Appendix M

Economic Impact Study

Economic Impact and Land Use Analysis of the Badger Hollow Solar Farm

By

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About the Author

Dr. David G. Loomis is Professor of Economics at Illinois State University and Co-Founder of the Center for Renewable Energy. He has over 10 years of experience in the renewable energy field and has performed economic analyses at the county, region, state and national levels for utility-scale wind and solar generation. He has served as a consultant for Clean Line Energy Partners, National Renewable Energy Laboratories, State of Illinois, E. ON, EDF Renewables, Invenergy, Geronimo Energy and others. Dr. Loomis is a widely recognized expert and has been quoted in the Wall Street Journal, Forbes Magazine, Associated Press, and Chicago Tribune as well as appearing on CNN.

Dr. Loomis has published over 15 peer-reviewed articles in leading energy policy and economics journals. He has raised and managed over $7 million in grants and contracts from government, corporate and foundation sources. He received the 2011 U. S. Department of Energy's Midwestern Regional Wind Advocacy Award and the 2006 Best Wind Working Group Award. Dr. Loomis received his Ph.D. in economics from Temple University in 1995.

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I. Executive Summary

Badger Hollow Solar Farm LLC, a subsidiary of Invenergy LLC, is developing the Badger Hollow Solar Farm in Iowa County, Wisconsin. Invenergy is North America's largest independent, privately held renewable energy provider. The Company develops, owns and operates large-scale renewable and other clean energy generation and energy storage facilities in North America, Latin America, Japan and Europe. The purpose of this report is to aid decision makers in evaluating the economic impact of this project on Iowa County and the State of Wisconsin. The basis of this analysis is to study the direct, indirect, and induced impacts on job creation, wages, and total economic output.

The Badger Hollow Solar Farm is a 300 MW solar project using single-axis tracking panels. The project represents an investment in excess of $360 million. The total development is anticipated to result in the following:

<u>Economic Impact</u>

<u>Jobs – all jobs numbers are full-time equivalents</u>

- 422 new local jobs during construction for Iowa County
- 500 new local jobs during construction for the State of Wisconsin
- Over 13 new local long-term jobs for Iowa County
- Over 18 new local long-term jobs for the State of Wisconsin

<u>Earnings</u>

- Over $20.2 million in new local earnings during construction for Iowa County
- Over $27.6 million in new local earnings during construction for the State of Wisconsin
- Over $553 thousand in new local long-term earnings for Iowa County annually
- Almost $1.1 million in new local long-term earnings for the State of Wisconsin annually

<u>Taxes</u>

- Iowa County will receive over $466,000 annually and the Township will receive over $333,000 annually from the Shared Revenue Utility Aid Formula.

This report also performs an economic land use analysis regarding the leasing of agricultural land for the new solar farm. That analysis yields the following results:

II. U. S. Solar PV Industry Growth and Economic Development

a. U.S. Solar PV Industry Growth

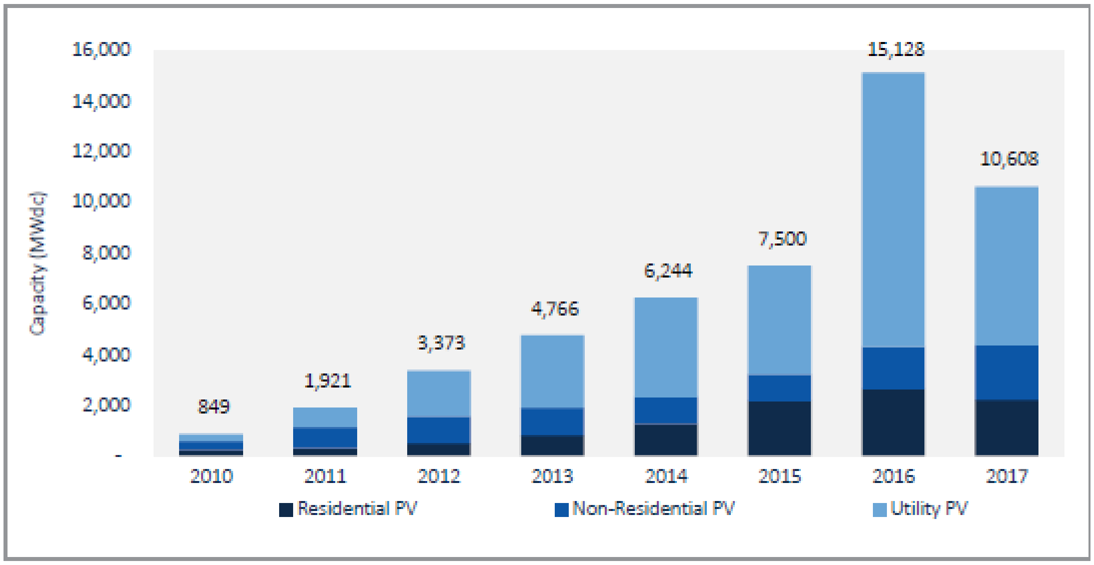
The U.S. solar industry is growing at a rapid but uneven pace. From 2013 to 2016, the amount of electricity generated from solar had more than doubled, increasing from 0.305 quadrillion Btu in 2013 to 0.624 quadrillion Btu in 2016 (EIA, 2018). The industry has continued to add increasing numbers of photovoltaic ("PV") systems to the grid. In 2016, the U.S. installed 15,128 megawatts DC ("MWdc") of solar PV driven mostly by utility-scale PV. In 2017, the U.S. installed 10,608 MWdc of solar PV, a 30% decrease from 2016.[1] Yet, as Figure 1 clearly shows, the capacity additions in 2017 still outpaced any previous year except the record-breaking 2016. The primary driver of this overall sharp pace of growth is large price declines. As seen in Figure 2, the price of solar PV has declined from about $7.50/watt DC in 2009 to almost $2.00/watt DC in 2015. Solar PV also benefits from the Federal Investment Tax Credit (ITC) which provides a 30 percent tax credit for residential and commercial properties. However, various federal tax reform measures and tariffs on imported solar panels by the Trump Administration may lessen the price declines in 2018 and beyond.

Utility-scale PV leads the installation growth in the U.S. A total of 6.2 gigawatts DC ("GWdc") of utility-scale PV projects were completed in 2017, accounting for 59% of the total installed capacity. An additional 2.0 GWdc are under construction and expected to come on-line in 2018. As seen in Figure 3, there are 30,045 MWdc of utility-scale PV solar operating in the U.S. with an additional 16,883 MWdc contracted, and another 26,700 MWdc announced.

Figure 1 – ANNUAL U.S. SOLAR PV INSTALLATIONS, 2010 – 2017

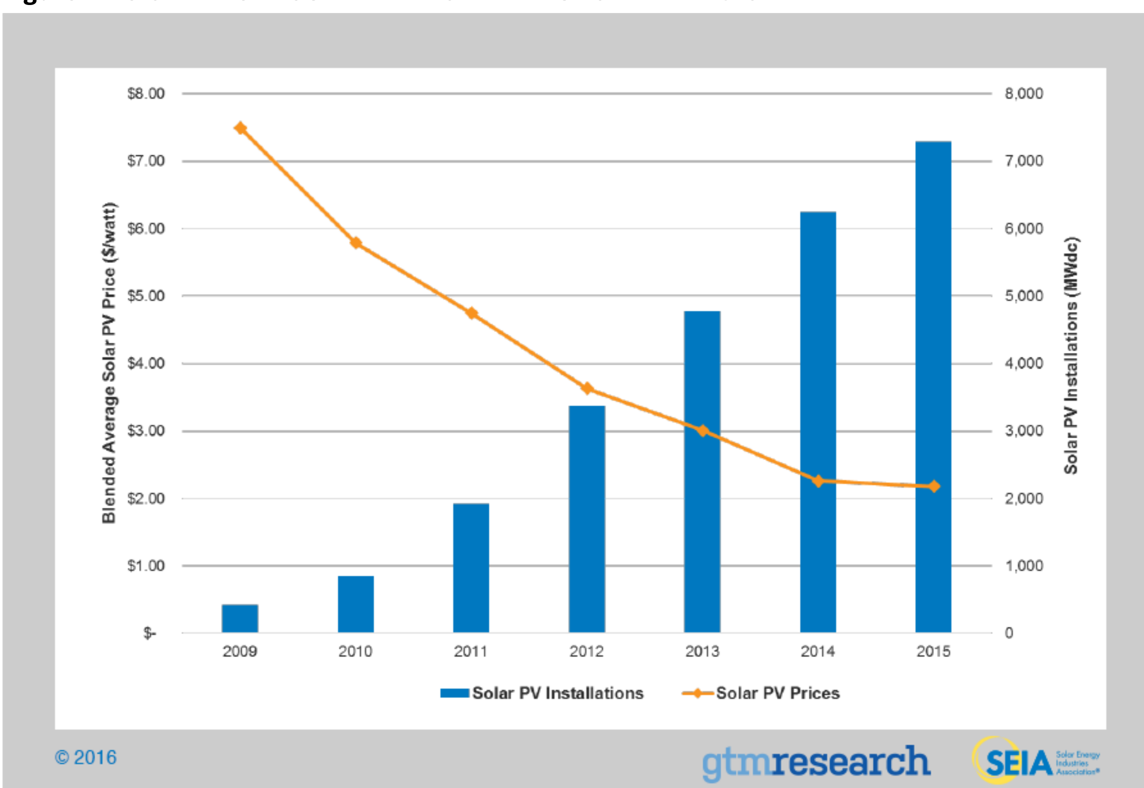
[1] Solar modules generate direct current (DC) electricity, which must be inverted to alternating current (AC) to connect to the grid. Projects typically have a DC/AC ratio of about 1.3. For example, Badger Hollow Solar Farm is 408 MW DC, but only 300 MW AC. The report uses DC measurement in this section because the trade organization, Solar Energy Industries Association, reports their statistics in this fashion. Elsewhere in the report, we will use AC measurement.

