Jackson County

Clean Energy Plan

Jackson County, Iowa

May 2022

Prepared by:

University of Iowa, School of Planning & Public Affairs &

Iowa Initiative for Sustainable Communities

Joshua Engelbrecht

Wael El Safi

Elizabeth Heron

Zachary Harland

Qihan Bai

ACKNOWLEDGEMENTS

The Jackson County Clean Energy Planning Team would like to thank the following individuals for their guidance and assistance with the plan:

Jackson County Board of Supervisors

Jack Willey

Larry McDevitt

Mike Steines

Jackson County Energy District

Bruce Fisher, Chair

Bill Hainstock, Vice Chair

Ben Davison, Secretary

Megan Andresen, Treasurer

Mike Griffin, Board Member

Victoria Putman, Board Member

Jackson County Economic Alliance

Dave Heiar, Senior Advisor

Kelley Brown, Executive Director

Jackson County Staff

Alisa Smith, Jackson County Auditor

Kristina Tranel, Zoning Administrator

City of Preston

Teresa Weinschenk, City Administrator

Alliant Energy

Mike Wagner, Community Development Manager

Jacob Semann, Key Account Manager

University of Iowa

School of Planning and Public Affairs

Faculty Advisors

Travis Kraus, Director of Iowa Initiative for Sustainable Communities

Samantha Zuhlke, Assistant Professor

Lucie Laurian, Professor and Director

Field Problems Alumni Mentor

Kaley Bangston, Alliance for Clean Energy New York

In addition:

Sarah Gardner, City of Iowa City Climate Action Engagement Specialist

Steve Guyer, Iowa Environmental Council, Energy & Climate Policy Specialist

David Osterberg, Senior Researcher for Common Good Iowa

TABLE OF CONTENTS

EXECUTIVE SUMMARY

The Jackson County Clean Energy Plan is a strategic plan for Jackson County, Iowa. The purpose of the plan is to formulate the first steps for transitioning from non-renewable to renewable energy sources and providing decision support for local leaders. This plan provides a vision for the future of energy in Jackson County to be locally owned, diverse, and equitable. All renewable energy investment recommendations offer an economic return with the goals of increasing public and private investment in county energy and promoting local initiative and involvement. This plan provides the legal, political, and technological information for local leaders to make decisions for the future of energy in Jackson County.

To achieve this vision, the plan entails three primary components. The first is collecting an inventory of current solar installations in the county. The Jackson County Energy District focuses its efforts on solar installation, and therefore, the inventory provides a baseline for goal setting and data reporting for the current generation. Using this baseline data, the Energy District website hosts an inventory map to collect future clean energy installations. The second component is a feasibility study evaluating the county-owned buildings with the highest economic return for solar panel installation. Lastly, the third component explores strategies and opportunities for transitioning to renewable energy for the rural town of Springbrook, IA.

Existing Solar Panel Installations Map

The plan evaluates the existing solar panel installation baseline in Jackson County by analyzing each installation site, system size, and land use category. There are about 64 solar panel installations from 2014 to 2021. This data is collected from building permits, municipal administers, and site data from solar installers. Nearly a quarter of the current installations are in 2021, and two-thirds of the installations are on residential properties. The baseline data is placed on an interactive map for the Jackson County Energy District to add future clean energy installations on their website.

Jackson County Building Feasibility Study

This study examines thirteen Jackson County-owned buildings to identify the economic feasibility of installing solar. The energy consumption and generation estimates indicate that all thirteen identified sites have a positive economic return on investment. Using December 2020 to November 2021 utility bill information, installing photovoltaic (PV) solar panels on all building sites saves the county an estimate of $46,783 per year in avoided electricity costs. The estimated return on investment over the 25-year warrantied lifetime of the installed systems is between $762,034 - $1,034,310 over 25 years, or between $30,500 - $41,300 per year.

Clean Energy Pilot Project: Springbrook, IA

Springbrook is a small rural community interested in exploring strategies for transitioning to renewable energy. The team conducted door-to-door engagement and a community survey to gain insight into residents' energy priorities and experiences. The primary concern is a desire to lower monthly energy bills and increase energy efficiency. Over 90% of residents surveyed in Springbrook hold renewable energy as somewhat or very important. Solar power generation received the highest support among renewable energy sources. The chapter explores three ownership models for distributed and centralized solar panels: 1) City of Springbrook, 2) Power Purchase Agreement, and 3) its utility provider. The only legal option (outside of municipalization) for a centralized solar facility is through the utility provider owning and distributing electricity generated from the system. After meeting with Springbrook's utility provider and having the application denied, the team's recommendation is to continue installing distributed solar for individual households and pursue a future partnership with the utility provider for a community solar project.

CHAPTER 1: INTRODUCTION

The Introduction chapter explains the purpose, context, and scope of the plan, outlines the development of the plan, and provides a brief guide to the document.

Purpose of the Plan

The purpose of the Jackson County Clean Energy Plan is a roadmap for the first steps in transitioning from non-renewable to renewable energy sources for Jackson County, Iowa. It combines economic practicality, equitable decision-making, and policy recommendations to envision a sustainable and resilient future. The plan covers a wide range of practices and current technologies to provide decision-making support to local leaders and the public, while also providing a framework to incorporate existing information and technologies, such as the use of batteries and storage for solar power. The plan outlines how to navigate the challenges and limitations for rural jurisdictions in installing community-wide solar systems.

The transition to clean energy can lead to long-term energy independence and positive economic outcomes for residents. The reduced utility costs can get reinvested in the local and regional economies. This plan identifies localized solutions by exploring scientific best practices, available technology, and potential collaborators in the practical applicability of renewable energy to reduce pollution, improve community resiliency, and become a long-term cost savings tool for local jurisdictions and individual households. In addition, this plan explores the legal policy opportunities and constraints that rural jurisdictions face in implementing community-wide solar systems in Iowa.

As state and federal energy policy and incentives change over time, the county and other interested jurisdictions will need to know the available resources, funding opportunities, and renewable energy source options in Iowa. If state or federal policy changes, this plan outlines resources and strategies for jurisdictions to track current policy.

Development of the Plan

The Jackson County Energy District (JCED) and the Jackson County Economic Alliance (JCEA) partnered with the Iowa Initiative for Sustainable Communities (IISC) and the University of Iowa School of Planning & Public Affairs (SPPA) in 2021 to develop a clean energy plan for Jackson County. The JCED identified specific projects to provide up-to-date information and education on clean energy and to understand the barriers and constraints of transitioning to renewable energy sources in the county.

Vision, Goals, and Objectives

The long-term vision for Jackson County's energy is to be…

LOCALLY OWNED

DIVERSE

EQUITABLE

*The objectives for this plan are to **retain energy money in Jackson County**, **reduce greenhouse gas emission**, and **increase control of energy production**. The goals are for Jackson County to **attract new residents**, be an **Iowa leader in clean energy production for rural counties**, and have a sound understanding of the legal, political, and technological **opportunities and constraints** for transitioning to clean energy in Iowa.*

Sustainability Statement

The framework for this plan is for the long-term commitment to county-wide sustainability. Sustainability is the dedication and responsibility to economic well-being, community health, and environmental flourishing that strives for an adaptive and resilient tomorrow for current and future generations of Jackson County residents.

The sustainability goals for Jackson County are to …

- *be a leader in local energy production for rural counties in Iowa*
- *retain and sustain energy dollars in the county*
- *explore cost-effective, clean, and equitable energy solutions*
- *encourage reinvestment in Jackson County communities*

Equity Statement

This plan integrates equity through the planning process and policy recommendations. Since this is a public project funded by local tax dollars, clean energy's economic benefits and burdens should be equitably shared in the community. For low-income households, the energy burden (the percentage of a household's income spent on energy) can be three times higher than for non-low-income households.

This high energy burden cost can significantly impact a household's ability to pay for food, medicine, or other essential needs (Office of Energy & Renewable Energy). This project aims to explore opportunities to alleviate the energy cost for all residents through either direct or in-direct ways. This plan uses the National Academy of Public Administration's definition for social equity throughout the planning process and policy recommendations:

"The fair, just and equitable management of all institutions serving the public directly or by contract; and the fair and equitable distribution of public services, and implementation of public policy; and the commitment to promote fairness, justice and equity in the formation of public policy."

Existing Clean Energy Initiatives

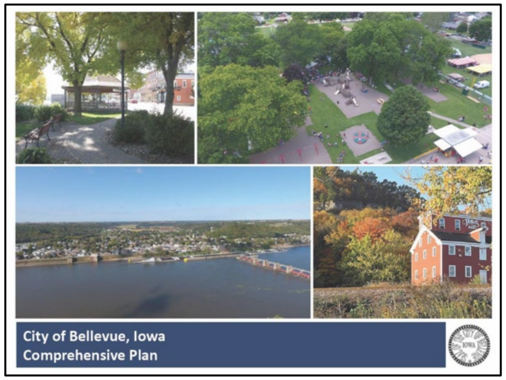
The Jackson County Clean Energy Plan is the first official plan addressing the transition to renewable energy in Jackson County. No county or local plans identified specifically address renewable energy. Counties and municipalities can set goals and action steps focused on renewable energy to facilitate the accessibility to clean and local energy in a faster and more inclusive way. The plans below informed this energy plan by indicating how the county and local municipalities had other relevant energy visions or goals.

Jackson County Tomorrow, 2018

The *Jackson County Tomorrow Plan* was adopted in 2018. The plan highlights and proposes policy solutions to address existing challenges such as a declining and aging population. This plan does not address renewable energy as an action step. However, the intersection between reducing utility costs through local energy generation and attracting new residents, specifically young professionals, to the area is a creative solution to address multiple existing challenges within the County. This plan informed the clean energy plan by highlighting the unique challenges Jackson County communities are facing.

City of Maquoketa, 2040 Comprehensive Plan

The *Maquoketa 2040 Comprehensive Plan* is the plan and vision for the County seat. Similar to the *Jackson County Tomorrow Plan*, this plan does not mention renewable energy. The plan uses Iowa's Smart Planning Principles which include integrating renewable energy in local planning. A city strategy for community growth in Maquoketa is for public investment in infrastructure to attract new industry and private sector investment. This could serve as an opportunity for the city to invest in clean energy as a strategy to attract residents. This plan outlines its priorities and recommendations for future investment, and it is important for this clean energy plan to be aware of any local plans or initiatives towards their energy infrastructure.



Bellevue Comprehensive Plan, 2022

The *Bellevue Comprehensive Plan* makes no explicit mention or priority for renewable energy. A goal for Bellevue is to "plan for, build, and improve infrastructure systems to meet anticipated growth and development needs" (Bellevue, 2022). Like Maquoketa's Comprehensive plan, public investments in renewable energy infrastructure may present opportunities to achieve the goal of attracting and retaining residents and industry.

Plan Components

The following diagram describes the information contained in the last five chapters of the Jackson County Clean Energy Plan. It serves as a roadmap to assist the reader in navigating the components of the plan.

Chapter 3: **Why Solar?**	Chapter 4: **Existing Solar Panel Installations**	Chapter 5: **Jackson County Feasibility Study**	Chapter 6: **Pilot Project: Springbrook, Iowa**	Chapter 7: **Lessons Learned**
Why Renewable Energy?	Solar Panel Inventory	Methodology	Community Profile	Key Takeaways
Project Partner Interest	Existing Solar Panel Map	Calculations	Public Engagement	Recommendations
Declining Cost of Solar	Solar Panel Interactive Map	Assumptions	System Options	
Technical Feasibility		Assumptions	Planning Process	
		Building Results	Recommendations	

CHAPTER 2: JACKSON COUNTY PROFILE

Location

Jackson County was founded in 1837 and is located in the eastern part of the state of Iowa with the Mississippi River on the eastern boundary (Figure 2.1) (Jackon County government, 2021). Jackson County contains thirteen cities, namely Maquoketa (the county seat), Bellevue, Preston, Sabula, Miles, Andrew, La Motte, Monmouth, St. Donatus, Baldwin, Zwingle (partially in Dubuque County), Spragueville, and Springbrook.

Jackson County is known for state parks, natural areas, historic sites, and campgrounds encompassing over 2,200 acres. Maquoketa Caves State Park (Figure 2.2) is well-known for its large number of caves. The county's proximity to the Mississippi River provides a unique river landscape with an abundance of recreational tourist activities such as hiking, biking, fishing, and boating.

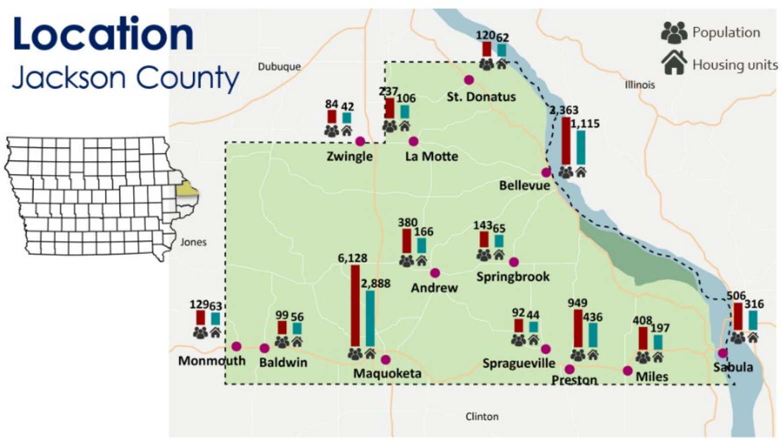


Figure 2.1. Jackson County Location Map

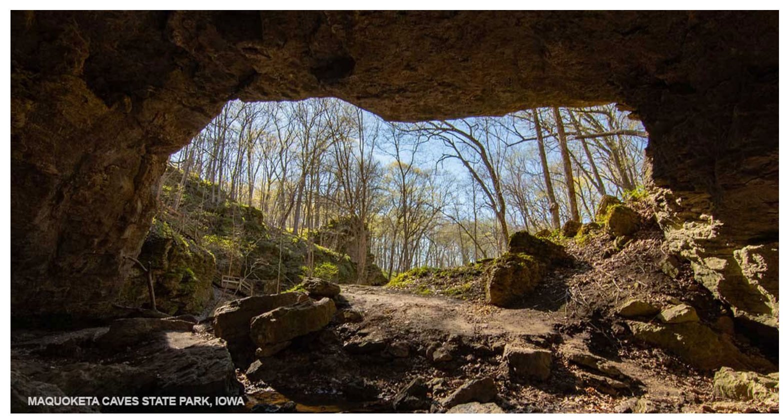


Figure 2.2. Maquoketa Caves State Park Photo

Demographics

Population and Age

Jackson County's population is 19,485 (U.S. Census, 2020). The population has stabilized around 20,000 since 1900. The county experienced a 1% decline between 2000 to 2010 and 2010 to 2020. Using a basic trend extrapolation projection method, the estimated population is projected to decrease approximately 3% to the 19,000-resident mark by 2040 (Figure 2.3). More detailed models may show different trends.

About 60% of the county's population live in municipalities and the remainder live in unincorporated areas (Table 2.1). The communities with the highest population are Maquoketa (6,128) and Bellevue (2,363). These two communities host about 44% of the county's population (U.S. Census Bureau, 2020).

Jackson County Municipality	Population (2020)	% of County Population
Maquoketa	6,128	31.4%
Bellevue	2,363	12.1%
Preston	949	4.9%
Sabula	506	2.6%
Miles	408	2.1%
Andrew	380	2.0%
La Motte	237	1.2%
Springbrook	143	0.7%
Monmouth	129	0.7%
St. Donatus	120	0.6%
Baldwin	99	0.5%
Zwingle	84	0.4%
Spragueville	92	0.5%
Unincorporated Area	7,847	40.3%
Total	**19,485**	**100.0%**

Table 2.1. Jackson County Municipality Population Estimates (2020)
(Source: U.S. Census Bureau 2020)

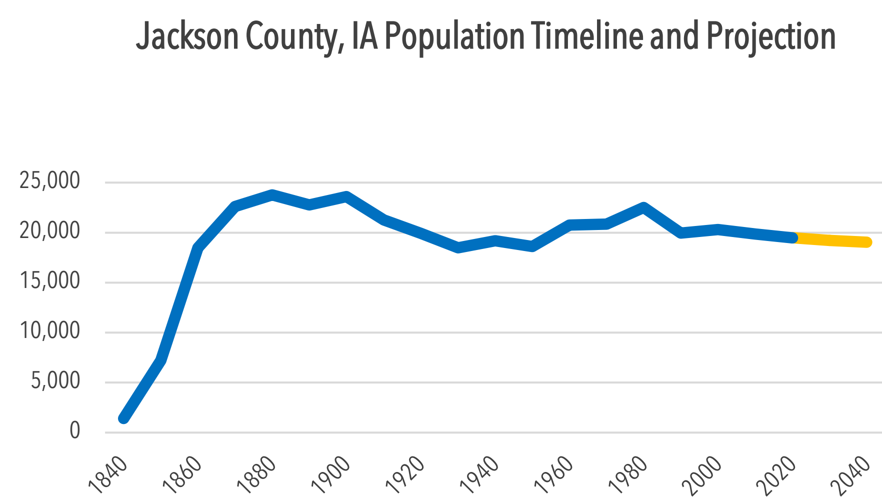


Figure 2.3. Jackson County population timeline & graph (Source: U.S. Census Bureau, 1840-2020)

Jackson County's median age is 44-years-old (Table 2.2) (ACS, 2016-2020). This age is about 14% older than the median age for Iowa and the U.S. in 2020. The population has significantly aged since 2000. The median age increased by 3.8 years from 2000 to 2010 and by 0.7 years from 2010 to 2020, for a total change of 4.5 years. The median age is rising faster than in Iowa and the U.S.

Median Age of Jackson County, Iowa, and the U.S.			
	2000	2010	2020
Jackson County, IA	39.1	42.9	43.6
Iowa	36.6	38.0	38.3
United States	35.3	37.2	38.2

Table 2.2: Jackson County Median Age 2000, 2010, and 2020. (Source: ACS 5-Year Estimates)

Currently, about 40% of the residents are between the ages of 30 and 60, an age group that typically has a stable job and children. The 40- to 49-year-old cohort experienced a 10-percentage point decrease compared to 2010. The 10- to 19-year-old population also declined by 6%, which may be due to the decline in the 40- to 49-year-old cohort, which often have children. In addition, as the percentage of the retirement population (60 to 70 age cohort) grows, the percentage of households that live off a fixed income may also increase.

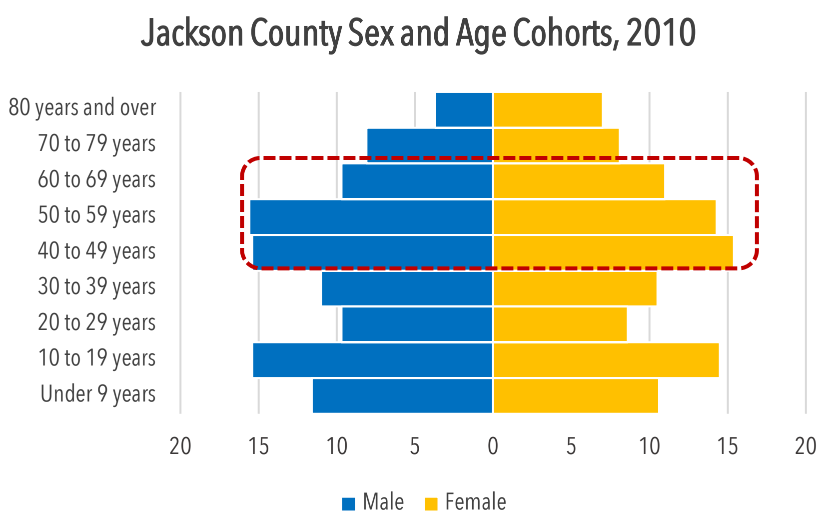


Figure 2.4. Jackson County Sex & Age Cohorts, 2010
(Source: ACS 5-Year Estimates, 2006-2010)

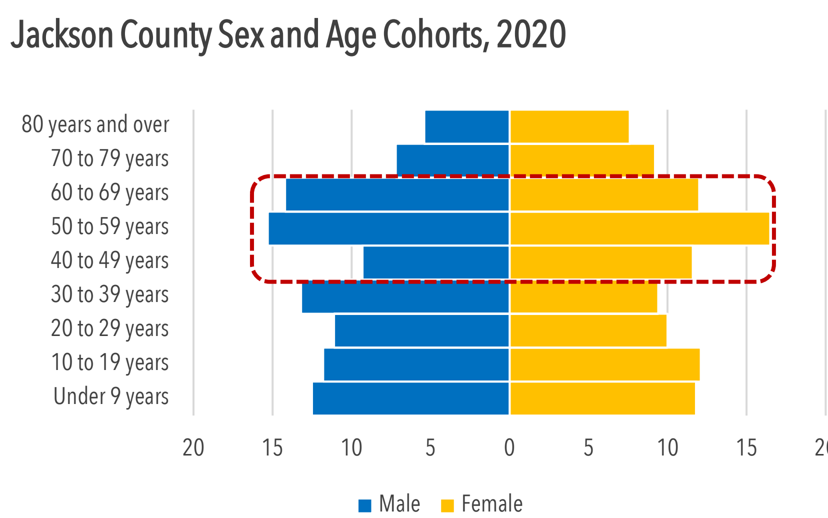


Figure 2.5. Jackson County Sex & Age Cohorts, 2020
(Source: ACS 5-Year Estimates, 2016-2020)

Income

The median household income in Jackson County is $59,042 (ACS, 2016-2020). This is slightly lower than Iowa's median income of $61,836. Approximately 25% of the county households earn more than $100,000 per year, less than Iowa as a state (Figure 2.6). The county's annual household income distribution is more dispersed, with 43% of the households earning less than $50,000 per year.

Housing

Jackson County has a total of 9,599 housing units (ACS, 2016-2020). The median housing value is $127,500 and is 17% lower than Iowa's median of $153,900. About 26% of the housing in Jackson County is valued between $50,000 to $99,999 (Figure 2.7). There is an 80.9% homeownership rate in Jackson County, about 10 percentage points higher than in Iowa. While housing units are growing each year modestly, the number of households is declining. The number of households peaked at 8,494 in 2014 and decreased by 3.7% by 2020 (Figure 2.7). Approximately 83% of households live in single-family homes, 8% of families live in mobile homes, and the remaining live in multi-family dwellings.

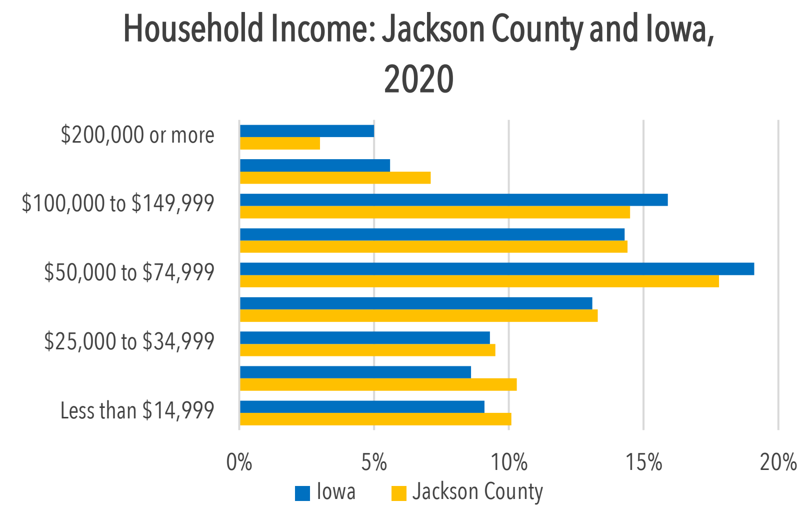


Figure 2.6. Jackson County and Iowa Household Income, 2020 (Source: ACS 5-Year 2016-2020)

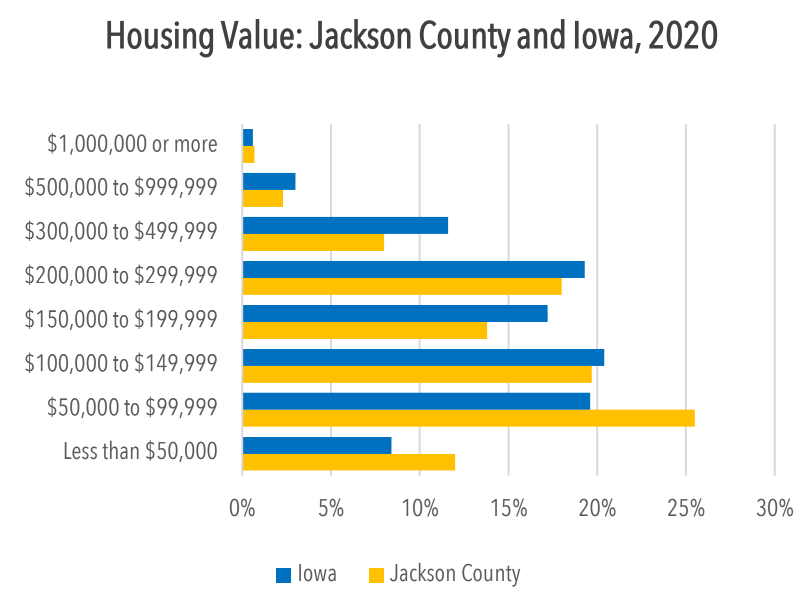


Figure 2.7. Jackson County and Iowa Housing Value, 2020 (Source: ACS 5-Year 2016-2020)

Employment

The top five primary industries in Jackson County are *Manufacturing* (17%), *Retail Trade* (14%), *Health Care & Social Assistance* (13%), *Educational Services* (8%), and *Construction* (8%) (ACS, 2015-2019). The employment history experienced a steady increase in employment from 2010 until the COVID-19 pandemic hit in 2020.

The county experienced a significant drop in the number of employed residents (Figure 2.8). Since the pandemic began, the county experienced a large spike in unemployment in 2020, even greater than after the Great Recession of 2009. However, the employment numbers continue to rise.

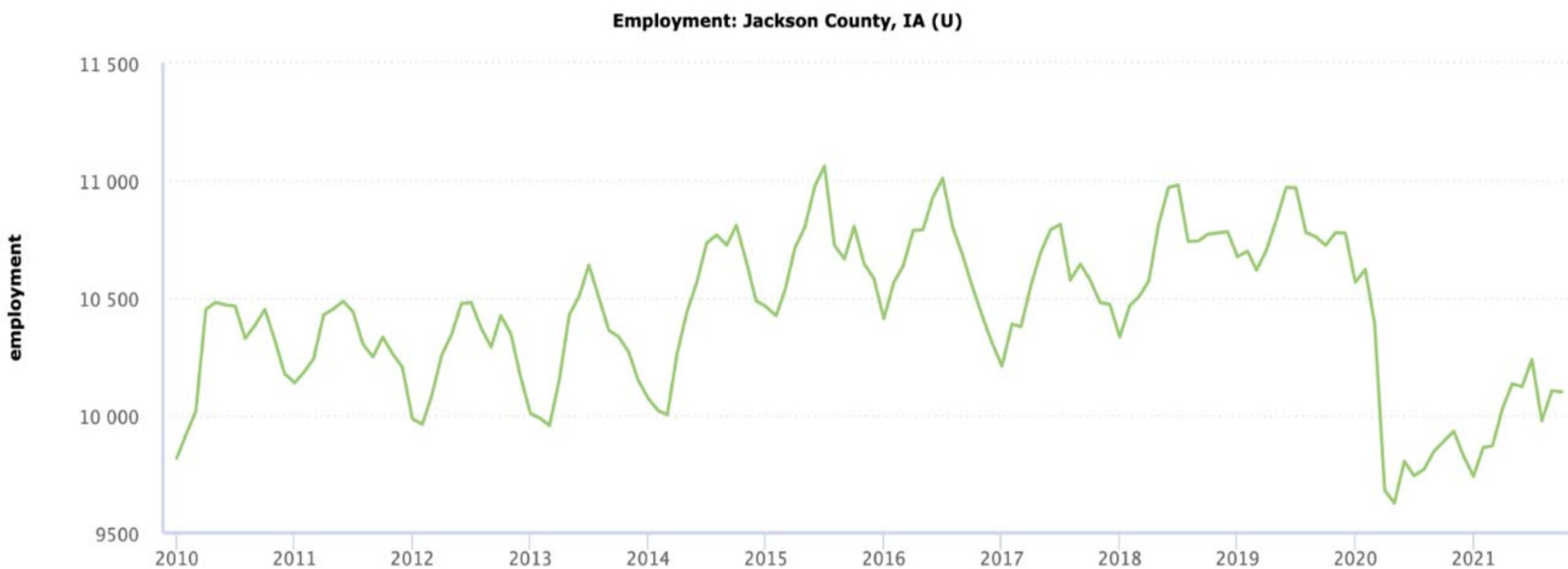


Figure 2.8. Jackson County, Total Employment, 2010-2021 (Source: U.S. Bureau of Labor Statistics)

Jackson County Energy Information

Electric Utility Service Providers

Geographically, Jackson County is primarily powered by Interstate Power and Light Company, otherwise known as Alliant Energy, and the Maquoketa Valley Electric Cooperative (see Figure 2.9). Other service providers to municipalities are Maquoketa Municipal, Bellevue Municipal, Preston Municipal Electric and Sabula Municipal Utilities. The Maquoketa Valley Electric Cooperative (MVEC) services the rural areas outside of Alliant Energy and the municipal utility territories.

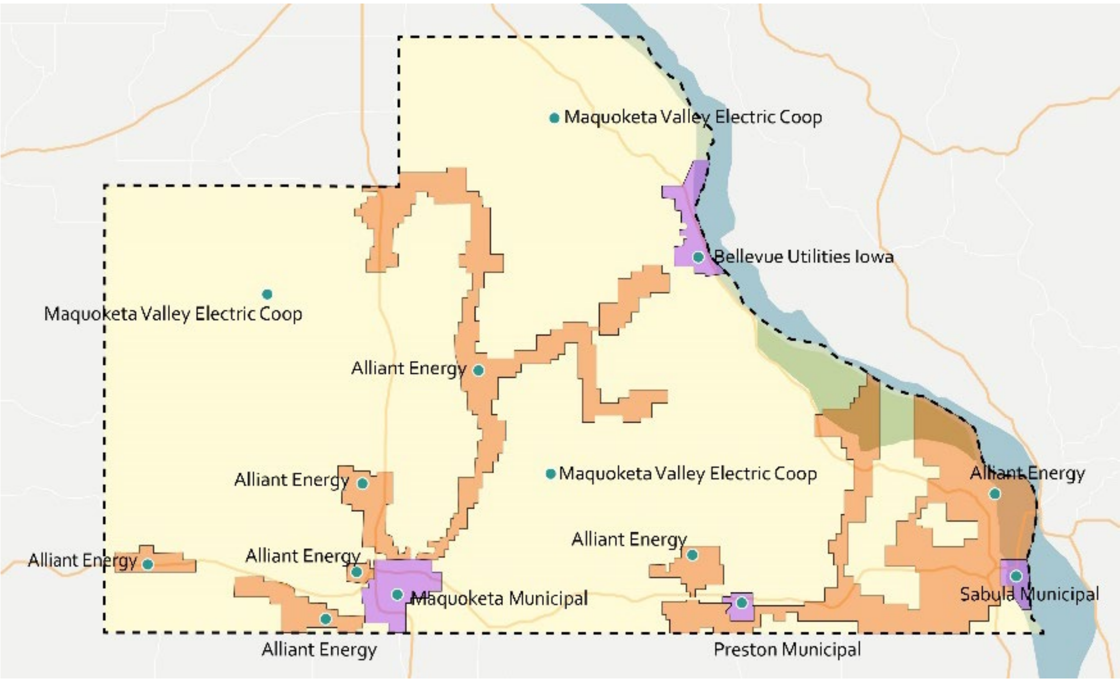


Figure 2.9. Electrical Service Area Boundaries. (Source: Iowa Utilities Board)

Energy Consumption

The total energy consumption in Jackson County is 317,569 Megawatts (MW) annually. Energy consumption per capita is 16.58 MW annually (Table 2.3). Jackson County's energy consumption is approximately 0.61% of Iowa's total energy consumption.

Jackson County, IA Annual Energy Consumption & Production (2021)				
	Total Consumption (MWh)	Total Consumption Per Capita (MWh)	Total Production (MWh)	Total Production Per Capita (MWh)
Jackson County	323,135	16.58	5,342	0.27
State of Iowa	52,908,449	16.58	66,120,266	20.72

Table 2.3: Jackson County, IA – Total Energy Consumption and Production 2021 (Source: Find Energy, Iowa)

Cost of Energy

Electricity prices reflect the cost of building, maintaining, and operating power plants and the electricity grid. The energy rate, measured as cost per kilowatt-hour (kWh), varies based on the demand, weather, availability of energy sources, and fuel costs. Rural households face the highest energy burdens and spend a larger percentage of their income on energy bills than the average household (ACEEE, 2018). Lower population over larger areas causes the cost and efficiency of delivering the energy to rural areas to be higher than delivering energy to urban areas (NRDC, 2018).

Compared to the national average, Iowa's average electricity rate is lower with an average of 12.8 cents per kWh compared to the U.S. rate of 13.8 cents. Jackson County has the 5th most expensive residential electricity rate in Iowa (Table 2.4). The county's residential average rate of 15.4 cents per kWh is 2.6 cents, or about 21% higher than the state's average 12.8 cents per kWh. The residential average monthly electricity bill in Jackson County is $116.04 and is ranked 64th most expensive average in the state out of the 99 counties. The county's average of $116.04 is $6.67 more expensive than the state's average of $109.37.

Top Five Iowa Counties Ranking by Residential Electricity Rate per kWh (2021)				
Rank	County	Population	Residential Rate per kWh	Residential Average Monthly Electricity Bill
1	Hancock County	10,795	17.53	$172.05
2	Winneshiek County	20,070	16.16	$144.70
3	Howard County	9,469	16.16	$144.70
4	Allamakee County	14,061	15.82	$147.53
5	*Jackson County*	*19,485*	*15.36*	*$117.24*
State of Iowa		**3,190,369**	**12.75**	**$110.82**

Table 2.4: Top 5 Iowa Counties Ranking by Residential Electricity Rate Per Kilowatt-Hour (2021) (Source: Find Energy, Iowa)

The residential electricity rate breakdown by utility residential provider is in Table 2.5. Alliant Energy services the majority of residential households and it holds the most significant percentage of the residential sales for electricity residential service (95%) in the county. Maquoketa Valley Electric has the second-lowest residential electricity rate (12.1 per kWh) but the highest average bill for residential households ($133.33 per month). Alliant Energy has the second-highest residential rate (16.8 per kWh) and the second-highest average bill ($126.10). This provider services most of the incorporated jurisdictions, which brings the service cost down, but the high cost per kWh brings the monthly bill higher.

Jackson County Residential Electricity Providers by Residential Electricity Rate (Accessed May 2022)				
Rank	Provider	Residential Rate (¢)	Residential Average Bill	Percent of County Residential Sales by MWh
1	Sabula Electric Utility	17.35	$101.25	0.1%
2	Preston Electric Utility	15.15	$108.37	0.1%
3	Alliant Energy	15.14	$111.76	95.3%
4	Maquoketa Municipal Electric Utility	12.14	$85.82	0.6%
5	Maquoketa Valley Electric	12.11	$133.33	3.6%
6	Bellevue Utilities	10.11	$60.33	0.3%

Table 2.5: Jackson County Residential Electricity Provider by Electricity Rate (2021) (Source: findenergy.com; accessed 05.24.2022)

The breakdown of residential, commercial, and industrial electricity costs by the municipality in Jackson County is in Table 2.6. The data is only available for the three largest municipalities: Maquoketa, Bellevue, and Preston. The average monthly bill for residential buildings is consistent with the Iowa state's costs. These municipalities are primarily serviced by their own public utility and do not include Alliant Energy's rate for service. Commercial building monthly electric bills are significantly cheaper than the state's average, even though the average rate per kWh is slightly higher. Industrial building monthly electric bills and the average rate per kWh are higher than the state in the three municipalities.

Jackson County, IA Average Bills and Rates (May 2022)						
	RESIDENTIAL		COMMERCIAL		INDUSTRIAL	
	Average Monthly Bill	Average Rate per kWh	Average Monthly Bill	Average Rate per kWh	Average Monthly Bill	Average Rate per kWh
State of Iowa	$110.82	12.75¢	$417.22	10.17¢	$17,086.77	6.67¢
City of Maquoketa	$94.10	12.30¢	$450.75	11.05¢	$48,299.06	8.71¢
City of Bellevue	$61.80	10.15¢	$414.33	8.11¢	n/a	n/a
City of Preston	$111.88	15.03¢	$260.39	12.58¢	$29,837.80	7.68¢

Table 2.6: Jackson County Average Bills and Rates (2021). (Source: findenergy.com; accessed 05.24.2022)

Energy Outages

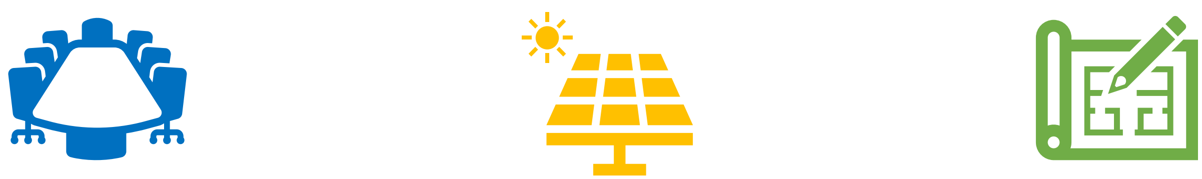
On average, Jackson County residents experience around one electric outage every year (Find Energy, 2020). These outages last about 85 minutes per interruption. This is consistent with Iowa's average of outages a year lasting 104 minutes. Power outages are usually due to snow, ice storms, tornadoes, or high-wind storms.

CHAPTER 3: WHY SOLAR?

This chapter outlines why the plan focuses on solar power generation in Jackson County's transition to clean energy. It reviews the project partner interest, rising energy cost, declining cost of solar panels, reduced reliance on fossil fuels, and the local economic growth potential of solar installation.

Renewable energy comes from natural sources or processes with continuous replenishment. There are five primary types of renewable energy: solar, wind, geothermal, hydropower, and biomass. Definitions and breakdowns of these sources can be found in Appendix A. The urgency to transition to clean energy sources is due to the rising cost of energy and the urgency to transition from fossil fuels to reduce greenhouse gas emissions.

The plan specifically orients Jackson County to transition into solar power generation due to project partner interest, the declining cost of solar panels, and the technical feasibility of other clean energy sources. In addition, Photovoltaic (PV) solar energy generation is a rapidly growing industry in Iowa and has the potential to provide economic growth opportunities for the county.



PROJECT PARTNER INTEREST

DECLINING COST OF SOLAR PANELS

TECHNICAL FEASIBILITY

Why renewable energy?

Most energy production has come from burning fossil fuels for more than a century. Coal, crude oil, and natural gas are considered fossil fuels because they are formed from fossilized, buried remains of plants and animals. The process of burning this material for energy takes a significant toll on human activity and the environment due to air and water pollution, global warming, and the reliance on finite resources. Energy production in Iowa has started to transition to wind and solar power to diversify its sources to prepare for the future energy demand.

What does rising energy costs mean for Jackson County?

Since Jackson County has the fifth most expensive residential electricity prices in Iowa (Table 3.1), a large concern is the rising cost of energy that will continue to put a large strain on personal finances.

In Figure 3.1, the cost for residential households has risen with an average annual increase of 2.3% between 2010 and 2020 for a total of about 25%. Using these past trends, energy prices are projected to continue to rise and put a further strain on household budgets. The cost of energy for all uses is predicted to continue its trend and inflate in price by approximately 3% per year (Bluestem, 2018).

Iowa: residential annual average cents per kWh

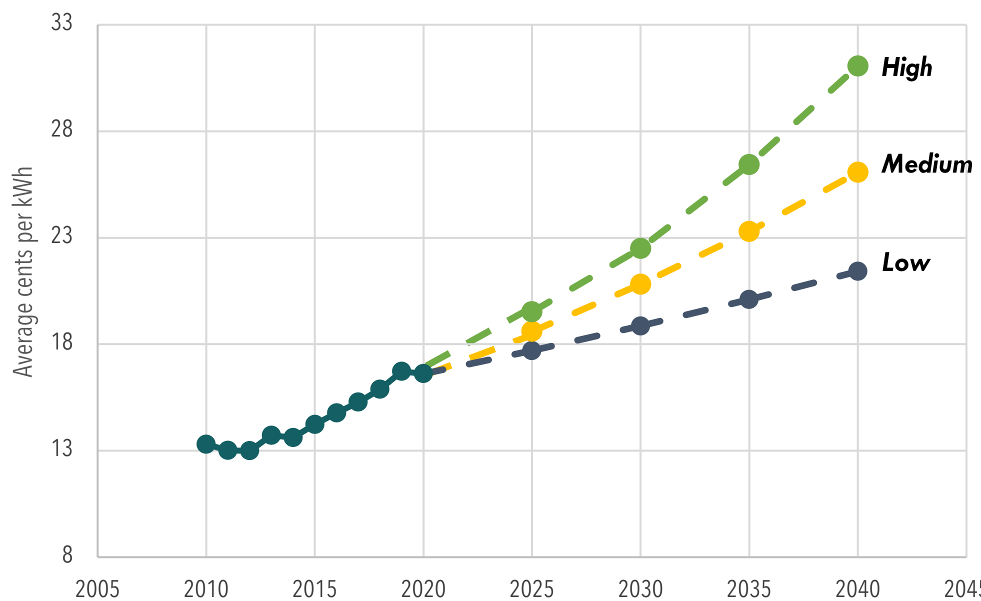


Figure 3.1: Iowa: residential annual average cents per kilowatt hour (kWh) 2010-2020, energy cost projection (2020-2040) (Source: Edison Electric Institute's Typical Bills and Average Rates Report, 2010-2020)

Why solar energy?

PROJECT PARTNER INTEREST

Two of the project partners, the Jackson County Energy District and the City of Springbrook, have a high interest in how PV solar power generation can be a method for reaching their sustainability and energy goals. The Energy District focuses its resources in educating and boosting solar panel installation across the county. This plan provides tools and analysis to assist in their clean energy initiatives.

DECLINING COST OF SOLAR PANELS

The cost of PV solar panels have significantly decreased in the last ten years. Figure 3.2 displays how the cost of solar panels has fallen dependent on the scale of the facility. Residential PV solar panel costs have dropped 64%, commercial rooftop panel costs have dropped 69%, and utility-scale panel costs have dropped 82%. The cost is influenced by global supply chains, tariffs, and labor shortages but the general trend has been decreasing costs as the technology advances and demand increases.

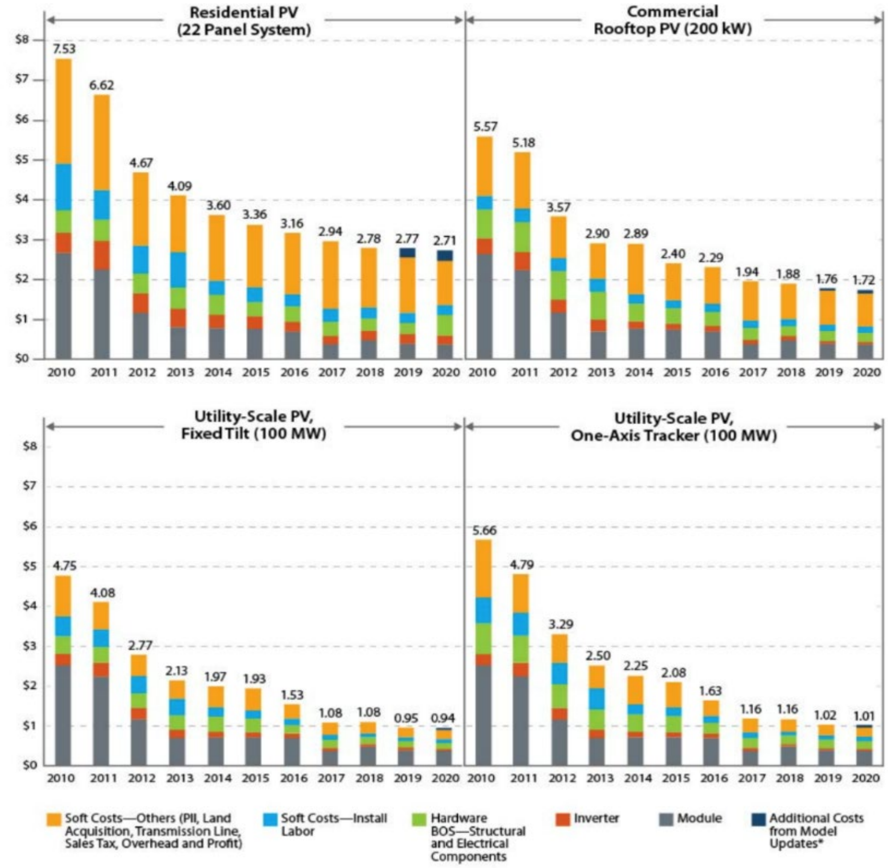


Figure 3.2: PV solar system prices (2010 - 2020) Source: National Renewable Energy Laboratory (NREL)

TECHNICAL FEASIBILITY

Solar power generation provides the largest opportunity over other renewable energy sources. Jackson County is geographically located in a low-speed wind zone, as illustrated in Figure 3.3. The annual average wind speed is low causing wind energy sources to be not as efficient or effective as other clean energy sources. The annual average wind speed in Jackson County above ground is less than 5 meters per second (m/s). An annual wind speed average of 5.8 m/s is preferred for utility-scale turbines (EIA, 2016).

Jackson County is in a moderately favorable area for the use of geothermal (Figure 3.4).

The National Renewable Energy Lab (NREL) considers hydrothermal temperatures greater or equal to 90 degrees Celsius (194 degrees Fahrenheit) to be suitable for electricity generation using Deep Enhanced Geothermal Systems. However, identified hydrothermal sites are concentrated in the western and southwestern states, with no identified sites within the state.

Biomass is not considered a viable option due to increased carbon emissions when burned for electricity. Medical professionals warn that burning biomass create air pollution can cause an array of health harms ranging from asthma attacks to cancer.

Therefore, this plan focuses on strategies for Jackson County to pursue PV solar generation to meet long-term goals and objectives.

