A Renewable America

POWERING UP MINNESOTA

A REPORT ON THE ECONOMIC BENEFITS OF RENEWABLE ELECTRICITY DEVELOPMENT

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JANUARY 2015

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, hydropower, biomass, geothermal and waste-to-energy already provide more than 13 percent of the 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 Minnesota. The North Star State's existing deployment of renewable energy is already delivering significant economic benefits, as $11 billion has already been invested to bring new renewable energy projects online through 2013.

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 Minnesota. The state is already home to more than an estimated 15,300 jobs in renewable power industries, energy efficiency and other conservation services.[4]

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.[5] Solar installation costs have fallen nearly 40 percent since 2010.[6]

A **reliable source of power**, renewable electricity can displace the most expensive, least efficient power sources on the utility grid. In a recent letter from the Minnesota Department of Commerce, it was reported that "the addition of wind and solar generation to supply 40% of Minnesota annual electric retail sales can be reliably accommodated by the electric power system".[7]

While there are many examples of successful Minnesota 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 by Minnesota Power, and the Hennepin Energy Recovery Center, as well as projects by large institutions, including IKEA and the Minneapolis-St. Paul International Airport, 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, Minnesota has the potential to deploy as much as 6,884 megawatts of additional installed renewable electricity capacity by 2030 (enough to supply over 50 percent of overall state electricity use). Our report finds that this deployment would:

- Create almost 35,000 additional jobs and $2 billion more in wages and benefits during construction.
- After construction and during its operation, this new renewable energy would create more than 1,200 additional annual jobs, approximately $76 million in annual wages and benefits, and about $28 million in annual tax revenue and $20 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 852 MW of additional renewable electricity capacity would be added by 2030. These additions would be driven by Minnesota's Renewable Portfolio Standard (RPS) and the increasing competitiveness of renewable energy technologies. Our report finds that this deployment would:

- Create almost 3,600 jobs and over $215 million in wages and benefits during construction.
- After construction and during operation, these new renewable electricity facilities would create more than 130 annual jobs, approximately $8 million in annual wages and benefits, and about $3.6 million in annual tax revenue and $2 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 Minnesota to reduce carbon dioxide emissions by 41 percent by 2030.[9] In our "High Renewables" case, renewable energy development would exceed the EPA assumption by a factor of three.[10] Even in the "Low Renewables" case, Minnesota would exceed the EPA assumption of renewable energy development thanks largely to the Minnesota RPS. As demonstrated in greater detail below, these results imply that Minnesota should be able to easily meet or exceed its emission reduction target.

MINNESOTA RENEWABLE ENERGY SUCCESS STORIES

Minnesota 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.

According to a recent report prepared for the Minnesota Department of Employment and Economic Development, Department of Commerce, Department of Agriculture, and Environmental Quality Board, nearly $11 billion has been invested to bring renewable energy projects online between 2004 and 2013. Between 2010 and 2013, bioenergy, solar and wind industries delivered $3.1 billion in wages to Minnesota employees. [11]

This section features an overview of current renewable electricity generation in Minnesota and includes four examples that illustrate the benefits of renewable power development. Utility-scale projects by Minnesota Power and the Hennepin Energy Recovery Center, as well as projects by large institutions, including IKEA and the Minneapolis-St. Paul International Airport, are featured in greater detail below.

Nearly 20 percent of Minnesota's electricity generation currently comes from renewable sources[12]:

- 3,035 MW of Wind Power
- 15 MW of Solar Power
- 204 MW of Hydropower
- 367.8MW of Biomass
- 123.2 MW of Waste-to-Energy

DRIVING ECONOMIC GROWTH

Renewable electricity is helping fuel Minnesota's economy.

- The state is home to more than an estimated 15,300 jobs in renewable power industries, energy efficiency and other conservation services.[13]
- There are more than 100 in-state wind and solar companies and suppliers – varying from manufacturing and operations to construction and other support sectors.[14]
- Minnesota's waste-to-energy facilities contribute $191 million in economic activity to the state.[15]

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 costs have fallen over 50 percent in the last five years[16]
- *"Wind energy is a valuable, low-cost substitute for natural gas and other fuels right now"* – Dave Sparby, Xcel Energy's Minnesota-region CEO[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.

- In a recent letter from the Minnesota Department of Commerce to the Minnesota Public Utilities Commission, it was reported that "the addition of wind and solar generation to supply 40% of Minnesota annual electric retail sales can be reliably accommodated by the electric power system".[19]
- Minnesota hydropower provides over 75,000 homes with electricity each year.[20]

MINNESOTA POWER STAYS COMPETITIVE BY DELIVERING AFFORDABLE AND RELIABLE RENEWABLE ELECTRICITY

> "We've had great success by taking a holistic approach to power generation here at Minnesota Power. By integrating multiple sources of renewable energy not only are we able to meet our industrial customers needs but we are also working towards an ambitious and achievable goal of 33 percent renewable energy by 2030."
>
> ***BILL LIBRO,***
> *DIRECTOR, FEDERAL AFFAIRS, MINNESOTA POWER*

EXECUTIVE SUMMARY:

Minnesota Power invests in a variety of renewable electricity projects across the state, including biomass, hydropower, solar, and wind. As a result, Minnesota Power is expected to meet the state Renewable Energy Standard of 25 percent renewable electricity by 2025, ten years ahead of schedule.

