Real **Potential,** Ready **Today**

Solar Energy in Iowa

Photo courtesy Luther College

Introduction

Iowa has the potential to be a leader in solar photovoltaic (PV) energy production. Iowa's solar resource is as good or better than most U.S. states. Just as important, solar energy complements Iowa's energy needs and existing energy resources very well.

Solar PV has become an economic option for many applications, consumers, and situations in Iowa. Solar PV now powers farms, businesses, universities, utilities, communities, other large consumers, vehicles, and homes. There is significant potential to repeat these successful uses of solar energy again and again across Iowa, and to expand to more types of uses.

Iowans can rely on solar PV when and where it is needed most. Solar energy is available during the day, as electricity use rises, and in particular during hot summer afternoons. Solar PV can be installed right where electricity is used. Beyond providing useful energy, solar PV offers many other benefits: job creation, consumer savings, cleaner air and water, innovation and technology investment, and improved grid stability.

Iowa's national leadership in wind energy demonstrates the potential that exists for solar PV. Solar PV is growing rapidly in Iowa and across the U.S. This booklet is intended to provide information about: Iowa's solar resource, how solar PV in Iowa compares to other states, how solar PV can integrate into Iowa's energy mix, recent examples of solar PV installations in Iowa, and the types of public policies that can encourage more solar PV.

Iowa ranks among the top third of U.S. states in the technical potential for solar PV energy production.[1] Iowa's 16th place ranking puts it ahead of many states south of Iowa, such as Florida, Georgia, Utah, Missouri, North Carolina and South Carolina. A solar PV array located in Iowa produces a comparable amount of electricity as one located in Miami, Houston, Atlanta, and more than ones located in Newark or Chicago.

Iowa has the potential to build enough solar PV to meet annual electric needs by more than 150 times over. Iowa's rooftop solar PV potential alone could meet close to 20% of Iowa's annual electric needs. The rooftops of Iowa homes, warehouses, schools, hospitals, car dealerships, parking ramps, and more are ideal locations for solar PV. Alternatively, using ground-mount solar PV to meet 5% or 10% of Iowa's annual electricity needs would require a very small geographic footprint. Using 21 of Iowa's 55,857 square miles of land for solar PV would provide 10% of Iowa's electricity needs.

Solar PV generates the most electricity during periods of highest demand, when electricity prices spike and when the electric grid is stressed. In Iowa and much of the Midwest, summer heat and electricity use go together, so energy use and prices are often highest on hot, sunny summer afternoons. By generating electricity during these times, solar PV can reduce costs and improve the reliability of the electric grid.

Solar and wind are complementary renewable energy resources. While wind turbines can produce energy at any time of day and any time of the year, wind energy production tends to be higher in the winter and higher at night. Solar energy is available during the day and production is higher during the summer.

The cost of installing solar power has decreased significantly in recent years. Prices fell on average 5% to 7% each year from 1998 to 2011.[2] Cost reductions from 2008 to 2012 were even greater. While the cost to install a watt of solar PV averaged $7.50 in 2008, that cost had come down to about $4 per watt in 2012.[3] Costs are expected to continue to decline in future years as well.

Solar PV offers significant economic benefits to Iowa. Adding 300 megawatts (MW) of solar PV in Iowa over a five year period would create an average of 2,500 jobs for each of those five years. Solar PV can reduce the dollars spent importing fossil fuels – and help provide Iowans with cleaner air and water.

The Iowa market for solar PV is ready for substantial growth. Iowa's solar resource and potential for solar PV development is as good or better than states that have hundreds of times what Iowa has installed today.

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On the cover

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Iowa's **Abundant** Solar Resource

Key points

- Iowa's solar resource is as good or better than many other parts of the country.
- Iowa ranks among the top third of U.S. states in the technical potential for solar PV development.
- Iowa's potential for generating electricity from solar PV far exceeds our total need for electricity.
- Solar PV in Iowa provides consistent and reliable energy throughout the year, even in winter.

Iowa's solar resource

Iowa has an abundant solar resource that is as good or better than many other states in the U.S. The desert Southwest or the Southeast may be considered the sunniest parts of the country. However, significant solar energy also reaches Iowa – enough to make Iowa a competitor with most other states. This map shows the varying amount of solar energy that reaches different parts of the U.S.

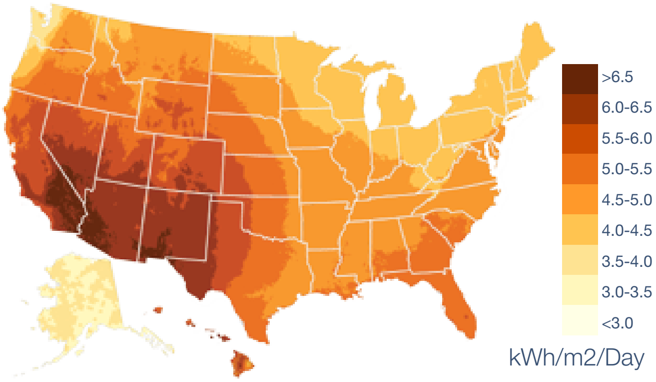
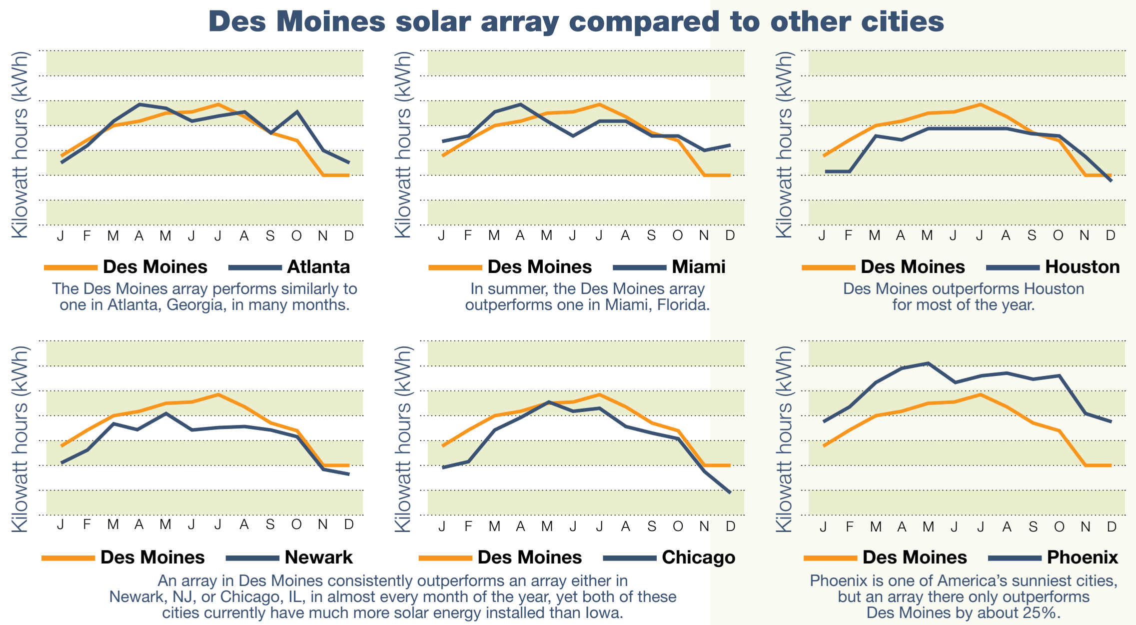


Figure 1. This map illustrates the solar resource that reaches each state in the U.S. Most of Iowa is covered by a solar resource similar to what is found to our south and east.[4]

Because so much solar energy reaches Iowa, the electricity generated by a solar PV system in Iowa performs favorably when compared to many other locations in the U.S. A solar PV array located in Iowa produces a comparable amount of electricity as one located in Miami, Houston, Atlanta, and more than one located in Newark or Chicago.

While Iowa compares favorably with many states, it is not far behind the very best states in the U.S. For example, a solar PV array located in America's sunniest states, such as New Mexico, Arizona, and Utah, would only produce about 25% more energy during the course of an entire year than the same PV array located in Iowa.

Figure 2. This chart compares the performance of the same solar PV array located in Des Moines and Atlanta, Miami, Houston, Phoenix, Newark, and Chicago.[5]



A state's **technical potential** for solar PV accounts for size of the state, topography, amount of land where PV development could be restricted, and other environmental and land use constraints—in addition to the amount of sunlight the state receives.

Iowa's technical potential for solar PV

Only comparing the solar energy resource itself, however, does not fully describe Iowa's solar resource or properly allow Iowa to be compared to other states. Because of land use differences and other restrictions on solar PV development among states, Iowa's technical potential to develop solar PV is an equally important metric to evaluate solar PV in Iowa.

The estimate of technical potential in Iowa looks beyond just the solar energy resource itself and accounts for key factors affecting whether and how much solar PV could be developed. These include the size of the state, the topography and slopes, amount of federal or protected land where PV development could be restricted, and other environmental and land use constraints.[6] Iowa's land use is generally favorable for solar PV development, with abundant land areas and building types that are suitable for ground-mount or rooftop solar PV arrays.