Figure 1.1 U.S. Annual PV Installations, 2010-2017



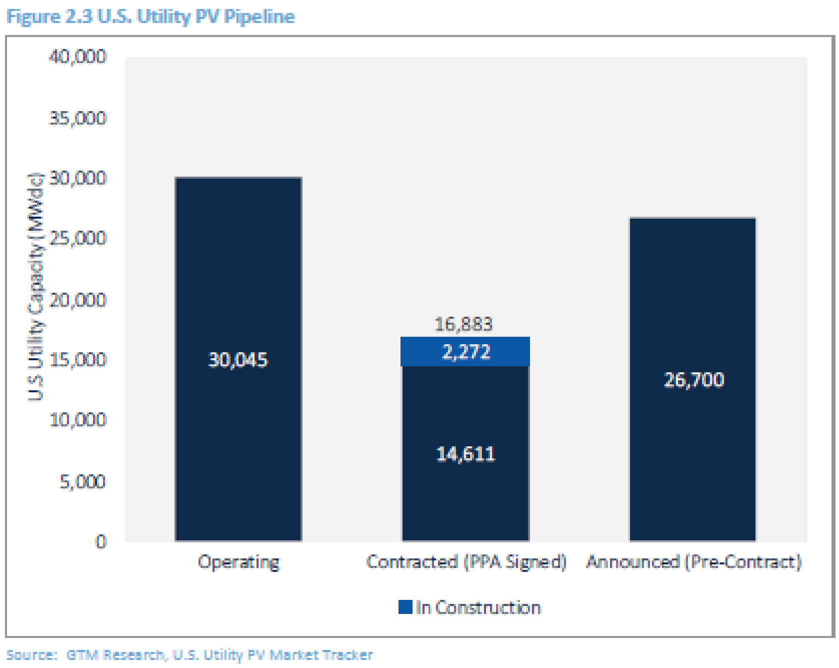
Solar Energy Industries Association, Solar Market Insight Report 2017

Figure 2 - U.S. ANNUAL SOLAR PV INSTALLATIONS AND PRICES



Solar Energy Industries Association, Solar Market Insight Report 2016 Q4

Figure 3 – U.S. Utility PV Pipeline



Solar Energy Industries Association (SEIA), Solar Market Insight Report 2017

b. Wisconsin Solar Industry

According to SEIA, Wisconsin is ranked 38th in the U.S. in cumulative installations of solar PV. California, North Carolina, and Arizona are the top 3 states for solar PV which may not be surprising because of the high solar irradiation that they receive. However, other states with similar solar irradiation to Wisconsin rank highly including New Jersey (5th), Massachusetts (6th), New York (11th), and Maryland (13th). In 2017, Wisconsin installed 20.9 MW of solar electric capacity bringing its cumulative capacity to 50.4 MW.

There are more than 184 solar companies in Wisconsin including 38 manufacturers, 98 installers/developers, and 48 others.[2] Figure 4 shows the locations of solar companies in Wisconsin as of the time of this report. Currently, there are 2,921 solar jobs in the State of Wisconsin according to SEIA.

There are a few currently operating solar projects in Wisconsin. New Auburn DPC Solar is the largest installation at 2.5 MW of capacity. Warren DPC Solar was completed in 2017 and is one of the largest installations in Wisconsin at 2 MW. Target Corporation has installed solar in Wisconsin with their 380 kW Oak Creek project.

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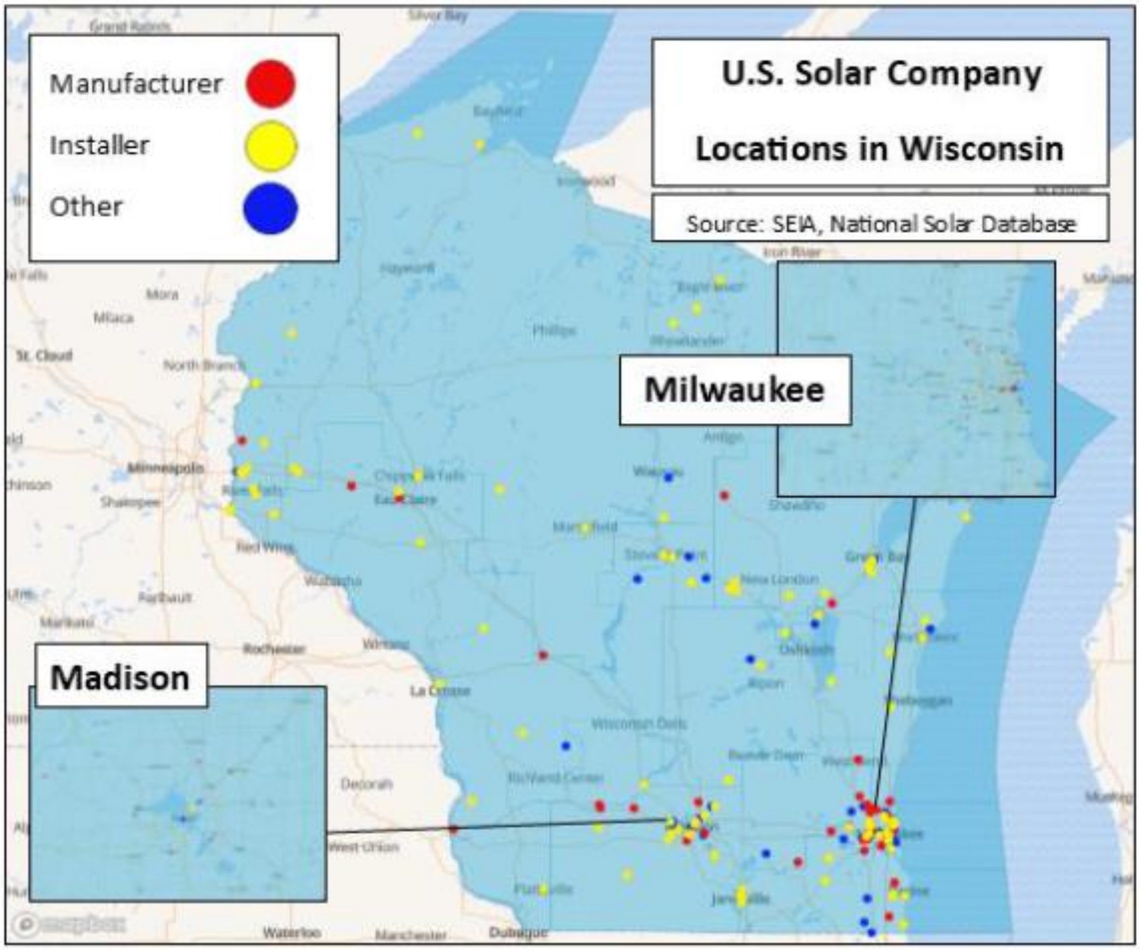
[2] Other" includes Sales and Distribution, Project Management, and Engineering.