BACKGROUND AND CONTEXT

Minnesota Power, a division of ALLETE, Inc., provides retail electric service to 144,000 customers and wholesale electric service to 16 municipalities, representing roughly 15 percent of total generation in the state. The utility relies on renewable electricity to deliver low-cost power generation. The primary driver for Minnesota Power's renewable electricity program is Minnesota's Renewable Electricity Standard, which requires utilities to produce 25 percent of their electricity from renewables, of which 1.5 percent must be from solar. By wisely managing many different renewable sources in Minnesota and throughout the region, Minnesota Power is on track to meet its renewable energy goals while keeping costs low and supply constant. As of 2013, Minnesota Power has deployed nearly 20 percent renewable electricity and is expected to meet the state renewable target 10 years ahead of schedule.

MAKING THE INVESTMENT

To meet the standard, Minnesota Power is pursuing all forms of renewable electricity - biomass, hydroelectric power, solar, and wind.

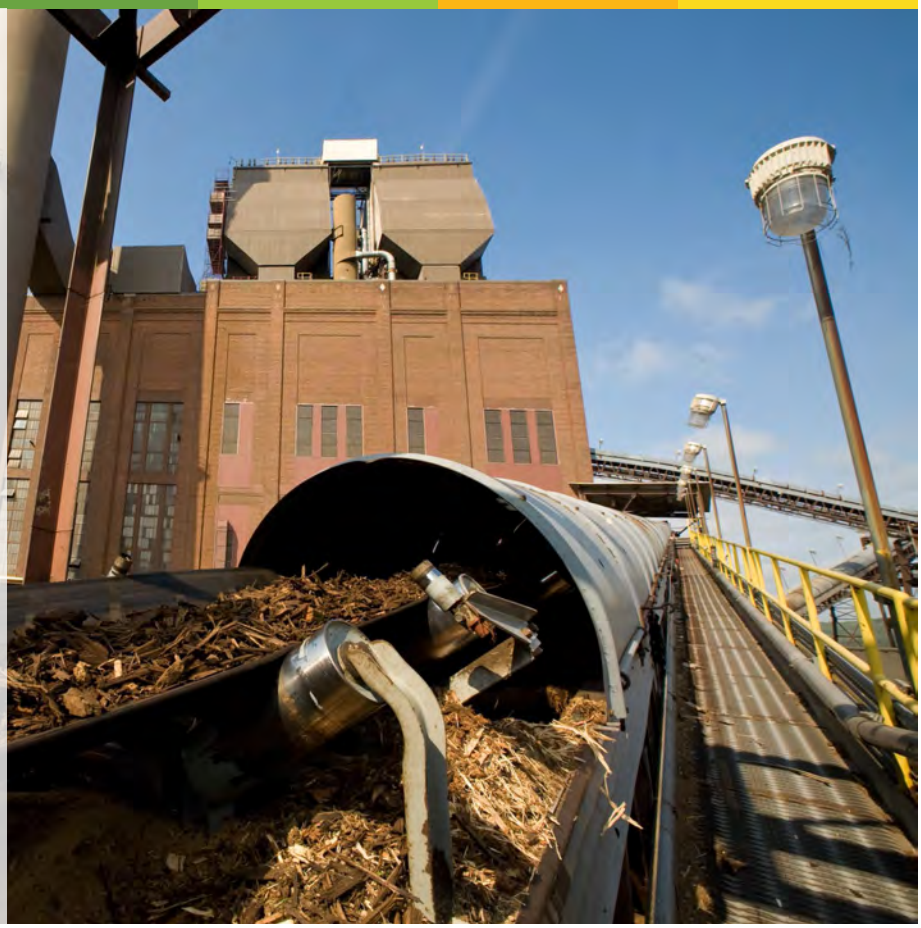
- **Wind**. In 2008, Minnesota Power built the Taconite Ridge Wind Energy Center, a 25 megawatt facility and the first commercial wind farm in northeastern Minnesota.
- **Hydropower**. Minnesota Power produces 115 megawatts of hydroelectric power across 11 locations in Minnesota, which represents the largest hydroelectric system in the state. Minnesota Power recently installed a more efficient turbine at the 12MW Fond du Lac Hydro Station on the St. Louis River.
- **Biomass**. Minnesota also has great biomass potential. Partnering with several industrial clients, Minnesota Power owns and operates three biomass facilities in the state, totaling over 100 megawatts of renewable energy generation. The 26.5 megawatt biomass facility in Grand Rapids is powered, in part, by wood waste generated on site. First opened in 1980,

NEW INVESTMENT

Minnesota Power is partnering with the Minnesota National Guard on a $25 million solar project that will meet 30 percent of Camp Ripley's energy needs.

DIVERSIFYING THE UTILITY GRID

By investing in a variety of renewable sources of electricity, Minnesota Power is keeping costs low for its consumers, and ensuring reliable service.



A 51 megawatt biomass facility in Duluth, Minnesota. Photo courtesy of Minnesota Power

this facility consumes almost 200,000 tons of waste wood material a year, supporting local jobs in the forest industry. Other Minnesota Power biomass facilities include a 23 megawatt facility in Cloquet and the 51 megawatt Hibbard Renewable Energy Center which uses biomass to produce steam for a pulp and paper mill. Biomass systems allow Minnesota Power customers to access affordable, base-load renewable energy year-round.

