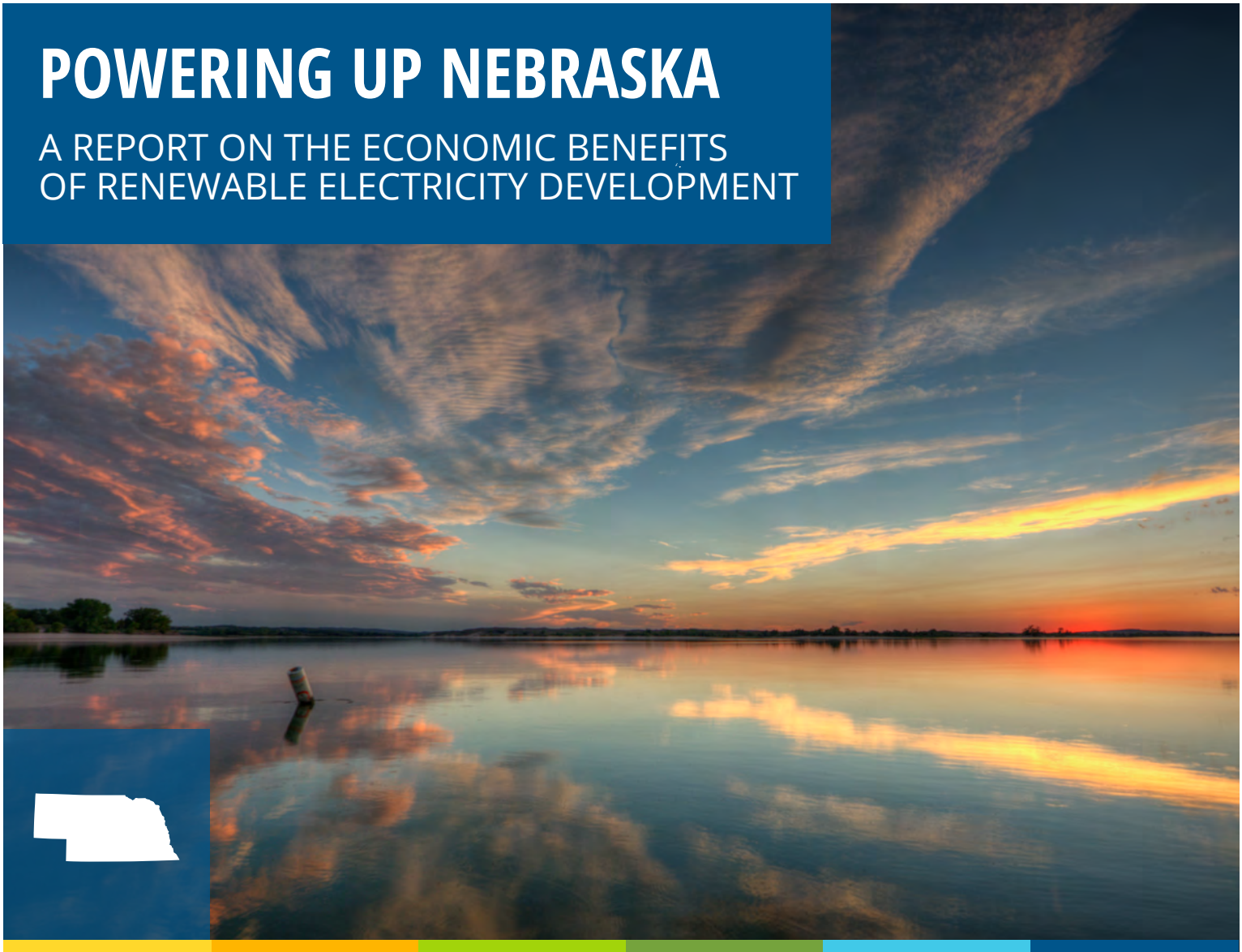
A Renewable America

POWERING UP NEBRASKA

A REPORT ON THE ECONOMIC BENEFITS OF RENEWABLE ELECTRICITY DEVELOPMENT



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PUBLISHED IN COLLABORATION WITH CREIGHTON UNIVERSITY

Creighton UNIVERSITY

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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 Nebraska. The Cornhusker State's existing deployment of renewable energy is already delivering significant economic benefits, as the sector has attracted over $1 billion in new investment to bring projects online through 2014.[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 Nebraska. The state is already home to more than 22,392 jobs in renewable power industries, energy efficiency, and other conservation services.[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 Nebraska 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. Utility-scale projects, including the Prairie Breeze Wind Energy Center, the Broken Bow wind farms in Custer County, and Laredo Ridge wind farm in Boone County, as well as renewable electricity projects that are powering Creighton University, are featured in greater detail below. The case studies demonstrate that renewable energy is delivering low cost, reliable electricity, while creating jobs and cost-savings for businesses and other institutions.

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 with renewable electricity.

In a **"High Renewables" scenario**, Nebraska has the potential to deploy as much as 6,225 megawatts (MW) of additional installed renewable electricity capacity by 2030 - enough to supply over 73 percent of overall state electricity use. Our report finds that this deployment would:

- Create 44,645 additional local jobs and over $2.5 billion more in wages and benefits during construction.
- After construction and during its operation, these new renewable energy projects would create over 1,140 additional annual jobs and over $64 million in annual wages and benefits. The projects would generate $49 million in annual tax revenue and $17 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 445 MW of additional renewable electricity capacity would be added by 2030. Our report finds that this deployment would:

- Create over 6,400 additional local jobs and $384 million more in wages and benefits during construction.
- After construction and during operation, these new renewable electricity facilities would create nearly 135 annual jobs and $8 million in annual wages and benefits.