FIGURE 4 – SOLAR COMPANY LOCATIONS IN WISCONSIN



Solar Energy Industries Association, Solar Spotlight: Wisconsin

c. Economic Benefits of Utility-Scale Solar Energy

Utility-scale solar energy projects have numerous economic benefits. Solar installations create job opportunities in the local area during both the short-term construction phase and the long-term operational phase. In addition to the workers directly involved in the construction and maintenance of the solar energy project, numerous other jobs are supported through indirect supply chain purchases and the higher spending that is induced by these workers. Solar projects strengthen the local tax base and help improve county services, and local infrastructure, such as public roads.

Numerous studies have quantified the economic benefits of Solar PV projects across the United States and have been published in peer-reviewed academic journals using the same methodology as this report. Some of these studies examine smaller-scale solar systems, and some examine utility-scale solar energy. Croucher (2012) uses NREL's Jobs and Economic Development Impacts ("JEDI") modeling methodology to find which state will receive the greatest economic impact from installing one hundred

2.5 kW residential systems. He shows that Pennsylvania ranked first supporting 28.98 jobs during installation and 0.20 jobs during operations. Wisconsin ranked fifth supporting 30.08 jobs during construction and 0.03 jobs during operations.

Jin et. al. (2016) analyzes the financing options and economic impact of solar PV systems in Normal, IL and uses the JEDI model to determine the county and state economic impact. The study examines the effect of 100 residential retrofit fixed-mount crystalline-silicone systems having a nameplate capacity of 5kW. Eight JEDI models estimated the economic impacts using different input assumptions. They found that county employment impacts varied from 377 to 1,059 job-years during construction and 18.8 to 40.5 job-years during the operating years. Each job-year is a full-time equivalent job of 2,080 hours for a year.

Loomis et. al. (2016) estimates the economic impact for the State of Illinois if the state were to reach its maximum potential for solar PV. The study estimates the economic impact of three different scenarios for Illinois – building new solar installations of either 2,292 MW, 2,714 MW or 11,265 MW. The study assumes that 60% of the capacity is utility-scale solar, 30% of the capacity is commercial, and 10% of the capacity is residential. It was found that employment impacts vary from 26,753 to 131,779 job years during construction and from 1,223 to 6,010 job years during operating years.

Several other reports quantify the economic impact of solar energy. Bezdek (2006) estimates the economic impact for the State of Ohio, and finds the potential for PV market in Ohio to be $25 million with 200 direct jobs and 460 total jobs. The Center for Competitive Florida (2009) estimates the impact if the state were to install 1,500 MW of solar and finds that 45,000 direct jobs and 50,000 indirect jobs could be created. The Solar Foundation (2013) uses the JEDI modeling methodology to show that Colorado's solar PV installation to date created 10,790 job-years. They also analyze what would happen if the state were to install 2,750 MW of solar PV from 2013 to 2030 and find that it would result in nearly 32,500 job years. Berkman et. al (2011) estimates the economic and fiscal impacts of the 550 MW_{AC} Desert Sunlight Solar Farm. The project creates approximately 440 construction jobs over a 26-month period, $15 million in new sales tax revenues, $12 million in new property revenues for Riverside County, CA, and $336 million in indirect benefits to local businesses in the county.

d. Solar PV and Wisconsin Taxes

Solar PV Projects are considered tax-exempt utility property in Wisconsin. However, the project owners pay into a shared revenue utility aid fund which is then distributed to both counties and municipalities by the Wisconsin Department of Revenue on an annual basis (Wisconsin Shared Revenue, 2018).

In the case of Badger Hollow, the Project will pay into the shared revenue utility aid fund based on two components. The first component consists of $2,000 per MW of name-plate generating capacity for a total of $600,000 (300 MW * $2,000). This component is distributed on the basis of 1/3 going to the town and 2/3 going to the county. The second component consists of two $1,000 per MW of name-plate generating capacity incentive payments of $300,000 each for an additional $600,000. The first incentive payment is distributed to the municipalities and second to the county.

Badger Hollow Solar Farm Project Description and Location

a. **Badger Hollow Solar Farm Project Description**

Badger Hollow is a proposed photovoltaic (PV) solar energy generating facility and associated systems totaling 300 MW AC nameplate capacity in Iowa County, WI. The Project will use single-axis tracker systems and be placed in service by the end of 2021.

b. Iowa County, Wisconsin

Iowa County is located in the southwest part of Wisconsin (see Figure 5). It has a total area of 768 square miles and the U.S. Census estimates that the 2016 population was 23,654 with 9,579 housing units. The County has a population density of 31.0 (persons per square mile) compared to 98.8 for the State of Wisconsin. Median household income in the county was $56,641 (2012-2016).

i. Economic and Demographic Statistics

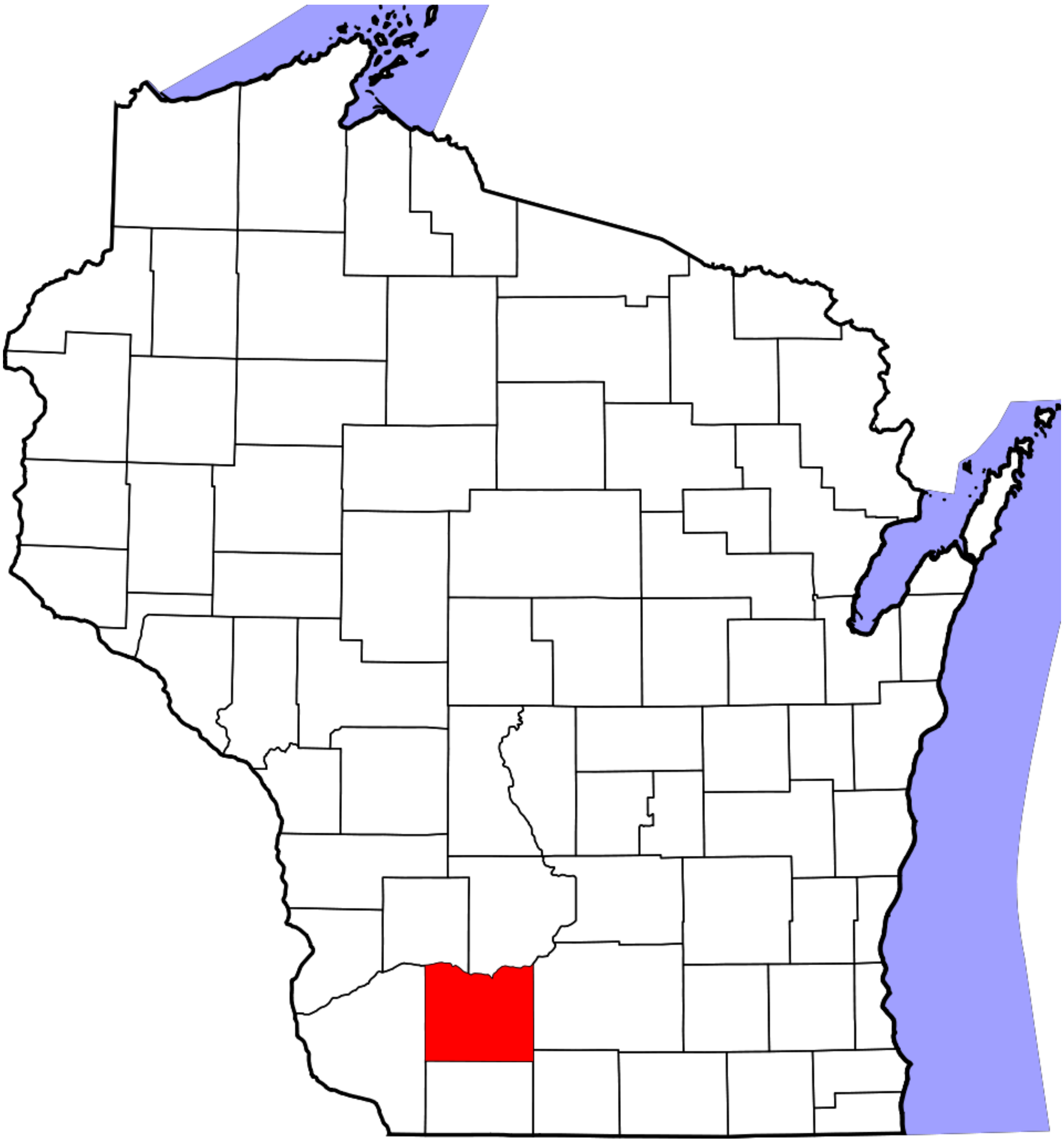
As shown in Table 2, the largest industries are retail trade, manufacturing and health care followed by accommodations and food services, transportation and warehousing and construction. The small number of workers in the construction sector (280) will potentially limit the local employment impacts from the solar energy project construction.