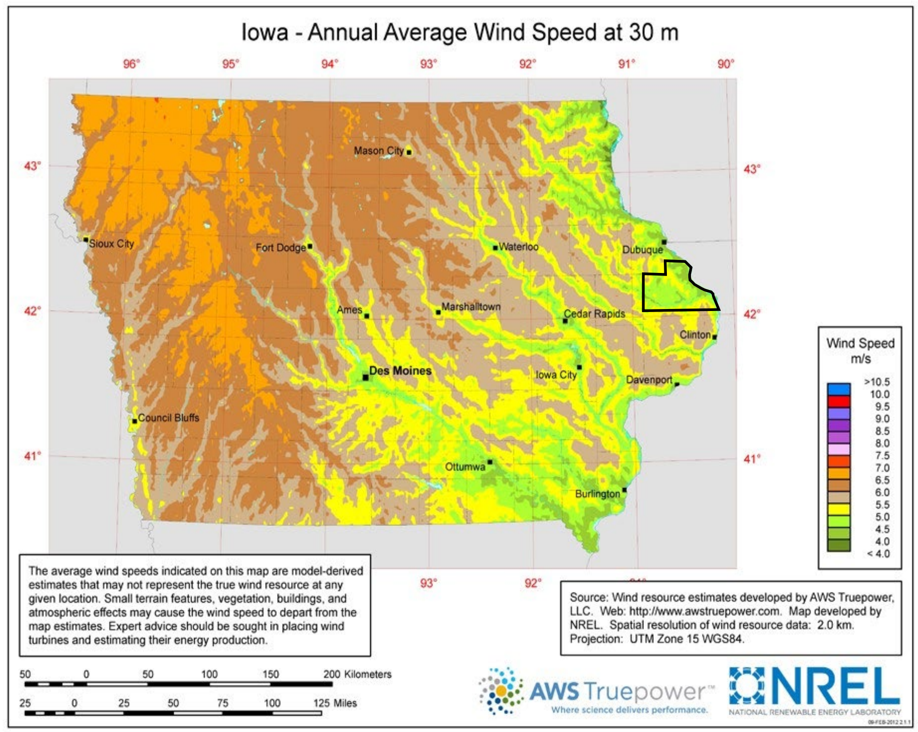


Figure 3.3. Iowa Annual Average Wind Speed at 30 m. Source: NREL, 2016(Source: NREL, 2016)

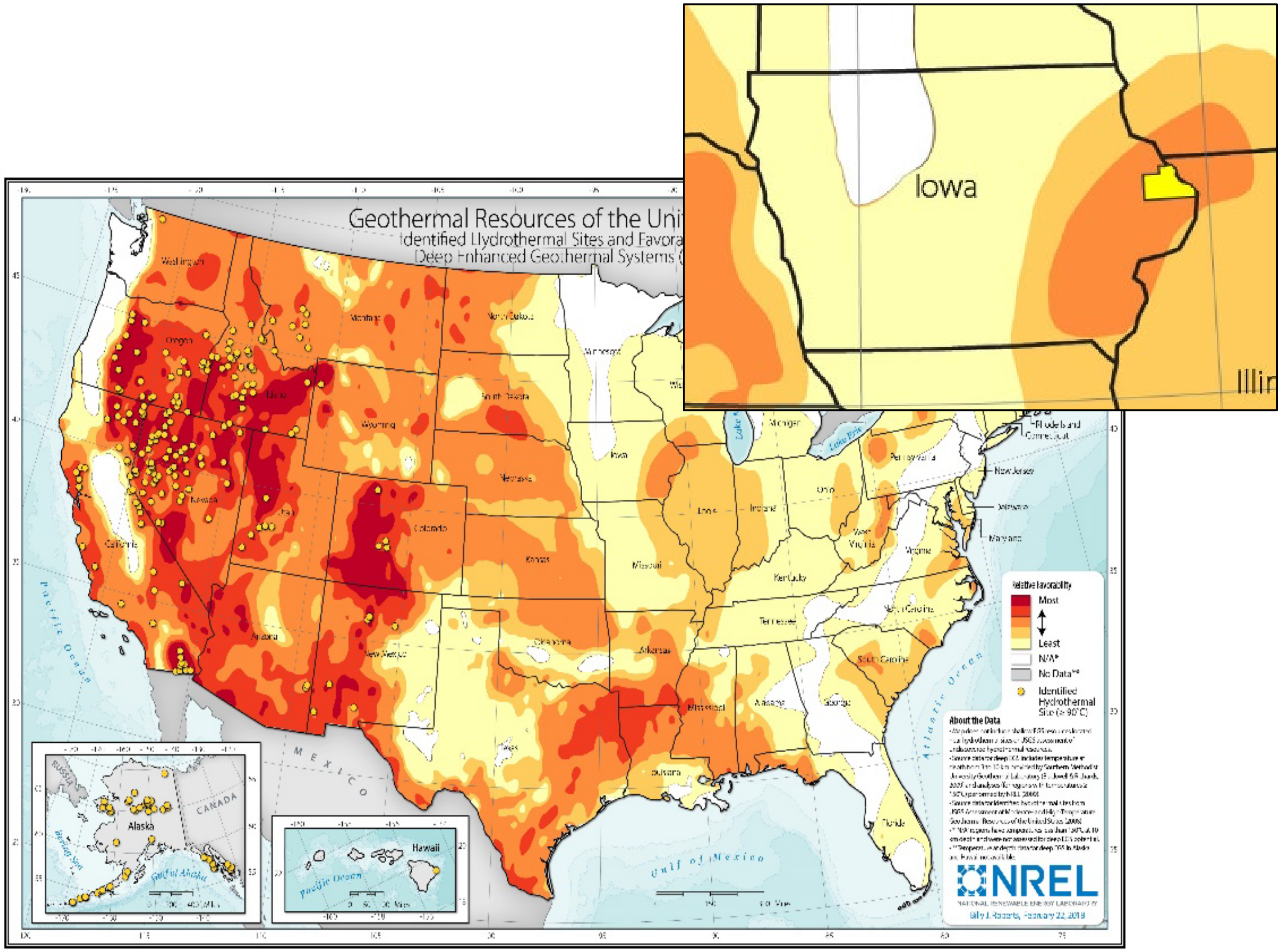


Figure 3.4. Geothermal Resources of the United States. (Source: NREL, 2016)

Solar Power Generation in Jackson County

Solar power generation is a rapidly growing industry, and private third parties are looking to invest in solar installation projects. Due to net metering and government tax credits, there is a substantial financial benefit and faster return on investment for private individuals serviced by Iowa's for-profit utilities. Government entities and non-profit organizations do not have access to tax credits and are not able to capitalize on those incentives. This limits the ability of these not-for-profit entities to benefit compared to private entities financially. More information about Solar energy in Iowa is available in Appendix C.

Figure 3.5. Photo of Solar Array at Hurstville Interpretive Center (Source: Jackson County Energy District)

Jackson County and its local municipalities have three options to install distributed solar power generation. First, these government entities can directly purchase and install the PV solar panels and pay the total upfront cost. While there would be an expensive initial cost, the financial return on investment would be entirely captured by Jackson County.

The second option is that the entities could partner with a private third party to invest in the project financially. A Power Purchase Agreement operates by having the private investor capture the tax credits not available to the county, and sell the electricity generated by the PV solar system back to the county at a rate lower than their current electricity rate.

Third, the utility provider could invest in solar panel installation in or near the community. In the second or third scenarios, the county or municipalities would not capture all the financial benefit from the solar since the incentives are shared amongst all parties. These ownership options depend on the utility provider on the energy cost and net metering laws.

Net metering law in Iowa applies to the two investor-owned utilities in Iowa, MidAmerican Energy and Alliant Energy (see Figure 3.6). Municipal or cooperative utilities are not required to offer net metering. In Jackson County, Alliant Energy is the largest energy provider out of the six providers.

WHAT IS *NET METERING?*

Net metering allows customers who have solar panels to receive a credit for any excess energy produced compared to what their home consumes. The excess energy is sent back to the grid as a credit to be used by the customer in times of lower energy production.

Net Metering in Iowa

The Iowa Utilities Board approved updated net metering pilot programs for MidAmerican Energy and Alliant Energy. The new rules apply to approximately 89% of the residential customers in Iowa. The maximum system size limit increased to 1 Megawatt (MW) from 500 Kilowatts (kW). There are changes to excess generation compensation. The previous rules carried over excess generation, the new programs require an annual "cash out" where remaining excess generation is credited at an avoided cost rate.

Customers are not allowed to net meter over 100% of their demand load. The two companies measure the 100% cap differently. MidAmerican bases the cap on annual energy use, while Alliant Energy bases it on maximum annual demand.

Figure 3.6. Net Metering Description (Source: Database of State Incentives for Renewable Energy, DSIRE, 2022)

The lack of net-metering is a disadvantage for customers serviced by the non-investor-owned utility providers. In particular, the four largest municipalities in Jackson County (Maquoketa, Bellevue, Preston, and Sabula) and the unincorporated areas are serviced by their own municipal utilities or the Maquoketa Valley Rural Electric Cooperative have less incentive to install solar systems.

Alliant Energy has 95% of Jackson County residential energy sales (Table 2.5) and the Iowa net metering laws directly benefit those Alliant Energy customers in Jackson County. While net metering is available, customers receive 50% of the avoided cost rate as cash-out credit for surplus kWh. Any installed system should be planned carefully to install a system sized to produce slightly less than the annual consumption to avoid forfeiting surplus generation at the annual cutoff date (Winneshiek Energy District, 2020).

CHAPTER 4: EXISTING SOLAR PANEL INSTALLATIONS

The Existing Solar Panel Installations chapter describes the current Jackson County solar installation data breakdown with location, size, and land use type up to 2021. An interactive map with the current installation data was created for the Jackson County Energy District to collect and display the future installations.

Jackson County Existing Solar Panel Installation Map

The data collected on the existing photovoltaic (PV) solar panel installations in Jackson County were the location, size, and land use type of the solar panels to create a baseline for the county. The data is collected by building permits, municipal administrators, and site data from two solar installation companies in Jackson County, Eagle Point Solar and Blue Sky Solar. The inventory map (Figure 4.4) reports the general location, installation date (Figure 4.1), and land use type of installation in the county. From the current data collected, there are 64 PV solar panel installations from 2014 to 2021 (Figure 4.2). About a quarter of the installations were in 2021 (Figure 4.1).

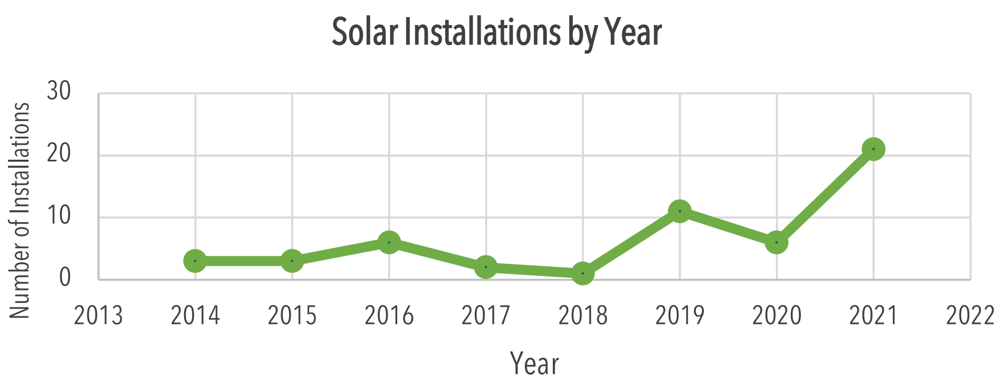


Figure 4.1. Solar installations in Jackson County

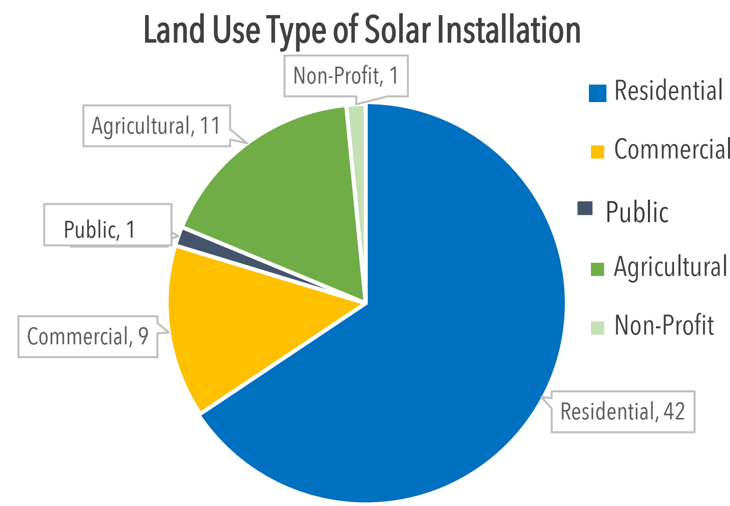


Figure 4.2. Land use of solar installations in Jackson County

The land use type of the solar installations is two-thirds residential, approximately 17% agricultural, and 15% commercial properties. The average size of installations in Jackson County is 16 kilowatts (kW) (Table 4.1 and Figure 4.3). This size solar system requires up to 1,200 square feet and typically pairs with 40-50 solar panels. The median sizes for residential and agricultural solar installations are 7 kW. The larger-scale solar facilities are located on commercial properties with an average of 39 kW in size.

Historically, the most prominent scale of solar power generation in Jackson County has been distributed solar or solar panels on individual property. Utility-scale solar projects, or solar farms, are recent endeavors in Iowa but are likely limited due to the absence of laws that permit virtual net metering.

A system is considered a utility-scale at 1,000 kW (1 Megawatt). The larger the solar system, the lower the cost of panels and maintenance and the higher the financial return. In addition, the easier it is to find third parties to invest in these projects financially.

SOLAR SIZE OF SOLAR INSTALLATION IN JACKSON COUNTY (2014-2021)	
	Size
RESIDENTIAL INSTALLATIONS	
Average	10 kW
Median	7 kW
COMMERCIAL INSTALLATIONS	
Average	39 kW
Median	38 kW
AGRICULTURAL INSTALLATIONS	
Average	8 kW
Median	7 kW
TOTAL INSTALLATIONS	
Total Average	**16 kW**
Total Median	**9 kW**

Table 4.1. Solar size of solar installations in Jackson County

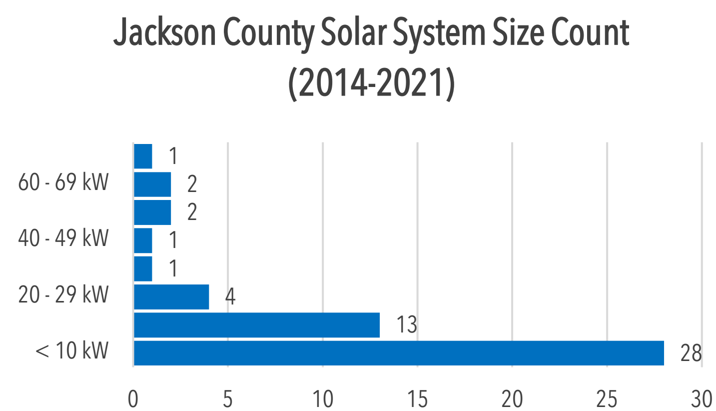


Figure 4.3. Solar system size graph in Jackson County

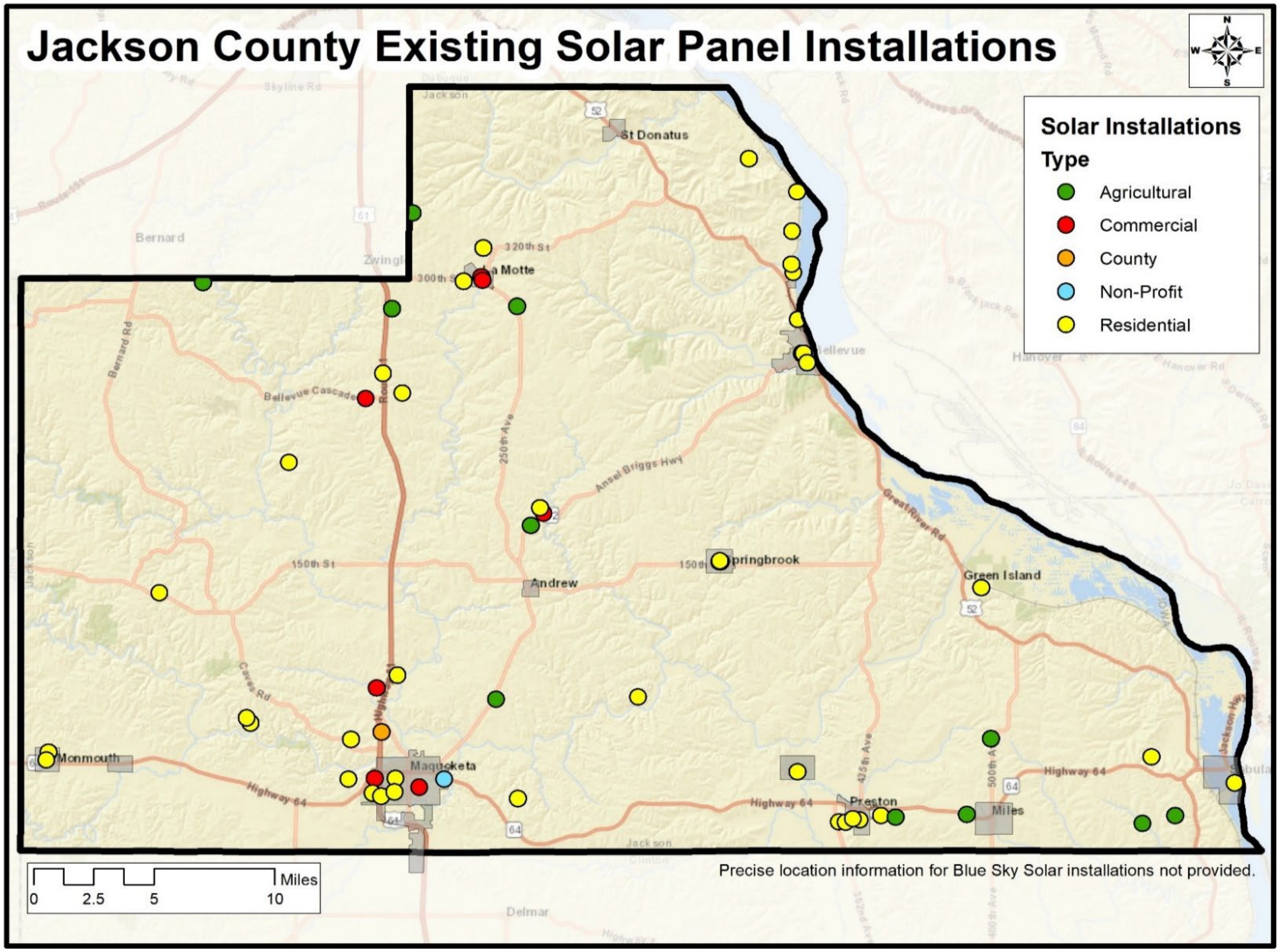


Figure 4.4 Existing solar panels installations map in Jackson County

Solar Installation Interactive Map

The *Solar Installation Interactive Map* (Figure 4.5) is a tool created for the Jackson County Energy District to continue collecting and displaying solar installations within the county. The energy district communicated the need to track future renewable energy growth by the system size, land use type, and carbon emissions offset. The interactive map is created by the online mapping software Google My Maps to visualize the data in Figure 4.4. The energy district will host and update this map on its official website.

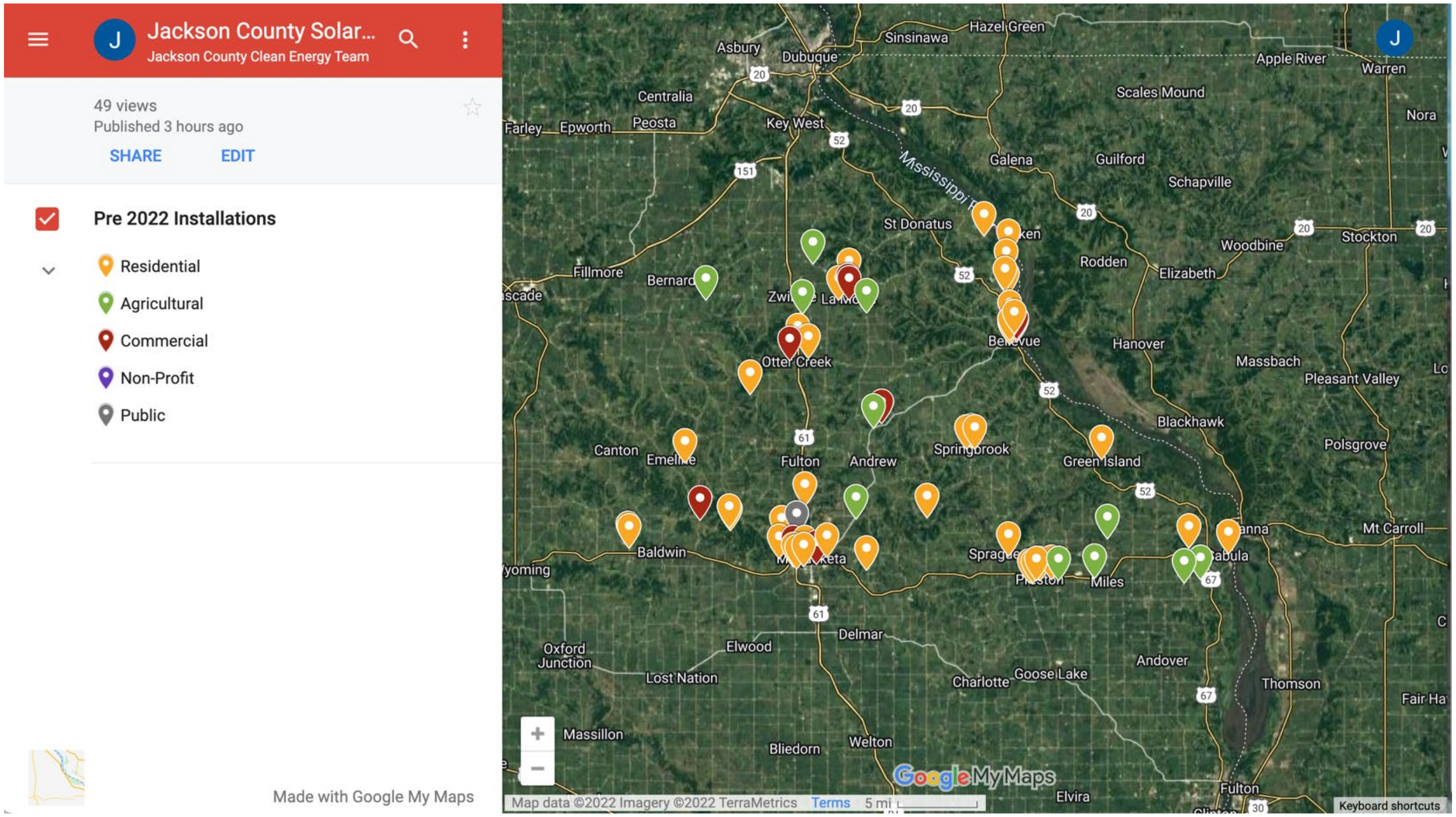


Figure 4.5 Solar installation interactive map in Jackson County

This tool aims to increase public awareness of how PV solar and other clean energy sources have been installed and utilized within the county. As the energy district continues to partner with the Jackson County Board of Supervisors and other local officials, the interactive map will be a marketing tool to spur solar installation or inform clean energy policy. The energy district intends to add future solar installations and other clean energy installations (wind, geothermal, etc.) to the map. Photos or other data can be collected and added to the installation points to illustrate further and display the installations (see Figure 4.6).

During the team's public engagement efforts for the clean energy pilot project in Springbrook, IA, a key takeaway was how the visibility of PV solar panels influenced the perception and acceptability of renewable energy. Several Springbrook residents expressed that due to the lack of visible large-scale PV solar panels within Jackson County, there is an assumption that PV solar is not a promising technology in the county. This map aims to showcase the prevalence of solar panels within the county.

The Environmental Protection Agency's *Greenhouse Gas Equivalencies Calculator* produced the carbon emissions offset by converting emissions or energy data to the equivalent amount of carbon dioxide emissions from using that amount. The calculator translates abstract measurements into concrete terms that are widely understood, such as the annual emissions from cars or households. These calculations are located within the map to communicate further renewable energy's role in reducing greenhouse gas emissions.

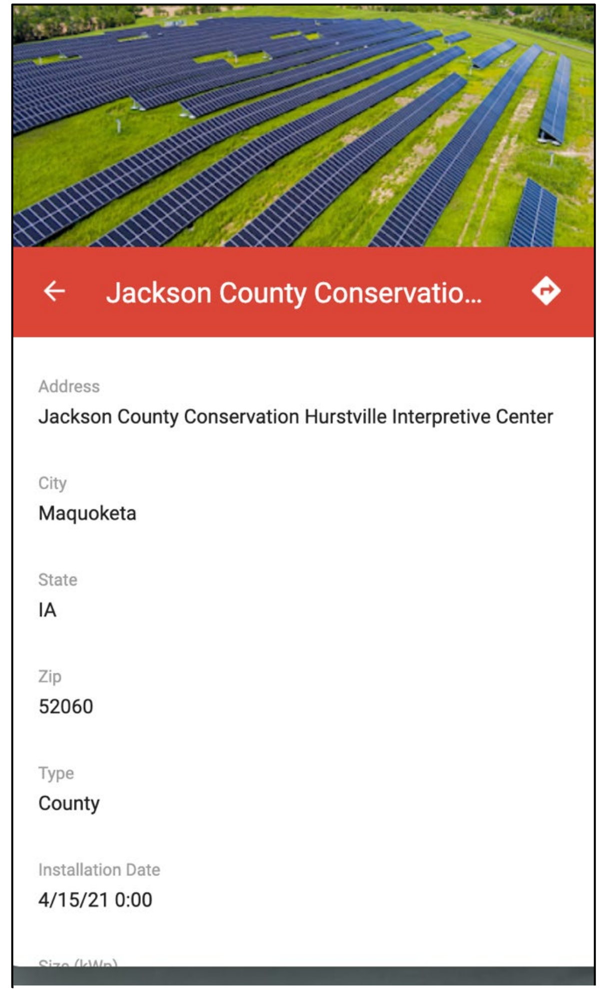


Figure 4.6 Solar installation interactive map in Jackson County

CHAPTER 5: JACKSON COUNTY FEASIBILITY STUDY

Introduction

The Jackson County government is the deedholder to 93 parcels and buildings across the county (Beacon, 2021). These buildings range from secondary road maintenance shops, campground offices, welcome centers, the county courthouse, and parcels set aside for conservation. To reduce operational costs and invest in renewable energy, the Jackson County government is interested in identifying which county-owned buildings have the greatest potential to install Photovoltaic (PV) solar panels. The priority is to see an adequate economic return from the solar installations. This analysis identifies county-owned buildings with the greatest PV solar potential. The process identified which of the 93 parcels are most suitable for PV solar, considering county priorities. The first step identified thirteen sites out of the original 93 that are suitable for PV solar installation. The second step calculated the potential solar generation of each of these thirteen sites using the annual energy consumption data.

Identifying Solar Feasibility

The Jackson County Board of Supervisors prioritizes the South Sabula Lake Campground, the soon-to-be constructed County Jail in Maquoketa, the county's secondary roads maintenance shops and other Jackson County administration buildings.

To calculate solar feasibility, the first step is to identify the county-owned parcels with buildings located on site. The GIS database by Beacon for Jackson County provided the parcel data required to navigate the county-owned parcels with buildings. A portion of the county-owned properties with buildings are ruled unfeasible using the ESRI solar calculator tool (Khanna, 2021) due to the building orientation, roof angle, tree cover, or physical restrictions of the roof using LiDAR data collected for the state of Iowa.

Name	System Size (kilowatt DC)	Price (Per Watt)	System Cost	Payback Period (Years)	Lifetime Avoided Cost	Return (per Year)
Penrose Annex	7.14	$2.53	$18,064.20	0.3	$36,422.81	$734.34
		$1.80	$12,852.00	0.2		$942.83
Sheriff Office	29.24	$2.53	$73,977.20	8.7	$148,899.64	$2,996.90
		$1.80	$52,632.00	6.2		$3,850.71
Courthouse	86.02	$2.53	$217,630.60	8.7	$437,948.68	$8,812.72
		$1.80	$154,836.00	6.2		$11,324.51
County Jail	109.48	$2.53	$276,984.40	8.7	$557,279.86	$11,211.82
		$1.80	$197,064.00	6.2		$14,408.63
Campground	109.48	$2.53	$276,984.40	13.0	$371,410.53	$3,777.05
		$1.80	$197,064.00	9.2		$6,973.86
Secondary Roads HQ	11.22	$2.53	$28,386.60	8.9	$55,636.84	$1,090.01
		$1.80	$20,196.00	6.3		$1,417.63
La Motte Shop	4.08	$2.53	$10,322.40	8.8	$20,417.19	$403.79
		$1.80	$7,344.00	6.3		$522.93
Prairie Creek Shelter	1.36	$2.53	$3,440.80	8.6	$6,927.26	$139.46
		$1.80	$2,448.00	6.2		$179.17
Baldwin shop	5.10	$2.53	$12,903.00	8.5	$26,432.97	$541.20
		$1.80	$9,180.00	6.0		$690.12
Preston Shop	5.78	$2.53	$14,623.40	8.7	$29,130.95	$580.30
		$1.80	$10,404.00	6.2		$749.08
Springbrook Shop	1.36	$2.53	$3,440.80	16.0	$3,755.30	$12.58
		$1.80	$2,448.00	11.4		$52.29
Butler shop	1.02	$2.53	$2,580.60	14.8	$3,026.12	$17.82
		$1.80	$1,836.00	10.6		$47.60
Bellevue Shop	1.70	$2.53	$4,301.00	8.9	$8,385.63	$163.39
		$1.80	$3,060.00	6.4		$213.03
Overview Table (Table 5.0)	Total	**$2.53**	$943,639.40	9.63	$1,705,673.76	$30,481.37
		$1.80	$671,364.00	6.85		$41,372.39

Calculating Solar Potential

After a portion of the sites are eliminated, a total of thirteen sites remained. Jackson County administrators provided utility data for the identified sites. Orientation and potential tree cover were reevaluated using the 2021 aerial imagery. Three priority sites are in Chapter 5 and **the remaining feasibility site studies are in Appendix D**.

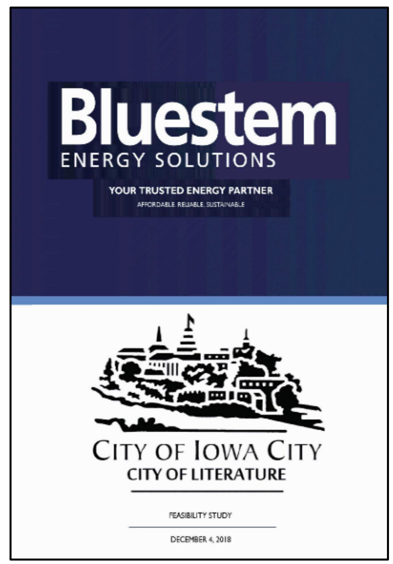
The team calculated the estimated generation for each site's individual PV solar system using ArcGIS Pro and NREL PVWatts (NREL, 2017).

The utility data is used to calculate either the 100% energy generation need (for investor-owned), or the monthly baseload need (for non-investor-owned) for each building, depending on the utility company servicing the site. The baseload is calculated by taking the average of the four lowest months of electricity usage.

Net metering policies for Iowa investor-owned utilities allow up to 110% of a building's electricity demand to be credited back to the utility and

Feasibility Study Data
The following data are used in the analysis:

- Jackson County building footprint vectors (Created by team)
- Jackson County Building Utility Data (Supplied by County Staff)
- Jackson County Parcel information (Supplied by Beacon)
- Jackson County LiDAR data (GeoTREE Center, 2016)



Bluestem Energy Solutions, 2018

The Bluestem Energy Solutions report, prepared for the City of Iowa City, serves as the model report for the county-owned building feasibility for installing solar panels. In addition to providing key information about Solar in Iowa and existing and emerging technology.

The methodology in the Bluestem report was simplified to create this feasibility study. Additionally, the payback period calculation used by the Bluestem report was utilized specifically in the team's feasibility study.

are only applicable for the two for-profit utility companies, Mid-American Energy and Alliant Energy (Uhlenhuth, 2020). Maquoketa Valley Electric Co-op and other municipal utility providers use an "avoided cost" to pay the generator at a rate that fluctuates with the wholesale purchase rate. The size of a PV solar system is designed to match the estimated energy usage without exceeding the amount allowed. Calculating a PV solar system's size at 100% of generation is used in this study and is recommended by local commercial solar installers.

Using the building footprint vector data and parcel information, the square footage of the roof is calculated and compared to the solar panel size to determine the percent cover for each system.

Figures 5.1 to 5.3 display each building's electricity consumption from December 2020 to November 2021. The maps show the specific location of each site and the estimated avoided electricity cost (with the 3% energy inflation assumption) for potential PV solar. Tables 5.1 to 5.3 displays additional information used to calculate the system size and return on financial investment. Using existing purchase rates and installation costs, each site calculated the amount of money retained through solar panel installation, payback period, and total costs diverted over a PV solar panel project's lifetime.

Feasibility Study Assumptions

The analysis is based on the following assumptions about solar panels, environmental features, and energy costs:

- 340-Watt Panel produce 43.5 kWh/month (Solar reviews, 2021)
- 4.5 hours of Peak Sunlight (Hyder, 2019)
- Panels are 17.6 ft^2. Average dimensions are 5.41 ft. x 3.25 ft. (Energy Sage, 2021)
- Calculations are done without the use of federal tax credits. Under certain purchasing models have a 26% federal tax credit can be applied in 2022 or a 22% federal tax credit applied in 2023 (Energy.gov, 2021). The Iowa State tax incentives expired in 2022. Ongoing work to reestablish those programs are currently in progress, but no legislation has been passed.
- Solar panel warrantied lifetime is 25 years (NREL, 2018)
  Solar panels are capable of producing electricity after 25 years, however, after that timeframe degradation in generation is expected. About 20-25 years is the standard warranty to guarantee a consistent level of generation with a known rate of degradation.
- 3% annual inflation in energy costs over the 25-year lifetime.
- Jackson County building rooftops are assumed to be structurally strong enough to support PV solar panels.

Each row of the table represents a different price per watt, ranging from $2.53 - $1.80 per watt. The price of each PV solar system is also calculated with the contribution of the Hammond Moonshot grant (labeled as "w/Grant"). Table 5.0 summarizes the range of PV solar system prices calculated by the study. Figures 5.1 to 5.3 can be used to calculate the payback period by taking the intersection of the system size line and the estimated avoided electricity curve. This payback period differs from the payback period displayed in the corresponding table. The payback period calculations represent two separate methods for calculation. The payback period in the table is calculated using the formula:

$$Payback\ Period = \frac{PV\ System\ Cost}{PV\ System\ Saving\ x\ (1\ x\ e)^{N}}$$

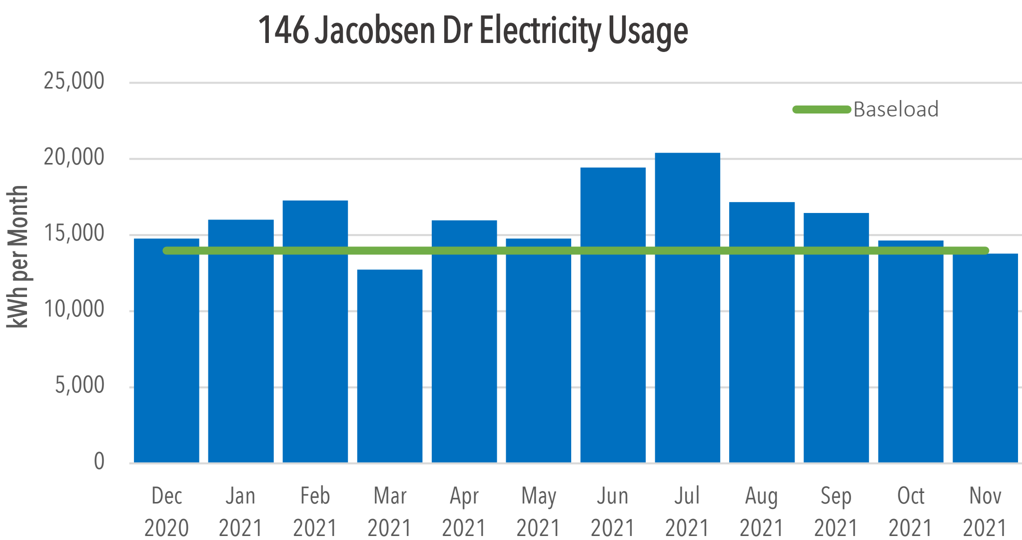
Where ***e*** represents a 3% annual energy inflation rate and ***N*** represents the 25-year warrantied lifetime of the PV solar panels (Bluestem, 2018).

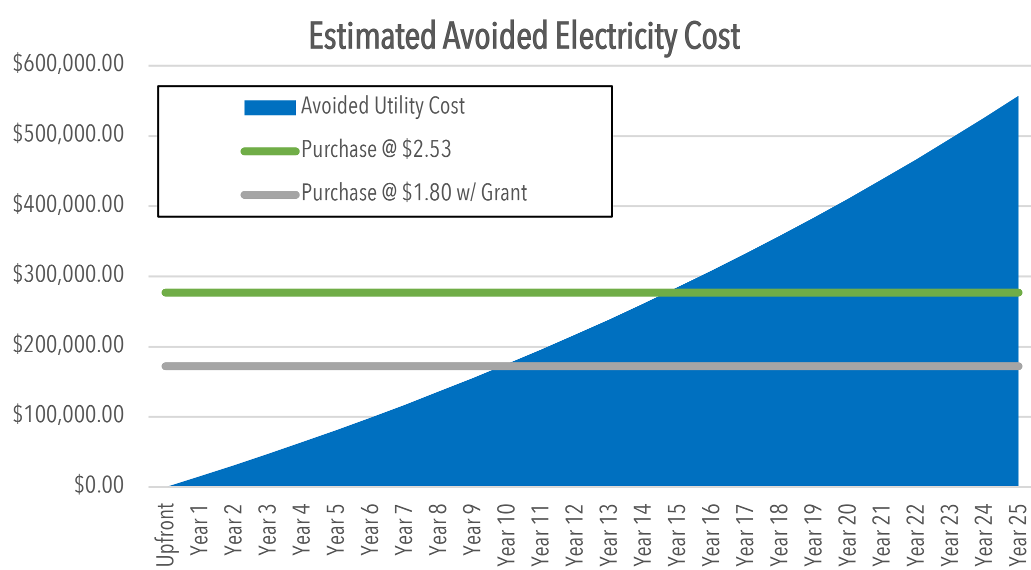
Power Purchase Agreements (PPA)

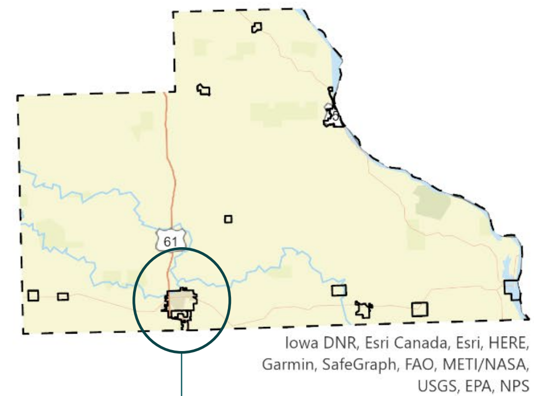
This analysis does not consider a Power Purchase Agreement (PPA) as a viable financing option for the systems explored. In discussion and input with local solar commercial installers, using a PPA has several complicating factors that make estimating the cost of multiple installations difficult. The key takeaways from these discussions include:

- PPA's are extremally unique to each project. To be effective and profitable, they require careful attention to generation potential and existing electricity purchase rates. The private investors interested in capitalizing on federal and state tax credits only tolerate investments of a certain risk. Typically, this manifests as a minimum system size threshold (250 kW for ground-mounted solar or 500 kW), where a PPA makes financial sense for investment.
- The solar tax incentives do not directly reduce the cost of a system. The capital sources that move to finance PPA's expect a certain financial level of return. In addition to the increased legal fees and background costs associated with a complex agreement, the investors typically absorb solar tax incentives to ensure financial return.

County Jail – 146 Jacobsen Dr. Maquoketa, IA (Figure 5.1)







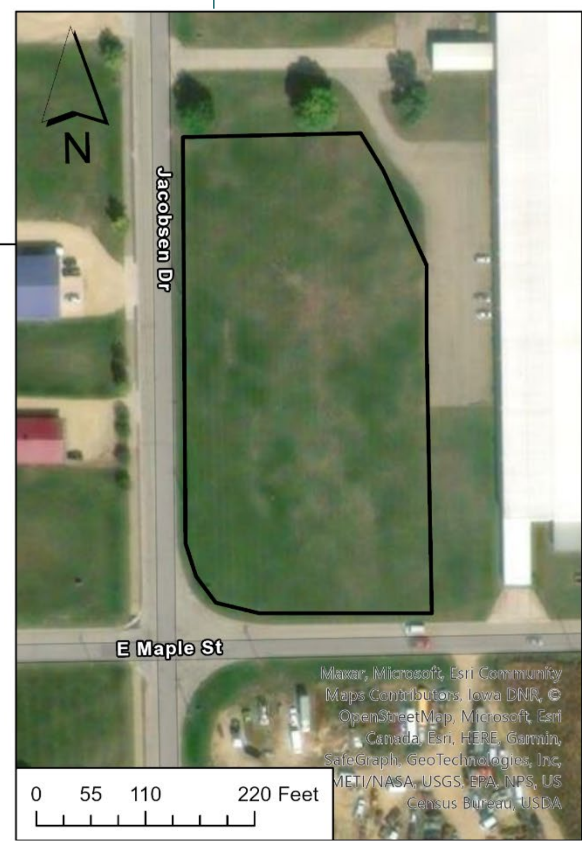


Figure 5.1.2. Picture | Delaware County Jail

The Jackson County Jail closely follows the Delaware County Jail model in Manchester, IA. The electricity usage used to calculate the system size for the Jackson County Jail is collected from the Delaware County Jail utility data. Additionally, the roof size requirements (Table 5.1) are used to calculate Delaware County Jail's percent coverage as a template.

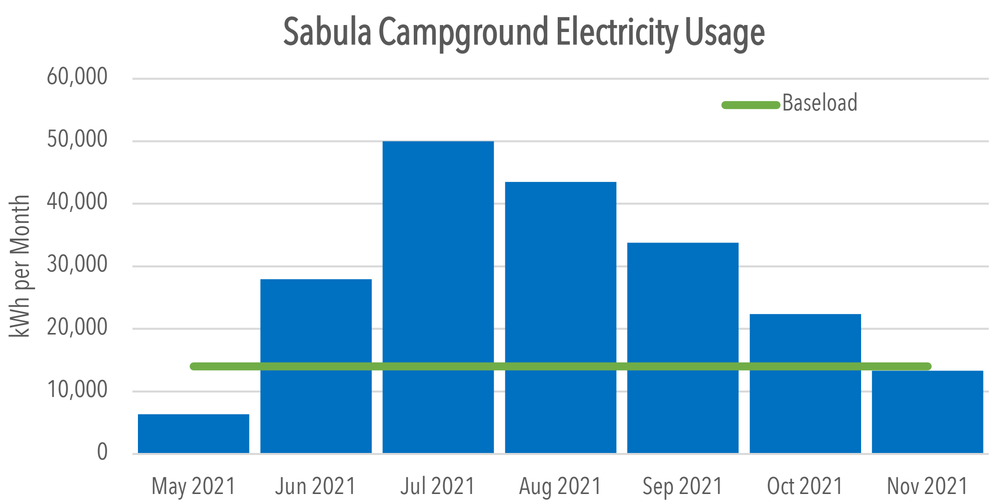
County Jail – 146 Jacobsen Dr. Maquoketa, IA (Table 5.1)

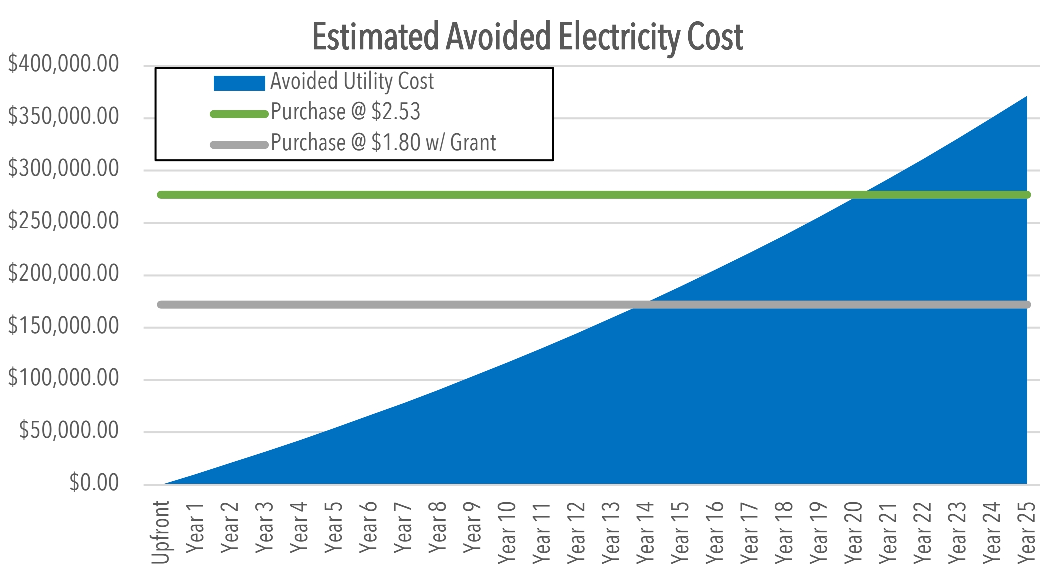
Baseload (kWh)	Number of Panels (340 Watt)	System Size (kW DC)	DC-AC Ratio	System Size (kW AC)	Price Per Watt	System Cost
13,975.00	322	109.48	1.2	91.23	$2.53	$276,984.40
					$2.53 w/ Grant	$251,984.40
					$2.09	$228,813.20
					$2.09 w/ Grant	$203,813.20
					$1.80	$197,064.00
					$1.80 w/ Grant	$172,064.00

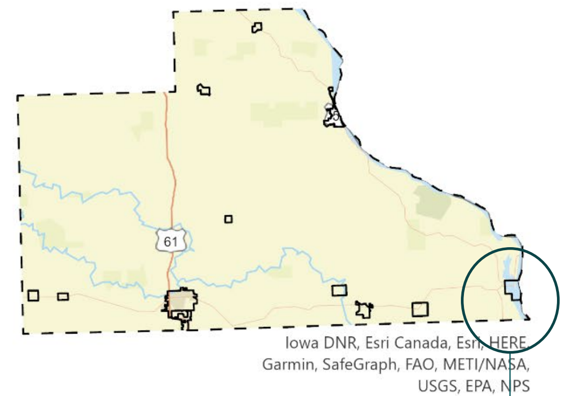
Avoided kWh (per Year)	Avoided Cost Total (per Year)	Payback Period (Years)	Lifetime Avoided Cost	Lifetime Return	Return (per Year)	Percent Return (per Year)
146,129.00	$15,285.00	8.7	$557,279.86	$280,295.46	$11,211.82	4.0%
		7.9		$305,295.46	$12,211.82	4.8%
		7.1		$328,466.66	$13,138.67	5.7%
		6.4		$353,466.66	$14,138.67	6.9%
		6.2		$360,215.86	$14,408.63	7.3%
		5.4		$385,215.86	$15,408.63	9.0%

Orientation	Tree Cover	PV System Requirements (Square Feet)	Roof Size (Square Feet)	Percent Coverage
Flat	None	5,558	18,100	30.7%

Sabula Campground - Sabula, IA (Figure 5.2)







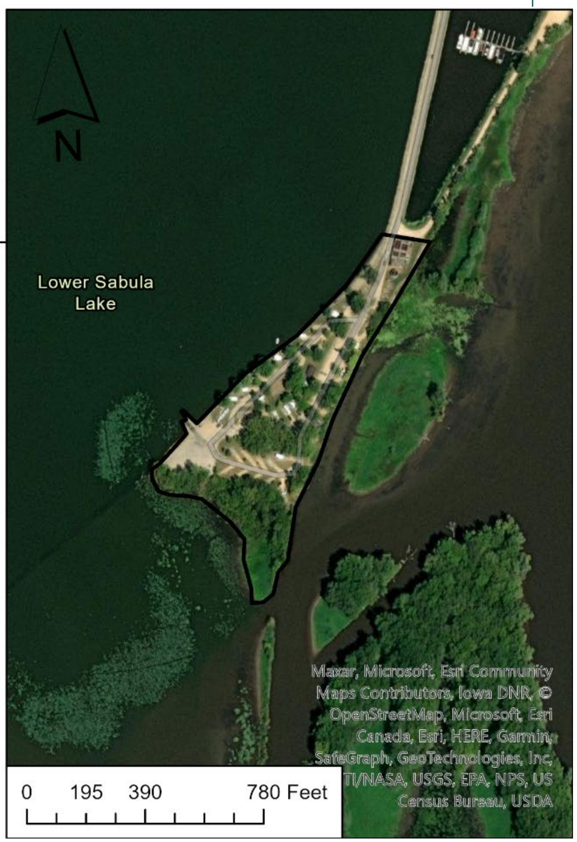


Figure 5.2.2. Picture | Sabula Campground

The Sabula Campground presents several challenges that should be considered when evaluating the site's potential for PV Solar.