According to the National Renewable Energy Laboratory (NREL), Iowa could generate over 7,000,000 gigawatt-hours (GWh)[7] from solar PV. As a result, Iowa ranks among the top third of U.S. states in the potential for solar PV energy production according to the NREL study.[8] Iowa's 16th place puts it ahead of many southern and southeastern states (Figure 3), such as Florida, Georgia, Utah, Missouri, North Carolina and South Carolina, even though as much or possibly more sun reaches those states.[9]

The 7,000,000 GWh that solar PV could generate in Iowa far exceeds the 57,000 GWh generated by all sources (coal, gas, wind, nuclear, etc.) in the state

Total solar PV technical potential, selected states

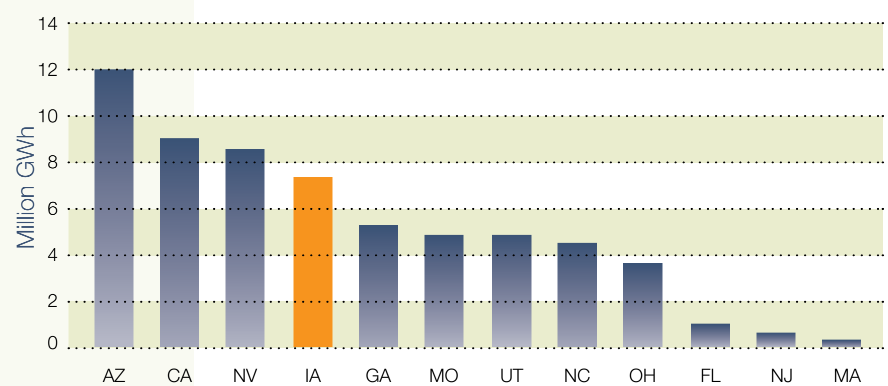


Figure 3. Iowa's technical potential ranks above many states that are further south.[10]

Iowa solar potential compared to electric generation and sales

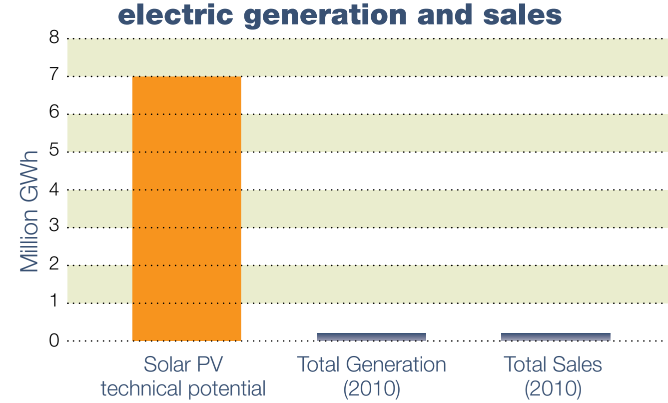


Figure 4. Iowa's solar potential far exceeds the amount of energy generated and sold in the state in 2010.

in 2010, or the 45,000 GWh Iowans consumed that year.[11] This means that Iowa's potential for solar PV – if fully utilized – is many times larger than Iowa's need for electricity, as Figure 4 demonstrates. In fact, Iowa has the potential to build enough solar PV to meet annual electric needs by more than 150 times over.[12]

Solar PV produces energy throughout the year

Solar PV in Iowa can reliably produce electricity on every day and in every month of the year. On a typical summer day, solar PV starts producing before 8 a.m. and is likely to continue until about 8 p.m.

On a typical winter day, solar PV starts producing by 9 a.m. and is likely to continue producing until about 6 p.m. While there are fewer hours of daylight to generate electricity in the winter than in the summer, the typical day in January, April, July and October is not that different, as seen in Figure 5. In fact, the clear, dry winter air, lower temperatures, and other factors actually allow solar PV systems to operate more efficiently than on some hot, humid summer days.

The longer summer days and shorter winter days mean that solar PV arrays generate the most electricity in the summer months. However, winter production, particularly in January and February, is still significant (Figure 6).

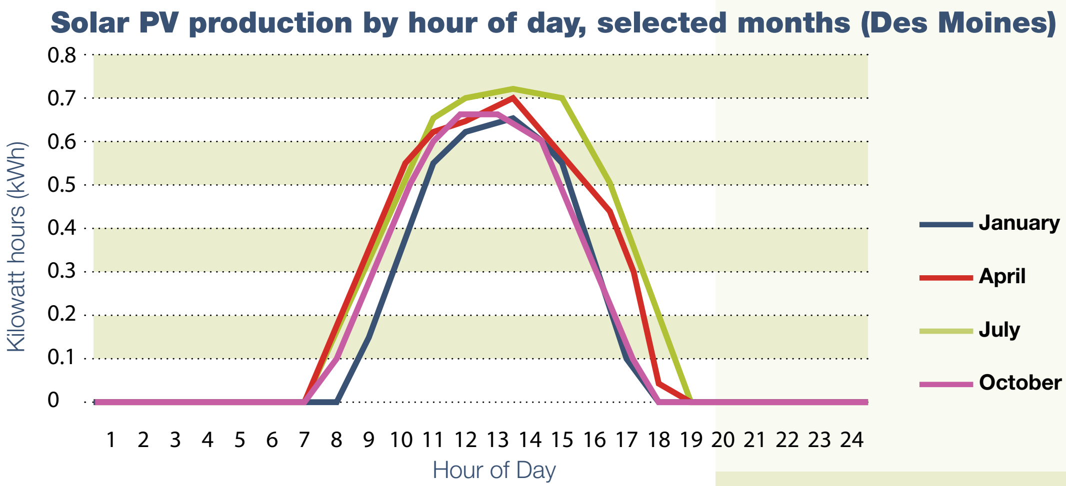


Figure 5. In Iowa, solar PV produces more energy in the summer than in the winter, but the average days in January, April, July, and October are not that different.[13]

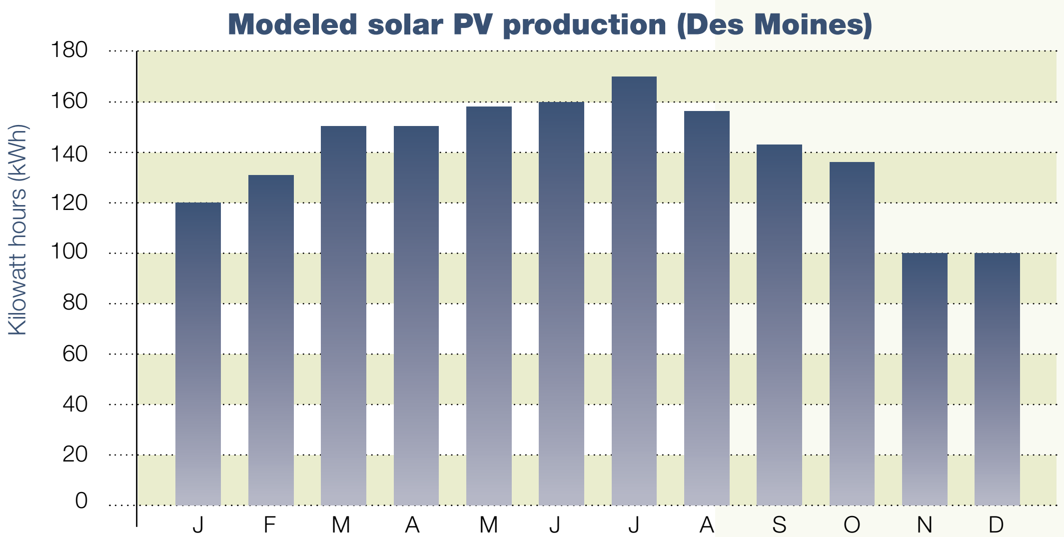


Figure 6. This chart shows the average monthly production of a solar PV array in Iowa throughout the year.

Photo courtesy Access Energy Cooperative

Solar Energy's Role in Iowa's Energy Mix

Key points

- Solar PV is available when the demand for electricity is highest.
- Solar PV is available when electricity is most expensive.
- Solar PV has a small geographic footprint.
- Solar PV is a good complement to wind power.

Solar PV is available when demand for energy is highest

Iowans generally use more electricity during the day than at night and more during the summer than the winter. On a typical summer day, electricity use across the entire state rises in the morning and throughout the day until reaching a peak in the middle or late afternoon, when solar panels are very productive, or the early evening before solar production ends. On hot sunny summer afternoons, Iowans consume the most electricity and at times this electricity use can stress or exceed the capacity of the electric grid. In 2011, about 85% of municipal utilities and 50% of cooperative utilities reported that their monthly peak occurred between the hours of noon and 6 p.m., as depicted in Figure 7.

Access Energy Cooperative headquarters building

Activated: July 2011
Size: 100 kW
Project type: Rooftop on an office/maintenance building
Location: Mt. Pleasant, Iowa

At Access Energy Cooperative in Mount Pleasant, General Manager Bob Swindell says a solar installation on the Cooperative's corporate headquarters (see photo at left) is beating its performance goals, providing nearly a third of the facility's total electric usage while filling as much as 85% of the facility's peak demand for the day.

As a utility manager, Swindell especially prizes the solar array's ability to match peak demand on summer days.

"Solar generates most of its energy on sunny days," he explained, "which is when electrical usage is the highest—on the hottest, sunniest days of summer."

He described a recent hot June day in which his facility's peak demand from the electric grid began at 9:00 a.m., the time when the solar panels were beginning to ramp up production for the day. By 2:00 p.m., when the Cooperative experienced peak demand for the entire month, the grid was only providing about 15% of the facility's electric demand at that time.

"The solar array does an excellent job of tracking our office's load," Swindell said. "Its performance has exceeded our expectations."