Table 2 Non-Governmental Employment by Industry in Iowa County

Industry	Number	Percent
Retail trade	3,984	44.9%
Manufacturing	1,139	12.8%
Health care and social assistance	1,071	12.1%
Accommodations and food services	661	7.5%
Transportation and warehousing	476	5.4%
Construction	280	3.2%
Wholesale trade	260	2.9%
Finance and insurance	191	2.2%
Other services (except public administration)	187	2.1%
Professional, Scientific, and Technical Services	160	1.8%
Arts, entertainment, and recreation	125	1.4%
Information	65	0.7%
Administrative	44	0.5%
Agriculture, forestry, fishing and hunting	28	0.3%
Utilities	20-99	0.2%-1.1%
Management of companies and enterprises	20-99	0.2%-1.1%
Educational services	20-99	0.2%-1.1%
Real estate and rental and leasing	17	0.2%
Mining, quarrying, and oil and gas extraction	0-19	0.0%-0.2%

Source: 2016 County Business Patterns, U.S. Census

Figure 5 – Map of Iowa County, Wisconsin



ii. Agricultural Statistics

Wisconsin is ranked ninth among U. S. states in total value of agricultural products sold (Census, 2012). It is ranked eighth in the value of livestock, and sixteenth in the value of crops (Census, 2012). In 2017, Wisconsin had 68,500 farms and 14.3 million acres in operation with the average farm being 209 acres (State Agricultural Overview, 2017). Wisconsin had 3.5 million cattle and produced 30.3 billion pounds of milk (State Agricultural Overview, 2017). In 2017, Wisconsin yields averaged 174 bushels per acre for grain corn with a total market value of $1.7 billion (State Agricultural Overview, 2017). Soybean yields averaged 47 bushels per acre with a total market value of $940 million (State Agricultural Overview, 2017). The average net cash farm income per farm is $44,058 (Census, 2012).

In 2012, Iowa County had 1,588 farms covering 350,813 acres for an average farm size of 221 acres (Census, 2012). The total market value of products sold was $195 million, with 70 percent coming from livestock sales and 30 percent coming from crop sales (Census, 2012). The average net cash farm income of operations was $29,959 (Census, 2012).

The 2,100 acres planned to be used by the Badger Hollow Solar Farm represents just 0.60% of the acres used for farming in Iowa County. As we will show in the next section, solar farming is a better land use on a purely economic basis than livestock or crops for the particular land in this Project.

IV. Land Use Methodology

a. Agricultural Land Use

Many are concerned about the conversion of farmland to residential, commercial and industrial uses. In his article, "Is America Running out of Farmland?" Paul Gottlieb shows that in the Continental United States, prime farmland has declined 1.6% from 1982-2010. Conversion of farmland to other uses "has a number of direct and indirect consequences, including loss of food production, increases in the cost of inputs needed when lower quality land is used to replace higher quality land, greater transportation costs of products to more distant markets, and loss of ecosystem services. Reduced production must be replaced by increasing productivity on remaining land or by farming new lands." (Franscis et. al., 2012)

On the other side of the debate, Dwight Lee considers the reduction in farmland as good news. In his article, "Running Out of Agricultural Land," he writes, "farmland has been paved over for shopping centers and highways, converted into suburban housing tracts, covered with amusement parks, developed into golf courses, and otherwise converted because consumers have communicated through market prices that development is more valuable than the food that could have been grown on the land." (Lee, 2000)

Total U.S. cropland has remained steady over the past five years. In 2012, 257.4 million acres in the U.S. were cropland while in 2017, 249.8 million acres were cropland. In 2012, just over 40 percent of all U.S. land was farmland (Census of Agriculture, 2012). According to the World Bank, the percentage of agricultural land has increased worldwide from 36.0 in 1961 to 37.3 in 2015. The Arab World, Caribbean Small States, East Asia, South Asia and Sub-Sahara Africa have all experienced growth in the percentage of agricultural land. Thus, from a global perspective, it is simply not true that we are running out of farmland. Even in the U.S., large quantities of farmland are not disappearing.

One valid criticism of the "market forces" arguments is that flow of land only goes from agricultural to non-agricultural uses. In theory, land should move in a costless way back and forth between urban and rural uses in response to new market information. Since agricultural land seldom goes back to agricultural use once it is converted, one needs to account for this in the analysis of farm land. The common assumption then is that urban development is irreversible and leads to an "option value" argument. (Gottlieb, 2015)

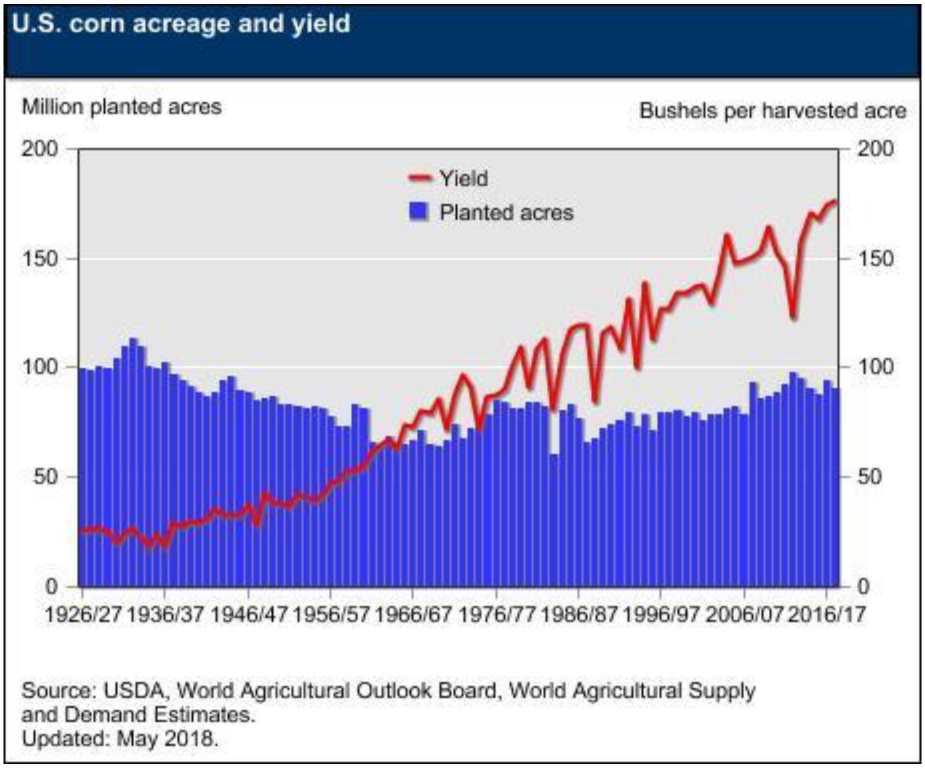
In finance, an option is a contract which gives the holder the right but not the obligation to buy or sell an underlying asset. A real option value is a choice made with business investment opportunities, referred to as "real" because it typically references a tangible asset instead of financial instrument. In the case of agricultural land, the owner retains the right to sell the land in future years if they don't sell in the current year. From a finance viewpoint, this "option" to sell in the future has value to the owner and since it is a tangible asset rather than a financial instrument, we call it a "real option."

b. Agricultural Land and Solar Farms

However, the present case of leasing agricultural land for a solar energy generating facility rises above this debate in several important ways. First, the use of agricultural land for a solar energy center is only temporary, and certainly not irreversible. The term of the solar easements for this Project is twenty-five years with a possible extension of twenty-five years, then the easements would expire. At the end of the easement, the land will be restored to its original condition and will likely return to agricultural use. This restoration is ensured by easement terms and conditions as well as likely permit conditions. This is far different from residential or commercial development where the land is often owned in fee and there are no decommissioning requirements or surety. Second, the total amount of agricultural land being used for solar energy is miniscule compared to the conversion of agricultural land permanently to residential housing and commercial development. Third, the ongoing annual lease payments will continue to go to the landowner who will retain ownership of the land both during and after the lease. At the end of the lease and when the project is responsibly decommissioned, the landowner could resume farming the land. In other conversions, the land is sold by the farmer to another party – usually a housing developer or commercial real estate broker. In this case, the values and goals of the new landowner differ significantly from the original landowner. Fourth, the free market economic forces are working properly because solar farms present landowners with an opportunity for a higher value use on their land. This also allows the landowner to diversify their income away from agricultural products alone, better weather economic downturns, and keep the land in the family.