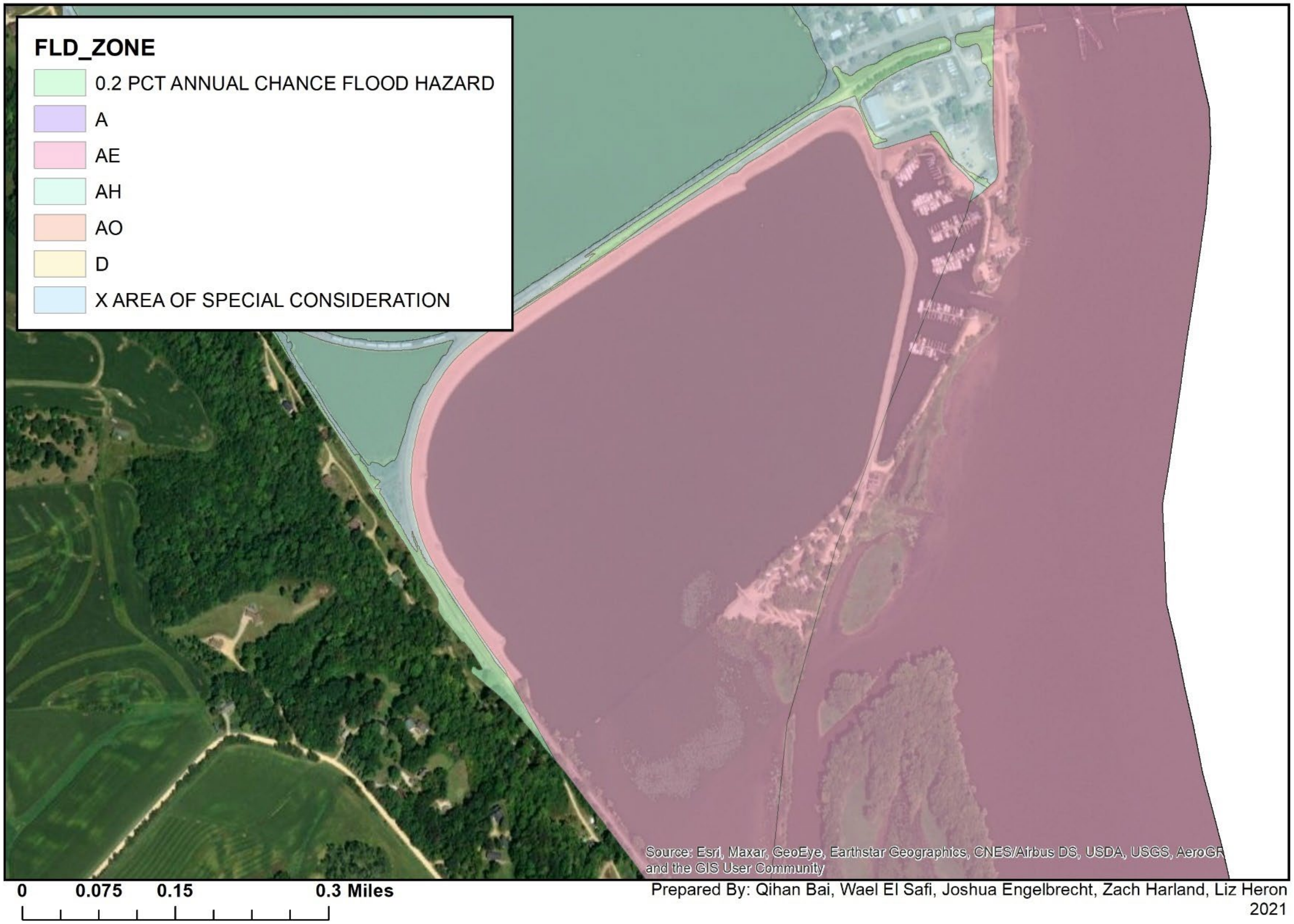
1. The Sabula Campground is within the 100-year floodplain (Figure 5.2.3). While the annual chance of flooding is 1%, the probability that the campground will flood at least once during the 25-year warrantied lifespan of the PV solar system is 22% (NOAA, 2018).
2. The site itself is impacted heavily by shade and tree cover, making locating the PV solar system within the campground a challenge to install without removing any existing trees.
3. The campground is only in operation from April 1 to October 31. The PV solar generation occurring off-season would flow directly to Sabula Municipal Utility without offsetting any campground costs.

These three considerations could be addressed by:

1. Locating the PV solar system for the Sabula Campground off-site at either another Jackson County parcel or a Sabula Municipal-owned parcel. This presents an opportunity for an agreement with the Sabula Municipal Utility to modify their avoid cost charges in exchange for additional seasonal generation from this PV solar system.
2. Locating the PV solar system on Lower Sabula Lake. Appendix G discusses floating PV technology suited for over-water operations that could be utilized. Additional investigation on the additional costs and permits required are necessary.

Campsite Flood Zones

Figure 5.2.3 Sabula Campsite Flood Hazard Areas



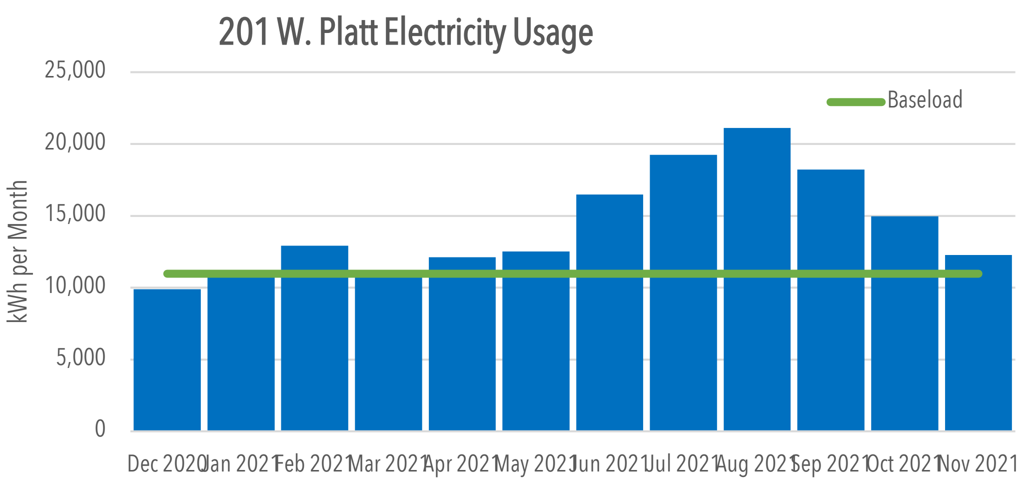
Sabula Campground - Sabula, IA (Table 5.2)

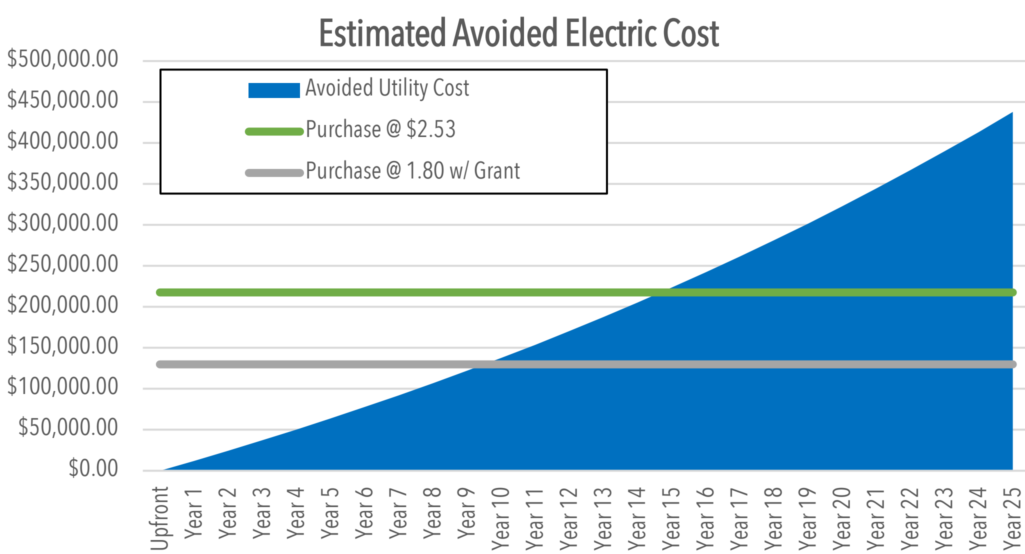
Baseload (kWh)	Number of Panels (340 Watt)	System Size (kW DC)	DC-AC Ratio	System Size (kW AC)	Price Per Watt	System Cost
14,004.00	321.9310345	109.48	1.2	91.23	$2.53	$276,984.40
					$2.53 w/ Grant	$251,984.40
					$2.09	$228,813.20
					$2.09 w/ Grant	$203,813.20
					$1.80	$197,064.00
					$1.80 w/ Grant	$172,064.00

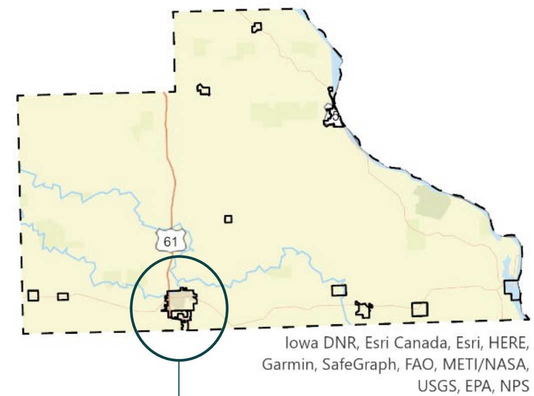
Avoided kWh (per Year)	Avoided Cost Total (per Year)	Payback Period (Years)	Lifetime Avoided Cost	Lifetime Return	Return (per Year)	Percent Return (per Year)
85,417.00	$10,187.00	13.0	$371,410.53	$94,426.13	$3,777.05	1.4%
		11.8		$119,426.13	$4,777.05	1.9%
		10.7		$142,597.33	$5,703.89	2.5%
		9.6		$167,597.33	$6,703.89	3.3%
		9.2		$174,346.53	$6,973.86	3.5%
		8.1		$199,346.53	$7,973.86	4.6%

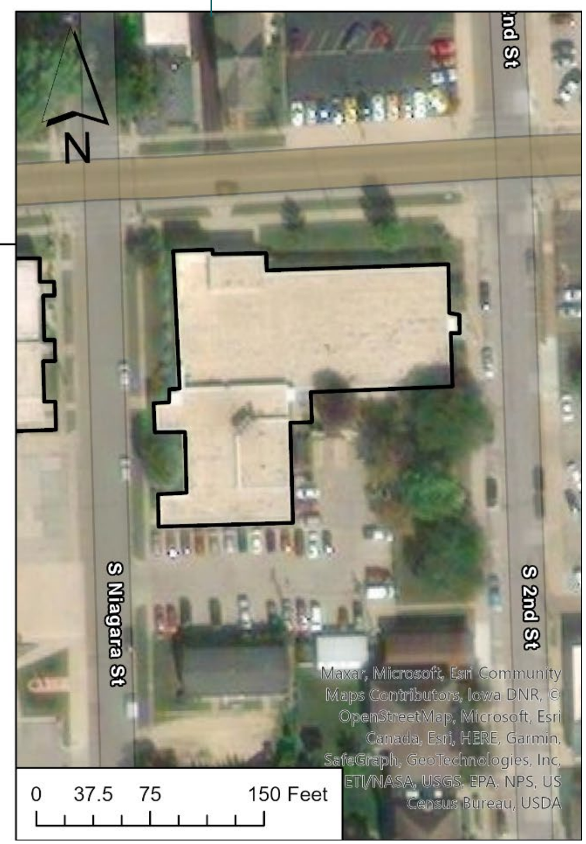
Orientation	Tree Cover	PV System Requirements (Square Feet)	Campsite Size (Square Feet)	Percent Coverage
Flat	Heavily Impacted	5,569	211,953	2.6%

Courthouse – 201 W Platt St. Maquoketa, IA (Figure 5.3)









Courthouse – 201 W Platt St. Maquoketa, IA (Table 5.3)

Baseload (kWh)	Number of Panels (340 Watt)	System Size (kW DC)	DC-AC Ratio	System Size (kW AC)	Price Per Watt	System Cost
10,970.00	252	86.02	1.2	71.68	$2.53	$217,630.60
					$2.53 w/ Grant	$192,630.60
					$2.09	$179,781.80
					$2.09 w/ Grant	$154,781.80
					$1.80	$154,836.00
					$1.80 w/ Grant	$129,836.00

Avoided kWh (per Year)	Avoided Cost Total (per Year)	Payback Period (Years)	Lifetime Avoided Cost	Lifetime Return	Return (per Year)	Percent Return (per Year)
115,787.00	$12,012.00	8.7	$437,948.68	$220,318.08	$8,812.72	4.0%
		7.7		$245,318.08	$9,812.72	5.1%
		7.1		$258,166.88	$10,326.68	5.7%
		6.2		$283,166.88	$11,326.68	7.3%
		6.2		$283,112.68	$11,324.51	7.3%
		5.2		$308,112.68	$12,324.51	9.5%

Orientation	Tree Cover	PV System Requirements (Square Feet)	Roof Size (Square Feet)	Percent Coverage
Flat	Minimal	4,363	22,521	19.4%

Results

Consumption information and generation estimates indicate that all thirteen of the reviewed county building sites have a positive return on investment by installing PV solar panels.

Installing PV solar panels on the identified buildings is estimated to save Jackson County approximately $46,783 per year in avoided electricity utility bills. Over the lifespan of PV solar panels, installation is estimated to avoid a total of approximately $1.7 million in utility costs while only costing between $671,000 - $950,000 to install.

In total, the return for installing PV solar panels on the identified county buildings is between **$762,034 - $1,034,309 over 25 years**, or between **$30,500 - $41,300 per year.**
(Table 5.0).

The results of this analysis are conservative in their return estimations. As stated earlier, the price of energy inflation is estimated to increase by 3 percent per year. This estimate represents the general average across the U.S. This percentage may fluctuate depending on the specific utility provider. Higher annual inflation results in a quicker payback period and larger return because the outright purchase of a PV solar system locks in the electricity rate for the lifespan of the solar panels.

There are several assumptions made to simplify the technical calculations to determine the systems cost. The model uses an estimation of the annual production of each PV solar system and makes its additional assumptions on weather patterns and the climate of the area. Lastly, in future project bids for PV solar installations in the county, the solar installation company will conduct its own feasibility analysis to provide their potential customer with a cost estimate.

This feasibility study is designed to take these considerations into account. The primary objective of this study is to confirm that PV solar systems on county buildings should be an endeavor that the Jackson County Clean Energy District and the Jackson County Board of Supervisors explore further.

Potential Funding Sources

Hammond Solar Moonshot Grant

This analysis considers the Hammond Moonshot Grant as a viable way to reduce the overall system cost for the county. Input and advice from local commercial solar installers inform the analysis that local solar installers have successfully used this grant in the past. The grant consists of a maximum total of $25,000 delivered to a non-profit organization to assist with the installation of PV solar panels. For systems that are higher than $25,000, the Moonshot Grant is used to estimate the system's overall cost.

Tables F.1 & F.3.1-F.10 (Appendix F), indicate that the PV solar system cost is below $25,000. These systems represent the installations that would benefit most from bundling several smaller PV systems together to take advantage of the grant's full amount.

Community Facilities Direct Loan & Grant Program

The U.S. Department of Agriculture has several programs designed for rural areas to explore further:

https://www.rd.usda.gov/programs-services

The Community Facilities Direct Loan & Grant Program is designed for populations less than 20,000 people. Funds can be used to purchase, construct, and/or improve essential community facilities, purchase equipment, and pay related project expenses.

Note:

The USDA maintains grant and loan programs related to renewable energy and community facilities. In the context of the Jackson County feasibility study, the intersection between facility improvement and renewable energy increases the options Jackson County jurisdictions can utilize to fund these projects.

CHAPTER 6: CLEAN ENERGY PILOT PROJECT

SPRINGBROOK, IOWA

Introduction

This part of the project attempts to answer: *what are the options available for a small Iowa community to participate in solar energy*? Springbrook, IA, has approximately 143 residents located in central Jackson County. The town is interested in exploring opportunities to take the initiative regarding energy sources for their community. Springbrook was selected for this investigation due to the strong city leadership and resident support for clean energy and the town's connection to the Jackson County Energy District.

The primary objectives of this are to evaluate the relevant policy and engage the residents to gather input on energy priorities, concerns, and experiences. The key takeaways from the team's engagement highlight concerns about lowering monthly energy bills, increasing control over how their energy is generated, diversifying the energy sources towards renewable energy, and continuing the town's service with its utility provider, Alliant Energy. There are unique challenges and opportunities that Springbrook can use to partner with Alliant Energy to potentially become a pilot project for solar power in the future.

The research for this project focuses on solar energy because that is the desire and interest of the community. As outlined in Chapter 3, solar power generation provides a unique opportunity to instill a large-scale, inclusive project for the whole community. The research also examined feasibility of a microgrid or battery system to create a resilient system towards natural disasters or grid power outages. Lastly, there are short- and long-term goal recommendations and the lessons learned for distributed and centralized solar power generation for Springbrook.

Springbrook Community Profile

Location

Springbrook is located in the eastern part of Jackson County and has a total area of approximately 0.6 square miles (Figure 6.1). According to the 2020 Census and ACS 5-Year (2020), Springbrook's size ranks 9th in Jackson County with a population of 143 and a median age of 55.9 years. The primary public facilities in the town are the local fire station and post office.

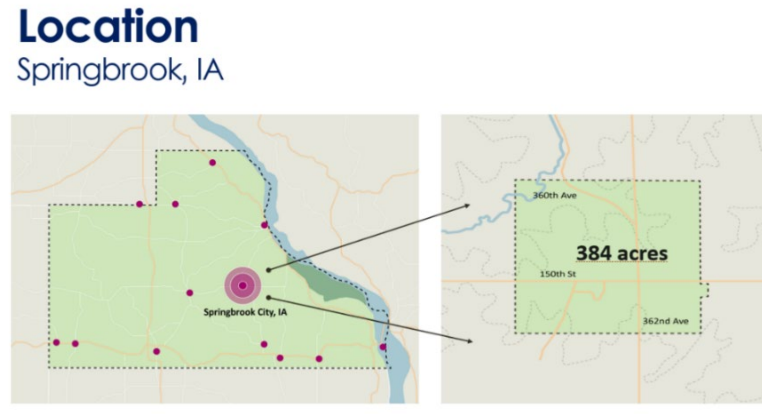


Figure 6.1. Springbrook location and area.

Figure 6.2. View from Springbrook

Figure 6.3. View from Springbrook

Population and Age

The highest peak of Springbrook's population was in 1910, reaching 217 people, and after 1990, the population remained below 200. By 2010, the population stabilized at around 150 people. (Figure 6.4).

The median age of Springbrook is 56-years-old and is higher than Jackson County's median age of 44-years-old. The majority of the residents are in the middle-aged cohort between 50- to 69-years old (Figure 6.5). The age distribution graph displays that the 50 to 69 age cohort accounts for nearly 50% of the population. In contrast, about 23% of the community's primary working-age cohort is 20- to 49-years old. Young people under the age of 20-years old, make up about 14% of the total population, with 8% of children under the age of 15.

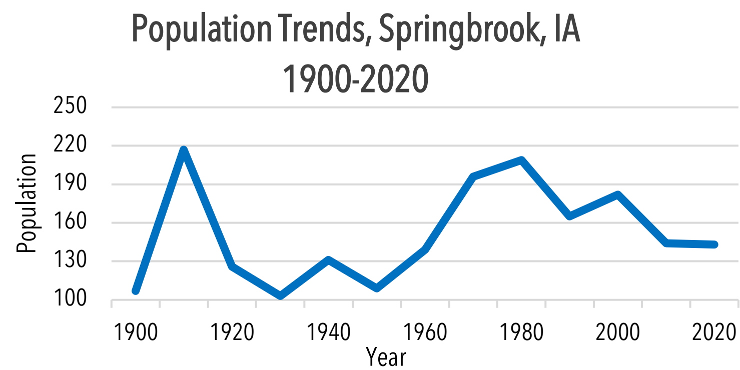


Figure 6.4. Population Trends, Springbrook, IA, 1900-2020. (Source: U.S. Census Bureau)

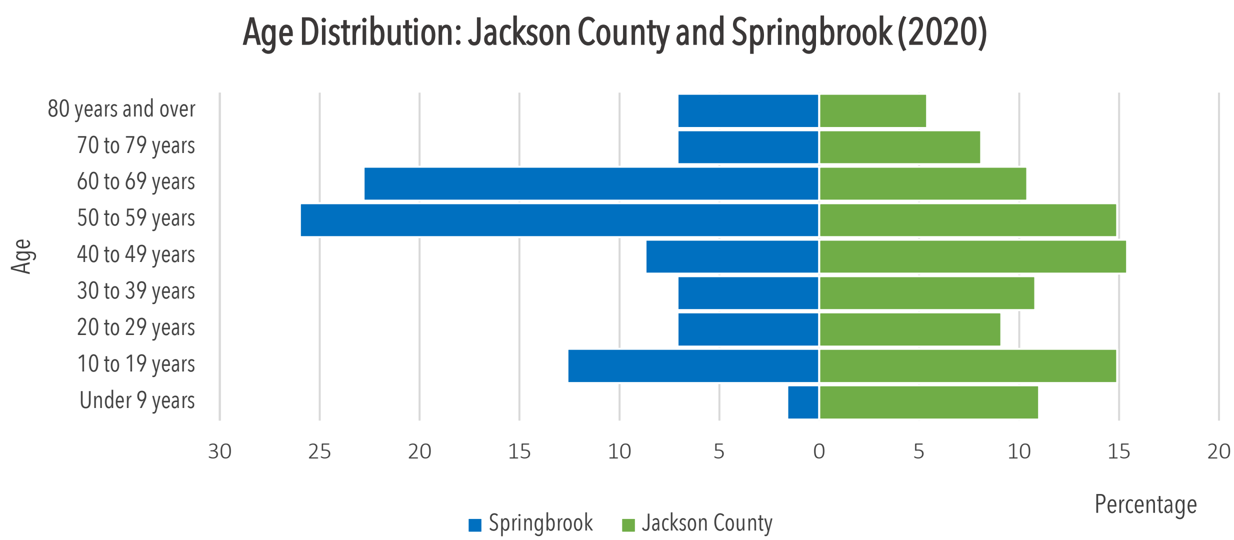


Figure 6.5. Jackson County and Springbrook Age Distribution (Source: ACS 5-Year Estimates, 2016-2020)

Income

Springbrook's median income is $66,875 and is approximately $8,000 higher than the Jackson County median and $5,000 higher than the state of Iowa median (ACS, 2016-2020). This data was collected during the COVID-19 pandemic in 2020 and could potentially lead to a decrease in household income in Springbrook compared to the median income in 2019 ($72,500). The poverty rate increased from 1.3% to 7.1% from 2019 to 2020. The relatively affluent residents' incomes create a unique opportunity for a smoother clean energy transition since solar energy has a high initial investment. PV Solar projects lower monthly electricity bills in the long term and can ease the financial pressure caused by reduced household income or the transition to fixed income.

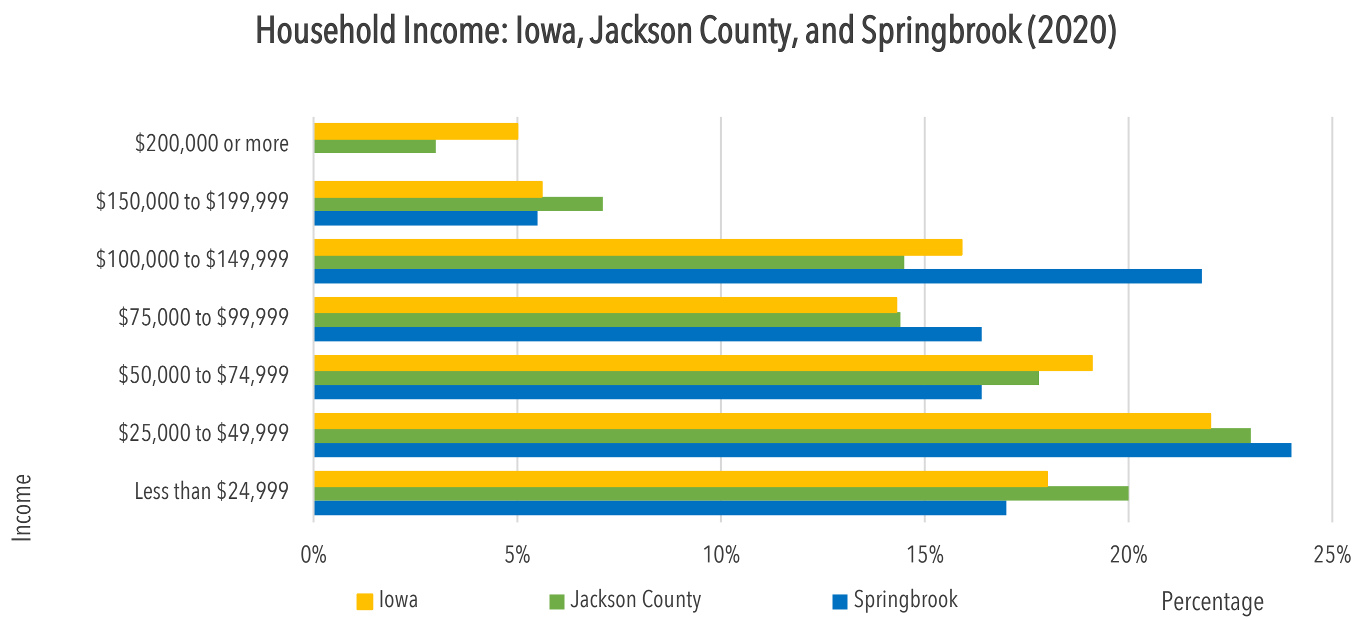


Figure 6.6. Household Income: Jackson County, IA, Springbrook, IA, and Iowa, 2020. (Source: ACS 5-Year Estimates 2016-2020)

Education

Residents in Springbrook have varying levels of education. The majority of the population (57%) have a high school diploma or an equivalent degree. The following highest educational attainment is some college experience, but no degree (22%). Aside from a high school diploma or equivalent and some college, no degree, the other levels of education are noticeably a lower percentage (Figure 6.7).

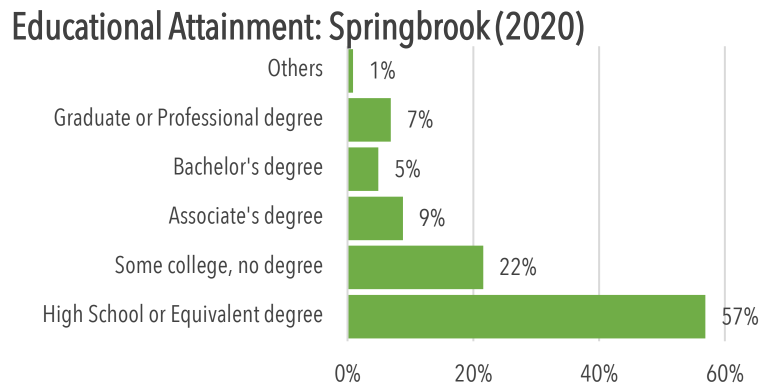


Figure 6.7. Educational Attainment, Springbrook, IA, 2020. Source: ACS 5-Year Estimates, 2016-2020)

Housing and Households

The city has a total of 65 housing units and 55 households. Approximately half of Springbrook's housing was built before 1939 (ACS, 2016-2020). The newest homes were constructed between 2000 to 2009 and account for 7% of the total housing stock. The remaining were built between 1940 to 1989.

Over 90% of Springbrook households live in single-family homes. More than 60% of the housing is valued below $100,000, with a median home value of $92,800. The median is less than Jackson County at $152,800 and the state of Iowa at $153,900 (Table 6.1).

Older homes often consume more energy due to lower energy efficiency and cause higher monthly electricity bills. According to the Housing Heating Fuel data, approximately 80% of the homes are heated with natural gas and 9% with electricity. With the continuing rise in the cost of natural gas globally, there will be an increase in household energy expenditures in Springbrook.

Housing Value: Springbrook, Jackson County, Iowa (2020)			
	Springbrook	Jackson County	Iowa
Less than $50,000	9.4%	5.3%	8.4%
$50,000 to $99,999	52.8%	23.3%	19.6%
$100,000 to $299,999	37.8%	55.8%	56.9%
$300,000 to $499,999	0.0%	11.3%	11.6%
$500,000 to $999,999	0.0%	3.2%	3.0%
$1,000,000 or more	0.0%	1.1%	0.60%
Median (dollars)	$92,800	$152,800	$153,900

Table 6.1. Housing Values in Springbrook, Jackson County, and Iowa 2020. Source: ACS 5-Year Estimates, 2016-2020)

Energy Consumption

According to data provided by Springbrook's energy utility provider, Alliant Energy, Springbrook's residential electricity use in 2021 is 621,994 kilowatt hours (kWh), with an average monthly usage of 51,833 kWh (Table 6.2). According to the 2015 Residential Energy Consumption Survey, older houses in the Midwest typically consume more energy and bear the higher electricity costs per square foot. More than 90% of Springbrook's houses were built before 2000, which means most households are likely to pay higher utility bills due to older housing structures such as airy solid walls and leaky windows.

Springbrook, IA Energy Consumption (Jan - Dec. 2021)		
	Customer Counts	Consumption (kWh)
Residential Electric Service	74	621,994
Commercial Electric Service	18	168,779
City of Springbrook Streetlighting	2	769
Natural Gas Use	76	63,826
OVERALL TOTAL	**170**	**855,367**

Table 6.2. Springbrook, IA, energy consumption. (Source: Alliant Energy)

Existing Solar Energy in Springbrook

Three Springbrook residents have installed solar panels on their properties. Through interviews, residents are very satisfied with their current solar system, which has been working well and has significantly saved money on their energy bills since installation (Figure 6.8).

Figure 6.8. Picture: Springbrook Residents' Solar System

Public Engagement

Introduction and Engagement Takeaways

The primary objectives for the engagement were to gather resident input on priorities, concerns, and the long-term vision for Springbrook. Public engagement is an essential component of this project to ensure the recommendations align with the vision and goals of the residents. The process includes a variety of engagement methods to provide opportunities for residents to give input and questions. The team developed a project website, distributed a community survey, and performed door-to-door outreach with a meet-and-greet event.

The primary takeaways of the engagement are to lower monthly energy bills, increase the community's energy control, diversify the energy sources, and be inclusive of any potential projects. The community desires to continue its contract service with the current utility provider, Alliant Energy, and has no interest in forming a public municipality. Many households have backup generators, and the Springbrook has a generator for the Fire Station. For many decades, there has not been a significant storm or power grid outage, according to residents and preparing for natural disasters and grid vulnerabilities are not a community priority. There is no major concern or urgency to address energy issues in their community, but they are willing to commit to a community project.

Project Website

The team created a project website to aid the public engagement process by communicating the objectives of the plan and its process (Figure 6.9). Springbrook residents and other parties could find information related to the plan purpose, plan schedule, and access the community survey. Any interested parties could use the website to contact the team for questions or comments.

Figure 6.9. Plan Website page image

Door-to-Door Outreach and Meet-and-Greet Event

On November 6th, 2021, the team went door-to-door to each household and held a meet-and-greet event at the Springbrook Fire Station. The team went to 67 residences and met with 25 households to introduce the project, distribute the community survey, and hear initial thoughts on energy use and sources in Springbrook (Figures 6.10-6.12).

Residents are supportive towards a community energy project if it is economically and legally feasible. The concerns are high monthly bills and dependency on utility provider. There is hesitation to install solar panels on personal residences due to the inability to afford the upfront cost and lack of information on solar.

Figure 6.10. Springbrook Door-to-Door Outreach Photo

Personal testimony of positive or negative experiences with solar panels had a significant impact on residents' views on solar. There was no discussion on climate change or disaster resiliency.

Figure 6.11. Springbrook Door-to-Door Outreach Photo

Figure 6.12. Springbrook Door-to-Door Outreach Photo

Community Survey

The last engagement effort was a community survey in November 2021. The survey was distributed to each household and was available online through the project website. The survey questioned residents on four topics: *demographics*, *community and household*, *disaster preparedness*, and *energy use*.

The survey results aimed to gain an understanding of the vision and priorities to guide the research and recommendations for the community. There was a total of 23 responses. Below are the highlights for each section and the full survey results are in Appendix F. The population of Springbrook is around 143, and the survey response rate is about 16% of the community (U.S. Census, 2020). The survey results are not fully representative of the community, therefore, using multiple methods for engagement is essential in reaching the diverse demographics of the population.

The survey results closely aligned with the discussion from the door-to-door engagement. There was significant interest in solar power generation and the potential benefit of lowering monthly bills and transitioning to renewable energy. Lastly, there is a consistent divide between households that can afford solar installation versus households without resources to consider installation.

RESPONDENT PROFILE

Approximately 91% of the survey respondents are above the age of 50. The majority of the respondents are above the age of 65 (65%) (Figure 6.13). The majority of the survey takers had a high school degree, GED, or other equivalents (57%), or had some college experience (22%). The majority of the respondents (44%) had an annual household income between $30,000 and $74,999. About 21% work in farming or agriculture and 24% are self-employed.

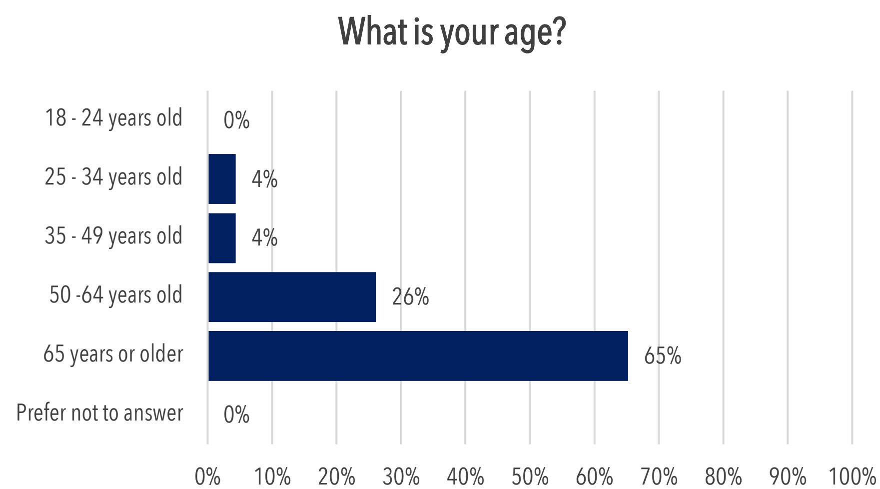


Figure 6.13. Survey Respondent Age Cohort

COMMUNITY GROWTH

When asked what the reasons are for living in Springbrook, the top responses were:

Housing affordability (18%) **Family (16%)** **Size of the community (15%)**

Over half of the respondents (57%) hope to see moderate population growth (less than 10%) in Springbrook, while only 26% want significant growth (10-30%). Most of the respondents (45%) selected that their monthly electric and gas utility bill is between $150 and $200, and about a third (30%) have bills over $200. The longest power outage that respondents have experienced in Springbrook is between 1-5 hours (52%) or 6-12 hours (30%). None of the respondents had experienced an outage longer than a day.

ENERGY PRIORITIES

The most important identified priority to address in Springbrook's energy future as:

Lower energy bills

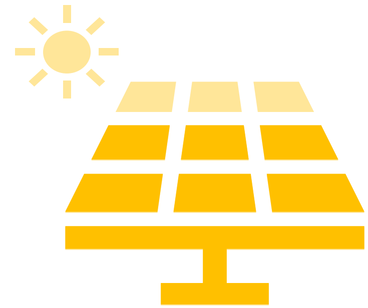
54%

Other concerns regarding energy efficiency (14%), energy independence or the dependency on the utility provider (12%). The least important factors are local control, attracting new residents, and equity.

ENERGY USE

When asked which energy sources would be supported for Springbrook, the majority gave support for solar (65%), natural gas (63%), and wind (53%). Coal and nuclear power were the least supported options.

The vast majority of the survey takers consider renewable energy as either somewhat (39%) or very important (52%). When asked about how important it is to have locally produced energy, over half of the survey takers answered as somewhat important (57%), but about 90% responded somewhat or very important.



Upfront cost is too high

62%

The respondents were either interested or partly interested in installing solar panels on their homes. However, the upfront cost was the most significant factor keeping the respondent from installing.

The survey takers were split 50-50 if they would be interested in having the option to purchase locally produced solar energy between yes and not sure. Considering the other questions answered, the cost would be the largest factor as high energy bills are a primary concern. About half responded that they do not want to see any increase in their energy bill if it meant purchasing renewable energy, while 30% were willing to see a slight increase of less than 10% (Figure 6.14).

Survey respondents have mixed views on Springbrook as an energy pilot community – about 40% are somewhat interested, 30% are not interested, and 22% are very interested. When asked if they were interested in Springbrook establishing a municipal-owned utility, respondents were not that interested (55%) or somewhat interested (23%).

How much more would you be willing to pay on your energy bill to purchase renewable energy?

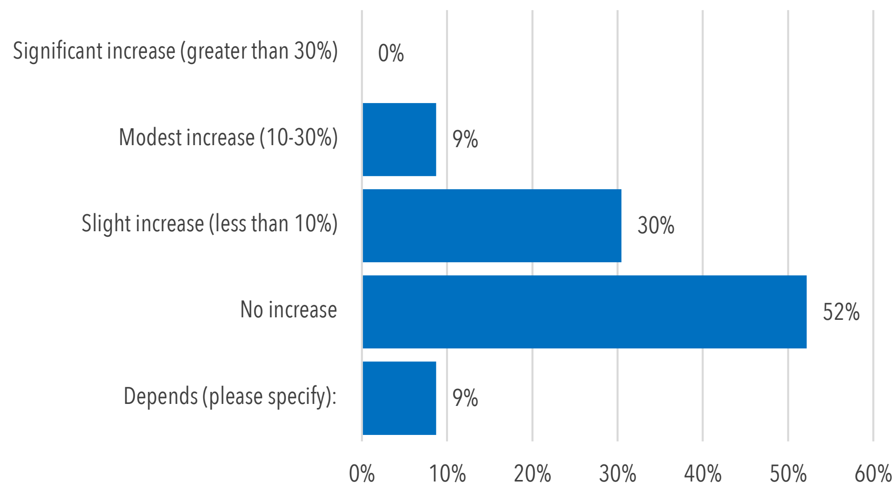


Figure 6.14. How much more would you be willing to pay on energy bill to purchase renewable energy?

Solar Installation Options

After engagement efforts and identifying residents' priorities for energy in Springbrook, the team explored the community's opportunities to install a centralized solar power system. This section outlines the community priorities that guided the project and the factors influencing how to identify the type of system that is feasible for Springbrook. It briefly outlines the ownership models and potential challenges for each option. After the research process, the team met with Alliant Energy representatives to present the prospective project to the company. Alliant Energy evaluated Springbrook as a community hosted solar site and determined they would not move forward on such a project at this time. The chapter ends with short- and long-term strategies recommended for Springbrook and other small rural Iowa communities interested in how to implement solar power and increase energy efficiency.

Springbrook's Energy Priorities

The door-to-door outreach and distributed survey consistently reveal the largest priorities for Springbrook residents are to lower their monthly energy bills and have greater control or influence in how energy is distributed and sourced in their community. Residents desire to continue their service with Alliant Energy and do not want to form a municipal utility. Both resiliency and climate change were *not* noted as priorities. If the community had a strong interest in exploring resilient solar systems against grid outages, a battery storage system would need to be an additional avenue explored. Since many households have backup gasoline generators available for a power outage and the fire station has access to a larger one, a microgrid or battery was not considered.

Land Availability

The City of Springbrook has land available located directly east of the town on the banks of the sewage treatment plant ponds (Figure 6.15). The total land area is around five acres available for potential solar installation.

Figure 6.15. Springbrook, IA Sewage Treatment Plant Pods Land Availability

OPPORTUNITIES

The opportunities that Springbrook can leverage for a potential solar project:

- *Strong city leadership and resident support for a solar project*
- *Available land ideal for ground-mounted PV solar panels*
- *Relatively higher median household income*
- *Energy demand is less than 1 Megawatt (MW) which means the grid infrastructure does not need to be upgraded with fiber optic cables*

CHALLENGES

The challenges that Springbrook must overcome for a potential solar project:

- *Lack of resources to maintain and operate a solar facility*
- *Financing the facility*
- *Franchise agreement limitations*
- *Utility provider owning grid infrastructure*
- *Virtual net metering unavailable*
- *Limited equity opportunities*
- *Less third-party investment interest due to facility size (economies of scale)*
- *Relative profitability of third-party Power Purchase Agreement vs. direct purchase of facility*

PROJECT TYPE SELECTION FACTORS

Technology

The technological factors include the overall adaptability of the solar installation. The goal is to implement a solar system technology that is workable, suitable, and feasible to use for its required purposes.

Community

The important community factors are the number of households and their energy consumption, household income, and community preference for where the solar panels are to be installed.

Legal / Policy

The utility service agreement creates restrictions to the energy supply services. The state legislations and policies that govern utility providers and consumers are taken into consideration to deciding on the type and size of the solar energy system.

Finance

The available state and federal incentives are important factors to decide on the system provider to make use of these programs. Other finance options offered by financial institutions and nonprofit grants are considered.

Solar System Scenarios

The three systems for community solar installation are 1) distributed solar generation, 2) centralized solar generation, and 3) centralized solar generation with a microgrid or battery system. The feasibility for a community to pursue these system options depends on its utility provider and population. There are limited opportunities for Springbrook and an in-depth description of the solar system options for other communities to explore are in Chapter 7.

DISTRIBUTED SOLAR GENERATION

Photovoltaic (PV) Solar panels can be installed at different scales. *Distributed solar generation* is the term used when electricity is generated from multiple sources and the panels are installed near the point of use (Figure 6.16). It is generated at a small-scale, typically meeting the capacity of one household or business. The household or business is responsible for the system installation, maintenance, and upfront payment. This can be a significant cost burden for households with limited financial means.

Figure 6.16. Distributed solar generation (Roof installation)

In the occurrence of a main grid power outage, the individual solar system will not work unless the system is connected to a storage battery system. While this option involves the highest investment for property owners, it entails the most extensive and quickest financial return.

The utility company credits households for energy feedback surplus on their energy bill. Individuals can benefit from available state[1] or federal solar incentives (Table 6.2). The average solar installation in Iowa ranges in gross cost from $13,000 to $19,000 (before tax credits) dependent on the cost per panel and system size (EnergySage, 2022).

To receive the full benefits of a PV solar system, installing battery storage to hold excess electricity generated can improve the system's performance. Less energy being used from the grid leads to lower electricity bills and dependence on fossil fuels. Residential grid-tied solar panels paired with lithium-ion batteries typically cost between $7,000 and $14,000 to install. Lithium-ion batteries continue to decrease in price and are eligible for the 26% federal solar tax credit available for private installers (SolarReviews, 2022). A battery unit's lifespan is approximately 5- to 15-years and will need to be replaced to match the entire lifespan of the solar power system.

For Springbrook, currently, three household solar systems are installed. Many residents have a high interest in installing solar panels but have not done enough research or have the available funds to pay for the upfront cost. As noted earlier, the tax credits are available for private entities, such as a property owner or private business, but not for a government entity or non-profit organization. Residents have access to *Grow Solar* for Jackson County to be a resource for up-to-date information on installing solar but also to participate in bulk purchasing to secure discounts on installation.

What is Grow Solar Jackson County?

Grow Solar Jackson County is a public education and bulk purchasing program to make transitioning to solar easier and affordable for Jackson County home and business owners.

This program combines home and business owners buying power to secure significant discounts in solar installation.

The primary program partners are the Jackson County Energy District, the Nature Conservancy in Iowa, and the Midwest Renewable Energy Association.

For more information, visit the website: www.growsolar.org/jackson-county/

[1] Iowa Solar Energy System Tax Credit has expired December 31, 2021 but may be extended dependent on Iowa legislature.

PV Solar Installation for the City of Springbrook

The City of Springbrook could install PV solar panels for their city services, such as servicing the city park or wastewater plant, and this would provide an indirect benefit to the residents. The utility expenses could be reinvested in the community in other ways. The energy demand for the city has a maximum demand of 40 kilowatts (kW), and the system would cost at least $50,000 to install. While seeking a third-party investor with a PPA is a possibility, it is challenging because private parties invest in a certain scale of solar projects. Like the feasibility study in Chapter 5, investors are looking for projects at a scale of at least 250 kW for ground-mounted solar or 500 kW for roof-mounted solar. Estimating the financial return with a PPA is complex and depends on the project, but the City could explore PPAs as an option.

