MINNESOTA

CLEAN ENERGY ECONOMY PROFILE

How Industry Sectors are Advancing Economic Growth

OCTOBER 2014

About this Report

Minnesota's Clean Energy Economy Profile report is the state's most comprehensive effort to quantify the businesses, employment, wages, and investments directly engaged in the clean energy economy.

Findings demonstrate that employment in clean energy firms is growing more rapidly than employment in the state overall. Moreover, these are high-quality jobs, with wages well above the state average. Finally, the report shows the vital link between the state's clean energy policies and industry growth.

This research is part of the Minnesota National Governors Association (NGA) Policy Academy's effort to align economic development and clean energy strategies. Minnesota was one of four states selected to participate. The scope of this report is limited to assessing the size and characteristics of the clean energy industry sectors identified above. In addition to this analysis, Minnesota is partnering with the NGA Policy Academy, industry, and its supply chain on an action plan that will identify opportunities and encourage more jobs, wages, investments, and earnings due to the international clean energy economy. More information about the NGA project and its findings can be found at www.mn.gov/deed/clean. Upon request, this document can be made accessible for people with disabilities by calling: 651-259-7175.

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EXECUTIVE SUMMARY

Readily available and reliable energy is critical for the economic vitality, public health, and well-being of all Minnesotans. Because it has no natural deposits of coal, natural gas or petroleum, Minnesotans have spent at least $13 billion every year since 2010 on fossil fuels imported into the state.[1] Minnesota can ease the effects from importing fossil fuels by using its abundant natural renewable resources, such as wind, solar, and many types of biomass. Minnesota has become a national leader in growing the clean energy economy, and is positioned to compete in a $1.13 trillion global clean energy market.[2]

Minnesota's longstanding and new energy policies are sending a signal to businesses that are comparing investment opportunities. This report shows that the state's steady support is stimulating growth across clean energy sectors, creating a diversity of good-paying jobs, a concentration of expertise, substantial clean energy infrastructure, and a variety of businesses spanning the value chain.

Clean energy is reducing Minnesota's dependence on non-renewable sources of energy. For example, only 4 percent of the electricity generated in Minnesota in 2000 came from renewable energy, but by 2011 renewable electricity jumped to 16 percent of total generation.[3] Minnesota farmers are providing feedstock for renewable ethanol to replace more than 10 percent of petroleum gasoline the state imports for vehicles. The state is now an energy exporter as well, with 880 million gallons of ethanol exported to other states in 2011.[4] Farmers also reduce imports of diesel by providing a minimum of 5 percent renewable diesel for fuel sold in the state during winter months and 10 percent for summer months.

As a result, Minnesota has a growing clean energy economy that sustains local jobs and attracts investment. These clean energy businesses employ workers and generate revenue directly from products or services that use less energy to provide the same service, or produce heat, power, or fuel from renewable sources of energy. This assessment includes clean energy sectors (along with their value chains) known to have a direct but undetermined impact on the economy: energy efficiency, wind, solar, bioenergy, and smart grid. A strong local value chain, including manufacturing, supplying components or raw material, sales and distribution, installation and maintenance, and research or development, can give the state a competitive advantage in the industry.

Minnesota's clean energy economy is growing quickly in terms of jobs, wages, and market development. This report includes the following findings:

- **Minnesota's early start and continued support of clean energy policies creates a competitive advantage:** State policies dating back to 1980 sent strong market signals to investors. These policies provided incentives that encouraged development and adoption of energy efficient and renewable energy technologies. For example, Minnesota passed a law in 2013 to provide an incentive payment for solar systems manufactured in the state, and in 2010 a state goal for utilities to achieve 1.5 percent annual energy savings took effect. These policies have further stimulated markets by influencing federal standards and supporting development of community-centered enterprises.
- **The clean energy market is developing rapidly, reducing the state's dependence on imported energy:** Biofuels production capacity, energy efficiency savings, and solar and wind installations all had triple-digit percentage jumps between 2000 and 2012. As of 2012, annual energy efficiency savings and renewable electricity capacity in Minnesota was enough to power over 1.4 million homes in the state for a year. State biofuel production capacity was enough to replace traditional fuel for 1.7 million vehicles for one year.

- **Employment in clean energy sectors reached 15,300 in 2014 and is growing faster than total state employment**: Clean energy employment in Minnesota surged 78 percent between January 2000 and the first quarter of 2014, growing steadily through the recession. The state's total employment grew only 11 percent over the last 15 years. Over 15,300 workers are employed in a diversity of clean energy sectors in Minnesota. Of these workers, about 60 percent are in the energy efficiency sector, and the rest are spread across bioenergy, wind power, solar energy, and smart grid.
- **Workers in clean energy earn high average wages compared with the state average:** Minnesota workers in the clean energy economy earned over $1 billion in wages in 2013. Average annual wages in the clean energy economy reached over $71,000 in 2013, which was 42 percent higher than the statewide average for all jobs of about $50,000. Within clean energy sectors, average wages range from $61,500 in wind to $80,300 in smart grid. These jobs range from installation and maintenance to manufacturing and research.
- **Minnesota is advancing innovation in clean energy sectors, with strong patent and investment activity:** Minnesota companies are developing and deploying new clean energy technologies at an increasing rate. Minnesota ranked eighth in the US in total clean energy patents in 2013 — a leap from a decade ago when the state ranked 20th — and companies received about $450 million in early stage investment over the last 10 years. Companies also received nearly $11 billion in project financing from the private sector to install renewable energy projects between 2004 and 2013.

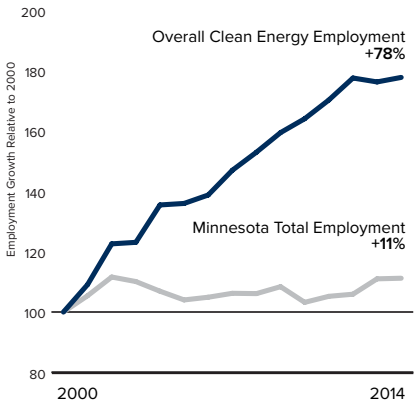
The clean energy economy is creating an increasing number of high-paying jobs, decreasing dependence on imported fuels, and improving air and water quality in the state. Other states have increasingly recognized the value of the clean energy industry and are rapidly accelerating their support for it. However, thanks to robust developments in the last 25 years, along with public and private sector technical and financial expertise, Minnesota is well positioned to benefit from a window of opportunity presented by the growing, international clean energy economy and advance local clean energy economic development.

CLEAN ENERGY ECONOMY PROFILE AT A GLANCE

Clean Energy Employment and Wages

The clean energy economy is growing rapidly, creating jobs with good-paying wages. Minnesota employed over 15,300 workers in energy efficiency, bioenergy, wind, solar, and smart grid sectors as of first quarter 2014. Clean energy employment grew faster than employment in the state overall over the last 15 years. Moreover, wages in clean energy are well above the state average.

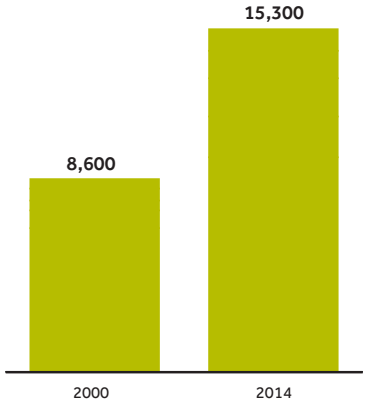
EMPLOYMENT GROWTH
2000-2014



Clean energy employment grew faster than total state employment since January 2000

Jobs in Minnesota's overall clean energy economy jumped 78 percent between 2000 and 2014, reaching more than 15,300 in the first quarter of 2014. Over the same time period, total employment in the state increased 11 percent.

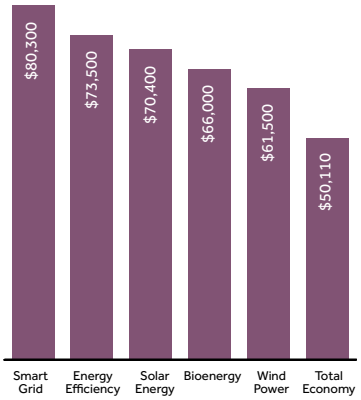
CLEAN ENERGY EMPLOYMENT
2000 and 2014



Employment in the clean energy economy nearly doubled in the last 15 years

Employment in Minnesota's clean energy economy has grown across all sectors and diversified over time; while energy efficiency remains the largest sector, bioenergy, smart grid and solar employment all more than doubled between 2000 and 2014. Wind employment nearly tripled over the same period.

AVERAGE ANNUAL WAGE
2013



Average annual wages in the clean energy economy are 42 percent higher than the statewide average for all jobs

Total payroll was over $1 billion in 2013. Average wages ranged from roughly $61,500 annually in the wind sector, to roughly $80,300 annually for smart grid jobs.

Clean Energy Market Development

Policies enacted by the Legislature have helped stimulate growth across sectors and increased in-state production of clean energy from the early 1980s through today.

COMPARISON OF CLEAN ENERGY MARKET DEVELOPMENT
Minnesota, 2000-2012

	2000-2012 % change
Energy Efficiency cumulative savings	524%
Bioenergy electricity production	40%
Installed wind energy capacity	935%
Installed solar energy capacity	9670%
Biofuel (Ethanol) production capacity	408%

As of 2012, annual energy efficiency savings and renewable electricity capacity in Minnesota was enough to power over 1.4 million homes in the state for a year

Energy efficiency savings, bioenergy electricity generation, wind and solar installations, and ethanol production had triple digit percentage jumps between 2000 and 2012 across nearly all sectors.

Clean Energy Innovation

Minnesota companies are driving clean energy innovation, and developing and deploying clean energy technologies at an increasing rate.

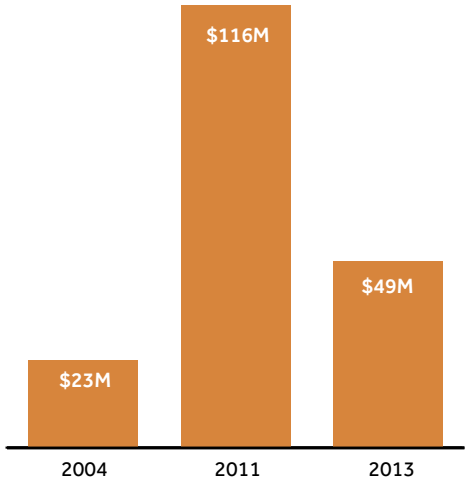
CLEAN ENERGY PATENTS REGISTERED
Minnesota Rank among U.S. States, 2013

	Rank in U.S.	Total Patents
Smart Grid	6	44
Energy Efficiency	12	38
Solar Energy	13	9
Wind Power	13	4
Bioenergy	22	3
Total Clean Energy Rank	8	98

In 2013, Minnesota ranked 8th in the U.S. for patents registered

Minnesota is becoming an innovation leader in developing clean energy technologies; it ranked eighth in the US for number of patents registered in 2013, up from 20th in 2003. The state is also a leader in smart grid technologies, ranking sixth in the nation in patents registered in 2013

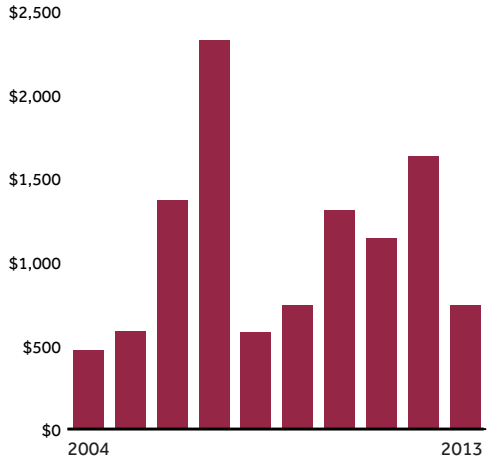
EARLY STAGE INVESTMENT
Inflation adjusted



Clean energy companies received over $450 million in early stage investment between 2004 and 2013

Between 2004 and 2013, Minnesota's clean energy companies received over $450 million of early stage investment. Bioenergy companies received the most investment over the period, followed by energy efficiency technology companies. Investment has declined from peak levels in 2011, mirroring a nationwide change in early stage clean technology investment.

RENEWABLE ENERGY PROJECT FINANCING
In Millions of Dollars, Inflation adjusted



Nearly $11 billion in renewable energy project financing from the private sector between 2004 and 2013

Financing for renewable energy projects in Minnesota totaled nearly $11 billion between 2004 and 2013, led by recent investments in wind projects, and investments in biofuel production facilities in earlier years. As in other states, uncertainty surrounding federal energy policies has deterred some investors in recent years.

INTRODUCTION

Readily available and reliable energy is critical for the economic vitality, public health and well-being of all Minnesotans. Because it has no natural deposits of coal, natural gas or petroleum, Minnesotans have spent at least $13 billion every year since 2010 on fossil fuels imported into the state.[5] Minnesota can ease the effects from importing fossil fuels by using its abundant natural renewable resources, such as wind, solar, and many types of biomass. Minnesota has become a national leader in growing the clean energy economy, and is positioned to compete in a $1.13 trillion global clean energy market.[6]

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This increase in clean energy consumption and production in Minnesota is creating a growing clean energy economy, sustaining local jobs, and attracting investment to the state. This report profiles Minnesota's progress in expanding its clean energy economy in terms of jobs, wages, and innovation. In addition, the report shows how state policies have helped stimulate clean energy economic development.

Minnesota's Clean Energy Economy

Minnesota's clean energy economy includes a wide variety of businesses that are creating or providing products or services with environmental, economic or social benefits. The state's clean energy economy is growing and creating new jobs and businesses in many sectors. This profile of Minnesota focuses on companies and business units in clean energy sectors. These companies employ workers and generate revenue directly from products or services that allow the entire economy to transition away from fossil fuels and use natural resources more efficiently.

What is a Clean Energy Business?

Clean energy businesses employ workers and generate revenue directly from products or services that use less energy to provide the same service, or produce heat, power or fuel from renewable sources of energy.

This assessment only included sectors of the clean energy economy known to have direct but undetermined impact on jobs, wages, and contributions to Minnesota's economy. While there is a broad range of companies that are adopting clean energy technologies in Minnesota, this profile focused specifically on the sectors that are creating or providing clean energy products or services. The clean energy sectors included in this analysis are energy efficiency, wind, solar, bioenergy, and smart grid (Table 1).[9] This analysis also includes businesses' value chain functions. A strong local value chain can give the state a competitive advantage in the industry. Therefore, it is important to understand the range of businesses directly engaged in clean energy sectors. Value chain functions include manufacturing, supplying components or raw material, sales and distribution, installation and maintenance, and research or development.

Table 1

MINNESOTA CLEAN ENERGY ECONOMY SECTORS	
Energy Efficiency	Technologies, methods or strategies that result in using less energy to produce the same service or product, or to provide the same level of performance, comfort or convenience. It can include a conservation or efficiency strategy that helps users save energy in the buildings environment (e.g. insulation, energy management systems, green roofs), or a specific technology that is more efficient than traditional types (e.g. LED lights, Energy Star appliances or windows).
Wind Power	Wind power technology encompasses turbines, blades, and towers, and related components and services, such as site development and installation for the residential, commercial and utility-scale markets.
Solar Energy	Solar energy technology includes solar thermal and photovoltaic (PV) for the residential, commercial and utility-scale markets. It can include solar system components including inverters, racking, other balance of system, and monitoring equipment, and services such as installation, finance, consulting, and manufacturing.
Bioenergy	Bioenergy includes technology that uses biomass (e.g. wood, grasses corn, soy, municipal solid waste and gas) to produce heat, electricity, fuel, and/or chemicals, and includes services such as research, production, and sales of the products.
Smart Grid	Smart grid refers to integrated, automated communication between components of the electric grid, including centralized and distributed energy production, transmission and use (e.g. smart meters and measuring devices, energy storage, improved management dashboards and decision support software).

GROWING MINNESOTA'S CLEAN ENERGY ECONOMY

Minnesota Policies Stimulating Economic Development

Minnesota has been a leader in the national clean energy economy, creating policies to stimulate economic development in clean energy since the early 1980s. A diverse set of stakeholders developed these policies, including policy makers, private companies, local, state, and federal governments, as well as academic institutions, and organizations. Aligning these stakeholders has helped build a strong Minnesota clean energy economy.

Public policy is particularly important in new markets such as clean energy, as emerging technologies move into the commercialization phase and compete with long-standing energy infrastructure, incentives, and policies. The government can play a pivotal role in stimulating demand for clean energy products by removing barriers to adoption, setting standards, encouraging support of local businesses, and increasing affordability for consumers. Increasing market demand, in turn, helps companies achieve economies of scale and lower their costs. While clean energy technologies are maturing and becoming increasingly cost competitive, supportive policies help the market work through the early stages of growth.

The Minnesota Clean Energy Policy Timeline on the following pages shows the state's continued support of the clean energy market, including early support for biofuel production and energy efficiency, as well as recent efforts to encourage demand in the solar energy sector. Each section of the timeline focuses on major legislative actions related to development of the biofuels (including ethanol and biodiesel), renewable electricity (including biomass, wind and solar), and energy efficiency markets, as well as key milestones related to growth in the clean energy economy.

CLEAN ENERGY POLICY LEGEND

The statutes listed below are key legislative mandates and incentives to stimulate clean energy growth in Minnesota. The progression of these statutes is displayed in the policy timeline on the following pages.

- **Energy Conservation Improvement 216B.241** Energy savings requirement for Minnesota electric and natural gas utilities
- **Sustainable Building Guidelines 16B.325** Sustainable building design guidelines for all new state buildings and for all major renovations state buildings
- **Renewable Energy Production Incentive 216C.41** Legislation includes definitions, incentive payments, and payment periods for local renewable energy production
- **Cogeneration and Small Power Production 216B.164** Law encourages cogeneration and small power production (e.g. solar)
- **Renewable Energy Objective/Standard 216B.1691** Goal is for the state's electric utilities to obtain specific percentages of energy from renewables
- **Community-Based Energy Development Tariff 216B.1612** A tariff established to optimize local, regional, and state benefits from renewable energy development and to facilitate community-based renewable energy projects in state
- **Funding for Renewable Development 116C.779** Renewable development account and incentive program
- **Solar Energy Incentive Program 116C.7792** Requirement for the state's utilities to operate a program to provide solar energy production incentives for small solar energy systems
- **"Made in Minnesota" Solar Energy Production Incentive 116C.411-415** Incentive program for consumers who install PV and solar thermal systems using solar modules and collectors certified as manufactured in Minnesota
- **Oxygenated Gasoline (Ethanol) 239.791** Minimum ethanol content required in Minnesota
- **Biodiesel Content Mandate 239.77** Minimum biodiesel content required in Minnesota
- **Ethanol Development; Producer Payments 41a.09** Goal for ethanol production plants in the state attain a certain levels; cash payments for producers of ethanol located in the state

MINNESOTA CLEAN ENERGY POLICY TIMELINE

Energy Efficiency

1980
Public Utilities Commission directed utilities to evaluate cost effectiveness of efficiency (1980-1983)

1983
Utilities with revenues greater than $50 million required to operate at least one conservation improvement program (1983-1989)

1989
All Public Utilities were required to operate conservation improvement programs

1991
1.5% of electric and 0.5% of natural gas GOR is required to be spent for conservation improvement programs (1991-2010)

1994
Xcel to spend 2.0% of their annual GOR on conservation programs (1994-2007)

2001
All new state buildings to exceed the state energy code by at least 30% by January 15, 2003; and for all major renovations by February 1, 2009

Renewable Electricity

1983
40 kW net metering law requires utility interconnection and payment to customer for net excess energy they produce

1994
Renewable Energy Production Incentive payments for electricity generated from local renewable sources [wind added in 1995, biomass added in 2001]

2001
Renewable Energy Objective passed with goal for electric utilities to obtain specific percentages of energy from renewables

Biofuel

1980
4 cents/gallon blenders tax credit for 10% ethanol (E10) (1980-1986)

1986
20 cents/gallon ethanol production incentive (1986-2013)

1989
Pump label for 10% ethanol no longer required

1995
Ethanol to provide 2.7% oxygen level for gasoline in metro area (1995-2003)

1997
Ethanol to provide 2.7% oxygen level for gasoline state-wide (1997-2003)

Clean Energy Milestones

1986
First ethanol plant opens

1997
Wind installations reach more than 1,000 MW cumulative capacity

2001
CIP reaches cumulative savings of more than 10 million MMBTU

Energy Efficiency

2007
Requirement to change from spending to energy savings goal passed

2008
All new state-funded buildings to reduce use of fossil fuel energy 60% by 2010, 70% by 2015, 80% by 2020 and 90% by 2025

2010
1.5% annual savings goal for utilities takes effect

Renewable Electricity

2002
$1 million/year Solar Electric Rebate Program established from Renewable Development Fund (2002-2006)

2005
Community-Based Energy Development (C-BED) Tariff requires 20-year power purchase agreement from public utilities for community-owned renewable energy projects

2007
Renewable Portfolio Standard requires electric utilities to obtain 25% of energy from renewable sources by 2015 (30% for Xcel Energy) [took effect in 2010]

Increase to $3 million/year for the Solar Electric Rebate program from the Renewable Development Fund (2007) and ARRA (2009) (2007-2012)

2009
10% of a utility's CIP program may be used for solar; Xcel Solar*Rewards and others established (2010-2013)