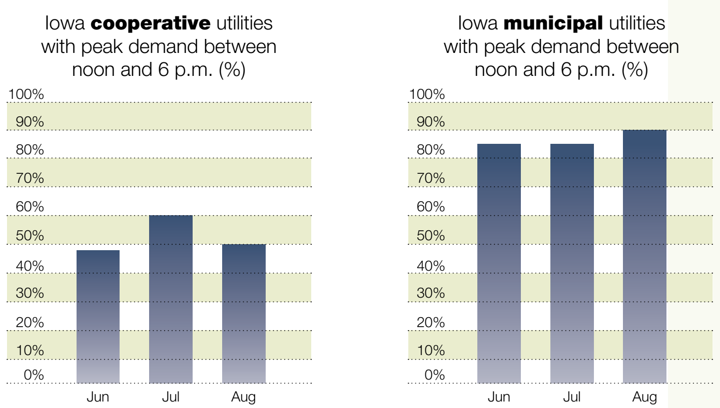


Figure 7. In the summer, about 50% of Iowa's cooperative utilities and 85% of municipal utilities reach their monthly system coincident peak between noon and 6 p.m., when solar PV is producing energy. These charts include the 36 cooperative utilities and 114 municipal utilities that reported data in 2011.[14]

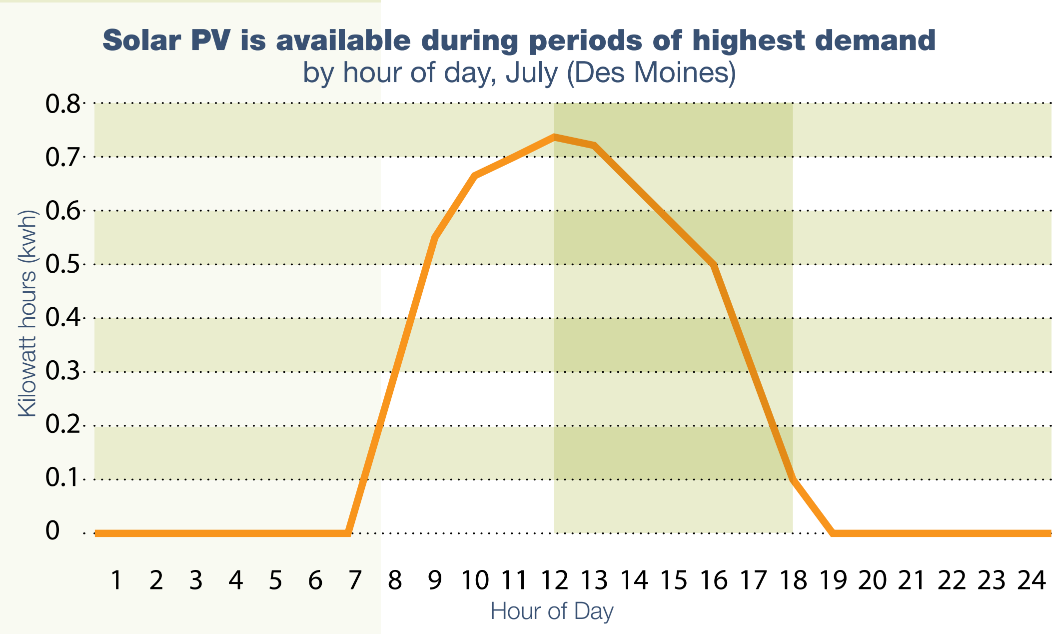


Figure 8. This chart shows a large amount of solar energy is available when Iowa utilities experience peak demand, shown in the highlighted area. Two strategies exist to help a utility with late afternoon or early evening peak demand succeed with solar. First, a rotating axis array or a southwest facing array would produce more energy at the end of the day than the south-facing array used in this model, allowing solar PV to contribute more energy at 5 or 6 p.m. In addition, demand-side management programs can shift demand so more occurs during peak solar production hours. Currently, these programs shift demand away from those hours.

Solar PV is producing energy during these times when utility peaks are likely to occur. Figure 8 shows the hourly production of a solar PV array that faces due south compared to the window of time when utility peaks typically occur.

A recent study by the Iowa Association of Municipal Utilities for the Breda municipal utility concluded that solar PV production coincides with that utility's peaks.[15] The IAMU compared Breda's historical electrical load data with actual local weather data. This analysis allowed the IAMU to find that Breda's "summer peak demand occurs when temperatures are above 90 degrees and skies are clear."[16] This allows for a prediction that solar PV will be available reliably during Breda's peaks.

Figure 9. The following chart shows that solar PV systems in Iowa were producing electricity at or above average production for the month on almost every day when power demand was at its highest.

Utility Peak Day and Curtailment in 2012[17]	Solar PV Production in 2012[18]
June 18	**High**
June 27	**High**
June 28	**High**
July 2	Low
July 3	Low
July 5	**High**
July 6	**High**
July 16	**High**
July 17	**High**
July 18	**High**
July 23	**High**
July 24	**High**
July 25	**High**
August 1	**High**
August 3	**High**
August 29	**High**
August 30	**High**

The summer of 2012 provides a good example of the availability of solar during hot summer afternoons. During that summer, MidAmerican Energy and Alliant Energy called on their customers to use less electricity, typically between the hours of 12:00 noon and 7:00 pm.[19] Both utilities were reducing peak load on these days caused primarily by high temperatures and the resulting high electrical demand of air conditioners.[20] As Figure 9 demonstrates, actual production data from a solar PV array in Iowa shows that solar production was very good on almost every day that Iowa utilities experienced peak loads for the summer.

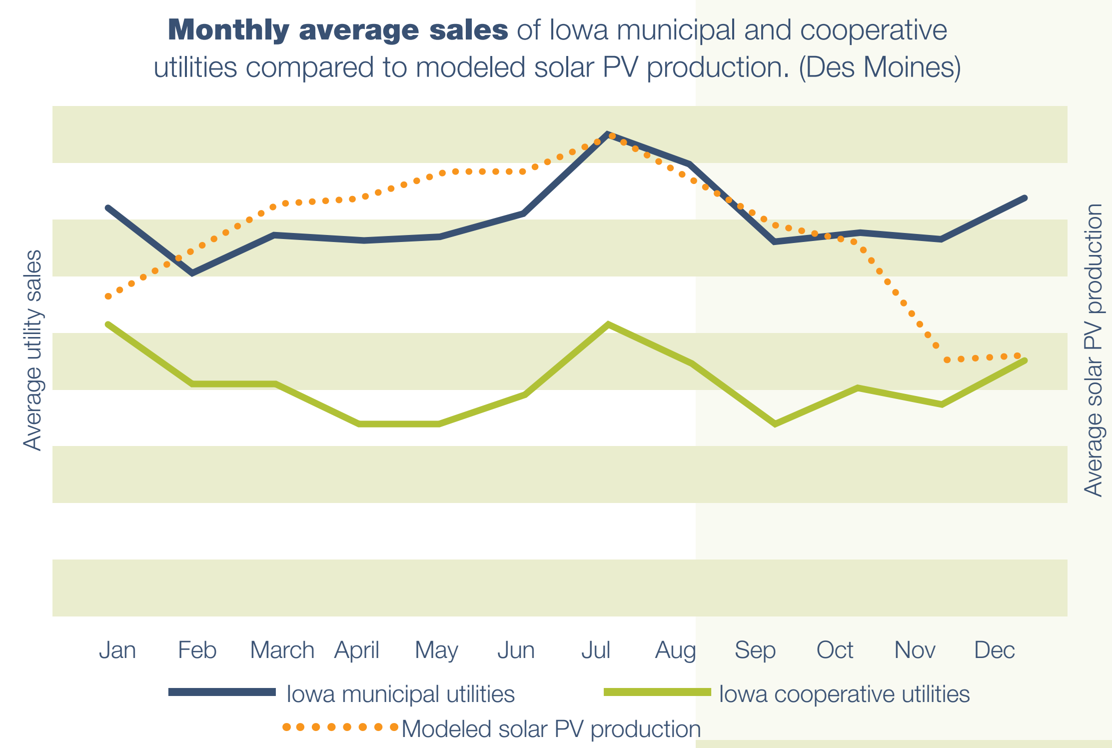


Figure 10. For most of the year, the trend of monthly solar PV production follows and closely matches the trend of monthly electricity sales for Iowa's municipal and cooperative utilities.[21]

In addition to being available on a daily basis, solar PV can meet electricity needs throughout the year. During the course of the calendar year, the monthly solar production trend closely matches the monthly electricity sales trend for Iowa's cooperative and municipal utilities (Figure 10). Electricity sales typically grow starting in February and reach a high in July, then begin to fall during the autumn months. Solar PV production closely follows this trend. There is an exception in December and January, when some utilities with customers that heat with electricity see a spike in electricity sales. Solar PV production does not follow that increase in electricity use.

Solar PV is available when energy is most expensive

Solar PV's availability during the high demand times is not just a matter of convenience, but also cost savings. When electricity is in high demand, it is also typically more expensive. Wholesale energy prices are often highest on hot, sunny summer afternoons. By generating more electricity during these times, solar PV can reduce costs for those customers who have solar PV arrays and for the system as a whole – reducing costs for all customers (Figure 11).