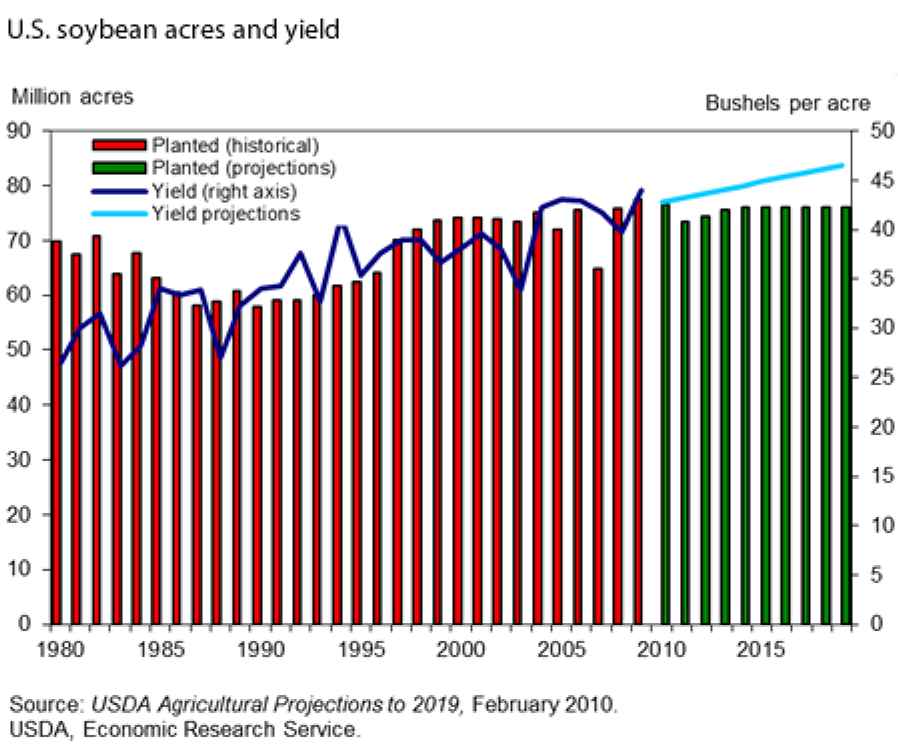
Farmland has gotten more productive over the years with better farming equipment and techniques resulting in higher yields on the same amount of land. Corn production has risen due to improvements in seed varieties, fertilizers, pesticides, machinery, reduced tillage, irrigation, crop rotations and pest management systems. Figure 6 shows the dramatic increase U.S. corn yields since 1926. Soybean yields have also increased though not as dramatically. Figure 7 displays the soybean yields in the U.S. since 1980.

Figure 6 – U.S. Corn Acreage and Yield



Source: USDA, Economic Research Service, https://www.ers.usda.gov/topics/crops/corn-and-other-feedgrains/background/

Figure 7 – U.S. Soybean Acreage and Yield



c. Methodology

To analyze the specific economic land use decision for a solar energy center, this section uses a methodology first proposed by Gazheli and Di Corato (2013). A "real options" model is used to look at the critical factors affecting the decision to lease agricultural land to a company installing a solar energy generating facility. According to their model, the landowner will look at his expected returns from the land that include the following: the price that they can get for the crop (typically corn or soybeans); the average yields from the land that will depend on amount and timing of rainfall, temperature and farming practices; and the cost of inputs including seed, fuel, herbicide, pesticide and fertilizer. Not considered is the fact that the landowner faces annual uncertainty on all these items and must be compensated for the risk involved in each of these parameters changing in the future. In a competitive world with perfect information, the returns to the land for its productivity should relate to the cash rent for the land.

For the landowner, the key analysis will be comparing the net present value of the annual solar lease payments to expected profits from farming. The farmer will choose the solar farm lease if:

$$NPV(Solar\ Lease\ Payment_t) > NPV(P_t * Yield_t - Cost_t)$$

Where NPV is the net present value; Solar Lease Payment_t is the lease payment the owner receives in year t; P_t is the price that the farmer receives for the crop (corn or soybeans) in year t; Yield_t is the yield based on the number of acres and historical average of county-specific productivity in year t; Cost_t is the total cost of farming in year t and will include (the cost of seed, fertilizer, the opportunity cost of the farmer's time. Farming profit is the difference between revenue (price times yield) and cost. The model will use historical agricultural data from the county (or state when the county data is not available).

The standard net present value calculation presented above, uses the expected value of many of the variables that are stochastic (have some randomness to them). The "real options" enhancement allows for the possibility that subsequent decisions could modify the farming NPV. This enhancement allows for a more dynamic modeling process than the static analysis implied by the standard NPV. By projecting historical trends and year-to-year variations of farming profits into the future, the real options model captures the new information about farming profitability that comes from crop prices, yields and cost in each future year.

Following Gazheli and Di Corato (2013), we assume that the net returns from agriculture fluctuates according to the following geometric Brownian motion:

$$\frac{d\pi t}{\pi t} = \propto dt + \sigma dzt$$

Where πt is the farming profit in year t; α is drift; σ is volatility and dzt is a standard Wiener process.[3] The drift and volatility parameters come from historical farm profitability data. Land Use Results

In order to analyze future returns from farming the land, we will use historical data from Iowa County to examine the local context for this analysis. The United States Department of Agriculture's National Agricultural Statistics Service publishes county-level statistics every five years. Table 3 shows the historical data from 1992 to 2012 for total farm income, production expenses, average farm size, and average market value of machinery per farm.

Table 3 – Agricultural Statistics for Iowa County, Wisconsin

	1992	1997	2002	2007	2012
Total Farm Income Per Farm	$84,133	$79,559	$69,051	$87,119	$123,008
Total Farm Production Expenses (average/farm)	$65,381	$64,026	$58,322	$70,170	$111,632
Average Farm Size (acres)	273	263	218	201	221
Net Cash Income per Farm[4]	$19,307	$13,055	$19,683	$24,924	$29,959
Average Market Value of Machinery Per Farm	$69,163	$62,499	$62,660	$86,696	$116,704

Source: United States Department of Agriculture's National Agricultural Statistics Service (NASS), Census of Agriculture

The production expenses listed in Table 3 include all direct expenses like seed, fertilizer, fuel, etc. but do not include the depreciation of equipment and the opportunity cost of the farmer's own time in farming. To estimate these last two items, we can use the average market value of machinery per farm and use straight-line depreciation for 30 years with no savage value. This is a very conservative estimate of the depreciation since the machinery will likely qualify for a shorter life and accelerated or bonus depreciation. To calculate the opportunity cost of the farmers time, we obtained the mean hourly wage for farming in each of these years from the Bureau of Labor Statistics. Again, to be conservative, we estimate that the farmer spends a total of 8 weeks @ 40 hours/week farming in a year. It seems quite likely that a farmer spends many more hours than this in direct and administrative time on the farm.

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[3] A Wiener process is a continuous-time stochastic process names in honor of Norbert Wiener. For more explanation about a Wiener process and the methodology for real options analysis, please see Dixit and Pindyck's *Investment Under Uncertainty,* (1994).

[4] Net Cash Income per farm is reported by the NASS and does not exactly equal income minus expenses. NASS definition for this item is, "Net cash farm income of the operators. This value is the operators' total revenue (fees for producing under a production contract, total sales not under a production contract, government payments, and farm-related income) minus total expenses paid by the operators. Net cash farm income of the operator includes the payments received for producing under a production contract and does not include value of commodities produced under production contract by the contract growers. Depreciation is not used in the calculation of net cash farm income."

