Kane County
Solar Renewable Energy Potentials Study

February 2023

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Introduction

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Introduction

Intent of This Study

The intent of this study is to support the County in appropriate and effective renewable energy goalsetting within the County's Climate Action Planning process. This study seeks also to support the County establish strategies addressing renewable energy development. The primary focus of this study is to establish the Community-Wide rooftop solar PV potential throughout the County, including economic and environmental benefits.

This report includes recommended near and long-term renewable energy targets and recommended implementation strategies for consideration through the Climate Action Planning process. As detailed in the report, this effort has included:

1) Collect County-wide satellite data (NREL, NOAA, and NASA data).
2) Determine building roof stock characteristics and solar suitable buildings, calculate total suitable areas by roof configuration/orientation.
3) Calculate total rooftop solar Capacity and annual energy generation by roof configuration/orientation
4) Identify cost efficient annual energy generation potential.
5) Research solar market at national, State and regional levels. Identify low, medium, and high solar market absorption rates and County-wide solar PV goals.
6) Identify environmental and economic benefit of solar including economic development and job creation potential (NREL JEDI model)

Introduction

The following are considerations building owners should be aware of before "going solar".

How Solar PV Works

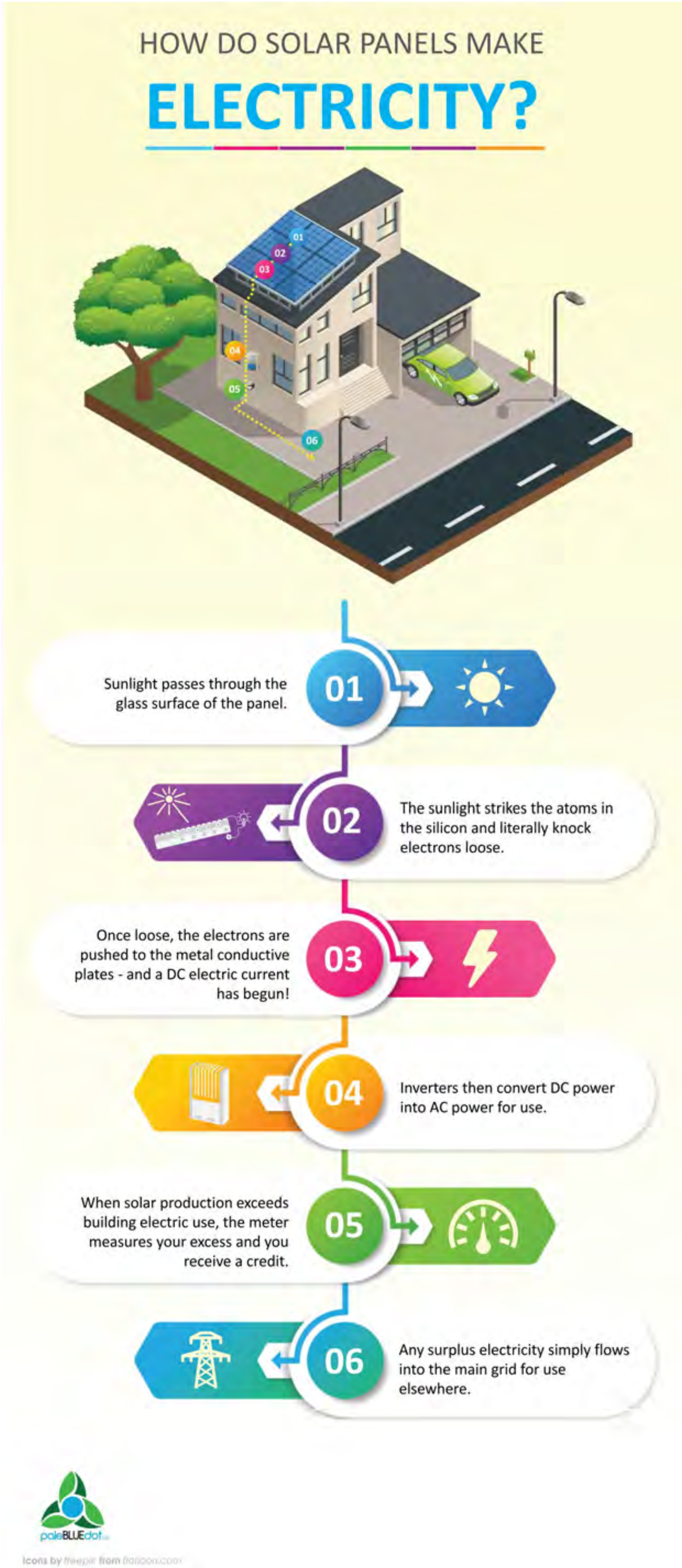
Solar electricity is created using Solar Photovoltaic panels, or Solar PV for short. The word photovoltaic, or PV, comes from the process of converting light (photons) to electricity (voltage), which is called the PV effect. The key to a solar PV panel is the semiconductor material.

Solar PV semiconductors combine properties of some metals and properties of insulators - making them uniquely capable of converting light into electricity. The simple explanation of how solar panels create electricity is that as sunlight (specifically UV light) strikes the semiconductor materials in the PV cell, the energy knocks loose electrons. Those electrons then move back and forth between semiconductor plates producing an electric current.

Structural Capacity for Rooftop Arrays

The assessments included in this report do not include assessments of rooftops tructures to accept the additional loading of a solar PV array. Projects which anticipate rooftop arrays should have a preliminary structural assessment to confirm solar PV loading can be adequately handled by the existing structure. The weight of a PV system varies based on the panel and racking systems selected.

For rooftop arrays, two racking system configurations are common: flush or tilted mechanically fastened racking types (which require roof penetrations, or clamp on standing seams); and ballasted racking types (which use weighted components to make the array stationary through gravity and typically do not require roof penetrations). A reasonable "rule of thumb" for solar PV array assembly structural loading is 2-4lbs per square foot for typical flush or tilted racking systems, or 5-9lbs for ballasted racking systems.