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 Nebraska to reduce carbon dioxide emissions by 26 percent by 2030.[9] Based on our "High Renewables" case, Nebraska could produce more than six times the renewable energy projected by EPA.[10] As demonstrated in greater detail below, these results imply that the state should be able to easily meet its emission reduction target.

NEBRASKA RENEWABLE ENERGY SUCCESS STORIES

Nebraska is home to dozens 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 significantly to the state's economy.

Nebraska's existing deployment of renewable energy is already delivering significant economic benefits, as the sector has attracted over $1 billion in new investment to bring projects online through 2014.[11]

This section features an overview of current renewable electricity generation in Nebraska and includes four examples that illustrate the benefits of renewable power development. Utility-scale projects, including the Prairie Breeze Wind Energy Center, the Broken Bow wind farms in Custer County, and Laredo Ridge wind farm in Boone County, as well as renewable electricity projects that are powering Creighton University, are featured in greater detail below.

More than 8 percent of Nebraska electricity generation currently comes from renewable sources:[12]

- 735 MW of Wind Power
- 278 MW of Hydropower
- 10.9 MW of Biomass Power

DRIVING ECONOMIC GROWTH

Renewable electricity is helping fuel Nebraska's economy.

- The state is home to more 22,392 jobs in renewable power industries, energy efficiency, and other conservation services.[13]
- Existing wind projects generate $2.4 million in annual land lease payments to farmers and landowners.[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:

- Wind power saved electricity customers in Nebraska and surrounding states more than $1.2 billion in 2013.[15]
- Wind power costs have fallen over 50 percent in the last five years.[16]
- Solar installation costs have fallen nearly 40 percent since 2010.[17]

RELIABLE SOURCE OF POWER

Renewable electricity can displace the most expensive, least efficient power sources on the utility grid.
There is currently enough installed wind capacity to power 100,000 average homes in Nebraska per year.[18]

PRAIRIE BREEZE WIND ENERGY CENTER POWERS UP NEBRASKA

"When siting the project's turbines, we worked with local officials and the community to site them appropriately. We worked with landowners to find parcels of land that would host the turbines and help support local families and businesses. The Prairie Breeze operations and maintenance building is located in downtown Elgin, where our wind technicians work. Our employees and our investment in wind power will support the local economy for the long-term."