2013
Net metering expanded to include customers with > 40 kW < 1,000 kW capacity compensated with a kilowatt-hour credit on their bill

Value of Solar Tariff alternative to net metering compensates customers for net value of PV on distribution system

Solar Energy Standard requires public utilities to have 1.5% of electric sales from solar by 2020

Xcel Solar*Rewards changed to performance based incentive with funds of $5 million/year for 5 Years (2014-2019)

"Made in Minnesota" provides an incentive payment for solar PV and solar thermal systems certified as manufactured and installed in the state

Biofuel

2002
Biodiesel Mandate passed, 2% Biodiesel (B2) required after Sept. 29, 2005 (2002-2009)

2003
10% Ethanol blend mandated for gasoline (2003-2013)

2008
5% Biodiesel (B5) required after May 1, 2009

2009
Highest blend of ethanol approved by the U.S. EPA to be used in MN (remained 10%)

2013
Word change from "ethanol" to "biofuel" to support agnostic biofuel for future years

2014
10% Biodiesel required for summer months; 5% winter months after July 1, 2014

Clean Energy Milestones

2002
10,000+ direct clean energy jobs in the state

2007
Over $2 billion project financing for wind energy and biofuel deployment

2012
15,000+ direct clean energy jobs in the state

Solar installations reach more than 10 MW cumulative capacity

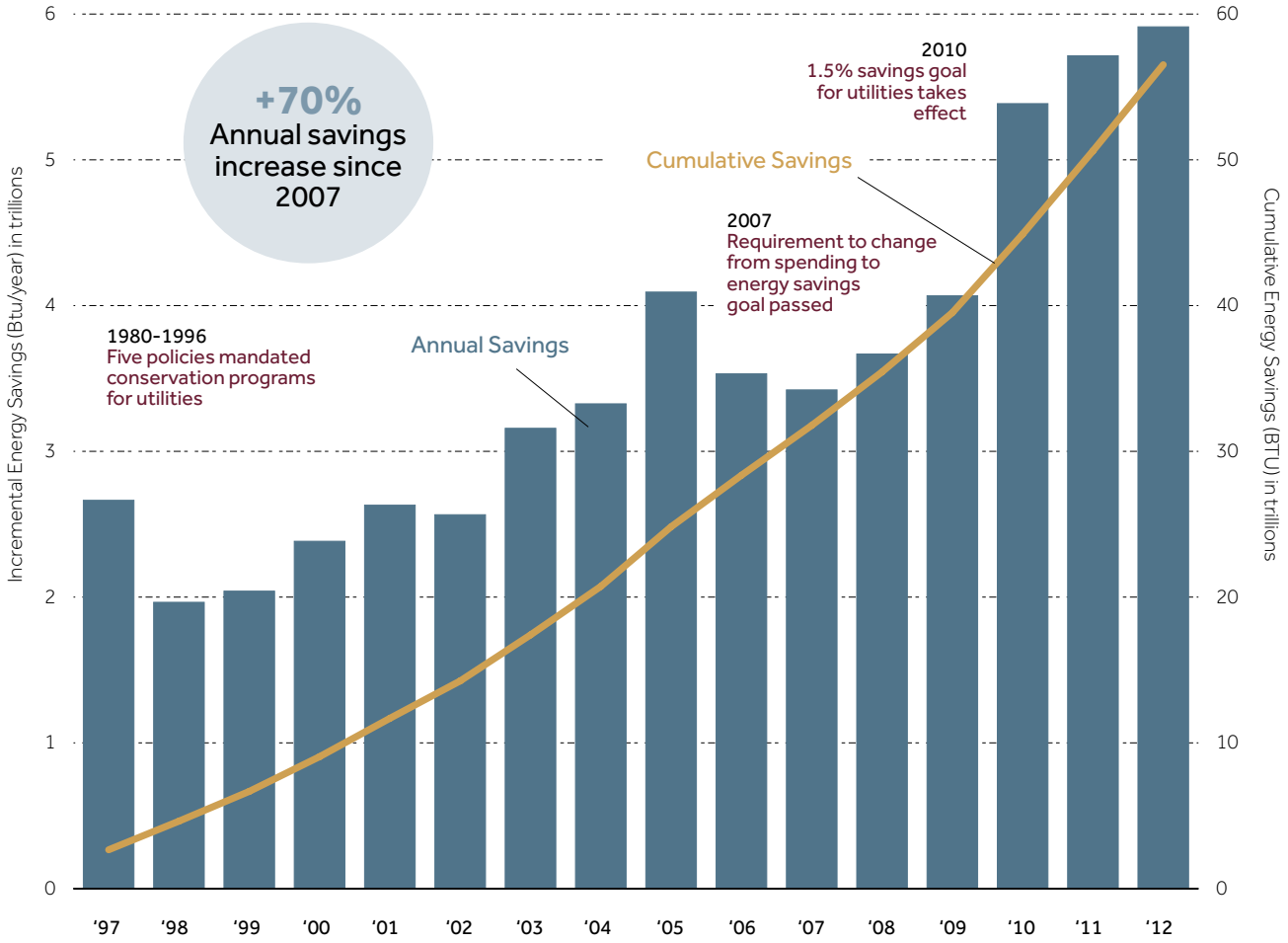
Clean Energy Market Development

ENERGY EFFICIENCY

The state has long supported energy efficiency technologies and services as a way to reduce energy costs for Minnesota households and businesses, as well as reduce the need for expensive utility infrastructure expansions and associated emissions. Starting in the 1980s, state utilities were required to have at least one energy efficiency program, termed a Conservation Improvement Program (CIP). In 1991, utilities were required to spend 1.5 percent of electric revenue and 0.5 percent of natural gas revenue on conservation improvement. Those requirements switched from an expenditure-related goal to an energy savings target in 2007, and in 2010 utilities were mandated to achieve annual energy savings of 1.5 percent. Figure 1 shows that as of 2012, CIP measures saved over 56 trillion BTUs of electric and natural gas. Annual savings in 2012 are more than double the savings in 1997, and are about 70 percent higher than annual savings in 2007.

Figure 1

ENERGY EFFICIENCY
Combined Electric and Gas Savings through the Conservation Improvement Program
Minnesota, 1997-2012



Data Source: Minnesota Department of Commerce
Analysis: Collaborative Economics

RENEWABLE ELECTRICITY

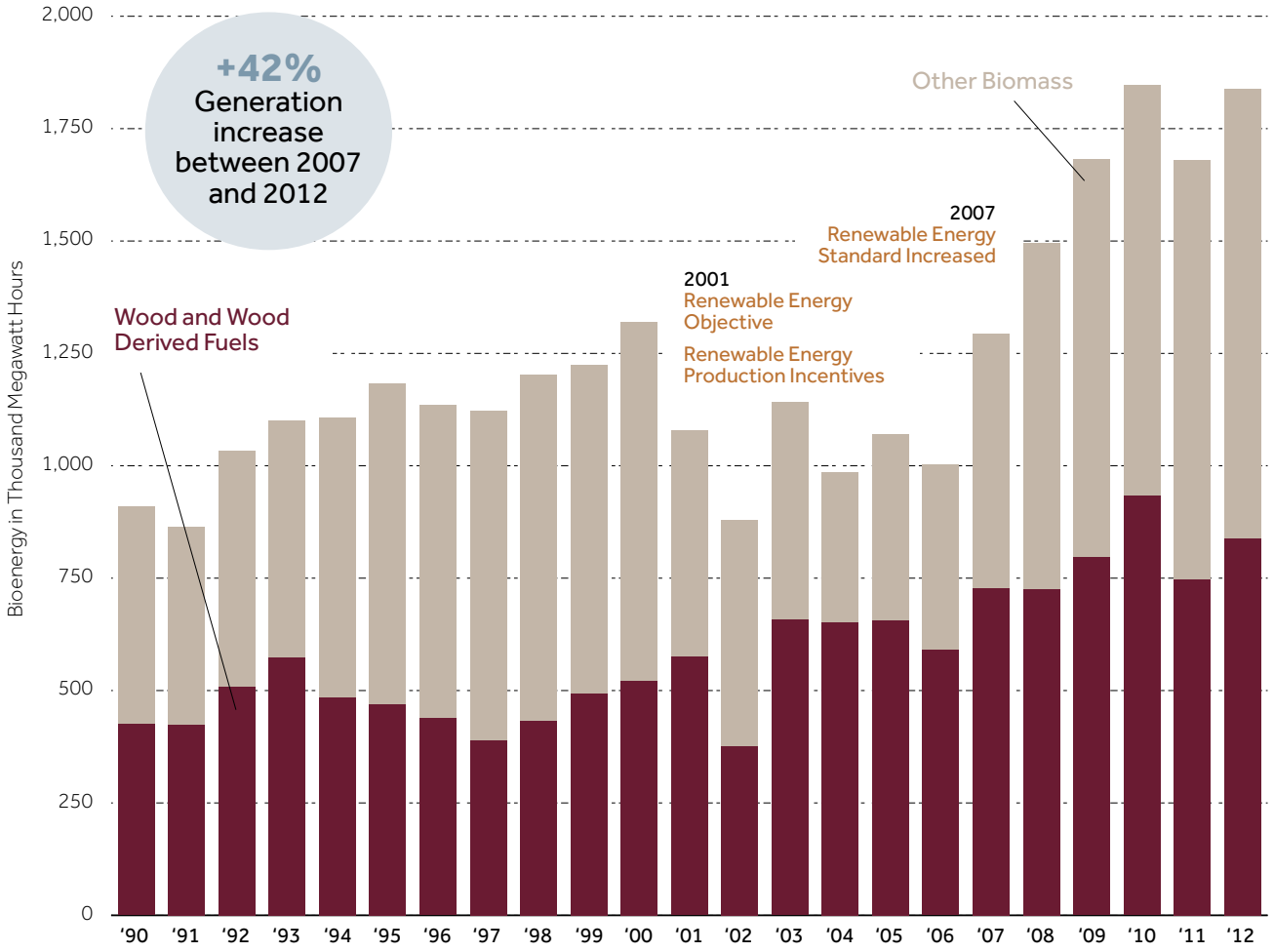
Minnesota is increasingly using its abundant natural renewable resources to produce electricity. Bioenergy, wind, solar, and hydro energy offer multiple clean energy options to diversify production and use, and benefit local economies. Minnesota has enacted a number of policies that provide a strong market signal supporting investment in renewable electricity production in the state, starting in 1994 with an incentive payment for electricity produced from renewable energy. The state also set aggressive goals for production (originally established in 2001 and increased in 2007) that require utilities to obtain at least 25 percent of their electricity from renewable sources by 2025.

Bioenergy Electricity

Bioenergy electricity in Minnesota includes energy from biomass, such as combusting wood or wood-derived fuel, and from capturing and burning gas from landfills or manure lagoons. Electricity from bioenergy sources reached 1,838 thousand megawatt hours (MWh) in 2012, twice the generation amount in 1990 (Figure 2). Although several factors impact production, since the renewable energy standard increased in 2007, bioenergy electricity generation jumped 42 percent (between 2007 and 2012).

Figure 2

BIOENERGY ELECTRICITY GENERATION BY SOURCE
Minnesota, 1990-2012



Note: Other Biomass includes biogenic municipal solid waste, landfill gas, sludge waste, agricultural byproducts, other biomass solids, other biomass liquids, and other biomass gases (including digester gases and methane).
Data Source: U.S. Energy Information Administration
Analysis: Collaborative Economics

Wind Electricity

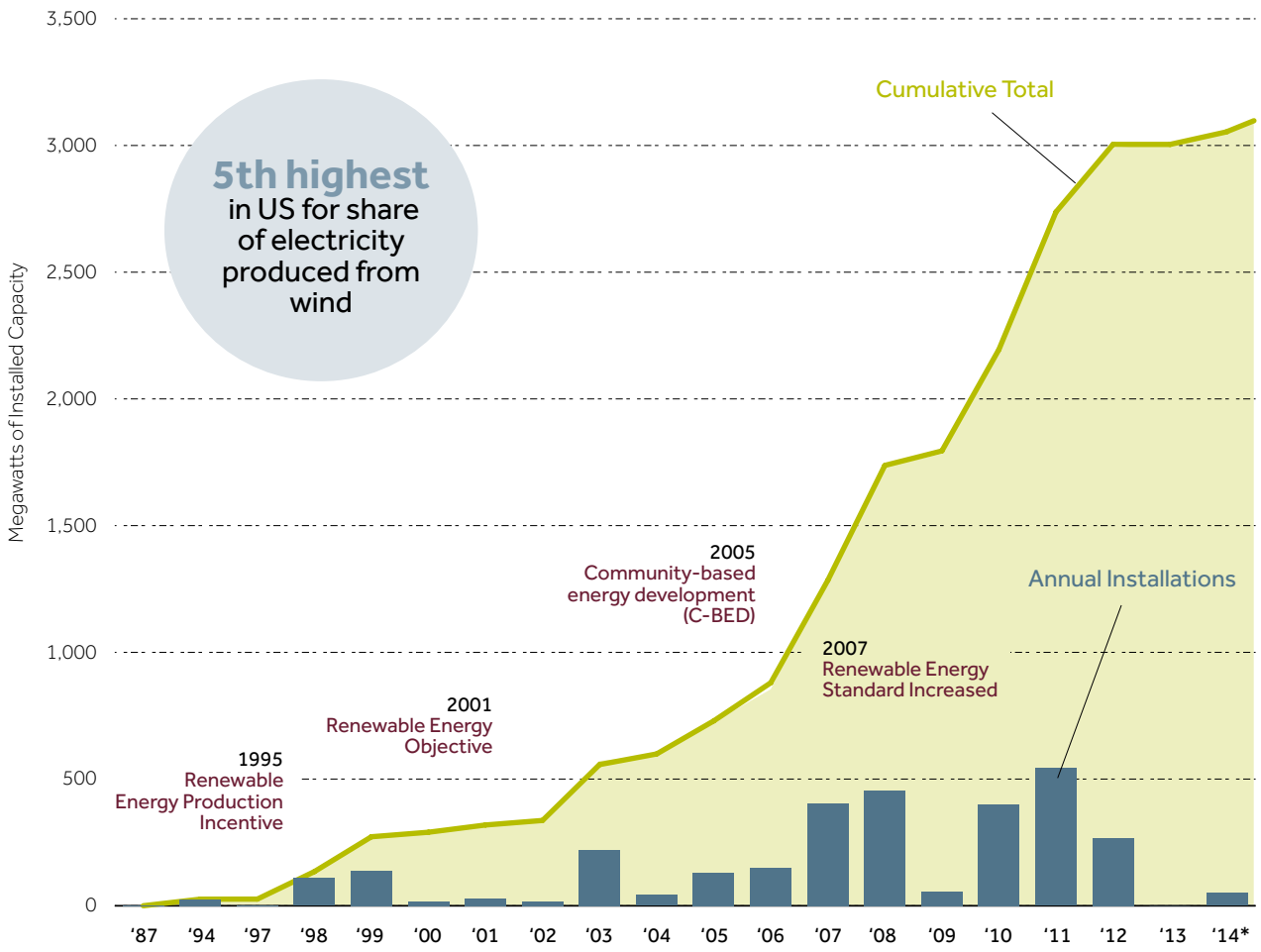
Minnesota has also worked to expand its wind market, given that it has the 12th best wind resource potential in the country. In addition to Minnesota's renewable energy policies noted above, in 2005 the state passed a community-based energy development (C-BED) tariff with specific provisions to support community-owned wind projects. Minnesota generated 15.7 percent of the state's total electricity from wind in 2013—the fifth highest share produced in the US — while the country as a whole generated only 4.1 percent of electricity from wind.[10] Figure 3 shows a steady increase in cumulative wind capacity in Minnesota over the years, reaching 3,054 megawatts of total capacity as of July 2014. Cumulative installations in 2014 are more than 10 times 2000 levels and more than twice the capacity in 2007. While increasing steadily over the decade, new installations dropped in 2013, largely due to the uncertainty around federal tax incentives for wind. This trend has been mirrored in states around the nation, though Minnesota still maintains its position as seventh in the nation in total installed wind capacity through 2013.

Figure 3

WIND ENERGY INSTALLATIONS

Annual and Cumulative

Minnesota, 1987-2014*



* Data as of July 2014

Data Source: Minnesota Department of Commerce

Analysis: Collaborative Economics

Solar Electricity

Electricity from solar sources is an emerging, fast-growing type of renewable energy in Minnesota. In addition to energy policies supporting all forms of renewable energy, the state has implemented a number of solar-specific programs and mandates, which help to defray the up-front cost for consumers and stimulate demand for solar. In 2002, the state of Minnesota established a solar electric rebate program of $1 million, with additional funds in subsequent years to stimulate installation activity. Since then, many utilities in the state have established their own solar electric and solar thermal incentive programs, such as Xcel Energy's Solar*Rewards program.

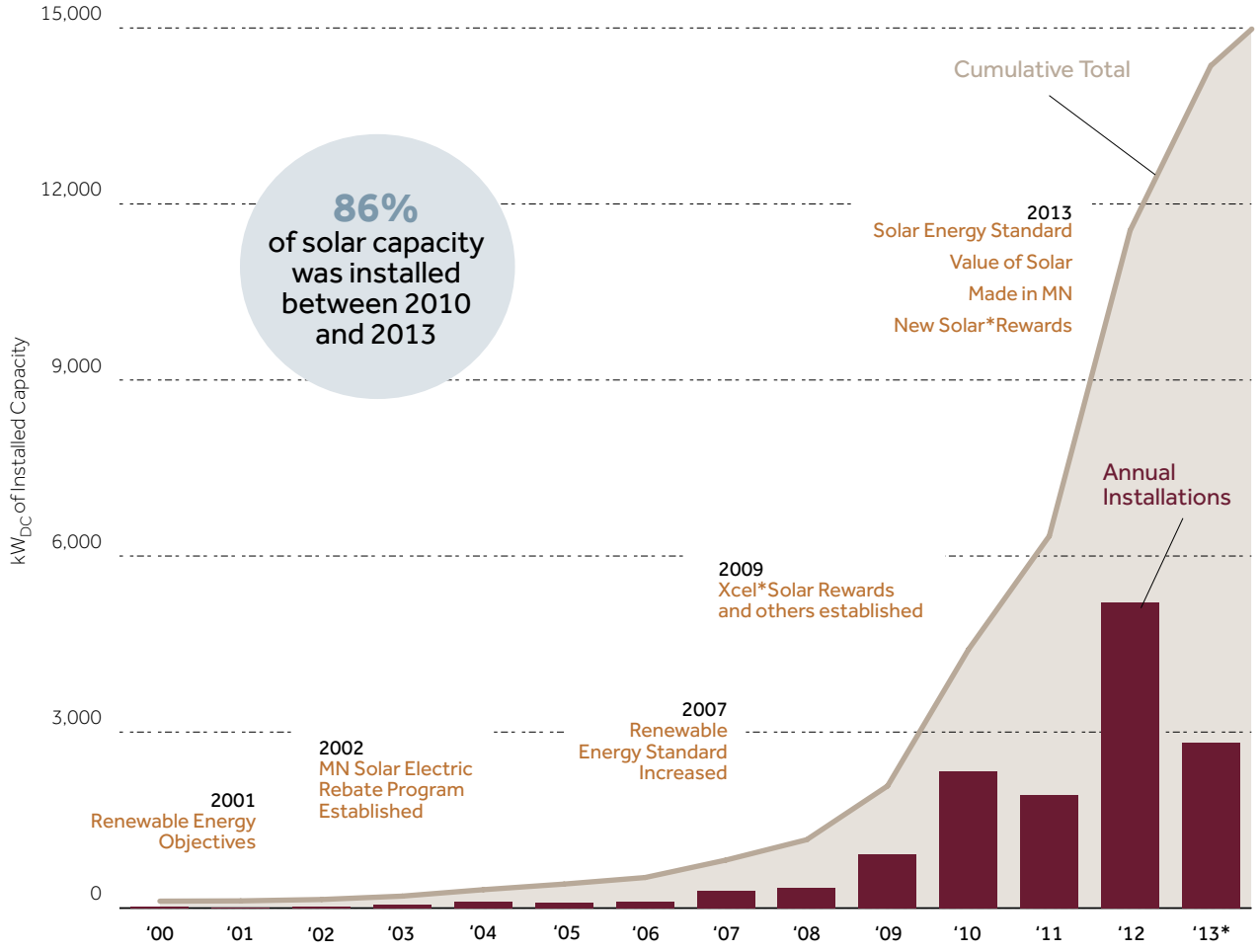
In 2013, Minnesota adopted multiple supportive policies, including an incentive for customer-sited solar energy systems manufactured in Minnesota, a solar energy standard for public utilities to generate 1.5 percent of electric sales from solar by 2020, and a requirement for Xcel Energy to develop a program for community participation in solar projects. Minnesota also created the nation's first Value of Solar tariff mechanism as an alternative to net metering in 2013. Utilities have the option to use the tariff to compensate customers through a credit for the value of operating distributed photovoltaic systems. Figure 4 shows that as of September 2013, Minnesota has more than 14,000 kilowatts (kW), equivalent to14 megawatts (MW), of solar energy capacity installed. Most of this capacity (86 percent) was installed between 2010 and 2013. The Minnesota Department of Commerce projects that solar capacity will continue to increase to 400 megawatts by 2020 due to the 2013 legislation.