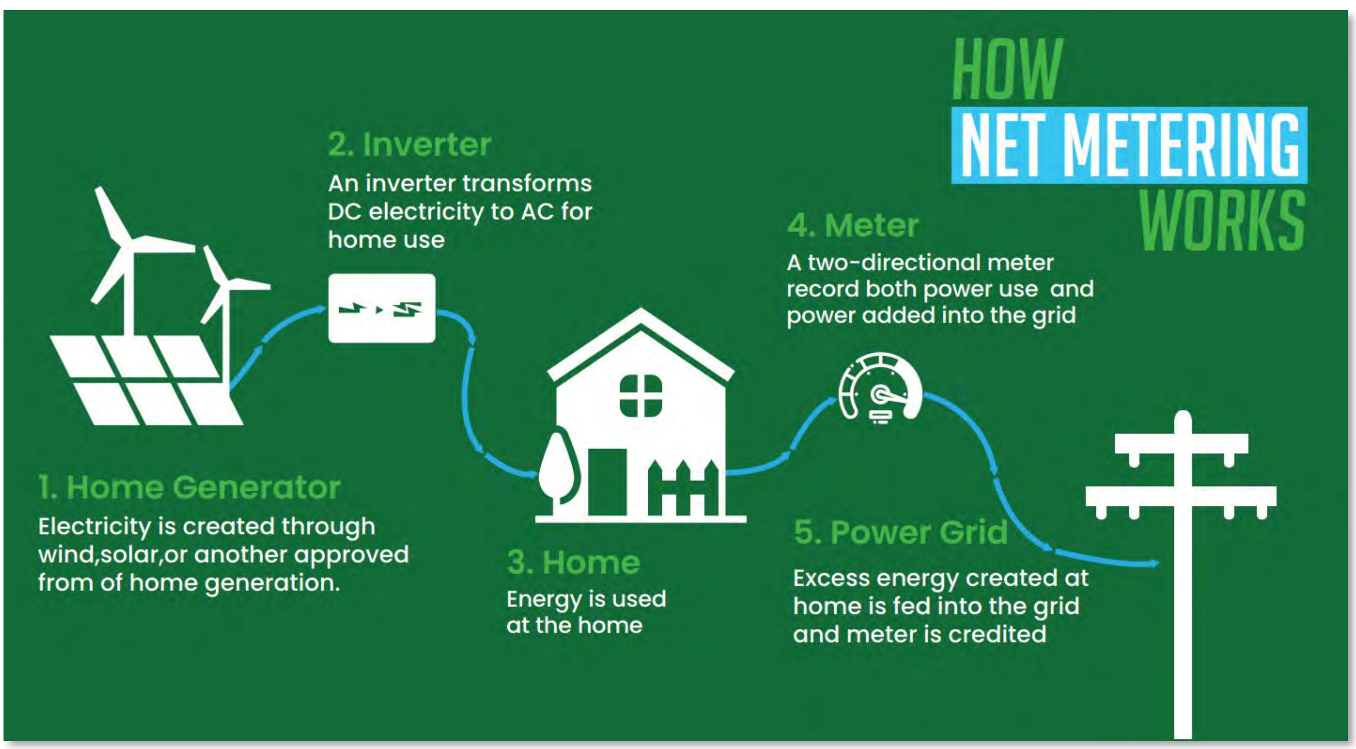
Introduction

Net Metering

The site concepts in this report are based on grid-connected systems with net metering. Net metering tracks the amount of energy generated on site, as well as the amount of energy consumed from the grid. Net metering allows customers to get credit on their energy bill from excess energy generation, when the amount of energy a solar panel system generates is greater than the amount of energy consumed from the electric utility. Such interconnection is considered non-incentivized, meaning that the site/solar array owner will retain the renewable energy credit that the PV system produces and will offset the cost of energy needed when the solar panels are not producing energy (nighttime, short and cloudy days). According to Duke Energy "It has been shown that customers with net metering systems tend to be much more aware of their energy consumption, so they usually consume less energy than the average retail customer. Net metering is also a way to increase the energy in the power grid to keep up with increases in demand during peak power-use times."

Net Metering in Northbrook

The Illinois net metering program began April 1, 2008. Commonwealth Edison, the Ameren Illinois Utilities, and MidAmerican Energy Company must now offer customers credits on their electric bills for electricity generated by renewable energy systems. Applications for the program are accepted on a first-come, first-serve basis. Under Illinois rules, eligible renewable generators of 40 kW or less receive a one-to-one retail rate credit. These customers will be compensated for excess electricity generated by their renewable energy systems at the same rate that they pay when buying electricity from their utility. These credits will be carried over month-to-month, with the annual period running from May to April, or November to October, at the customer's discretion.



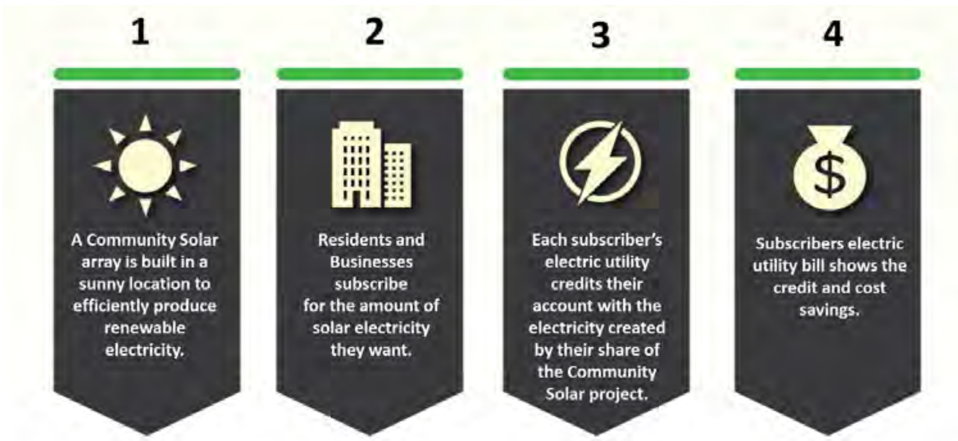
Introduction

Community Solar in Illinois

In 2016, the Illinois Legislature passed the Future Energy Jobs Act (FEJA) establishing a state goal for 100% renewable energy by 2050. The legislature created the Illinois Shines program to create opportunities for citizens to have access to solar energy without putting solar panels on their roofs through community solar projects. Community solar is a distributed solar energy deployment model that allows customers to buy or lease part of a larger, offsite shared solar photovoltaic (PV) system. Community members subscribing to a solar facility receive credits for their share of the power produced, either in electricity bill savings or energy credits.

In accordance with FEJA, the Illinois Power Agency and Illinois Commerce Commission are responsible for creating equitable community solar programs. This is accomplished by Illinois Power Agency purchasing Renewable Energy Credits (RECs) from projects and setting prices through a lottery-style Adjustable Block Program. These credits are used to meet the State's Renewable Portfolio Standard requirements. Illinois Power Agency is anticipated to purchase renewable energy credits from an estimated 400 megawatts of community solar through 2030.