Table 4 – Machinery Depreciation and Opportunity Cost of Farmer's Time for Iowa County, Wisconsin

	1992	1997	2002	2007	2012
Average Market Value Machinery Per Farm	\$69,163	\$62,499	\$62,660	\$86,696	\$116,704
Annual Machinery Depreciation over 30 years - Straight Line (Market Value divided by 30)	\$2,305	\$2,083	\$2,089	\$2,890	\$3,890
Mean Hourly Wage in WI for Farming (Bureau of Labor Statistics)	\$7.61	\$9.24	\$11.99	\$13.17	\$14.78
Annual Opportunity Cost of Farmer's Time (Wage times 8 weeks times 40 Hours/Week)	\$2,436	\$2,957	\$3,837	\$4,214	\$4,730

To get the total profitability of the land, we take the net cash income per farm and subtract depreciation expenses and the opportunity cost of the farmer's time. To get the profit per acre, we divide by the average farm size. Finally, to account for inflation, we use the Consumer Price Index (CPI) to convert all profit into 2017 dollars (i.e. current dollars).[5] These calculations and results are shown in Table 5.

Table 5 – Profit Per Farm Calculations for Iowa County, Wisconsin

	1992	1997	2002	2007	2012
Net Cash Income per Farm	\$19,307	\$13,055	\$19,683	\$24,924	\$29,959
Machinery Depreciation	(\$2,305)	(\$2,083)	(\$2,089)	(\$2,890)	(\$3,890)
Opportunity Cost of Farmer's Time	(\$2,436)	(\$2,957)	(\$3,837)	(\$4,214)	(\$4,730)
Profit	\$14,566	\$8,015	\$13,758	\$17,820	\$21,339
Average Farm Size (Acres)	273	263	218	201	221
Profit Per Acre in 2012 Dollars	\$53.35	\$30.47	\$63.11	\$88.66	\$96.56
CPI	141.9	161.3	180.9	210.036	229.601
Profit Per Acre in 2017 Dollars	\$92.69	\$46.58	\$86.00	\$104.06	\$103.67

Using an unsophisticated static analysis, the farmer would be better off using his land for solar if the solar lease rental per acre exceeds the inflation-adjusted 2012 profit per acre of \$103.67. Yet this static analysis fails to capture the dynamics of the agricultural market and the farmer's hope for future prices and crop yields to exceed the current level. To account for this dynamic, we use the real options model discussed in the previous section. Recall that the net returns from agriculture fluctuates according to the following geometric Brownian motion:

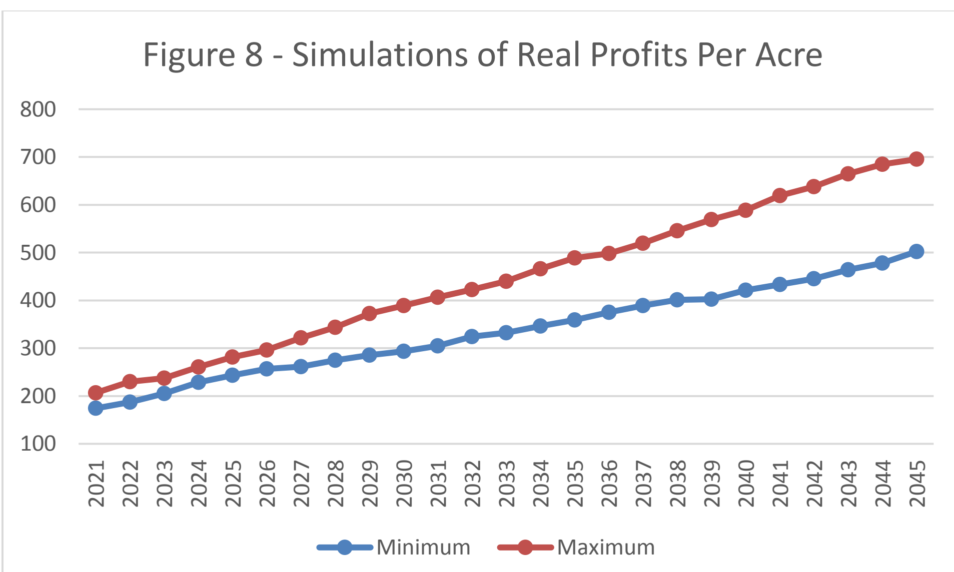
$$\frac{d\pi t}{\pi t} = \propto dt + \sigma dzt$$

Where α is drift; σ is volatility and dzt is a standard Wiener process. A standard Wiener process dzt is simulated by randomly picking a number from the normal distribution with a mean of zero and a standard deviation of 1. Drift is the expected annual increase in profits using 2017 dollars plus half of the variance in this number. Using the data from 1992 to the present, the expected annual increase in real profits was \$0.75 and the variance is \$33.30. Volatility measures how those annual real profits have

[5] We will use the Consumer Price Index for All Urban Consumers (CPI-U) which is the most common CPI used in calculations. For simplicity, we will just use the CPI abbreviation.

varied from year to year. Since the Census of Agriculture is only reported every five years, the annual increases are linearly interpolated from the five-year numbers. This may understate the volatility but there are no annual values to compare them to. From 1992 to the present, the standard deviation of the change in annual real profits is $5.77 which is our value for σ or volatility. Using this information, we can simulate future profitability for the farmer using the above equation.

Each year, we assume that the real profits go up by $17.39 (drift) plus $5.77 times the random normal distribution number (Weiner Process). Because of this randomness, we can simulate multiple futures using Monte Carlo simulation. We assume that the solar farm will begin operation in 2021 and end 25 years later in 2045. Using 500 different simulations, the real profit per acre never exceeds $695.39 in 2045 (when the lease expires). In this case, the average annual profit over the 25 years is $457.48. The lowest real profit per acre is $502.18 in 2045 because we have excluded any annual decrease in real profits from the analysis. In this case, the average annual profit over the 25 years is $342.34. Simulations with these decreases in real profits for agriculture added in will show that the solar lease makes the farmer better off, by excluding these decreases, we are again building in conservative assumptions into our calculations. Figure 8 is a graph of the highest and lowest real profit per acre simulations. Figure 9 shows the average annual profits between the minimum and maximum scenario. <u>The solar lease per acre payment is higher than the $457.48 average annual payment projected in the maximum simulation by 2045 which means the farmer is financially better off under the solar lease in every year over the 25-year lease.</u>



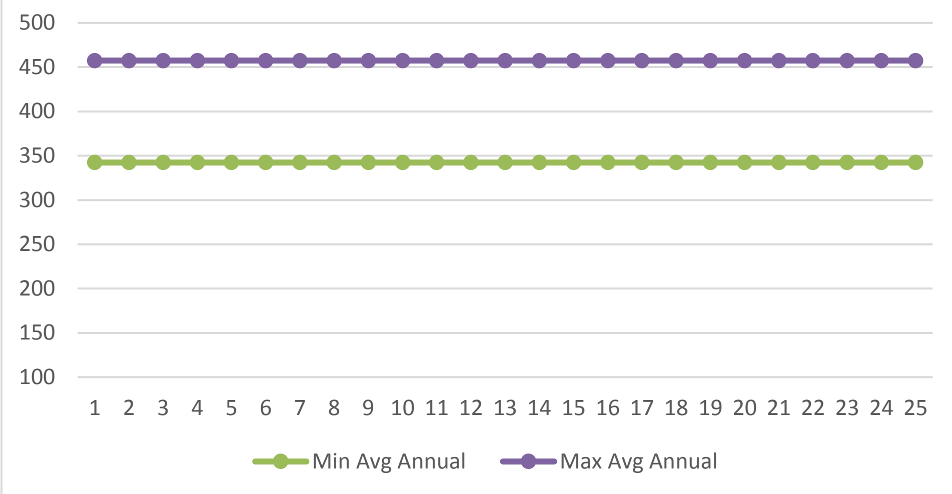


Figure 9 - Simulations of Real Profits Per Acre

There may be a concern that agriculture has changed so much since 1992 that these historical numbers are no longer relevant. In fact, 1997 was a particularly low year for agricultural profitability. If we exclude 1992 and 1997 from the analysis, this will only use more recent data. In this case the drift is $2.91 and the standard deviation is $1.56 (much lower than the previous example). A lower drift rate and standard deviation translates to a lower risk evaluation of agricultural profitability through 2045. As it turns out, these more constant profits from agriculture result in lower future simulated profits. <u>Even in this case, the real profit per acre in 2045 ranges from $163.31 to $222.10 as shown in Figure 10. The average annual profit in these scenarios is $142.61 and $172.36 for the maximum scenario as shown in Figure 11. These values are again much lower than the solar lease.</u>