- **Solar**. Minnesota Power will partner with the Minnesota National Guard to build a 10 megawatt solar array at Camp Ripley in Little Falls (roughly enough energy to power 2,000 homes). This $25 million project will supply the base with 30 percent of on-site energy needs and will be the single largest solar array in the state once completed in 2015.

Minnesota Power also owns 500 megawatts of wind power in North Dakota and plans to import 383 megawatts of hydroelectric power from Manitoba, Canada beginning in 2030 via a proposed 500 kV transmission line. The North Dakota wind farms and Canadian hydroelectric power projects directly benefit Minnesota Power's customers by providing reliable and low-cost electricity year round.

HENNEPIN ENERGY RECOVERY CENTER POWERS TARGET FIELD IN MINNEAPOLIS

"The Hennepin Energy Recovery Center is located in downtown Minneapolis, across from Target Field. We are able to take the waste generated at Target Field and convert it into energy for them to use. This facility meets extremely high air quality and emissions standards and generates positive environmental and economic benefits for the county."

CARL MICHAUD
DIRECTOR,
HENNEPIN COUNTY ENVIRONMENTAL SERVICES

EXECUTIVE SUMMARY:

The Hennepin Energy Recovery Center, a waste-to-energy facility, generates more than $9 million in annual revenue for Hennepin County and supports 50 full-time employees ranging from repair and maintenance technicians to plant operators. The facility produces 39.6 megawatts of renewable electricity - enough to power 25,000 average Minnesota homes – and diverts an estimated 365,000 tons of waste from landfills.

BACKGROUND AND CONTEXT

The Hennepin Energy Recovery Center (HERC) began commercial operation in 1989, to serve the solid waste management needs of the largest county in Minnesota. Hennepin County owns, and Covanta Energy maintains and operates, the facility. The facility processes about 365,000 tons of garbage a year, nearly half of the garbage generated in Hennepin County.

HERC uses trash to create reliable, renewable electricity that is sold to Xcel Energy and steam that heats the downtown district energy system and the Target Field ballpark, home of the Minnesota Twins.

Waste-to-energy is classified by the U.S. EPA as a net greenhouse gas reducer over a landfill, as waste-to-energy facilities do not generate methane.[21] Energy generated at waste-to-energy facilities offset the need to produce energy at power plants that use fossil fuels. One ton of trash processed at HERC creates electricity to run a house for three weeks. If buried in a landfill, that same waste would only create electricity to run a house for three days.

MAKING THE INVESTMENT

The Hennepin County project was financed through municipal bonds which were paid back through revenue generated from the sale of electricity to Xcel Energy and disposal fees paid by waste collectors.

HERC provides significant economic value in the community. In addition to the revenue generated by the facility, HERC provides 50 stable, long-term, well-paying jobs, ranging from repair and maintenance technicians to plant operators.

Processing waste for energy at HERC is just one part of the county's integrated waste management system that emphasizes waste prevention, reuse, recycling and composting. About 45 percent of the waste generated in the county is recycled, higher than the national average.[22]

TECHNOLOGY SPOTLIGHT: WASTE TO ENERGY

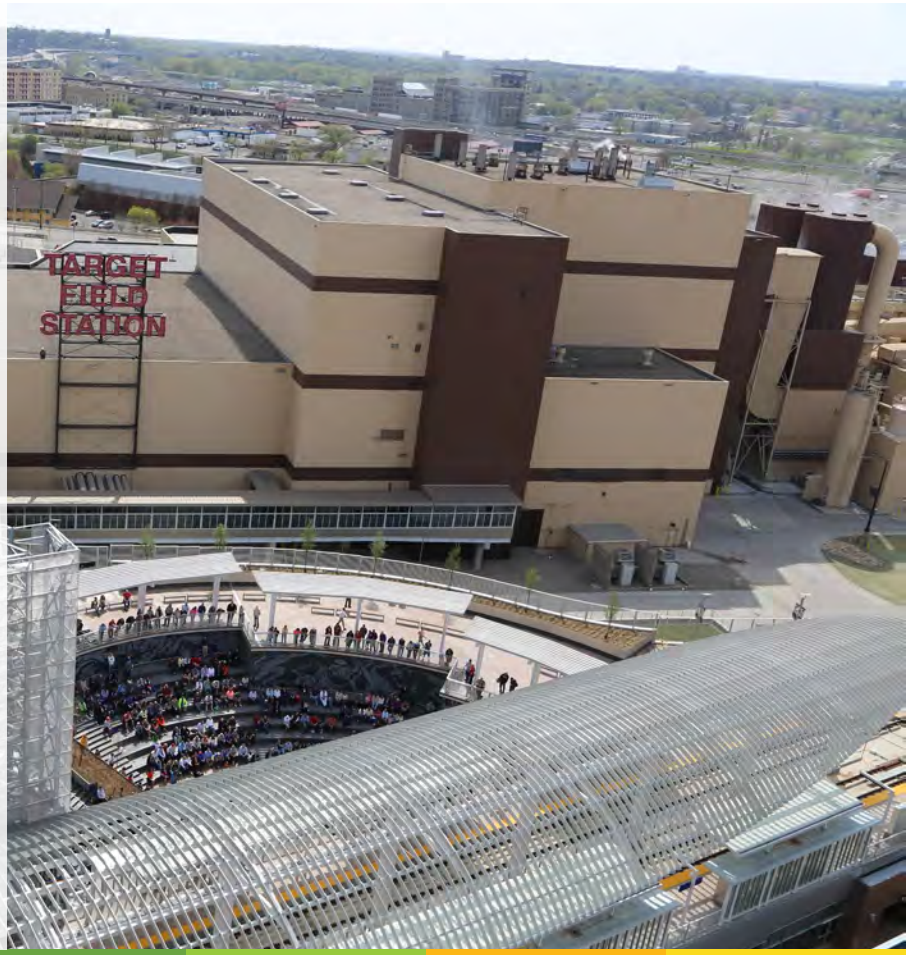
Nationwide, the waste-to-energy sector employs approximately 5,400 Americans with direct labor earnings estimated at $459 million in wages, salaries, and benefits. Waste-to-energy generated approximately 14.5 million megawatt hours of electricity in 2012, enough to power 1.3 million average U.S. homes.[23] It is estimated that a new waste-to-energy facility built today generates approximately $1 billion in total direct and indirect spending with an estimated 700 to 1,000 construction jobs created over the average two and a half year construction time span.[24]

