array. Photo courtesy of General Motors.

WIND ENERGY POWERS HONDA TRANSMISSION PLANT IN RUSSELLS POINT

> "Installing wind power helps us meet our carbon reduction goals without hurting our bottom line. These two wind turbines enable us to achieve a 10 percent reduction in greenhouse gas emissions by 2020 (from 2010 levels), and meet a core environmental commitment for Honda operations."
>
> ***JOE WAUBEN***
> *OPERATIONS PLANNING DEPARTMENT, HONDA NORTH AMERICA*

EXECUTIVE SUMMARY:

The Honda Transmission plant in Russells Point annually receives up to 13 percent of its power from two on-site wind turbines, making it the first major automotive manufacturing facility in the U.S. to obtain a substantial amount of its electricity directly from wind turbines installed on-site. The installation of these two wind turbines required ten full-time construction workers.

BACKGROUND AND CONTEXT

Honda has a global commitment to reduce the environmental impact of its products and manufacturing operations around the world, by 2020. The goal includes a 30 percent reduction in carbon dioxide (CO2) emissions from Honda products and significant CO2 reductions from the company's plants and other operations, compared with 2000 levels.

As part of this commitment, Honda North America tasked all U.S. factories to complete a thorough evaluation of renewable energy potential. In 2012, the Russells Point factory completed an intensive review of renewable energy options and in 2014 became the first Honda North America facility to deploy a large-scale renewable energy resource.

The facility installed two General Electric 1.7 megawatt wind turbines, making it the first major automotive manufacturing facility in the U.S. to obtain a substantial amount of its electricity directly from wind turbines installed on-site. Originally projected to supply 10 percent of the plant's electricity per year, actual results show the wind turbines exceeded expectations in their first year of operation, supplying 13 percent of the plant's power needs. In one month, the turbines managed to provide over 30.6 percent of the plant's power requirements.[21]

RELIABLE POWER

The facility receives up to 13 percent of its power from two on-site wind turbines.

CARBON REDUCTIONS

The installation helps to reduce Honda's greenhouse gas emissions by 10 percent by 2020.

The Russells Point Honda factory receives 13 percent of its power from two on-site wind turbines. Photo courtesy of Honda North America.

MAKING THE INVESTMENT

The company secured support for the project from the local community, including Washington Township, which approved two zoning variances to construct the wind turbines.

Honda North America partnered with two companies to install this wind project. ConEdison Solutions owns the two wind turbines and Juhl Energy is the project developer tasked with operations and maintenance. The 20-year power purchase agreement offers certainty on the price of renewable energy the facility purchases.

The installation of these two wind turbines required ten full-time construction workers.

The turbine blades are approximately 160 feet long and are installed on 260-foot high towers on the property, which is best suited for a maximum capacity of two wind turbines.

TECHNOLOGY SPOTLIGHT: WIND IN OHIO

Ohio is ranked number one in the U.S. for wind-related manufacturing facilities, with over 60 facilities producing for the wind industry including blade, tower and turbine nacelle assembly. There have been over $890 million in capital investments in Ohio wind energy projects. These projects generate $3 million in annual land lease payments to farmers and landowners, and $3.6 million in annual taxes to schools and local government.[22]

PILKINGTON GLASS SUPPORTS OHIO'S SOLAR MANUFACTURING INDUSTRY

> "The Pilkington solar array project represents what Ohio companies can accomplish when they work together. We have a strong solar manufacturing industry in Ohio and the expertise necessary to bring these projects to life."
>
> ***STEVE GILES***
> *VICE PRESIDENT, ALTERNATIVE ENERGY, HULL & ASSOCIATES*

EXECUTIVE SUMMARY:

In 2011, Pilkington Glass, in partnership with renewable electricity project developer Hull & Associates, designed and installed a 250 kilowatt (kW), one-acre solar photovoltaic array at its facility in Northwood, Ohio. The solar array meets 12 percent of the facility's total electricity use, reducing annual electric consumption and emissions. The panels were manufactured using Pilkington glass and other Ohio manufactured components at the First Solar plant located in Perrysburg.

BACKGROUND AND CONTEXT

Pilkington Glass is an international glass manufacturing company. The site of the solar array at Pilkington Glass's Research and Development facility in Northwood, Ohio, takes advantage of the facility's previously undeveloped brownfield site. This 250 kW system, completed in 2011, represents a $1.5 million investment and provides 12 percent of facility electricity use. At the time of its construction, the solar array was the largest private sector, on-site renewable electricity project in Ohio.