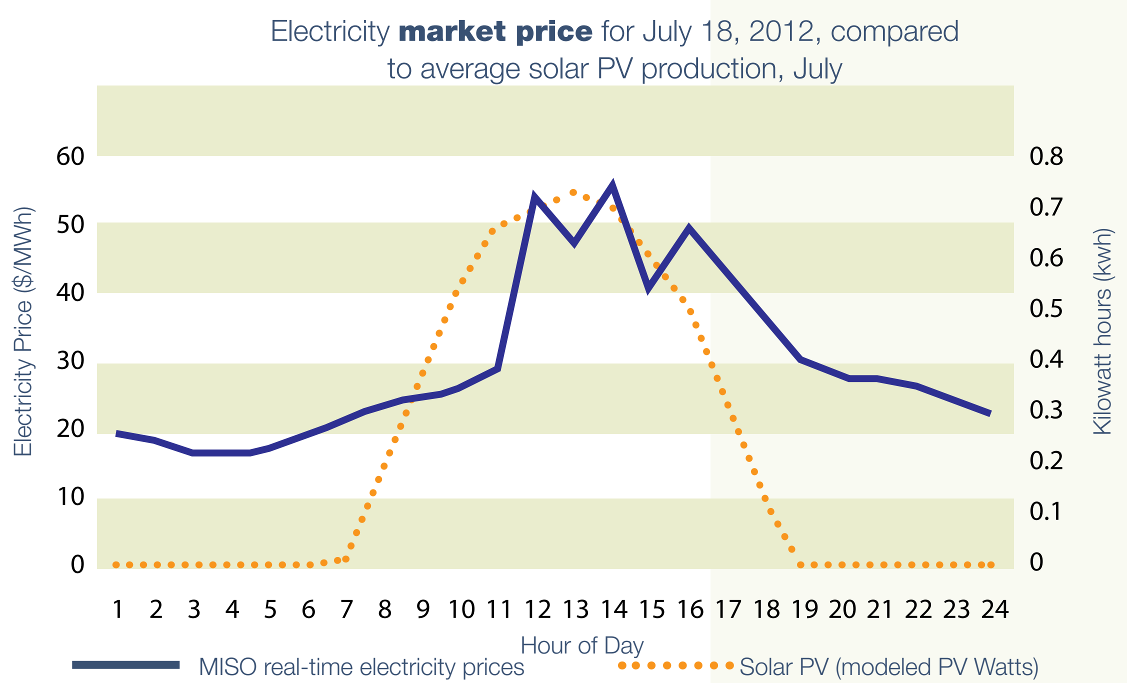


Figure 11. This graph compares the average summer production from a PV array in Iowa with the hourly changes in wholesale prices in the Midwestern electricity market (MISO) on the hot summer day of July 18, 2012. On these types of days, solar PV production and electricity prices frequently follow a similar trend.[22]

Generating 5% of our electricity from solar is a realistic target.

Solar PV is available when the electric grid is stressed

In addition to cost, periods of highest demand can cause stress on the electric grid, which solar PV can help reduce. At times of high demand, power lines can overload and cause blackouts or brownouts. More inefficient and polluting power plants are also called to generate electricity. Distributed solar PV can reduce the amount of electricity that consumers are trying to get from the grid during these peak times, thus reducing strain on power lines and reducing the need for additional power plants to come on-line.

A good example of solar PV's ability to help the grid comes from a study of the widespread blackout in the U.S. on August 14, 2003, which could have been prevented with more solar PV on the system.[23] The blackout occurred on a hot summer afternoon, during a time with peak energy demand but also plenty of solar energy availability. The grid was experiencing stress when several specific events caused power lines to fail, including a large power plant shutting down and tree branches damaging lines. Had more solar PV been operating across the regional grid, it would have reduced stress and risk of failure. Solar PV equivalent to a small fraction of the peak load on the grid at the time could have made the difference.

Solar energy fits well among Iowa's current sources of electric power

Expanded solar power in the context of Iowa's current energy mix

Iowa's current electricity mix is dominated by coal-fired power plants (approximately 65%) and wind energy (25%), followed by small portions of nuclear, natural gas, and hydropower. Generating 5% of our electricity from solar is a realistic target.[24] If solar energy were to account for 5% of Iowa's annual electricity generation, it would be higher than the amount of electricity generated by natural gas and hydropower. At 10%, solar would be higher than natural gas and nuclear energy (Figure 12).

Solar targets compared to select Iowa generation sources

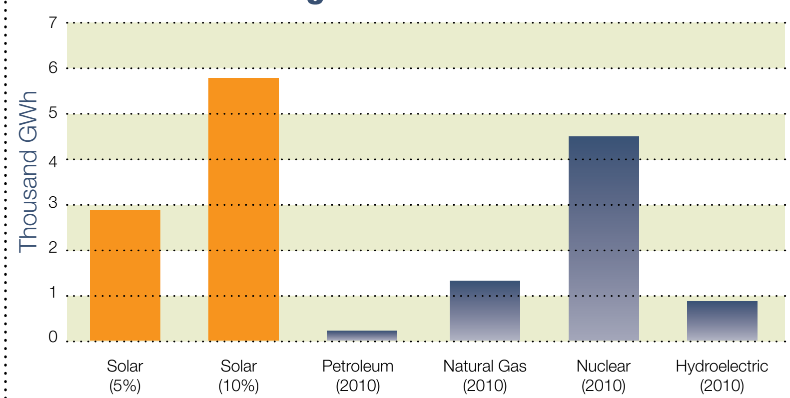


Figure 12. Solar can realistically provide as much or more electricity to Iowans as natural gas, nuclear, or hydro do today.

Solar PV has a small footprint

Expanding solar PV to meet 5% or 10% of Iowa's electricity needs can be accomplished with a small footprint. Iowa does not need to take a large portion of agricultural land out of production.

Iowa's rooftop solar PV potential alone could meet close to 20% of Iowa's annual electric needs. By focusing on rooftop applications – homes, warehouses, schools, hospitals, car dealerships, parking ramps, and many others – solar PV could meet a significant share of Iowa's needs.

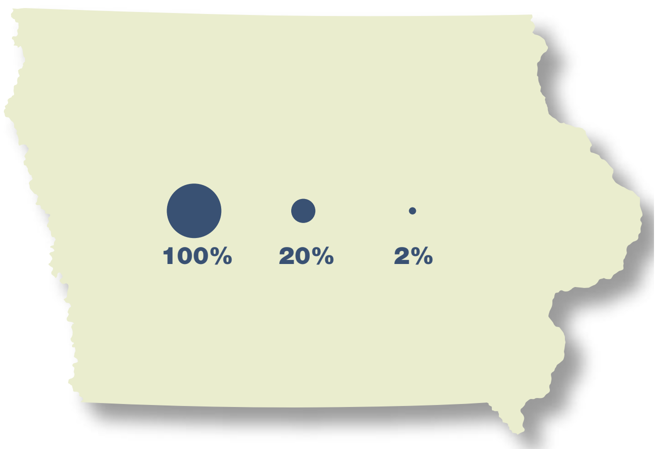


Figure 13. The three circles above represent the geographical area needed to install enough solar PV to meet 100%, 20%, and 2% of Iowa's electricity needs. All solar would not be centralized in a single location, so this just a representative illustration of the land area required.

Photos courtesy Eagle Point Solar/Barry Shear

Colony Brands, Inc.

Activated: December 2011
Size: 150 kW
Project Type: Warehouse rooftop
Location: Peosta, Iowa

At Colony Brands' distribution warehouse center in Peosta, Iowa, a tremendous source of electricity is sitting on the roof. John Mitchell, maintenance manager for Colony Brands, said in their first year, the company was excited to see their 625 solar panels produce in excess of 200,000 kWh.

Mitchell, who leads electric savings efforts on the company's green team, said "We thought it was the right thing to do as far as the environment goes. We think we will be able to keep more than 230,000 pounds of carbon dioxide out of the atmosphere every year with this array."

He also said the facility is a "picture perfect" location for a solar array with plenty of roof space and a good southern exposure. The panels have a light footprint on the facility itself—adding only 3.5 pounds per square foot in load to the roof and are held in place by ballast, not mechanical fasteners. This installation method minimized modifications to the facility while still being able to withstand up to 120 MPH winds.

Various incentives to support solar energy also helped lighten the project's financial load. Through depreciation, federal energy credits, and incentives from Alliant Energy, the company was able to shave nearly $450,000 off the cost of the installation. Mitchell said given the electric savings from the installation, Colony Brands' solar panels will pay for themselves years before the end of their useful lives. After that time, the installation will begin putting money into the bank by providing reliable energy for the facility at a fixed cost.

Utility-scale solar PV in rural and urban areas would likely be larger solar fields installed on the ground, rather than on rooftops. A collection of rural solar fields that adds up to 21 square miles of land would provide 10% of Iowa's electricity needs. Iowa has 55,857 square miles of land, so this amount of solar would occupy just .037% of Iowa's land area[26] (Figure 13).