How Does Community Solar Work



Renewable Energy Credits

Renewable Energy Credits (RECs) are tradable, non-tangible energy commodities that represent proof that a quantity of electricity was generated from an eligible renewable energy resource. RECs represent all of the "green" or clean energy attributes of electricity produced from renewable resources like solar PV. A REC includes everything that differentiates the effects of generating electricity with renewable resources instead of using other types of resources. It is important to remember that a REC also embodies the claim to the greenness attributes of renewable electricity generation, and only the ultimate consumer of the REC has rights to the claim. Once a producer or owner of a REC has sold it, rather than consuming it themselves, they have sold the claim and cannot truthfully state that they are using renewable electricity, or that the electricity that was produced with the REC is renewable.

Many building owners interested in pursuing the installation of a solar PV system on their property are motivated from an interest in using (and claiming) renewable energy for operations. Very careful understanding of a project's Renewable Energy Credits and the status of their ownership is critical. Failure to carefully define ownership of REC may cause the inability of a building owner to claim the renewable benefits they wish to obtain. Building owners should assume that RECs will not be available for any projects which are delivered through a "third party" project delivery method, community solar subscription, or any project which utilizes a utility subsidized approach. It may be possible for building owners to retain REC credits, however, and paleBLUEdot recommends that any building owner looking into "third party" solar arrays explore the retention of all REC credits produced by the recommended projects if financially feasible.

From a Greenhouse Gas accounting perspective, this means that facilities served through community solar subscriptions or third party ownership structures will not be able to account for emissions reductions due to renewable energy use unless REC credits are purchased. In this situation, without the purchase of REC credits, the County's GHG Inventory will need to use the regional electric grid emissions factors for calculation of emissions.

Introduction

Peak Shaving and Demand Charges

Customers pay for electricity in one of two ways: consumption, measured in kilowatt-hours (kWh); and demand, measured in kilowatts (kW). Most residential customers only pay for consumption. Many commercial customers are on demand charge tariffs and they pay for both demand and consumption. With demand charge billing the customer pays for the highest power load reached – the peak demand. Peak demand is defined as the highest average load during a specific time interval (usually 15 minutes) in each billing cycle. Utilities use demand charges to help recover costs associated with running power plants or buying power from other utilities on the energy spot market. Demand charges also help utilities recover transmission costs to customers with large energy needs.

Not all utility customers are on demand charge tariffs, but for large consumers of electricity those charges can be a significant part of a monthly utility bill. Utility customers who do have demand charge tariffs can see a large portion of their monthly electric bill going towards demand charges (30% to 70% is not uncommon).

The most effective way to manage utility costs for customers with demand charges is a practice called peak shaving. Peak shaving involves proactively managing overall demand to eliminate short-term demand spikes, which set a higher peak. This process lowers and smooths out the electric use "curve" and reduces peak loads, which reduces the overall cost of demand charges. Solar arrays with a battery energy storage system allows customers to peak shave. Battery energy storage systems are dispatchable; they can be configured to strategically charge and discharge at the optimal times to reduce demand charges. Sophisticated control software with learning algorithms differentiates battery energy storage systems from regular batteries. These algorithms learn a customer's load profile, anticipate peak demand, and switch from the grid to batteries when needed most - reducing the customer's peak load and saving on demand charge costs.

Peak Shaving and Local Utilities

Many local electric utilities and electric co-ops do not generate their own power. Instead, these utilities often purchase power from large electric generators and then distribute that electricity to their consumers. In this situation, local electric utilities typically have long-term electric purchase agreements with their electricity suppliers. In some instances, the pricing defined in the local utility's power purchase agreement imposes increased rates for peak demand timeframes, like the peak demand rates end customers may experience. For local electric utilities which have peak power purchase rates defined, the deployment of solar arrays and solar storage systems within their local electric service area reduce the local electric grid's peak demand and avoid costs associated with peak demand power purchase.

Project Delivery Options

There are many options for pursuing solar projects on your business or residential property including:

Purchasing a System:

Paying for your system yourself is the simplest path for owning your solar system, but the initial cost of a solar panel system can be the biggest hurdle. Through a direct purchase, or "cash option", you purchase the solar system just as you would a car or house.

Solar Lease:

A Solar Lease is one of the options for "third party ownership" where the system is owned by the leasing company and typically installed with no "up front" costs. In a solar lease the customer typically pays a set monthly rate for your solar panel system, but receive free electricity from the panels that offsets the monthly cost of the lease. Solar leases are allowable in many States, however, not all jurisdictions allow solar leases. Currently, the State of Illinois does not have legislation clearly allowing for Solar Leases.

Power Purchasing Agreement (PPA):

A solar power purchase agreement (PPA) is a financial agreement where a developer arranges for the design, permitting, financing, and installation of a solar array on a customer's property. The developer sells the power generated to the host customer – typically at a fixed rate that is lower than the local utility's retail rate. Payments within a PPA agreement are based on the actual energy produced by the solar array every month. This lower electricity price serves to offset the customer's purchase of electricity from the grid. The developer receives the income from the sales of the electricity as well as any tax credits and other incentives generated from the system. Customer's entering into a PPA who wish to claim the "green attributes" of the solar energy will need to negotiate with the solar developer to retain the solar Renewable Energy Credits. Currently, the State of Illinois does not have legislation clearly allowing for Power Purchase Agreements.

Introduction

Solar Financing and Incentives

Solar energy delivers positive environmental impacts, and contributes to our nation's energy independence. According to the Department of Energy, solar provides more jobs in electricity generation nationally (373,800) than coal, natural gas, oil, nuclear, and other fuels combined (288,000). To encourage the continued expansion of solar, governments, and utilities offer solar tax breaks and financial incentives to make solar more accessible for today's businesses and homeowners. The following are some of the incentives available in Illinois:

Illinois' SREC incentive: the Adjustable Block Program

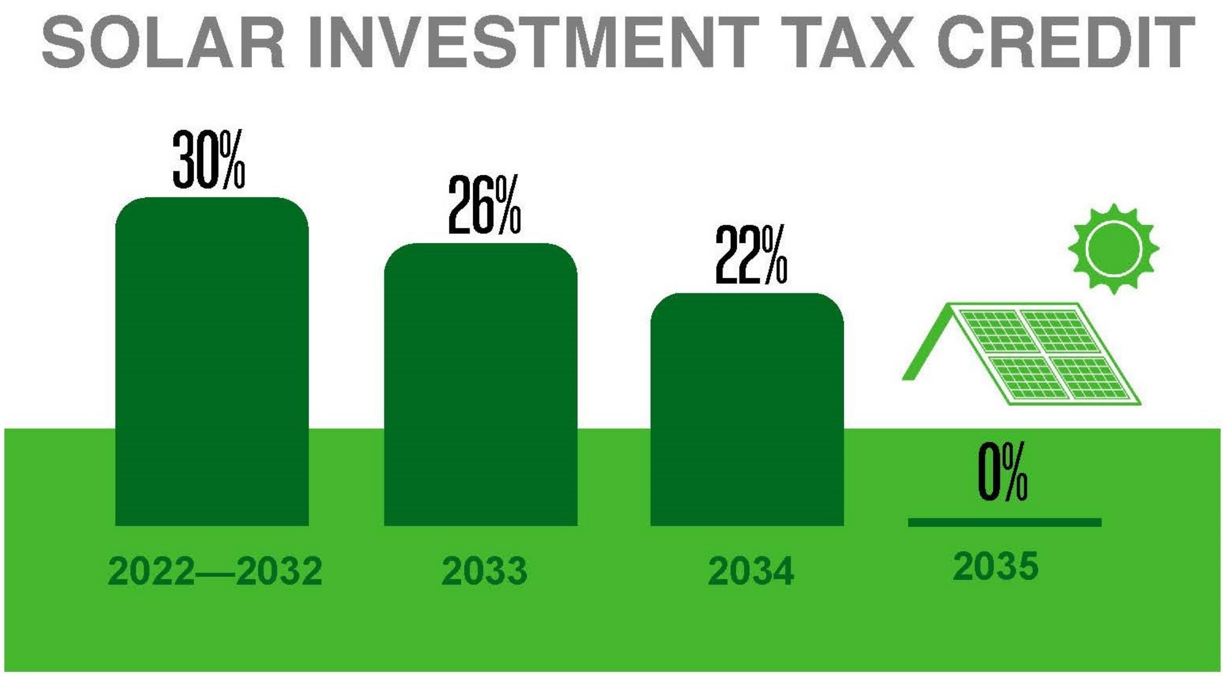
Illinois' renewable portfolio standard (RPS) means the state is committed to producing 25 percent of its electricity from renewable resources by 2025. Under the Adjustable Block Program, also known as Illinois Shines, for each megawatt hour (MWh) of electricity your solar system produces, you will be granted one Solar Renewable Energy Credit (SREC) that you can then sell in the market, creating a nice income stream for the life of the system. (https://illinoisshines.com/)

ComEd Commercial Solar Rebates

ComEd provides rebates for commercial and industrial (C&I) customers to help decrease the out-of-pocket costs of installing solar. ComEd customers who install solar on business properties are eligible for $250 per kilowatt (kW) of installed solar power (up to 2,000KW of installed capacity). (https://www.comed.com/SmartEnergy/MyGreenPowerConnection/Pages/SolarIncentivesCredits.aspx)

Federal Investment Tax Credit

The Incentive Tax Credit will provide a Federal tax credit for a portion of the solar pv installation costs. The ITC credit is equal to 30% of the project costs for years 2023 - 2032 and will be stepping down to 26% in 2033, 22% in 2024 and 0% for years 3035 and beyond. (https://www.energysage.com/solar/cost-benefit/solar-investment-tax-credit/)



Federal Modified Accelerated Cost Recovery System (MACRS)

The U.S. tax code allows for a tax deduction for the recovery of the cost of tangible property over the useful life of the property. The Modified Accelerated Cost Recovery System (MACRS) is the current depreciation method for most property. The market certainty provided by MACRS allows businesses in a variety of economic sectors to continue making long-term investments and has been found to be a significant driver of private investment for the solar industry and other energy industries. Businesses can write off the value of their solar energy system through using MACRS, reducing their tax burden and accelerating returns on solar investments. Accelerated depreciation can reduce net system cost by an additional 30 percent. (https://www.irs.gov/businesses/small-businesses-self-employed/a-brief-overview-of-depreciation)

SOLAR MYTHS BUSTED

1 SOLAR PANELS WILL DAMAGE MY ROOF

Fact: The solar PV cells attached to rooftops use modern materials perfected in labs. Holes need to be drilled into a roof to attach solar panels, but your roof can still be protected. Reputable solar panel installation companies follow industry best practices, like using quality flashed mounts to waterproof roof penetrations

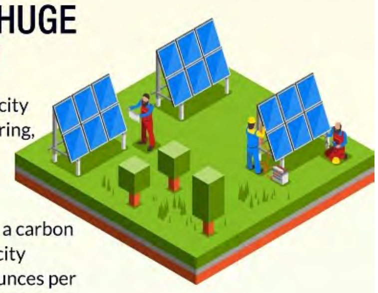
2 SOLAR PANELS DON'T WORK IN COLD CLIMATES

Fact: If there are any daylight hours in your area, solar panels can still be effective. This is why Germany—which receives about the same amount of sunshine as Alaska—is currently a solar superpower. In fact, even though Utah is known for a long winter season, the state has enough solar power potential to provide all the electricity the U.S. needs. Solar panels are built to withstand varying temperatures, and they can produce electricity from indirect light.

3 SOLAR PANELS ARE TOXIC.

Fact: Detailed analysis indicates that the large-scale implementation of solar has the potential to reduce pollution-related environmental impacts of electricity production, such as GHG emissions, freshwater ecotoxicity, eutrophication, and particulate-matter exposure. The pollution caused by higher material requirements of these technologies is small compared with the direct emissions of fossil fuel-fired power plants

4 SOLAR ELECTRICITY HAS A HUGE CARBON FOOTPRINT



Fact: The operation of solar pv modules generating electricity do not produce greenhouse gas emissions. The manufacturing, installation, and on-going maintenance of solar PV does produce a carbon footprint – what is known as "Lifecycle emissions".

The lifecycle emissions of electricity generated by coal has a carbon footprint of 35.3 ounces per KWh generated, while electricity generated by natural gas has a carbon footprint of 17.65 ounces per KWh generated. Meanwhile, the lifecycle emissions for Solar PV equates to an average of 1.4 ounces of greenhouse gas for every kWh the panel will produce over its lifetime – a 92% reduction of emissions over natural gas and a 98% reduction of emissions over coal.

5 SOLAR ELECTRICITY DOES NOT REALLY HAVE ENVIRONMENTAL AND HEALTH BENEFITS

Fact: In the United States, the actual environmental and health benefits for every solar module (individual panel) installed is:

- 10,600 lbs of greenhouse gases eliminated
- Equivalent to 94,000 Cubic Feet of Manmade Atmosphere avoided
- 69,650 gallons of freshwater saved
- Equivalent to the annual water use of 232 households saved
- Creates more jobs: nationally, solar employs 350,000 people – twice that of the coal industry.
- Elimination of over 5 pounds of particulate air pollution for every solar panel installed.