This project was a unique opportunity in which various businesses throughout Ohio were able to work together on the design, development, manufacturing, installation and maintenance of this project.

The project development team consisted of energy experts including lawyers, engineers, architects, construction managers, accountants, finance specialists, and other specialists in the field.

MAKING THE INVESTMENT

Located on one acre of industrial land that was closed for nearly 30 years, the Pilkington solar array consists of 3,400 First Solar panels and uses Pilkington manufactured glass. First Solar manufactures all of its panels at its Perrysburg facility, near Toledo, Ohio. Hull & Associates financed part of the $1.5 million project cost with support from a $681,000 state and federal grant.

Based in Dublin, Ohio, Hull & Associates provides the critical expertise necessary to develop and design renewable electricity projects. With a team of energy experts, Hull & Associates helps mitigate risks and financial uncertainties for clients by owning and operating the systems for their customers and selling the generated electricity through long-term, fixed rate, power purchase agreements.

TECHNOLOGY SPOTLIGHT: SOLAR IN OHIO

Not only does solar provide a clean and reliable power supply, it is also cost competitive with other renewable energy sources and in some cases, conventional fuels. The cost per kWh for solar power has fallen dramatically in the last decade. Solar installation costs have fallen nearly 40 percent since 2010. There are more than 200 in-state solar companies and suppliers, employing 3,800 people.[23] One quarter of these companies have manufacturing facilities in the state. The First Solar manufacturing plant in Perrysburg recently announced plans to hire an additional 120 employees in order to meet increasing demand. The plant currently has 1,100 employees and manufactures two million panels a year.[24]

LOCAL PRODUCTION AND INVESTMENT

The $1.5 million project used Pilkington glass and components manufactured at other Ohio facilities.

PART OF GROWING OHIO SOLAR INDUSTRY

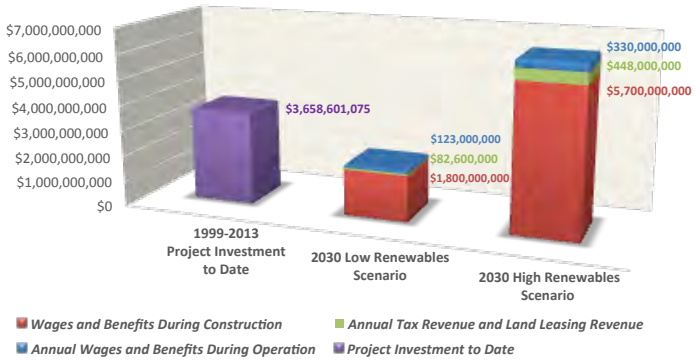
First Solar, which manufactured components on the project, produces 2 million panels a year, and has 1,100 employees.

The Pilkington Glass solar array provides 12 percent of total electricity.

OHIO'S RENEWABLE FUTURE

Our key findings are listed in the summary tables below (see Methodology section for data sources and methods used).

Current Investment and Potential Future Opportunities for Renewable Electricity in Ohio

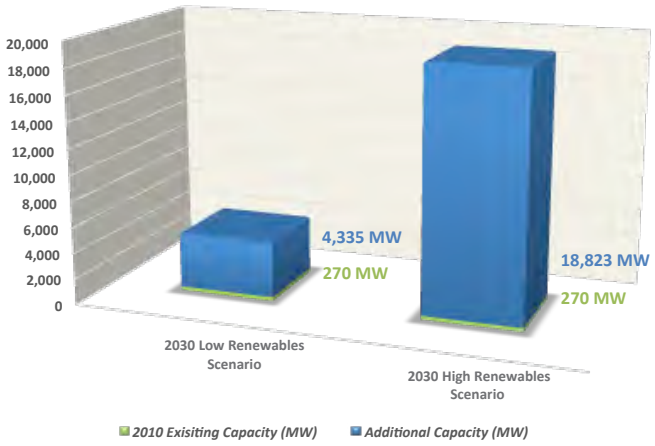


In a "High Renewables" scenario, Ohio has the potential to attract nearly $6 billion more in wages and benefits during construction, in addition to added annual land leasing and tax revenue during operation.