JAMES WILLIAMS
SENIOR MANAGER, BUSINESS DEVELOPMENT, INVENERGY

EXECUTIVE SUMMARY:

The 200-megawatt (MW) Prairie Breeze Wind Energy Center, located in Antelope, Boone, and Madison Counties, delivers an estimated $3 million annually in tax revenue, landowner payments, and staff salaries. The project supported 230 jobs during construction, and now employs 14 full-time operations and maintenance staff members. A 73.5 MW "second-phase" project expansion is currently under construction, with operations scheduled to begin in 2015.

BACKGROUND AND CONTEXT

Located approximately 100 miles northwest of Lincoln, the Prairie Breeze Wind Energy Center was developed - and is owned and operated - by leading clean energy company Invenergy. Electricity generated by the 200 MW project - enough to power 60,000 average homes - is sold to the Omaha Public Power District (OPPD) through a long-term agreement. This purchase allows the utility to surpass its voluntary goal of producing ten percent renewable energy for retail sales by 2020. In fact, OPPD expects its renewable energy portfolio to make up 30 percent of its generating portfolio by 2018.

Invenergy worked closely with many local stakeholders - including business owners, residents, government officials, and others – in developing its first energy generation facility in Nebraska, with the project receiving strong support from the community.

NEW TAX REVENUE, LAND LEASE PAYMENTS, AND WAGES

The Prairie Breeze Wind Energy Center delivers an estimated $3 million a year in tax revenue, payments to landowners, and job wages.

JOB CREATION

The project supported 230 construction jobs, and now employs a staff of 14 to operate and maintain the facility.

The 200 MW Prairie Breeze Wind Energy Center is the largest wind farm in Nebraska, delivering enough electricity to power 60,000 homes. Photo courtesy of Invenergy.

MAKING THE INVESTMENT

The Prairie Breeze Wind Energy Center utilizes 118 1.7 MW General Electric wind turbines, with each unit taking up less than one-third of an acre of land for participating project landowners.

Through property tax revenue, landowner payments, and staff salaries, the project contributes more than $3 million annually to its host community's economic development, an investment expected to last over the lifespan of the project.

Facility construction created more than 230 jobs. Currently, a staff of 14 operates and maintains the project.

SPOTLIGHT: WIND IN NEBRASKA

As of September 2014, Nebraska has more than 800 MW of installed wind power, enough capacity to power more than 166,000 homes.[19] The Nebraska Power Association estimates that the state will have close to 1,300 MW of installed wind power by 2018, spurring continued investment and job-growth and strengthening rural economies.[20]

CREIGHTON UNIVERSITY'S SOLAR AND WIND PROJECTS CREATE THE NEXT GENERATION IN ENERGY LEADERSHIP

> "At Creighton University we are preparing the next generation of renewable energy specialists. Through the use of our on-site solar arrays and wind turbines we are able to teach both the technical and the policy side of renewable energy deployment. Renewable energy will undoubtedly continue to grow as an industry, both in Nebraska and nationally. This initiative also helps offset our carbon footprint, saves us money, and helps us in our goal to create a more sustainable campus."
>
> ***LARRY HOPP***
> ***DIRECTOR OF THE ENERGY TECHNOLOGY PROGRAM, CREIGHTON UNIVERSITY***

EXECUTIVE SUMMARY:

Located in downtown Omaha, Creighton University began the process of retrofitting its campus with renewable energy resources in 2010. With 120 kilowatts (kW) of solar and wind power units now installed, Creighton's renewable energy systems serve as a working laboratory while also helping the school reach their sustainability and renewable electricity goals. The on-campus solar array is the largest in the state, and was the result of a collaborative $2.9 million investment from the U.S Department of Energy and Omaha Public Power District.

BACKGROUND AND CONTEXT

Creighton University is a large Jesuit institution located in downtown Omaha. Understanding the value and potential of an academic program focused on renewable energy, the University spearheaded a $2.9 million investment effort to integrate renewable power into the campus and its curriculum in 2010 with the development of an Energy Technology program, along with on-campus solar and wind installations. One of the four solar arrays installed on campus is the largest installation in the state to date, and by utilizing both technologies, the University has created real-life laboratories for undergraduate students.[21] Students are now able to gain valuable field expertise, conduct research on improving solar panel efficiency, experiment with different panel manufacturers, and explore options to improve sustainable energy awareness among students and faculty. The largest section of the solar array is an 85 kW unit that sits above a campus parking lot. Three additional solar arrays are spread across different locations around the campus. All power from these projects is used on-site to offset overall campus energy use.