INCREASING LOCAL REVENUE

The Hennepin Energy Recovery Center provides Hennepin County with more than $9 million in annual revenue.

REDUCING LANDFILL DISPOSAL

By diverting an estimated 365,000 tons of waste from landfills, the Energy Recovery Center provides reliable power and leaves the county land for other uses.



The Hennepin Energy Recovery Center generates more than $9 million in annual revenue for Hennepin County and produces 39.6 megawatts of renewable electricity. Photo courtesy of Covanta.

IKEA SOLAR INVESTMENT SHINING BRIGHTLY BENEATH MINNESOTA SKIES

"IKEA has a strong commitment to sustainability and we appreciate that there are ways to be sustainable that are economically beneficial to our company. All IKEA solar investments have been evaluated and approved based on their financial return."

JOSEPH ROTH
PUBLIC AFFAIRS MANAGER, IKEA

EXECUTIVE SUMMARY:

IKEA plugged in the largest rooftop solar installation in Minnesota in 2012, highlighting the company's commitment to "produce more renewable energy than the energy we consume worldwide by 2020." The 128,000-square-foot solar photovoltaic array consists of a 1,014 kilowatt system, built with 4,316 solar panels (enough to power the equivalent of 100 average homes). It will reduce IKEA's annual carbon dioxide emissions by over 800 tons. The solar installation created 15 full-time construction jobs.

BACKGROUND AND CONTEXT

IKEA, the Swedish-based home furnishing retailer, has recently announced a 100 percent renewable energy goal across its entire global fleet of stores. In just the last three years, IKEA has installed solar panels at 40 of its U.S. retail locations and distribution centers. Solar power offers an economically viable way to reduce electricity load, save money, and provide long-term affordable power.

All IKEA solar projects are evaluated and approved based on a companywide payback analysis to insure these investments deliver a significant return. IKEA owns and operates each of its solar photovoltaic energy systems, as opposed to a solar lease or a power purchase agreement.

RELIABLE POWER

The IKEA solar installation offsets more than 20 percent of overall store energy usage.

CARBON REDUCTIONS

The installation also reduces IKEA's carbon dioxide footprint by over 800 tons.

One megawatt solar array covers the entire roof of IKEA's Bloomington store. Photo courtesy of IKEA.

MAKING THE INVESTMENT

The 1 megawatt system at the Bloomington location was the 31st completed solar project for IKEA in 2012 and at the time of construction was the largest single rooftop solar installation in Minnesota. IKEA contracted with SoCore Energy, a national commercial solar energy developer, to develop this customized solar power system for the Bloomington location. The installation of the IKEA solar array created 15 full-time jobs. The Bloomington solar array offsets more than 20 percent of overall store energy usage. Xcel Energy, the utility provider, pays IKEA a "capacity payment" for the company's solar investment due to the fact that it offsets the electricity costs of all other consumers during peak hours. The IKEA Bloomington solar array will produce approximately 1,161,328 kWh of clean electricity annually, reducing IKEA's carbon dioxide footprint by over 800 tons.

RESULTS

With solar installations at almost 90 percent of their U.S. store and distribution center locations, IKEA is well on its way to achieve 100 percent renewable energy by 2020. Realizing significant cost reductions, IKEA continues to prove that solar is a boost to the corporate bottom line.

SOLAR POWER TAKES OFF AT MINNEAPOLIS-ST. PAUL INTERNATIONAL AIRPORT

> "This is a financially attractive project that also lessens our power consumption off the grid and reduces carbon emissions. The Minneapolis-St. Paul International Airport has a strong heritage of environmental stewardship, and we are always looking for ways to enhance the sustainable development and operation of the airport."
>
> ***DENNIS PROBST***
> *EXECUTIVE VICE PRESIDENT*
> *METROPOLITAN AIRPORT COMMISSION*

EXECUTIVE SUMMARY:

In October 2014, the Minneapolis-St. Paul International Airport broke ground on the largest solar array in the state. The 3-megawatt system is projected to generate more than $10 million of net present value cash flow over 30 years, create 250 jobs and supply more than 20 percent of the facility's total electricity usage.