Jobs During Construction and Operation

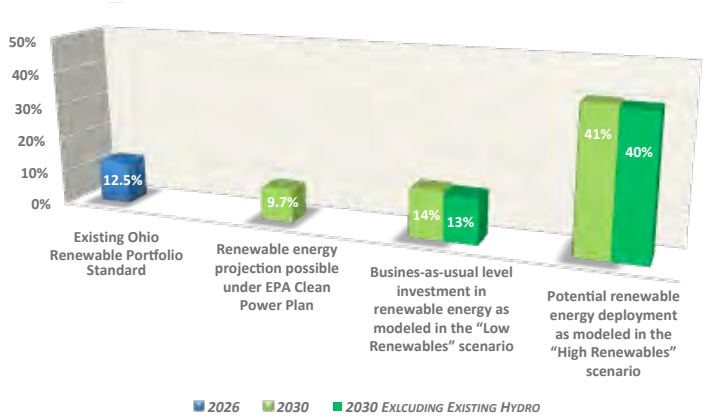
In a "High Renewables" scenario, Ohio has the potential to create nearly 100,000 additional local jobs during construction and 6,225 additional annual jobs committed to operations and maintenance.

Additional Installed Capacity (MW)



In a "High Renewables" scenario, Ohio has the potential to supply over 40 percent of overall state electricity use from renewable electricity.

Potential Renewable Electricity Capacity



In our "High Renewables" case, renewable energy development (excluding existing hydroelectric power) would produce nearly four times as much renewable energy as EPA projected.

OHIO'S RENEWABLE ELECTRICITY DEVELOPMENT POTENTIAL FAR EXCEEDS THE PROPOSED CLEAN POWER PLAN

The EPA Clean Power Plan calls for Ohio to reduce carbon dioxide emissions by 28 percent by 2030.[25] EPA based Ohio's target on cuts through the following measures:

- A 5.4 percent reduction through increased efficiency of coal plants
- A 4.2 percent reduction through increased use of low-emitting natural gas combined cycle plants where excess capacity is available
- An 8.7 percent reduction through the use of more zero-emitting power sources such as renewable energy and nuclear power, and
- A 9.4 percent reduction through energy efficiency improvements to reduce electricity demand.[26]

Ohio has a great deal of flexibility in developing its compliance plan, and may choose these or other carbon reduction strategies. A state could select a different balance among the approaches than EPA used to set the proposed emission reduction target.

Analysis from the Union of Concerned Scientists (UCS) demonstrates that even under a conservative growth scenario, states can achieve twice the renewable energy proposed by the EPA. According to UCS analysis, the Clean Power Plan does not sufficiently consider existing renewable energy deployment rates or the falling costs of renewable energy.[27]

Another recent analysis based on modeling by ICF International, a business management consulting firm, concludes that the EPA utilized outdated renewable energy cost considerations, including "levelized costs for both wind and solar energy that are 46 percent above current average costs".[28] The recent price drops in renewable energy will likely make the proposed rule less expensive to meet, and provide even greater opportunity for renewable energy development.

Our analysis shows that Ohio could meet the entire EPA emissions reduction target through the increased use of renewable energy.

Indeed, Ohio also has the potential for significant renewable electricity development far beyond what is likely under the proposed standards. Developing those resources would attract substantial investment to the state and create thousands of new jobs.

Renewable energy projection possible under EPA Clean Power Plan[29]	**9.7% by 2030**
Existing Ohio Renewable Portfolio Standard	**12.5% by 2026**
Business-as-usual level investment in renewable energy (excluding existing hydroelectric power) as modeled in the "Low Renewables" scenario	**13% by 2030**
Business-as-usual level investment in renewable energy as modeled in the "Low Renewables" scenario	**14% by 2030**
Potential renewable energy deployment (excluding existing hydroelectric power) as modeled in the "High Renewables" scenario	**40% by 2030**
Potential renewable energy deployment as modeled in the "High Renewables" scenario	**41% by 2030**

In the proposed Clean Power Plan, the EPA proposed a 2030 target emissions rate for each state. This target is based on EPA estimates of how each state could leverage a mix of measures, including adding new renewable electricity generation. States are not required to achieve EPA's renewable projections in order to comply with the proposed Clean Power Plan, or they may exceed them if cost-effective for the state. For Ohio, EPA projects 9.7 percent renewable energy generation under the proposed rule by 2030. The "High Renewables" scenario modeled here and in the NREL *Renewable Electricity Futures* study would exceed the EPA proposed target four-times over.[30]

In fact, Ohio already meets the EPA proposed target and is on track to exceed it before 2030, due to a state Renewable Portfolio Standard of 12.5 percent by 2026. In May of 2014, Ohio voted to freeze the multi-year renewable ramp-up schedule for two years and pushed back the final renewable benchmark of 12.5 percent from 2024 to 2026.