Interested in the potential deployment of wind power within an urban environment, the Energy Technology Program also recently added four 1.2 kW vertical axis wind turbines. Vertical wind turbines are less than 20 feet tall and are typically located on city roofs. Seeking to expand their research capabilities and capacity, Creighton University is exploring options to add additional solar, wind, and bio energy systems to the campus renewable energy capacity.

MAKING THE INVESTMENT

The University inaugurated its ambitious new alternative energy program in 2010. The $2.9 million investment was split between solar and wind energy installations, and developing the program's curriculum and research & development capability. The program began with the help of a U.S Department of Energy grant to promote renewable energy education and research. Critical support was also provided by the Omaha Public Power District.

The four different solar arrays are comprised of panels from six different solar manufactures. Some panels are fixed, while others are tracking panels that continuously orient themselves towards the direction of the sun throughout the day. These solar-tracking arrays serve as teaching stations and provide students and researchers with real-time data that creates a hands-on experience with all aspects of the technology.

An Industry Advisory Council composed of utility and industry representatives from across the nation meets with Energy Technology students twice a year to provide advice on current trends within the industry. This involvement exposes students to career opportunities while helping to ensure the curriculum stays effective and relevant.

TECHNOLOGY SPOTLIGHT: SOLAR POWER

A recent steep decline in the cost of solar panels has spurred rapid growth in U.S. solar industry employment. Nearly 174,000 Americans now work in the industry and the sector has experienced more than 20 percent job growth for two years in a row.[22] The industry also expects solar jobs to continue to grow in 2015, predicting that more than 36,000 jobs will be added over the next 12 months.[23]

NEW INVESTMENT

Creighton University developed on-campus solar and wind projects with a $2.9 million investment from the U.S Department of Energy and Omaha Public Power District.

JOB TRAINING FOR THE FUTURE

Students gain valuable field expertise by working with the on-campus projects. The Creighton University curriculum provides an opportunity to conduct research on improving solar panel efficiency, experiment with different panel manufacturers, and explore options to improve sustainable energy awareness among students and faculty.

Creighton University has installed four solar arrays on campus, the largest solar installation in Nebraska. Photo courtesy of Creighton University.

BROKEN BOW WIND FARMS BRING MILLIONS IN INVESTMENT AND JOBS

"Nebraska is really in the buckle of the wind belt. We already have more than 800 MW of wind energy installed and are looking to add more each year. The Broken Bow wind projects were a huge benefit to our community. The developers that came to Custer County were very respectful. They listened to our residents and cared about the land and the results. Wind energy is a great investment in Nebraska now and for the future."

MELISSA GARCIA
PRESIDENT, CUSTER COUNTY ECONOMIC DEVELOPMENT CORPORATION

EXECUTIVE SUMMARY:

Broken Bow I and II wind farms in Custer County have created an estimated 400 construction jobs, 23 permanent positions, and driven more than $16 million in direct investment to this rural community. The project also generates $185,000 in annual tax revenue. With 155 megawatts (MW) of installed power, the Broken Bow wind farms generate enough electricity to power 55,000 homes.

BACKGROUND AND CONTEXT

Completed in 2010 and spread across 11,000 acres, the Broken Bow I project is comprised of 54 turbines and generates 80 MW of power. Following the success of this project, Broken Bow II was completed in 2014, representing a 75 MW expansion of 43 additional turbines. In total, these two wind farms generate enough electricity to power 55,000 homes.

Owned and operated by NRG Energy (Broken Bow I) and Sempra U.S. Gas & Power (Broken Bow II), both projects sell a portion of the 155 MW of power to the Nebraska Public Power District, which is working to increase its renewable energy portfolio to 10 percent of its energy supply by 2020. The projects also supply the Omaha Public Power District, Lincoln Electric System and the City of Grand Island with low-cost wind power.

NEW JOBS AND INVESTMENT

The Broken Bow wind farms in Custer County have created an estimated 400 construction jobs, 23 permanent positions, and driven more than $16 million in direct investment.