BACKGROUND AND CONTEXT

Solar power is taking off in Minnesota. In October 2014 the Metropolitan Airports Commission (MAC), announced plans to build a 3-megawatt solar array system atop long-term parking facilities. "This ambitious new solar energy project will create jobs, reduce the airport's carbon footprint and save the Airports Commission hundreds of thousands of dollars a year" said Jeff Hamiel, the Commission's executive director and CEO.[25] The project is expected to create an estimated 250 new construction jobs and, once completed in October of 2015, to be the largest solar array in the state.

In addition to installing 3 megawatts of solar, the airport will convert 7,700 metal halide light fixtures to energy-savings LEDs. The combination of renewable energy and energy efficiency will serve as a hedge against future rate hikes.

MAKING THE INVESTMENT

The $25.3 million investment was made possible through a combination of funding sources including $23 million in Qualified Energy Conservation Bonds, a low-cost public financing tool, and $2 million in grants through Xcel Energy's Renewable Development Fund. The total upfront cost of the project for the MAC was just under $100,000 (less than 1 percent of the total project cost). Once completed in October 2015, the project will generate more than $10 million of net present value cash flow to the MAC by 2045.

MADE IN MINNESOTA

Ameresco, an energy efficiency and renewable energy company, is leading the construction of the airport project in partnership with a number of Minnesota-based companies. Minneapolis-based tenKsolar, Inc will manufacture 3,595 of the 8,705 total panels and invertors planned for the project. Other local companies involved in the project include Hunt Electric and Cooper Lighting (a subsidiary of Eaton Corporation). Funding for the project is provided by Minneapolis-based Thrivent Financial.

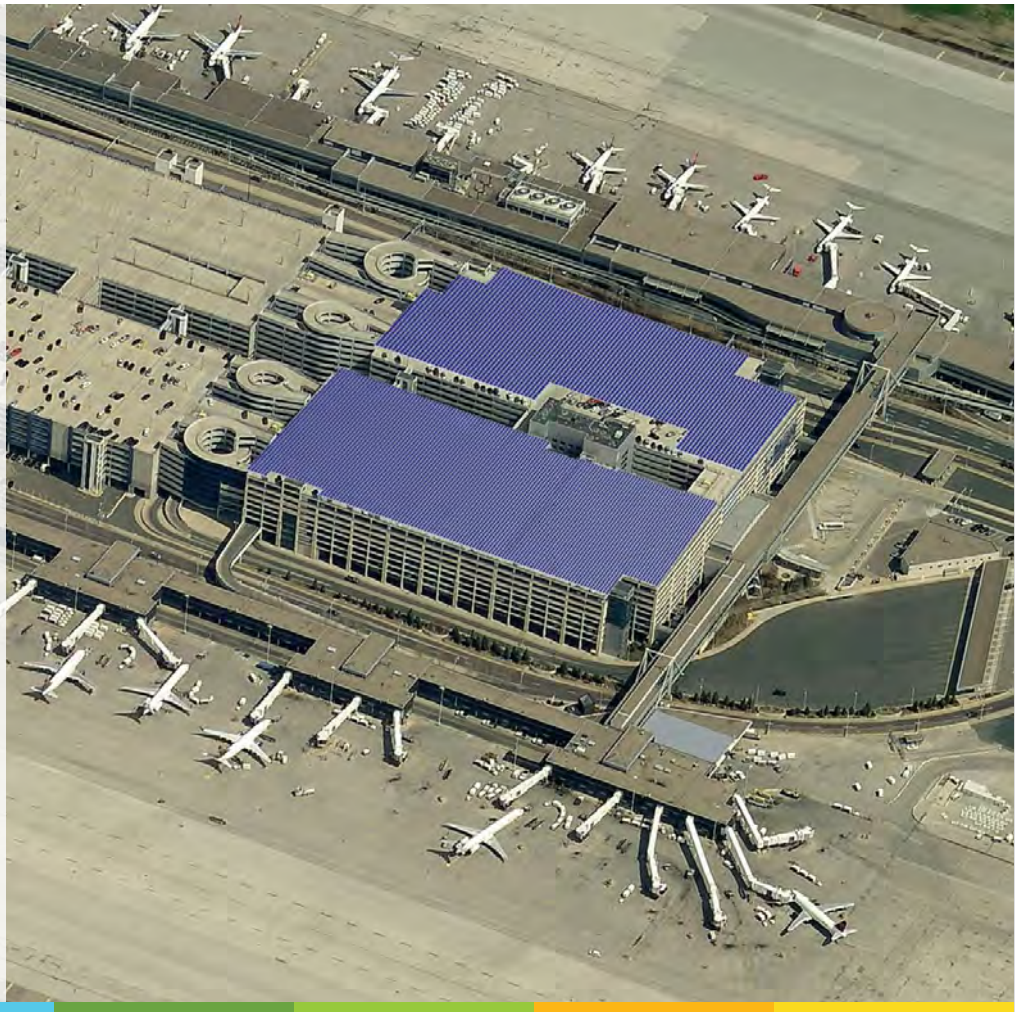
Overall, 53 percent of the solar and 65 percent of the entire project components are manufactured in Minnesota and 95 percent of all project components are manufactured in the U.S. Minnesota Solar Energy Industries Association reports that as of 2013 the solar industry in Minnesota represents 2,000 direct manufacturing jobs and nearly 7,000 indirect manufacturing jobs.[26] The installation of the MSP airport solar array is expected to create 250 new construction jobs.

COST SAVINGS

The Minneapolis-St. Paul International Airport solar array will generate more than $10 million of net present value cash flow over 30 years.