RESEARCH METHODOLOGY

PURPOSE OF STUDY

David Gardiner and Associates (DGA) conducted this study for the Wind Energy Foundation and the A Renewable America campaign to assess the overall opportunity for renewable energy-based economic development in Ohio.

.METHODOLOGY

DGA modeled the economic effects of a renewable electricity future in 2030 for Ohio based on two trajectories from the 2012 National Renewable Energy Laboratory (NREL) Renewable Electricity Futures (REF) study, the most comprehensive analysis of high-penetration renewable electricity in the United States to date.[31] That study involved a collaboration of more than 100 experts from 35 institutions representing national energy labs, academia, utilities, grid operators, industry, financial institutions, environmental groups and renewable energy businesses. It found that the United States could reliably meet at least 80 percent of its electricity needs from renewable energy resources by 2050, at a cost comparable with other scenarios for reducing harmful carbon dioxide (CO_2) and other power plant pollutants.

DGA features a "Low Renewables" and a "High Renewables" scenario based on updated 2014 results of the NREL Regional Energy Deployment System (ReEDS) model, completed by authors of the original REF study.[32]

- The "Low Renewables" scenario in this study is based on the "Low Demand Baseline" in the REF study. It assumes that electricity demand grows very slowly, and that no new renewable energy policies are enacted. Existing federal policies are assumed to expire as scheduled.
- The "High Renewables" scenario in this study is based on the REF "Core 80% RE scenario '80% RE-ITI'". It assumes that policies are enacted to achieve 49 percent of total contiguous U.S. electricity generation from renewable sources in 2030 and 80 percent in 2050, without specifying which of many policies could enable achieving that goal. It also assumes low electricity demand growth, and only incremental technology improvement (ITI) that reflects partial achievement of the future technical advancements that may be possible for each technology.

DGA did not utilize the scenario from REF that assumed a higher rate of "Evolutionary Technology Improvement", or scenarios that assumed "No Technology Improvement" or that assumed various potential constraints on renewable energy development, such as inadequate available renewable resources, inadequate transmission, or inadequate flexibility technologies, such as energy storage, needed to balance electricity demand with supply.[33] DGA also did not utilize REF scenarios with high energy demand, which would have produced higher levels of renewable energy development.

ReEDS calculates the mix of renewable energy and other technologies in each state that could meet the national renewable energy goals at the lowest total system cost.

DGA then calculated the economic development impacts of the five major renewable electricity technologies (biomass, geothermal, hydroelectric power, solar, and wind) using the NREL Jobs and Economic Development Impact (JEDI) model, with its generic default cost assumptions. JEDI was initially designed to estimate economic impacts of renewable energy to state economies, and later refined to focus on specific renewable energy projects. It includes both direct employment in the projects and their supply chains, and indirect and induced employment including wages and benefits spent in the state or local region.

The JEDI model is not a macroeconomic model, and does not calculate any offsetting reduction in employment in other parts of the economy, such as extracting fossil fuels. Many previous studies have found, however, that renewable energy technologies yield more employment per dollar or per megawatt than fossil fuel technologies, and thus lead to net increases in employment.[34]

DGA has also not calculated the economic benefits of other investments needed to enable the "High Renewables" scenario, such as upgrades to transmission and distribution systems, or the development of energy storage or other flexibility resources. ReEDS calculates that the "High Renewables" scenario would also be accompanied by 2,165 MW of electricity storage technologies by 2030.

While distributed generation solar photovoltaics are exogenous to the ReEDS model, which focuses primarily on utility-scale solar opportunities, the REF study utilized a separate model to represent rooftop solar PV deployment.