RELIABLE POWER

The projects provides 155 MW of electricity, enough to power 55,000 homes.

The Broken Bow wind farms generate enough renewable electricity to power 55,000 homes. Photo courtesy of Midwest Wind Energy.

MAKING THE INVESTMENT

For a small county such as Custer, with a population of slightly more 10,000 residents, wind power development has proven an indispensible economic opportunity. The Broken Bow projects have helped revive the rural community with high paying jobs, long-term land lease payments to farmers and ranchers, and a substantial contribution to the local and county tax base.

Broken Bow I required a $145 million investment, creating 100 local construction jobs in the area and $5.4 million in wages and salary earnings.[24] The wind farm currently has eight full-time employees.

At peak construction, Broken Bow II employed about 300 construction workers. During construction, the indirect and induced benefit to Custer County and neighboring counties is estimated to have been more than $2 million, with an additional $7 million in total output. The indirect and induced benefits during operation are almost $150,000 per year.

Together, the two wind farms support 23 full-time wind energy technicians, specialists and engineers. The median salary of a wind turbine technician was $46,000 in 2012 which is $12,000 higher than the median income for all other occupations in Nebraska.[25]

The Broken Bow wind farms contribute more than $185,000 annually in local tax revenue, helping to offset taxes for local residents. The increased tax base gives counties the opportunity to decrease the current property tax rate and reduce the overall burden on Nebraska's land and homeowners. It is also estimated that landowners receive around $540,000 per year in lease royalties from these projects.[26]

LAREDO RIDGE WIND FARM DELIVERS ECONOMIC BOOST TO BOONE COUNTY

"Wind energy has been a boon for Nebraska. These wind farms are delivering clean and renewable power, but they are also delivering millions of dollars in tax revenue, land lease payments, and direct and indirect spending."

DAVID LEVY, PARTNER, BAIRD HOLM LLP

EXECUTIVE SUMMARY:

The Laredo Ridge wind farm in Boone County represents a $200 million investment, creating 100 local construction jobs and $5.5 million in new wages. The project generated $300,000 in tax revenue during construction and now contributes more than $600,000 in annual property taxes to local governments and $5,000 per turbine to landowners, helping to revitalize this rural community. Completed in January 2011, the project generates 80 megawatts (MW) of clean, renewable electricity – enough power to meet the needs of 26,000 homes.

BACKGROUND AND CONTEXT

The Laredo Ridge wind farm project is located in Boone County, about three miles north of Petersburg, a city of 400 residents. Comprised of 54 1.5 MW GE turbines, and spread across 7,600 acres, the wind farm was designed and built by Midwest Wind Energy and is owned by Laredo Ridge Wind, an affiliate of Edison Mission Group. The project produces 80 MW of power, which is sold to the Nebraska Public Power District (NPPD) through a 20-year power purchase agreement. The NPPD has a voluntary commitment to increase it renewable energy portfolio to 10 percent of total energy supply by 2020.

MAKING THE INVESTMENT

The Laredo Ridge wind farm required a $200 million investment and created eight full-time positions in a town with less than 400 residents. During construction, Laredo Ridge supported almost 100 local construction jobs and created $5.5 million in wages and salary earnings with a total economic output of $13.4 million.[27] The wind farm now supports 14 full-time employees and generates more than $3 million in wages and total economic output.

Wind farms are also a substantial contributor to the state and local tax base. The Laredo Ridge wind farm generated $300,000 in tax revenue during construction and now contributes more than $600,000 in annual property taxes to local governments and $5,000 per turbine to landowners, helping to revitalize this rural community. These tax payments make the project one of the largest single contributors in Boone County, helping to offset taxes for local residents.

TECHNOLOGY SPOTLIGHT: WIND IN THE U.S.

The United States is the leading producer of wind energy worldwide. By the end of 2014, the U.S. had an installed wind capacity of approximately 62,300 MW.[28] On average, American wind power attracts $15 billion in private investment a year to the economy, while supporting 73,000 well-paying jobs over the last five years.[29] Growing American wind power has spurred the creation of a brand new domestic manufacturing sector with more than 500 factories in 43 states.