JOB CREATION

The construction of the array, the largest in the state, will create 250 jobs.



Construction begins on 3-megawatt solar array at Minneapolis-St. Paul International Airport
Photo Courtesy of MAC

MINNESOTA'S RENEWABLE FUTURE

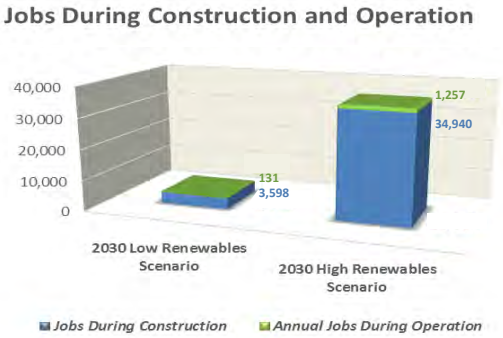
Our key findings are listed in the summary table below (see Methodology section for data sources and methods used).

In a "High Renewables" scenario, Minnesota has the potential to attract over $2 billion more in wages and benefits during construction".

Future Investment Opportunities for Renewable Electricity in Minnesota

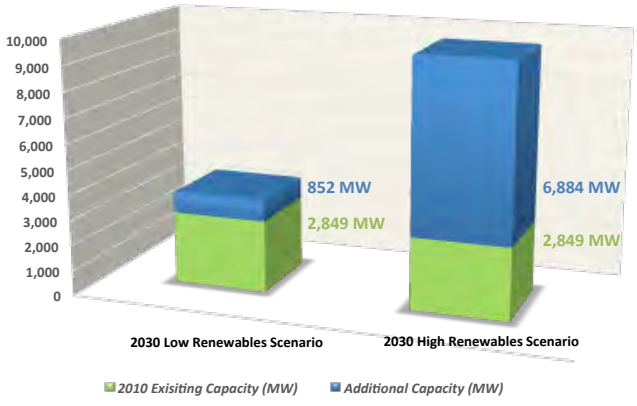
In a "High Renewables" scenario, Minnesota has the potential to create almost 35,000 additional local jobs during construction and more than 1,200 additional annual jobs committed to operations and maintenance.

Jobs During Construction and Operation



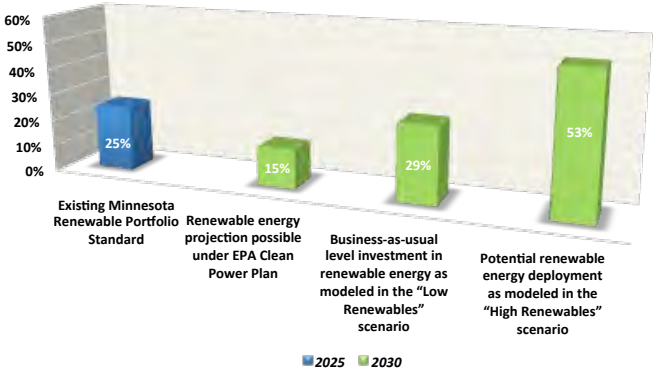
In a "High Renewables" scenario, Minnesota could double its renewable energy use from 2010 levels by 2030.

Additional Installed Capacity (MW)



In our "High Renewables" case, renewable energy development would produce three times as much renewable energy in Minnesota as EPA projected.

Potential Renewable Electricity Capacity



MINNESOTA'S RENEWABLE ELECTRICITY DEVELOPMENT POTENTIAL FAR EXCEEDS THE CLEAN POWER PLAN REQUIREMENTS

The EPA Clean Power Plan calls for Minnesota to reduce carbon dioxide emissions by 41 percent by 2030.[27] EPA based Minnesota's target on cuts through the following measures:

- A 5.5 percent reduction through increased efficiency of coal plants
- A 26.5 percent reduction through increased use of low-emitting natural gas combined cycle plants where excess capacity is available
- A 2.9 percent reduction through the use of more zero-emitting power sources such as renewable energy and nuclear power, and
- An 11.5 percent reduction through energy efficiency improvements to reduce electricity demand.[28]

Minnesota 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.[29]

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".[30] 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 Minnesota could meet the entire EPA emissions reduction target through the increased use of renewable energy. Indeed, Minnesota 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[31]	**15% by 2030**
Business-as-usual level investment in renewable energy as modeled in the "Low Renewables" scenario	**29% by 2030**
Existing Minnesota Renewable Portfolio Standard	**25% by 2025**
Potential renewable energy deployment as modeled in the "High Renewables" scenario	**53% 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 Minnesota, EPA projects 15 percent renewable energy generation under the proposed rule by 2030.

In accordance with the proposed rule, states will continue to drive significant carbon dioxide emissions reductions by investing in renewable electricity technologies. For example, according to the EPA, every ton of municipal solid waste processed at a waste-to-energy facility reduces lifecycle GHG emissions by one ton of carbon dioxide equivalents.

Minnesota already meets the EPA proposed target and is on track to significantly exceed it before 2030, due to a robust state Renewable Portfolio Standard of 25% by 2025.

The "High Renewables" scenario modeled here and in the NREL *Renewable Electricity Futures* study would exceed the EPA proposed target three-times over.

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 Minnesota.