Section 02

Solar in Illinois

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Solar in Illinois

As of December 2021, Illinois has a total of 302 megawatts (302,000,000 watts) of solar capacity installed statewide. There are a total of 37,995 solar installations in the State—a 122% increase over just two years previously. The State of Illinois ranks 21st nationally for total solar energy production capacity.

The State's solar installation total is enough to power 176,379 homes. The share of the State's total electricity use that comes from solar power, however, is less than 0.81%. This indicates great potential for growth throughout the State. Current solar growth projections for the State equal an additional 3,407 MW over the next 5 years - a growth rate that ranks 12th nationally.

Costs for Solar PV installation in the State have declined 4% since 2016. Price declines have been accompanied with increasing rate of investment in solar energy. A total of $2 billion has been invested in Solar PV installations. The industry currently employs 5,259 people in 298 companies Statewide.

Buildings

81%
solar-viable

2.5K
existing solar installations

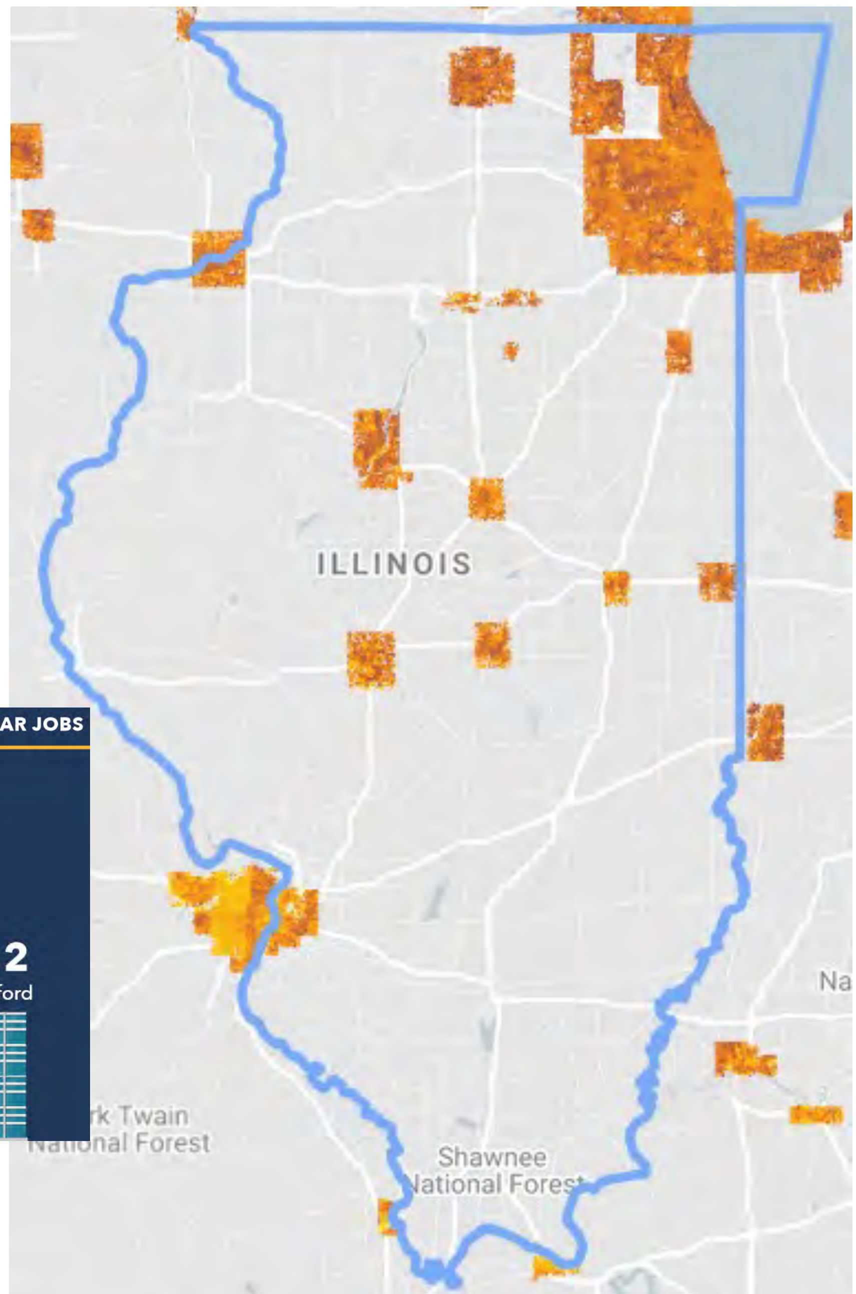
Based on 60% data coverage over buildings in this geographic area. All estimates are based on buildings viable for solar panels. Included panels receive at least 75% of the maximum annual sun in the county. For Illinois, the average value of the threshold is 981 kWh/kW

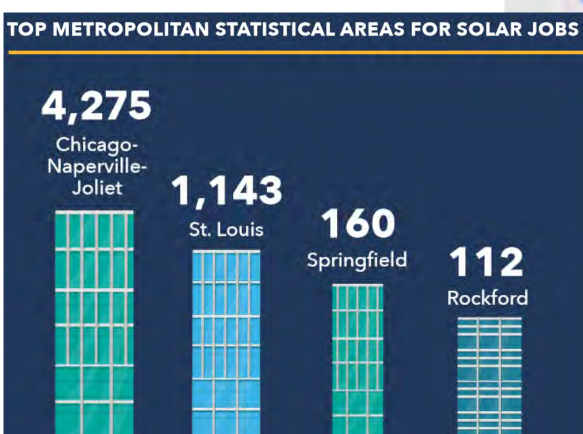
Roofs
2.1M

Roof space
2.9B
sq ft

Capacity
41.1K
MW DC

Electricity
47.3M
MWh AC per yr





(sources: Solar Energy Industries Association SEIA, Solar Foundation, Project Sunroof)

STATE SOLAR *spotlight*

Illinois

Ranks
15th
for total installed solar capacity

Total solar installed (MW)
1,909.30
876.2 MW in 2021

Growth projection over the next 5 years (MW)
4,943
Ranks 10th

Solar jobs in the state[1]
5,520
Ranked 13th in 2021

Enough solar installed to power
288,215
homes

343
solar companies are currently operating in Illinois[3]

72
manufacturers

73
installers/developers

198
other companies

Value of the state solar market **$3 billion**
with billion invested in 2021

Percentage of state's electricity from solar[2]
1.39%

Price decline over the last ten years
52%

Solar Companies in Illinois

Section 03

Solar in Kane County

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Solar in Kane County

Based on information available from Project Sunroof and Stanford University's DeepSolar project, it is estimated that the Kane County has 250 solar installations with a generating Capacity of 12.6 MW. This is equal to 0.1% of the total solar generating Capacity in the State, compared to the County's 4% share of State population. According to the Stanford University DeepSolar analysis project, Kane County has an average of 0.94 solar PV installations per 1,000 homes. This is approximately 82% of the State average.