NEW INVESTMENT, JOB CREATION

The Laredo Ridge wind farm in Boone County required a $200 million investment, creating 100 local construction jobs and $5.5 million in new wages.

INCREASED LOCAL TAX REVENUE

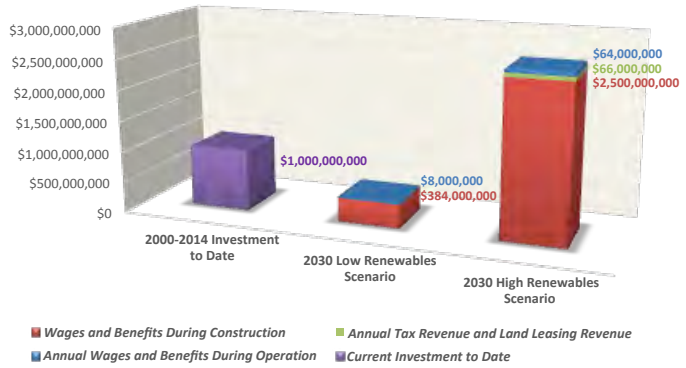
The project generated $300,000 in tax revenue during construction and now contributes more than $600,000 in annual property taxes to local governments and $5,000 per turbine to landowners.

The Laredo Ridge wind farm generates 80 MW of renewable electricity, enough power to meet the needs of 26,000 homes. Photo courtesy of Midwest Wind Energy.

NEBRASKA'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 Nebraska

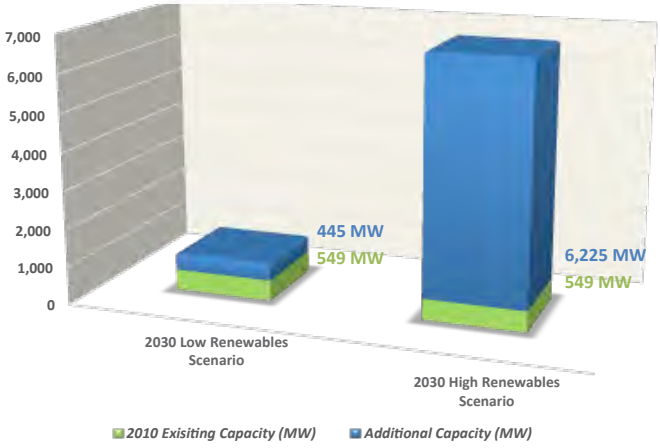


In a "High Renewables" scenario, Nebraska has the potential to attract an additional $2.5 billion in wages and benefits during new project construction in addition to $66 million in possible annual land leasing and tax revenue.

Jobs During Construction and Operation

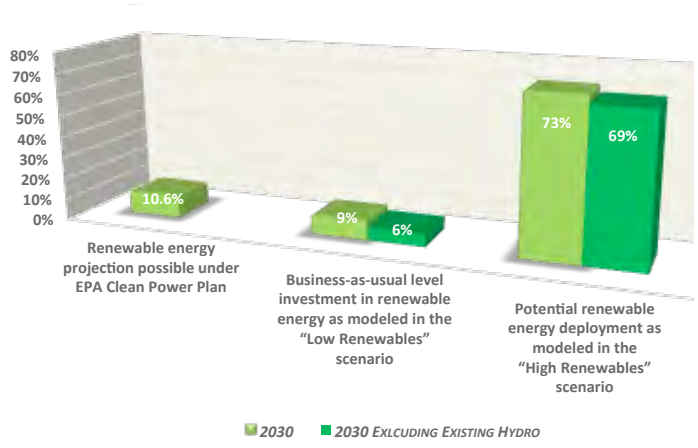
In a "High Renewables" scenario, Nebraska has the potential to create over 44,000 additional local jobs during construction and over 1,100 additional annual jobs committed to operations and maintenance.

Additional Installed Capacity (MW)



In a "High Renewables" scenario, Nebraska has the potential to supply over 73 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 six times as much renewable energy as EPA projected.