Figure 4

SOLAR ENERGY INSTALLATIONS

Annual and Cumulative

Minnesota, 2000-2013*



* Data as of September 30, 2013

Data Source: Minnesota Department of Commerce

Analysis: Collaborative Economics

BIOFUELS – Ethanol and Biodiesel

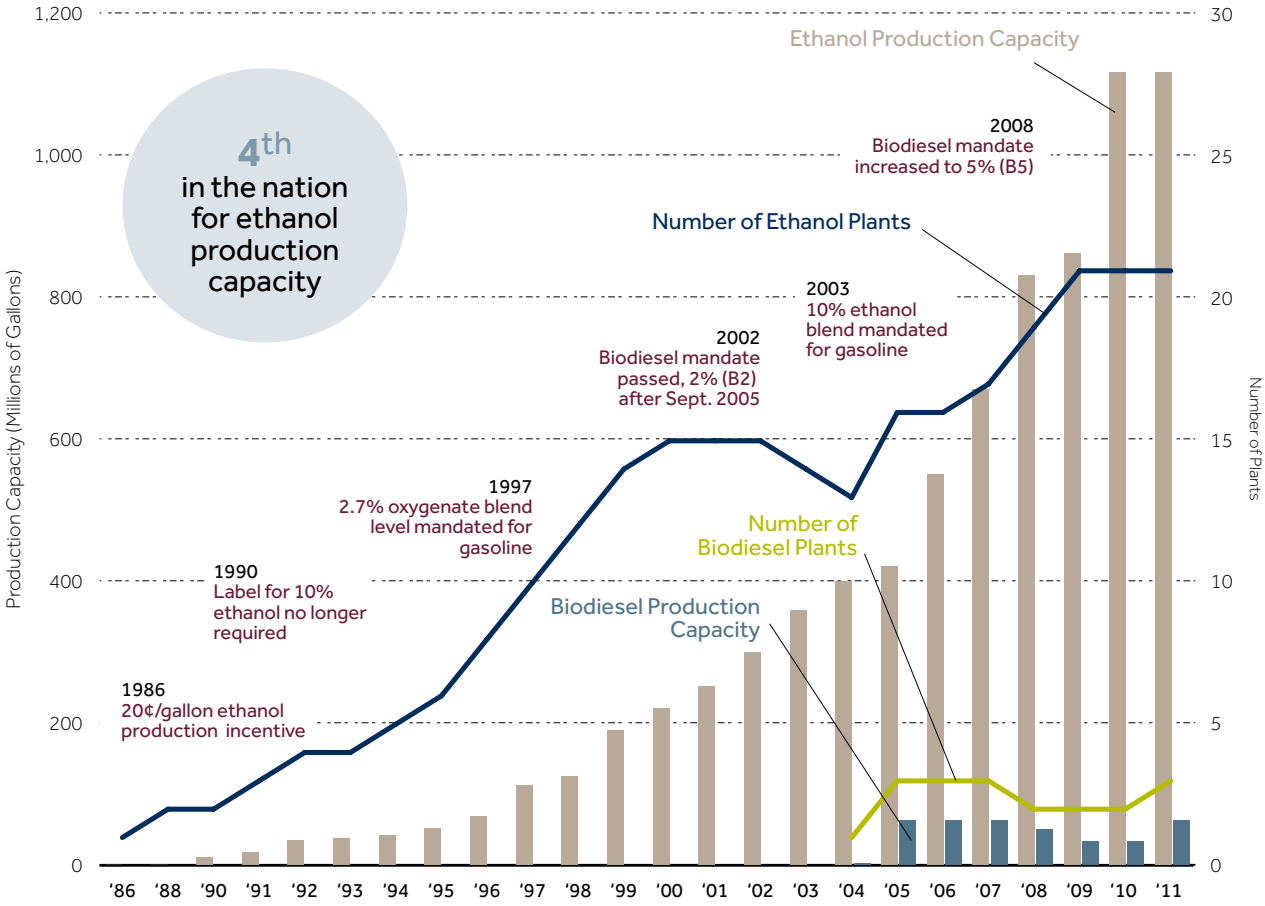
Minnesota's biofuel market has been active for over 20 years, adding economic value to the state's large agriculture industry, creating new jobs, and reducing air pollution from gasoline and diesel. The state was an early supporter of ethanol, with policies dating back to 1980. In 1986, the Legislature created an incentive to keep and create ethanol jobs in the state through a 20-cent per gallon ethanol producer payment to Minnesota ethanol facilities. In 2003, the Legislature also passed a blend mandate, and now nearly 10 percent of the state's gasoline is replaced by ethanol. In 2002, Minnesota became the first state to mandate the use of diesel with 2 percent biodiesel being required on September 29, 2005. The state has since increased that mandate to 5 percent biodiesel in 2009 and 10 percent during summer months beginning July 1, 2014.

Figure 5 illustrates the growth in the state's biofuel production over time, and highlights key biofuel policies that occurred between 1986 and 2011. These policies as well as the strong private sector response have established Minnesota as fourth in the nation for ethanol production capacity,[11] with 21 plants that can produce more than 1 billion gallons of ethanol a year. The state also has three biodiesel plants with 63 million gallons of production capacity per year. Production capacity grew rapidly in the last decade, with nearly five times more capacity in 2010 than 2000. Except for one plant converting to isobutanol – another alcohol biofuel and biochemical – the number of plants in ethanol production has remained steady since 2009. These production facilities employ workers directly and also create a steady market for the state's large agricultural crops of corn and soy.

Figure 5

BIOFUEL CAPACITY

Ethanol and Biodiesel Production Capacity and Plants
Minnesota, 1986-2011



Data Source: Minnesota Department of Agriculture
Analysis: Collaborative Economics

Change in the Clean Energy Market Over Time

Table 2 summarizes the tremendous growth of Minnesota's clean energy market between 2000 and 2012, with triple-digit percentage jumps in nearly every sector. Clean energy development in the state reduces dependence on imported energy and continues to offer a significant economic growth opportunity. As of 2012, annual energy efficiency savings and renewable electricity capacity in Minnesota was enough energy to power over 1.4 million homes in the state for a year, and state biofuel production capacity was enough to replace traditional fuel for 1.7 million vehicles for one year.

Table 2

COMPARISON OF CLEAN ENERGY MARKET DEVELOPMENT
Minnesota, 2000-2012

	2000	2012	2000-2012 percent change
Energy Efficiency cumulative savings	9 trillion BTU	56.5 trillion BTU	524%
Bioenergy electricity production	1,320 Thou MWh	1,838 Thou MWh	40%
Installed wind energy capacity	290 MW	3,004 MW	935%
Installed solar energy capacity	118 kW	11,550 kW	9670%
Biofuel (Ethanol) production capacity	220 millions of gallons	1,117 millions of gallons	408%

Data Source: Minnesota Department of Commerce and Department of Agriculture, and U.S. Energy Information Administration
Analysis: Collaborative Economics

1.4 MILLION

Energy savings and renewable electricity in Minnesota is equal to enough energy to power over 1.4 million homes in the state for one year (2012)

1.7 MILLION

Biofuel production capacity in Minnesota is enough to replace traditional fuel for 1.7 million vehicles for one year (2012)

EMPLOYMENT IN THE CLEAN ENERGY ECONOMY

Minnesota's clean energy economy includes companies and business units that have a primary mission and focus in clean energy sectors. Clean energy companies in the state were identified using multiple sources, including a survey issued by the Minnesota Department of Employment and Economic Development, industry codes, and industry association lists (see appendix for full methodology). The state's clean energy economy created nearly 7,000 jobs over the last 15 years, growing seven times faster than the state's overall employment. Clean energy employment in Minnesota surged 78 percent between January 2000 and first quarter 2014, while the state's total employment grew only 11 percent over the same period (Figure 6).

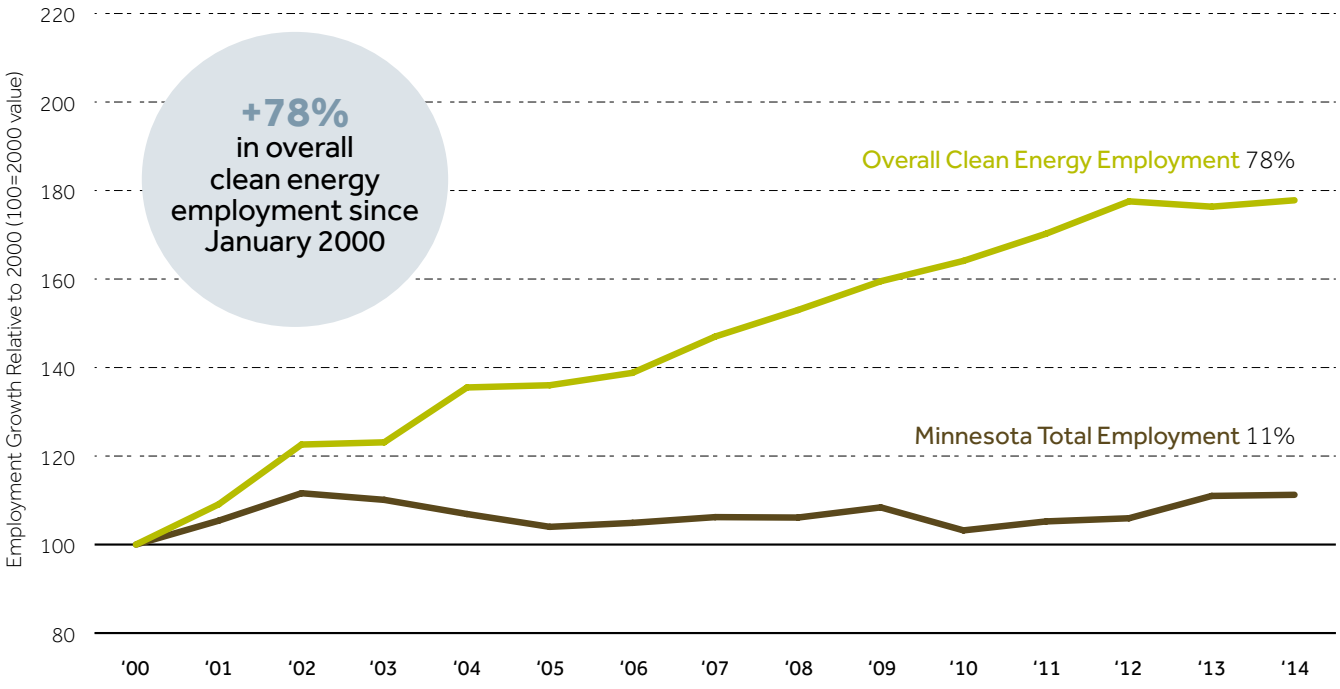
Over 15,300 workers are employed in Minnesota's clean energy economy, up from about 8,600 in 2000. For comparison, clean energy employment is larger than the semiconductor manufacturing industry, which accounts for roughly 14,900 jobs in Minnesota.[12] Clean energy employment grew steadily since 2000 and continued to increase through the economic recession, with only a slight dip in first quarter 2013 (-0.7 percent) which it recovered by first quarter 2014 (+0.8 percent). Minnesota's total employment has grown since the recession, though only by 0.2 percent between first quarters 2013 and 2014.

Over 15,300 workers are currently employed in Minnesota's clean energy economy, compared to about 8,000 in 2000

Figure 6

CLEAN ENERGY AND TOTAL EMPLOYMENT GROWTH

Percent Change in Employment Compared to 2000
Minnesota, 2000-2014



Data Source: National Establishment Time Series Database (NETS), IEGC, MN DEED Economic Analysis Unit Survey-July 2014
Analysis: Collaborative Economics

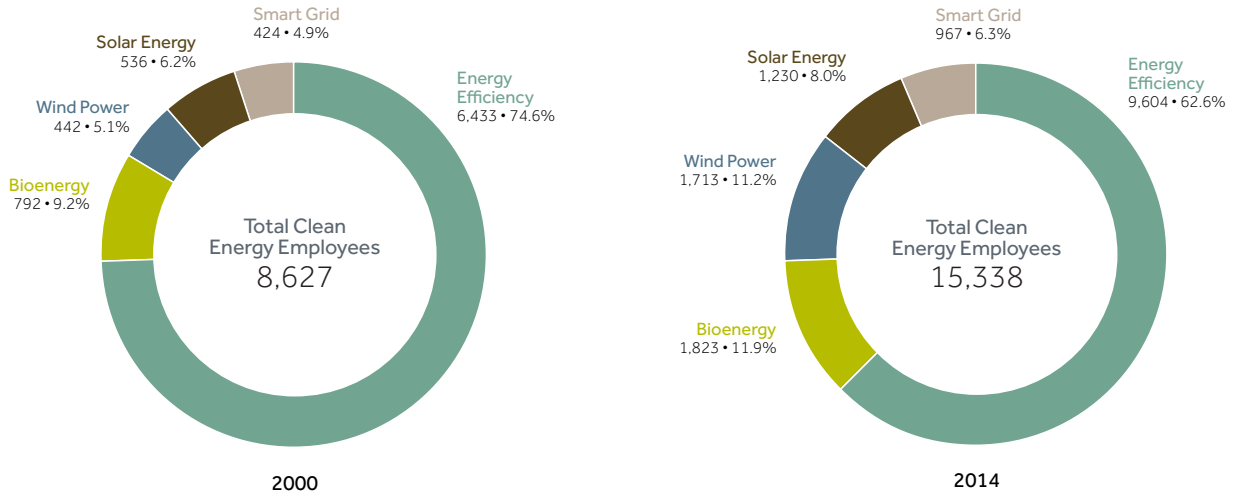
Employment by Clean Energy Sector

Minnesota's clean energy economy grew across all five sectors (energy efficiency, wind power solar energy, bioenergy, and smart grid) between January 2000 and first quarter 2014 (Figure 7). In 2000, nearly three-fourths of clean energy employment was in the energy efficiency sector. While employment in energy efficiency grew, the share of total clean energy employment decreased to 62.6 percent by 2014 as each of the other sectors expanded. Bioenergy, encompassing both biomass thermal energy and electricity and biofuels, is the next largest sector with 11.9 percent of clean energy employment in 2014, up from 9.2 percent of the total in 2000. Wind power gained the largest share of the total, rising from 5.1 percent of clean energy employment in 2000 to 11.2 percent in 2014.

Figure 7

CLEAN ENERGY EMPLOYMENT SHARE BY SECTOR

Minnesota, 2000 and 2014



Data Source: National Establishment Time Series Database (NETS), IEGC, MN DEED Economic Analysis Unit Survey-July 2014
Analysis: Collaborative Economics

The clean energy economy is diversifying as all five sectors have expanded, though energy efficiency remains the largest sector in the state

Figure 8 illustrates the number of employees in each sector over time. As of first quarter 2014, the energy efficiency sector had 9,600 employees, and remains the largest clean energy sector in Minnesota. While the growth rate is the lowest among clean energy sectors between January 2000 and first quarter 2014 (+49 percent), it grew the most in total number employees (+3,170 jobs) (Figure 9). In the recent year between first quarters 2013 and 2014, energy efficiency had the second-highest growth rate among sectors at 1.7 percent.

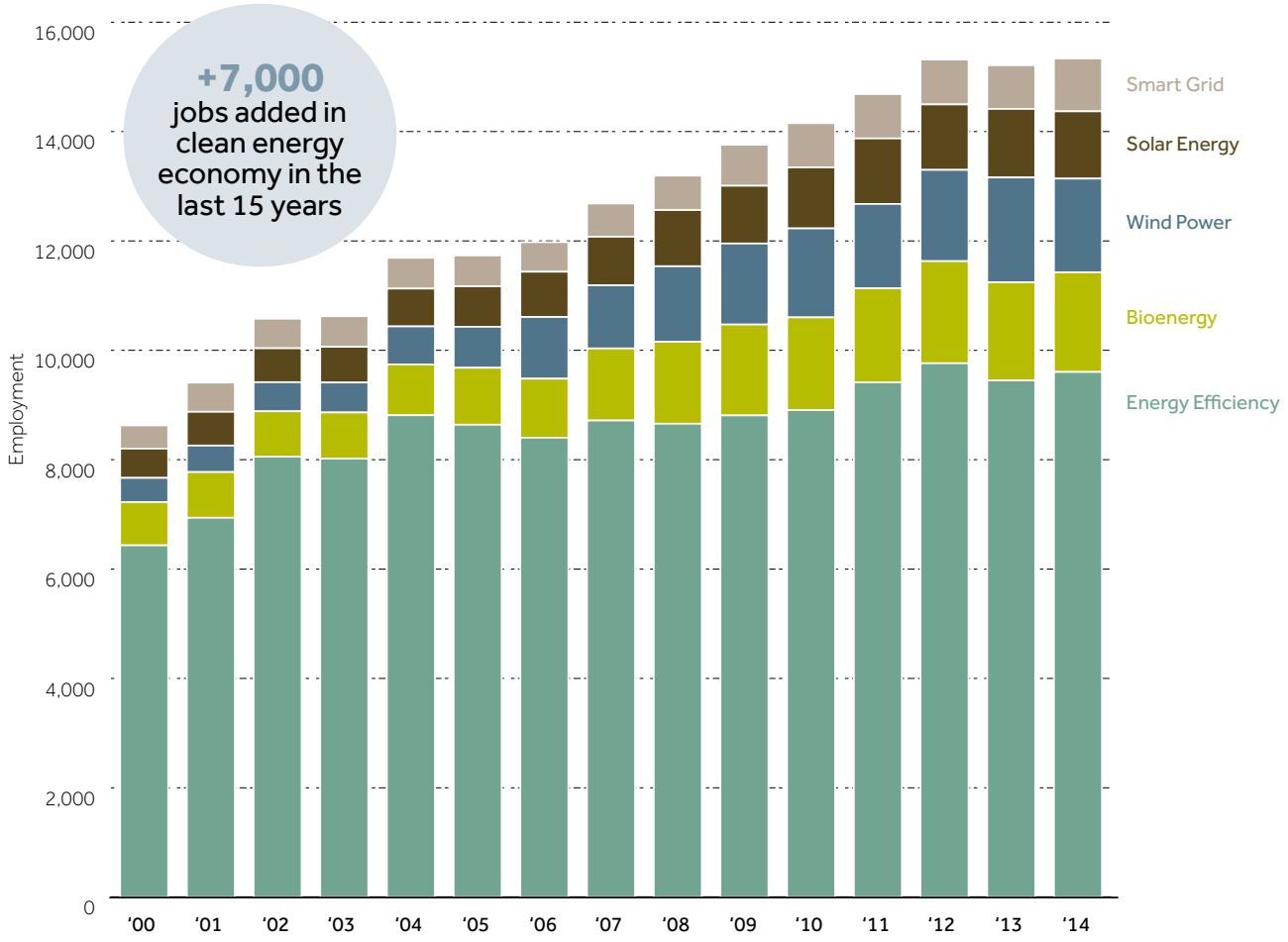
The bioenergy sector is the second largest, with 1,800 employees as of first quarter 2014. Employment more than doubled over the last 15 years, up from about 800 employees in January 2000. Between first quarters 2013 and 2014, bioenergy employment grew 1.5 percent.

The wind power sector is third largest with 1,700 jobs in first quarter 2014. In spite of year to year fluctuations, the longer-term trajectory demonstrates a rapidly expanding wind sector in Minnesota. Wind employment grew the fastest since 2000, with almost four times more jobs in first quarter 2014. This growth trend mirrors the rise in installations in the longer term and the fluctuations in development, including the drop in new installations 2013.