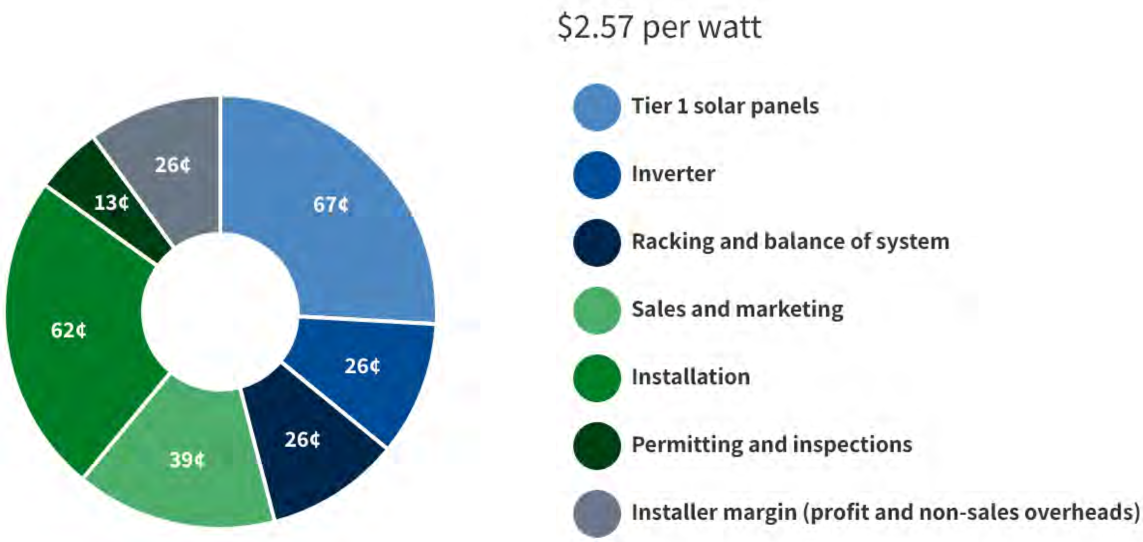
The total solar installation Capacity in the Kane County is estimated to generate 13.9 million kWh annually - enough to power 1,500 homes. As noted in Section 2, costs for Solar PV installation in the State have declined significantly since 2015. The Kane County currently has an estimated total of 10 solar companies, or approximately 3% of the State's total solar business entities.

Kane County's Solar Share

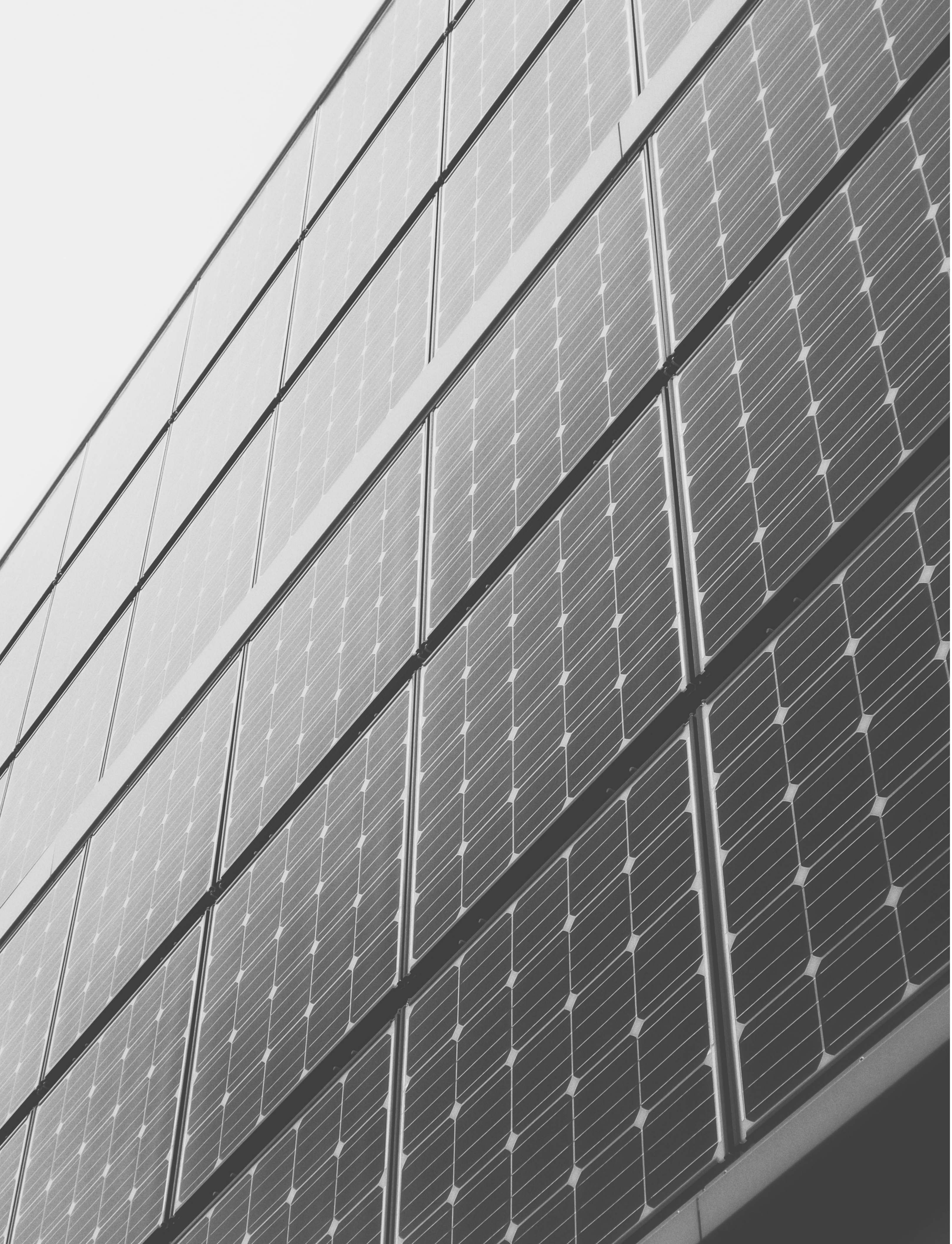
	State	Community	Community
Population	12,720,000	515,588	**4.05%**
Number of Solar Installations	37,995	252	**0.66%**
Average Solar Installations / 1,000 households	1.14	0.94	**82.46%**
Estimated Solar Generating Capacity (MW)	1,909	1.89	**0.10%**
Average Array Size (KW)	50.24	7.50	**15%**
Solar Industry Businesses	343	10	**2.92%**