The REF study and JEDI model do not include specific estimates for waste-to-energy technology. We include an estimate of the technical potential for waste-to-energy expansion in the key findings section of the report, based on a recent study from Columbia University.[35] The growth assumptions for waste-to-energy in this report are based on the percent of municipal solid waste (MSW) used at waste-to-energy facilities in Europe (which process 25 percent of MSW using waste-to-energy facilities, as opposed to 7.6 percent in the United States). Unlike the ReEDS modeling for other technologies, that estimate is not based on any assessment of the economic competitiveness of waste-to-energy relative to other electricity generation technologies. Other studies, such as the U.S. Energy Information Administration Annual Energy Outlook, have found that significant expansion of waste to energy is unlikely under business-as-usual or with modest renewable energy or greenhouse gas reduction policies. Expanded use of waste-to-energy is possible under policies favorable to that technology, however.

APPENDIX

Total Renewable Electricity (Biomass, Hydroelectric, Solar, and Wind)	2030 High Renewables Scenario	2030 Low Renewables Scenario
Additional Installed Capacity	18,823 MW	4,335 MW
Local Jobs During Construction	99,967	31,140
Wages and Benefits During Construction	$5.7 billion	$1.8 billion
Annual Jobs During Operation	6,225	2,398
Annual Wages and Benefits During Operation	$330 million	$123 million
Annual Tax Revenue	$396 million	$73 million
Annual Land Leasing Revenue	$52 million	$9.6 million
Wind (8 MW in 2010)	2030 High Renewables Scenario	2030 Low Renewables Scenario
Additional Installed Capacity	17,337 MW	3,208 MW
Local Jobs During Construction	76,021	14,053
Wages and Benefits During Construction	$4.2 billion	$777 million
Annual Jobs During Operation	4,104	759
Annual Wages and Benefits During Operation	$224 million	$41 million
Annual Tax Revenue	$395 million	$73 million
Annual Land Leasing Revenue	$52 million	$9.6 million
Biomass (118 MW in 2010)	2030 High Renewables Scenario	2030 Low Renewables Scenario
Additional Installed Capacity	936 MW	735 MW
Local Jobs During Construction	4,955	3,890
Wages and Benefits During Construction	$407 million	$320 million
Annual Jobs During Operation	95	74
Annual Wages and Benefits During Operation	$1.1 million	$1.1 million
Solar (14.5 MW in 2010)	2030 High Renewables Scenario	2030 Low Renewables Scenario*
Additional Installed Capacity	411 MW	356 MW
Local Jobs During Construction	14,979	11,550
Wages and Benefits During Construction	$803 million	$618 million
Annual Jobs During Operation	124	97
Annual Wages and Benefits During Operation	$7.2 million	$5.6 million
Hydroelectric (130 MW in 2010)	2030 High Renewables Scenario	2030 Low Renewables Scenario
Additional Installed Capacity	139 MW	57 MW
Local Jobs During Construction	4,012	1,646
Wages and Benefits During Construction	$245 million	$100 million
Annual Jobs During Operation	70	28
Annual Wages and Benefits During Operation	$4.3 million	$1.7 million

Both scenarios estimate an extremely limited deployment of geothermal in Ohio.

***NREL assumed no growth for distributed generation solar PV in the Low Renewables scenario.**

Separately, this report also reviewed the technical potential for waste-to-energy in Ohio.

Waste-to-Energy (0 MW in 2014)	2030 Additional Capacity Potential
	218 MW

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Page 2: Wheat, Turbines and Dark Storm Clouds at Ohio Northern University in Ada, Ohio on Flickr
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Page 2: 103.73 kW solar array in Acton from the Massachusetts Clean Energy Center on Flickr
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ABOUT THE ORGANIZATIONS

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A project of the Wind Energy Foundation, a 501c3 nonprofit organization, *A Renewable America* provides education about the many benefits of American-made renewable electricity. A Renewable America raises public awareness of how each of the six major U.S. renewable electric technologies – biomass, geothermal, hydro, solar, waste-to-energy, and wind power – are already providing a substantial amount of clean, affordable, and reliable electricity.

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The Wind Energy Foundation is a 501c3 nonprofit organization dedicated to raising public awareness of wind as a clean, domestic energy source through communication, research, and education. The Foundation is also committed to supporting ongoing research that furthers the continued growth of wind energy.

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ENDNOTES

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9 U.S. EPA, *Clean Power Plan Toolbox for States,* November 24, 2014, http://www2.epa.gov/cleanpowerplantoolbox (This level may change in the final rule).

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