Seasonal comparison of wind and solar production by hour of day

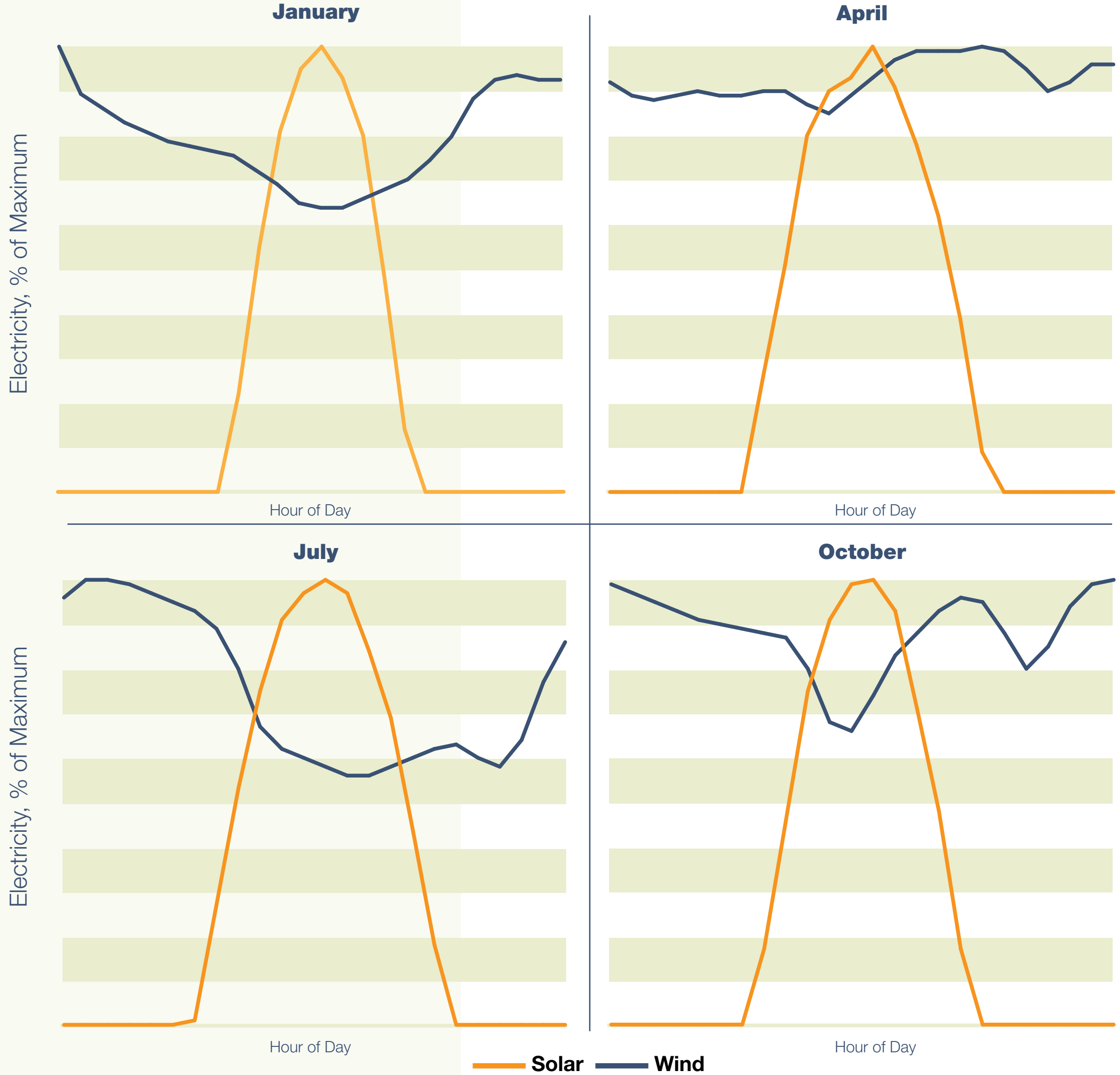


Figure 14. This graph compares an average day of wind production with an average day of solar production in the months of January, April, July, and October. In each of these months, as wind production declines during the day, solar PV production increases. Shortly after PV declines, wind power picks back up. Note that this figure compares two different types of data sets. We used real historical hourly wind production data from MISO and modeled hourly solar data from NREL's PV Watts. More research is needed on the interaction of wind and solar in market and non-market conditions. For example, the wind data from MISO may be influenced by curtailments to wind farms caused by market price, congestion, or other factors.[27]

Solar and wind energy fit together well

Iowa is a leading state for wind energy, so how solar fits in with Iowa's existing – and growing – wind industry is an important consideration. Fortunately solar and wind are complementary renewable energy resources. While wind turbines can produce energy at any time of day and any time of the year, wind energy production tends to be higher in the winter and can be higher at night. Solar energy is available during the day and production is higher during the summer. Combining solar and wind energy means that Iowa could rely on much greater overall levels of renewable energy.

Comparison of monthly wind and solar production

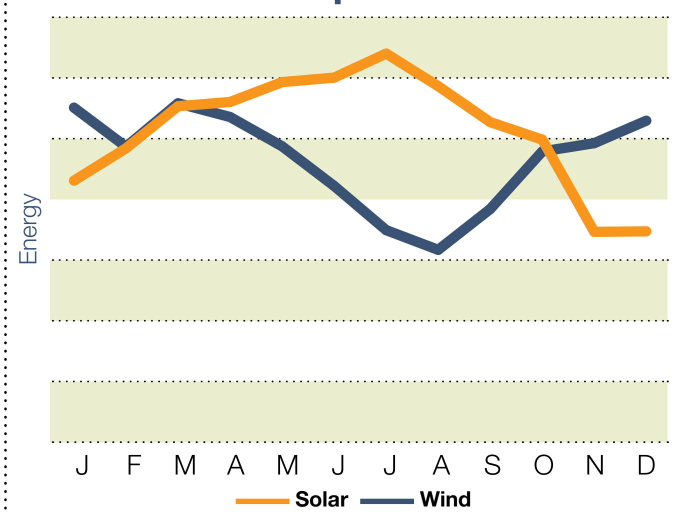


Figure 15. Solar production is highest in summer months, when wind production declines. As solar production declines in winter, wind production is at its highest.[28]

Cost and Installation Trends for Solar PV

Key points

- Solar PV prices have fallen significantly in recent years and further price declines are expected.
- Nationally and in Iowa, the rate of solar PV installations is increasing rapidly each year.
- Despite recent growth, Iowa has only a fraction of the solar PV installed that states with the most capacity have.

Prices declining rapidly

The cost of installing solar PV has decreased annually while the technology performance has increased slightly. For example, prices fell on average 5% to 7% each year from 1998 to 2011.[29] Annual price reductions from 2008 to 2012 were even greater (Figure 16). While the cost to install a watt of solar PV averaged $7.50 in 2008, that cost had come down to about $4 per watt in 2012.[30] Much of this decrease was caused by a reduction in the price of solar PV panels themselves.

Costs are expected to continue to decline in future years as well. The Department of Energy's SunShot Vision Study identifies goals of reaching $1/watt for utility-scale PV, $1.25/watt for commercial PV, and $1.50/watt for residential PV by 2020.[31] Further decreases in module or panel prices can be expected. There are opportunities to reduce the costs associated with solar PV installation, permitting, interconnection, taxes, and financing (the so-called 'soft costs').

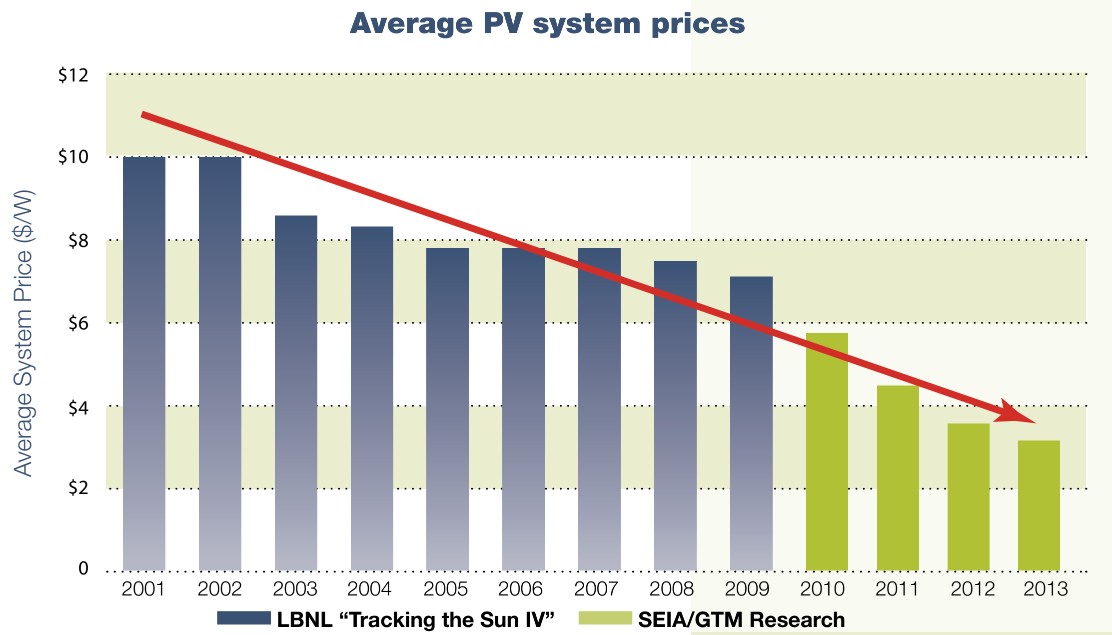


Figure 16. Solar PV prices have come down dramatically in recent years.[32] Source: Solar Energy Industries Association and Greentech Media

Photo courtesy Luther College/Aaron Lurth

Multi-modal transportation center & Baker Village array

UNI multi-modal transportation center
Activated: October 2010
Size: 206 kW
Project Type: Rooftop
Location: Cedar Falls, Iowa

Luther College Baker Village array
Activated: August 2012
Size: 280 kW
Project Type: ground mount
Location: Decorah, Iowa

Two of Iowa's largest solar installations are located at higher education institutions in the state, serving as prominent examples of institutional commitments to sustainability while also providing a substantial energy resource. At Luther College in Decorah, a 280 kW array activated in August, 2012, and a smaller 20 kW array nearby were designed to totally meet the entire electric needs of a six building student housing complex. South of Decorah, in Cedar Falls, a 206 kW solar array atop the University of Northern Iowa's multimodal transportation center, opened in August 2010. Over the course of the year, energy production from this array exceeded the energy demand of the facility that supports it, with additional energy helping to power several adjacent campus buildings.