Solar in Kane County

Estimated Solar PV Installation Cost by Component in Kane County



Graphic Source: SolarReviews.com



Section 04

County Wide Solar Potential

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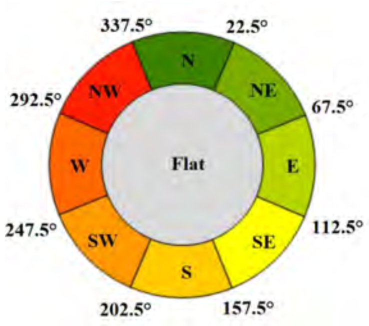
Region Wide Solar Potentials

Methodology and Data

This section calculates the total technical Capacity and total generation potential for rooftop solar in the Region. Total

Input Data

Roof plane survey data is provided by National Renewable Energy Laboratory (NREL). NREL data is based on lidar data obtained from the U.S. Department of Homeland Security (DHS). Insolation levels for annual sun exposure are based on data from NOAA and NREL.



Azimuth Classifications

Zip Codes Included in Study

60109	60175
60110	60177
60118	60184
60119	60502
60120	60505
60123	60506
60124	60510
60134	60511
60136	60538
60140	60539
60151	60542
60174	60554

Tilt and Azimuth

The orientation (tilt and azimuth) of a roof plane is important for determining its suitability for PV and simulating the productivity of installed modules. For this study roof plane tilt for each square meter of roof area within all community zip codes were determined using the lidar data set. Roof tilts are organized into 5 categories:

Flat	(0° - 9.5°)
Low	(9.5°- 21.5°)
Mid-Low	(21.5° – 34.5°)
Mid-High	(34.5° – 47.5°)
High	(47.5° and higher)

For this study, the second component of roof plane orientation -the azimuth (aspect) – was identified for each square meter of roof area. Each square meter was categorized into one of nine azimuth classes, shown in the graphic to the right, where tilted roof areas were assigned one of the eight cardinal and primary intercardinal directions.

All roof planes with Northwest, North, and Northeast azimuths were excluded from this study.

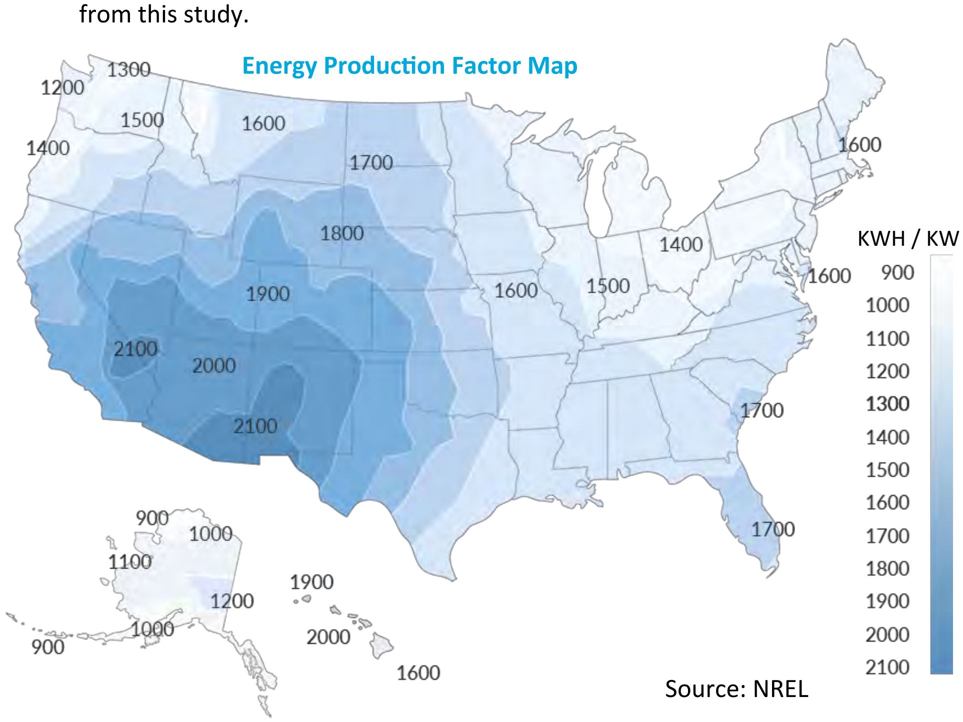
Generation Potential

The potential "Nameplate Capacity" potential per square foot of roof plane area was calculated. This calculation assumed a typical 400 watt Capacity panel with a footprint of 79" x 40".

Next, this nameplate Capacity was adjusted for assumed system losses including shading, heat loss, mismatch, snow, dirt, etc. Assumed losses were calculated for each azimuth orientation and rage from 22% system loss for flat arrays to 34% for East/Southeast orientations. Additionally, losses were calculated for roof tilt classifications based on the System Advisor Model.

Lastly, generation potential was calculated using the base Energy Production Factor for the region (annual KWH production/KW nameplate Capacity), modified by the loss factors outlined above.