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

The EPA Clean Power Plan calls for Nebraska to reduce carbon dioxide emissions by 26 percent by 2030.[30] EPA based Nebraska's target on cuts through the following measures:

- A 6 percent reduction through increased efficiency of coal plants
- A 4.3 percent reduction through increased use of low-emitting natural gas combined cycle plants where excess capacity is available
- A 7.5 percent reduction through the use of more zero-emitting power sources such as renewable energy and nuclear power, and
- An 8.6 percent reduction through energy efficiency improvements to reduce electricity demand.[31]

Nebraska 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.[32]

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".[33] 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.

Nebraska has the potential for significant renewable electricity development far beyond what is projected 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[34]	**10.6% by 2030**
Business-as-usual level investment in renewable energy (excluding existing hydroelectric power) as modeled in the "Low Renewables" scenario	**6% by 2030**
Business-as-usual level investment in renewable energy as modeled in the "Low Renewables" scenario	**9% by 2030**
Potential renewable energy deployment (excluding existing hydroelectric power) as modeled in the "High Renewables" scenario	**69% by 2030**
Potential renewable energy deployment as modeled in the "High Renewables" scenario	**73% 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 Nebraska, EPA projects 10.6 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 by a factor of six.[35]

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 Nebraska.

METHODOLOGY

DGA modeled the economic effects of a renewable electricity future in 2030 for Nebraska 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.[36] 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.[37]

- 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.[38] 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.[39]

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.[40] 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 (Hydroelectric, Solar, and Wind)	2030 High Renewables Scenario	2030 Low Renewables Scenario
Additional Installed Capacity	6,225 MW	445 MW
Local Jobs During Construction	44,645	6,405
Wages and Benefits During Construction	$2.5 billion	$384 million
Annual Jobs During Operation	1,140	134
Annual Wages and Benefits During Operation	$64 million	$8 million
Annual Tax Revenue	$49 million	$1.2 million
Annual Land Leasing Revenue	$17 million	$0.7 million
Wind (213 MW in 2010)	2030 High Renewables Scenario	2030 Low Renewables Scenario
Additional Installed Capacity	5,557 MW	244 MW
Local Jobs During Construction	22,150	966
Wages and Benefits During Construction	$1.2 billion	$53 million
Annual Jobs During Operation	817	35
Annual Wages and Benefits During Operation	$45 million	$2 million
Annual Tax Revenue	$26 million	$1.2 million
Annual Land Leasing Revenue	$17 million	$0.7 million
Solar (0.04 MW in 2010)	2030 High Renewables Scenario	2030 Low Renewables Scenario
Additional Installed Capacity	135 MW	NA*
Local Jobs During Construction	8,040	NA*
Wages and Benefits During Construction	$418 million	NA*
Annual Jobs During Operation	60	NA*
Annual Wages and Benefits During Operation	$3.4 million	NA*
Annual Tax Revenue	$22.5 million	NA*
Hydroelectric (332 MW in 2010)	2030 High Renewables Scenario	2030 Low Renewables Scenario
Additional Installed Capacity	533 MW	200 MW
Local Jobs During Construction	14,454	5,439
Wages and Benefits During Construction	$878 million	$330 million
Annual Jobs During Operation	263	100
Annual Wages and Benefits During Operation	$16 million	$6 million

Both scenarios estimate an extremely limited deployment of biomass and geothermal in Nebraska.

***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 Nebraska.

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

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ABOUT THE ORGANIZATIONS

A RENEWABLE AMERICA

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.

For more information, visit www.arenewableamerica.org.

CREIGHTON UNIVERSITY

Creighton University is a comprehensive Catholic, Jesuit institution located in Omaha, Neb. Home to more than 7,500 undergraduate and graduate students with more than 700 full-time faculty in nine schools and colleges, Creighton affords an incomparable interprofessional education, bridging health professions programs with law, business and the arts and sciences. Since 2010, Creighton has been a leader in renewable energy in the State of Nebraska, erecting the largest solar array in the state, capable of generating up to 120 kW of clean, renewable power. The University has also created an undergraduate major in energy technology, with bachelor's degrees in sustainable energy and energy science.

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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.

For more information, visit www.windenergyfoundation.org.

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