Figure 8

CLEAN ENERGY EMPLOYMENT BY SECTOR

Minnesota, 2000-2014



Data Source: National Establishment Time Series Database (NETS), IEGC, MN DEED Economic Analysis Unit Survey-July 2014
Analysis: Collaborative Economics

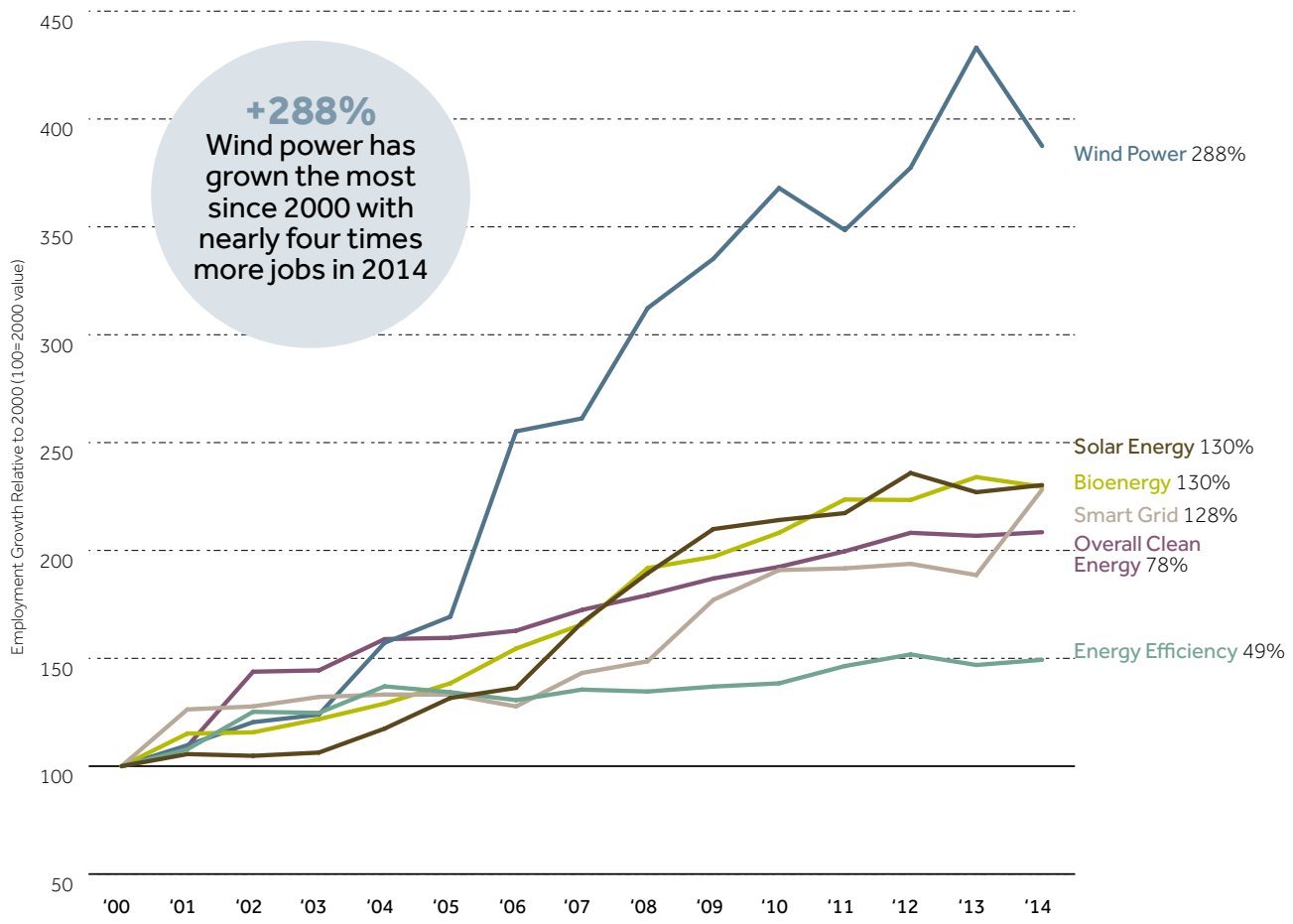
The solar energy sector comprised about 1,200 jobs as of first quarter 2014. Employment in solar more than doubled between January 2000 and first quarter 2014, and expanded 16 percent in the last five years alone. In the recent year between first quarters 2013 and 2014, solar decreased by about 2 percent, largely due to the transition to new solar policies and programs in the state.

Smart grid is the least developed but fastest growing clean energy sector with nearly 1,000 jobs in first quarter 2014. Between January 2009 and first quarter 2014, employment in smart grid increased 29 percent, and jumped 21 percent between first quarters 2013 and 2014.

Figure 9

CLEAN ENERGY EMPLOYMENT GROWTH BY SECTOR

Percent Change in Employment Compared to 2000
Minnesota, 2000-2014



Data Source: National Establishment Time Series Database (NETS), IEGC, MN DEED Economic Analysis Unit Survey-July 2014
Analysis: Collaborative Economics

Solar, bioenergy and smart grid all experienced triple-digit percent employment growth between 2000 and 2014

Employment by Value Chain Functions

The clean energy economy includes companies across the value chain, which can help provide the state with a competitive advantage in the industry. Value chain functions are important to analyze because businesses directly engaged in manufacturing, supplying components or raw material, sales and distribution, installation and maintenance, research or development are all important parts of a clean energy sector. From the point of conception until sale to the customer and maintenance over the lifetime of the product, there are many distinct activities in the value chain that take place in Minnesota's clean energy economy.

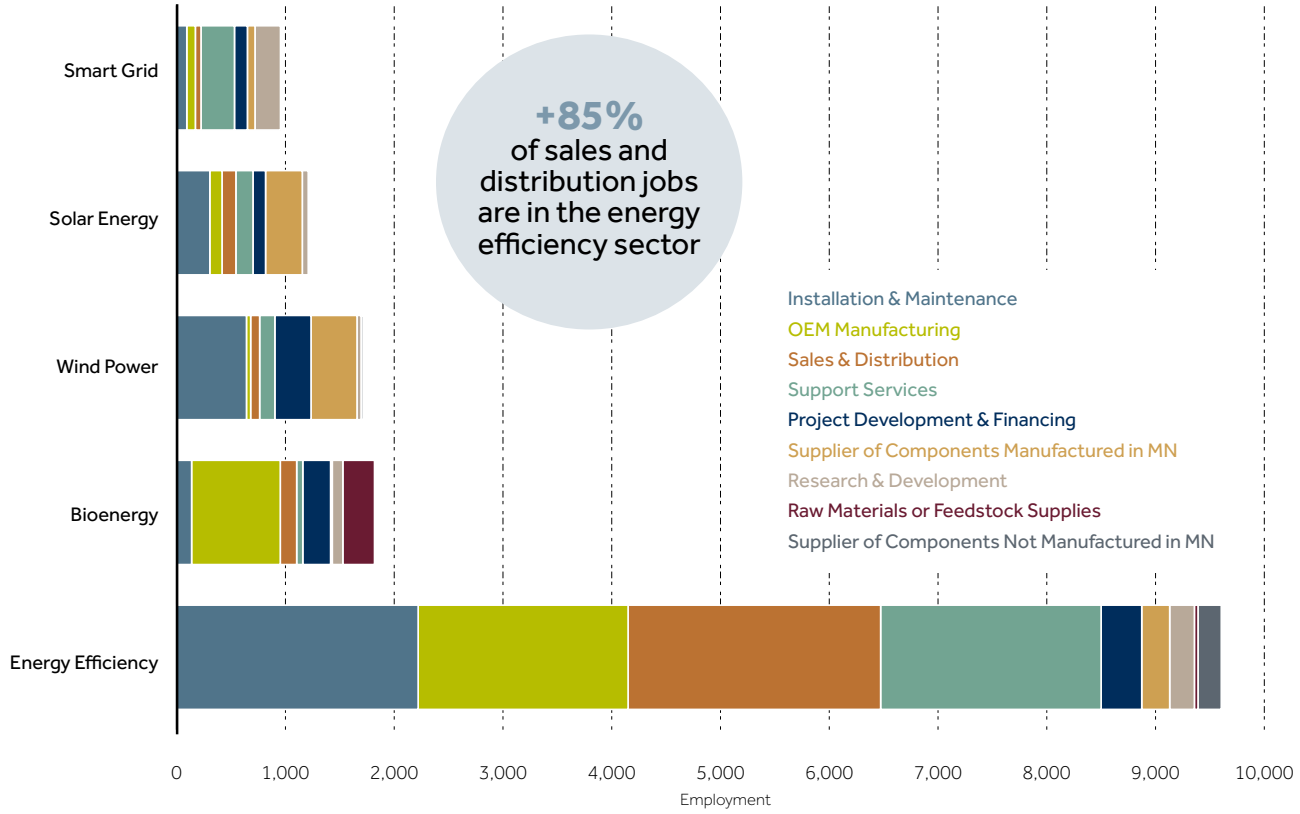
Figure 10 shows employment by clean energy sector and value chain function.[13] Energy efficiency is the largest employer by sector, and therefore generally has the highest level of employment across value chain functions. It employees about 85 percent of all clean energy economy jobs in product sales and distribution functions, and about 65 percent of all clean energy economy jobs dedicated to installation and maintenance. The energy efficiency sector also has the most original equipment manufacturing (OEM) jobs – about 65 percent of all clean energy economy OEM jobs reported.

Bioenergy has the second highest number of OEM manufacturing jobs, primarily from biofuel production facilities. The bioenergy sector also has the most employees in raw material or feedstock suppliers, 88 percent of all clean energy economy jobs in this category, with companies that supply biomass feedstock such as corn and wood.

Wind and solar have the most jobs in companies that supply components manufactured in Minnesota (38 percent and 31 percent of total clean energy economy component supplier jobs). Smart grid has the highest number of jobs in research and development (36 percent of total clean energy economy research and development jobs), typical for emerging, rapidly evolving industries.

Figure 10

CLEAN ENERGY EMPLOYMENT BY SECTOR AND VALUE CHAIN FUNCTION
Minnesota, 2014



Data Source: National Establishment Time Series Database (NETS), IEGC, MN DEED Economic Analysis Unit Survey-July 2014
Analysis: Collaborative Economics

Overall, installation and maintenance is the largest value chain function in the clean energy economy, with nearly 3,400 jobs in first quarter 2014 (Table 3). Employment in installation and maintenance grew 80 percent between January 2000 and first quarter 2014, with growth in companies such as those that install energy conservation measures and solar panels.

OEM manufacturing is the second largest clean energy economy value chain function with nearly 3,000 employees. Considered together with suppliers of components manufactured in Minnesota, there are more than 4,000 clean energy manufacturing jobs in the state.

Sales and distribution is another prominent value chain function, accounting for more than 2,700 jobs in first quarter 2014. Support services and project development and financing have grown rapidly since 2000 (+109 percent and +142 percent respectively), with increases in companies like those that provide energy management services or manage the development of new wind or solar projects

Each clean energy sector in Minnesota has a different distribution of value chain functions, as seen in Figure 11. Energy efficiency jobs are in companies primarily in the four largest value chain functions, while other sectors are spread across more functions. Bioenergy employment is concentrated in OEM manufacturing. Wind power and solar energy employment are both concentrated in installation and maintenance and in suppliers of components manufactured in Minnesota. Smart grid jobs are primarily in research and development and support services.

Table 3

TOTAL CLEAN ENERGY EMPLOYMENT BY VALUE CHAIN
Minnesota

	2014 Employment	2000-2014 Percent Change	2009-2014 Percent Change
Installation & Maintenance	3,396	80%	11%
OEM Manufacturing	2,974	75%	12%
Sales & Distribution	2,736	61%	13%
Support Services	2,688	109%	22%
Project Development & Financing	1,196	142%	0%
Supplier of components manufactured in MN	1,103	24%	-5%
Research & Development	651	53%	29%
Raw Material or Feedstock Supply	330	303%	18%
Supplier of components not manufactured in MN	264	58%	-3%

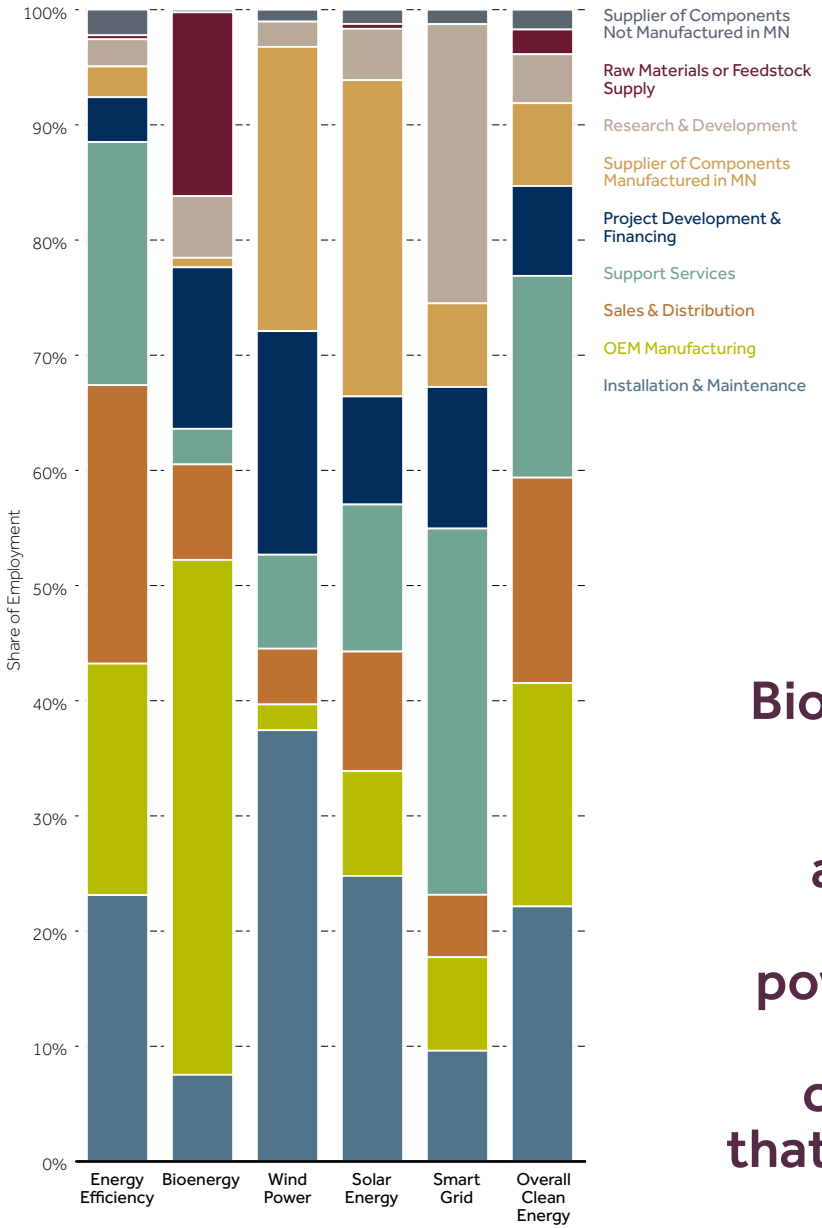
Data Source: National Establishment Time Series Database (NETS), IEGC, MN DEED Economic Analysis Unit Survey-July 2014
Analysis: Collaborative Economics

While installation and maintenance is the largest single value chain function, manufacturing (including both OEMs and Minnesota-based component suppliers) contributes over 4,000 clean energy jobs.

Figure 11

CLEAN ENERGY EMPLOYMENT SHARE BY SECTOR AND VALUE CHAIN FUNCTION

Minnesota, 2014



Data Source: National Establishment Time Series Database (NETS), IEGC, MN DEED Survey as of July 22, 2014
Analysis: Collaborative Economics

Each clean energy sector in Minnesota has a different distribution of functions, as seen in Figure 11. Energy efficiency jobs are in companies primarily in the four largest value chain functions, while other sectors are spread across more functions. Bioenergy employment is concentrated in OEM manufacturing. Wind power and solar energy are both concentrated in installation & maintenance and suppliers of components manufactured in Minnesota, and smart grid jobs are primarily in research & development and support services.

Bioenergy employment is concentrated in OEM manufacturing at biofuel production facilities, while wind power and solar energy both have a high concentration of jobs that supply components manufactured in Minnesota

Clean Energy Businesses

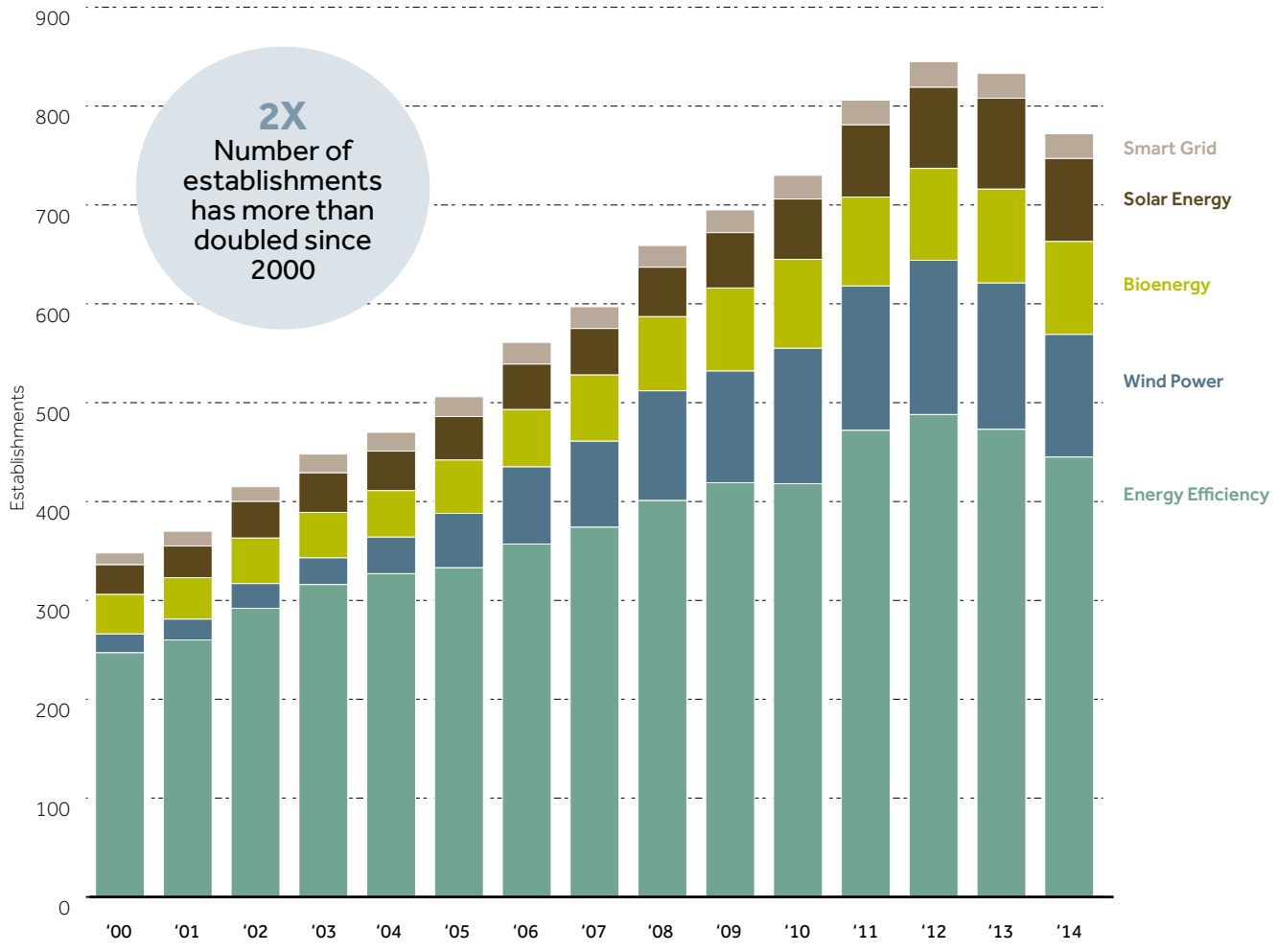
The number of establishments, or individual business locations, in the clean energy economy has more than doubled since 2000, reaching a total of 772 establishments in first quarter 2014 (Figure 12). These establishments are primarily small- and medium-sized employers. As of first quarter 2014, 51 percent of clean energy establishments had fewer than five employees, and 91 percent had fewer than 50 employees. The wind power sector has the second highest number of establishments, even though it is third highest in total employment. This occurs because most wind establishments are small employers, such as individual wind farms, whereas bioenergy firms such as biofuel production facilities have a higher concentration of jobs per site.

Despite a long term growth trend, the number of clean energy establishments dropped 7 percent between first quarters 2013 and 2014, with declines in all sectors except smart grid. This mirrors a statewide decrease in establishments of 7.5 percent between first quarters 2013 and 2014. The majority of the clean energy establishment decreases in the last year occurred in the energy efficiency and wind sectors at business locations with five or fewer employees. The decline in wind establishments aligns with a drop in wind installations and employment, partly due to uncertainty around federal policies and incentives considered important for parties financing wind projects.