Alliant Energy has a program called the *Customer Hosted Renewables Project*. Prospective projects for Springbrook would need to be at least 200 kW to 1 MW in scale. If the facility is larger than 1 MW, the distribution line infrastructure would need to be upgraded with fiber optic cables to manage and stabilize the grid. This installation costs about $28 per foot and can significantly increase the cost of a solar project. A *Customer-Hosted Solar Project* was done in partnership with the City of Perry, Iowa (see case study below).

Case Study: Customer-Hosted Solar Project in Perry, Iowa

Perry is a city located in Dallas County, Iowa with a population of less than 8,000 and approximately 2,800 households. Alliant Energy and the City of Perry agreed to a 7-acre community solar project with a total capacity of one megawatt equivalent to 1.7 million kWh (Figure 37). By hosting the solar facility, the City of Perry will receive $45,470 annually from 25 years of rent (Caufield, 2021). *The City will also receive renewable energy credits from the project to offset their greenhouse gas and carbon dioxide emissions and help them move toward their sustainability goals.*

What is a Customer-Hosted Solar Project?

The program is part of Alliant Energy's Clean Energy Vision to advance toward the aspirational goal to attain net-zero carbon dioxide emissions from its electricity generation by 2050.

The program enables customers (business or community) with land or rooftop space to host solar farms and receive lease payments and renewable energy credits.

Alliant Energy oversees the installation and construction of the solar facility and will own, operate, and maintain it. There are no upfront, financing, or other costs to the customer. (Alliant Energy, 2021)

CENTRALIZARD SOLAR GENERATION

Figure 6.17. Centralized solar generation

Centralized solar generation, or a community solar facility, is a system that flows energy power to multiple customers such as individuals, businesses, and other entities (Figure 6.17). This method provides homeowners, renters, and businesses equal access to solar energy's environmental and economic benefits. Customers use the energy generated at an off-site array and can participate by buying or leasing a portion of the solar panels in the array. Community solar systems provide opportunities for customers who are unable to install solar panels on their own homes or business due to financial reasons or other restrictions, such as roof orientation or condition (Energy.gov). Community solar facilities generally have a capacity of less than 5 MW and are placed on leased property.

Centralized Solar Generation in Springbrook

There are three ownership models for centralized solar power generation: 1) public/non-profit ownership, 2) Power Purchase Agreement (PPA) with a third party, or 3) utility provider ownership. For Springbrook, the only feasible option for centralized solar generation is if the utility provider (Alliant Energy) agrees to install and maintain a solar facility. This facility could be located in Springbrook or outside the community that residents could subscribe to through Alliant Energy's *Community Solar Program*.

City of Springbrook

Third Party (PPA)

Alliant Energy

PUBLIC OWNERSHIP (City of Springbrook)

It is **not** feasible for the City of Springbrook to install a community solar facility. The City would need to go through the legal process to form a municipal utility to distribute solar to its residents. There would be a substantial upfront cost of around $1 million for a 1 MW solar facility (SolarReviews, 2022). Additionally, the current grid system is owned and maintained by its current utility provider, the city would be required to purchase or implement its own grid system. The franchise agreement with Alliant Energy states that this utility can be the only service provider for a certain period of time. Lastly, there is no community interest for public ownership.

THIRD PARTY (PPA)

It is **not** feasible for the City of Springbrook to partner with a third party with a PPA to install a community solar facility. The city would need to form a municipal utility to obtain the legal right to distribute energy to its residents. Until the utility is created, third party partnerships are not available.

UTILITY PROVIDER (Alliant Energy)

The only opportunity for Springbrook to implement a centralized solar facility is through a partnership with its utility provider, Alliant Energy, to own and maintain the facility. Since Alliant Energy is the current utility provider and owns the grid infrastructure, it has the lowest legal, regulatory, and financial obstacles for transitioning to solar. The community solar facilities are located on leased land, the city would benefit by receiving rental payments to alleviate its energy costs.

The challenge of this model is the community has little involvement in the process and how the services are distributed. This is one of the many solar projects Alliant Energy is working on and it can be a slow process to initiate and install. The company currently does one community solar project every other year.

The only opportunity that Alliant Energy has is their *Community Solar Program* coming to Iowa (see page 67).

Alliant Energy, Community Solar Program

The Community Solar Program is currently administered only in Wisconsin and is recently announced to be in Iowa. Customers purchase blocks of 250-watts (AC) and receive credits up to 100% on monthly utility bills. The blocks are credited on the bill for up to 20 years with an estimated 14-year payback. While this is a program that can meet some households needs, it does not meet the goals of Springbrook and is not an available option for the entire community. The community solar projects in Wisconsin have waitlists. There are administrative costs and upfront subscription fees for customers to invest in the system. Each 250-watt solar block costs $375 and produces an average of 431 kWh per year.

Since the program is available in Wisconsin, here is a breakdown of the potential customer cost using the *Alliant Energy Community Solar Calculator* for a single-family residential household using 10,380 kWh* wishing to offset 100% of their utility bill (Alliant Energy, Community Solar Calculator):

24 number of solar blocks

$9,000 one time, up-front subscription cost

10,333 annual kWh solar generation

$651.00 estimated annual credit

The average cost after the federal tax credit to install solar panels on a residential property in Iowa is between $11,101 to $13,567 with an average payback period of 5.8 to 7.1 years (Solar Reviews, 2022). In this case, the property owner owns the panels and receives the full economic benefit. The Community Solar program through Alliant Energy significantly strips the economic return of solar panel installation from the customer.

**Iowa residential household average consumption is 865 kWh per month or 10,380 kWh per year (Choose Energy, 2020)*

CENTRALIZED SOLAR GENERATION WITH A MICROGRID OR BATTERY SYSTEM

A *microgrid* can serve a small geographical area like a neighborhood or small community (Figure 6.18). Alliant Energy is currently installing a community microgrid as a pilot project in Boaz, Wisconsin, a small village with 122 households (see case study below). It provides grid stability, particularly in a geographic area with many solar customers and high demand for infrastructure. Neighboring communities can benefit from the microgrid, making it a regional opportunity for Jackson County.

This option is **not** available for Springbrook residents unless implemented through Alliant Energy.

Figure 6.18. Centralized Solar with Battery

Case Study: Community-Microgrid in Boaz, Wisconsin

Alliant Energy announced in October 2021 that their first community microgrid system will be built in the Village of Boaz in Richland County, Wisconsin to enhance the community's energy reliability. This is a small village of 156 people. Boaz was selected due to experiencing ten power outages between 2017-2019 and the grid needed stability.

This project will create a small-scale, independent utility grid with a dedicated power source that will allow it to provide energy to its customers when the central grid is down, or service is interrupted. As the microgrid disconnects from the central grid, it can still provide power to around 120 customers through one or more distributed generation sources such as batteries, wind, solar, or combinations thereof(Church, 2021).

Project Development

Alliant Energy Correspondence

The team met with Alliant Energy representatives on February 8, 2022, with the Jackson County Energy District and the Jackson County Economic Alliance to present the case for a solar energy partnership in the Customer-Hosted Solar program. The grid does not require fiber optic cable installation since Springbrook's demand is higher than 200 kW but lower than 1 MW. The team pointed to other projects Alliant Energy has worked on, such as the City of Perry, and the company's own accelerated sustainability goals, *Clean Energy Vision*, of achieving net-zero carbon dioxide emissions by 2050 and eliminating all coal from its generation by 2040.

After submitting a formal application, the team was told the company's engineers would evaluate the grid infrastructure to ensure its capacity to hold a larger solar facility. After the engineers report their findings, the internal staff would discuss whether Springbrook would be a suitable candidate for a Customer Hosted Solar project.

In April 2022, Alliant Energy denied the application. The discussion in February 2022 was focused on a centralized solar system that would serve the entirety of Springbrook- in follow up correspondence, Alliant indicated that the system would have to serve a single user (i.e. the City of Springbrook). The representatives also responded that Springbrook's only opportunity is for individual distributed solar systems or to participate in their "Alliant Energy Community Solar" program.

Springbrook Recommendations

SHORT TERM STRATEGIES

Distributed solar generation

Springbrook residents have a high interest in solar installation on their personal property. The City of Springbrook and the Jackson County Energy District can connect residents to the "Grow Solar Jackson County" (see page 62) to receive up-to-date information and participate in the bulk purchasing program to make the solar installation more affordable.

The city could create incentives or other financial assistance to help residents with the upfront installation cost.

The city could install solar panels for city services and explore possible PPA options. This would indirectly benefit its residents and could reinvest the tax funds elsewhere in the community.

Home Weatherization and Energy Efficiency

Since Springbrook has an older housing stock and there are concerns over energy efficiency, residents can weatherize their homes to help reduce heating and cooling costs and improve the energy efficiency of their homes. Federal funding is available for low-income households through the "Weatherization Assistance Program (WAP)" U.S. Department of Energy to install insulation, update heating and cooling systems, and upgrade electrical appliances.

Virtual Net Metering and State Tax Incentive Advocacy

Iowa policies significantly impact Springbrook's ability to implement solar power generation, so it is essential that Springbrook advocates reinstating the financial incentives and virtual net metering laws to eliminate barriers to community energy in Iowa laws and policies. Contact legislature representatives and continue to pursue a partnership with Alliant Energy to emphasize long-term energy priorities and goals.

LONG TERM STRATEGIES

Centralized solar generation

Continue partnership with Alliant Energy to host a centralized solar facility. Alliant Energy will continue to look for communities to locate potential projects and if Springbrook can continue to communicate to representatives that there is high interest and desire from the community, it will keep Springbrook as a candidate.

Microgrid or battery system

If Springbrook continues to install solar panels, the solar power and additional energy generated put higher strain and instability on the grid infrastructure. Battery storage has the potential to be a more cost-effective way to modernize the grid and avoid rebuilding the local energy grid. In December 2019, Alliant Energy installed a utility-scale battery in rural Wellman, IA, to accommodate the solar demand. A microgrid or battery system would create stability, reliability, and resiliency to the grid.

Incorporate clean energy objectives in the franchise agreement

One strategy for negotiations with the utility provider is incorporating clean energy objectives in their franchise agreement. A franchise agreement is a negotiated contract between a municipality and an electric service provider that grants that utility provider the right to install and maintain electrical infrastructure. The clean energy objectives commit the city and utility to partner together to achieve the joint energy goals.

CHAPTER 7: LESSONS LEARNED

This Jackson County Clean Energy Plan is the first official plan for Jackson County to jumpstart its transition towards renewable energy sources by exploring the opportunities to participate in solar power generation. Jackson County can have locally owned, diverse, and equitable energy generation if a proactive approach toward its energy is taken. The three components are a solar panel installation inventory for the county, a solar feasibility study for county-owned buildings, and exploring solar opportunities for Springbrook. Each component of this plan prioritizes return on investments, promoting local involvement, and participating in sustainability initiatives. The lessons learned from the planning process for this plan are outlined below.

KEY TAKEAWAYS

Solar power generation brings opportunity

Historically, communities had little influence in how the energy they consumed was sourced and distributed. Franchise agreements lock communities into decades of contract service for coal and natural gas distribution with large utility providers, which only in recent years have actively considered transitioning to renewable energy. The energy industry is reaching a transitional period where communities are aspiring to have a voice in the future of their energy use. Rising energy costs, climate change, and pollution are a growing threat to the future livelihood of cities. Communities are learning that they have the resources and capital to directly mitigate against those threats.

Installing solar power at a utility-scale brings access to clean and renewable energy to urban and rural communities. Typically, the individual property owners who have the financial resources have been the primary beneficiaries of solar power. If communities could expand the scale and install solar power for neighborhoods, communities, or regions, the positive externalities can benefit everyone.

As the cost of energy continues to rise and the cost of solar panels declines, transitioning to solar brings opportunities for substantial cost savings and revenue. Communities could use the energy savings to reinvest that capital back into their local economies to spur growth and prosperity. Solar panels can be a secondary use to any land – residential, agricultural, or industrial – without interfering with its primary use.

Jackson County should participate in Iowa's greater transition to clean energy sources by advocating and partnering with its utility providers and local organizations to spur the progression towards renewables. Bottom-up demand and persistent advocacy for change in how Jackson County's energy is sourced and distributed can make a difference in the future of its communities.

Renewable energy feasibility in Jackson County

Photovoltaic (PV) solar is the most promising renewable energy source within Jackson County. Wind speeds in Jackson County are below the preferred speed for the location of wind turbines. Additionally, Jackson County has some potential to take advantage of geothermal electricity generation, but the Midwest and the State of Iowa have not made investments in geothermal generation that would warrant its current consideration. Jackson County currently have a small level of PV solar installations. Through data collection efforts, Jackson County residents and organizations are generating approximately 2,259,400 kWh per year using PV solar electricity. This is equivalent to offsetting 977 metric tons of CO_2.

While this distributed generation represents an estimated 0.6% of the county's average annual electricity usage, PV solar installations in 2021 make up a quarter of all the systems installed in the county since 2014. This indicates that solar energy in Jackson County is building momentum. The Jackson County Energy District have worked to coordinate group-buys for PV solar systems which likely account for an increase in PV solar installations in 2021. The financial benefits of transitioning to distributed solar generation have been made clear and offer tangible benefits to Jackson County residents beyond offsetting metric tons of CO_2.

Understanding resident energy concerns

The public engagement with Springbrook residents is a small representation of the energy concerns for Jackson County. The primary concerns residents held were expensive and rising energy bills, energy efficiency, and dependency on their utility provider.

The greatest and consistent desire amongst residents is to lower energy bills as it becomes a greater strain on household budgets. Almost half of the survey respondents reported average monthly electric and gas bills between $150 - $200 and a third of the respondents paying more than $200. While there is high interest in solar panel installation on residences and transitioning to sustainable energy sources, the high energy bills are obstacles in affording the upfront cost of solar panels that would further strain finances.

Approximately 30% of the Jackson County housing stock was built before 1939 and about half were built before 1980 (ACS 5-Year Estimates, 2016-2020). A home's structure and age impact how it uses and retains energy. Like installing solar panels, energy efficiency investment can be a financial burden as updating appliances or adding insulation can be another strain on a household's budget. Resident concern over energy efficiency corresponds with the desire to lower monthly energy bills.

Communities that service their energy from a non-public utility are heavily dependent on its provider. Due to franchise agreements and providers owning the grid infrastructure, communities are forced into continuing service with the utilities. There is no competition in the energy market. Springbrook residents are concerned on the financial impacts of being tied to one provider with the ultimate control of its energy use.

Two noteworthy takeaways from the public engagement are minimal urgency to address disaster resiliency or climate change. The ability to pay for monthly utility bills is the largest priority for the residents. Most households in Springbrook have a back-up gasoline generator to use for power outages and this is enough for residents to feel prepared for future outages.

Since Jackson County has not experienced a significant grid outage in recent history, there is not a strong desire to prepare for a significant event. In addition, Springbrook has recently had a younger demographic move to their community which can be unexperienced of how detrimental a disaster could be. If Jackson County is not prepared for a grid outage scenario, their residents, particularly low-income households, are vulnerable.

Climate change was not identified as a motivator or reason for interest in clean energy in Jackson County by survey respondents. Transitioning to renewable energy is one of the key strategies to address global rising temperatures due to clean sources not releasing carbon dioxide. While the lack of climate change discussion does not mean that residents have no interest in climate change mitigation, residents have alternative motivations to be interested in clean energy.

As the Jackson County Energy District and other entities pursue clean energy in Jackson County, these priorities and takeaways may be an aid to the process.

Economies of scale and funding assistance limitations

The only available funding assistance opportunities for government jurisdictions are to partner with a third-party investor through a Power Purchase Agreement (PPA), grant funding, or loans. PPA opportunities in Jackson County are not readily available due to third-party investors seeking investments in utility-scale solar projects. According to local solar installers, the threshold for PPA investors is a minimum of 250 kilowatts (kW) for ground-mounted or 500 kW for roof-mounted panels to receive an adequate return on investment. A 250-kW ground-mounted system is approximately 18,000 square feet (0.4 acres) and 1,000 panels generating 31,000 kW per month depending on the orientation, location, etc.

Due to economies of scale, small solar systems bear a greater cost in purchasing and maintaining the panels. These systems are perceived as financially risky to private investors. If a county or local government seeks to install solar on a government building, a PPA is not a likely option. Even if there is an opportunity to partner through a PPA, the additional financial return captured by utilizing available tax credits primarily benefits the investor and guarantees their return instead of directly reducing the PV system cost.

The additional legal fees and administrative costs associated with developing a PPA remain constant regardless of the system size. Investors seeking to guarantee their own financial returns typically look for projects with a larger generation potential. As a caveat, local installers may find smaller "passion projects" that they would be willing organize a PPA for. It is not impossible for smaller PV systems to enter a PPA, it is simply less common.

While some grant funding is available for government entities, the 26% federal tax credit available to private solar installers provides larger and more reliable financial assistance. Increased funding opportunities for local governments and non-profit organizations to invest in solar would substantially benefit communities by alleviating the energy cost and reinvesting that money elsewhere.

Variability in small versus large community solar options

There are disparities in small versus large communities' accessibility to affordable solar. A community's ability to implement a centralized solar system is severely limited on state law, resources, and demand. If a community is serviced through a non-investor-owned utility provider, it must go through the expensive and legal process of forming a municipality to gain independence from its provider. This process takes a substantial amount of resources and is no small endeavor. The size of the community influences its access to financial resources to afford the upfront cost and the demand threshold must meet a certain standard to make the return on investment profitable enough.

The larger and denser the population, the less it costs to power those homes and businesses. Economies of scale makes it cheaper to install a large solar system for a reduced cost per panel and installation costs. The jurisdictions in Iowa that have installed community solar systems range from Cedar Rapids to Ames that have public utilities and control the rules on how they service their residents.

Rural towns are more likely to be serviced by the two investor-owned utility companies, MidAmerican Energy or Alliant Energy, who have a large say in the outlook of energy. Since Jackson County is a rural county, this limits its ability to transition to solar at the same pace as urban counties. The two largest cities in Jackson County are Maquoketa (6,128 pop.) and Bellevue (2,363 pop.). There are eight communities with a population less than 1,000 and three communities less than 100 people. Lastly, approximately 8,000 people or 40% of the county's population live in unincorporated areas.

While accessibility to distributed solar systems are becoming increasingly affordable, the most effective method to transition to clean energy is to expand the scale of installation. This brings down the cost and makes it accessible to the entire community, rather than exclusively to those that can afford the upfront cost of installing solar on their personal properties. In Maquoketa, for example, its public utility can legally install clean energy and has a larger tax base to afford it. Small communities serviced by Alliant Energy do not hold the legal power or resources to install solar.

Lastly, when utility providers are seeking potential locations to site solar projects, small communities are overlooked due to the higher economic cost to generate and distribute. More rural communities seems to have less access to solar power generation through utility-scale projects.

Importance of clean energy goals and initiatives in local plans

There are no clean energy goals or targets within local plans in Jackson County. The 10 Smart Planning Principles for Iowa jurisdictions attempts to address planning for a community's economic, environmental, and social future. These principles are to be used during all planning, zoning, and development decisions for local and state agencies.

The third principle is: "*Clean, Renewable and Efficient Energy: Planning, zoning, development and resource management should be undertaken to promote clean and renewable energy use and increased energy efficiency*"

The three strategies for this principle are to (i) encourage sustainable building practices; (ii) increase access to clean, renewable energy; and (iii) support energy efficiency efforts in individual homes and businesses.

Integrating clean energy goals within the comprehensive plan, capital improvement plan, or other local plans prepares local governments more effectively transitioning to cleaner energy sources. When zoning ordinances or building codes are updated, they can correlate with the long-term vision and future infrastructure plans.

Impact of state policy and incentives

Solar power generation does not need financial incentives to make the investment profitable. While the upfront cost is a substantial barrier to low- to middle-income households to participate, there are many reasons for public, private, and non-profit entities to install solar panels and generate energy locally. Solar is a rapidly growing industry that does not require government financial assistance to produce positive returns on investments. However, the availability of tax credits and government policy should be supporting communities in reaching energy goals rather than being a hurdle to overcome.

Iowa state solar incentives, rebates, and tax credit

Solar tax credits make installing solar panels more affordable and accessible for many homeowners and businesses. The expired Iowa Solar Energy System Tax Credit offered residents and businesses a 13% of the total solar system cost back on the state income tax. There was a maximum credit cap of $5,000 for residential and $20,000 for commercial installations.

After the credit expired in 2021, there were many applications that were not able to receive the credit. The credit incentivized solar installation in addition to the federal solar tax credit. The nonrenewal of the credit will slow the transition and accessibility to solar power.

Virtual net metering

If the Iowa legislature could permit virtual net metering or meter aggregation, it would expand the opportunities for a small community, such as Springbrook. *Virtual net metering* expands net metering by allowing customers to receive credits on their monthly energy bill by partaking in a solar system located off-site and shared among many customers. This provides opportunities for households that would not ordinarily be able to participate in solar, for example, renters or households who prefer not to install panels on their property. If virtual net metering were allowed, larger-scale solar projects could be installed to decrease the shared cost. Customers can use the most productive sites to obtain a larger financial return.

Investor-owned utility providers essentially monopolize the industry by owning current and future energy infrastructure. If there are significant legal and financial barriers to customer-owned infrastructure, the energy cost and consequences will multiply. Permitting small communities or neighborhoods to aggregate meters to decrease the household energy bills and address environmental threats could produce fast track progress toward the long-term goals and vision for communities.

Community solar ownership opportunities

Community solar was explored for Springbrook, a rural town with a population of 145. These systems are made possible through virtual net metering. As discussed earlier, net metering is eligible for customers of Iowa's two investor-owned utility companies, MidAmerican Energy and Alliant Energy. Customers receive a "credit" on their electricity bill for financial savings. For example, if a customer's share of the solar system is 10 kWh of electricity, it will reduce their energy bill on a one-for-one basis by 10 kWh.

While Springbrook had many legal and financial obstacles in implementing community solar in their town, other Jackson County communities have more opportunities. As described in Chapter 6, there are three general ownership models for a community solar facility: 1) municipal utility/non-profit organization, 2) PPA, or 3) utility provider. Each model depends on whether a community has Alliant Energy or an outside utility service provider which severely limits its options for solar power. The table on the following page displays the system size and ownership requirements.

If a community owns and maintains its energy production and distribution, there is legal power to install solar. The four Jackson County municipalities with public utilities are: Maquoketa, Bellevue, Sabula, and Preston. The rest of the county services their power from Alliant Energy or Maquoketa Valley Electric. The four communities with ownership of its energy production have local control capabilities that other towns do not have. There is greater opportunity for equitable decision making in installing solar, for example the municipalities can create energy rebates for low-to-moderate income households to participate.

For the remaining towns in Jackson County, there are complex legal, regulatory, financial, and operational challenges to installing community solar. Realistically, the town's only options are to partner with its utility provider. As the pressure continues to build for Alliant Energy to transition to clean energy, there could be greater opportunities to inquire about projects. Currently, Alliant Energy invests in one solar project every other year. The primary benefit of the utility provider investing in the project are small communities with limited resources are not required to pay the up-front installation cost and maintain the facility. If a community desires to create grid resiliency and stability, a battery system or microgrid can be implemented. The system would be an additive to the solar facility to continue to generate power if the greater grid is out.

SOLAR INSTALLATION TYPE	CONNECTED TO GRID? (Yes/No/Both)	INSTALLED CAPACITY	CUSTOMER UPFRONT COST PAYMENT (Yes/No)	OWNERSHIP	TAX CREDIT (Yes/No)
DISTRIBUTED SOLAR GENERATION	Yes	<10 KW	Yes	Public/Non-Profit	No
				Private (PPA)	Yes
				Utility Provider	Yes
CENTRALIZED SOLAR GENERATION	Yes	>1 MW	No	Public/Non-Profit	No
				Private (PPA)	Yes
				Utility Provider	Yes
CENTRALIZED SOLAR GENERATION w/ MICROGRID	Both	> 10 KW	No	Public/Non-Profit	No
				Private (PPA)	Yes
				Utility Provider	Yes

Recommendations

JACKSON COUNTY RECOMMENDATIONS
1. **Add requirements for PV solar installation to improve data quality** Jackson County Administration currently requires permits for ground mounted Photovoltaic (PV) solar installations. We recommend that the county adopts additional permit requirements or registration for roof mounted PV solar installations to allow for a more reliable and singular dataset of existing renewable energy in the county to be measured and evaluated over time. Additionally, we recommend partnering with Jackson County municipalities to coordinate and create their recording of PV solar installations to create an even more robust dataset that would give a more wholistic view of the renewable energy sources within Jackson County.
2. **Install PV solar panels on county-owned buildings** The feasibility study outlined in Chapter 5 (and Appendix D) indicates that PV solar installations on county-owned buildings produce a positive economic return. We recommend continuing this process by pursuing partnerships with professional solar installers to provide estimates of costs associated with a PV solar installation on county buildings.
3. **Solar-ready building and zoning codes** Partner with Jackson County jurisdictions to develop zoning and development standards to support solar panel adoption across the county. Incorporate building codes that make the process for solar easier, such as ensuring the weight of roofs are physically capable of holding solar panels or allotting additional land for ground-mounted solar installations where rooftop solar is not feasible. Zoning laws can be a hinderance to a property owner's ability to install by placing limitations on where solar can be installed. Local governments can earn a "SolSmart" designation that recognize communities that adopt plans and ordinances to spur solar installation. Additional resources to assist communities include the Great Plain's Institute *Local Government Solar Toolkit* and the Iowa Environmental Council *Iowa Solar Siting Resource Guide: A Roadmap for Counties*.

4. **Clean energy policy advocacy**
   Energy policy is overseen by the Iowa Legislature and the Iowa Utilities Board. Encouraging involvement with the local Jackson County Energy District and legislature representatives to support stronger clean energy policy will impact clean energy accessibility and affordability within the county.

5. **Encourage involvement in Grow Solar Jackson County**
   The *Grow Solar Jackson County* program through the Jackson County Energy District is an opportunity to make solar power in the county affordable and accessible to residents and businesses. This program increases civic engagement among residents to actively participate in the future of energy in their communities.

6. **Encourage municipalities to pursue conversations with utility providers**
   Municipalities and community leaders should start regular conversations with its utility providers about the timeline for transitioning to renewable energy sources. Discussion over strategies and partnerships with the providers can spur clean energy development and implementation.

SPRINGBROOK SHORT TERM STRATEGIES

Distributed solar generation

Springbrook residents have a high interest in solar installation on their personal property. The City of Springbrook and the Jackson County Energy District can connect residents to the "Grow Solar Jackson County" (see page 62) to receive up-to-date information and participate in the bulk purchasing program to make the solar installation more affordable.

The city could create incentives or other financial assistance to help residents with the upfront installation cost.

The city could install solar panels for city services and explore possible PPA options. This would indirectly benefit its residents and could reinvest the tax funds elsewhere in the community.

Home Weatherization and Energy Efficiency

Since Springbrook has an older housing stock and there are concerns over energy efficiency, residents can weatherize their homes to help reduce heating and cooling costs and improve the energy efficiency of their homes. Federal funding is available for low-income households through the "Weatherization Assistance Program (WAP)" U.S. Department of Energy to install insulation, update heating and cooling systems, and upgrade electrical appliances.

Virtual Net Metering and State Tax Incentive Advocacy

Iowa policies significantly impact Springbrook's ability to implement solar power generation, so it is essential that Springbrook advocates reinstating the financial incentives and virtual net metering laws to eliminate barriers to community energy in Iowa laws and policies. Contact legislature representatives and continue to pursue a partnership with Alliant Energy to emphasize long-term energy priorities and goals.

SPRINGBROOK LONG TERM STRATEGIES

Centralized solar generation

Continue partnership with Alliant Energy to host a centralized solar facility. Alliant Energy will continue to look for communities to locate potential projects and if Springbrook can continue to communicate to representatives that there is high interest and desire from the community, it will keep Springbrook as a candidate.

Microgrid or battery system

If Springbrook continues to install solar panels, the solar power and additional energy generated put higher strain and instability on the grid infrastructure. Battery storage has the potential to be a more cost-effective way to modernize the grid and avoid rebuilding the local energy grid. In December 2019, Alliant Energy installed a utility-scale battery in rural Wellman, IA, to accommodate the solar demand. A microgrid or battery system would create stability, reliability, and resiliency to the grid.

Incorporate clean energy objectives in the franchise agreement

One strategy for negotiations with the utility provider is incorporating clean energy objectives in their franchise agreement. A franchise agreement is a negotiated contract between a municipality and an electric service provider that grants that utility provider the right to install and maintain electrical infrastructure. The clean energy objectives commit the city and utility to partner together to achieve the joint energy goals.

Glossary

Community Microgrid

A Community Microgrid is a coordinated local grid area served by one or more distribution substations and supported by high penetrations of local renewables and other distributed energy resources (DER), such as energy storage and demand response.

Community Solar

The U.S. Department of Energy defines community solar as any solar project or purchasing program, within a geographic area, in which the benefits of a solar project flow to multiple customers such as individuals, businesses, nonprofits, and other groups.

Economies of Scale

In microeconomics, economies of scale are the cost advantages that enterprises obtain due to their scale of operation and are typically measured by the amount of output produced.

Electrical Grid

An electrical grid is an interconnected network for electricity delivery from producers to consumers. Electrical grids vary in size and can cover whole countries or continents. It consists of power stations, electrical substations, electric power transmission and electric power distribution.

Kilowatt-hour (kWh)

The kilowatt-hour is a unit of energy equal to one kilowatt of power sustained for one hour or 3600 kilojoules (3.6 megajoules). It is commonly used as a billing unit for energy delivered to consumers by electric utilities.

Life Cycle Cost

The estimated cost of owning and operating a photovoltaic system for the period of its useful life.

Local Distribution Company (LDC)

A local distribution company (LDC) is a distribution company that maintains the portion of the utility supply grid that is closest to the residential and small commercial consumer.

Megawatt (MW)

1,000 kilowatts, or 1 million watts; standard measure of electric power plant generating capacity.

Microgrid

A microgrid is a self-sufficient energy system that serves a discrete geographic footprint. Within microgrids are one or more kinds of distributed energy (solar panels, wind turbines, combined heat & power, generators) that produce its power and contain energy storage.

Photovoltaic (PV)

Photovoltaic (PV) devices generate electricity directly from sunlight via an electronic process that occurs naturally in certain types of material, called semiconductors.

Power Purchase Agreements (PPA)

A Power Purchase Agreement (PPA) is an arrangement in which a third-party developer installs, owns, and operates an energy system on a customer's property. The customer then purchases the system's electric output for a predetermined period.

Renewable Energy

Renewable energy is energy that is collected from renewable resources that are naturally replenished on a human timescale. It includes sources such as sunlight, wind, rain, tides, waves, and geothermal heat.

Solar Battery System

When your home doesn't need all the energy being produced by your solar panels, the excess energy is stored in the battery. When the solar panels aren't generating enough energy to fill the power needs of the building, the battery discharges reserve power to make up the difference.

Solar Energy

Solar energy is radiant light and heat from the Sun that is harnessed using a range of technologies such as solar power to generate electricity, solar thermal energy including solar water heating, and solar architecture.

Solar Investment Tax Credit (ITC)

The solar Investment Tax Credit (ITC) is one of the most important federal policy mechanisms to support the growth of solar energy in the United States.

Special Districts

Special districts are independent, special-purpose governmental units that exist separately from local governments such as county, municipal, and township governments, with substantial administrative and fiscal independence.

Insolation

The average amount of solar radiation received, usually calculated in $kWh/m^2/day$

Basic service charge

This is the fixed charge to each customer to connect their home or business to our system and to maintain the meter and connection.

Usage Costs

This is the cost per kWh of energy used at your home or business. If you look at your meter, the number displayed is a count of the kWh your home or business uses.

Energy Adjustment Clause (EAC) Charge

While several charges and credits flow through this line on your bill, the main component is the cost of fuel to produce energy, or the cost to purchase energy for customers.

Regional Transmission Service Charge

Transmission service is provided to our customers by a third-party provider. This provider's rates are based upon annual filings with the Federal Energy Regulatory Commission (FERC). Alliant Energy participates in FERC filings on behalf of our customers.

Renewable Energy Rider

This item helps cover the costs of bringing more renewable energy to customers. The charge allows for recovery of the costs from wind farms constructed in Iowa and is applied to your monthly bill. Many factors go into this cost, including the forecasted renewable energy costs and total demand. The customer benefits of Production Tax Credits also flow through this line item.

Energy Efficiency Cost Recovery

This charge covers the costs to deliver energy efficiency plans. The charge is adjusted annually and is based on your energy use.

Demand Response Cost Recovery

This program provides a discount to customers who, in return, are willing to reduce their energy usage during times of high energy demand. Demand response programs are designed to lower the costs for all customers by reducing the amount of power that must be purchased on very hot days when the price and demand is the highest. It also reduces the need for new power generation.

Local Option Tax or Franchise Fee

Depending on your community, you may have a franchise fee or local option sales tax added to your bill. You cannot have both on your bill. This charge is requested by your community.

Appendices

Appendix A – Types of Clean Energy and the Future of Fossil Fuels
Appendix B – Solar Energy in Iowa
Appendix C – GIS Interactive Map and Greenhouse Gas Equivalent Calculator
Appendix D – Feasibility Study and NREL Reports
Appendix E – Technology Review

Appendix A

Types of Clean Energy and the Future of Fossil Fuels

What is Clean Energy?

Clean energy, also known as renewable energy, comes from natural sources or processes that are naturally replenished. It is essential to identify different types of clean energy, as this is a clean energy plan. However, because of the requests by community partners, solar is the only clean energy type that this plan will discuss and focus on.

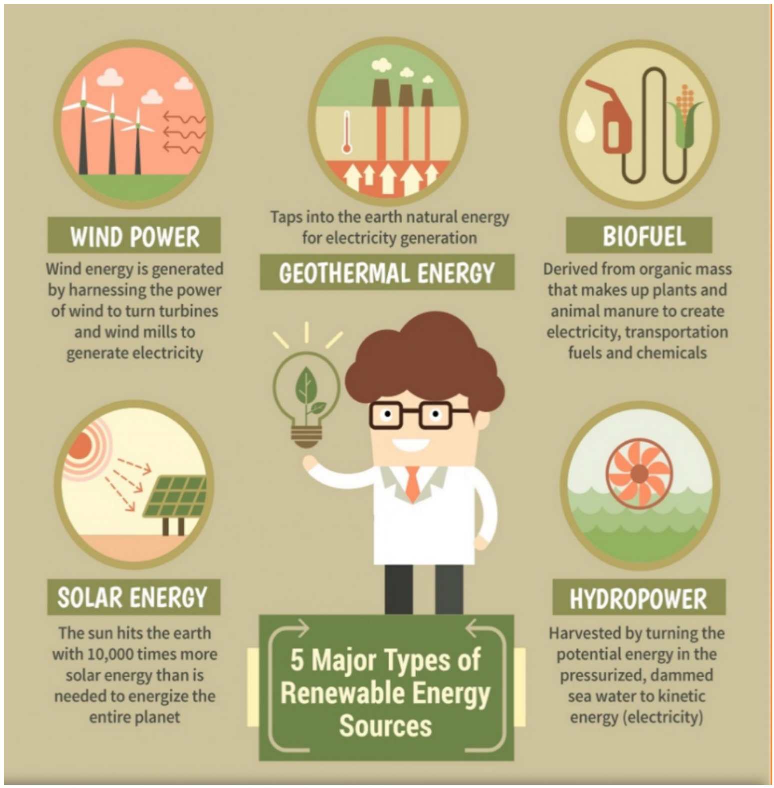


Figure A.1. Major Types of Renewable Energy Sources. Source: VectorStock.com

Types of Clean Energy

The primary types of renewable energy sources are *biomass, geothermal, wind, solar*, and *hydropower.*

Biomass is a renewable organic material that comes from animals and plants. Sources for biomass energy are wood and wood processed waste, biogenic materials used in municipal solid waste, agricultural crops and waste materials, and human sewage and animal manure.

Geothermal uses heat found within the earth's crust. Geothermal can heat water for bathing, heat buildings, and generate electricity.

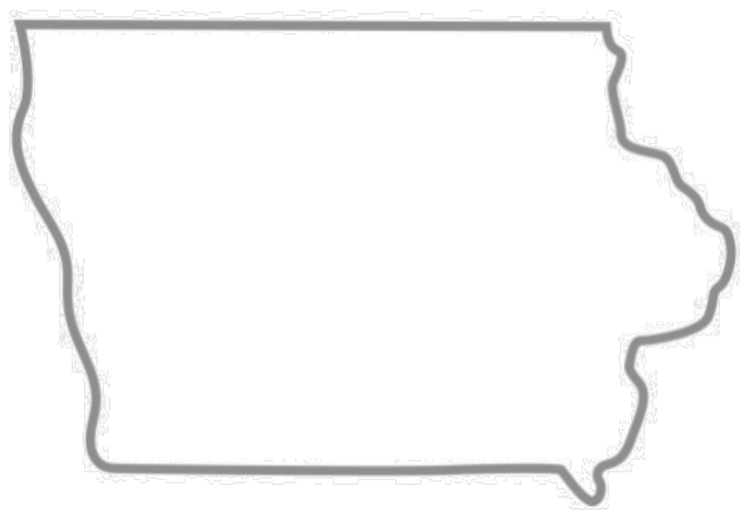
Wind uses windmills to produce energy for electricity. In the process, the uneven heating of the earth's surface causes wind. The uneven heating of water and land causes wind through 1) cool air moving over water, 2) heating up of land (which heats faster than water), and 3) warm air rising over the land.

Solar converts sunlight into electricity. The sun's rays provide solar radiation and solar panels collect the energy from the sun and convert that energy into heat and electricity.

Hydropower uses water to provide electricity. Hydropower relies on the water cycle for electricity generated. Solar energy heats water on the surface, causing it to evaporate. Then, water vapor condenses into clouds and falls as precipitation. Lastly, precipitation falls onto water surfaces, eventually evaporating again and continuing the water cycle (EIA, 2021).

The Future of Fossil Fuels

Fossil fuels are estimated to be depleted over the next 100 years, although the precise date is not determined. The estimates state that oil will be depleted by 2052 and gas by 2060. Even though non-renewable resources, such as natural gas, crude oil, and coal are projected to be significantly depleted within the next century, the fossil fuel consumption rate is not decreasing at the necessary pace. Fossil fuels continue to be consumed at higher rates than renewable energy and nuclear energy and have higher overall energy production rates. As of 2019, fossil fuels accounted for 85% of all energy consumed, increasing from 80% in 2014. Fossil fuels have negative effects on the environment that contribute to climate change: resulting in global warming, the melting of ice caps, and rising sea levels (Nath, 2021).



Appendix B

Solar Energy in Iowa

Nationally, as of the third quarter of 2021, Iowa is ranked 30th (22nd in 2020) in the U.S. for solar energy (SEIA, 2021). In total, 440.4 Megawatts (MW) of solar energy have been installed, which is enough to power 60,071 homes. Total solar installations in the state have reached 7,392. Currently, only 0.67% of the state's electricity comes from solar energy. A total of 773 jobs are attributed to solar and 66 solar companies exist. The total investment in solar in Iowa is $592 million. Over the next five years in Iowa, the projected growth of solar energy is estimated to be 980 MW (SEIA, 2021). Figure B.1 below shows annual solar installations for the State of Iowa since 2012. The figure shows an increase in residential, commercial, community solar, and utility installations. Although utility solar installations are the most notable increase, the increase in commercial and residential solar installations also significant. The increase can be attributed to the demand for solar in recent years and provides a better understanding of the solar installations within the state since 2012 and the changes that have occurred.

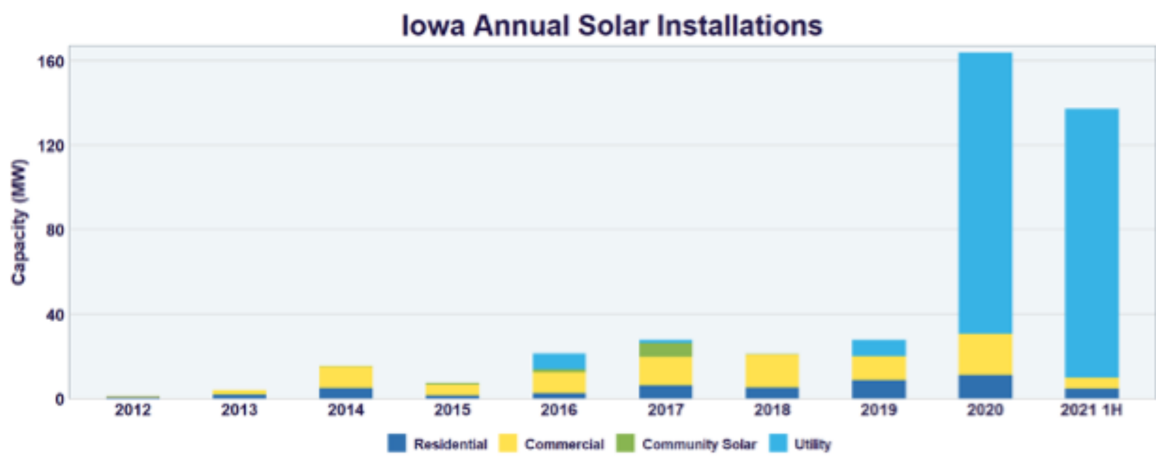


Figure B.1. Iowa Annual Solar Installations (2012-2021). Source: Solar Energy Industries Association (SEIA)

In Iowa, the largest solar project is Wapello Solar Facility in Louisa County. The project started delivering energy to the grid in March 2021 and is made up of 100 MW. In total, the project has 318,000 bifacial solar panels (both sides of the panel generates energy) and solar panels covering 800 acres of land (Clark, 2021).

As of November 2021, the cost of an average solar panel in Iowa is $3.21 per kilowatt hour (kWh). In the U.S., the average home requires between 19 and 23 solar panels based on the average electricity usage of 877 kWh per month or 10,524 kWh per year. Overall, the cost of purchasing and installing solar can be reduced with the 26% Federal Investment Tax Credit (ITC). The State of Iowa previously had an 18% tax credit for solar installation, but that credit ended at the end of 2021 and legislators have not come to an agreement to expand it into the future (EnergySage, 2021).

On March 12, 2020, Senate Bill 583 was passed in the State of Iowa. The bill puts net metering into law for the first time and adds a new optional inflow-outflow billing system. Each utility will decide whether it wants to offer net billing or inflow-outflow billing. *Net billing* is a billing method where customers pay all applicable charges and are credited in kilowatt-hours for energy exported to the electric utility during the billing period. *Inflow-outflow billing* includes customers paying for all application charges, but those customers are credited in dollars (rather than kWh) at the outflow purchase rate for energy that is exported to the utility during the billing period (Iowa Environmental Council, 2020).

The average solar payback period around 12-16 years with the average payback period being 13.38 years. Additionally, the 20-year savings for solar is $19,200. Table 8 below shows the average cost a kilowatt system, ranging from 3 kW to 10 kW. The system cost with and without the Federal Solar Investment Tax Credit (ITC) is identified below as well. (EnergySage, 2021).

System	System Cost	System Cost (after ITC)
3kW	$9,360	$7,126
4Kw	$12,840	$9,502
5Kw	$16,050	$11,877
6Kw	$19,260	$14,252
7Kw	$22,470	$16,628
8Kw	$25,680	$19,003
9Kw	$28,890	$21,379
10Kw	$32,100	$23,754

Table B.1. Solar System Cost (Source: Energy Sage, 2021)

As mentioned earlier, Iowa ranks 30th in the country for solar installation. Iowa's solar ranking is determined by several factors, including the percentage of homes in the state powered by solar and total homes powered by solar, total solar companies and jobs in the state, investment in solar in the state, and the estimated growth projection over the next five years.

Across the U.S., there has been a total of 108.7 Gigawatts and 3,060,407 solar energy systems installed. Comparing to neighboring states, Table B.2 identifies solar statistics for Iowa and its six surrounding states of Minnesota, Wisconsin, Illinois, Nebraska, Missouri, and South Dakota. It is important to identify solar statistics in Iowa and neighboring states because other states can offer lessons to Iowa for how to increase the prevalence and economic opportunity for solar installation in the state (SEIA, 2021).

State	Iowa	Minnesota	Wisconsin	Illinois	Nebraska	Missouri	South Dakota
National Ranking	29th	15th	27th	24th	46th	34th	50th
State Homes Powered by Solar	54,407	213,732	76,931	98,419	8,332	33,623	210
% of State's Electricity from Solar	0.57%	3.56%	0.61%	0.50%	0.24%	0.66%	0.01%
Solar Jobs	773	3,993	2,910	5,259	1,246	2,522	452
Solar Companies in the State	71	164	171	346	32	137	15
Total Solar Investment in the State	$567 million	$2.4 billion	$669 million	$1.5 billion	$95 million	$793 million	$4 million
Drop in Prices over the last 5 year	36%	36%	36%	36%	36%	36%	36%
Growth Projection (over 5 year)	1,238MW	1,631 MW	3,741MW	2,633MW	746MW	849 MW	312 MW

Table B.2. Solar Ranking of Surrounding States (Source: SEIA, 2021)

The Iowa Utilities Board (IUB) has regulatory authority over Investor-Owned Utility (IOU) rates and service issues. Additionally, the IUB has authority over safety, service, and engineering issues for rural electric cooperatives (REC's), and municipal electric utilities that exist in the State of Iowa. Table B.3 below shows the number of existing utilities by type in the state and the percentage of customers that each utility has.

Iowa Utility Electric Profile (2020)

UTILITY TYPE	# OF UTILITIES	# OF CUSTOMERS	% CUSTOMERS	MWH SALES[1]	% SALES
IOU	2	1,199,330	72.33%	38,289,079	75.83%
Muni	136	222,399	13.41%	5,272,730	10.44%
REC[2]	43	236,491	14.26%	6,930,592	13.73%
Total	**181**	1,658,220	**100.00%**	50,492,401	**100.00%**

Table B.3. Iowa Utility Electric Profile (2020) (Source, IUB, 2020)

Clean Energy Districts

A clean energy district is a local organization that is created to strengthen communities by leading, accelerating, and implementing locally owned clean energy and has a goal of achieving 100% local renewable energy by 2050 (which is the goal of all clean energy districts in Iowa). Working towards 100% local renewable energy is accomplished through energy auditing and planning, sponsoring Green Iowa AmeriCorps, education, economic development, policy, and leading a movement with other clean energy districts. Jackson County currently has an energy district, but Jackson County's Energy District is not part of the Clean Energy Districts of Iowa, or CEDI, whose purpose is to promote efficient energy systems and clean energy production. Although Jackson County's Energy District is not currently part of CEDI, plans are in the works for Jackson County to eventually become part of CEDI in the future.

The Jackson County Energy District has a three-pronged community building mission: 1) to positively affect the local economy by retaining energy dollars in Jackson County, 2) to slow climate change by promoting wise energy use, and 3) to facilitate fair access to clean and local energy.