Photo courtesy University of Northern Iowa

Installations on the rise

As costs fall and performance improves, more and more solar PV is being installed. Annual installations increased rapidly starting in about 2010. This is true in Iowa and nationally, although Iowa's growth is occurring a year or two behind the national average.

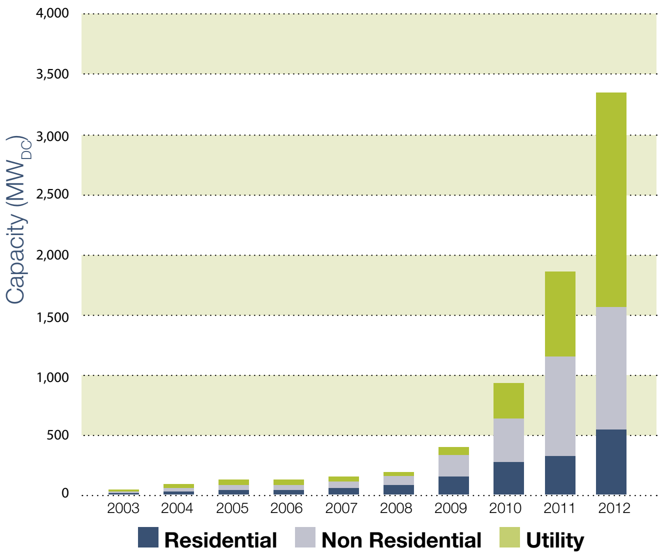
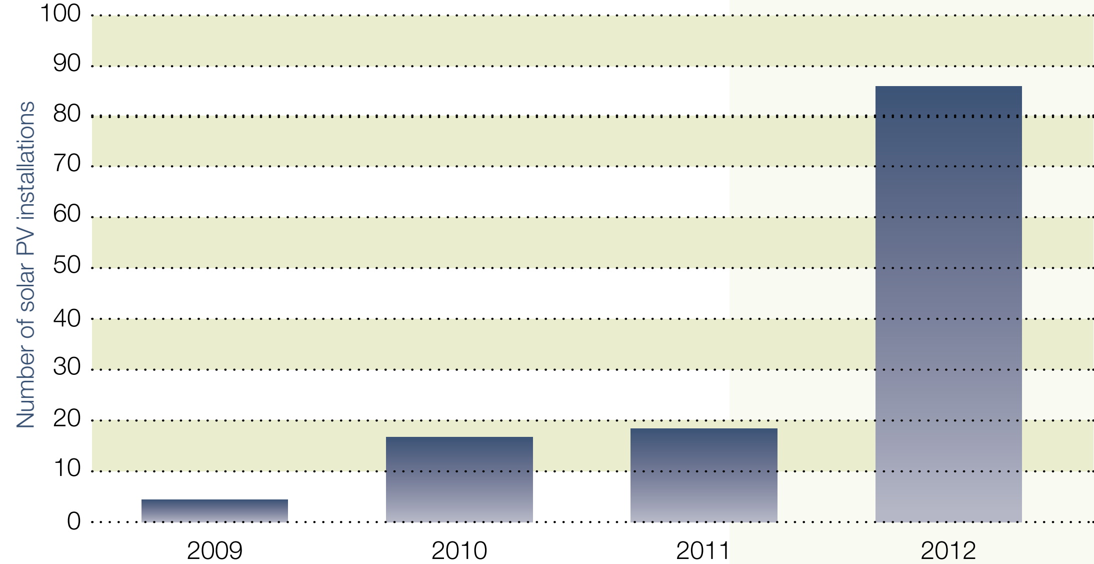


Figure 17. Solar PV capacity nationally has increased dramatically in the past decade. This chart show annual or incremental solar PV capacity added by year from 2001 to 2010.[33]
Source: The Interstate Renewable Energy Council, Inc.

Figure 18. Solar installations are increasing annually, as measured by interconnection agreements in Alliant Energy and MidAmerican Energy's service territories from 2009-2012.[34]

Solar PV installations have increased substantially in the Alliant and MidAmerican territories



Iowa is ready for much more growth in solar PV

By the end of 2012, many U.S. states had a level of solar capacity that was an order of magnitude higher than Iowa. While some of these states might be expected – such as California at 2,902 MW or Arizona at 1,097 MW – others may not be. New Jersey had 971 MW, North Carolina had 229 MW, Massachusetts had 198 MW, and Pennsylvania had 196 MW.[35] Iowa's solar resource and potential for solar PV energy production is as good or better than each of these four states, yet Iowa ended 2012 with between 1-2 MW of installed capacity. Iowa's electric rates are similar to a state like North Carolina, which is seeing dramatically higher rates of solar installations. The Iowa market is ready for substantial growth.

Despite progress, Iowa lags well behind other states in annual solar installations

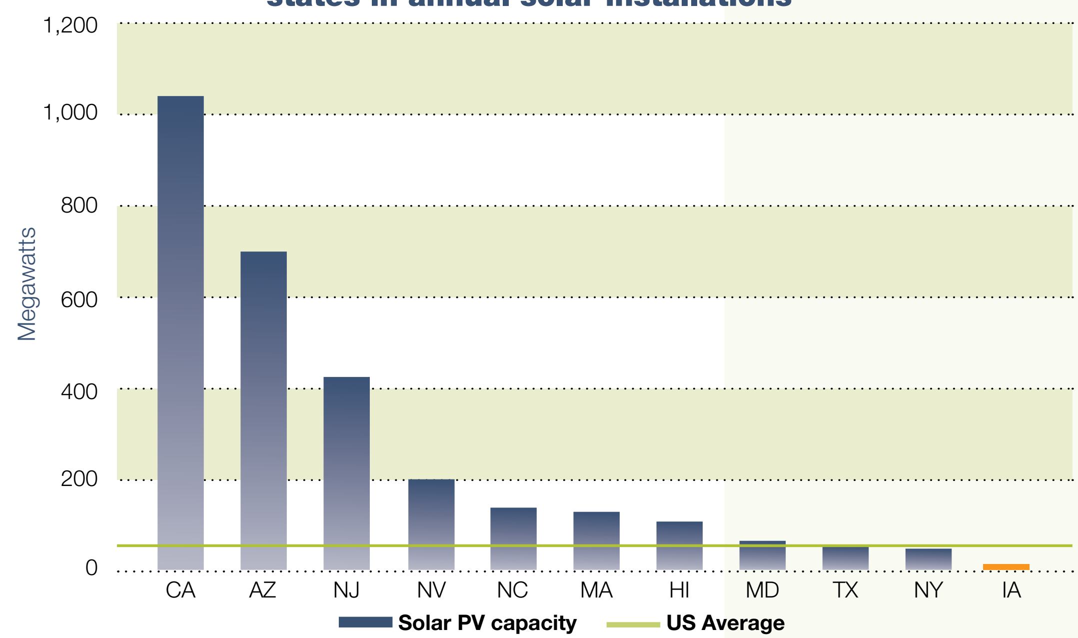


Figure 19. This chart compares the top ten states for solar installations in 2012 with Iowa. Iowa installed approximately 1 megawatt of solar PV in 2012, while California saw over 1,000 MW installed. States with similar electric rates and solar resources as Iowa, such as North Carolina, installed 132 MW or 132 times what Iowa installed.
Source: SEIA/GTM Research: U.S. Solar Market Insight®; Iowa Environmental Council Analysis

Photo courtesy Luther College/Imsouchivy Sous

Solar PV, Jobs, and Economic Impacts

Highly visible from Highway 1, Allan Mallie's 40 kW solar installation will provide electricity for his new 2,400 head hog finishing facility.

Key points

- Adding 300 megawatts of solar PV over 5 years would create an average of 2,500 jobs each year.
- Solar PV can help Iowa reduce the $14 billion spent annually importing energy sources.
- Solar PV provides economic value by improving the electric grid and creating cleaner air and water.

Solar PV creates jobs

Adding more solar energy in Iowa will create new jobs in local economies across the state. For example, a recent study found that adding 300 MW of solar PV in Iowa over a five year period would create an annual average of 2,500 jobs during that time.[36] The number of jobs depends on how much PV is installed in a given year. In the study, the year when the most PV is installed would see almost 5,000 jobs.

Most jobs are either direct jobs installing solar panels on homes and businesses or indirect and induced jobs associated with those installations. The direct jobs include installers, contractors, and electricians as well as sales and distribution, engineering, and more. While most jobs are temporary and installation-related, there are a small number of permanent operations and maintenance jobs. Because solar installations are local, the jobs themselves are created locally.

The job creation study did not include any new manufacturing in Iowa. However, as Iowa has seen with the wind industry, a vibrant market for solar in Iowa could result in additional jobs related to manufacturing

Allan Mallie farm

Activated: April 2013
Size: 40kW
Project type: Ground mounted/ agricultural
Location: Near Lisbon, Iowa

Allan Mallie operates two hog finishing facilities on his farm near Lisbon, a 15 year old 1,000 head finishing facility and a new 2,400 head facility Mallie recently decided to add.

Listening to Mallie describe the nearly two dozen fans, some of which are as large as 50 inches, that move air through the new facility, as well as the heaters and motors to provide feed to the hogs, it quickly becomes clear that electric costs can weigh heavily on his profitability.