Figure 12

CLEAN ENERGY ESTABLISHMENTS BY SECTOR

Minnesota, 2000-2014

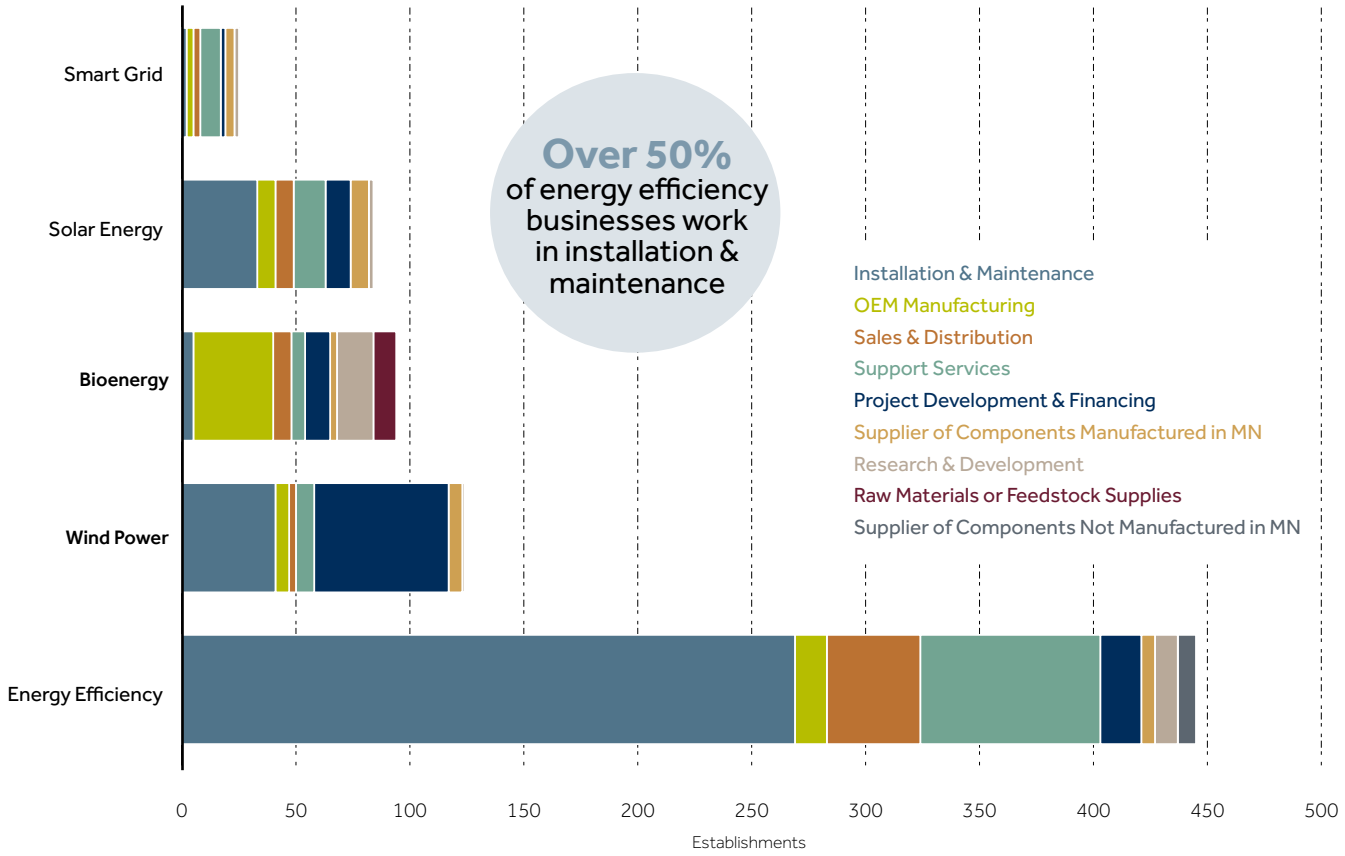


Data Source: National Establishment Time Series Database (NETS), IEGC, MN DEED Economic Analysis Unit Survey-July 2014
Analysis: Collaborative Economics

The distribution of business establishments across value chain functions varies from employment by value chain function. Figure 13 shows that more than half of energy efficiency establishments work primarily in installation and maintenance functions, much more than their share of employment in the sector. OEM manufacturing, on the other hand, is a smaller part of total energy efficiency than its employment proportion. This aligns with the types of businesses in energy efficiency, with many small businesses that install conservation measures such as weatherization, and a few larger corporations that manufacture efficient products. Solar energy and wind power have smaller proportions of establishments that supply component parts manufactured in Minnesota, illustrating that these are relatively small number of companies but that they employ a larger than average number of workers. Bioenergy has a higher proportion of research and development establishments compared with employment levels, and smart grid is spread fairly evenly across value chain functions, with the most in support services.

Figure 13

CLEAN ENERGY ESTABLISHMENTS BY SECTOR AND VALUE CHAIN FUNCTION
Minnesota, 2014



Data Source: National Establishment Time Series Database (NETS), IEGC, MN DEED Economic Analysis Unit Survey-July 2014
Analysis: Collaborative Economics

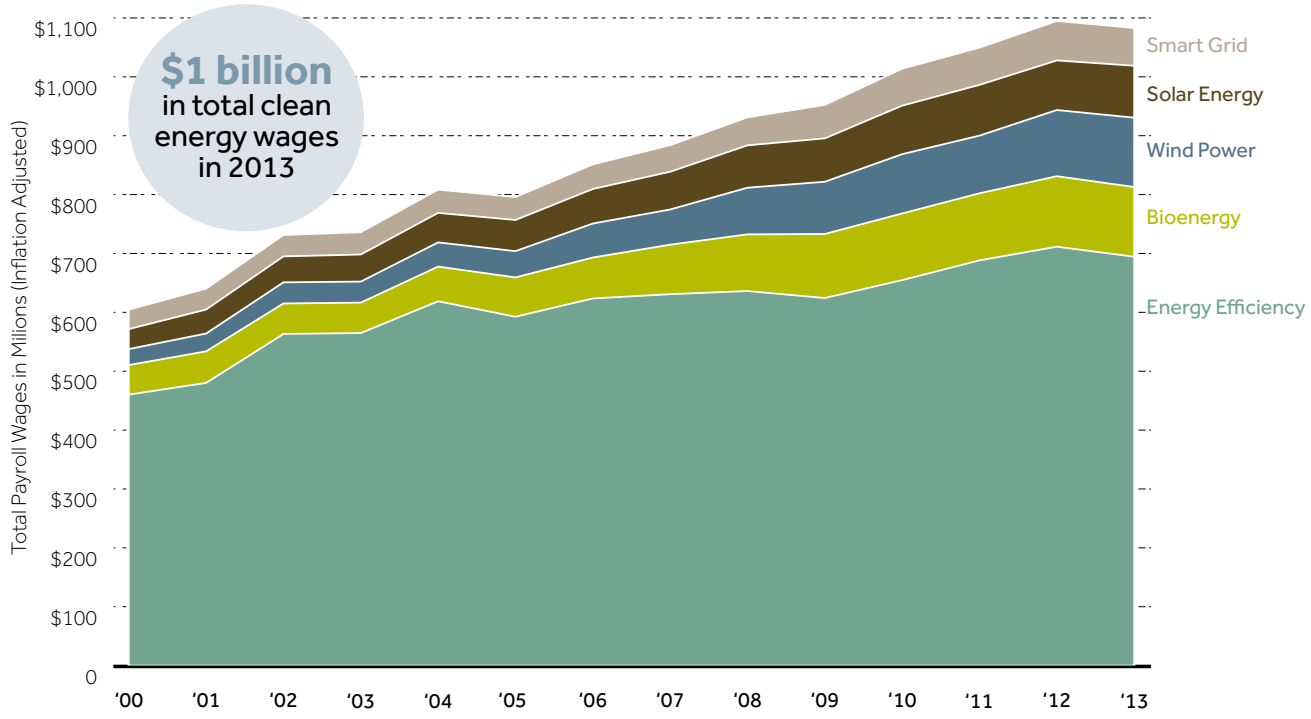
Clean Energy Wages and Revenue Source

Wages in the Clean Energy Economy

Minnesota workers in the clean energy economy brought home over $1 billion in wages in 2013, up 79 percent from about $600 million in 2000 (full year wages, inflation adjusted to 2013 dollars). Figure 14 illustrates the rapid growth in total wages in each sector between 2000 and 2013, reflecting the increase in employment over the same period. Wages decreased slightly in 2013 as a result of the dip in employment in that year. Energy efficiency sector wages grew 51 percent between 2000 and 2013, reaching nearly $700 million. Bioenergy and wind power sectors each generated about $118 million in wages in 2013, with bioenergy double and wind power quadruple the amount in 2000. Solar energy wages totaled roughly $88 million in 2013, 2.6 times higher than 2000, and smart grid total wages doubled since 2000 to reach $64 million in 2013.

Figure 14

CLEAN ENERGY WAGES
Minnesota, 2000-2013*



*In 2013 dollars
Data Source: MN Unemployment Insurance Database
Analysis: MN DEED Economic Analysis Unit

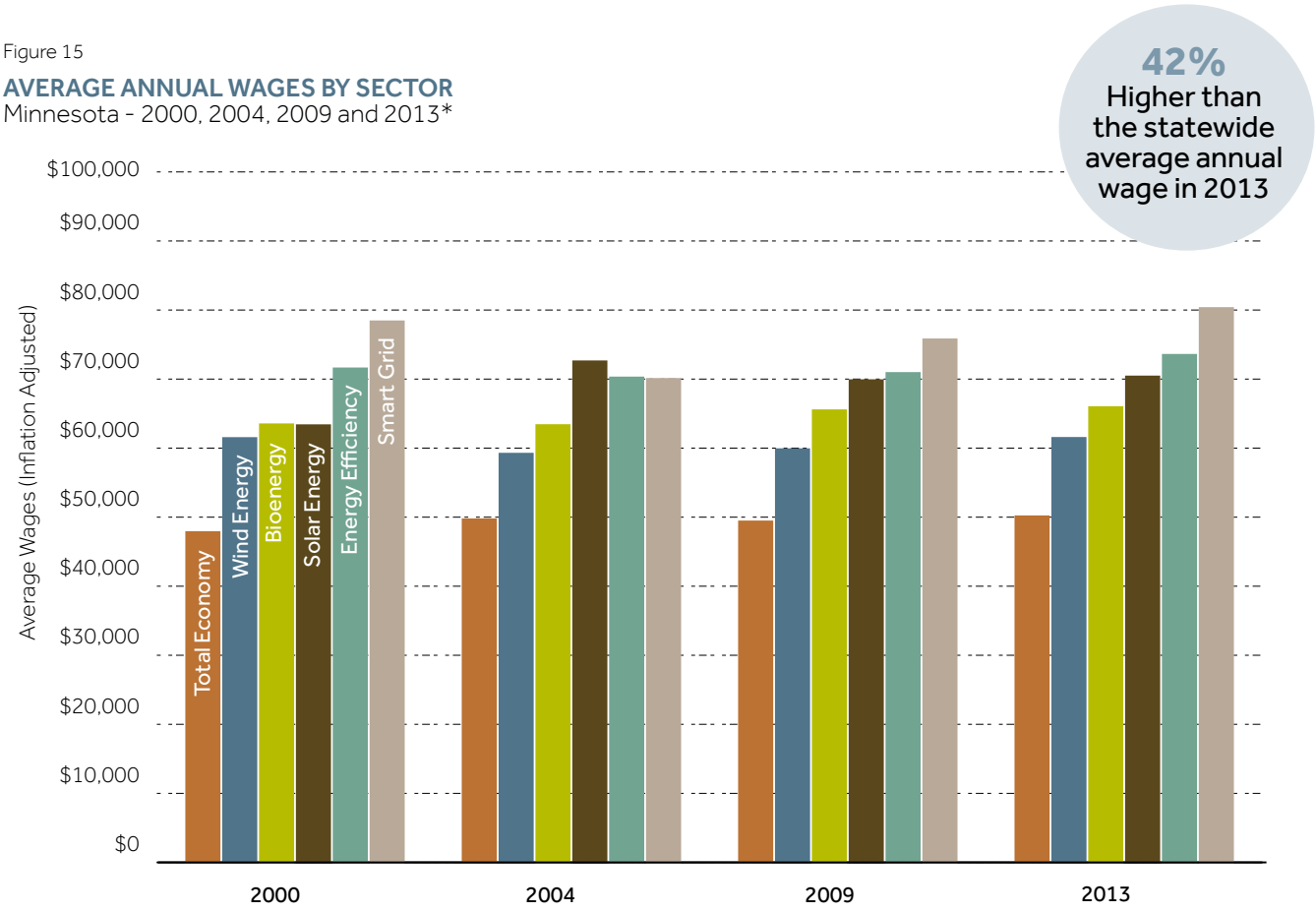
Clean energy jobs, on average, pay workers more than the average job in Minnesota overall. Average annual wages in the clean energy economy were about $71,000 in 2013, which was 42 percent higher than the statewide average annual wage of about $50,100. Clean energy average wages were also higher than both construction and manufacturing industries in 2013 ($57,320 and $ 59,575 respectively).[14]

As shown in the value chain function analysis, these jobs are diverse and range from installation and manufacturing to sales, not just in high-tech functions like research and development with high education requirements. Other research suggests that higher than average wages are also a result of the specialized knowledge required for some clean energy jobs. These clean energy jobs often require a vocational or bachelor's degree, or on-the-job training for required technical skills.[15]

Clean energy average wages are driven by the largest sector, energy efficiency, though average annual wages in each clean energy sector are consistently more than the state average (Figure 15). Inflation-adjusted wages have increased slightly since 2000, with the largest jump in solar energy average annual wages of 11 percent. The smart grid sector reported the highest average annual wages in 2013 at $80,300, followed by energy efficiency at $73,500, solar energy with $70,400, bioenergy with $66,000, and wind power at $61,500.

Figure 15

AVERAGE ANNUAL WAGES BY SECTOR
Minnesota - 2000, 2004, 2009 and 2013*



*In 2013 dollars
Data Source: MN Unemployment Insurance Database
Analysis: MN DEED Economic Analysis Unit

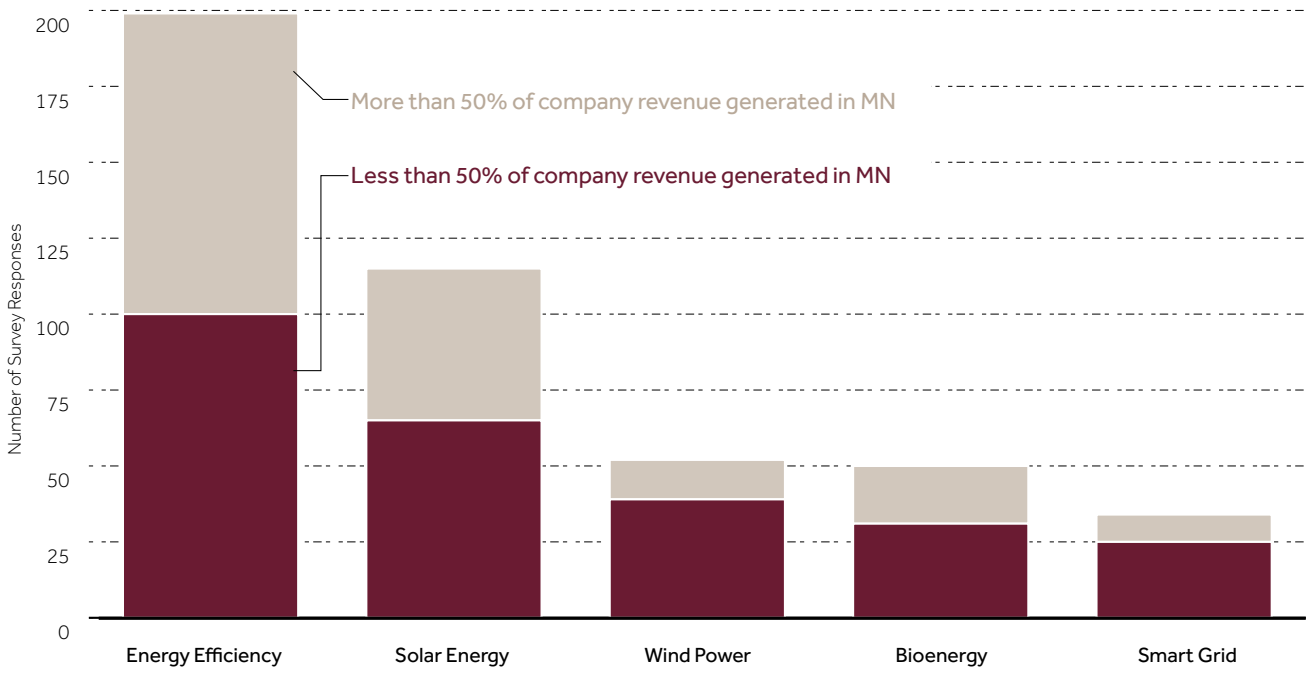
Reported Revenue in the Clean Energy Economy

Minnesota clean energy companies maintain a majority of their operations in Minnesota, with most surveyed companies reporting that more than half of their revenue is generated from within Minnesota. Energy efficiency and solar energy sector companies in particular generate most of their revenues from within Minnesota, which is a reflection of common value chain functions in those sectors that are often based locally, such as installation and maintenance of energy systems or solar panels. The majority of companies in the wind power, bioenergy, and smart grid sectors reported that more than half of their revenue came from outside of Minnesota. This could reflect their services or products such as wind developers that operate in neighboring states, or producers of biofuel or component parts that sell out of state.

Few clean energy companies reported revenue from exports and operations outside of the US (Figure 16). About three-quarters of the companies in each sector reported no revenue generated from outside of the US, and less than 10 percent reported more than 25 percent of their revenue from exports. This suggests that Minnesota clean energy companies have a largely untapped opportunity for exporting products and services to other states and countries

Figure 16

COMPANY REVENUE BY LOCATION SOURCE
Minnesota, 2014



Data Source: MN DEED Economic Analysis Unit Survey-July 2014
Analysis: Collaborative Economics

Regional Clean Energy Employment

Minnesota's diversity of sectors and value chain activities in the clean energy economy build from a broad range of assets and clean energy activities within its regions. The seven geographical regions used in this analysis are defined by the Minnesota Initiative Foundations, and are larger groupings of the 10 economic development regions serviced by the state's Department of Employment and Economic Development.[16] These regions have different strengths and capacities in the clean energy economy, largely based on local renewable resources, historical industries, workforce capacity, and supporting institutions.

The Twin Cities Metro area has the most jobs in the clean energy economy, as would be expected given the large population in the region (Table 4). The map in Figure 17 factors in regional levels of total employment, and shows that the Southwest region actually has the highest concentration of clean energy employees compared with the state average. This high concentration in the Southwest suggests a regional specialization and competitive advantage, even though the total number of clean energy employees is fourth highest.

The Twin Cities Metro has the highest total employment levels in the overall clean energy economy of Minnesota's regions. With over 9,700 jobs, the Metro accounted for 63 percent of Minnesota clean energy employment in 2014. Between January 2000 and first quarter 2014, Metro clean energy employment rose by nearly 53 percent, led by strong growth in the smart grid and solar sectors (+185 percent and +138 percent, respectively). Energy efficiency continued to account for the largest proportion of clean energy jobs in the region (73 percent of the total), with solar energy as the second-largest sector with 10 percent of clean energy jobs in the region.

Table 4

REGIONAL CLEAN ENERGY EMPLOYMENT
Minnesota

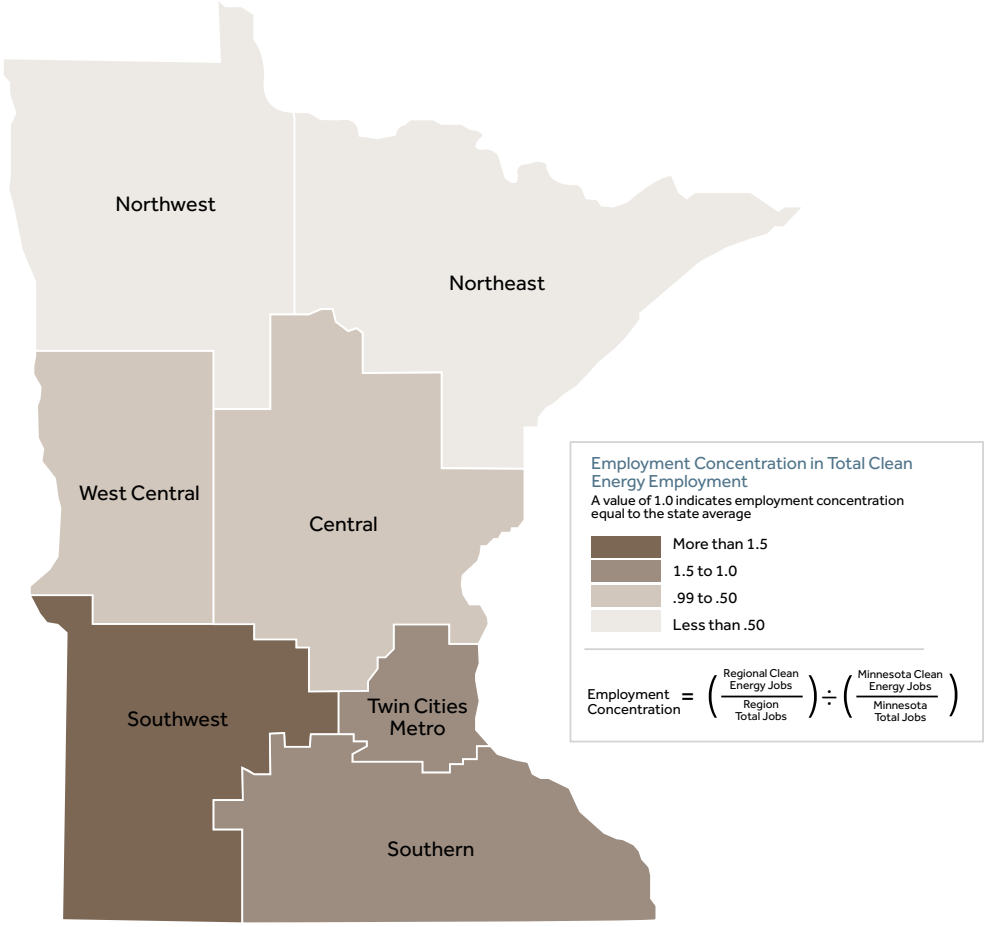
	Clean Energy Employment 2014	% Change in Clean Energy Employment 2000-2014
Twin Cities Metro	9,725	53%
Southern	2,234	71%
Central	1,393	191%
Southwest	1,312	425%
Northeast	317	146%
West Central	283	408%
Northwest	74	13%
Minnesota State Total	15,338	78%

Data Source: National Establishment Time Series Database (NETS), IEGC, MN DEED Economic Analysis Unit Survey-July 2014
Analysis: Collaborative Economics

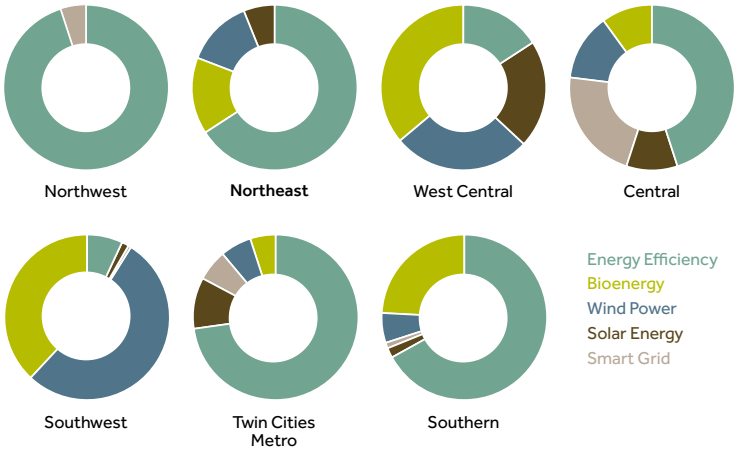
9,725 jobs
in Twin Cities Metro, the highest total employment level in overall clean energy economy

Figure 17

TOTAL CLEAN ENERGY EMPLOYMENT CONCENTRATION BY REGION
Relative to Minnesota, 2014



REGIONAL CLEAN ENERGY EMPLOYMENT DISTRIBUTION BY SECTOR
Minnesota, 2014



Why is Employment Concentration Important?