Energy districts work to enable policies, funding opportunities and collaboration. The districts function through public engagement, market transformation, advocacy, and readiness. In an energy district, clean energy prosperity and climate stewardship interact to build partnerships between communities and counties by working toward locally owned clean energy. Members of energy districts work with local, state, and federal agencies and policymakers to promote and implement clean energy.

The Clean Energy Districts of Iowa provides technical assistance, energy audit services, and energy-saving measures and promote locally owned clean energy because it leads to job creation, retainment of wealth, energy prosperity, and advancement of climate stewardship. Energy districts are inclusive and built on the basis that universal replication is possible, and a clean energy future will happen by, and for the people (CEDI, 2021).

Electric service in Iowa

The state of Iowa's electricity sources are transitioning from traditional fossil fuels to renewable energy sources. In 2020, coal-fired generation declined, accounting for 24% of the state's net electricity generation, significantly lower than the 53% in 2015. Three-fifths of Iowa's total electricity is generated from renewable sources, primarily wind energy. Wind power generates 57% of Iowa's net electricity generation and about 11,400 MW (Figure B.3). The state of Iowa ranks second behind Texas in wind power generation (U.S. Energy Information Administration). Although solar energy is responsible for a smaller portion of Iowa's electricity generation, approximately 0.04% in 2020, solar projects have significantly grown since 2020 due to increased awareness, state policy, and the decline of cost in solar panels (see Table B.4). The largest increase in solar production is utility-scaled, typically the capacity of 1 MW or larger.

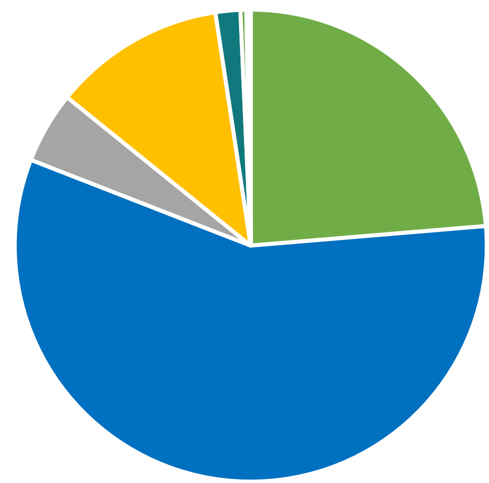
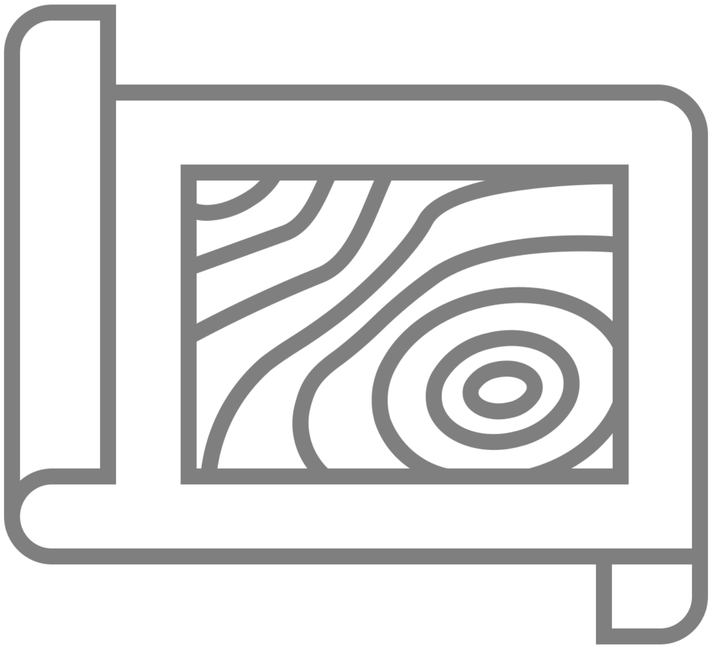


Figure B.3. Iowa State energy generation

Electric generation in Iowa by energy source	2020 Capacity (MW)	Percentage of Capacity	2020 Generation (MWH)	Percentage of Generation
Coal	5,754.7	25.6%	14,146,835	23.7%
Wind	11,406.9	50.8%	34,182,302	57.3%
Nuclear	0	0.0%	2,904,863	4.9%
Natural Gas	4,215.0	18.8%	7,036,824	11.8%
Hydro	129.2	0.6%	1,025,215	1.7%
Other Renewables	22.0	0.1%	207,440	0.4%
Petroleum	924.2	4.1%	111,111	0.2%
Solar	18.4	0.1%	22,082	0.1%
Total	**22,470.4**	**100%**	**59,636,672**	**100%**

Table B.4. Iowa Electric Profile (2020 - Including Non-Utility Generation). Source: Iowa Utilities Board



Appendix C

GIS Interactive Map and Greenhouse Gas Equivalent Calculator

	ArcGIS (ESRI)/ArcGIS Pro (ESRI)	ArcGIS Story Maps	QGIS	OpenStreetMap	Google My Maps
Free use	No	Yes (Subscription unlocks more features)	Yes	Yes	Yes (not entirely)
Easy operation	No	Yes	No	Somewhat	Yes
Interactive Map	Yes	Yes	Yes	Yes	Yes
Data export	Yes	Need Subscription	Yes	Yes	Yes
Display information (pictures, data, location descriptions)	Yes	Yes	Yes	Yes	Yes
Multi-users not simultaneously	Yes	One account or Subscribe	Yes	One account	One account
Data Calculation	Yes	No	Yes	No	Via data table
Color difference by uses	Yes	No	Yes	Yes	Yes
Live data	Yes	Via website link	Yes	Via website link	Via website link
List on the side (navigation)	No	Yes	No	Yes	Yes
Further updates	Yes	Yes	Yes	Yes	Yes
Features other than maps	More technology-related features	Used for storytelling	More technology-related features	Yes	Yes, but may include additional costs

Table C.1. Interactive Map Options

EPA Greenhouse Gases Equivalencies Calculator

The EPA's Greenhouse Gases Equivalencies Calculator was used to calculate carbon emissions offset for existing solar installations. To calculate the carbon emissions offset, the Kilowatt system size is multiplied by 2,700 (the average amount of hours of sunlight the State of Iowa gets per year). For example, if you have a 5 kilowatt (kW) solar system, you would enter 13,500 into the calculator. Then, energy data is selected, and the unit Kilowatt-hours used is also selected, the amount is then put in and convert data is selected, which is shown in Figure C.1.

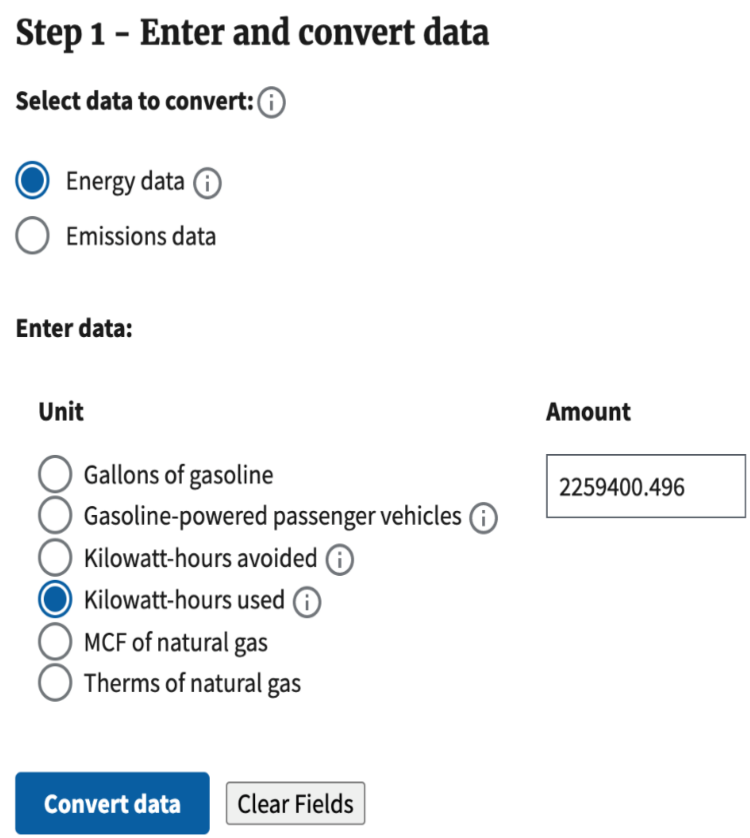


Figure C.1. Data Calculator

After the number is entered, a list of variables such as metric tons of Carbon Dioxide (CO2) equivalent, tree seedlings grown for 10 years, pounds of coal burned per year, number of smartphones charged per year and several other variables are calculated. This helps to give an idea of the carbon emissions that are offset by the total kilowatt hours produced for each solar installation. If the question mark is clicked under one of the results, it will direct the user to a page that explains how each result is calculated and what goes into calculating it. An example of some of the results generated is in the figure below (Figure C.2.) and an explanation for one of the calculations is shown in the figure below (Figure C.3.). The EPA calculator can be found at this link: https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

Step 2 - View results

977 Metric Tons **of Carbon Dioxide (CO_2) equivalent**

This is equivalent to greenhouse gas emissions from:

211 gasoline-powered passenger vehicles driven for one year

2,426,117 miles driven by an average gasoline-powered passenger vehicle

This is equivalent to CO_2 emissions from:

109,981 gallons of gasoline consumed

96,012 gallons of diesel consumed

Figure C.2. Results List

Gallons of gasoline consumed

In the preamble to the joint EPA/Department of Transportation rulemaking on May 7, 2010 that established the initial National Program fuel economy standards for model years 2012-2016, the agencies stated that they had agreed to use a common conversion factor of 8,887 grams of CO_2 emissions per gallon of gasoline consumed (Federal Register 2010). For reference, to obtain the number of grams of CO_2 emitted per gallon of gasoline combusted, the heat content of the fuel per gallon can be multiplied by the kg CO_2 per heat content of the fuel.

This value assumes that all the carbon in the gasoline is converted to CO_2 (IPCC 2006).

Calculation

8,887 grams of CO_2/gallon of gasoline = 8.887×10^{-3} metric tons CO_2/gallon of gasoline

Sources

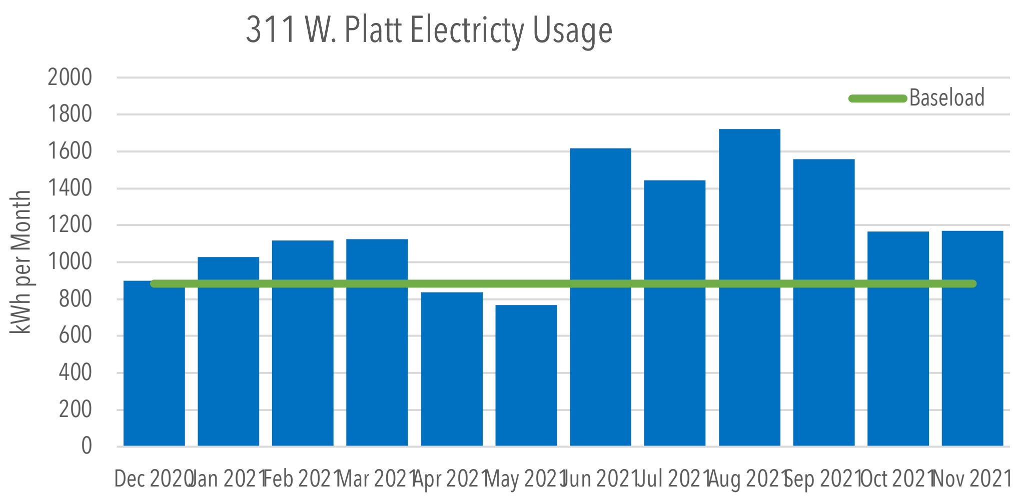
- Federal Register (2010). Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards; Final Rule, page 25,330 (PDF) EXIT (407 pp, 5.7MB, About PDF).
- IPCC (2006). 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Volume 2 (Energy). Intergovernmental Panel on Climate Change, Geneva, Switzerland EXIT.

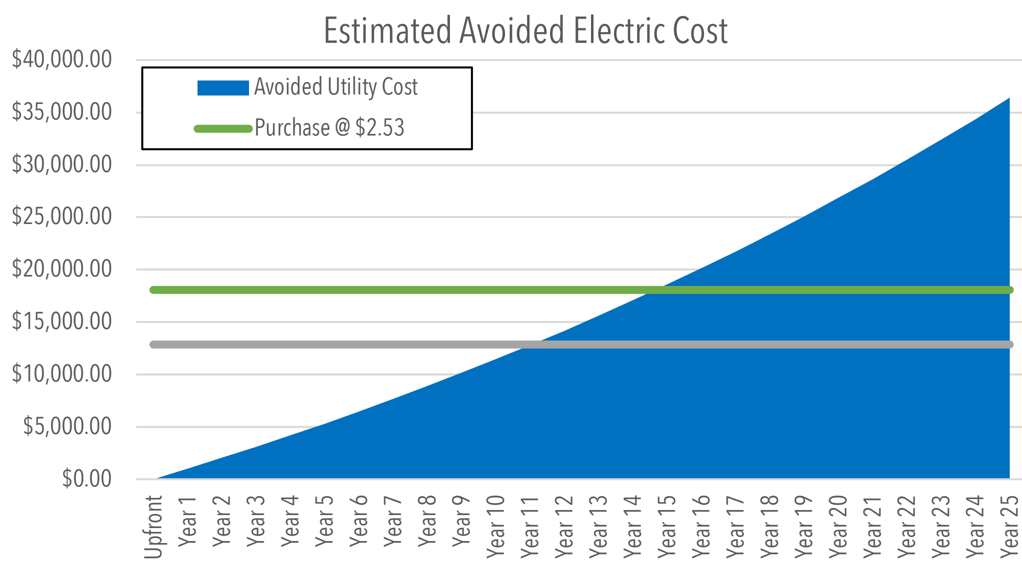
Figure C.3. Results Explained

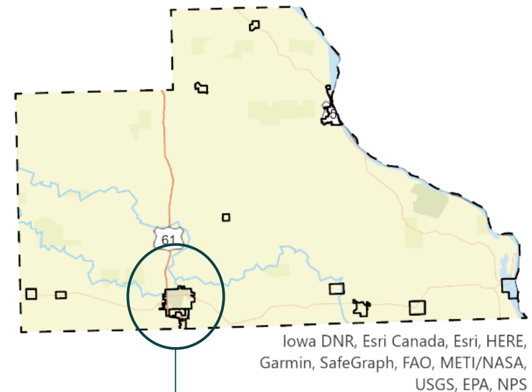
Appendix D

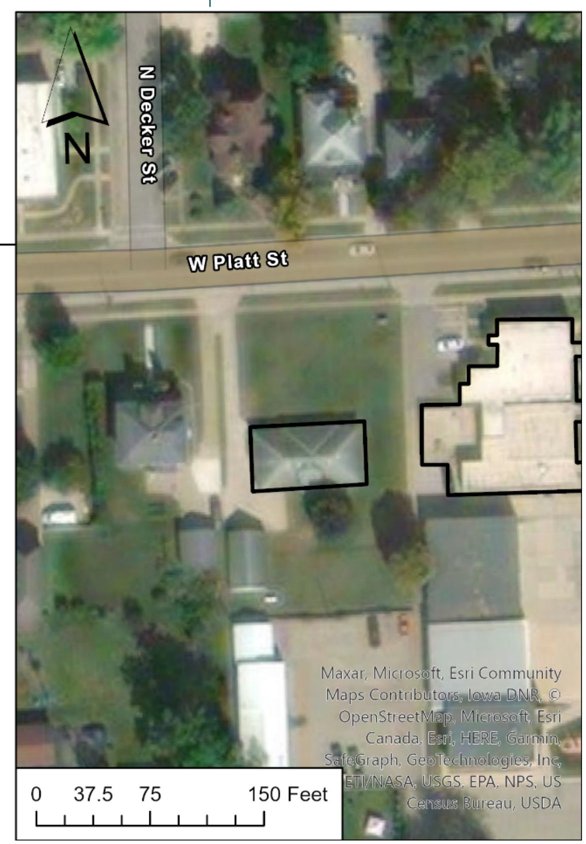
Feasibility Study (Continued) & NREL PVWatts Model Reports

Penrose Annex – 311 W Platt St. Maquoketa, IA (Figure D.1)









Penrose Annex – 311 W Platt St. Maquoketa, IA (Table D.1)

Baseload (kWh)	Number of Panels (340 Watt)	System Size (kW DC)	DC-AC Ratio	System Size (kW AC)	Price Per Watt	System Cost
883.50	21	7.14	1.2	5.95	$2.53	$18,064.20
					$2.09	$14,922.60
					$1.80	$12,852.00

Avoided kWh (per Year)	Avoided Cost Total (per Year)	Payback Period (Years)	Lifetime Avoided Cost	Lifetime Return	Return (per Year)	Percent Return (per Year)
9,158.00	$999.00	0.3	$36,422.81	$18,358.61	$734.34	4.1%
		0.3		$21,500.21	$860.01	5.8%
		0.2		$23,570.81	$942.83	7.3%

Orientation	Tree Cover	PV System Requirements (Square Feet)	Roof Size (Square Feet)	Percent Coverage
North/South	Some	351	3,155	11.1

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Caution: Photovoltaic system performance predictions calculated by PVWatts® include many inherent assumptions and uncertainties and do not reflect variations between PV technologies nor site-specific characteristics except as represented by PVWatts® inputs. For example, PV modules with better performance are not differentiated within PVWatts® from lesser performing modules. Both NREL and private companies provide more sophisticated PV modeling tools (such as the System Advisor Model at https://sam.nrel.gov) that allow for more precise and complex modeling of PV systems.

The expected range is based on 30 years of actual weather data at the given location and is intended to provide an indication of the variation you might see. For more information, please refer to this NREL report: The Error Report.

The energy output range is based on analysis of 30 years of historical weather data for nearby, and is intended to provide an indication of the possible interannual variability in generation for a Fixed (open rack) PV system at this location.

RESULTS

9,622 kWh/Year*

System output may range from 9,270 to 10,110 kWh per year near this location.

Month	Solar Radiation (kWh / m² / day)	AC Energy (kWh)	Value ($)
January	2.57	497	52
February	3.54	598	62
March	4.58	833	86
April	5.55	944	98
May	6.19	1,051	109
June	6.33	1,019	106
July	6.58	1,079	112
August	6.11	997	103
September	5.57	903	94
October	4.14	733	76
November	2.87	501	52
December	2.40	466	48
Annual	4.70	9,621	$ 998

Location and Station Identification

Requested Location	311 W Platt St. Maquoketa, IA
Weather Data Source	Lat, Lon: 42.05, -90.66 1.4 mi
Latitude	42.05° N
Longitude	90.66° W

PV System Specifications *(Residential)*

DC System Size	7.14 kW
Module Type	Standard
Array Type	Fixed (open rack)
Array Tilt	20°
Array Azimuth	180°
System Losses	14.08%
Inverter Efficiency	96%
DC to AC Size Ratio	1.2

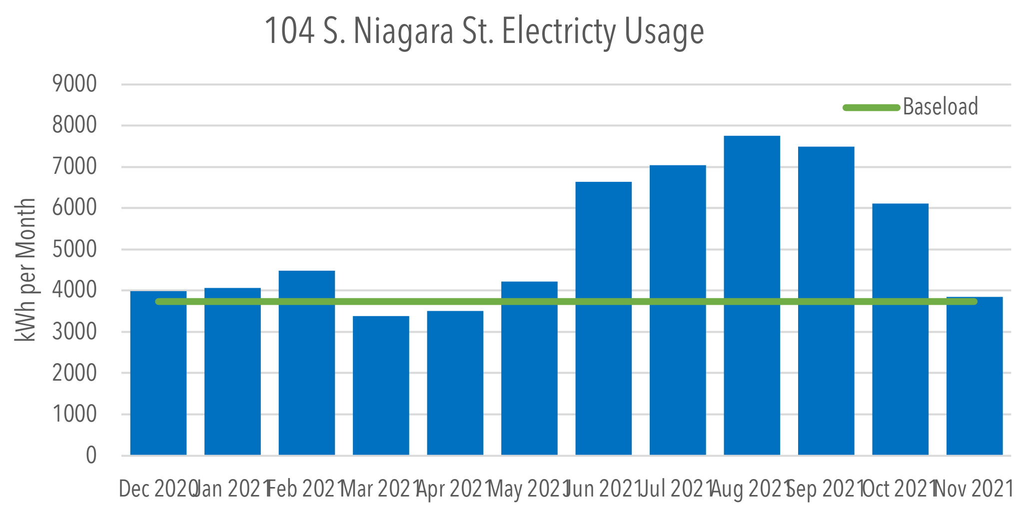
Economics

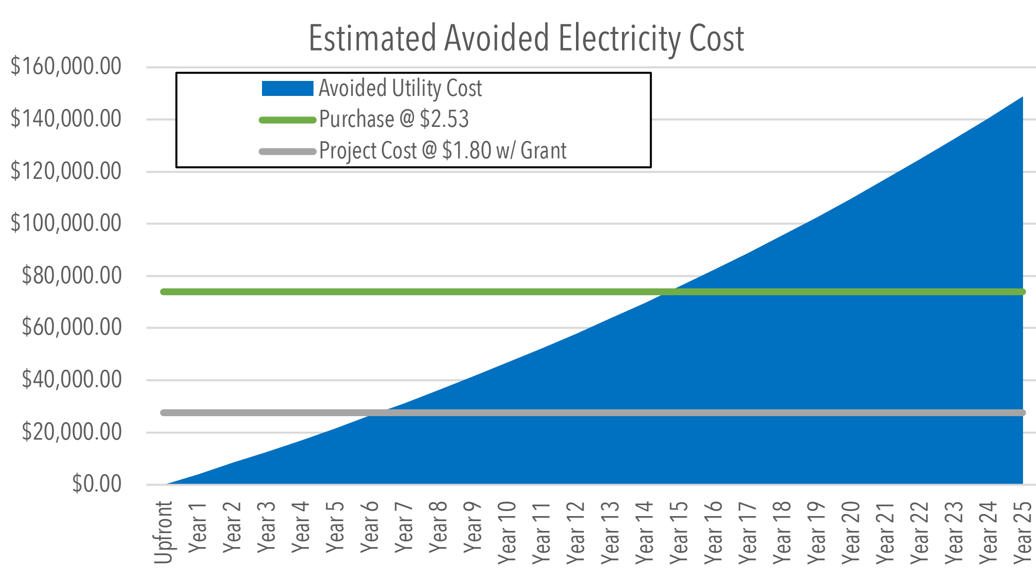
Average Retail Electricity Rate	0.104 $/kWh

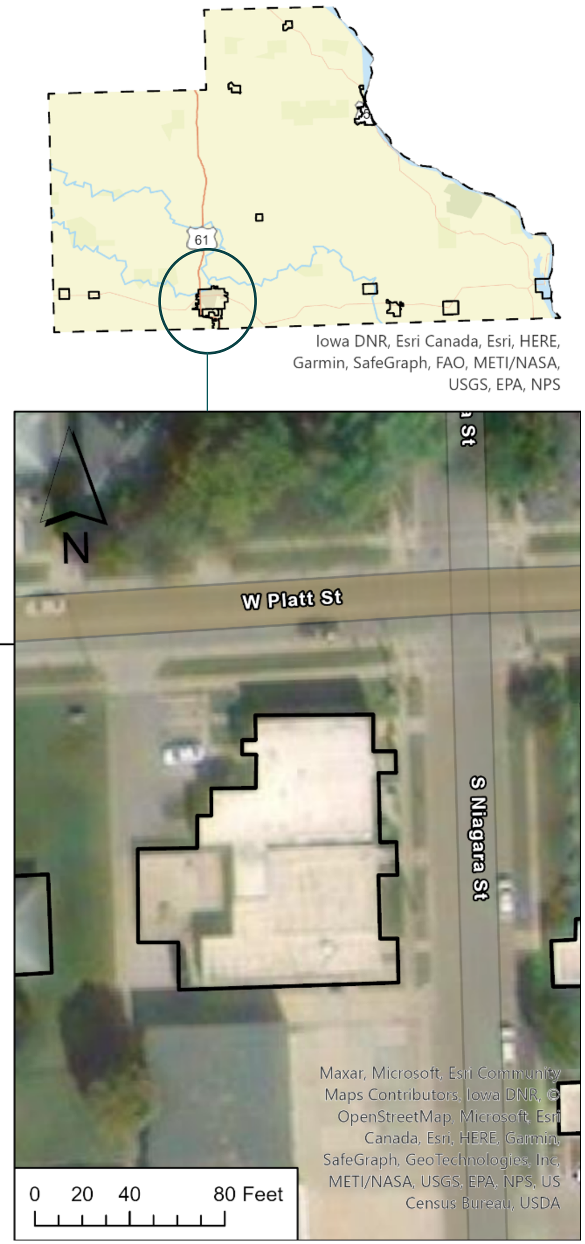
Performance Metrics

Capacity Factor	15.4%

Sheriff's Office – 104 S Niagara St. Maquoketa, IA (Figure D.2)







Sheriff's Office – 104 S Niagara St. Maquoketa, IA (Table D.2)

Baseload (kWh)	Number of Panels (340 Watt)	System Size (kW DC)	DC-AC Ratio	System Size (kW AC)	Price Per Watt	System Cost
3,739.50	86	29.24	1.2	24.37	$2.53	$73,977.20
					$2.53 w/ Grant	$48,977.20
					$2.09	$61,111.60
					$2.09 w/ Grant	$36,111.60
					$1.80	$52,632.00
					$1.80 w/ Grant	$27,632.00

Avoided kWh (per Year)	Avoided Cost Total (per Year)	Payback Period (Years)	Lifetime Avoided Cost	Lifetime Return	Return (per Year)	Percent Return (per Year)
38,942.00	$4,084.00	8.7	$148,899.64	$74,922.44	$2,996.90	4.1%
		5.7		$99,922.44	$3,996.90	8.2%
		7.1		$87,788.04	$3,511.52	5.7%
		4.2		$112,788.04	$4,511.52	12.5%
		6.2		$96,267.64	$3,850.71	7.3%
		3.2		$121,267.64	$4,850.71	17.6%

Orientation	Tree Cover	PV System Requirements (Square Feet)	Roof Size (Square Feet)	Percent Coverage
Flat	None	1,487	9,386	15.8%

NREL NATIONAL RENEWABLE ENERGY LABORATORY

Caution: Photovoltaic system performance predictions calculated by PVWatts® include many inherent assumptions and uncertainties and do not reflect variations between PV technologies nor site-specific characteristics except as represented by PVWatts® inputs. For example, PV modules with better performance are not differentiated within PVWatts® from lesser performing modules. Both NREL and private companies provide more sophisticated PV modeling tools (such as the System Advisor Model at https://sam.nrel.gov) that allow for more precise and complex modeling of PV systems.

The expected range is based on 30 years of actual weather data at the given location and is intended to provide an indication of the variation you might see. For more information, please refer to this NREL report: The Error Report.

The energy output range is based on analysis of 30 years of historical weather data for nearby, and is intended to provide an indication of the possible interannual variability in generation for a Fixed (open rack) PV system at this location.

RESULTS

39,406 kWh/Year*

System output may range from 37,964 to 41,404 kWh per year near this location.

Month	Solar Radiation (kWh / m² / day)	AC Energy (kWh)	Value ($)
January	2.57	2,037	211
February	3.54	2,450	254
March	4.58	3,413	354
April	5.55	3,867	401
May	6.19	4,304	446
June	6.33	4,173	432
July	6.58	4,419	458
August	6.11	4,082	423
September	5.57	3,700	383
October	4.14	3,000	311
November	2.87	2,053	213
December	2.40	1,909	198
Annual	**4.70**	**39,407**	**$ 4,084**

Location and Station Identification

Requested Location	104 S Niagara St Maquoketa, IA
Weather Data Source	Lat, Lon: 42.05, -90.66 1.4 mi
Latitude	42.05° N
Longitude	90.66° W

PV System Specifications *(Residential)*

DC System Size	29.24 kW
Module Type	Standard
Array Type	Fixed (open rack)
Array Tilt	20°
Array Azimuth	180°
System Losses	14.08%
Inverter Efficiency	96%
DC to AC Size Ratio	1.2

Economics

Average Retail Electricity Rate	0.104 $/kWh

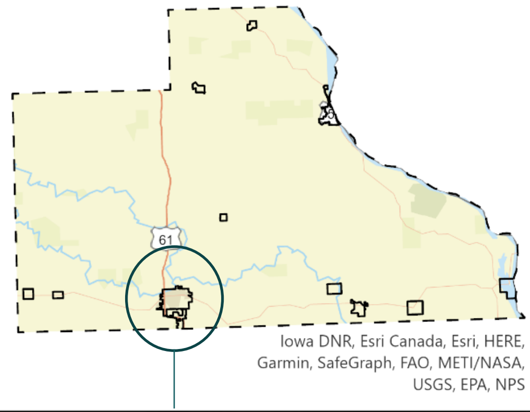
Performance Metrics

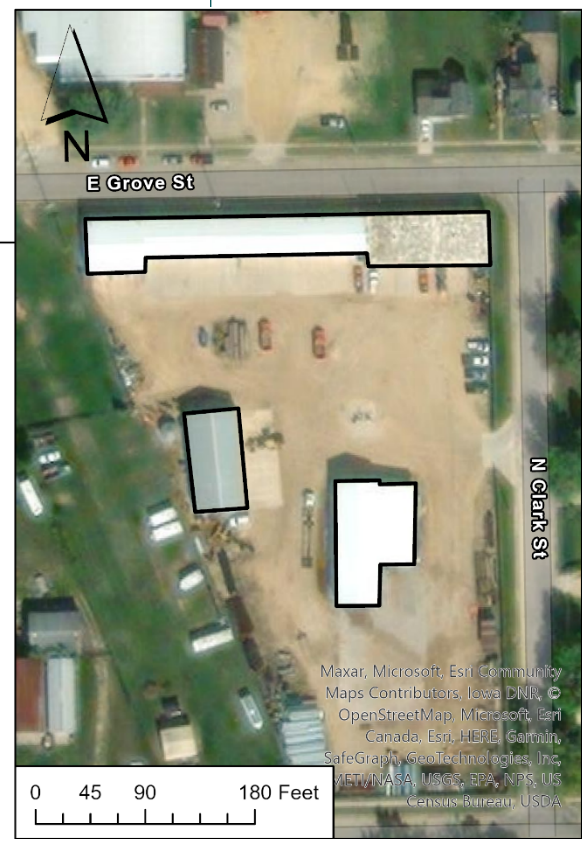
Capacity Factor	15.4%

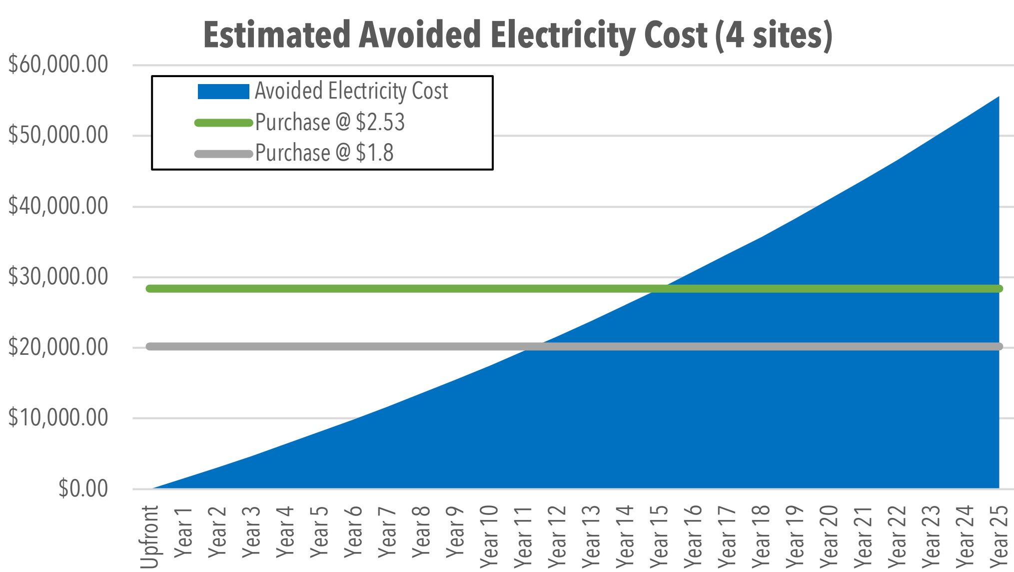
Secondary Roads – 509 E Grove St. Maquoketa, IA (Figure D.3)

The 509 E Grove St. Site represents a site with 4 buildings with their own unique electricity meter. The graph below displays the estimated avoided electricity cost for all four systems combined.

Individual PV system specific are displayed on the following pages (Table 4.6.2-4.6.4)





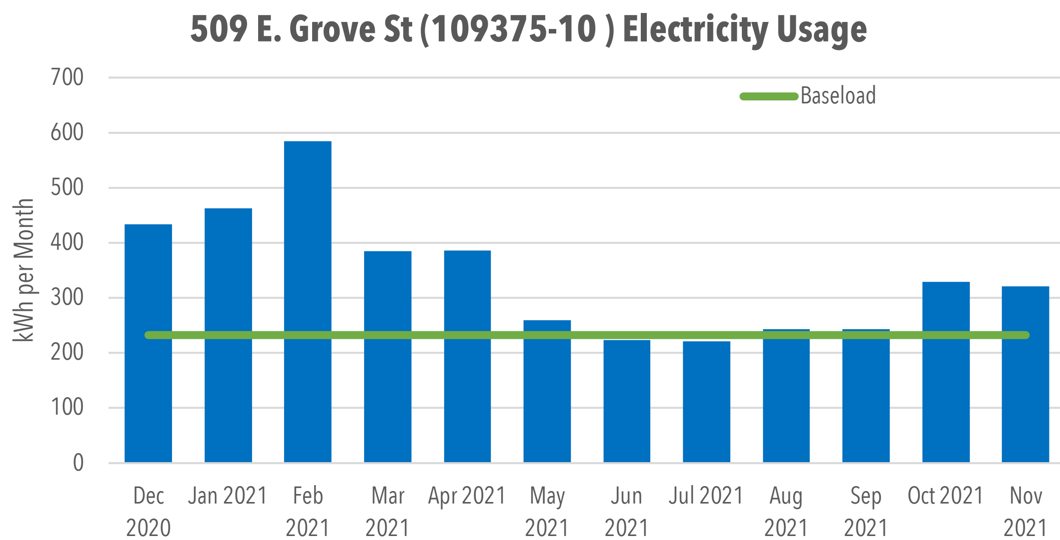


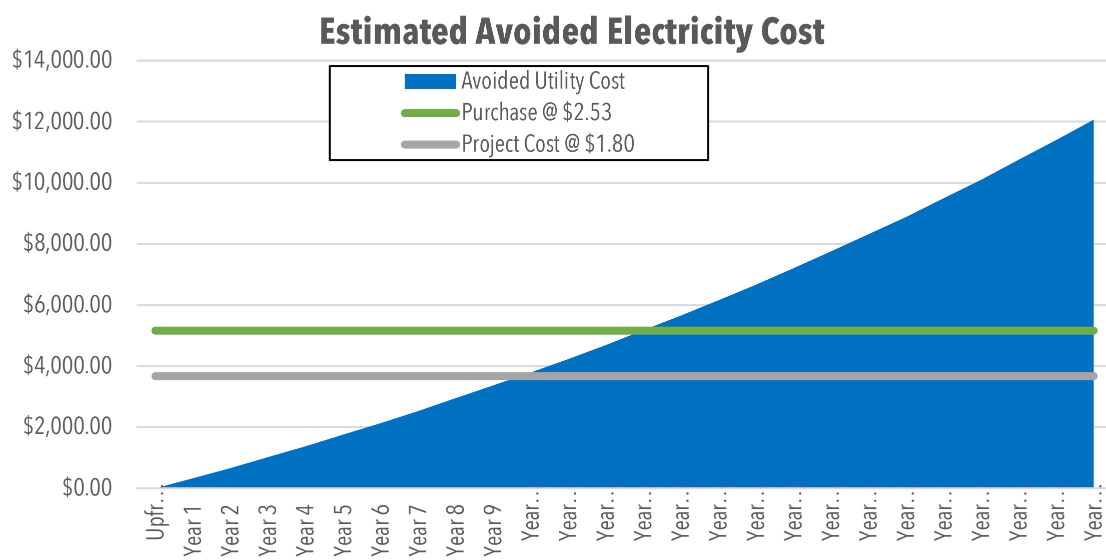
Secondary Roads HQ Overview – 509 E Grove St. Maquoketa, IA (Table D.3)

Baseload (kWh)	Number of Panels (340 Watt)	System Size (kW DC)	DC-AC Ratio	System Size (kW AC)	Price Per Watt	System Cost
1428.5	33	11.22	1.2	9.35	2.53	$28,386.60
					$2.53 w/ Grant	$3,386.60
					2.09	$23,449.80
					1.80	$20,196.00

Avoided kWh (per Year)	Avoided Cost Total (per Year)	Payback Period (Years)	Lifetime Avoided Cost	Lifetime Return	Return (per Year)	Percent Return (per Year)
13,516.00	$1,526.00	8.9	$55,636.84	$27,250.24	$1,090.01	3.8%
		1.1		$52,250.24	$2,090.01	61.7%
		7.3		$32,187.04	$1,287.48	5.5%
		6.3		$35,440.84	$1,417.63	7.0%

Secondary Roads – 509 E Grove St. Maquoketa, IA - 109375-10 (Figure D.3.1)





Secondary Roads – 509 E Grove St. Maquoketa, IA - 109375-10 (Table D.3.1)

Baseload (kWh)	Number of Panels (340 Watt)	System Size (kW DC)	DC-AC Ratio	System Size (kW AC)	Price Per Watt	System Cost
232.50	6	2.04	1.2	1.70	$2.53	$5,161.20
					$2.09	$4,263.60
					$1.80	$3,672.00

Avoided kWh (per Year)	Avoided Cost Total (per Year)	Payback Period (Years)	Lifetime Avoided Cost	Lifetime Return	Return (per Year)	Percent Return (per Year)
2,732.00	$331.00	7.4	$12,068.02	$6,906.82	$276.27	5.4%
		6.2		$7,804.42	$312.18	7.3%
		5.3		$8,396.02	$335.84	9.1%

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Caution: Photovoltaic system performance predictions calculated by PVWatts® include many inherent assumptions and uncertainties and do not reflect variations between PV technologies nor site-specific characteristics except as represented by PVWatts® inputs. For example, PV modules with better performance are not differentiated within PVWatts® from lesser performing modules. Both NREL and private companies provide more sophisticated PV modeling tools (such as the System Advisor Model at https://sam.nrel.gov) that allow for more precise and complex modeling of PV systems.

The expected range is based on 30 years of actual weather data at the given location and is intended to provide an indication of the variation you might see. For more information, please refer to this NREL report: The Error Report.

The energy output range is based on analysis of 30 years of historical weather data for nearby, and is intended to provide an indication of the possible interannual variability in generation for a Fixed (open rack) PV system at this location.

RESULTS

3,207 kWh/Year*

System output may range from 3,089 to 3,369 kWh per year near this location.

Month	Solar Radiation (kWh / m² / day)	AC Energy (kWh)	Value ($)
January	2.61	170	18
February	3.60	206	21
March	4.56	279	29
April	5.25	304	31
May	5.79	332	34
June	6.39	343	36
July	6.49	354	37
August	6.07	332	34
September	5.56	303	31
October	4.13	243	25
November	3.05	183	19
December	2.46	157	16
Annual	**4.66**	**3,206**	**$ 331**

Location and Station Identification

Requested Location	509 E Grove St, Maquoketa, IA 52060
Weather Data Source	Lat, Lon: 42.09, -90.66 1.1 mi
Latitude	42.09° N
Longitude	90.66° W

PV System Specifications *(Residential)*

DC System Size	2.4 kW
Module Type	Standard
Array Type	Fixed (open rack)
Array Tilt	20°
Array Azimuth	180°
System Losses	14.08%
Inverter Efficiency	96%
DC to AC Size Ratio	1.2

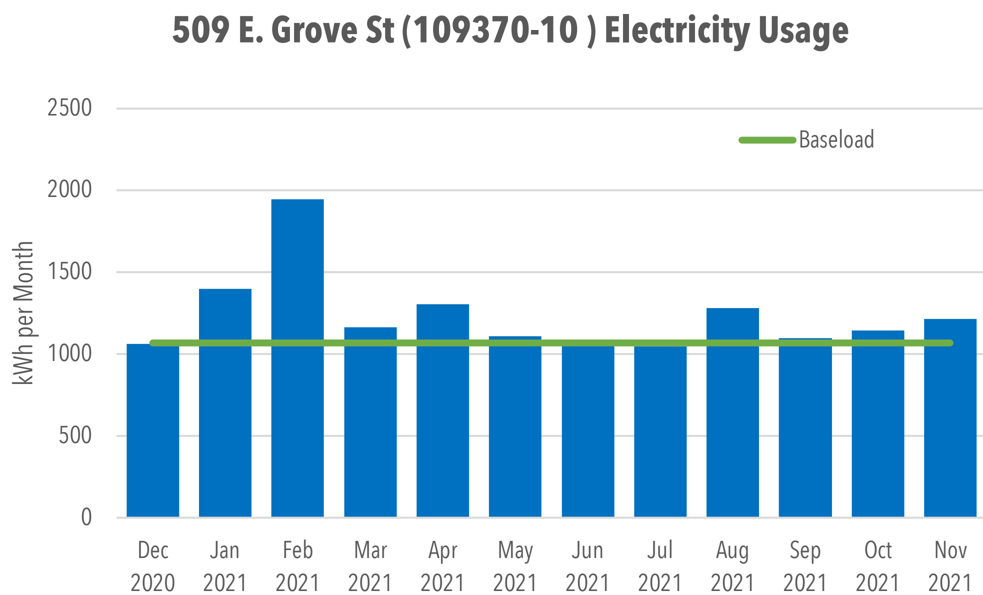
Economics

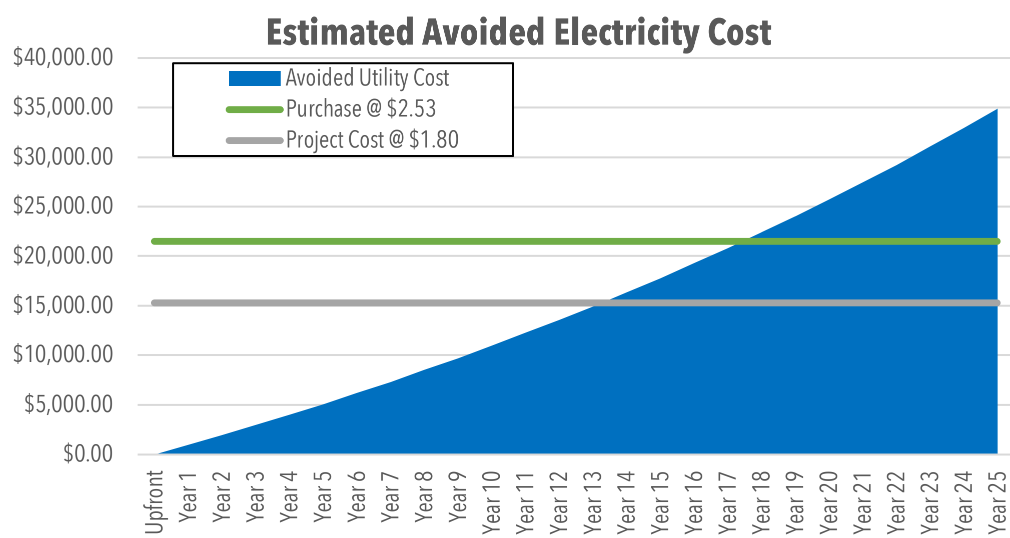
Average Retail Electricity Rate	0.104 $/kWh

Performance Metrics

Capacity Factor	15.3%

Secondary Roads – 509 E Grove St. Maquoketa, IA - 109370-10 (Figure D.3.2)





Secondary Roads – 509 E Grove St. Maquoketa, IA - 109370-10 (Table D.3.2)

Baseload (kWh)	Number of Panels (340 Watt)	System Size (kW DC)	DC-AC Ratio	System Size (kW AC)	Price Per Watt	System Cost
1,068.00	25	8.5	1.2	7.08	$2.53	$21,505.00
					$2.09	$17,765.00
					$1.80	$15,300.00

Avoided kWh (per Year)	Avoided Cost Total (per Year)	Payback Period (Years)	Lifetime Avoided Cost	Lifetime Return	Return (per Year)	Percent Return (per Year)
9,237.00	$957.00	10.7	$34,891.52	$13,386.52	$535.46	2.5%
		8.9		$17,126.52	$685.06	3.9%
		7.6		$19,591.52	$783.66	5.1%

RESULTS

1,140 kWh/Year*

System output may range from 1,098 to 1,198 kWh per year near this location.