"I'm not in it just for show and tell," Mallie said. "I want this thing to be productive, save me money, and keep all this new energy we're creating in a clean form."

Mallie reports that, as a pork producer, solar energy brings him a wide range of benefits. First, on the hottest summer days when he closes the side curtains on his facility and relies on his bank of fans to move the air and cool the building, his solar panels are likely to be near peak production.

Second, the solar panels have no moving parts and are easy to maintain. Finally, Mallie was able to create a solar installation that exactly matched his electric needs, rather than choosing a wind turbine that might have been too big or too small. Because solar PV is modular, Mallie will be able to easily expand his array if his electric needs change. Mallie said he has considered expanding his installation to provide as much as one megawatt of electric capacity.

Stan Pfoff, Mallie's electrician, said solar energy is a way for farmers to stabilize their electric rates throughout the 25-year life of a typical solar installation. He said for many farmers, the decision to install solar is similar to buying propane in August to lock in a lower price.

Mallie said he hopes his installation, which is right along Highway 1 in Lisbon, will help others nearby learn about and choose solar power.

Karl Chevrolet in Ankeny has installed a solar canopy over an electric vehicle charging station.

of panels or related equipment in the supply chain (inverters, racks, components, etc.).

Nationally, solar jobs have been growing consistently as solar installations and solar markets grow. Since 2010, estimates show that solar jobs have increased annually by approximately 13%. This trend is expected to continue or even increase in the near term as solar installations increase.[37]

Solar PV creates economic value

In addition to creating jobs, solar PV provides a number of other benefits that have economic value. These include reduced use of fossil fuels to generate energy, a cleaner environment, and an improved electric grid.

Iowa imports fossil and nuclear fuels to produce electricity, fuel cars and trucks, heat homes and businesses, and meet other energy needs. The total cost of all energy imports is approximately $14 billion annually.[38] The cost of importing coal for just electricity production is over $500 million annually. By using solar PV to power homes and businesses as well as electric vehicles, Iowa can reduce the need to import these fuels. The dollars not spent on imported fossil fuels are then available to be spent in local economies across the state, providing an economic boost in addition to the direct job creation.

Solar PV can help reduce the need to build large and expensive power plants. Distributed solar PV can reduce the need for transmission and distribution lines and helps to eliminate the energy losses from power plants and power lines. Solar PV can support the reliability of the existing grid by providing a range of so-called grid benefits, such as reactive power and voltage control, power quality, frequency regulation, and many others.

By reducing the use of fossil fuels, solar PV provides environmental and public health benefits. Reducing fossil fuel use will reduce emissions of sulfur dioxide, nitrogen oxides, carbon dioxide, mercury, and fine particulates, which leads to cleaner air and water and improved public health.

Numerous studies in recent years have quantified some of these benefits to help understand the full value provided by solar PV. Depending on the specific benefits that are quantified and other factors, these studies often find a value of solar in the range of 10 cents to 15 cents/kWh.[39] In other words, solar PV can provide an economic value that is greater than its cost.

Solar project economics

For those who install solar PV, a significant benefit is stabilizing energy costs in the short term and reducing them in the long term. The key factors determining the economics of particular project include the cost of installing solar PV, the cost of financing, and the cost of energy that will be avoided. These vary significantly from project to project. However, with the incentives in Iowa, the simple payback of many solar PV projects is now in the range of five to seven years and typically no more than ten years. Meanwhile, solar PV can be expected to perform for many years more than the simple payback, with most systems are under warranty for twenty or twenty-five years. Metrics other than simple payback, such as return on investment and internal rate of return, can be useful to evaluate the economic performance of solar PV and compare the investment in solar PV to other potential investments.

Even if 100% of the cost of a solar PV system is financed, many projects can be financed in a way that allows the owner of the new system to have no increase in energy costs on a monthly basis after the project is installed. In other words, the amount it takes to pay the loan for the upfront cost of the solar PV system is often offset by the savings on energy costs. Once paid off in five or ten years, the owner will see a significant reduction in monthly energy costs. The electricity from solar PV is then essentially free.

A Farm Bureau office in Humboldt, Iowa.

The World Food Prize Hall of Laureates, Des Moines.

5 Solar PV and **Public Policy**

Key points

- Public policies at the national, state and local level play an important role in solar PV development.
- Iowa has adopted some key policies for solar PV, and there are additional policy options to consider.

Public policy is an essential driver for all energy technologies and markets in Iowa. Past policies at the state and federal level led to the development of Iowa's current mix of coal, natural gas, nuclear, and wind. New policies can help drive solar development going forward.

Because solar fits with so many types of customers and applications, from small rooftop systems on homes to large commercial and industrial rooftops, community solar arrays and even solar fields, it is important to have a menu of policy options available to support many types of applications. Policies can eliminate barriers and create incentives to invest in solar PV. Policies can establish a competitive market and a fair price for the energy produced from solar PV and ensure that solar PV is simple and inexpensive to permit, install, and connect to the grid.

Tax incentives help offset upfront costs. There is a 30% federal income tax credit in place, which Iowa matches with an additional credit of 15%. The Iowa tax credit is capped at $5,000 for residential taxpayers and $20,000 for business taxpayers. Together, these credits can offset up to 45% of the cost of solar PV depending on factors such as system size. In addition to the tax credits, businesses can take advantage of bonus depreciation as an additional tax benefit and Iowa offers property tax and sales tax exemptions for solar PV. Tax credits are important but are not available in every situation. For example, a school, university, city, or other entity without tax liability that is interested in developing solar typically cannot benefit from tax credits.[40]

Utility incentives can also offset upfront costs. Several Iowa utilities currently offer some form of incentive, including upfront rebates, low interest loans, and incentive rates (incentive rates or feed-in tariffs provide a set price per energy unit provided to the grid for a set period of time). However, most customers in Iowa do not have access to these programs, so many more utilities could offer some form of incentive to customers to install solar PV.

Additional **loan and grant programs** are available to offset the upfront cost for certain types of projects. For example, the Iowa Energy Center offers a low interest loan program for renewable energy, including solar PV. The U.S. Department of Agriculture offers a competitive grant program through its Rural Energy for America Program (REAP), which has begun providing grants to on-farm solar PV projects in Iowa and other states.

Third-party power purchase agreements (PPAs) are an important policy for solar PV, particularly in situations where the party interested in solar cannot take advantage of tax credits. Under a third-party PPA, a business will develop and install a solar project on a customer's property and sell energy to the customer

Farmer's Electric Cooperative, located near Kalona, Iowa, was the first to offer a community solar project for customers to invest in.

under a long-term contract. Because the business can take advantage of tax incentives, secure financing, and offer a long-term contract, the price of solar to the customer is often competitive with existing electricity prices. In 2014, the Iowa Supreme Court affirmed that third party PPAs are legal in Iowa.[41] A similar but often less useful policy – a third-party lease of solar PV – is also available in Iowa.

Many states have set targets for solar PV development as a part of the state's **renewable energy standard**. Under these policies, a fixed amount of solar PV (such as a certain number of megawatts) or a set percentage of solar PV compared to total electricity needs (such as 2%) is targeted for a future date. Utilities then acquire solar PV using whatever approach or approaches make sense in the service territory to meet the target. Residential or business installations, community solar, or utility-owned solar could all be used to meet the target.

Interconnection policies govern the process and requirements for solar PV to be connected to the grid. The Iowa Utilities Board (IUB) has adopted well-regarded interconnection rules for Iowa's investor-owned electric utilities and Linn County REC, which has elected to be rate regulated by IUB. These rules set out clear and fair standards for forms and paperwork, fees, timelines for approval, insurance requirements, safety, and equipment standards. With these rules in place, customer-sited PV can be connected to the grid in a simple, straightforward process.

Iowa's **net metering** policy allows solar PV systems under 500 kW to 'net' out monthly production against the customer's energy use at the retail rate. The customer's electric meter can run forward and backward over the course of the month. If the solar PV array produces more than the customer uses, there is a credit. If PV produces less, the customer will be charged for those additional kilowatt-hours. This policy is only required for utilities that are rate regulated by the Iowa Utilities Board, like MidAmerican and Alliant. Some municipal and cooperative utilities offer a version of net metering, but it varies considerably by utility. Virtual net metering would allow customers to net meter with a solar PV array at a remote location, such as a community solar project. Virtual net metering generally has not been adopted in Iowa.

Community solar is attractive because it can allow more participants to invest in and benefit from solar PV. For example, a renter or a homeowner that has a shady roof or yard can both still own or support a portion of a solar PV project. Other policies may be needed to expand community solar in Iowa, such

Acronyms

kW – kilowatt
kWh – kilowatt-hour
MW – megawatt
MWh – megawatt-hour
GW – gigawatt
GWh – gigawatt-hour
PV – photovoltaic

as different types of tax incentives. Community solar projects can be owned by utility consumers or by utilities themselves.

Community solar represents one option for **utility ownership** of solar PV. Others include owning large-scale solar PV arrays that are typically located on the ground but can also be distributed on rooftops at multiple locations.

Local zoning and permitting are also important policies for solar PV. Some communities in Iowa have zoning ordinances which create barriers for solar, such as restrictions on where solar can be installed on individual private property or in parts of the community. Unclear, expensive, time-consuming, or variable permitting requirements also create barriers for both those interested in installing PV and to the businesses that install PV in multiple communities. A significant share of the total cost of installing PV can go towards these 'soft costs.' By simplifying, streamlining, and standardizing the permitting and zoning requirements in communities across the state, solar PV will be both easier and less expensive to install. In addition, new communities can be planned to include solar PV or to be solar-ready.