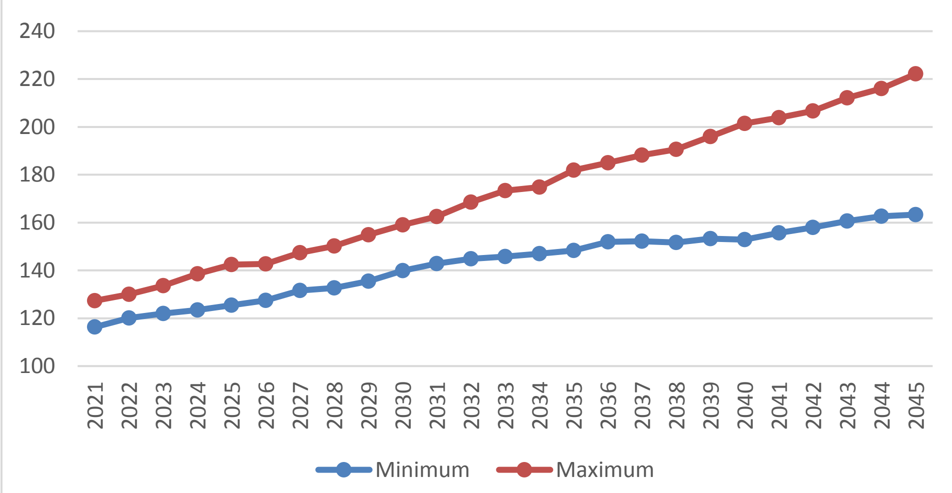
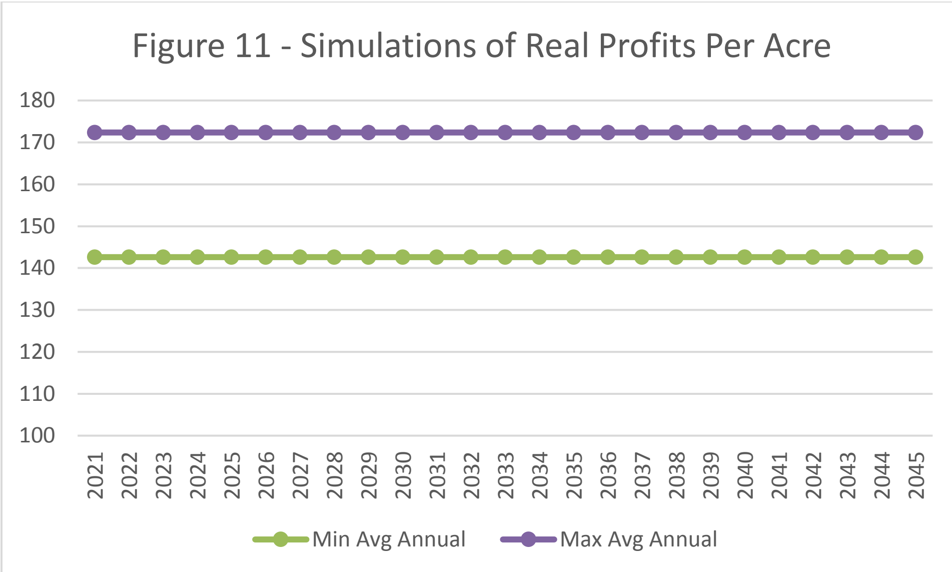
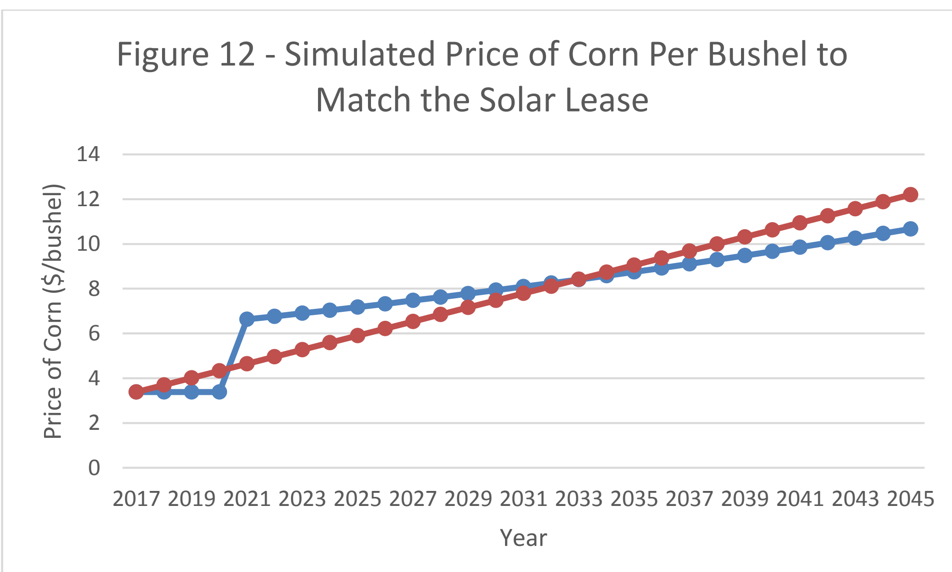


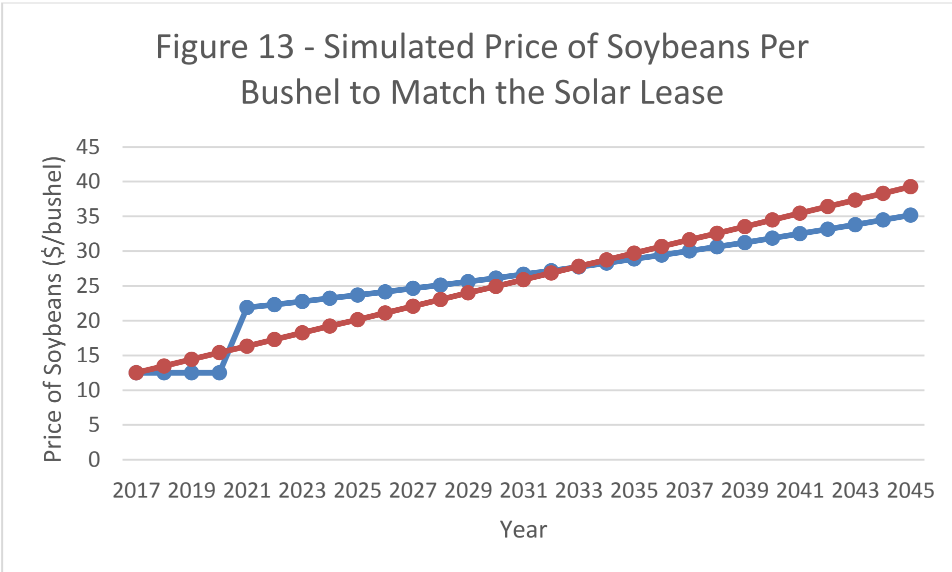
Figure 10 - Simulations of Real Profits Per Acre



Another way to look at this problem would be to ask: How high would the price of corn or soybeans have to rise to make farming more profitable than the solar lease? Below we assume that the yields on the land and all other input costs stay the same. In this case, the price of corn would have to rise from $3.25 per bushel in 2020 to $6.63 in 2021 and rise to $10.67 per bushel by 2045 as shown in Figure 12. Alternatively, the price of corn would need to rise by $0.315 per bushel each year from 2018 to 2045 when it would reach $12.20 per bushel.



Alternatively, if we assume the yields and input costs stay the same, the price of soybeans would have to rise from $9.35 per bushel in 2020 to $21.88 per bushel in 2021 and rise to $35.18 by 2045 as shown in Figure 13. For a linear increase, the price of soybeans would need to rise by $0.955 per bushel each year from 2018 to 2045 when it would reach $39.27 per bushel



If we assume that the price of corn and soybeans stays the same, the yields for corn would need to more than double from 174 bushels per acre in 2017 to 355 bushels per acre in 2021 and stay at that level until 2045. The yields for soybeans would need to rise from 47 bushels per acre in 2017 to 110 bushels per acre in 2021 and stay there until 2045.