Month	Solar Radiation (kWh / m^2 / day)	AC Energy (kWh)	Value ($)
January	1.77	47	5
February	2.68	64	7
March	3.74	96	10
April	4.62	113	12
May	5.50	133	14
June	6.30	142	15
July	6.24	143	15
August	5.53	128	13
September	4.63	106	11
October	3.06	75	8
November	2.13	53	5
December	1.54	40	4
Annual	**3.98**	**1,140**	**$ 119**

Location and Station Identification

Requested Location	509 E Grove St. Maquoketa, IA
Weather Data Source	Lat, Lon: 42.09, -90.66 1.1 mi
Latitude	42.09° N
Longitude	90.66° W

PV System Specifications *(Residential)*

DC System Size	1.02 kW
Module Type	Standard
Array Type	Fixed (roof mount)
Array Tilt	20°
Array Azimuth	270°
System Losses	14.08%
Inverter Efficiency	96%
DC to AC Size Ratio	1.2

Economics

Average Retail Electricity Rate	0.104 $/kWh

Performance Metrics

Capacity Factor	12.8%

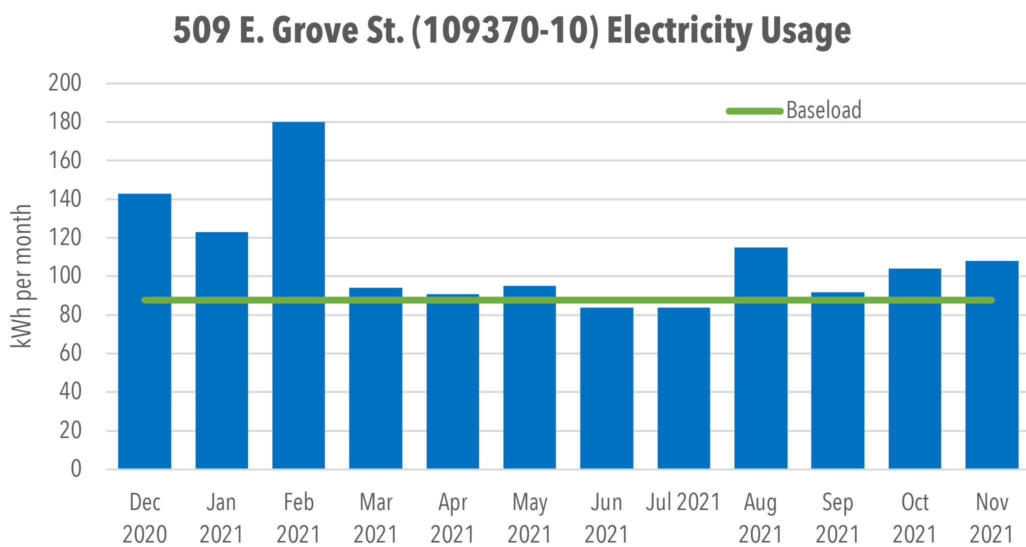
NREL
NATIONAL RENEWABLE ENERGY LABORATORY

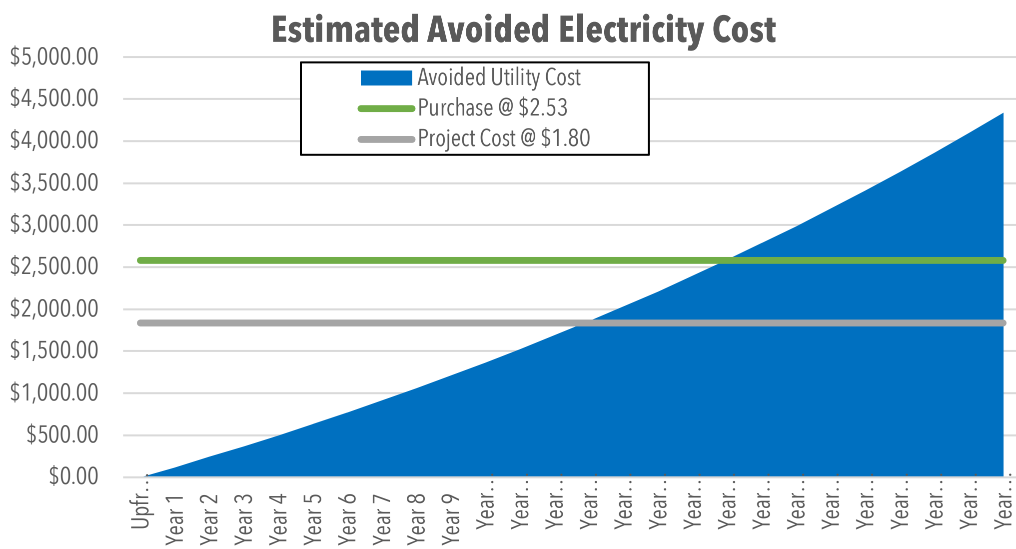
Caution: Photovoltaic system performance predictions calculated by PVWatts® include many inherent assumptions and uncertainties and do not reflect variations between PV technologies nor site-specific characteristics except as represented by PVWatts® inputs. For example, PV modules with better performance are not differentiated within PVWatts® from lesser performing modules. Both NREL and private companies provide more sophisticated PV modeling tools (such as the System Advisor Model at https://sam.nrel.gov) that allow for more precise and complex modeling of PV systems.

The expected range is based on 30 years of actual weather data at the given location and is intended to provide an indication of the variation you might see. For more information, please refer to this NREL report: The Error Report.

The energy output range is based on analysis of 30 years of historical weather data for nearby, and is intended to provide an indication of the possible interannual variability in generation for a Fixed (open rack) PV system at this location.

Secondary Roads – 509 E Grove St. Maquoketa, IA - 109370-10 (Figure D.3.3)



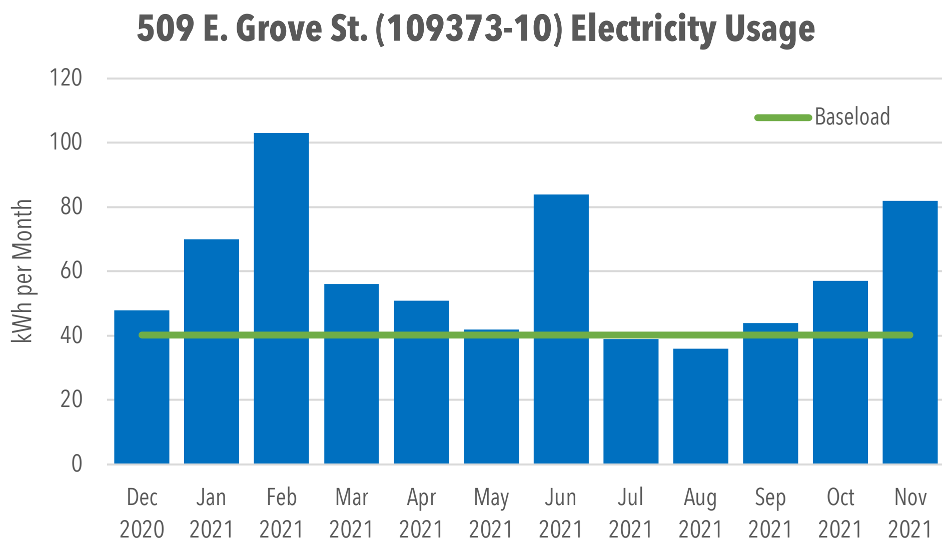


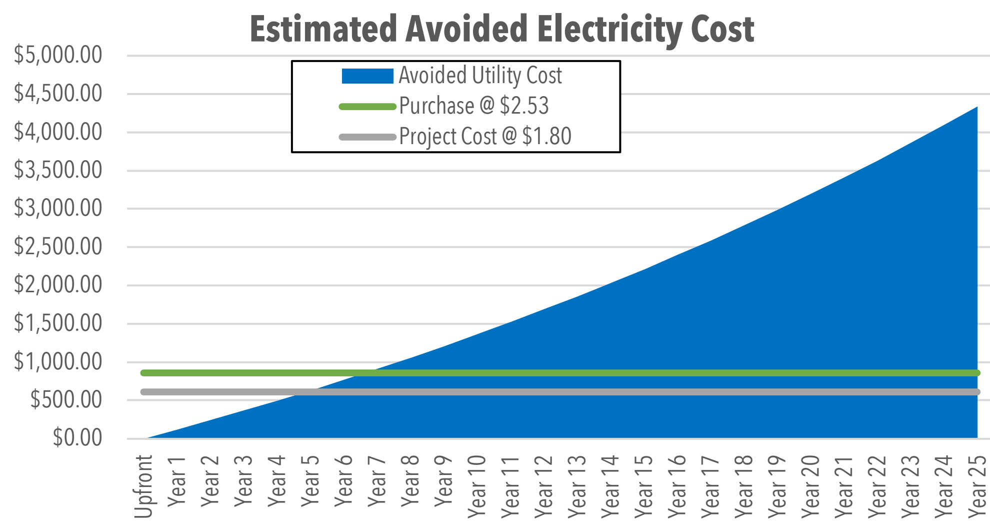
Secondary Roads – 509 E Grove St. Maquoketa, IA - 109370-10 (Table D.3.3)

Baseload (kWh)	Number of Panels (340 Watt)	System Size (kW DC)	DC-AC Ratio	System Size (kW AC)	Price Per Watt	System Cost
87.75	2	1.02	1.2	0.85	$2.53	$2,580.60
					$2.09	$2,131.80
					$1.80	$1,836.00

Avoided kWh (per Year)	Avoided Cost Total (per Year)	Payback Period (Years)	Lifetime Avoided Cost	Lifetime Return	Return (per Year)	Percent Return (per Year)
934.00	$119.00	10.4	$4,338.65	$1,758.05	$70.32	2.7%
		8.6		$2,206.85	$88.27	4.1%
		7.4		$2,502.65	$100.11	5.5%

Secondary Roads – 509 E Grove St. Maquoketa, IA - 109373-10 (Figure D.3.4)





Secondary Roads – 509 E Grove St. Maquoketa, IA - 109373-10 (Table D.3.4)

Baseload (kWh)	Number of Panels (340 Watt)	System Size (kW DC)	DC-AC Ratio	System Size (kW AC)	Price Per Watt	System Cost
40.25	1	0.34	1.2	0.28	$2.53	$860.20
					$2.09	$710.60
					$1.80	$612.00

Avoided kWh (per Year)	Avoided Cost Total (per Year)	Payback Period (Years)	Lifetime Avoided Cost	Lifetime Return	Return (per Year)	Percent Return (per Year)
613.00	$119.00	3.5	$4,338.65	$3,478.45	$139.14	16.2%
		2.9		$3,628.05	$145.12	20.4%
		2.5		$3,726.65	$149.07	24.4%

RESULTS

9,501 kWh/Year*

System output may range from 9,154 to 9,983 kWh per year near this location.

Month	Solar Radiation (kWh / m^2 / day)	AC Energy (kWh)	Value ($)
January	1.77	395	41
February	2.68	535	55
March	3.74	802	83
April	4.62	941	97
May	5.50	1,106	115
June	6.30	1,185	123
July	6.24	1,191	123
August	5.53	1,063	110
September	4.63	885	92
October	3.06	626	65
November	2.13	442	46
December	1.54	330	34
Annual	**3.98**	**9,501**	**$ 984**

Location and Station Identification

Requested Location	509 E Grove St. Maquoketa, IA
Weather Data Source	Lat, Lon: 42.09, -90.66 1.1 mi
Latitude	42.09° N
Longitude	90.66° W

PV System Specifications *(Residential)*

DC System Size	8.5 kW
Module Type	Standard
Array Type	Fixed (roof mount)
Array Tilt	20°
Array Azimuth	270°
System Losses	14.08%
Inverter Efficiency	96%
DC to AC Size Ratio	1.2

Economics

Average Retail Electricity Rate	0.104 $/kWh

Performance Metrics

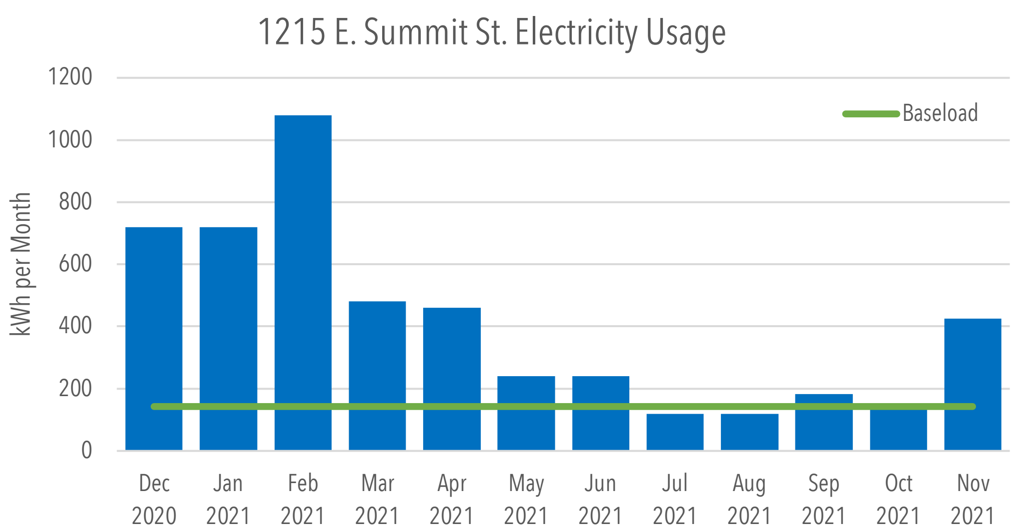
Capacity Factor	12.8%

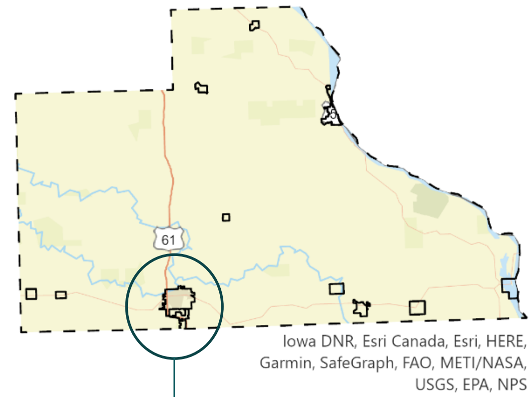
Caution: Photovoltaic system performance predictions calculated by PVWatts® include many inherent assumptions and uncertainties and do not reflect variations between PV technologies nor site-specific characteristics except as represented by PVWatts® inputs. For example, PV modules with better performance are not differentiated within PVWatts® from lesser performing modules. Both NREL and private companies provide more sophisticated PV modeling tools (such as the System Advisor Model at https://sam.nrel.gov) that allow for more precise and complex modeling of PV systems.

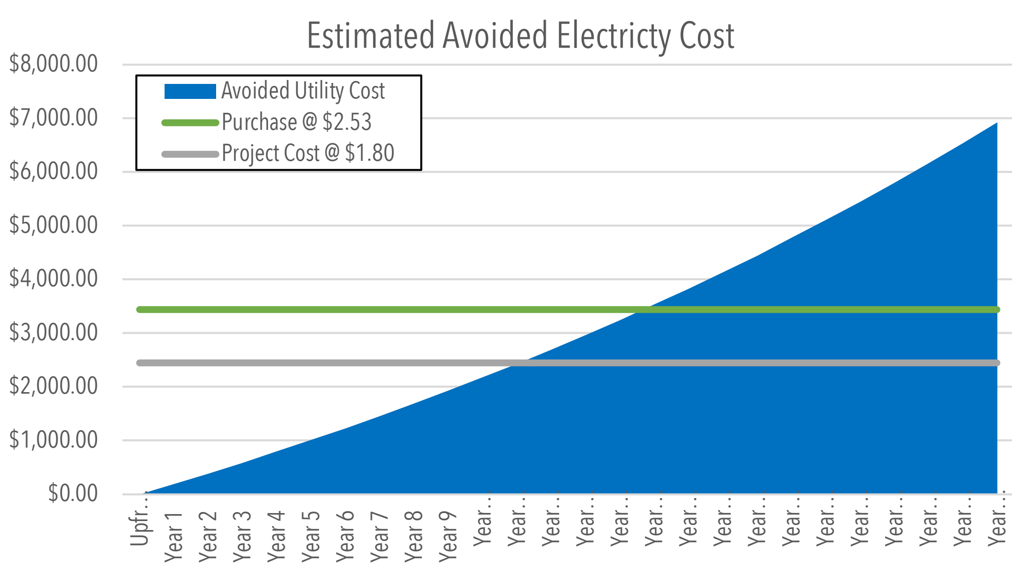
The expected range is based on 30 years of actual weather data at the given location and is intended to provide an indication of the variation you might see. For more information, please refer to this NREL report: The Error Report.

The energy output range is based on analysis of 30 years of historical weather data for nearby, and is intended to provide an indication of the possible interannual variability in generation for a Fixed (open rack) PV system at this location.

Prairie Creek – 1215 Summit St. Maquoketa, IA (Figure D.4)







Prairie Creek – 1215 Summit St. Maquoketa, IA (Table D.4)

Baseload (kWh)	Number of Panels (340 Watt)	System Size (kW DC)	DC-AC Ratio	System Size (kW AC)	Price Per Watt	System Cost
142.75	4	1.36	1.2	1.13	$2.53	$3,440.80
					$2.09	$2,842.40
					$1.80	$2,448.00

Avoided kWh (per Year)	Avoided Cost Total (per Year)	Payback Period (Years)	Lifetime Avoided Cost	Lifetime Return	Return (per Year)	Percent Return (per Year)
1,713.00	$190.00	8.6	$6,927.26	$3,486.46	$139.46	4.1%
		7.1		$4,084.86	$163.39	5.7%
		6.2		$4,479.26	$179.17	7.3%

Orientation	Tree Cover	PV System Requirements (Square Feet)	Roof Size (Square Feet)	Percent Coverage
N/S	Potentially Many	57	2,709	2%

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Caution: Photovoltaic system performance predictions calculated by PVWatts® include many inherent assumptions and uncertainties and do not reflect variations between PV technologies nor site-specific characteristics except as represented by PVWatts® inputs. For example, PV modules with better performance are not differentiated within PVWatts® from lesser performing modules. Both NREL and private companies provide more sophisticated PV modeling tools (such as the System Advisor Model at https://sam.nrel.gov) that allow for more precise and complex modeling of PV systems.

The expected range is based on 30 years of actual weather data at the given location and is intended to provide an indication of the variation you might see. For more information, please refer to this NREL report: The Error Report.

The energy output range is based on analysis of 30 years of historical weather data for nearby, and is intended to provide an indication of the possible interannual variability in generation for a Fixed (open rack) PV system at this location.

RESULTS

1,833 kWh/Year*

System output may range from 1,766 to 1,926 kWh per year near this location.

Month	Solar Radiation (kWh / m² / day)	AC Energy (kWh)	Value ($)
January	2.57	95	10
February	3.54	114	12
March	4.58	159	16
April	5.55	180	19
May	6.19	200	21
June	6.33	194	20
July	6.58	206	21
August	6.11	190	20
September	5.57	172	18
October	4.14	140	14
November	2.87	96	10
December	2.40	89	9
Annual	**4.70**	**1,835**	**$ 190**

Location and Station Identification

Requested Location	1215 E Summit St Maquoketa, IA
Weather Data Source	Lat, Lon: 42.05, -90.66 1.0 mi
Latitude	42.05° N
Longitude	90.66° W

PV System Specifications *(Residential)*

DC System Size	1.36 kW
Module Type	Standard
Array Type	Fixed (open rack)
Array Tilt	20°
Array Azimuth	180°
System Losses	14.08%
Inverter Efficiency	96%
DC to AC Size Ratio	1.2

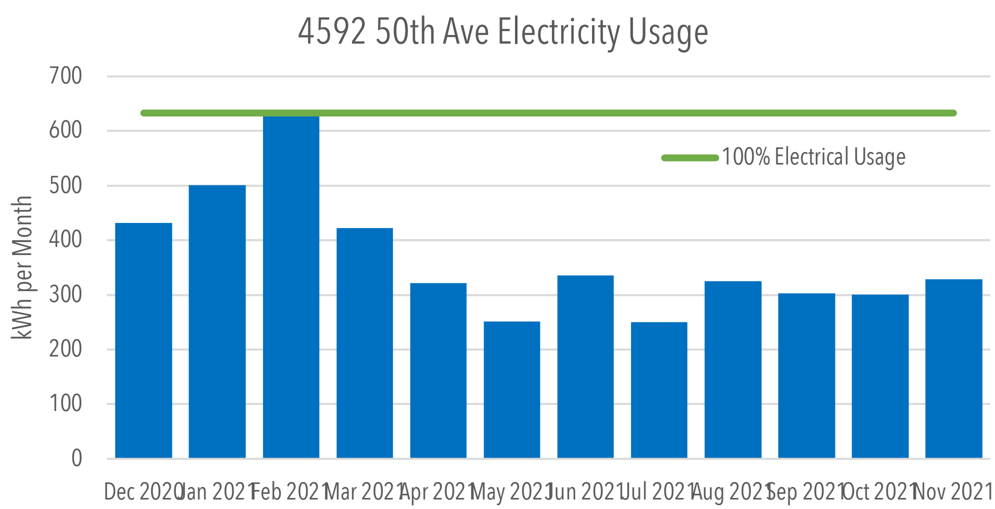
Economics

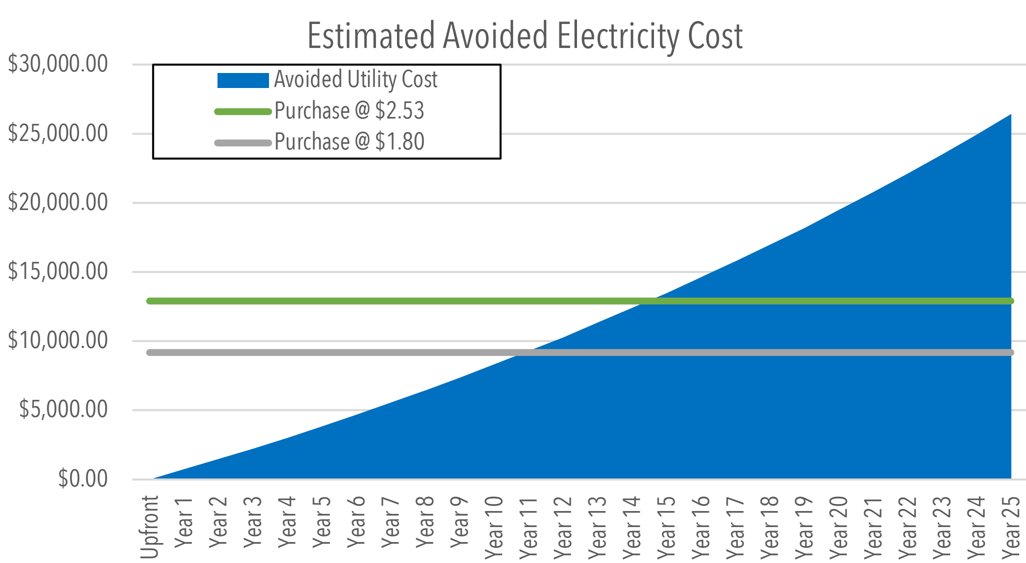
Average Retail Electricity Rate	0.104 $/kWh

Performance Metrics

Capacity Factor	15.4%

Baldwin Shop – 4592 50th Ave. Baldwin, IA (Figure D.5)





Baldwin Shop – 4592 50th Ave. Baldwin, IA (Table D.5)

100% (kWh)	Number of Panels (340 Watt)	System Size (kW DC)	DC-AC Ratio	System Size (kW AC)	Price Per Watt	System Cost
633	15	5.1	1.2	4.25	$2.53	$12,903.00
					$2.09	$10,659.00
					$1.80	$9,180.00

Avoided kWh (per Year)	Avoided Cost Total (per Year)	Payback Period (Years)	Lifetime Avoided Cost	Lifetime Return	Return (per Year)	Percent Return (per Year)
3,966.00	$725.00	8.5	$26,432.97	$13,529.97	$541.20	4.2%
		7.0		$15,773.97	$630.96	5.9%
		6.1		$17,252.97	$690.12	7.5%

Orientation	Tree Cover	PV System Requirements (Square Feet)	Roof Size (Square Feet)	Percent Coverage
N/S	None	252	2,466	10.2%

NREL NATIONAL RENEWABLE ENERGY LABORATORY

Caution: Photovoltaic system performance predictions calculated by PVWatts® include many inherent assumptions and uncertainties and do not reflect variations between PV technologies nor site-specific characteristics except as represented by PVWatts® inputs. For example, PV modules with better performance are not differentiated within PVWatts® from lesser performing modules. Both NREL and private companies provide more sophisticated PV modeling tools (such as the System Advisor Model at https://sam.nrel.gov) that allow for more precise and complex modeling of PV systems.

The expected range is based on 30 years of actual weather data at the given location and is intended to provide an indication of the variation you might see. For more information, please refer to this NREL report: The Error Report.

The energy output range is based on analysis of 30 years of historical weather data for nearby, and is intended to provide an indication of the possible interannual variability in generation for a Fixed (open rack) PV system at this location.

RESULTS

6,794 kWh/Year*

System output may range from 6,545 to 7,138 kWh per year near this location.

Month	Solar Radiation (kWh / m^2 / day)	AC Energy (kWh)	Value ($)
January	2.71	372	39
February	3.72	442	47
March	4.66	599	63
April	5.28	636	67
May	5.82	710	75
June	6.25	709	75
July	6.57	758	80
August	6.33	720	76
September	5.52	632	67
October	4.09	511	54
November	3.07	390	41
December	2.35	313	33
Annual	4.70	6,792	$ 717

Location and Station Identification

Requested Location	4592 50th Ave. Baldwin, IA
Weather Data Source	Lat, Lon: 42.09, -90.86 1.5 mi
Latitude	42.09° N
Longitude	90.86° W

PV System Specifications *(Residential)*

DC System Size	5.1 kW
Module Type	Standard
Array Type	Fixed (roof mount)
Array Tilt	20°
Array Azimuth	180°
System Losses	14.08%
Inverter Efficiency	96%
DC to AC Size Ratio	1.2

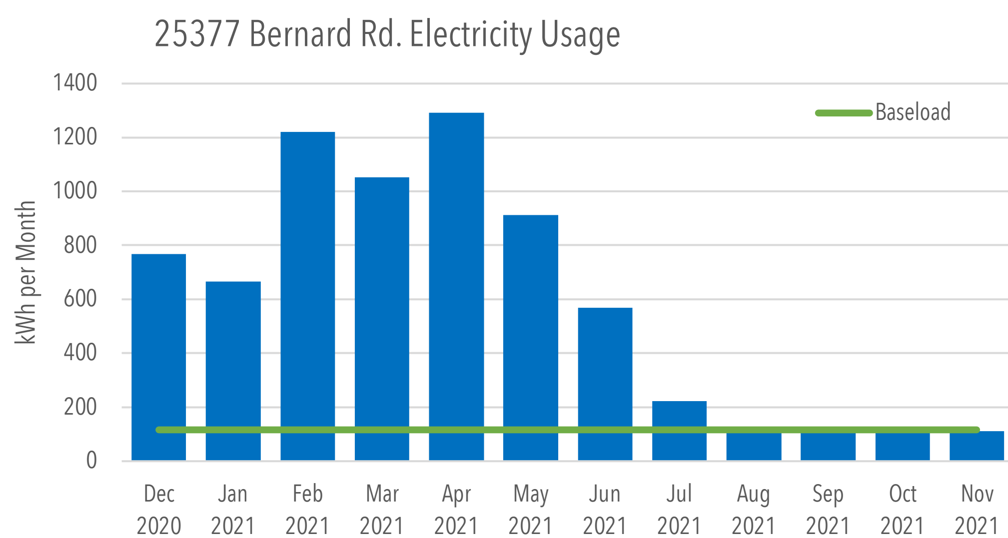
Economics

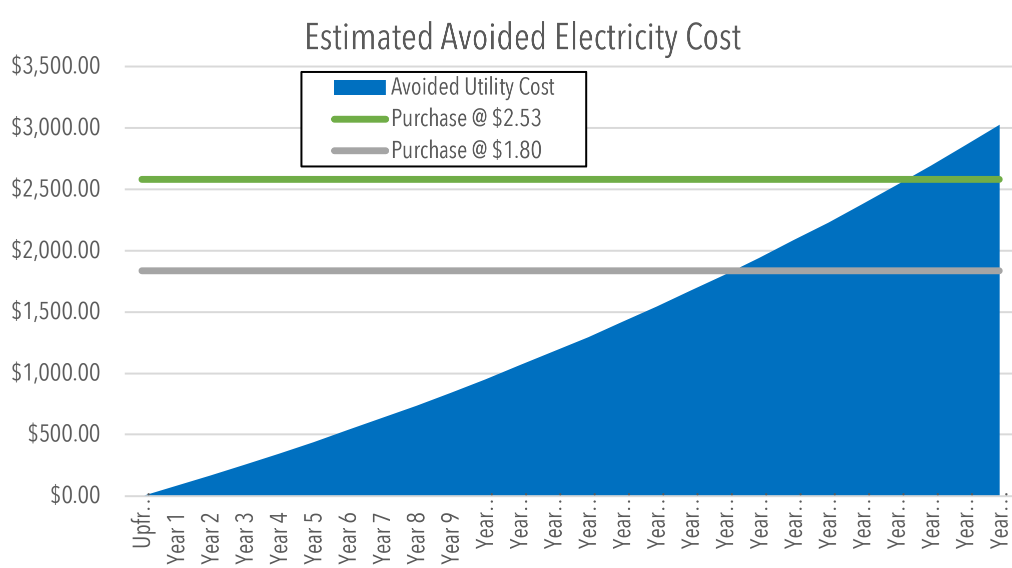
Average Retail Electricity Rate	0.106 $/kWh

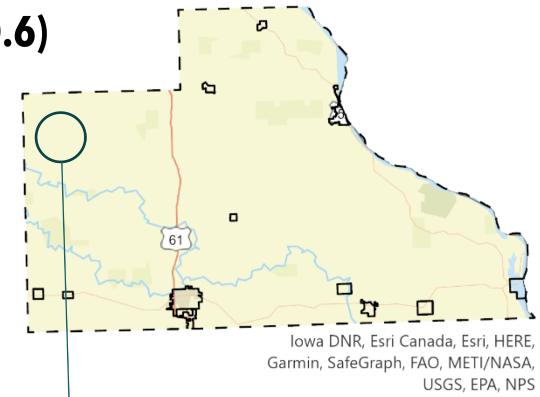
Performance Metrics

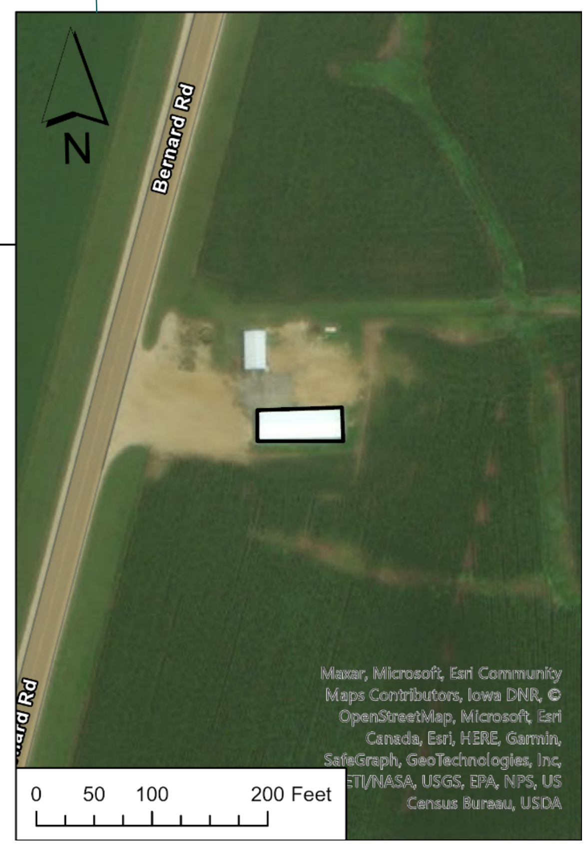
Capacity Factor	15.2%

Butler Shop, 25377 Bernard Rd, Jackson County, IA (Figure D.6)









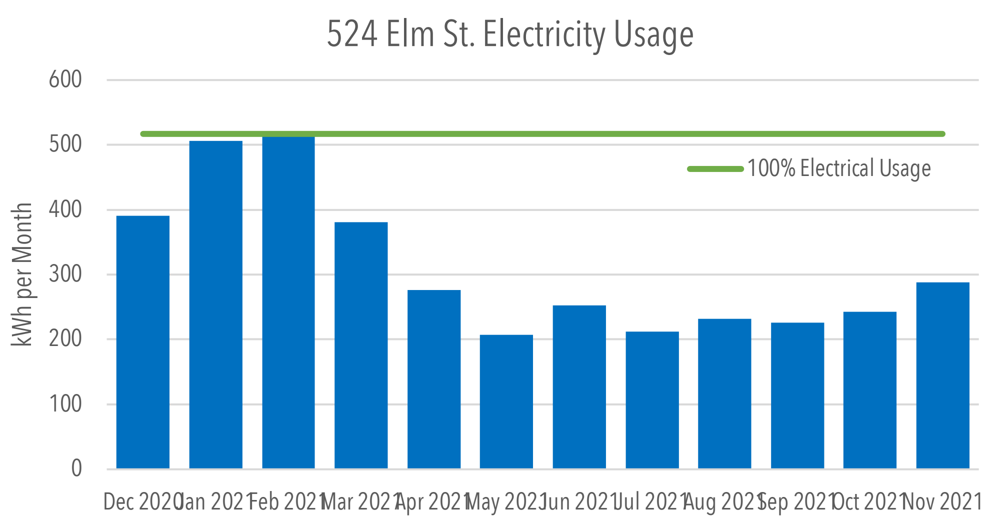
Butler Shop, 25377 Bernard Rd, Jackson County, IA (Table D.6)

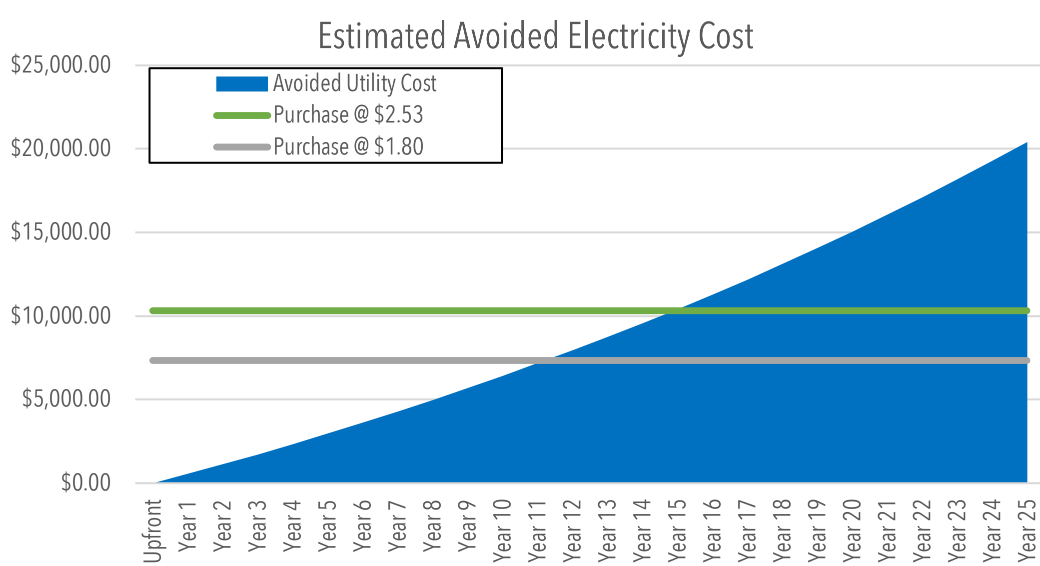
Baseload (kWh)	Number of Panels (340 Watt)	System Size (kW DC)	DC-AC Ratio	System Size (kW AC)	Price Per Watt	System Cost
116.25	3	1.02	1.2	0.85	$2.53	$2,580.60
					$2.09	$2,131.80
					$1.80	$1,836.00

Avoided kWh (per Year)	Avoided Cost Total (per Year)	Payback Period (Years)	Lifetime Avoided Cost	Lifetime Return	Return (per Year)	Percent Return (per Year)
1,759.00	$83.00	14.8	$3,026.12	$445.52	$17.82	0.7%
		12.3		$894.32	$35.77	1.7%
		10.6		$1,190.12	$47.60	2.6%

Orientation	Tree Cover	PV System Requirements (Square Feet)	Roof Size (Square Feet)	Percent Coverage
N/S	None	52	2,064	2.5%

La Motte Shop – 524 Elm St. La Motte, IA (Figure D.7)





La Motte Shop – 524 Elm St. La Motte, IA (Table D.7)

100% (kWh)	Number of Panels (340 Watt)	System Size (kW DC)	DC-AC Ratio	System Size (kW AC)	Price Per Watt	System Cost
517	12	4.08	1.2	3.4	$2.53	$10,322.40
					$2.09	$8,527.20
					$1.80	$7,344.00

Avoided kWh (per Year)	Avoided Cost Total (per Year)	Payback Period (Years)	Lifetime Avoided Cost	Lifetime Return	Return (per Year)	Percent Return (per Year)
3,136.00	$560.00	8.8	$20,417.19	$10,094.79	$403.79	3.9%
		7.3		$11,889.99	$475.60	5.6%
		6.7		$13,073.19	$522.93	7.1%

Orientation	Tree Cover	PV System Requirements (Square Feet)	Roof Size (Square Feet)	Percent Coverage
NNW/SSE	None	206	3,944	5.2%

RESULTS

5,311 kWh/Year*

System output may range from 5,116 to 5,580 kWh per year near this location.

Month	Solar Radiation (kWh / m^2 / day)	AC Energy (kWh)	Value ($)
January	2.42	268	28
February	3.56	340	36
March	4.60	475	50
April	5.31	514	54
May	5.94	582	61
June	6.43	585	62
July	6.56	603	64
August	6.03	557	59
September	5.33	492	52
October	4.02	398	42
November	2.71	269	28
December	2.15	229	24
Annual	**4.59**	**5,312**	**$ 560**

Location and Station Identification

Requested Location	524 W. Elm St. La Motte, IA
Weather Data Source	Lat, Lon: 42.29, -90.62 0.5 mi
Latitude	42.29° N
Longitude	90.62° W

PV System Specifications *(Residential)*

DC System Size	4.08 kW
Module Type	Standard
Array Type	Fixed (roof mount)
Array Tilt	20°
Array Azimuth	150°
System Losses	14.08%
Inverter Efficiency	96%
DC to AC Size Ratio	1.2

Economics

Average Retail Electricity Rate	0.106 $/kWh

Performance Metrics

Capacity Factor	14.9%

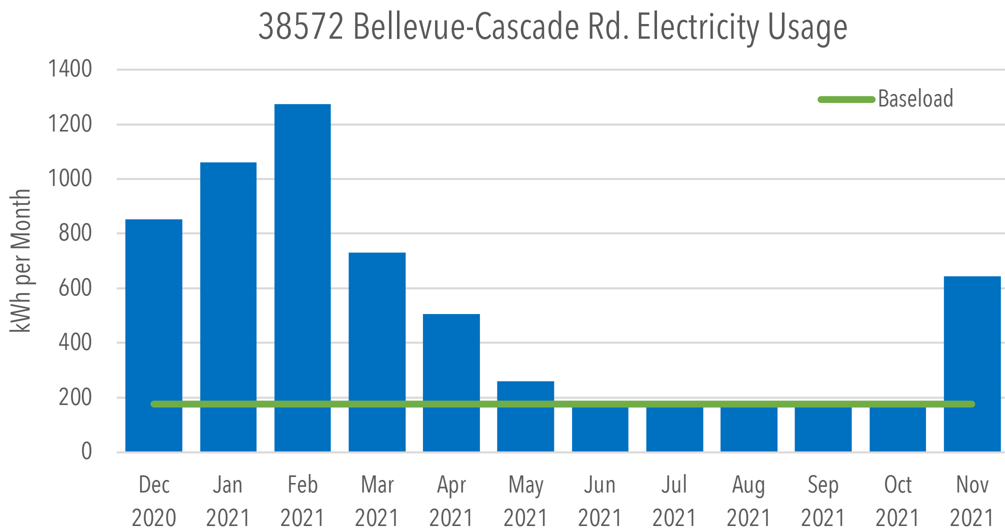
NREL
NATIONAL RENEWABLE ENERGY LABORATORY

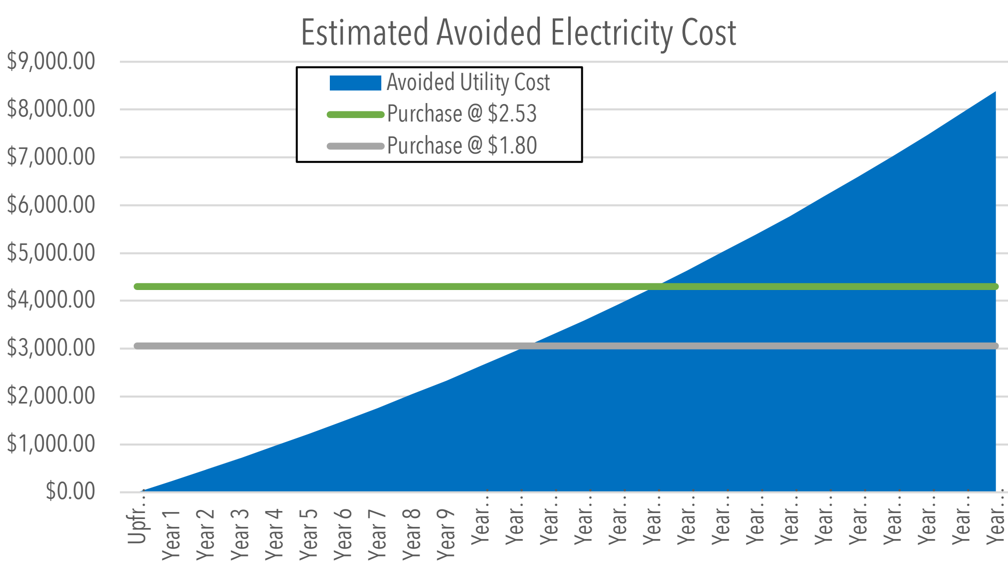
Caution: Photovoltaic system performance predictions calculated by PVWatts® include many inherent assumptions and uncertainties and do not reflect variations between PV technologies nor site-specific characteristics except as represented by PVWatts® inputs. For example, PV modules with better performance are not differentiated within PVWatts® from lesser performing modules. Both NREL and private companies provide more sophisticated PV modeling tools (such as the System Advisor Model at https://sam.nrel.gov) that allow for more precise and complex modeling of PV systems.

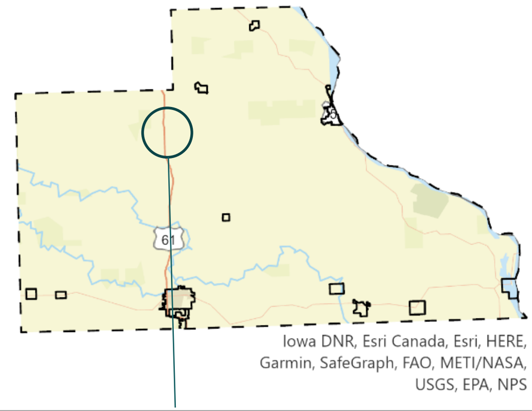
The expected range is based on 30 years of actual weather data at the given location and is intended to provide an indication of the variation you might see. For more information, please refer to this NREL report: The Error Report.

The energy output range is based on analysis of 30 years of historical weather data for nearby, and is intended to provide an indication of the possible interannual variability in generation for a Fixed (open rack) PV system at this location.

Otter Creek Shop - 38572 Bellevue-Cascade Rd Jackson County IA (Figure D.8)







Bellevue Shop - 38572 Bellevue-Cascade Rd Jackson County IA. (Table D.8)

Baseload (kWh)	Number of Panels (340 Watt)	System Size (kW DC)	DC-AC Ratio	System Size (kW AC)	Price Per Watt	System Cost
176.75	4	1.7	1.2	1.42	2.53	$4,301.00
					2.09	$3,553.00
					1.80	$3,060.00

Avoided kWh (per Year)	Avoided Cost Total (per Year)	Payback Period (Years)	Lifetime Avoided Cost	Lifetime Return	Return (per Year)	Percent Return (per Year)
1,770.00	$230.00	8.9	$8,385.63	$4,084.63	$163.39	3.8%
		7.4		$4,832.63	$193.31	5.4%
		6.4		$5,325.63	$213.03	7.0%

Orientation	Tree Cover	PV System Requirements (Square Feet)	Roof Size (Square Feet)	Percent Coverage
NNE/SSW	None	70	1,713	4.08%

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Caution: Photovoltaic system performance predictions calculated by PVWatts® include many inherent assumptions and uncertainties and do not reflect variations between PV technologies nor site-specific characteristics except as represented by PVWatts® inputs. For example, PV modules with better performance are not differentiated within PVWatts® from lesser performing modules. Both NREL and private companies provide more sophisticated PV modeling tools (such as the System Advisor Model at https://sam.nrel.gov) that allow for more precise and complex modeling of PV systems.

The expected range is based on 30 years of actual weather data at the given location and is intended to provide an indication of the variation you might see. For more information, please refer to this NREL report: The Error Report.

The energy output range is based on analysis of 30 years of historical weather data for nearby, and is intended to provide an indication of the possible interannual variability in generation for a Fixed (open rack) PV system at this location.

RESULTS

1,844 kWh/Year*

System output may range from 1,776 to 1,937 kWh per year near this location.

Month	Solar Radiation (kWh / m² / day)	AC Energy (kWh)	Value ($)
January	2.54	96	12
February	3.63	119	15
March	4.58	162	20
April	5.33	176	22
May	6.06	201	25
June	6.48	202	25
July	6.60	209	26
August	6.10	193	24
September	5.47	172	22
October	3.98	137	17
November	2.79	95	12
December	2.25	82	10
Annual	**4.65**	**1,844**	**$ 230**

Location and Station Identification

Requested Location	38572 Bellevue-Cascade Rd. Otter Creek, IA
Weather Data Source	Lat, Lon: 42.25, -90.66 0.7 mi
Latitude	42.25° N
Longitude	90.66° W

PV System Specifications *(Residential)*

DC System Size	1.4 kW
Module Type	Standard
Array Type	Fixed (roof mount)
Array Tilt	20°
Array Azimuth	200°
System Losses	14.08%
Inverter Efficiency	96%
DC to AC Size Ratio	1.2

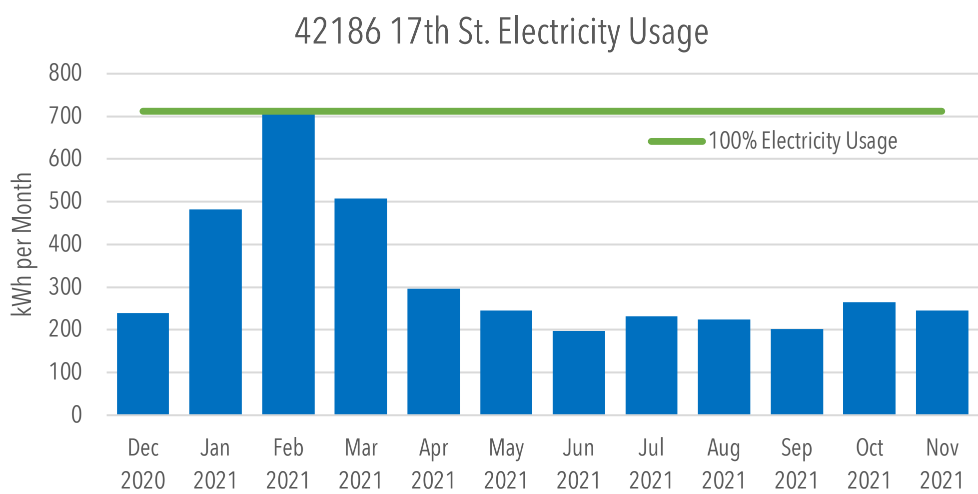
Economics

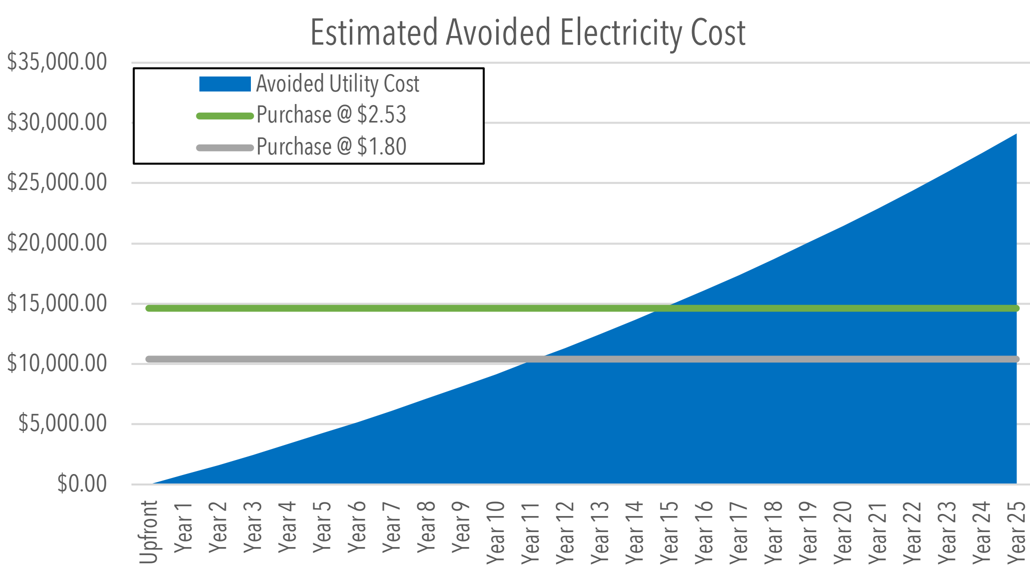
Average Retail Electricity Rate	0.126 $/kWh

Performance Metrics

Capacity Factor	15.0%

Preston Shop – 42186 17th St. Preston, IA (Figure D.9)





Preston Shop – 42186 17th St. Preston, IA (Table D.9)

100% (kWh)	Number of Panels (340 Watt)	System Size (kW DC)	DC-AC Ratio	System Size (kW AC)	Price Per Watt	System Cost
712	17	5.78	1.2	4.816666667	$2.53	$14,623.40
					$2.09	$12,080.20
					$1.80	$10,404.00

Avoided kWh (per Year)	Avoided Cost Total (per Year)	Payback Period (Years)	Lifetime Avoided Cost	Lifetime Return	Return (per Year)	Percent Return (per Year)
3,521.00	$799.00	8.7	$29,130.95	$14,507.55	$580.30	4.0%
		7.2		$17,050.75	$682.03	5.6%
		6.2		$18,726.95	$749.08	7.2%

Orientation	Tree Cover	PV System Requirements (Square Feet)	Roof Size (Square Feet)	Percent Coverage
N/S	None	283	2,436	11.6%

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Caution: Photovoltaic system performance predictions calculated by PVWatts® include many inherent assumptions and uncertainties and do not reflect variations between PV technologies nor site-specific characteristics except as represented by PVWatts® inputs. For example, PV modules with better performance are not differentiated within PVWatts® from lesser performing modules. Both NREL and private companies provide more sophisticated PV modeling tools (such as the System Advisor Model at https://sam.nrel.gov) that allow for more precise and complex modeling of PV systems.