Employment concentration is a measure of the importance of an industry in a region compared with a larger region. Higher concentration of employment may be evidence of an industry cluster and a regional competitive advantage. Research links regional clusters to superior industry performance due to better-developed supplier networks, supply of skilled labor, productivity increases, and access to resources. Policy that supports this clustering can lead not only industry growth, but also increased prosperity for the regional economy.

Data Source: National Establishment Time Series Database (NETS), IEGC, MN DEED Economic Analysis Unit Survey-July 2014
Analysis: Collaborative Economics

Minnesota's Southwestern region has the highest clean energy employment concentration in the state, and experienced the fastest rate of growth in clean energy employment over the past 15 years. Clean energy employment in the Southwest reached 1,300 jobs in first quarter 2014 (9 percent of state total), and was five times higher than January 2000 employment levels. The region's strong wind resources and agricultural assets have encouraged installation of wind farms and bioenergy facilities; the Southwest region's wind sector employment is the largest of any region, accounting for over 40 percent of all wind jobs in Minnesota. Bioenergy is the second largest sector for the region, with 500 jobs in first quarter 2014.

The Southern region has the second highest number of jobs in Minnesota's clean energy economy, with about 2,200 jobs (15 percent of the state total) in first quarter 2014. Energy efficiency and bioenergy are the region's strongest sectors, with roughly 1,500 and 500 jobs, respectively, and the region has the most bioenergy employees in the state. The sector has grown substantially over the past decade, nearly tripling between 2000 and 2014, largely based on strong growth in ethanol plants and production.

Minnesota's Central region accounts for the third-highest number of total clean energy jobs in the state (slightly less than 1,400 jobs as of first quarter 2014), with 9 percent of the state total. The region has the second highest levels of solar energy and smart grid employment (roughly 140 and 300 jobs, respectively). The region's largest sector is energy efficiency, followed by smart grid. All sectors have grown substantially over the past decade.

In the Northeast, Northwest, and West Central regions, clean energy employment levels and concentration are relatively low, but have expanded in the last 15 years and offer opportunities for good jobs in the future. Northeast (317 jobs), West Central (283 jobs), and Northwest (74 jobs) collectively accounted for 4 percent of the state total in the first quarter of 2014. Please note that these employment figures represent conservative estimates of clean energy jobs in each region; the Appendix offers more detail on methodology, which involved review of the National Establishments Time Series (NETS) database and a survey of Minnesota's clean energy businesses by DEED. Energy efficiency is the largest sector in the Northeast and Northwest regions, while the West Central region's most prominent sector is bioenergy, followed by wind power. In the Northeast region, energy efficiency jobs roughly doubled over the decade through first quarter 2014 and tripled over the 15-year period, with similar increases in solar employment. In the Northwest region, energy efficiency employment in first quarter 2014 was 40 percent higher than in 2000, although it remained a fairly small sector (70 jobs in 2014). West Central's clean energy employment overall was five times larger in first quarter 2014 than in January 2000, with increases concentrated in wind, bioenergy, and solar.

CLEAN ENERGY INNOVATION

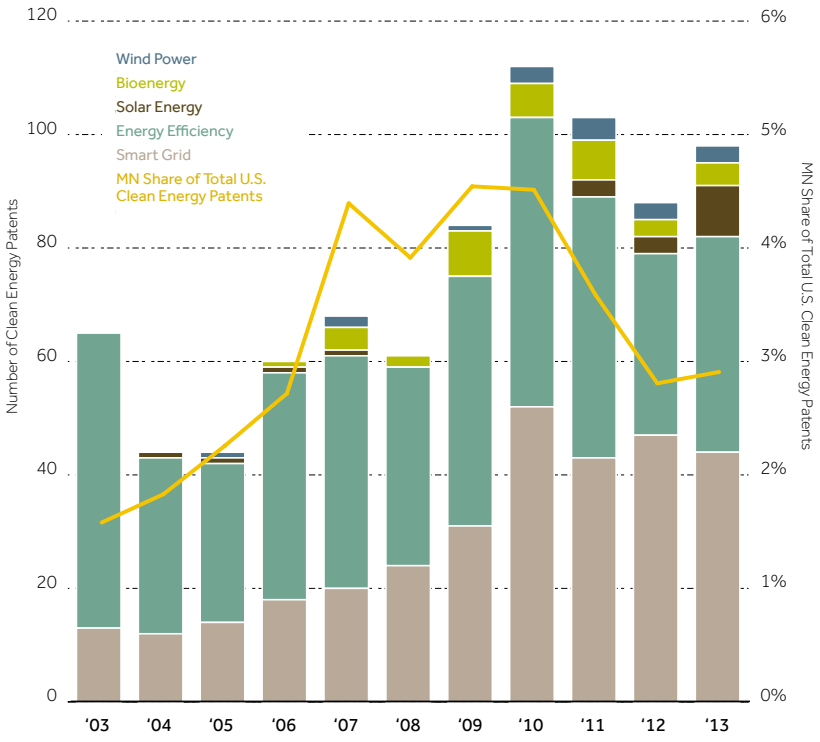
Innovation is the cornerstone of the clean energy economy, creating new products and processes that allow the state to transition away from fossil fuels and use natural resources more efficiently. Clean energy sectors are driven by innovation of new technologies, processes, and materials that disrupt or transform existing industries. Clean energy innovation includes corporate research, university labs and research centers, startup business activity, business and technology incubators, and more. Since innovation can be difficult to measure directly, a number of proxy data points are commonly used to gauge activities that surround innovation. This section evaluates three of these common measures in order to measure activity at the development, growth and deployment stages of clean energy innovations.

Innovation Development: Patents

Patents have long been used to measure an important aspect of innovation: the output of research efforts to produce commercializable intellectual property. In 2013, Minnesota ranked eighth in the country in total clean energy patents, a leap from a decade ago when the state ranked 20th (Table 5). Minnesota not only ranks high in the US, but the state is also a leader in the Midwest, behind only Michigan and Illinois. Minnesota's gain in ranking is due to strong and growing performance throughout the decade, particularly since 2010. Figure 18 illustrates that in the early years of the new millennium, Minnesota clean energy patents grew in both total number and in total share of US clean energy patents. Minnesota's share of total US clean energy patents peaked in 2010, with 112 total clean energy patents, or 4.5 percent of the US total. In 2011 and 2012, patent activity and market share declined slightly, but started to rebound in 2013.

Figure 18

CLEAN ENERGY PATENTS BY TECHNOLOGY TYPE
Minnesota and Share of U.S., 2003-2013



Data Source: 1790 Analytics, Patents by Technology; USPTO Custom Data Extracts
Analysis: Collaborative Economics

Table 5

TOP RANKING STATES IN CLEAN ENERGY PATENTS REGISTERED
2013

	Total Clean Energy Patents	2013 Rank	2003 Rank
California	1,125	1	1
Texas	340	2	4
New York	267	3	2
Massachusetts	210	3	13
Michigan	192	5	3
New Jersey	110	6	7
Illinois	103	7	8
Minnesota	98	8	20
Colorado	98	8	11
Pennsylvania	95	10	9

Ranked 8th
in the country
in total clean
energy patents

At the sector level, Minnesota performs competitively in the areas of smart grid, energy efficiency, solar energy, and wind power. Clean energy patents were mostly in the energy efficiency sector in earlier years, but more recently activity increased across all sectors, similar to employment patterns in the state. Smart grid in particular grew over the last decade, with more than three times the patents in 2013 as in 2003. Bioenergy had high activity from 2009 to 2011, and solar energy patents jumped in 2013 to nine patents compared to three in 2012. Minnesota ranks high among states in the smart grid sector, with patents in technologies such as batteries and energy infrastructure (Table 6). Almost half of the clean energy patents in 2013 were related to smart grid, placing Minnesota sixth in the nation. Minnesota is also close to the top 10 states in energy efficiency, solar energy, and bioenergy.

Most of the patent activity in Minnesota comes from local companies. Firms that had the largest contribution to patenting activity in the clean energy sectors over the last decade include 3M, Honeywell, and IBM (Table 7). The presence of large firms that are internationally recognized for their research activity contributes important weight to Minnesota's innovation economy, drawing talent and resources, and helping attract new businesses and entrepreneurs to the state.

The smart grid sector registered more than three times as many patents in 2013 than in 2003, placing Minnesota sixth in the nation for patents in smart grid

Table 6

CLEAN ENERGY PATENTS REGISTERED
Minnesota Rank among U.S. States, 2013

	Rank in U.S.	Total Patents
Smart Grid	6	44
Energy Efficiency	12	38
Solar Energy	13	9
Bioenergy	13	4
Wind Power	22	3
Total Clean Energy Rank	8	98

Table 7

TOP 10 CLEAN ENERGY INVENTOR COMPANIES
Minnesota, 2013

	Total Clean Energy Patents	State Rank
3M Innovative Properties Co.	141	1
Honeywell International	102	2
IBM	90	3
Medtronic	66	4
Rosemount	25	5
Seagate Technology	24	6
Cymbet Co.	23	7
Celadon Systems	20	8
Micron Technology	18	9
SPX Co.	17	10

Data Source for Tables 5 and 6: 1790 Analytics, Patents by Technology; USPTO Custom Data Extracts
Analysis: Collaborative Economics

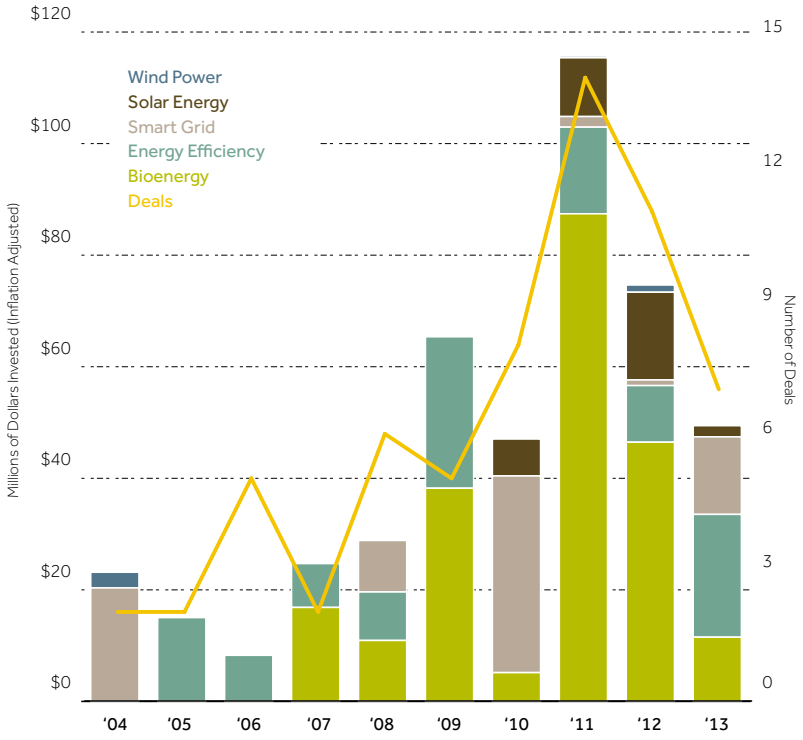
Innovation Growth: Early Stage Investment

To move from an idea or prototype to a commercializable product, researchers, inventors, and entrepreneurs need funding. Early stage investments, like venture capital, grants, and loans are an indicator of how active investors are in helping Minnesota entrepreneurs bring their ideas to market. In terms of overall early stage investment, private companies in the state received about $450 million between 2004 and 2013, about half of which was in the bioenergy sector. In 2013, seven companies received a total of nearly $50 million. The state's most recent investment high was in 2011, with 14 deals totaling over $115 million in early stage funding for clean energy private companies (Figure 19). The rise in early stage investment in clean technologies between 2009 and 2011, followed by a steep decline, mirrors the nationwide trend in clean technology investment. Despite this recent decline, companies are still launching and receiving funding.

Venture capitalists varied funding for clean energy sectors in Minnesota over the years. Energy efficiency companies are fairly consistently funded, such as SAGE Electrochromatics, and recently there has been a surge in funding for bioenergy companies such as the biochemical firm BioAmber. Smart grid and solar have also received bumps in funding in recent years, with companies such as the energy storage firm Cymbet and solar firm tenKsolar. Over the past decade, Minnesota has attracted over $400 million in venture capital dollars for clean energy companies, placing it second only to Illinois when in the Midwest (Table 8).

Figure 19

EARLY STAGE INVESTMENT IN CLEAN ENERGY COMPANIES
Minnesota, 2004-2013



Note: Early stage includes venture capital, angel, grants and debt/loans for private companies. Does not include corporate research.
Data Source: CB Insights
Analysis: Collaborative Economics

Table 8

TOTAL VC INVESTMENT IN CLEAN TECHNOLOGY COMPANIES
By Midwest State, 2004-2013

	2004-2013 (in millions)
Illinois	$788.66
Minnesota	$422.38
Michigan	$411.64
Wisconsin	$128.10
Iowa	$108.97

Over $400M in venture capital dollars for Minnesota clean energy companies over the past decade

Innovation Deployment: Project Finance

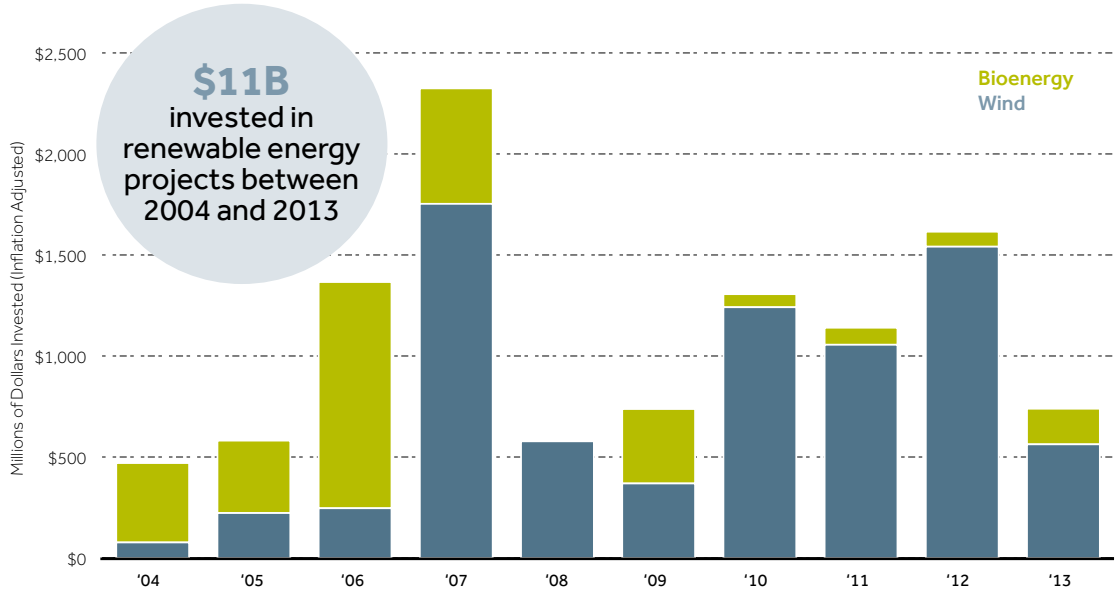
Project financing is a key enabler of clean energy deployment, helping companies, governments, and individuals bridge the up-front investment cost of projects. To bring technologies to scale and to deploy them requires the next level of financing beyond early stage venture capital or grants. Project financing investment is primarily composed of private funds in the form of tax equity, corporate financing, or loans from banks, and focuses on installing and deploying technology, such as utility scale renewable energy projects and biofuel production facilities.

Movement into project finance in the clean energy economy signals a maturation of the market as investors see the technology not as something to bet on, but as something that generates guaranteed returns. Unlike early stage investment, which is an investment in the company itself, project financing investment affects company growth through higher sales. As new technologies are deployed, companies benefit from higher revenues, economies of scale in production, and access to lower cost of capital as risk falls. Although project finance is not the only enabler of clean energy sales, it is an important tool for renewable energy deployment, especially for large-scale projects.

Between 2004 and 2013, the private sector invested nearly $11 billion total in renewable energy projects in Minnesota (Figure 20).[17] The decrease in investment in 2013 tracks with a decrease in wind installations in the state, largely as a consequence of uncertainty surrounding the federal production tax credit. Bioenergy received the most investment in earlier years as new ethanol production facilities launched in the state. Wind power received the most investment since 2007, which tracks to high installation activity in recent years. Utility-scale wind projects, like the Grand Meadow and Bent Tree wind farms, attract investors who see Minnesota's wind market and its future productivity as a smart investment in a secure and growing market.

Figure 20

PRIVATE RENEWABLE ENERGY PROJECT FINANCING
Minnesota, 2004-2013



Note: Data includes projects receiving asset finance in New Build, Acquisition, and Refinancing; Bioenergy sector includes Biofuels and Biomass & Waste

Data Source: Bloomberg New Energy Finance

Analysis: Collaborative Economics

Public and Utility Investment in Project Financing

Minnesota government agencies, utilities, and non-profits invest over $400 million annually in energy efficiency and renewable energy projects in the state.

CONCLUSION

Minnesota demonstrates how the clean energy economy can increase economic competitiveness, provide high-paying jobs, decrease dependence on imported fuels, and improve air and water quality. State policies have removed barriers and attracted investment since the early 1980s. Minnesota is continuing to stimulate economic development with new policies, such as policies passed in 2013 that encourage adoption of solar energy in the state. This consistent policy support can provide a conducive environment for clean energy businesses to locate and grow in Minnesota.

The clean energy economy in Minnesota now sustains over 15,300 jobs and has expanded 78 percent since 2000, while state employment overall increased 11 percent. Employment in the clean energy economy is increasingly diversifying across sectors, as relatively small sectors such as solar, wind, and smart grid are rapidly expanding. Regions in the state are specializing and growing their clean energy economies, largely based on local renewable resources. These clean energy jobs are providing average annual wages that are 42 percent higher than the statewide average, and offer opportunities in a wide variety of businesses. Businesses in the state are inventing new clean energy technologies, placing Minnesota eighth in the US in total clean energy patents in 2013. Companies are also attracting new investment to expand the local clean energy market, with nearly $11 billion in project financing in the state between 2004 and 2013. This clean energy development reduces the state's dependence on imported fossil fuels.

Due in part to national jobs and economic reports - including market intelligence reports about the growing international demand for clean energy products - other states are rapidly accelerating efforts to attract new clean energy investments.

However, the state has a significant competitive advantage due to Minnesota's robust developments in the clean energy economy over the last 25 years, along with its public and private sector technical and financial expertise, substantial clean energy infrastructure, and businesses spanning the value chain. Minnesota has created a window of opportunity to meaningfully compete in a $1.13 trillion global clean energy market and advance clean energy economic development in communities throughout the state.

APPENDIX

Clean Energy Savings and Installation Data

The Minnesota Department of Commerce provided data for energy efficiency savings, solar, and wind installation capacity.

The Minnesota Department of Agriculture provided data for ethanol and biodiesel production capacity and number of plants.

The US Energy Information Administration provided data for bioenergy electricity generation as net generation of electricity by energy source.

This report analyzes the impact of current Minnesota clean energy policy on only five industries. It does not consider the impacts (positive and negative) on other Minnesota industries; nor does it consider alternative policies which might have produced more positive and less negative results.

Employment Data Methodology

Collaborative Economics has developed a multifaceted approach for identifying and tracking the growth of businesses with operations primarily in the Clean Energy Economy. This methodology was originally developed for work carried out on behalf of Next 10, a California-based nonprofit, and published in the California Green Innovation Index and Many Shades of Green (2008, 2009, 2010, 2012, 2013, and 2014), and was enhanced and revised in conjunction with Minnesota Department of Employment and Economic Development (DEED) databases and analysis.