V. Economic Impact Methodology

The economic analysis of solar PV project presented uses NREL's latest Jobs and Economic Development Impacts (JEDI) PV Model (PV12.23.16). The JEDI PV Model is an input-output model that measures the spending patterns and location-specific economic structures that reflect expenditures supporting varying levels of employment, income, and output. That is, the JEDI Model takes into account that the output of one industry can be used as an input for another. For example, when a PV system is installed, there are both soft costs consisting of permitting, installation and customer acquisition costs, and hardware costs, of which the PV module is the largest component. The purchase of a module not only increases demand for manufactured components and raw materials, but also supports labor to build and install a module. When a module is purchased from a manufacturing facility, the manufacturer uses some of that money to pay employees. The employees use a portion of their compensation to purchase goods and services within their community. Likewise, when a developer pays workers to install the systems, those workers spend money in the local economy that boosts economic activity and employment in other sectors. The goal of economic impact analysis is to quantify all of those reverberations throughout the local and state economy.

The first JEDI Model was developed in 2002 to demonstrate the economic benefits associated with developing wind farms in the United States. Since then, JEDI models have been developed for biofuels, natural gas, coal, transmission lines and many other forms of energy. These models were created by Marshall Goldberg of MRG & Associates, under contract with the National Renewable Energy

Laboratory. The JEDI model utilizes state-specific industry multipliers obtained from IMPLAN (IMpact analysis for PLANning). IMPLAN software and data are managed and updated by the Minnesota IMPLAN Group, Inc., using data collected at federal, state, and local levels. This study analyzes the gross jobs that the new solar energy project development supports and does not analyze the potential loss of jobs due to declines in other forms of electric generation.

The total economic impact can be broken down into three distinct types: direct impacts; indirect impacts, and inducted impacts. **Direct impacts** during the construction period refer to the changes that occur in the onsite construction industries in which the direct final demand (i.e., spending on construction labor and services) change is made. Onsite construction-related services include installation labor, engineering, design, and other professional services. Direct impacts during operating years refer to the final demand changes that occur in the onsite spending for the solar operations and maintenance workers.

The initial spending on the construction and operation of the PV installation will create a second layer of impacts, referred to as “supply chain impacts” or “indirect impacts.” **Indirect impacts** during the construction period consist of changes in inter-industry purchases resulting from the direct final demand changes and include construction spending on materials and PV equipment, as well as other purchases of goods and offsite services. Utility-scale solar PV indirect impacts include PV modules, invertors, tracking systems, cabling, and foundations.

Induced impacts during construction refer to the changes that occur in household spending as household income increases or decreases as a result of the direct and indirect effects of final demand changes. Local spending by employees working directly or indirectly on the Project that receive their paychecks and then spend money in the community is included. The model includes additional local jobs and economic activity that are supported by the purchases of these goods and services.

VI. Economic Impact Results

The economic impact results were derived from detailed project cost estimates supplied by Invenergy. In addition, Invenergy also estimated the percentages of project materials and labor that will be coming from within Iowa County and the State of Wisconsin.

Two separate JEDI models were produced to show the economic impact of the Badger Hollow Solar Farm. The first JEDI model used the 2016 Iowa County multipliers from IMPLAN. The second JEDI model used the built-in IMPLAN multipliers for the State of Wisconsin and the same project costs.

Tables 2-4 show the output from these models. Table 2 lists the total employment impact from the Badger Hollow Solar Farm for Iowa County and the State of Wisconsin. Table 3 shows the impact on total earnings and Table 4 contains the impact on total output.

Table 2 Total Employment Impact from the Badger Hollow Solar Farm

	Iowa County Jobs	State of Wisconsin Jobs

Construction		
Project Development and Onsite Labor Impacts (direct)	190	190
Module and Supply Chain Impacts (indirect)	181	195
Induced Impacts	51	115
New Local Jobs during Construction	422	500
Operations (Annual)		
Onsite Labor Impacts (direct)	8.2	8.2
Local Revenue and Supply Chain Impacts (indirect)	2.9	2.6
Induced Impacts	2.5	7.5
New Local Long Term Jobs	13.6	18.3

The results from the JEDI model show significant employment impacts from the Badger Hollow Solar Farm. Employment impacts can be broken down into several different components. Direct jobs created during the construction phase typically last anywhere from 12 to 18 months depending on the size of the project; however, the direct job numbers present in Table 2 from the JEDI model are based on a full time equivalent (FTE) basis for a year. In other words, 1 job = 1 FTE = 2,080 hours worked in a year. A part time or temporary job would constitute only a fraction of a job according to the JEDI model. For example, the JEDI model results show 422 new direct jobs during construction in Iowa County, though the construction of the solar center could involve closer to 844 workers working half-time for a year. Thus, due to the short-term nature of construction projects, the JEDI model often significantly understates the number of people actually hired to work on the project. It is important to keep this fact in mind when looking at the numbers or when reporting the numbers.

As shown in Table 2, new local jobs created or retained during construction total 422 for Iowa County, and 500 for the State of Wisconsin. New local long-term jobs created from the Badger Hollow Solar Farm total 13.6 for Iowa County and 18.3 for the State of Wisconsin.

Direct jobs created during the operational phase last the life of the solar energy center, typically 20-30 years. Direct construction jobs and operations and maintenance jobs both require highly-skilled workers in the fields of construction, management, and engineering. These well-paid professionals boost economic development in rural communities where new employment opportunities are often welcome due to economic downturns. Accordingly, it is important to not just look at the number of jobs but also the earnings that they produce. Table 3 shows the earnings impacts from the Badger Hollow Solar Farm, which are categorized by construction impacts and operations impacts. The new local earnings during construction total over $20 million for Iowa County and over $27.6 million for the State of Wisconsin. The new local long-term earnings total over $553 thousand for Iowa County and almost $1.1 million for the State of Wisconsin.

Table 3 Total Earnings Impact from the Badger Hollow Solar Farm

	Iowa County	State of Wisconsin
Construction		
Project Development and Onsite Earnings Impacts	$11,739,546	$11,739,546

Module and Supply Chain Impacts	$6,707,911	$10,331,949
Induced Impacts	$1,820,874	$5,529,885
New Local Earnings during Construction	$20,268,331	$27,601,380
Operations (Annual)		
Onsite Labor Impacts	$338,828	$578,184
Local Revenue and Supply Chain Impacts	$123,479	$132,687
Induced Impacts	$91,267	$386,383
New Local Long-Term Earnings	$553,574	$1,097,254

Output refers to economic activity or the value of production in the state or local economy. It is an equivalent measure to the Gross Domestic Product, which measures output on a national basis. According to Table 4, the new local output during construction totals over $49.3 million for Iowa County and almost $62.5 million for the State of Wisconsin. The new local long-term output totals over $1.1 million for Iowa County and over $2.0 million for the State of Wisconsin.

Table 4 Total Output Impact from the Badger Hollow Solar Farm

	Iowa County	State of Wisconsin
Construction		
Project Development and Onsite Jobs Impacts on Output	$18,832,458	$18,832,458
Turbine and Supply Chain Impacts	$23,671,238	$27,792,032
Induced Impacts	$6,855,032	$15,872,487
New Local Output during Construction	$49,358,728	$62,496,977
Operations (Annual)		
Onsite Labor Impacts	$338,828	$578,184
Local Revenue and Supply Chain Impacts	$437,566	$376,443
Induced Impacts	$343,637	$1,109,284
New Local Long-Term Output	$1,120,031	$2,063,911

VII. Tax Revenue

Solar PV projects in Wisconsin will increase the tax base for the county and township in which they are located through the shared revenue utility aid fund. This funding creates a new revenue source for county and township government services.

Table 5 details the shared revenue utility aid tax implications of the Badger Hollow Solar Farm. There are several important assumptions built into the analysis in this table. First, the analysis assumes that the project has a capacity of 300 MW for taxing purposes. Second, the projections use the MW based payment and incentive payment formulas in the "Wisconsin Shared Revenue Utility Aid Summary" developed by the Wisconsin Department of Revenue.

According to Table 5, the townships will receive $500,000 annually from the Badger Hollow Solar Farm and Iowa County will receive over $700,000 annually.

Table 5 Illustration of “Utility Aid” Paid by the Badger Hollow Solar Farm

	Total	Township	County
MW based Payment	$600,000	$200,000	$400,000
Incentive Payment	$600,000	$300,000	$300,000
Total	$1,200,000	$500,000	$700,000

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IX. Curriculum Vita – David G. Loomis (latest CV will be inserted here)