The expected range is based on 30 years of actual weather data at the given location and is intended to provide an indication of the variation you might see. For more information, please refer to this NREL report: The Error Report.

The energy output range is based on analysis of 30 years of historical weather data for nearby, and is intended to provide an indication of the possible interannual variability in generation for a Fixed (open rack) PV system at this location.

RESULTS

7,576 kWh/Year*

System output may range from 7,299 to 7,960 kWh per year near this location.

Month	Solar Radiation (kWh / m² / day)	AC Energy (kWh)	Value ($)
January	2.52	390	41
February	3.48	474	50
March	4.72	689	73
April	5.30	732	77
May	5.98	818	86
June	6.35	810	86
July	6.69	876	92
August	6.12	798	84
September	5.38	701	74
October	4.01	569	60
November	2.77	388	41
December	2.16	333	35
Annual	**4.62**	**7,578**	**$ 799**

Location and Station Identification

Requested Location	42186 17th St Preston
Weather Data Source	Lat, Lon: 42.05, -90.42 0.8 mi
Latitude	42.05° N
Longitude	90.42° W

PV System Specifications *(Residential)*

DC System Size	5.78 kW
Module Type	Standard
Array Type	Fixed (roof mount)
Array Tilt	20°
Array Azimuth	150°
System Losses	14.08%
Inverter Efficiency	96%
DC to AC Size Ratio	1.2

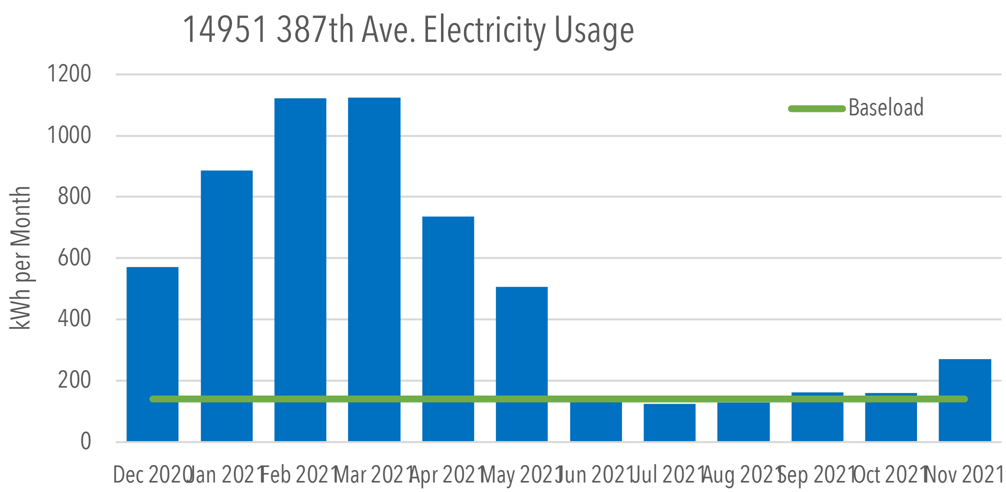
Economics

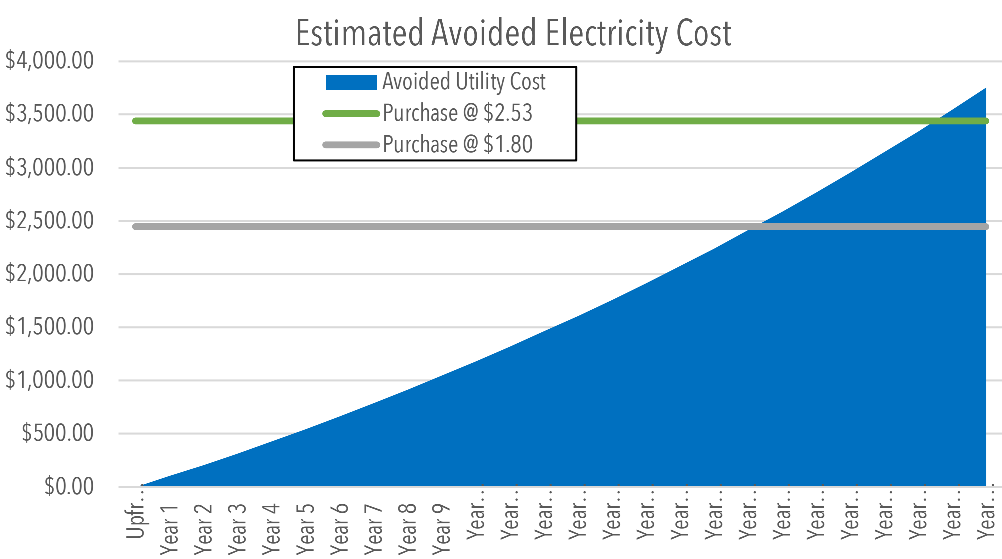
Average Retail Electricity Rate	0.106 $/kWh

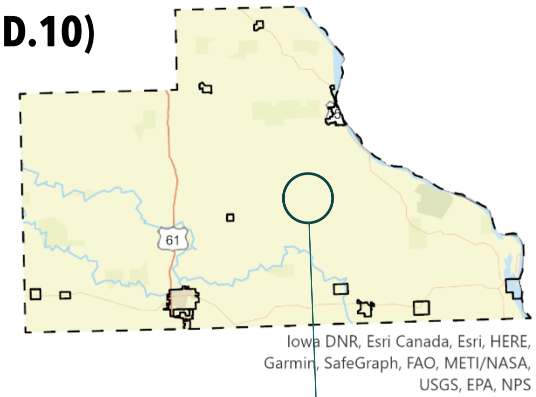
Performance Metrics

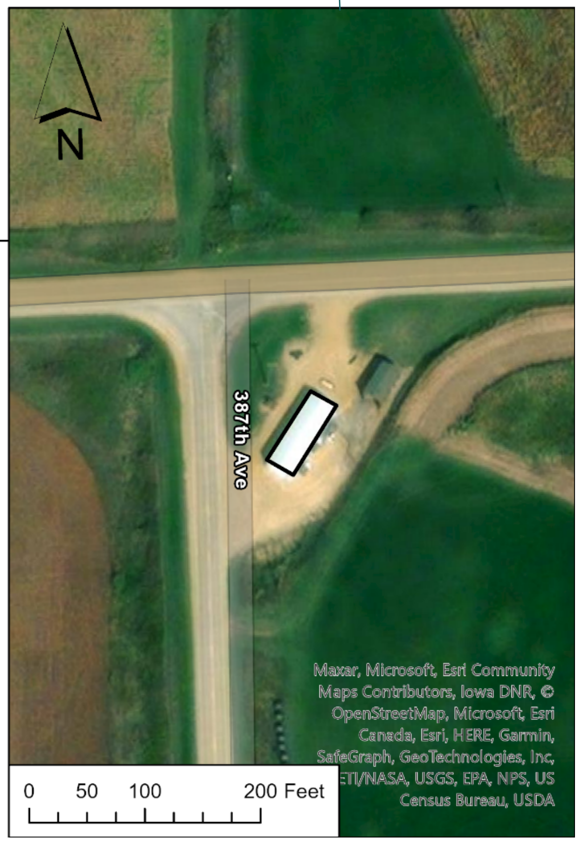
Capacity Factor	15.0%

Springbrook Shop – 14951 387th Ave, Springbrook IA (Figure D.10)









Springbrook Shop – 14951 387th Ave, Springbrook IA (Table D.10)

Baseload (kWh)	Number of Panels (340 Watt)	System Size (kW DC)	DC-AC Ratio	System Size (kW AC)	Price Per Watt	System Cost
140.75	4	1.36	1.2	1.13	2.53	$3,440.80
					2.09	$2,842.40
					1.80	$2,448.00

Avoided kWh (per Year)	Avoided Cost Total (per Year)	Payback Period (Years)	Lifetime Avoided Cost	Lifetime Return	Return (per Year)	Percent Return (per Year)
1,583.00	$103.00	16.0	$3,755.30	$314.50	$12.58	0.4%
		13.2		$912.90	$36.52	1.3%
		11.4		$1,307.30	$52.29	2.1%

Orientation	Tree Cover	PV System Requirements (Square Feet)	Roof Size (Square Feet)	Percent Coverage
NW/SE	None	55	1,825	3.0%

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

RESULTS

1,725 kWh/Year*

System output may range from 1,662 to 1,813 kWh per year near this location.

Month	Solar Radiation (kWh / m^2 / day)	AC Energy (kWh)	Value ($)
January	2.44	89	5
February	3.35	108	6
March	4.42	151	9
April	5.03	165	10
May	6.02	196	12
June	6.26	192	12
July	6.45	198	12
August	5.87	183	11
September	5.25	162	10
October	3.68	123	7
November	2.57	86	5
December	1.97	72	4
Annual	**4.44**	**1,725**	**$ 103**

Location and Station Identification

Requested Location	14951 387th Ave, Bellevue, IA
Weather Data Source	Lat, Lon: 42.17, -90.46 0.8 mi
Latitude	42.17° N
Longitude	90.46° W

PV System Specifications *(Residential)*

DC System Size	1.36 kW
Module Type	Standard
Array Type	Fixed (open rack)
Array Tilt	20°
Array Azimuth	225°
System Losses	14.08%
Inverter Efficiency	96%
DC to AC Size Ratio	1.2

Economics

Average Retail Electricity Rate	0.060 $/kWh

Performance Metrics

Capacity Factor	14.5%

Caution: Photovoltaic system performance predictions calculated by PVWatts® include many inherent assumptions and uncertainties and do not reflect variations between PV technologies nor site-specific characteristics except as represented by PVWatts® inputs. For example, PV modules with better performance are not differentiated within PVWatts® from lesser performing modules. Both NREL and private companies provide more sophisticated PV modeling tools (such as the System Advisor Model at https://sam.nrel.gov) that allow for more precise and complex modeling of PV systems.

The expected range is based on 30 years of actual weather data at the given location and is intended to provide an indication of the variation you might see. For more information, please refer to this NREL report: The Error Report.

The energy output range is based on analysis of 30 years of historical weather data for nearby, and is intended to provide an indication of the possible interannual variability in generation for a Fixed (open rack) PV system at this location.

NATIONAL RENEWABLE ENERGY LABORATORY

Caution: Photovoltaic system performance predictions calculated by PVWatts® include many inherent assumptions and uncertainties and do not reflect variations between PV technologies nor site-specific characteristics except as represented by PVWatts® inputs. For example, PV modules with better performance are not differentiated within PVWatts® from lesser performing modules. Both NREL and private companies provide more sophisticated PV modeling tools (such as the System Advisor Model at https://sam.nrel.gov) that allow for more precise and complex modeling of PV systems.

The expected range is based on 30 years of actual weather data at the given location and is intended to provide an indication of the variation you might see. For more information, please refer to this NREL report: The Error Report.

The energy output range is based on analysis of 30 years of historical weather data for nearby, and is intended to provide an indication of the possible interannual variability in generation for a Fixed (open rack) PV system at this location.

RESULTS

147,544 kWh/Year*

System output may range from 142,143 to 155,024 kWh per year near this location.

Month	Solar Radiation (kWh / m^2 / day)	AC Energy (kWh)	Value ($)
January	2.57	7,627	790
February	3.54	9,174	950
March	4.58	12,779	1,324
April	5.55	14,478	1,500
May	6.19	16,115	1,670
June	6.33	15,623	1,619
July	6.58	16,545	1,714
August	6.11	15,283	1,583
September	5.57	13,852	1,435
October	4.14	11,233	1,164
November	2.87	7,688	796
December	2.40	7,146	740
Annual	**4.70**	**147,543**	**$ 15,285**

Location and Station Identification

Requested Location	County Jail Maquoketa, IA
Weather Data Source	Lat, Lon: 42.05, -90.66 1.6 mi
Latitude	42.05° N
Longitude	90.66° W

PV System Specifications *(Residential)*

DC System Size	109.48 kW
Module Type	Standard
Array Type	Fixed (open rack)
Array Tilt	20°
Array Azimuth	180°
System Losses	14.08%
Inverter Efficiency	96%
DC to AC Size Ratio	1.2

Economics

Average Retail Electricity Rate	0.104 $/kWh

Performance Metrics

Capacity Factor	15.4%

RESULTS

145,526 kWh/Year*

System output may range from 140,200 to 152,904 kWh per year near this location.

Month	Solar Radiation (kWh / m^2 / day)	AC Energy (kWh)	Value ($)
January	2.63	7,768	544
February	3.64	9,487	664
March	4.74	13,070	915
April	5.20	13,740	962
May	5.87	15,408	1,079
June	6.25	15,452	1,082
July	6.44	15,799	1,106
August	6.22	15,444	1,081
September	5.42	13,518	946
October	3.90	10,478	733
November	3.14	8,370	586
December	2.36	6,992	489
Annual	**4.65**	**145,526**	**$ 10,187**

Location and Station Identification

Requested Location	Sabula Camground, Sabula, IA
Weather Data Source	Lat, Lon: 42.09, -90.18 1.3 mi
Latitude	42.09° N
Longitude	90.18° W

PV System Specifications *(Residential)*

DC System Size	109.48 kW
Module Type	Standard
Array Type	Fixed (open rack)
Array Tilt	20°
Array Azimuth	180°
System Losses	14.08%
Inverter Efficiency	96%
DC to AC Size Ratio	1.2

Economics

Average Retail Electricity Rate	0.070 $/kWh

Performance Metrics

Capacity Factor	15.2%

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Caution: Photovoltaic system performance predictions calculated by PVWatts® include many inherent assumptions and uncertainties and do not reflect variations between PV technologies nor site-specific characteristics except as represented by PVWatts® inputs. For example, PV modules with better performance are not differentiated within PVWatts® from lesser performing modules. Both NREL and private companies provide more sophisticated PV modeling tools (such as the System Advisor Model at https://sam.nrel.gov) that allow for more precise and complex modeling of PV systems.

The expected range is based on 30 years of actual weather data at the given location and is intended to provide an indication of the variation you might see. For more information, please refer to this NREL report: The Error Report.

The energy output range is based on analysis of 30 years of historical weather data for nearby, and is intended to provide an indication of the possible interannual variability in generation for a Fixed (open rack) PV system at this location.

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Caution: Photovoltaic system performance predictions calculated by PVWatts® include many inherent assumptions and uncertainties and do not reflect variations between PV technologies nor site-specific characteristics except as represented by PVWatts® inputs. For example, PV modules with better performance are not differentiated within PVWatts® from lesser performing modules. Both NREL and private companies provide more sophisticated PV modeling tools (such as the System Advisor Model at https://sam.nrel.gov) that allow for more precise and complex modeling of PV systems.

The expected range is based on 30 years of actual weather data at the given location and is intended to provide an indication of the variation you might see. For more information, please refer to this NREL report: The Error Report.

The energy output range is based on analysis of 30 years of historical weather data for nearby, and is intended to provide an indication of the possible interannual variability in generation for a Fixed (open rack) PV system at this location.

RESULTS

115,927 kWh/Year*

System output may range from 111,684 to 121,805 kWh per year near this location.

Month	Solar Radiation (kWh / m^2 / day)	AC Energy (kWh)	Value ($)
January	2.57	5,993	621
February	3.54	7,208	747
March	4.58	10,041	1,040
April	5.55	11,376	1,179
May	6.19	12,662	1,312
June	6.33	12,275	1,272
July	6.58	13,000	1,347
August	6.11	12,008	1,244
September	5.57	10,884	1,128
October	4.14	8,826	914
November	2.87	6,041	626
December	2.40	5,615	582
Annual	**4.70**	**115,929**	**$ 12,012**

Location and Station Identification

Requested Location	201 w platt St. Maquoketa IA
Weather Data Source	Lat, Lon: 42.05, -90.66 1.4 mi
Latitude	42.05° N
Longitude	90.66° W

PV System Specifications *(Commercial)*

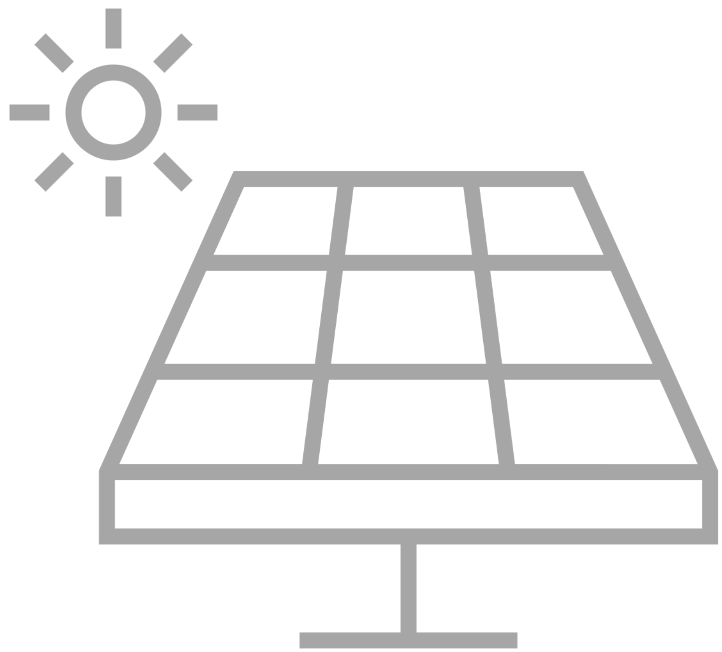
DC System Size	86.02 kW
Module Type	Standard
Array Type	Fixed (open rack)
Array Tilt	20°
Array Azimuth	180°
System Losses	14.08%
Inverter Efficiency	96%
DC to AC Size Ratio	1.2

Economics

Average Retail Electricity Rate	0.104 $/kWh

Performance Metrics

Capacity Factor	15.4%



Appendix E

Technology Review

This section explains existing solar technology and its applications, along with the materials used to make solar panels, how solar panels are manufactured, and how solar panels are recycled at the end of their life. Not all the applications are suitable or applicable to Jackson County, but it is useful to know what technology opportunities are available.

How Clean is Solar Energy?

When discussing solar energy specifically, the materials used to manufacture solar panels and how solar panels are manufactured and recycled, solar panels are not completely clean. However, solar energy is cleaner than using non-renewable sources.

Solar energy has a carbon footprint almost 20 times less than the carbon footprint of coal-powered electricity sources. For example, around 50 grams of CO2 per kilowatt-hour (kWh) is produced during the first few years of operating a solar energy system. After solar panels have been in operation for around three years, they become carbon neutral, thus no longer producing carbon emissions, and having no remaining carbon debt (Cool Effect, 2021).

Solar panels are primarily made from silicon, which comes from quartz. Quartz must be mined and heated in a furnace to obtain the usable forms of silicon that are needed for manufacturing solar panels. The process of mining and heating quartz releases sulfur dioxide and carbon dioxide into the atmosphere causing it to heat up, which is not sustainable for the environment (EnergySage, 2021).

The manufacturing of solar panels uses toxic chemicals and, if not handled or disposed of properly, those chemicals can have negative effects on the people or the environment. If solar panels are recycled properly and not thrown into a landfill, the process of disposing them can prevent materials such as lead and cadmium from harming the environment.

The three ways panels can be recycled is through re-use, mechanical, and chemical. Solar panels can be re-used and/or refurbished and continue producing energy after their warrantied lifetime, but the energy produced will be significantly less efficient than before. Mechanical recycling is breaking down solar panels and physically separating the components on the inside. On the other hand, chemical recycling of solar panels involves using reactions at a molecular level and then separating the ingredients that are inside a solar panel (EnergySage, 2021).

Solar Technology

Solar energy is the most abundant renewable energy sources; each hour the amount of solar energy striking the earth is about 170-petawatt hour which is more than enough to cover the world energy consumption for a year estimated about 160-petawatt hour. (DOE). Present technology allows the utilization of solar energy through three primary methods: photovoltaics (PV), which directly converts light to electricity; concentrating solar power (CSP), which uses heat from the sun to drive utility-scale electric turbines; and heating and cooling systems, which collects thermal energy to provide hot water, heating, and air conditioning. Solar energy can be deployed through distributed generation, whereby the equipment is located on rooftops or ground-mounted arrays close to where the energy is used. Some technologies can be further expanded into utility-scale applications to produce energy in a central power plant. (Association, 2021)

Photovoltaic (PV)

Photovoltaic technologies directly convert energy from sunlight into electricity. When sunlight strikes the PV module, made of semiconductor material, electrons are stripped from their atomic bonds. This flow of electrons produces an electric current that powers electrical devices or sends electricity to the grid. PV devices range from powering small electronics like calculators and car parking payment machines to entire homes and large buildings. PV generally lasts thirty years or more with minimal maintenance. In addition to crystalline silicon (c-Si), there are two other types of PV technology: thin-film PV, which is generally less efficient but often cheaper than c-Si modules and concentrating PV arrays, which uses lenses and mirrors that require direct sunlight and tracking systems. (Figure G.1) (Association, 2021)

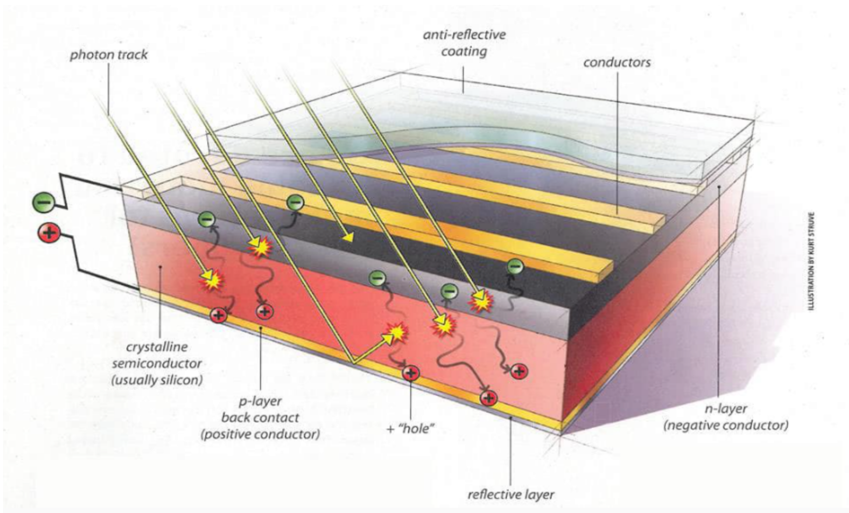


Figure E.1. Typical Crystalize Silicon Solar Cell (Association, 2021)

Solar heating and cooling

Solar heating and cooling technologies collect thermal energy from the sun and use this heat to provide hot water and space heating and cooling for residential, commercial, and industrial buildings (Figure G.2). There are several types of collectors: flat plate, evacuated tube, Integral Collector Storage (ICS), thermosiphon and concentrating. Water heating, space heating and cooling consume 69% of the energy used in an average U.S. household. A properly designed and installed system can provide 40-80% of water heating, space heating, and cooling needs of a building.

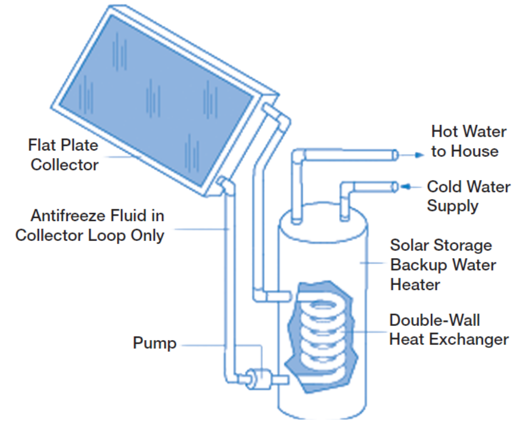


Figure E.2. Solar Heating and Cooling Graphic

Individual Residential Solar PV Panels

Residential solar photovoltaic panels are placed either on the rooftop or the ground; however, there are also advanced types of solar photovoltaics that integrate with the building elevations, architectural glass, roof shingles, or even solar skins that are made to integrate with custom designs. The system could have the option of storage batteries, and feedback surplus to the main grid (Figure G.3) (Morley, 2014).

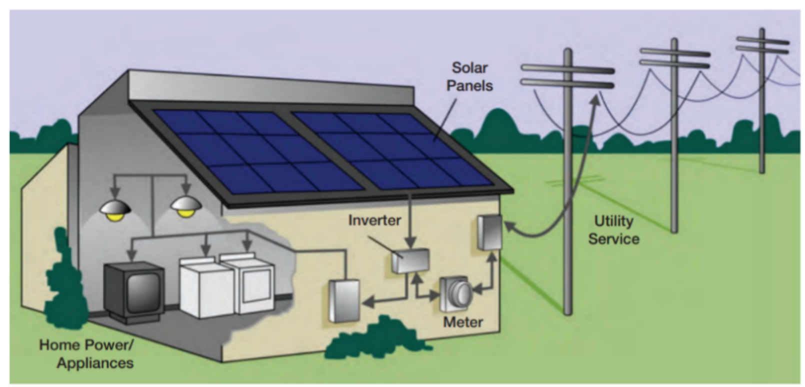


Figure E.3. Individual Residential Solar PV Panels

Utility-Scale Solar

Utility-scale solar defined by the Solar Energy Industries Association (SEIA) as a project with one megawatt capacity or more, while the National Renewable Energy laboratory (NREL) defines it as five megawatts or more. Utility-scale solar can connect to the local utility grid and feedback generated electricity. (Figure G.4) (Clearloop, 2020).

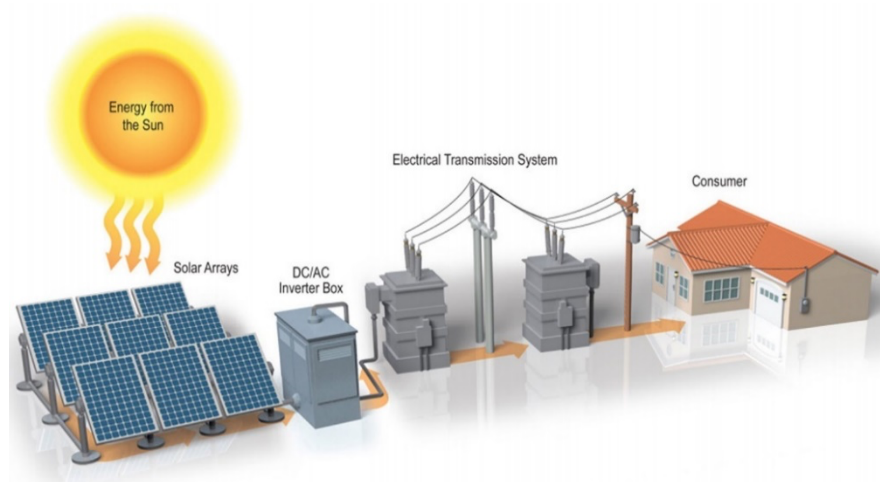


Figure E.4. Utility Scale Solar. Source: Wisconsin

Concentrating Solar Power (CSP) (Utility-Scale)

Concentrating solar power plants use mirrors to concentrate the sun's thermal energy to drive a conventional steam turbine to make electricity. The thermal energy concentrated in a CSP plant can be stored and used to produce electricity when it is needed (Figure G.4).

Figure E.5: Concentrated Solar Power (Association, 2021)

Microgrid

A microgrid is a collection of interconnected energy sources that are controlled by a microgrid controller to receive and distribute energy within a specific geographic area, such as college campuses, hospital complexes, military facilities, or neighborhoods. A microgrid could be designed to operate as a grid connected or a disconnected mode (island-mode). A microgrid set up similarly to the actual utility electric grid but on a smaller scale. Microgrid could operate and supply energy even if the utility grid fails, unlike simple rooftop solar panels connected to the utility grid that will not supply energy if the grid fails. Some microgrids include storage systems and some have electric vehicle charging stations. Advanced microgrid controller can manage energy supply efficiently, it can track real-time changes in energy prices on the utility grid, then it can decide to receive energy from the utility grid when the price is low to serve customers connected to the microgrid, rather than use energy from the microgrid energy resources. (Figure G.6). (Wood, 2020)

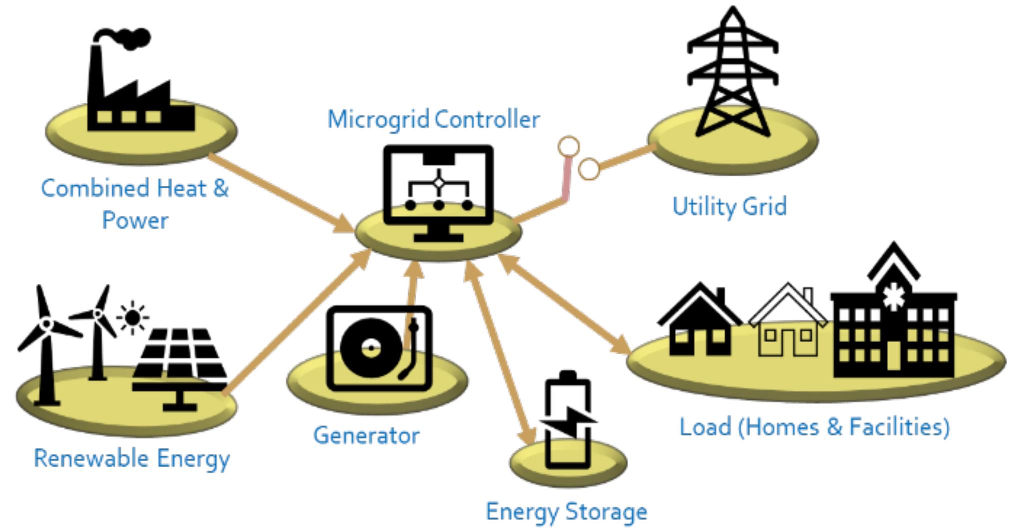


Figure E.6: Microgrid example

Community Solar/ Municipal Utility

Community Solar is defined as a system that allows multiple customers from multiple locations to subscribe or purchase part of a solar system and receive benefits based on energy generation. Community solar systems are normally owned and operated by local government, community members, a non-profit, or a third-party investor. (Figure G.7). (ILSR, 2021)

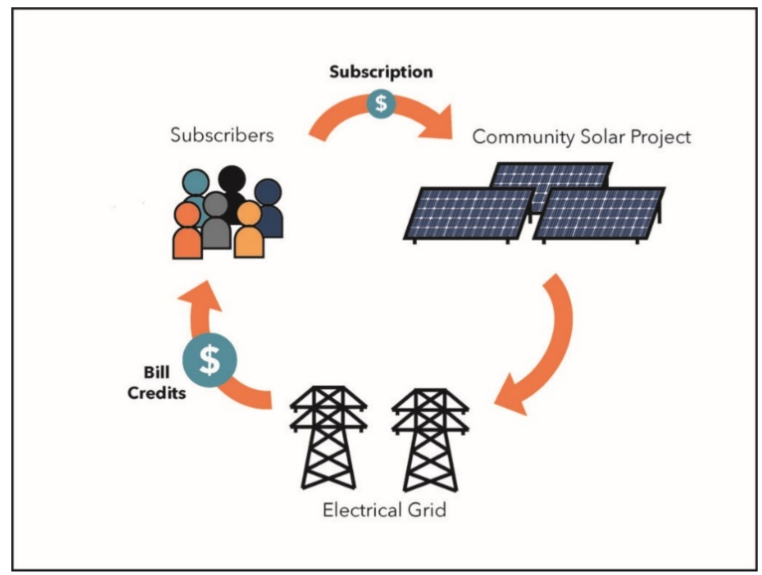


Figure E.7: Grid-Connected Community Microgrid

Advanced Solar Technology Innovations

Floating Solar Farms

Floating solar farms are an advanced form of solar technology, silicon panels offer more efficiency and are becoming cheaper over time. The photovoltaic panels are placed on bodies of water. Floating solar farms have the advantage of generating electricity without using productive l land. Installing floating photovoltaic panels is cheaper than installing land-based photovoltaic panels. Floating solar panels generate up to 10% more than land-based solar panels due to the water-cooling effect. Large floating solar farms also have other environmental benefits as they reduce the loss of water to evaporation and prevent noxious algae production (Figure G.8). (SolarReviews, SolarReviews, 2021)

Floating solar farms could also be installed in extremely cold and freezing areas. System components and materials are made to meet low temperature and heavy snow load specifications to resist brittle cracking and fracture. A 500 Kw floating solar farm was built on a lake in Bayan County, Heilongjiang Province, China in 2018, where the temperature in winter reaches -4 degrees Fahrenheit (Figure G.9). (BELLINI, 2021)

Figure E.8. Floating Solar Farm Source: Sungrow

Figure E.9. A 500-kW floating array located in Bayan County, Heilongjiang Province, China Where Temperature can be less than minus -4 Degrees Fahrenheit Celsius. Source: Sungrow

Agrovoltaic

The agrovoltaic or agrovoltaic is the combination use of land to produce photovoltaic solar energy and agricultural crops. The existence of both solar panels and crops in the same area results in sharing light, the shade generated by solar panels placed above crops creates a microclimate over the planting area which reduces stress on plants and produces high temperatures and UV rays. The microclimate could also provide more fresh crops, less water required for irrigation, and lower evaporation. Also, the microclimate creates moisture that has a cooling effect on solar panels that increase the energy generation efficiency. Moreover, sheep can be grazed under the solar panels, and beehives could be placed within the solar farm. (Figure G.10 & Figure G.11) (David, Agrivoltaic Systems, A Promising Experience, 2021)

23.

Figure E.10 Sheep under solar panels in Lanai, Hawaii Photo credited to (Wikipedia, Agrivoltaic, 2021)

Figure E.11 Agrovoltaic Solar Farm Photo credited to (David, Agrivoltaic Systems, A Promising Experience, 2021)

Building-Integrated Photovoltaics

Recent technology allows solar photovoltaics to blend into building architecture in the form of roofs, canopies, curtain walls, facades, and skylight systems without compromising building aesthetic and design. Photovoltaics panels serve both functions of building material and energy-generating devices, allowing natural light inside buildings the same as architectural glasses. Also, Building-Integrated Photovoltaics have High thermal and sound insulation. Building-Integrated Photovoltaics allow saving on building materials and the additional cost of solar panels mounting system. (SEIA, 2020).

Solar Skins

Solar Skins are a PV technology to integrate custom designs into solar panel systems. The sunlight falling on solar skins is filtered to reach the solar cells beneath it. Therefore, it provides solar energy and displays the custom image at the same time. These imprinted custom images, embedded into solar panels, can exactly match the grassy lawns or rooftops of any building. (Figure G.12) (SolarReviews, SolarReviews, 2021)

Figure E.12. Roof Top Solar Skins Panels

Solar Fabric

Researchers are developing solar fabrics for solar power in each fiber. These solar filaments can be embedded into t-shirts, winter coats, or any other clothing to help keep a person warmer, power **a** phone, and provide energy for other needs. Researchers have attempted to combine solar fabric and solar panels to include building facades that provide both shade and power. (SolarReviews, SolarReviews, 2021)

Photovoltaic Solar Noise Barriers (PVNB)

Noise barriers are constructed to eliminate highway traffic noise; however, barriers are now targeted to function as noise-reducing and power-generating elements

Effects of Weather on Solar

Cloudy Days/Nights

Solar panels still work on cloudy days; however, the efficiency is reduced. On average, solar panels will generate 10-30% normal power output on days with heavy cloud coverage. During the night, solar panels do not generate electricity. The highest generation time is during the hours of peak sunlight, when the solar panels may generate more power than the building consumes. Surplus power can be used to provide extra electricity with battery storage at night or can be sold back to utility companies (SI Solar, 2020).

Tornadoes and Hurricanes

Most solar panels are certified to withstand winds up to 140 miles per hour. For example, Florida's largest utility company reported that Hurricane Irma in 2017 damaged only .04% of the 1,000,000 panels in the storm's path.

Heavy Rain, Snow, and Ice

The rain helps solar panels work more effectively as the rain washes away dirt or other debris on the panels. Solar panels are strong enough to withstand damage by snow or ice. The panels can generate electricity through a thin layer of snow, however, several inches or more render the panel inoperable. There are tools, such as a snow rake for solar panels, to remove the accumulated snow off the panels when needed.

Hailstorms

Most solar panels are designed to withstand hail up to one inch in diameter falling at 50 miles per hour. Hail damage on solar panels is not a common occurrence.

Lightning

Lightning can melt panels and the inverter if it strikes at a precise location, but it is a rare occurrence. Most manufacturers abide by requirements that promote the safety of a home and the people during lightning storms (Vivint Solar, 2021).

Cloudy Days/Nights

Solar panels still work on cloudy days; however, the efficiency is reduced. On average, solar panels will generate 10-30% normal power output on days with heavy cloud coverage. During the night, solar panels do not generate electricity. The highest generation time is during the hours of peak sunlight, when the solar panels may generate more power than the building consumes. Surplus power can be used to provide extra electricity with battery storage at night or can be sold back to utility companies (SI Solar, 2020).

Tornadoes and Hurricanes

Most solar panels are certified to withstand winds up to 140 miles per hour. For example, Florida's largest utility company reported that Hurricane Irma in 2017 damaged only .04% of the 1,000,000 panels in the storm's path.

Heavy Rain, Snow, and Ice

The rain helps solar panels work more effectively as the rain washes away dirt or other debris on the panels. Solar panels are strong enough to withstand damage by snow or ice. The panels can generate electricity through a thin layer of snow, however, several inches or more render the panel inoperable. There are tools, such as a snow rake for solar panels, to remove the accumulated snow off the panels when needed.

Hailstorms

Most solar panels are designed to withstand hail up to one inch in diameter falling at 50 miles per hour. Hail damage on solar panels is not a common occurrence.

Lightning

Lightning can melt panels and the inverter if it strikes at a precise location, but it is a rare occurrence. Most manufacturers abide by requirements that promote the safety of a home and the people during lightning storms (Vivint Solar, 2021).