METHODOLOGY

DGA modeled the economic effects of a renewable electricity future in 2030 for Minnesota 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.[32] 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.[33]

- 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.[34] 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.[35]

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.[36] 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, Geothermal, Hydroelectric, Solar, and Wind)	2030 High Renewables Scenario	2030 Low Renewables Scenario
Additional Installed Capacity	6,884 MW	852 MW
Jobs During Construction	34,940	3,598
Wages and Benefits During Construction	$2.1 billion	$217 million
Annual Jobs During Operation	1,257	131
Annual Wages and Benefits During Operation	$76 million	$8 million
Annual Tax Revenue and Land Leasing Revenue	$48 million	$6 million
Wind (2,172 MW in 2010)	2030 High Renewables Scenario	2030 Low Renewables Scenario
Additional Installed Capacity	6,582 MW	831 MW
Jobs During Construction	26,942	3,401
Wages and Benefits During Construction	$1.6 billion	$204 million
Annual Jobs During Operation	949	120
Annual Wages and Benefits During Operation	$58 million	$7 million
Annual Tax Revenue and Land Leasing Revenue	$43 million	$5 million
Biomass (448 MW in 2010)	2030 High Renewables Scenario	2030 Low Renewables Scenario
Additional Installed Capacity	120.8 MW	1.5 MW
Jobs During Construction	617	3
Wages and Benefits During Construction	$53 million	$0.24 million
Annual Jobs During Operation	221	2
Annual Wages and Benefits During Operation	$13 million	$0.12 million
Annual Tax Revenue and Land Leasing Revenue	$0	$0
Hydroelectric Power (228 MW in 2010)	2030 High Renewables Scenario	2030 Low Renewables Scenario
Additional Installed Capacity	99.6 MW	18.9 MW
Jobs During Construction	2,851	161
Wages and Benefits During Construction	$188.7 million	$11.6 million
Annual Jobs During Operation	51	8
Annual Wages and Benefits During Operation	$3.5 million	$0.6 million
Annual Tax Revenue and Land Leasing Revenue	$4.5 million	$0.7 million
Solar (0.36 MW in 2010)	2030 High Renewables Scenario	2030 Low Renewables Scenario
Additional Installed Capacity	81.6 MW	N/A*
Jobs During Construction	4,530	N/A*
Wages and Benefits During Construction	$261 million	N/A*
Annual Jobs During Operation	36	N/A*
Annual Wages and Benefits During Operation	$2.2 million	N/A*
Annual Tax Revenue and Land Leasing Revenue	$0	N/A*

*** Both scenarios estimate an extremely limited deployment of geothermal in Minnesota.**

*** 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 Minnesota.

Waste-to-Energy	2030 Additional Capacity Potential
(123 MW in 2014)	96 MW

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Page 4: Wind farm in Rock, Minnesota on Flickr
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Page 7: A 51 megawatt biomass facility in Duluth, Minnesota –
Photo courtesy of Minnesota Power

Page 9: HERC is located in the heart of downtown Minneapolis, providing renewable energy to Target Field on the left, the transit hub in front and thousands of nearby homes and businesses.
Photo Courtesy of Covanta Energy

Page 11: Bloomington IKEA location with over 4,300 solar panels produces more than 1 megawatt of power.
Photo Courtesy of IKEA

Page 13 Construction begins on 3-megawatt solar array at Minneapolis-St. Paul International Airport
Photo Courtesy of MAC

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.

WIND ENERGY FOUNDATION

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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ENDNOTES

1 Gallup, Americans Look to Conservation and Renewable Energy for Solutions, April 2, 2014, http://www.gallup.com/poll/168176/americans-favor-energy-conservation-production.aspx.

2 U.S. Energy Information Agency, What is U.S. Electricity Generation by Source? http://www.eia.gov/tools/faqs/faq.cfm?id=427&t=3; see also, U.S. Federal Energy Regulatory Commission, Office of Energy Projects Energy Infrastructure Update for September 2014, https://www.ferc.gov/legal/staff-reports/2014/sep-infrastructure.pdf (New renewable projects represent 41 percent of generation capacity added in 2014).

3 U.S. Energy Information Agency, Frequently Asked Questions: What is U.S. Electricity generation by source? June 13, 2014, http://www.eia.gov/tools/faqs/faq.cfm?id=427&t=3 (noting that in 2013, the United States generated about 4,058 billion kilowatthours of electricity, 13 percent of which was from renewables); see also U.S. Environmental Protection Agency, Clean Energy: Calculations and References, September 9, 2014, http://www.epa.gov/cleanenergy/energy-resources/refs.html (noting that, "on average, each home consumed 12,069 kWh of delivered electricity (EIA 2013a).").

4 Collaborative Economics, Minnesota Clean Energy Economy Profile 2014, October 2014, http://mn.gov/deed/images/MN_CleanEnergyEconomyProfile_FullReport.pdf

5 U.S. Department of Energy, 2013 Wind Technologies Market Report

6 Solar Energy Industry Association (SEIA), Minnesota Solar Policy Fact Sheet, 2014, http://www.seia.org/state-solar-policy/minnesota-solar

7 Minnesota Department of Commerce, Minnesota Renewable Energy Integration and Transmission Study, November 2014, http://www.minnelectrans.com/documents/MRITS-report.pdf

8 U.S. EPA, Clean Power Plan Overview, June 13, 2014, http://www2.epa.gov/carbon-pollution-standards/fact-sheet-clean-power-plan-overview (To account for regional differences in power generation and electricity consumption, EPA proposed different emission reduction targets for each state).