Constructing the MN Clean Energy Economy employment database involved multiple data sources. To identify the potential Clean Energy Economy businesses, Collaborative Economics, in coordination with the state and industry stakeholders, developed a list of standard industrial classification (SIC) and North American Industry Classification System (NAICS) codes likely to include at least some clean energy companies, drawing on clean economy jobs and technology literature, as well as independent review of the industry code. In addition to these industry codes, Collaborative Economics identified specific companies active in the clean energy economy, leveraging multiple data sources, including records of clean energy investments (e.g. Bloomberg New Energy Finance, CB Insights), industry associations or databases (e.g. Solar Energy Industries Association, American Wind Energy Association, Renewable Fuels Association), media sources (e.g. GreenTech Media, CleanTechnica), and Minnesota's prior research and industry engagement efforts.

Using the 2012 National Establishments Time Series (NETS) database, Collaborative Economics leveraged the industry codes and company lists to identify specific Direct Clean Energy Economy establishments within Minnesota. The NETS database was developed by Walls & Associates, based on Dun & Bradstreet business-unit data and represents a census of jobs and establishments. The Institute for Exceptional Growth Companies (IEGC) at the University of Wisconsin Extension Division of Entrepreneurship and Economic Development provided 2013 and 2014 employment data, which was appended to the 2012 NETS database by Collaborative Economics. IEGC assembled, verified, and, where necessary, updated Dun & Bradstreet data for latest full calendar year rolling through each current quarter.

Through both automated and manual verification of these establishments, Collaborative Economics identified companies from within the potential list of companies that conducted a majority of their business activities in the clean energy economy, and assigned an appropriate clean energy segment and value chain. Identification of companies focused on establishments with employment in 2012-2014, and therefore does not include a full analysis of companies that may have been active in earlier years (e.g. 2000-2001) and closed before 2012. In cases where the results were uncertain and the activities of a business establishment could not be verified (e.g. on a company's website, through public record), the establishment was not included. Therefore, the analysis offers a conservative tracking of jobs in the Clean Energy Economy.

The jobs numbers reported in the database reflect all jobs at each vetted business location for which a majority of the business operations are in the clean economy. In the case of multi-establishment companies, only the clean energy establishments are included.

To further refine and tailor Minnesota's Clean Energy Economy jobs database, DEED issued a survey to businesses potentially in clean energy sectors regarding employment and revenue activity in each sector. Collaborative Economics used the survey results to identify additional establishments, and to apportion more specific levels of employment within companies to clean energy sectors and value chain functions. Establishments that reported clean energy employment at significantly different levels than the NETS/IEGC data were cross checked with DEED databases and, if appropriate, employment was adjusted and/or deflated over time at the average growth rate of the companies' respective clean energy sector. A total of 7,900 emails were sent (including to multiple within a company). As of July 22, 2014, 417 companies responded to the survey, for a response rate of 5.3 percent. A total of 335 companies provided usable employment information included in the final analysis.

Regional analysis uses the seven Minnesota Initiative Foundation regions. These regions are larger groupings of the ten economic development regions serviced by the state's Department of Employment and Economic Development.

Wage Data Methodology

DEED's Economic Analysis Unit conducted wage analysis using establishments identified in NETS/IEGC (described in employment methodology above) and Minnesota's unemployment insurance (UI) records. Minnesota's UI record database is a joint effort of DEED and the Bureau of Labor Statistics. Using a crosswalk provided by Dun & Bradstreet of DUNS numbers with tax identification numbers and a manual review process, researchers linked firms from the NETS database to DEED's UI records. This data set is comprised of data reported by employers as part of unemployment compensation filings (ES-202 Program). In doing so, DEED staff were able to link 89 percent of employment identified by NETS to an employer over the period. The firms researchers were unable to identify, tended to be small (<five employees) and recently founded. This finding is consistent with academic critiques of differences between NETS and the ES-202 program. The NETS employment and UI average wage per worker were combined to get total payroll. Where necessary, outliers were smoothed to ensure consistency between the two sources.

In the 11 percent of cases in which researchers were unable to link a NETS employer to the UI database, the research team used the average wage rate and multiplied by the remaining NETS clean energy employees by sector, and added to clean energy total wages.

All wages were adjusted for inflation using the U.S. city average Consumer Price Index of all urban consumers, published by the Bureau of Labor Statistics.

Early Stage Investment in Clean Energy Companies

Clean energy investment data are provided by CB Insights™ (www.cbinsights.com) and includes disclosed investment deals in private companies. Data is through December 2013. All figures were adjusted for inflation using the U.S. city average Consumer Price Index of all urban consumers, published by the Bureau of Labor Statistics.

Early Stage investment data includes venture capital (Angel, Seed, Series A-E+, Growth Equity, Bridge, and Incubator series types), debt (credit and loans from private investors such as banks, investment funds, and financial services groups), and grants from federal and state government agencies. Venture capital investment comprises the majority (93 percent of 2004-2013 total) of early stage investment in Minnesota.

Clean Energy Patents

For Solar, Wind, Bioenergy, and Smart Grid sectors, 1790 Analytics developed and performed the search of U.S. Patent data from the U.S. Patent & Trade Office based on search criteria defined in conjunction with Collaborative Economics. Smart Grid sector patents include Energy Infrastructure, Battery, Fuel Cell (not for vehicles) categories.

Energy efficiency sector patents were compiled from a custom search by Collaborative Economics. Analysis used U.S. Patent & Trade Office Custom Data Extracts and identified codes from an independent review of International Patent Classification codes listed in the World Intellectual Property Organization's IPC Green Inventory. Collaborative Economics removed any duplicates in categories.

Project Financing

Private sector project financing investment data are provided by Bloomberg New Energy Finance (www.bnef.com). All figures have been adjusted for inflation using the U.S. city average consumer price index of all urban consumers, published by the Bureau of Labor Statistics. The Bloomberg New Energy Finance asset finance database tracked deals financing acquisition, new build, and refinancing for utility-scale renewable energy projects. Financing is primarily from private sector entities and includes tax equity, corporate financing, and loans from banks. In the Bloomberg database, estimates have been made for those deals with undisclosed values as well as for untracked deals aiming to close the gaps in coverage caused by timelags in deal discovery. Where portfolios have been financed across multiple states, equal proportions of the financing have been assigned to each state.

The private renewable energy project finance data does not include other types of financing for implementation such as direct purchases by customers, property assessed clean energy (PACE) financing, energy service contracts, or revolving loans.

Public and utility project finance data is provided by the Coalition for Green Capital, in their Overview of Existing Minnesota Clean Energy Financing Programs, August 2014.

ENDNOTES

1. U.S. Energy Information Administration. "State Profile and Energy Estimates. http://www.eia.gov/state/data.cfm?sid=MN#ReservesSupply.
2. Navigant Research. "Advanced Energy Now 2014 Market Report: Global and U.S. Markets by Revenue 2011-2013 and Key Trends in Advanced Energy Growth." February 2014. Advanced Energy Economy.
3. U.S. Energy Information Administration. Net generation of electricity by energy source.
4. Minnesota Department of Agriculture. "Minnesota Ethanol Industry." 2012.
5. U.S. Energy Information Administration. "State Profile and Energy Estimates. http://www.eia.gov/state/data.cfm?sid=MN#ReservesSupply.
6. Navigant Research. "Advanced Energy Now 2014 Market Report: Global and U.S. Markets by Revenue 2011-2013 and Key Trends in Advanced Energy Growth." February 2014. Advanced Energy Economy.
7. U.S. Energy Information Administration. Net generation of electricity by energy source.
8. Minnesota Department of Agriculture. "Minnesota Ethanol Industry." 2012.
9. While Minnesota's overall clean economy includes additional sectors such as advanced transportation, hydropower, and water tech, analysis of Minnesota's clean energy economy is currently focused on these five sectors due to time and budget constraints.
10. AWEA Market Reports and State Factsheets http://www.awea.org/Resources/ as of August 6, 2014
11. State of Nebraska. "Ethanol Facilities' Capacity by State." As of February 2014. Official State of Nebraska Website. http://www.neo.ne.gov/statshtml/121.htm
12. For other industry employment comparisons, Collaborative Economics used North American Industry Classification System (NAICS) from National Establishment Time Series and Institute for Exceptional Growth Companies databases as of first quarter 2014. NAICS refer to Semiconductor and other Electronic Component Manufacturing (NAICS 3344).
13. For companies in the broader value chain that operate across multiple industries, such as suppliers of parts or raw materials, this analysis only included employment for companies in which clean energy proportion of operations could be verified, primarily through survey results. Therefore, this offers a conservative estimate of the full value chain.
14. Manufacturing and construction average annual wage data from Quarterly Census of Employment and Wages by NAICS Sector, private - all establishment sizes, Average Annual Wages in Minnesota, 2013.
15. Leibert, Alessia. "Minnesota's Emerging Green Economy: Green Jobs Report 2011." Minnesota Labor Market Information Office.
16. Regions are defined as Minnesota Initiative Foundation regions http://www.greaterminnesota.net/; Northland is "Northeast."
17. Energy efficiency and smart grid project financing data unavailable.
18. Kunkle, G. (2011). Business Establishment Employment Data: Nets Versus Es-202. Edward Lowe Foundation's Institute for Exceptional Growth Companies. Retrieved from: http://exceptionalgrowth.org/insights/NETSvsES-202.pdf

MINNESOTA

CLEAN ENERGY OVERVIEW

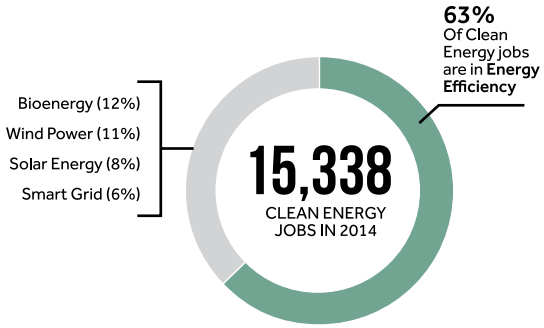
HIGHLIGHTS FROM MINNESOTA'S CLEAN ENERGY ECONOMY PROFILE

Clean energy businesses employ workers and generate revenue directly from products or services that use less energy to provide the same service, or produce heat, power or fuel from renewable sources of energy. The MN Clean Energy Economy Profile focuses on five clean energy sectors: Energy Efficiency, Bioenergy, Wind Power, Solar Energy, and Smart Grid.

EMPLOYMENT

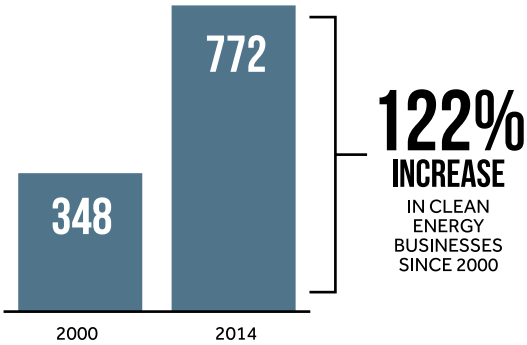
78% INCREASE IN CLEAN ENERGY JOBS SINCE 2000

+11% OVERALL STATE EMPLOYMENT GREW **ONLY 11%** DURING SAME TIME PERIOD



22% OF THESE JOBS ARE IN INSTALLATION AND MAINTENANCE OF CLEAN ENERGY TECHNOLOGIES

BUSINESSES



AVERAGE ANNUAL WAGE

$71,000 CLEAN ENERGY ECONOMY

$50,100 MINNESOTA OVERALL

CLEAN ENERGY WAGES ARE 42% HIGHER THAN THE STATEWIDE AVERAGE (2013)

OVER **$1 BILLION** IN TOTAL WAGES IN THE CLEAN ENERGY ECONOMY IN 2013

PATENTS

8TH

MINNESOTA RANKS EIGHTH IN THE NATION FOR REGISTERED CLEAN ENERGY PATENTS IN 2013, UP FROM TWENTIETH IN 2003

INVESTMENTS

$11 BILLION

NEARLY $11BILLION INVESTED IN MINNESOTA CLEAN ENERGY PROJECTS, $452 MILLION IN EARLY STAGE INVESTMENT (2004-2013)

BIOFUEL CAPACITY

1.7 MILLION

BIOFUEL PRODUCTION CAPACITY IN MINNESOTA IS ENOUGH TO REPLACE TRADITIONAL FUEL FOR 1.7 MILLION VEHICLES FOR ONE YEAR (2012)

ENERGY SAVINGS

1.4 MILLION

EFFICIENCY SAVINGS AND RENEWABLE ELECTRICITY GENERATION IN MINNESOTA IS EQUAL TO ENOUGH ENERGY TO POWER OVER 1.4 MILLION HOMES IN THE STATE FOR ONE YEAR (2012)

To download the full report, please visit: www.mn.gov/deed/clean.

Data Source: Minnesota Department of Commerce, National Establishment Time Series Database (NETS), Institute for Exceptional Growth Companies, MN DEED Economic Analysis Unit Survey-July 2014, MN Unemployment Database, 1790 Analytics, Patents by Technology; USPTO Patent File, CB Insights, Bloomberg New Energy Finance

Analysis and Design: Collaborative Economics

MINNESOTA

ENERGY EFFICENCY

SECTOR HIGHLIGHTS FROM MINNESOTA'S CLEAN ENERGY ECONOMY PROFILE

Energy efficiency includes products or strategies that result in using less energy to produce the same service or product, or to provide the same level of performance, comfort or convenience.

EMPLOYMENT

49% INCREASE IN ENERGY EFFICIENCY JOBS SINCE 2000

+11% OVERALL STATE EMPLOYMENT GREW **ONLY 11%** DURING SAME TIME PERIOD

9,604 ENERGY EFFICIENCY JOBS IN 2014

23% OF THESE JOBS ARE IN INSTALLATION AND MAINTENANCE OF ENERGY EFFICIENCY MEASURES

BUSINESSES

445 ENERGY EFFICIENCY BUSINESSES (2014)

80% INCREASE IN ENERGY EFFICIENCY BUSINESSES SINCE 2000

TIMELINE OF KEY POLICIES

1980-1996
Five policies mandated conservation programs for utilities

2007
Energy efficiency spending requirement for utilities changed to an energy savings goal

2010
1.5% savings goal for utilities takes effect

PATENTS

12TH IN U.S. FOR REGISTERED ENERGY EFFICIENCY PATENTS (2013)

ENERGY SAVINGS

180,000 SAVINGS EQUIVALENT TO AVERAGE ANNUAL CONSUMPTION OF OVER 180,000 HOMES (2012)

AVERAGE ANNUAL WAGE

$73,500 ENERGY EFFICIENCY SECTOR

$50,100 MINNESOTA OVERALL

To download the full report, please visit: www.mn.gov/deed/clean.

Data Source: Minnesota Department of Commerce, National Establishment Time Series Database (NETS), Institute for Exceptional Growth Companies, Minnesota Department of Commerce Efficiency Savings through the Conservation Improvement Program, Energy Information AdministrationMN DEED Economic Analysis Unit Survey-July 2014, MN Unemployment Insurance Database, 1790 Analytics, Patents by Technology; USPTO Patent File, CB Insights, Bloomberg New Energy Finance

Analysis and Design: Collaborative Economics

MINNESOTA

BIOENERGY

SECTOR HIGHLIGHTS FROM MINNESOTA'S CLEAN ENERGY ECONOMY PROFILE

Bioenergy is renewable energy that uses biomass (e.g. wood, corn, soy, municipal solid waste) to produce heat, electricity, fuel, and/or chemicals.

EMPLOYMENT

130% INCREASE IN BIOENERGY JOBS SINCE 2000

+11% OVERALL STATE EMPLOYMENT GREW **ONLY 11%** DURING SAME TIME PERIOD

1,823 BIOENERGY JOBS IN 2014

45% OF THESE JOBS ARE IN BIOENERGY PRODUCTION FACILITIES

BUSINESSES

94 BIOENERGY BUSINESSESS (2014)

135% INCREASE IN BIOENERGY BUSINESSES SINCE 2000

TIMELINE OF KEY POLICIES

1994 Renewable Energy Production Incentives

2001 Renewable Energy Objective passed with goal for utilities

2007 Renewable Energy Standard Increased to 25% of electricity by 2025

INVESTMENTS

$3.2B IN BIOENERGY PROJECT FINANCING (2004-2013)

BIOFUEL CAPACITY

4TH IN THE NATION FOR ETHANOL PRODUCTION CAPACITY (2013)

ELECTRICITY GENERATION

+42%

193,000 BIOELECTRICITY GENERATION IS EQUIVALENT TO THE ANNUAL ELECTRICITY USE OF 193,000 MN HOMES, UP 42% SINCE 2007 (2012)

AVERAGE ANNUAL WAGE

$65,900 BIOENERGY SECTOR

$50,100 MINNESOTA OVERALL

To download the full report, please visit: www.mn.gov/deed/clean.

Data Source: U.S. Energy Information Administration, National Establishment Time Series Database (NETS), Institute for Exceptional Growth Companies, Minnesota Department of Commerce, Energy Information Administration, MN DEED Economic Analysis Unit Survey-July 2014, MN Unemployment Insurance Database, CB Insights, Bloomberg New Energy Finance

Analysis and Design: Collaborative Economics

MINNESOTA

WIND POWER

SECTOR HIGHLIGHTS FROM MINNESOTA'S CLEAN ENERGY ECONOMY PROFILE

Wind power captures the natural wind in the outdoors and converts it into electricity using wind turbines, and can operate at large utility-scale or smaller distributed-scale at individual buildings.

EMPLOYMENT

288% INCREASE IN WIND POWER JOBS SINCE 2000

+11% OVERALL STATE EMPLOYMENT GREW **ONLY 11%** DURING SAME TIME PERIOD

1,713 WIND POWER JOBS IN 2014

57% OF THESE JOBS ARE IN DEVELOPING, INSTALLING AND MAINTAINING NEW WIND FARMS

BUSINESSES

124 WIND POWER BUSINESSES (2014)

553% INCREASE IN WIND POWER BUSINESSES SINCE 2000

TIMELINE OF KEY POLICIES

2001
Renewable Energy Objective passed with goal for utilities

2001
Renewable Energy Objective passed with goal for utilities

2005
Community-based energy development (C-BED) tariff requires 20-year power purchase agreements from utilities

Renewable Energy Production Incentive

2007
Renewable Energy Standard increased to 25% of electricity by 2025

INVESTMENTS

$7.6B INVESTED IN WIND ENERGY PROJECTS, 58% SINCE 2010 (2004-2013)

ELECTRICITY GENERATION

5TH MINNESOTA RANKS FIFTH IN THE U.S. FOR SHARE OF ELECTRICITY GENERATED FROM WIND (2013)

15.7% OF MINNESOTA'S TOTAL ELECTRICITY IS FROM WIND, WHILE THE U.S. AS A WHOLE GENERATED ONLY4.1% FROM WIND (2013)

AVERAGE ANNUAL WAGE

$61,500 WIND POWER SECTOR

$50,100 MINNESOTA OVERALL

To download the full report, please visit: www.mn.gov/deed/clean.

Data Source: Minnesota Department of Commerce, National Establishment Time Series Database (NETS), Institute for Exceptional Growth Companies, MN Economic Analysis Unit Survey-July 2014, MN DEED Unemployment Insurance Database, American Wind Energy Association Annual Market Report, 2013, CB Insights, Bloomberg New Energy Finance

Analysis and Design: Collaborative Economics

MINNESOTA

SOLAR ENERGY

SECTOR HIGHLIGHTS FROM MINNESOTA'S CLEAN ENERGY ECONOMY PROFILE

Solar energy captures sunlight and converts it to electricity or thermal energy, and includes solar thermal, solar hot water, and photovoltaic (PV) technologies for the residential, commercial and utility-scale markets.

EMPLOYMENT

130% INCREASE IN SOLAR ENERGY JOBS SINCE 2000

+11% OVERALL STATE EMPLOYMENT GREW **ONLY 11%** DURING SAME TIME PERIOD

1,230 SOLAR ENERGY JOBS IN 2014

25% OF THESE JOBS ARE IN INSTALLATION AND MAINTENANCE OF SOLAR ENERGY TECHNOLOGIES

BUSINESSES

85 SOLAR ENERGY BUSINESSES (2014)

180% INCREASE IN SOLAR ENERGY BUSINESSES SINCE 2000

TIMELINE OF KEY POLICIES

2001 Renewable Energy Objective passed with goal for utilities

2002 MN Solar Electric Rebate Program

2007 Renewable Energy Standard increased by 25% of electricity by 2025

2009 Xcel*Solar Reward and others established

2013 Solar Energy Standards Value of Solar Made in MN New Solar*Rewards

SOLAR INSTALLATIONS

2,400 SOLAR INSTALLATIONS IN MN CAN PRODUCE ENOUGH ENERGY TO POWER NEARLY 2,400 HOMES (2013)

86% OF SOLAR CAPACITY WAS INSTALLED BETWEEN 2010 AND 2013

AVERAGE ANNUAL WAGE

$70,400 SOLAR ENERGY SECTOR

$50,100 MINNESOTA OVERALL

To download the full report, please visit: www.mn.gov/deed/clean.

Data Source: Minnesota Department of Commerce, National Establishment Time Series Database (NETS), Minnesota Department of Commerce Solar Statistics, Energy Information Administration Institute for Exceptional Growth Companies, MN DEED Economic Analysis Unit Survey-July 2014, MN Unemployment Insurance Database, CB Insights, Bloomberg New Energy Finance

Analysis and Design: Collaborative Economics

MINNESOTA

SMART GRID

SECTOR HIGHLIGHTS FROM MINNESOTA'S CLEAN ENERGY ECONOMY PROFILE

Smart grid technology allows for two-way communication between the utility and its customers, enabling more automation, control, and responsiveness in the electric grid.