Appendix F

Springbrook Community Survey Results

Part 1: Respondent Profile Questions

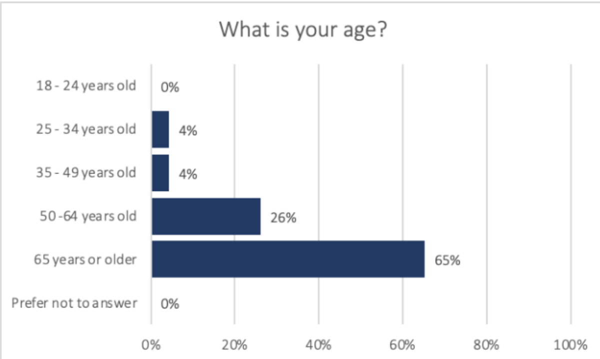


Figure F.1

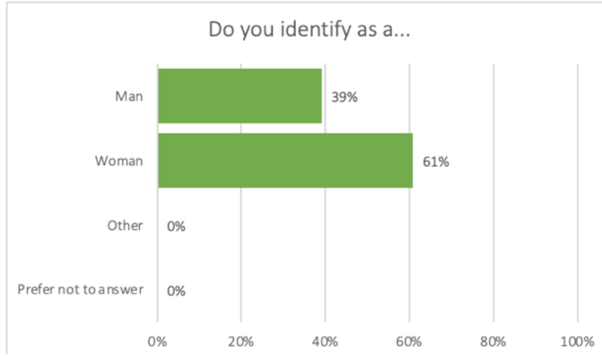


Figure F.2

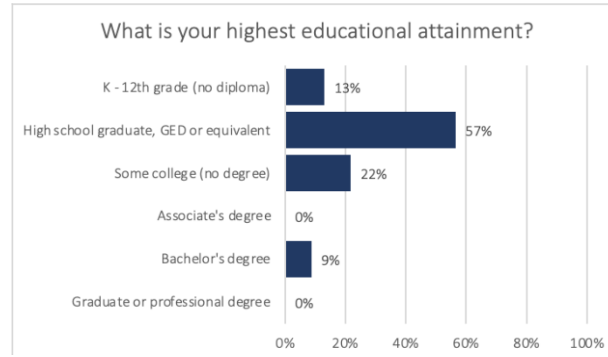


Figure F.3

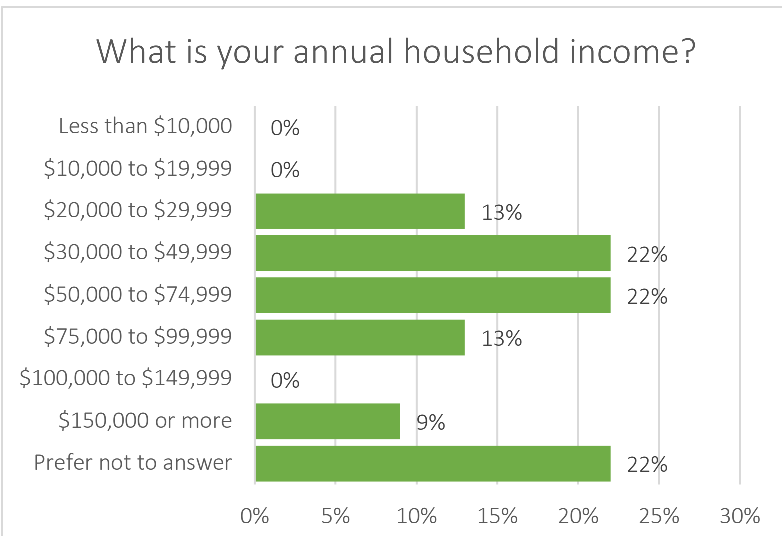


Figure F.4

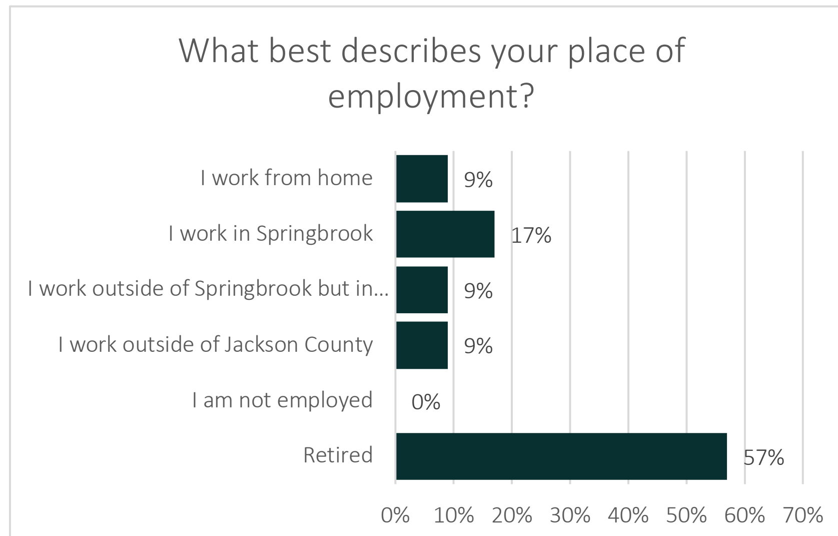


Figure F.5

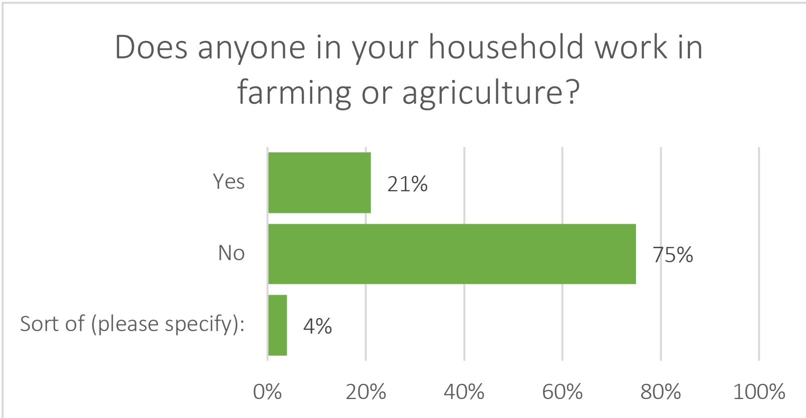


Figure F.6

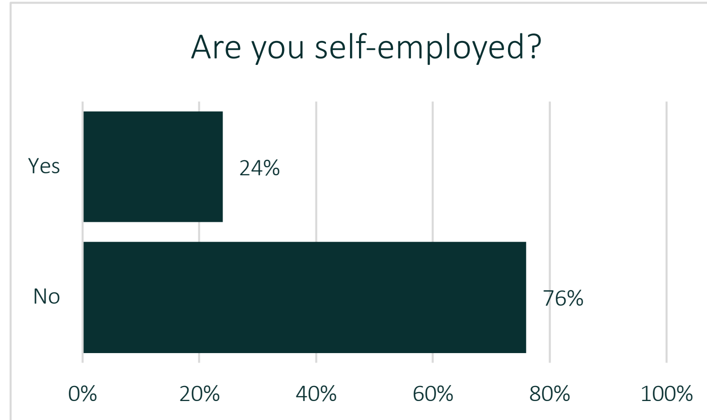


Figure F.7

Part 2: Household & Community Questions

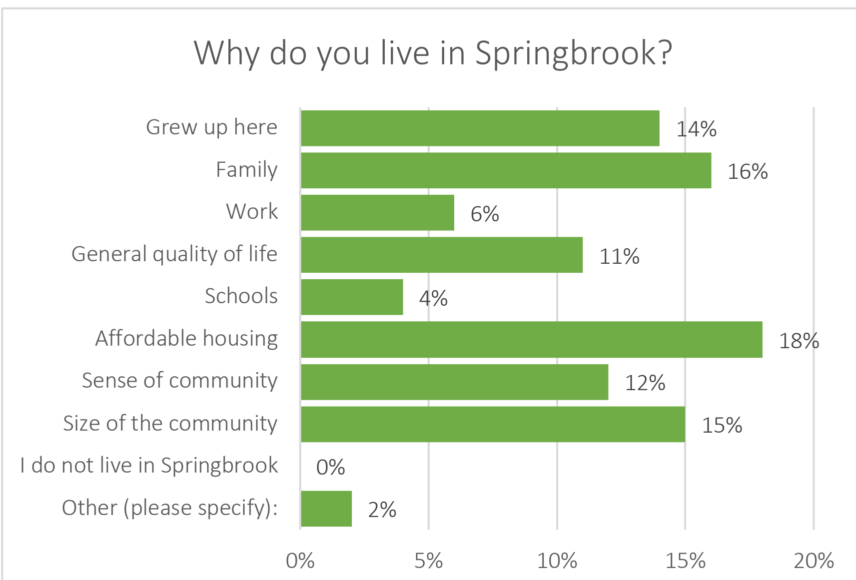


Figure F.8

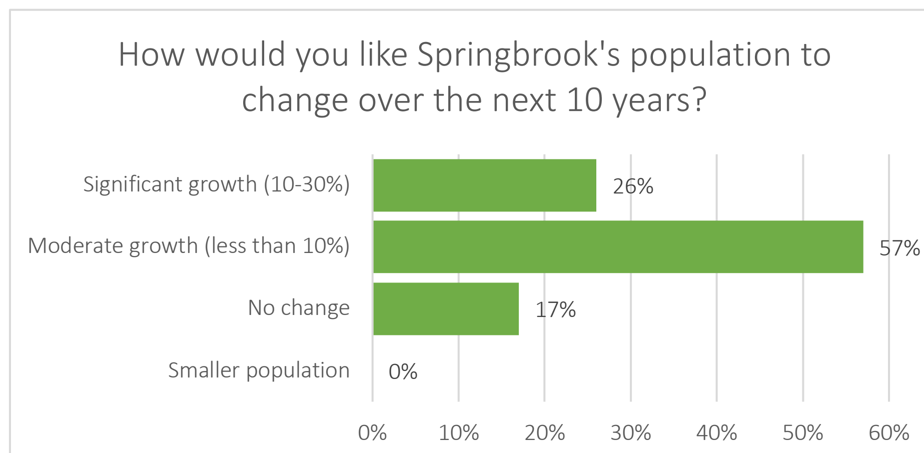


Figure F.9

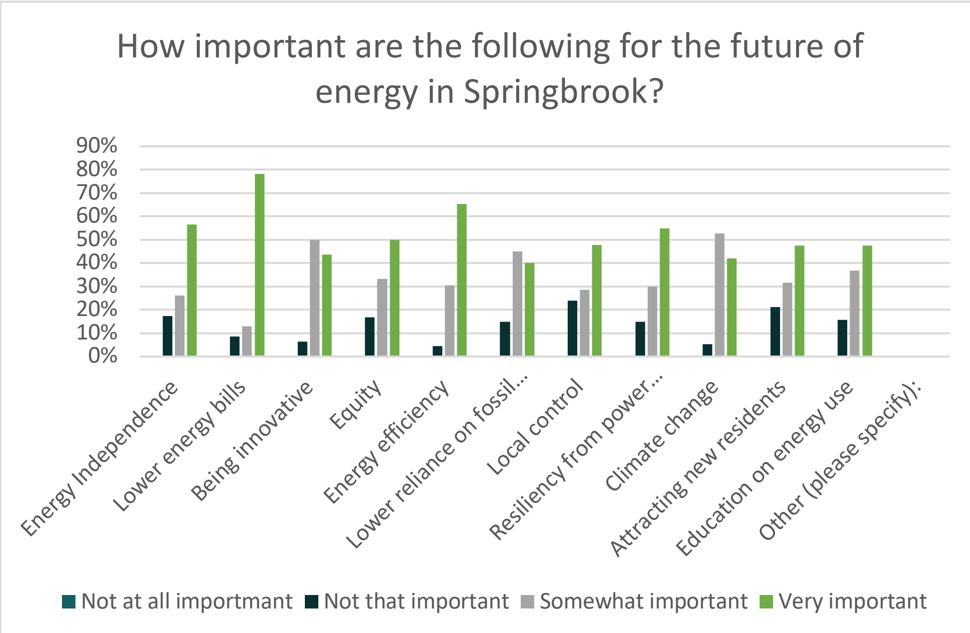


Figure F.10

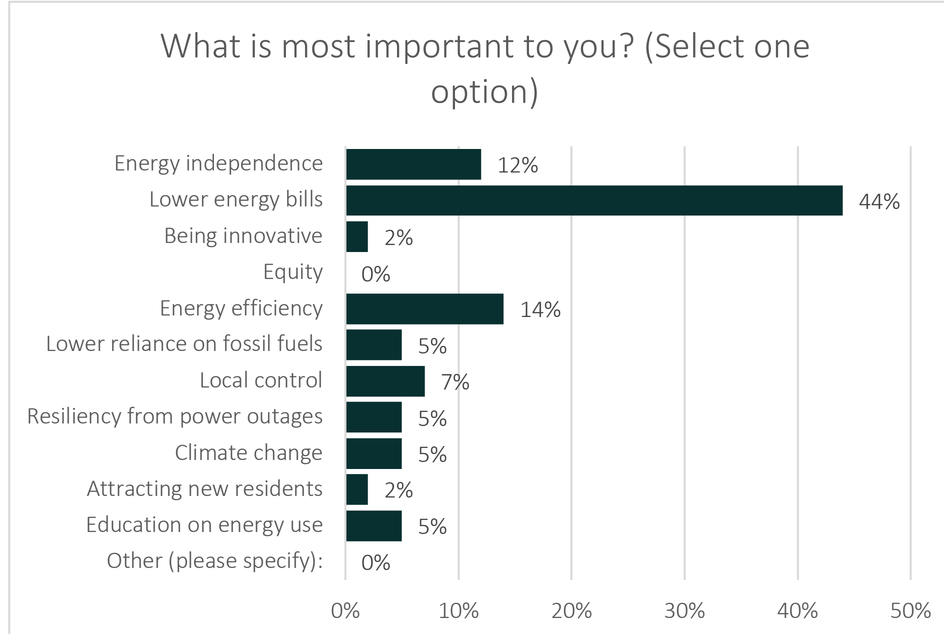


Figure F.11

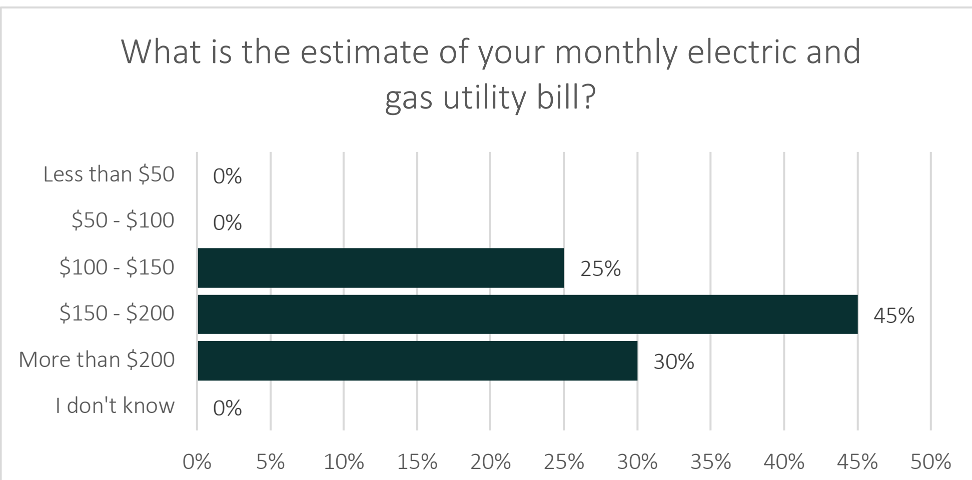


Figure F.12

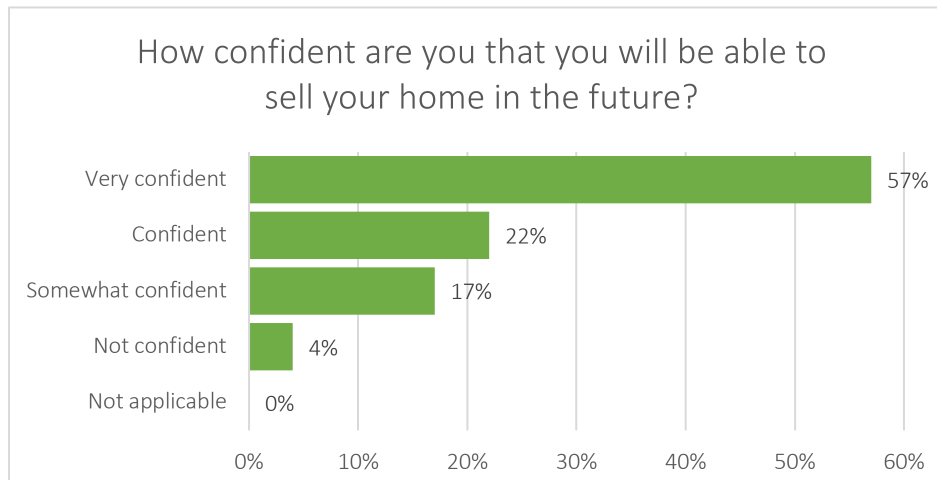


Figure F.13

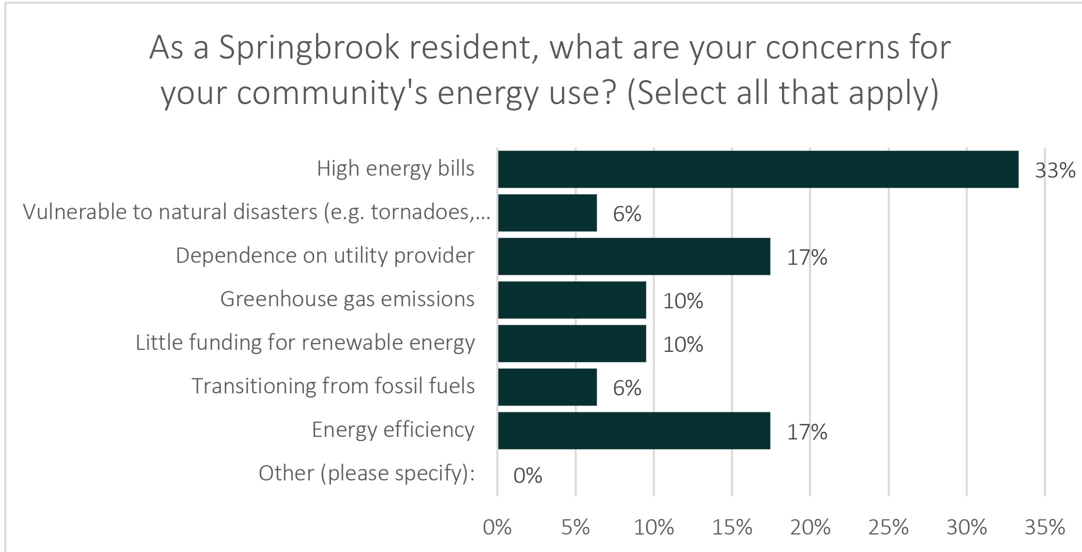


Figure F.14

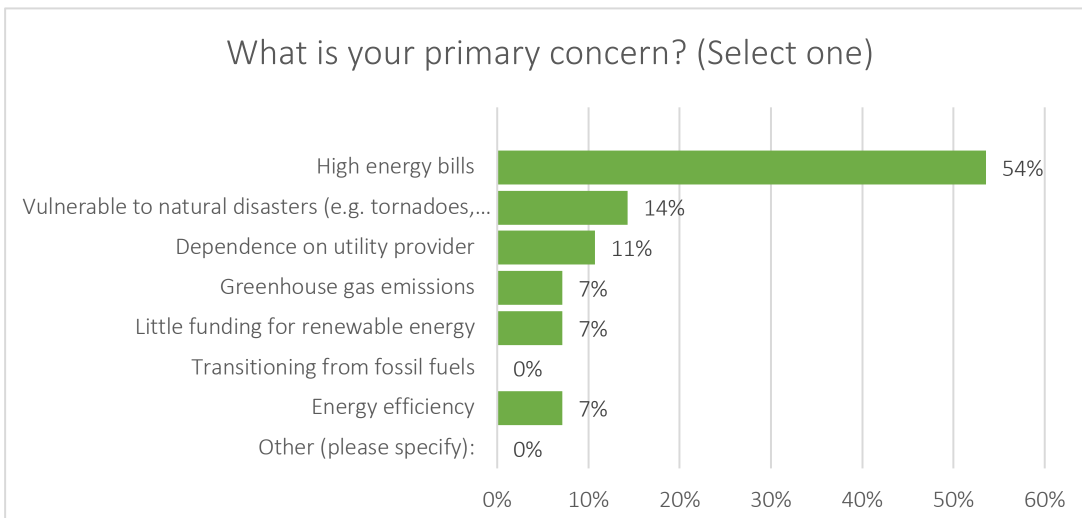


Figure F.15

Part 3: Disaster Preparedness

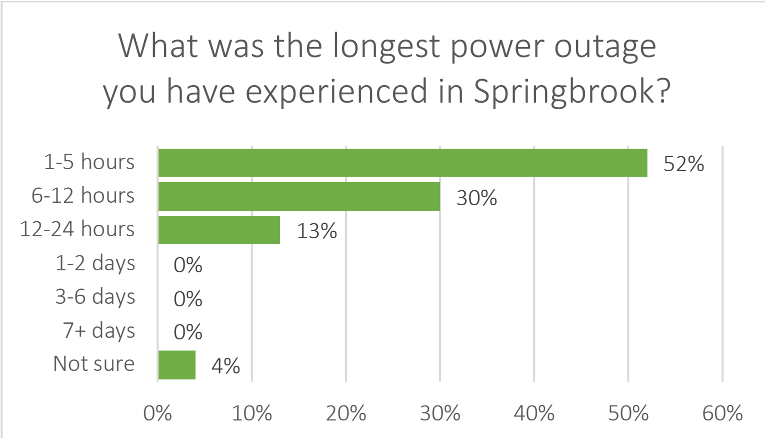


Figure F.16

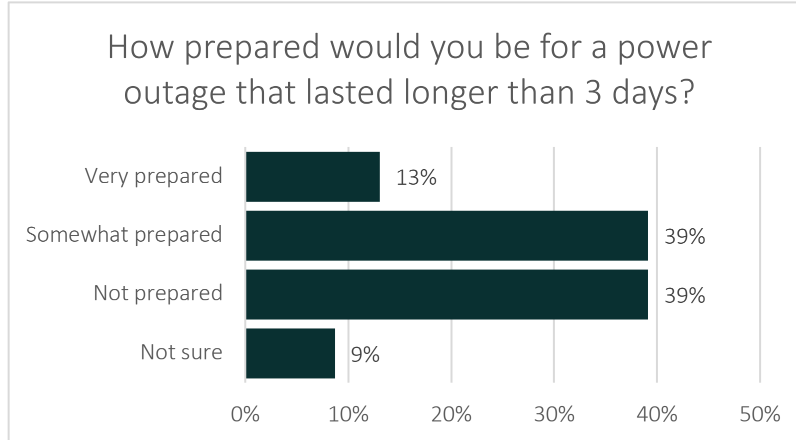


Figure F.17

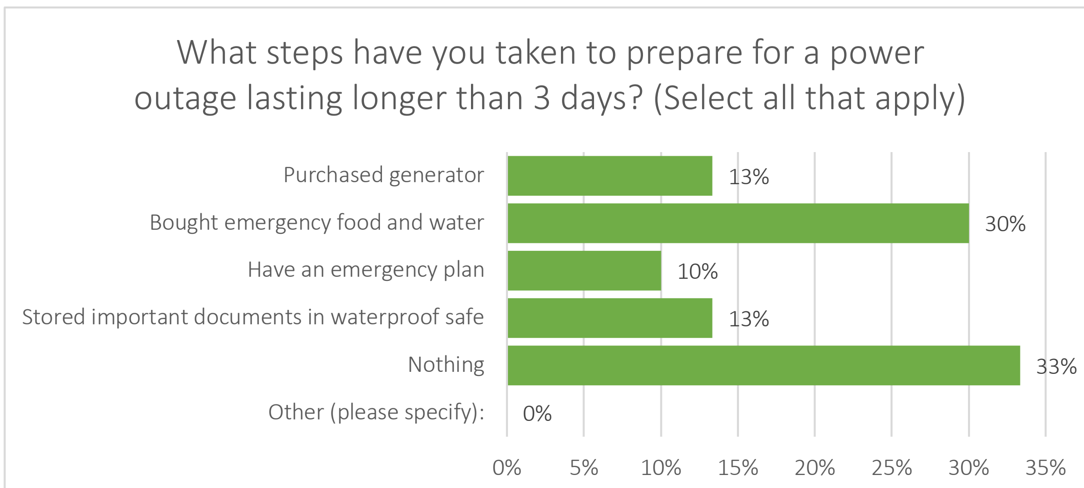


Figure F.18

Part 4: Energy Use Questions

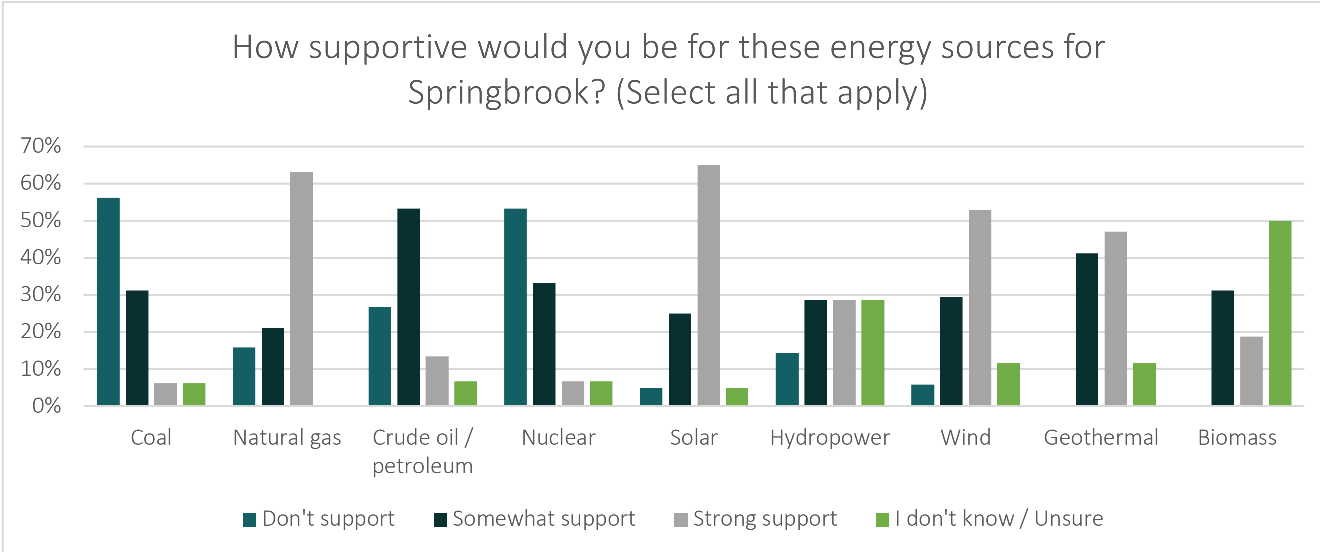


Figure F.19

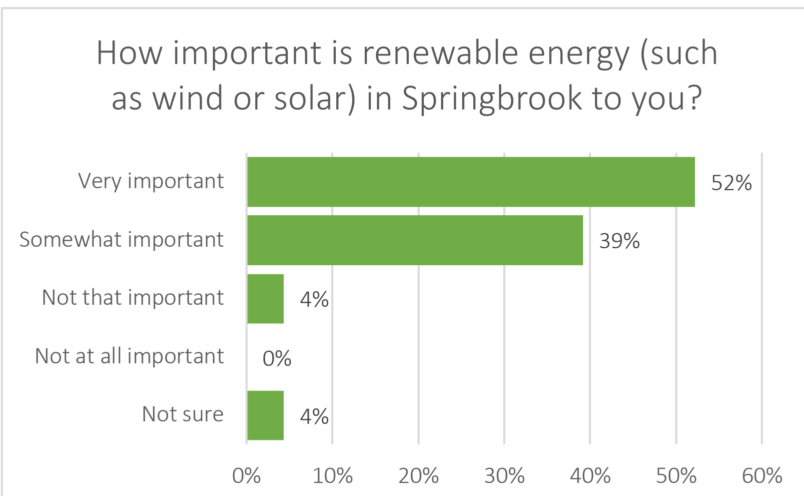


Figure F.20

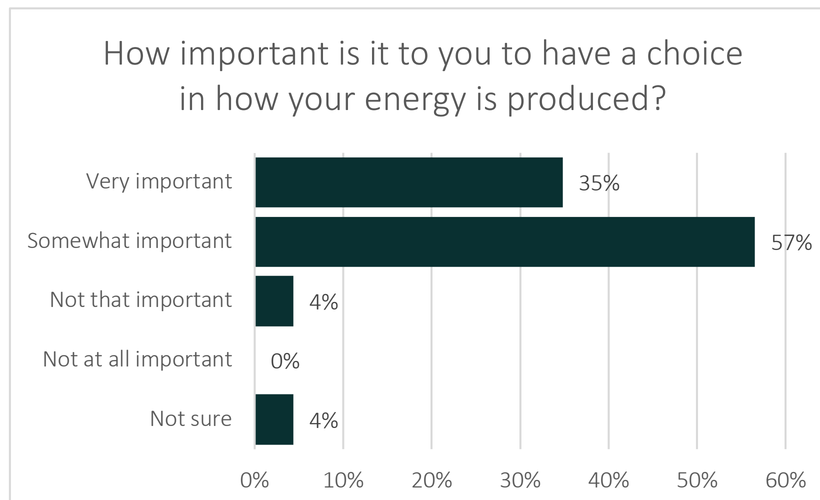


Figure F.21

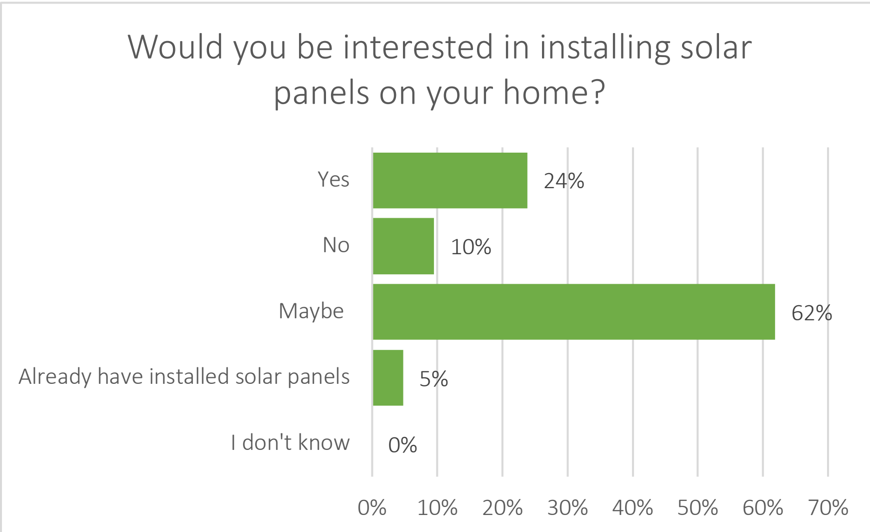


Figure F.22

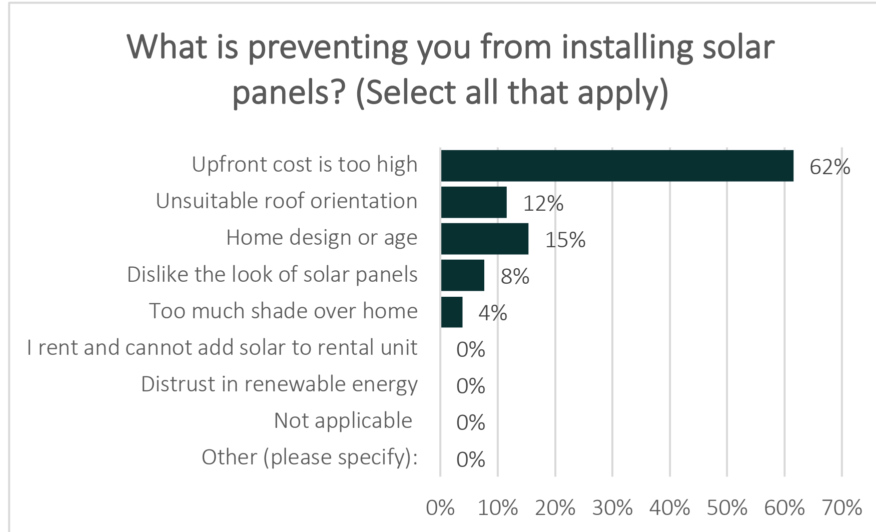


Figure F.23

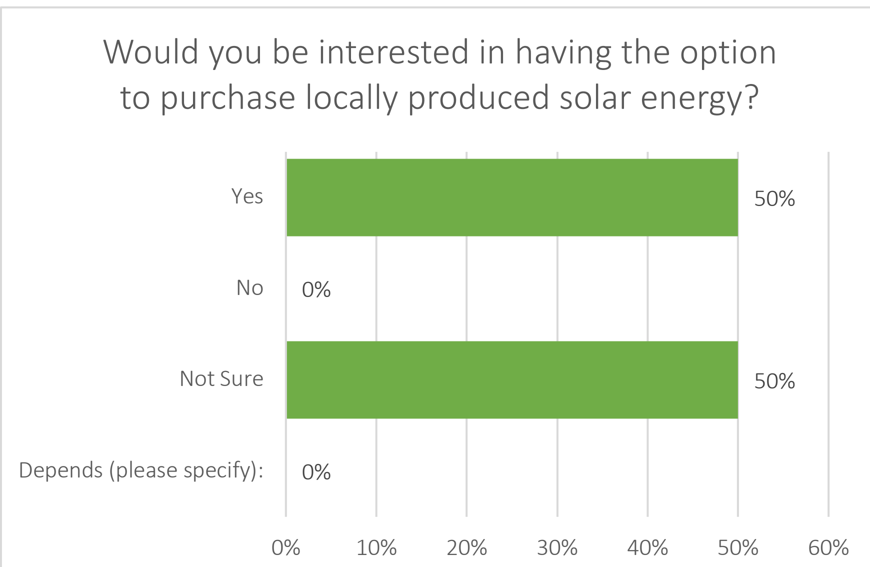


Figure F.24

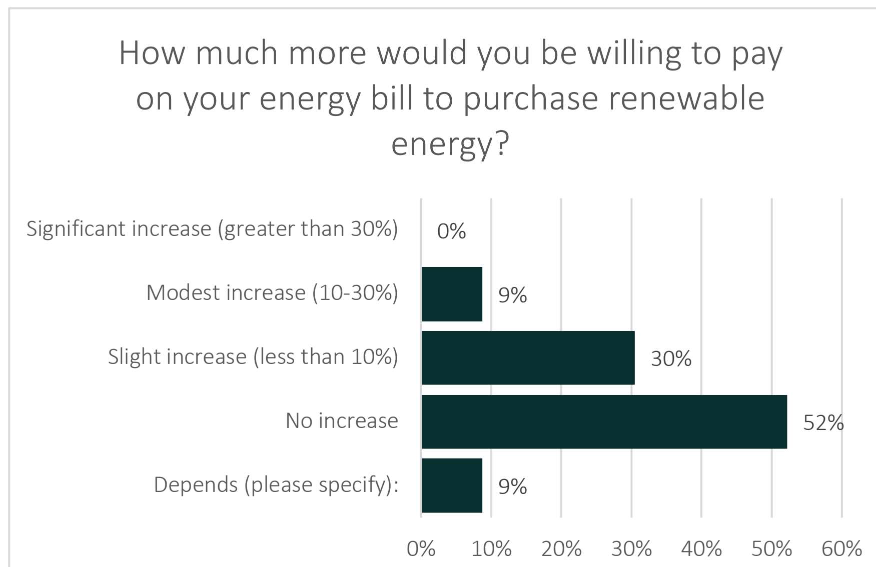


Figure F.25

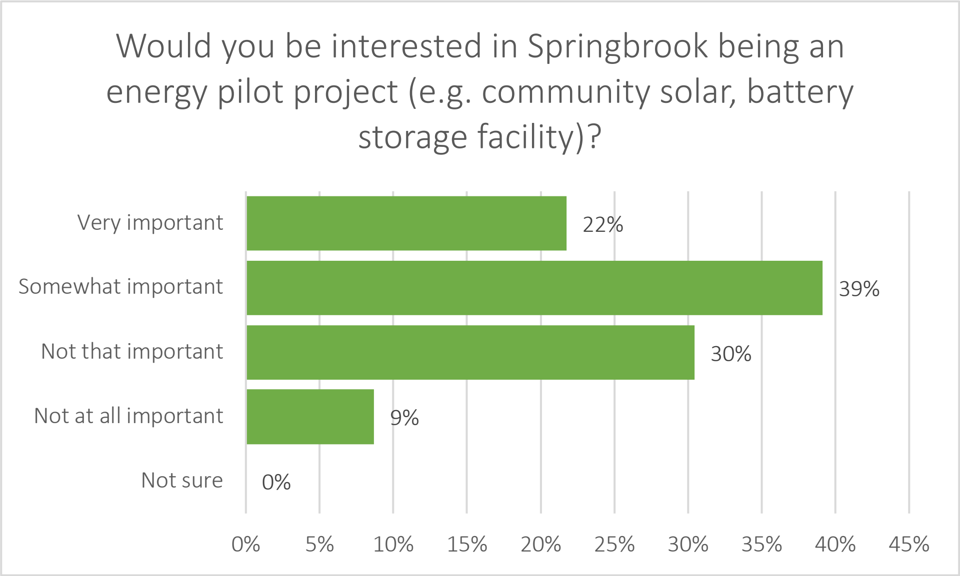


Figure F.26

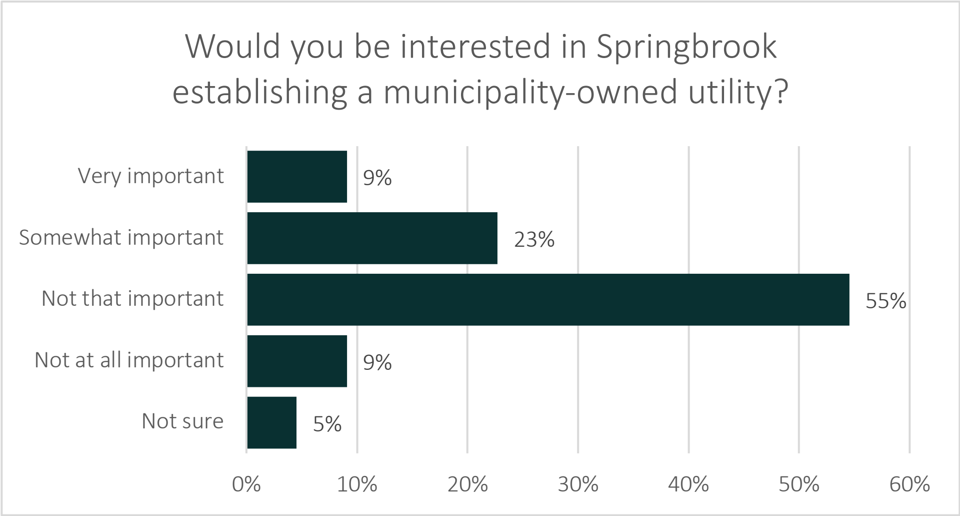


Figure F.27

References

References

ACS. (2019). *Springbrook city 2019: American Community Survey 5-Year*. Retrieved from U.S. Census Bureau: https://data.census.gov/cedsci/table?q=Springbrook%20city,%20Iowa%20Populations%20and%20People&tid=ACSST5Y2019.S0101

Alliant Energy. (2021, October). *Alliant Energy announces development plans for microgrid in Richland County*. Retrieved from https://www.alliantenergy.com/alliantenergynews/newscenter/28-boazmicrogrid

Alliant Energy. (2021, April 6). *Alliant Energy partners with Perry on Iowa's first customer hosted solar project*. Retrieved from https://www.alliantenergy.com/alliantenergynews/newsreleases/newsrelease040621

Alliant Energy Corporation. (2021). Sustainability Management and Environmental, Social and Governance (ESG) Performance Summary.

American Community Survey. (2019). *Jackson County 2019: ACS 5-Year*. Retrieved from https://data.census.gov/cedsci/table?q=Jackson%20County,%20Iowa%20Employment&tid=ACSST5Y2019.S0801

American Community Survey. (2019). *Jackson County 2020: ACS 5-Year*. Retrieved from https://data.census.gov/cedsci/table?q=Jackson%20County,%20Iowa%20Employment&tid=ACSST5Y2020.S0801

Ames, C. o. (2021). *City of Ames.* Retrieved December 3, 2021, from City of Ames: https://www.cityofames.org/government/departments-divisions-a-h/electric/smart-energy/solar-energy/sunsmart-ames-first-community-solar-farm

Art, E. (2021). *Energy Art.* Retrieved October 15, 2021, from Energy Art: https://news.energysage.com/sistine-solar-customized-solar-skins-solar-panel-system/

Association, S. E. (2021). *Solar Energy Industries Association.* Retrieved September 18, 2021, from Solar Energy Industries Association: https://www.seia.org/initiatives/photovoltaics

BELLINI, E. (2021, January 15). *pv magazine.* Retrieved November 15, 2021, from pv magazine: https://www.pv-magazine.com/2021/01/15/what-happens-to-floating-pv-when-the-water-surface-freezes/

Board, I. U. (2020). *Iowa's Electric Profile*. Retrieved from Iowa Utilities Board: https://iub.iowa.gov/iowas-electric-profile

Caufield, J. (2021, April). *Perry joins Alliant Energy in brownfield solar power project*. Retrieved from The Perry news: https://theperrynews.com/perry-joins-alliant-energy-in-brownfield-solar-power-project/

Cedar Falls Utilities. (2015). Retrieved from Simple Solar: https://www.cfu.net/webres/File/save-energy/FAQs_November%202015.pdf

Central Iowa Power Cooperative (CIPCO). (2020). Retrieved from Cooperation Down The Line 2020 Annual Report: https://www.cipco.net/sites/cipco/files/documents/Annual_Reports/CIPCO_2020_Annual_Report.v2.pdf

Church, B. (2021, November). *Alliant Energy to Build Its First Community Microgrid in Wisconsin*. Retrieved from Microgrid Knowledge: https://microgridknowledge.com/community-microgrid-alliant/

Church, B. (2021, November). *Alliant Energy to Build Its First Community Microgrid in Wisconsin*. Retrieved from Microgrid Knowledge: https://microgridknowledge.com/community-microgrid-alliant/

Clearloop. (2020, August 19). *Clearloop.* Retrieved December 3, 2021, from Clearloop: https://clearloop.us/2020/08/19/utility-scale-solar-projects/

David, R. R. (2021, April 30). *Agrivoltaic Systems, A Promising Experience*. Retrieved from Energy: https://energyindustryreview.com/analysis/agrivoltaic-systems-a-promising-experience/#:~:text=The%20agrivoltaic%20system%20is%20characterized,microclimate%20over%20the%20growing%20area.

David, R. R. (2021, April 30). *Agrivoltaic Systems, A Promising Experience.* Retrieved from Energy: https://energyindustryreview.com/analysis/agrivoltaic-systems-a-promising-experience/#:~:text=The%20agrivoltaic%20system%20is%20characterized,microclimate%20over%20the%20growing%20area

DOE. (n.d.). *Office of Science.* Retrieved December 3, 2021, from Energy.gove: https://www.energy.gov/science/doe-explainssolar-fuels

DynamicSLR. (2022). *The Economic Benefits of Solar Energy*. Retrieved from Dynamic SLR: https://www.dynamicslr.com/the-economic-benefits-of-solar-energy/

Electricity Local. (2021). *Springbrook Electricity Rates.* Retrieved November 15, 2021, from Electricity Local: https://www.electricitylocal.com/states/iowa/springbrook/#ref

Energy, A. (2019, December 11). *Alliant Energy News Release*. Retrieved from Allient Energy: https://www.alliantenergy.com/alliantenergynews/newsreleases/newsrelease121119

Energy, A. (2022). *Alliant Energy Community Solar Calculator: Fond du Lac*. Retrieved from Alliant Energy: https://www.alliantenergy.com/cleanenergy/whatyoucando/communitysolar/communitysolarcalculator

Energy, D. (2021). *Distributed Generation.* Retrieved November 15, 2021, from Duke Energy: https://sustainablesolutions.duke-energy.com/solutions/distributed-generation/?utm_source=Google&utm_medium=Paid+Search&utm_content=Distributed+Generation&utm_campaign=Brand+Launch

Energy, F. A. (2014). *Fireflower Alternative Energy* . Retrieved November 15, 2021, from Fireflower Alternative Energy : https://www.fireflower-alternative-energy.com/single-post/2015/11/28/time-is-money

EnergySage. (2022, April 30). *Solar Panel Cost in Iowa*. Retrieved from EnergySage : https://www.energysage.com/local-data/solar-panel-cost/ia/

GEOTREE. (2016). *Iowa LiDAR Mapping Project*. Retrieved from GEOTREE: http://www.geotree.uni.edu/en/extension/iowa-lidar-mapping-project/

GrowSolar. (2020, May). *Local Government Solar Toolkit.* Grow Solar. Retrieved from Grow Solar: https://www.growsolar.org/wp-content/uploads/2020/06/Iowa-Toolkit-May2020.pdf

Hammondclimatesolutions. (2022). *SOLAR MOONSHOT PROGRAM*. Retrieved from Hammondclimatesolutions: https://www.hammondclimatesolutions.com/solar-moonshot#questionnaire

ILSR. (2021). Retrieved December 3, 2021, from ILSR: https://ilsr.org/national-community-solar-programs-tracker/

Institute, G. P. (2020, Agust). *Iowa Solar Model Ordinance*. Retrieved from Betterenergy: https://www.betterenergy.org/wp-content/uploads/2021/02/IA-Solar-Ordinance-2020.pdf

Institute, G. P. (2022, January). *BEST PRACTICE GUIDANCE FOR SOLAR AND ZONING*. Retrieved from SOLSMART: https://solsmart.org/resources/best-practice-guidance-for-solar-and-zoning/

Institute, G. P. (n.d.). *Local Government Solar Toolkit* . Retrieved from Growsolar: https://www.growsolar.org/wp-content/uploads/2020/06/Iowa-Toolkit-May2020.pdf

Iowa Economic development and Iowa DOT. (2016, December). Retrieved from Iowa Energy Plan: http://www.iowaenergyplan.org/docs/IowaEnergyPlan.pdf

Iowa Utilities Board. (2020). *Iowa's Electric Profile*. Retrieved from https://iub.iowa.gov/iowas-electric-profile

Iowa Utilities Board. (2020, February 25). *IUB Approves Tariffs in Alliant Energy's Electric Rate Increase Case*. Retrieved from https://iub.iowa.gov/press-release/2020-02-25/iub-approves-tariffs-alliant-energys-electric-rate-increase-case

Iowa Utilities Board. (2021, April). *Electrical Service Area Boundaries*. Retrieved from https://iowa.maps.arcgis.com/apps/webappviewer/index.html?id=d595a7d431bc4c789065348a8f454dbb

Iowa, R. (2021). *Radio Iowa.* Retrieved December 3, 2021, from Radio Iowa: https://www.radioiowa.com/2021/04/08/city-owned-solar-array-planned-for-perry/

Jackon County government. (2021). *Our County & History*. Retrieved from Official Website for Jackson County, Iowa: https://jacksoncounty.iowa.gov/about/

Jackson County Energy District. (2020). *Virtual Solar Tour 2020*. Retrieved from https://jacksoncounty.energydistrict.org/2021/01/virtual-solar-tour-2020/

Jackson County Energy District. (2021). *Jackson County Energy District Awarded Clean Energy Project by IISC*. Retrieved from https://jacksoncounty.energydistrict.org/2021/08/jackson-county-energy-district-awarded-clean-energy-project-by-iisc/

Jarvis, E. (2017, December 15). *Schneider Electric.* Retrieved October 16, 2021, from se.com: https://blog.se.com/renewable-energy/2017/12/15/understanding-microgrid-categories-business-models/

Lane, C. (2022, March 23). *Solar batteries: Are they worth the cost?* Retrieved from SolarReviews: https://www.solarreviews.com/blog/is-solar-battery-storage-worth-it-given-current-solar-battery-cost

Lauren Ross, A. D. (2018). *The High Cost of Energy in Rural America: Household Energy Burdens and Opportunities for Energy Efficiency.* ACEEE. Retrieved from aceee: https://www.aceee.org/sites/default/files/publications/researchreports/u1806.pdf

Maas, S. (2020 , December). *Working from Home's Impact on Electricity Use in the Pandemic*. Retrieved from National Bureau of Economic Research: https://www.nber.org/digest-202012/working-homes-impact-electricity-use-pandemic

Morley, D. (2014, April 1). *Knowledge Center.* Retrieved November 15, 2021, from American Planning Association: https://www.planning.org/publications/report/9117592/

NRDC. (2016, September 14). *NRDC.* Retrieved December 13, 2021, from NRDC: https://www.nrdc.org/experts/sasha-stashwick/health-groups-congress-burning-biomass-bad-health

NREL. (2017). *PVWatts Calculator*. Retrieved from PVWatts: https://pvwatts.nrel.gov/

Ritchie, C. (2021, December 10). *Energy rankings: Which states use the most electricity per household?* Retrieved from Choose Energy: https://www.chooseenergy.com/news/article/the-states-that-use-the-most-and-least-amount-of-energy-per-household/

Ross, B. (2015, Spetember 21). *Creating "Solar-Ready" Communities*. Retrieved from Great Plain Institute: https://betterenergy.org/blog/creating-solar-ready-communities/

Ross, B. (2015, September 21). *Creating "Solar-Ready" Communities*. Retrieved from Betterenergy: https://betterenergy.org/blog/creating-solar-ready-communities/

Sacramento Municipal Utility District. (2020, June). *SMUD Neighborhood SolarShares.* Retrieved from https://www.smud.org/-/media/Documents/Business-Solutions-and-Rebates/PDFs/SMUD-Neighborhood-SolarShares-Prog-Manual.ashx

SEIA, S. E. (2020, June 11). *Solar Market Insight Report 2020 Q2.* Retrieved November 15, 2021, from Solar Energy Industries Association SEIA: https://www.seia.org/research-resources/solar-market-insight-report-2020-q2

Service, N. W. (2018, August 4). *Flood Return Period Calculator*. Retrieved from National Weather Service: https://www.weather.gov/epz/wxcalc_floodperiod

SHAHYD, K. (2018, July 18). *NRDC.* Retrieved from NRDC: https://www.nrdc.org/experts/khalil-shahyd/rural-families-overburdened-higher-energy-costs#:~:text=Due%20to%20the%20lower%20densities,than%20for%20their%20urban%20counterparts

SolarReviews. (2020, November 2). *Iowa solar panels guide 2022*. Retrieved from SolarReviews: https://www.solarreviews.com/solar-panels/iowa

SolarReviews. (2021, January 29). *SolarReviews.* Retrieved September 18, 2021, from SolarReviews: https://www.solarreviews.com/blog/solar-panel-technologies-that-will-revolutionize-energy-production

SOLSMART. (2022, January). *BEST PRACTICE GUIDANCE FOR SOLAR AND ZONING*. Retrieved from SOLSMART: https://solsmart.org/resources/best-practice-guidance-for-solar-and-zoning/

SOLSMART. (2022). *SOLAR ENERGY: SOLSMART'S TOOLKIT FOR LOCAL GOVERNMENTS*. Retrieved from SOLSMART: https://solsmart.org/solar-energy-a-toolkit-for-local-governments/solar-pv-construction-codes-permitting-and-inspection/

SOLSMART. (2022). *SOLAR ENERGY: SOLSMART'S TOOLKIT FOR LOCAL GOVERNMENTS*. Retrieved from SOSMART: https://solsmart.org/solar-energy-a-toolkit-for-local-governments/solar-pv-construction-codes-permitting-and-inspection/

The city of Ames. (2019, July). *Development and operation of a two MW community solar farm.* Retrieved from https://www.cityofames.org/home/showpublisheddocument/51819/636991507245900000

The city of Ames. (2021). *SunSmart: Ames's first Community solar farm*. Retrieved from https://www.cityofames.org/government/departments-divisions-a-h/electric/smart-energy/solar-energy/sunsmart-ames-first-community-solar-farm

U.S. Census Bureau. (2020). *Jackson County 2020: DEC Redistricting Data* . Retrieved from https://data.census.gov/cedsci/table?q=Jackson%20County%20iowa&tid=DECENNIALPL2020.P1

U.S. Census Bureau. (2020). *Springbrook city 2020: DEC Redistricting Data*. Retrieved from https://data.census.gov/cedsci/table?q=Springbrook&tid=DECENNIALPL2020.P1

University of Iowa, I. I. (2021). *Iowa City Solar 2030.* Iowa City.

USDA. (2022). *Community Facilities Direct Loan & Grant Program in Iowa*. Retrieved from USDA: https://www.rd.usda.gov/programs-services/community-facilities/community-facilities-direct-loan-grant-program/ia

Wikipedia. (2021, March). *Agrivoltaic.* Retrieved from Wikipedia: https://en.wikipedia.org/wiki/Agrivoltaic

Wikipedia. (2022, March 10). *Agrivoltaic*. Retrieved from Wikipedia: https://en.wikipedia.org/wiki/Agrivoltaic

Wisconsin, R. (n.d.). *Renew Wisconsin.* Retrieved December 3, 2021, from Renew Wisconsin: https://www.renewwisconsin.org/solarfarms/

Wood, E. (2020, March 28). *Micorgrid Knowledge* . Retrieved November 15, 2021, from Micorgrid Knowledge : https://microgridknowledge.com/microgrid-defined/