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).

10 In crafting its proposed rule, EPA elected not to allow states to count existing hydroelectric power toward their emission reduction targets in their state implementation plans. Thus, in applying the "High Renewables" scenario to determine how much renewable energy is likely to be available in any state to comply with EPA's proposed rule, it is necessary to remove NREL's data on existing hydropower. Whereas the full set of NREL data show that Minnesota can supply 53 percent of its electric power needs in 2030 from renewable sources, we apply a subset of these data (all data except existing hydropower) to conclude that EPA would allow 40 percent of Minnesota's potential renewable energy to count toward Clean Air Act section 111d compliance. This would be nearly three times the amount of renewable energy that EPA estimates will be needed to comply with its proposed rule.

11 Collaborative Economics, supra note 4. The definition of bioenergy industries includes both biofuels and biomass, a difference in methodology from this report which only looks at biomass.

12 Energy Information Administration, State Renewable Electricity Profiles, 2012, http://www.eia.gov/renewable/state/pdf/srp2010.pdf; American Council on Renewable Energy (ACORE), Renewable Energy in Minnesota, 2013 http://www.acore.org/files/pdfs/states/Minnesota.pdf; American Wind Energy Association (AWEA) State Wind Energy Statistics: Minnesota, 2014 http://www.awea.org/Resources/state.aspx?ItemNumber=5215; SEIA, supra note 5.

13 Collaborative Economics, supra note 4.

14 SEIA, supra note 11; AWEA supra note 11.

15 Energy Recovery Council (ERC), Waste-to-Energy Fact Sheet, July, 2014 (available on request).

16 U.S. DOE, 2013 Wind Technologies Market Report, 2014.

17 David Shaffer, "Xcel, Seeing a Good Deal, Adds Even More Wind Power", Star Tribute, August 14, 2013, http://www.startribune.com/business/219411891.html

18 SEIA, supra note 6.

19 Minnesota Department of Commerce, supra note 7

20 National Hydropower Association (NHA), Minnesota Fact Sheet, 2013, http://www.hydro.org/wp-content/uploads/2014/09/Minnesota.pdf

21 U.S. EPA, Energy Recovery from Waste, 2014, http://www.epa.gov/waste/nonhaz/municipal/wte/

22 U.S. EPA, Municipal Solid Waste, 2014, http://www.epa.gov/epawaste/nonhaz/municipal/

23 Energy Recovery Council (ERC), ERC Director of Waste-to-Energy Facilities, 2014, http://www.wte.org/userfiles/files/ERC_2014_Directory.pdf

24 Covanta, About Covanta, 2014, http://www.covanta.com/about-covanta.aspx

25 Ameresco, Construction of Minnesota's Largest Solar Energy Project Begins at Minneapolis-St. Paul International Airport, October 2, 2014, http://www.ameresco.com/news/construction-minnesota%E2%80%99s-largest-solar-energy-project-begins-minneapolis-st-paul-international-a

26 Minnesota Solar Energy Industry Association, "Minnesota Solar Manufacturing Supply Chain," June 2013, http://www.mnseia.org/sites/default/files/MnSEIASolarMfgReportJune2013v3.pdf

27 U.S. EPA, supra note 8.

28 Center for Climate and Energy Solutions, Proposed State Emission Rate Targets, http://www.c2es.org/federal/executive/epa/carbon-pollution-standards-map.

29 Union of Concerned Scientists, Strengthening the EPA's Clean Power Plan, October 2014, http://www.ucsusa.org/sites/default/files/attach/2014/10/Strengthening-the-EPA-Clean-Power-Plan.pdf

30 Natural Resources Defense Council, The EPA's Clean Power Plan Could Save Up to $9 Billion in 2030, November 2014, http://www.nrdc.org/air/pollution-standards/files/clean-power-plan-energy-savings-IB.pdf

31 Center for Climate and Energy Solutions, Renewable Generation in the Clean Power Plan, http://www.c2es.org/federal/executive/epa/carbon-pollution-standards-renewable-energy-map.

32 National Renewable Energy Labs, Renewable Electricity Futures, http://www.nrel.gov/analysis/re_futures/.

33 Trieu Mai, David Mulcahy, M. Maureen Hand, Samuel F. Baldwin, "Envisioning a Renewable Electricity Future for the United States", *Energy*, Volume 65, February 1, 2014, Pages 374-386, http://www.sciencedirect.com/science/article/pii/S0360544213009912.

34 REF found that none of these constraints examined precluded achieving 80 percent renewable energy by 2050, but that adding constraints or assuming no technology improvement increased the cost of achieving the goal.

35 Max Wei, et al., Putting Renewables and Energy Efficiency To Work: How Many Jobs Can The Clean Energy Industry Generate in the U.S ?, August 13, 2009, http://rael.berkeley.edu/sites/default/files/green_jobs_paper_Oct1809_0.pdf.

36 Nickolas J. Themelis and Charles Mussche, 2014 Energy and Economic Value of Municipal Solid Waste, Including Non-Recycled Plastics, Currently Landfilled in the Fifty States, July 9, 2014, http://www.americanchemistry.com/Policy/Energy/Energy-Recovery/2014-Update-of-Potential-for-Energy-Recovery-from-Municipal-Solid-Waste-and-Non-Recycled-Plastics.pdf.

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