EMPLOYMENT

128% INCREASE IN SMART GRID JOBS SINCE 2000

+11% OVERALL STATE EMPLOYMENT GREW **ONLY 11%** DURING SAME TIME PERIOD

967 SMART GRID JOBS IN 2014

24% OF THESE JOBS ARE IN RESEARCH & DEVELOPMENT OF SMART GRID TECHNOLOGY

BUSINESSES

25 SMART GRID BUSINESSES (2014)

108% INCREASE IN SMART GRID BUSINESSES SINCE 2000

TIMELINE OF KEY POLICIES

2001 Renewable Energy Objective passed with goal for utilities

2007 Renewable Energy Standard Increased to 25% of electricity by 2025

2010 1.5% energy savings goal for utilities takes effect

INVESTMENTS

$82M IN EARLY STAGE INVESTMENTS IN SMART GRID COMPANIES (2004-2013)

PATENTS

6TH IN U.S. FOR REGISTERED SMART GRID PATENTS IN ENERGY INFRASTRUCTURE AND STORAGE (2013)

AVERAGE ANNUAL WAGE

$80,300 SOLAR ENERGY SECTOR

$50,100 MINNESOTA OVERALL

To download the full report, please visit: www.mn.gov/deed/clean.

Data Source: National Establishment Time Series Database (NETS), Institute for Exceptional Growth Companies, MN DEED Economic Analysis Unit Survey-July 2014, MN Unemployment Insurance Database, 1790 Analytics, Patents by Technology; USPTO Patent File, CB Insights, Bloomberg New Energy Finance

Analysis and Design: Collaborative Economics

TWIN CITIES METRO

REGIONAL HIGHLIGHTS FROM MINNESOTA'S CLEAN ENERGY ECONOMY PROFILE

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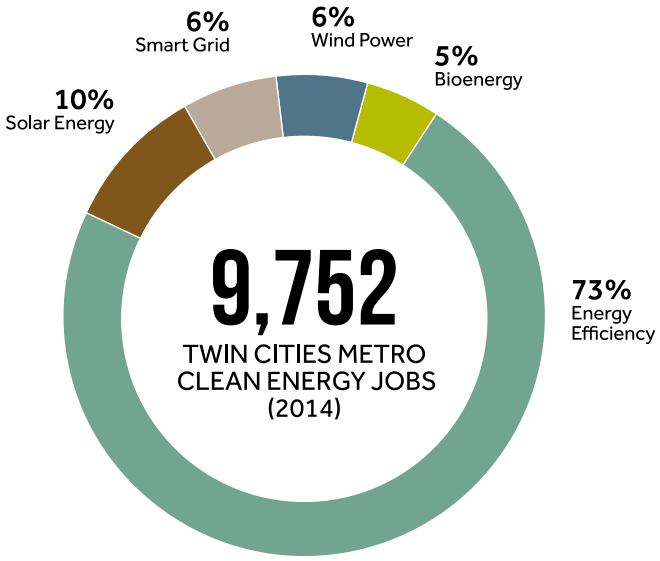
EMPLOYMENT

53% INCREASE IN REGIONAL CLEAN ENERGY JOBS SINCE 2000

+11% OVERALL STATE EMPLOYMENT GREW **ONLY 11%** DURING SAME TIME PERIOD

74% TWIN CITIES METRO HAS 74% OF MINNESOTA'S ENERGY EFFICIENCY JOBS (2014)

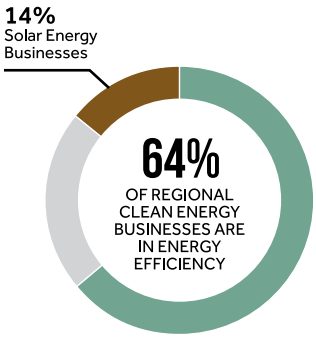
24% OF TWIN CITIES METRO JOBS ARE IN THE SALES AND DISTRIBUTION OF ENERGY EFFICIENCY PRODUCTS (2014)



BUSINESSES

398 REGIONAL CLEAN ENERGY BUSINESSES (2014)

52% SHARE OF STATE CLEAN ENERGY BUSINESSES



MINNESOTA OVERALL AVERAGE ANNUAL WAGE

$73,500 ENERGY EFFICIENCY SECTOR

$70,400 SOLAR ENERGY SECTOR

$50,100 MINNESOTA OVERALL

To download the full report, please visit: www.mn.gov/deed/clean.

Twin Cities Metro includes: Anoka, Carver, Dakota, Hennepin, Ramsey, Scott and Washington Counties

Data Source: National Establishment Time Series Database (NETS), Institute for Exceptional Growth Companies, MN DEED Economic Analysis Unit Survey-July 2014, MN Unemployment Insurance Database

Analysis and Design: Collaborative Economics

SOUTHERN REGION

REGIONAL HIGHLIGHTS FROM MINNESOTA'S CLEAN ENERGY ECONOMY PROFILE

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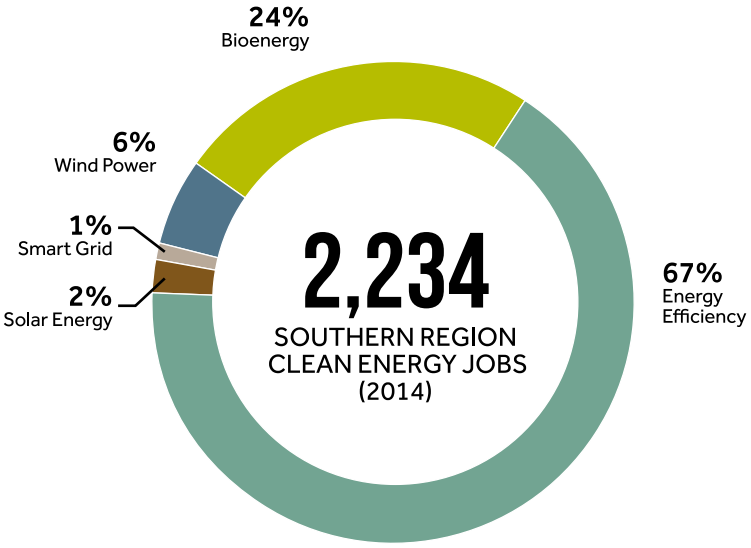
EMPLOYMENT

71% INCREASE IN REGIONAL CLEAN ENERGY JOBS SINCE 2000

+11% OVERALL STATE EMPLOYMENT GREW **ONLY 11%** DURING SAME TIME PERIOD



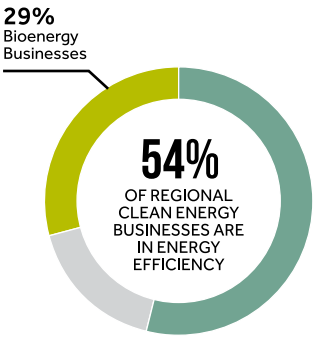
30% THE SOUTHERN REGION HAS 30% OF MINNESOTA'S BIOENERGY JOBS (2014)

54% OF THE SOUTHERN REGION'S JOBS ARE IN MANUFACTURING BIOFUEL AND ENERGY EFFICIENCY PRODUCTS (2014)

BUSINESSES

89 REGIONAL CLEAN ENERGY BUSINESSES (2014)

12% SHARE OF STATE CLEAN ENERGY BUSINESSES



MINNESOTA OVERALL AVERAGE ANNUAL WAGE

$73,500 ENERGY EFFICIENCY SECTOR

$66,000 BIOENERGY SECTOR

$50,100 MINNESOTA OVERALL

To download the full report, please visit: www.mn.gov/deed/clean.

Southern Region includes: Blue Earth, Brown, Dodge, Faribault, Fillmore, Freeborn, Goodhue, Houston, Le Sueur, Martin, Mower, Nicollet, Olmsted, Rice, Sibley, Steele, Wabasha, Waseca, Watonwan and Winona Counties

Data Source: National Establishment Time Series Database (NETS), Institute for Exceptional Growth Companies, MN DEED Economic Analysis Unit Survey-July 2014, MN Unemployment Insurance Database

Analysis and Design: Collaborative Economics

CENTRAL REGION

REGIONAL HIGHLIGHTS FROM MINNESOTA'S CLEAN ENERGY ECONOMY PROFILE

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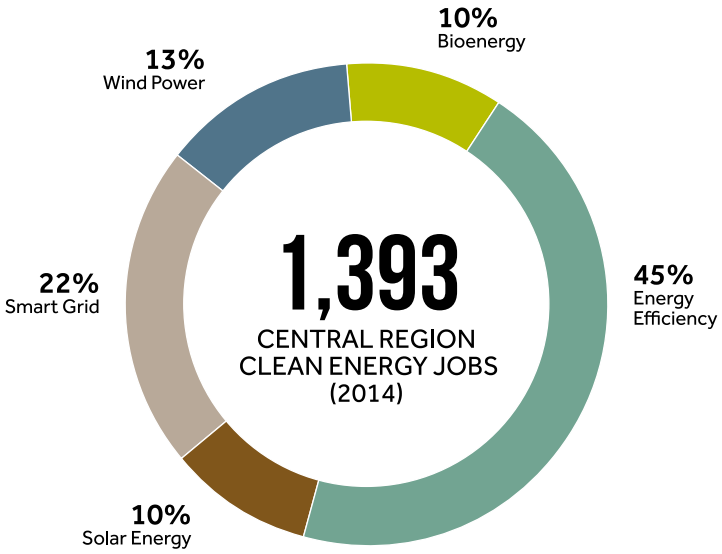
EMPLOYMENT

191% INCREASE IN REGIONAL CLEAN ENERGY JOBS SINCE 2000

+11% OVERALL STATE EMPLOYMENT GREW **ONLY 11%** DURING SAME TIME PERIOD



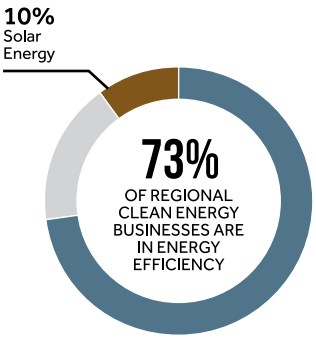
31% THE CENTRAL REGION HAS 31% OF MINNESOTA'S SMART GRID JOBS (2014)

31% OF THE CENTRAL REGION'S JOBS ARE IN INSTALLATION AND MAINTENANCE OF ENERGY EFFICIENCY, SOLAR AND WIND TECHNOLOGIES

BUSINESSES

101 REGIONAL CLEAN ENERGY BUSINESSES (2014)

13% SHARE OF STATE CLEAN ENERGY BUSINESSES



MINNESOTA OVERALL AVERAGE ANNUAL WAGE

$80,300 SMART GRID SECTOR

$73,500 ENERGY EFFICIENCY SECTOR

$50,100 MINNESOTA OVERALL

To download the full report, please visit: www.mn.gov/deed/clean.

Central Region includes: Benton, Cass, Chisago, Crow Wing, Isanti, Kanabec, Mille Lacs, Morrison, Pine, Sherburne, Stearns, Todd, Wadena and Wright Counties

Data Source: National Establishment Time Series Database (NETS), Institute for Exceptional Growth Companies, MN DEED Economic Analysis Unit Survey-July 2014, MN Unemployment Insurance Database

Analysis and Design: Collaborative Economics

SOUTHWEST REGION

REGIONAL HIGHLIGHTS FROM MINNESOTA'S CLEAN ENERGY ECONOMY PROFILE

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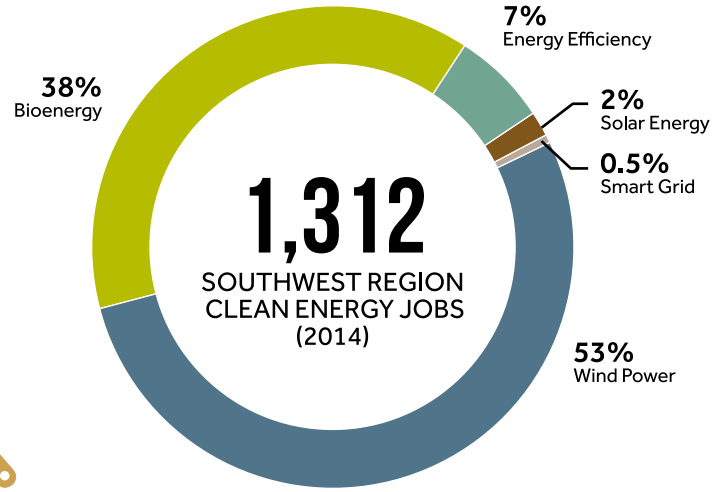
EMPLOYMENT

425% INCREASE IN REGIONAL CLEAN ENERGY JOBS SINCE 2000

+11% OVERALL STATE EMPLOYMENT GREW **ONLY 11%** DURING SAME TIME PERIOD



1.64 THE REGION HAS THE HIGHEST CLEAN ENERGY EMPLOYMENT CONCENTRATION IN THE STATE (2014)

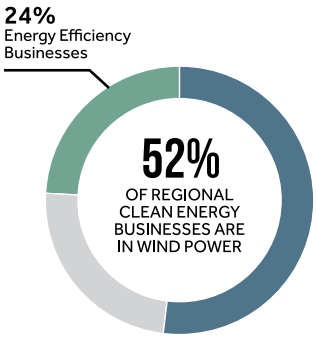
41% THE SOUTHWEST REGION HAS 41% OF MINNESOTA'S WIND POWER JOBS (2014)

27% OF THE SOUTHWEST REGION'S JOBS ARE IN INSTALLATION AND MAINTENANCE OF WIND POWER TECHNOLOGIES

BUSINESSES

84 REGIONAL CLEAN ENERGY BUSINESSES (2014)

11% SHARE OF STATE CLEAN ENERGY BUSINESSES



MINNESOTA OVERALL AVERAGE ANNUAL WAGE

$73,500 ENERGY EFFICIENCY SECTOR

$61,500 WIND POWER SECTOR

$50,100 MINNESOTA OVERALL

To download the full report, please visit: www.mn.gov/deed/clean.

Southwest Region includes: Big Stone, Chippewa, Cottonwood, Jackson, Kandiyohi, Lac qui Parle, Lincoln, Lyon, McLeod, Meeker, Murray, Nobles, Pipestone, Redwood, Renville, Rock, Swift and Yellow Medicine Counties

Data Source: National Establishment Time Series Database (NETS), Institute for Exceptional Growth Companies, MN DEED Economic Analysis Unit Survey-July 2014, MN Unemployment Insurance Database

Analysis and Design: Collaborative Economics

WEST CENTRAL + NORTHWEST REGIONS

REGIONAL HIGHLIGHTS FROM MINNESOTA'S CLEAN ENERGY ECONOMY PROFILE

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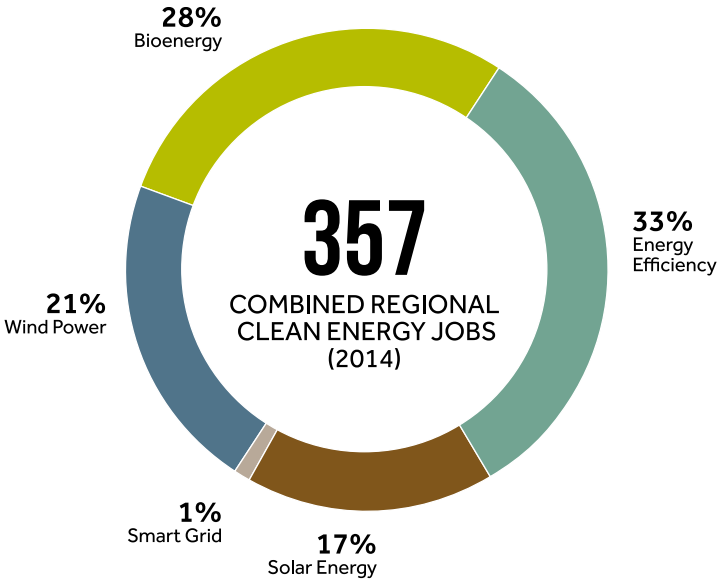
EMPLOYMENT

195% INCREASE IN REGIONAL CLEAN ENERGY JOBS SINCE 2000

+11% OVERALL STATE EMPLOYMENT GREW **ONLY 11%** DURING SAME TIME PERIOD



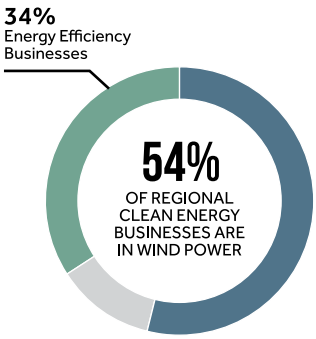
6% THE COMBINED REGIONS HAVE 6% OF MINNESOTA'S BIOENERGY JOBS (2014)

23% OF THE COMBINED REGIONS' JOBS ARE IN INSTALLATION AND MAINTENANCE OF ENERGY EFFICIENCY, WIND AND SOLAR TECHNOLOGIES

BUSINESSES

61 REGIONAL CLEAN ENERGY BUSINESSES (2014)

8% SHARE OF STATE CLEAN ENERGY BUSINESSES



MINNESOTA OVERALL AVERAGE ANNUAL WAGE

$73,500 ENERGY EFFICIENCY SECTOR

$66,000 BIOENERGY SECTOR

$50,100 MINNESOTA OVERALL

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West Central & Northwest Regions include: Becker, Beltrami, Clay, Clearwater, Douglas, Grant, Hubbard, Kittson, Lake of the Woods, Mahnomen, Marshall, Norman, Otter Tail, Pennington, Polk, Pope, Red Lake, Roseau, Stevens, Traverse and Wilkin Counties

Data Source: National Establishment Time Series Database (NETS), Institute for Exceptional Growth Companies, MN DEED Economic Analysis Unit Survey-July 2014, MN Unemployment Insurance Database

Analysis and Design: Collaborative Economics

NORTHEAST REGION

REGIONAL HIGHLIGHTS FROM MINNESOTA'S CLEAN ENERGY ECONOMY PROFILE

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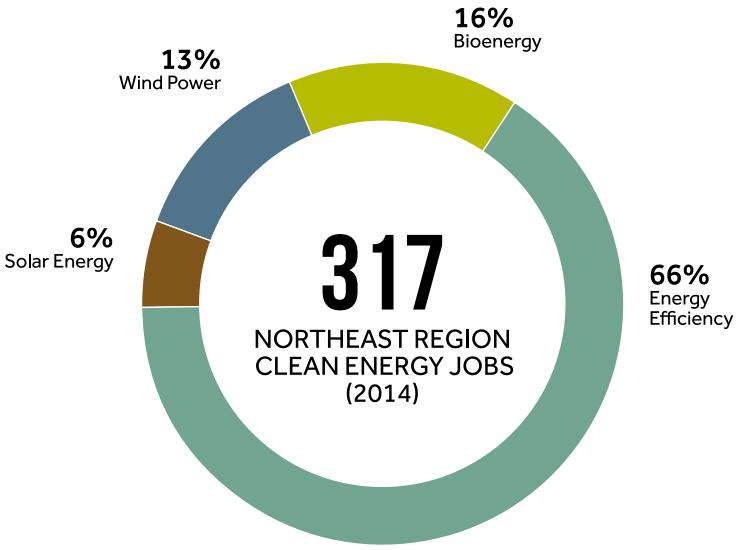
EMPLOYMENT

146% INCREASE IN REGIONAL CLEAN ENERGY JOBS SINCE 2000

+11% OVERALL STATE EMPLOYMENT GREW **ONLY 11%** DURING SAME TIME PERIOD



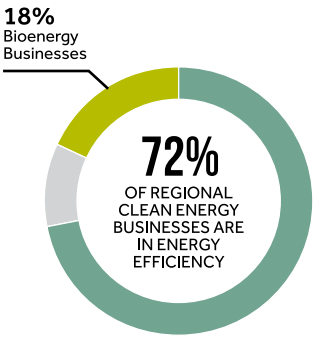
3% THE NORTHEAST REGION HAS 3% OF MINNESOTA'S BIOENERGY JOBS (2014)

39% OF THE NORTHEAST REGION'S JOBS ARE IN ENGINEERING SERVICES FOR CLEAN ENERGY TECHNOLOGIES

BUSINESSES

39 REGIONAL CLEAN ENERGY BUSINESSES (2014)

5% SHARE OF STATE CLEAN ENERGY BUSINESSES



MINNESOTA OVERALL AVERAGE ANNUAL WAGE

$73,500 ENERGY EFFICIENCY SECTOR

$66,000 BIOENERGY SECTOR

$50,100 MINNESOTA OVERALL

To download the full report, please visit: www.mn.gov/deed/clean.

Northeast Region includes: Aitkin, Carlton, Cook, Itasca, Koochiching, Lake and St. Louis Counties

Data Source: National Establishment Time Series Database (NETS), Institute for Exceptional Growth Companies, MN DEED Economic Analysis Unit Survey-July 2014, MN Unemployment Insurance Database

Analysis and Design: Collaborative Economics

MINNESOTA

CLEAN ENERGY ECONOMY PROFILE

Upon request, the information in this document can be made available in alternative formats for people with disabilities by calling 651-259-7175.

More information can be found at www.mn.gov/deed/clean.