Resources

Iowa Environmental Council
www.iaenvironment.org

Iowa Economic Development Authority
www.iowaeconomicdevelopment.com/Programs/Energy

Iowa Energy Center
www.iowaenergycenter.org

Iowa Solar Energy Trade Association
www.iowaseta.org

Department of Energy PV Watts calculator
www.nrel.gov/rredc/pvwatts

Department of Energy SunShot Initiative
www1.eere.energy.gov/solar/sunshot/index.html

Interstate Renewable Energy Council
www.irecusa.org

Solar Energy Industries Association
www.seia.org

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Endnotes

[1] Lopez et al, NREL, *U.S. Renewable Energy Technical Potentials: A GIS-Based Analysis* (2012).

[2] Department of Energy, *Photovoltaic (PV) Pricing Trends: Historical, Recent, and Near-Term Projections* (2012) at http://www.nrel.gov/docs/fy13osti/56776.pdf.

[3] *Id.*

[4] National Renewable Energy Laboratory, *Photovoltaic Resource of the United States* (2009). Map shows annual average solar resource for a solar PV system where the tilt equals the latitude. This and other solar resource maps are available at http://www.nrel.gov/gis/mapsearch/.

[5] Modeled using NREL PV Watts version 1.0. We used a 1 kW AC array (e.g., a 1.265 kW-dc array with a .79 derate factor), fixed, south-facing, and the PV Watts default recommended tilt for each location. NREL PV Watts is available here: http://rredc.nrel.gov/solar/calculators/pvwatts/version1/.

[6] Lopez et al, *National Renewable Energy Laboratory, U.S. Renewable Energy Technical Potentials: A GIS-Based Analysis*, (2012). This study identifies technical potential in three categories: utility-scale PV in rural areas, utility-scale PV in urban areas, and rooftop PV. The study excludes from rural utility-scale PV any development on many types of federal lands, protected lands, urban areas, slopes at or above 3%, and land areas less than 1 contiguous square kilometer. The study only used a limited portion of total rooftops for rooftop PV potential in different sectors (residential, commercial). The urban utility-scale PV potential excludes such areas as parking lots, roads, parks, and developed areas. The report and associated materials are available at http://www.nrel.gov/gis/re_potential.html.

[7] National Renewable Energy Laboratory, *Renewable Electricity Futures Study* (2012) at http://www.nrel.gov/analysis/re_futures/.

[8] Lopez et al, NREL, U.S. *Renewable Energy Technical Potentials: A GIS-Based Analysis* (2012).

[9] All rankings based data included in NREL's Renewable Electricity Futures Study (2012).

[10] All rankings based data included in NREL's Renewable Electricity Futures Study (2012).

[11] Energy Information Administration, *State Electricity Profile: Iowa 2010* (2012) ; NREL Renewable Electricity Futures Study (2012).

[12] EIA, State Electricity Profile: Iowa 2010 (2012); *NREL Renewable Electricity Futures Study* (2012). Calculations based on Iowa's 2010 retail sales.

[13] Modeling conducted using NREL PV Watts version 1.0 as described in note 2 above.

[14] Utility annual reports filed with the Iowa Utilities Board. Municipal utility reports are filed using Form ME-1, cooperative reports are filed using Form EC-1. We compiled data from all reports filed in 2012 for calendar year 2011. Individual reports can be accessed using the IUB's electronic filing system, https://efs.iowa.gov/efs/.

[15] Iowa Association of Municipal Utilities, *Feasibility Study of Peak Demand Reduction Strategies for the City of Breda Municipal Electric System* (2012).

[16] *Id. at 25*.

[17] Dates are those reported by IPL and MidAmerican in annual energy efficiency reports as triggered by a peak demand condition. Interstate Power and Light Company, *Annual Report for 2012 Energy Efficiency Plan*, (2013); MidAmerican Energy Company, *2012 Annual Report to the Iowa Utilities Board* (2013). Reports available at http://www.state.ia.us/government/com/util/energy/energy_efficiency/ee_plans_reports.html.

[18] Actual output from Farmer's Electric Cooperative community solar array, available at http://www.sunnyportal.com/Templates/PublicPageOverview.aspx?page=aafebac2-adeb-46b3-b1bd-bea47de83ec4&plant=021823d5-6be2-4790-9f48-bda9db491e-be&splang=en-US. A rating of 'high' indicates the solar panels were producing at 80% or greater of their monthly maximum daily production.

[19] Residential customers have devices connected to central air conditioners that allow utilities to reduce electricity use by cycling air conditioners off. Commercial and industrial customers scale back or stop energy-intensive processes during these hours and/or use backup generation. Customers sign up voluntarily for this program, but typically must curtail once called upon to do so.

[20] These are dates during which Iowa utilities called curtailment events for customers on interruptible or curtailment tariffs using a condition or criteria related to peak demand. Interstate Power and Light's electric tariff includes four conditions that trigger curtailment. Condition 2 "is designed to reduce peak demand" and is based on a loss of the full planning reserve margin for particular times. MidAmerican Energy's condition c is based on a system average high temperature exceeding 94 degrees Fahrenheit occurring, although other conditions could also be caused by peak demand in the local system or in the regional MISO system.

[21] Utility annual reports Form ME-1 and Form EC-1 filed with the IUB.

[22] MISO data from Real Time Market LMP report of the July-September 2012 quarter using data from the gennode MEC.BEPM.Neal4. We started with the list of dates that Iowa utilities called curtailment events and used MISO Market Subcommittee reports to screen out dates where high prices were the result of generator outages or other events not necessarily related to daily summer peaks caused by high temperatures and resulting air conditioning load.

[23] Richard Perez et al, *Availability of Dispersed Photovoltaic Resource During the August 14th 2003 Northeast Power Outage*, at http://www.asrc.cestm.albany.edu/perez/directory/LoadMatch.html.

[24] Current renewable energy standard policies in a number of states have a specific target for distributed renewables or solar PV ranging from .3% to 4.5% in the next 5-10 years. Database of State Incentives for Renewables and Efficiency (DSIRE), *RPS Policies with Solar/DG Provisions* at http://www.dsireusa.org/summarymaps/index.cfm?ee=1&RE=1. Longer-term, studies analyzing very high amounts of renewable energy, including 100% renewable energy, show solar PV contributing 10-20% of electricity needs. For example, a recent study on powering New York State with 100% renewable energy includes a 10% contribution from PV. See Jacobson et al, *Examining the feasibility of converting New York State's all-purpose energy infrastructure to one using wind, water, and sunlight*, Energy Policy, 2013.

[25] Annual generation from Petroleum, Natural Gas, Nuclear, and Hydroelectric from EIA, State Electricity Profile: Iowa 2010 (2012). Solar at 5% and 10% based on IEC calculations of total generation in Iowa using EIA data for all generation sources for 2010.

[26] Calculations conducted by IEC using NREL 80% by 2050 data. This may be a conservative estimate as other analyses have identified a smaller land area.

[27] For these graphs, we used NREL's PV Watts version 1.0 to model an average day for solar in January, April, July, and October. We used real historical hourly wind production data available from MISO to create an average day for wind for each of those same months, and then compared the two. MISO wind production data available here: https://www.misoenergy.org/LIBRARY/MARKETREPORTS/Pages/MarketReports.aspx.

[28] This chart uses modeled solar PV data from NREL's PV Watts version 1.0 and modeled wind data from the Iowa Energy Center's wind energy calculator.

[29] Department of Energy, *Photovoltaic (PV) Pricing Trends: Historical, Recent, and Near-Term Projections* (2012) at http://www.nrel.gov/docs/fy13osti/56776.pdf.

[30] *Id.*

[31] Department of Energy, *SunShot Vision Study* (2011) at http://www1.eere.energy.gov/solar/sunshot/vision_study.html.

[32] Chart used with permission from SEIA. SEIA/GTM Research, U.S. Solar Market Insight Q2 2013, and Lawrence Berkeley National Lab, Tracking the Sun IV.

[33] Interstate Renewable Energy Council, *U.S. Solar Market Trends 2012* (2013) available at http://www.irecusa.org/publications/.

[34] Based on data utilities file with the Iowa Utilities Board, including bi-annual interconnection reports.

[35] Solar Energy Industries Association and GTM Research, *U.S. Solar Market Insight: 2012 Year in Review* (2013) available at http://www.seia.org/research-resources/us-solar-market-insight.

[36] Iowa Policy Project et al, *Shining Bright: Growing Solar Jobs in Iowa* (2011).

[37] The Solar Foundation, *National Solar Jobs Census 2012* (2012).

[38] EIA State Energy Data System (SEDS), *Prices and Expenditures 2011* (2013).

[39] Rocky Mountain Institute eLab, *A Review of Solar PV Benefit & Cost Studies* (2013). This analysis reviews a number of recent studies that have attempted to identify and quantify the cost and benefits of installing solar PV.

[40] There are some creative financing models that use a public/private partnership to allow public entities or others without tax liability to benefit from at least some of the value in tax credits.

[41] Eagle Point Solar petitioned the Iowa Utilities Board for a declaratory order regarding the legal status of third party power purchase agreements in Iowa. After the IUB issued an order interpreting third party PPAs to violate Iowa law, Eagle Point appealed to the Polk County District Court. The district court overturned the IUB order and found them to be allowable under Iowa law. The IUB and utilities have appealed this order. The Iowa Supreme Court upheld the district court in a decision issued in July 2014.

Iowa Environmental Council

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