Energy Production Factor Map



Source: NREL

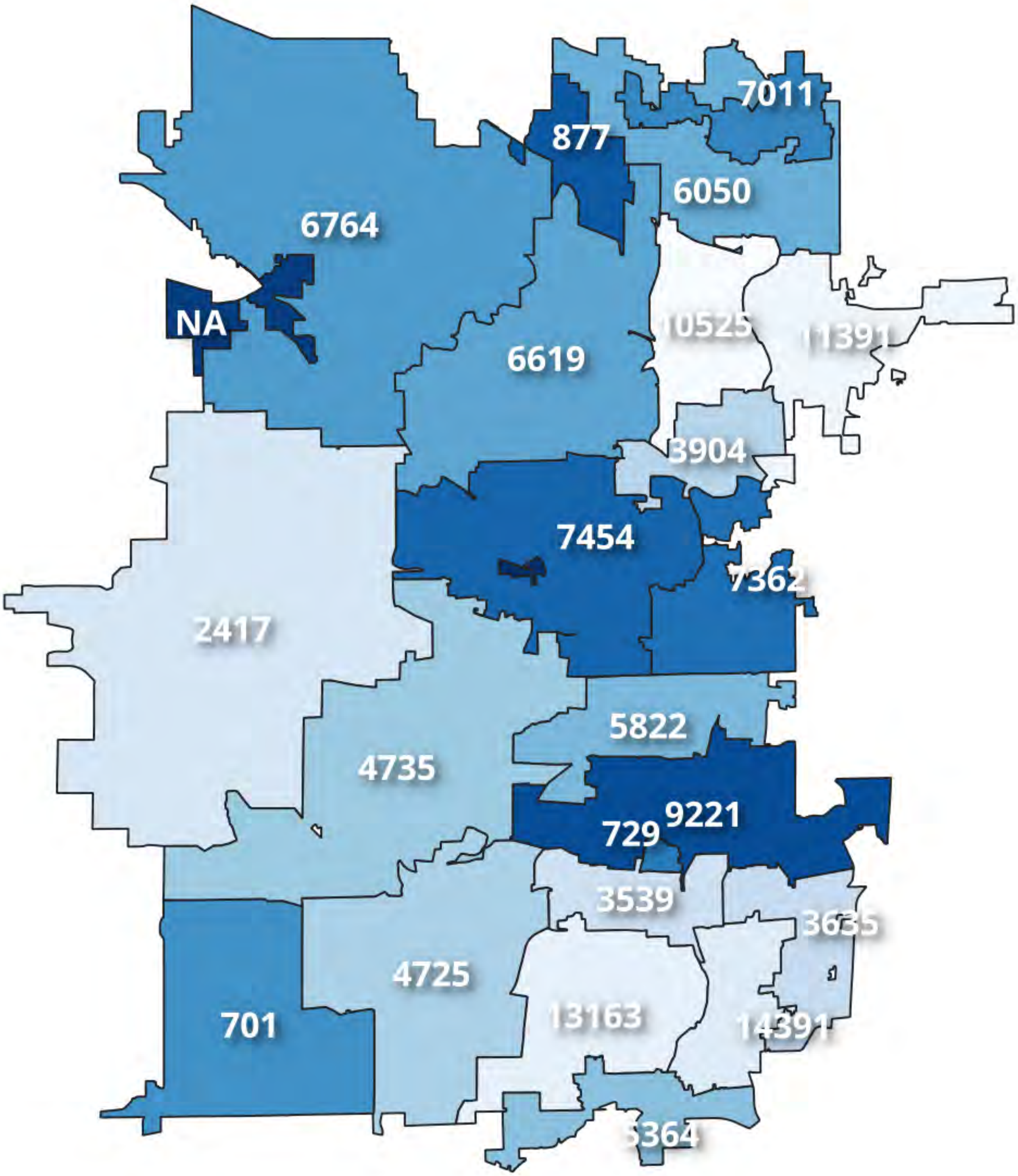
Region Wide Solar Potentials

Rooftop Technical Capacity In Kane County

Technical Capacity represents the total rooftop solar PV potential assuming economics and grid integration are not constraints. Based on the input and methodology previously outlined, there are an estimated 167,000 total buildings in Kane County, of those, it is estimated that 138,000 are "solar suitable" buildings.

These solar suitable buildings have an estimated 185,000 roof planes which are either flat or with an azimuth orientation of East, Southeast, South, Southwest, or West, with a total estimated square footage of 58.6 million square feet.

Estimated Solar Suitable Buildings by Zip Code In Kane County



Region Wide Solar Potentials

Rooftop Generation Capacity In Kane County

Generation Capacity represents the total amount of energy generation potential of the total Technical Capacity of the Region. As previously outlined, the generation Capacity is calculated using Region-specific annual energy production factor (annual KWH production/KW nameplate Capacity) which is based on the region's weather patterns and annual insolation levels (exposure to sun's energy). This energy production factor is then modified by estimated system losses by azimuth and estimated system losses by roof tilt.

The chart below illustrates the total generation potential by roof azimuth and by roof tilt classifications. The Grand Total rooftop solar PV energy generation potential for the County is 770,,558,768 KWH annually. This is estimated to be approximately 14% of the County's total electric consumption (see Greenhouse Gas Inventory).

Rooftop Technical and Generation Capacity In Kane County

			Flat		Low Tilt		Mid-Low Tilt		Mid-High Tilt		High Tilt	
Subtotal Flat												
Suitable Buildings	25,099	18.16%	**25,099**		-		-		-		-	
Suitable Roof Planes	46,180	18.16%	**46,180**		-		-		-		-	
Square Footage	14,598,565	18.16%	**14,598,565**		-		-		-		-	
Capacity (KW dc)	129,704	18.16%	**129,704**		-		-		-		-	
Generation (KWH)	161,870,826	21.01%	**161,870,826**		-		-		-		-	
Subtotal South Facing												
Suitable Buildings	36,434	26.37%	-		**7,857**		**23,394**		**5,165**		**18**	
Suitable Roof Planes	67,036	26.37%	-		**14,456**		**43,043**		**9,504**		**33**	
Square Footage	21,193,031	26.36%	-		**4,569,770**		**13,607,469**		**3,004,620**		**11,172**	
Capacity (KW dc)	188,294	26.36%	-		**40,601**		**120,899**		**26,695**		**99**	
Generation (KWH)	209,425,430	27.18%	-		**43,621,333**		**134,174,021**		**31,517,572**		**112,503**	
West + Southwest												
Suitable Buildings	38,333	27.74%	-		**6,887**		**25,357**		**6,063**		**26**	
Suitable Roof Planes	70,530	27.74%	-		**12,672**		**46,654**		**11,156**		**48**	
Square Footage	22,298,764	27.74%	-		**4,005,950**		**14,749,396**		**3,526,787**		**16,631**	
Capacity (KW dc)	198,118	27.74%	-		**35,592**		**131,044**		**31,335**		**148**	
Generation (KWH)	201,716,799	26.18%	-		**34,928,772**		**132,842,923**		**33,792,129**		**152,975**	
East + Southeast												
Suitable Buildings	38,320	27.73%	-		**6,982**		**25,249**		**6,063**		**25**	
Suitable Roof Planes	70,505	27.73%	-		**12,846**		**46,457**		**11,156**		**46**	
Square Footage	22,295,793	27.74%	-		**4,061,108**		**14,686,182**		**3,532,600**		**15,903**	
Capacity (KW dc)	198,092	27.74%	-		**36,082**		**130,483**		**31,386**		**141**	
Generation (KWH)	197,545,712	25.64%	-		**34,684,280**		**129,563,748**		**33,154,401**		**143,284**	
Grand Total			**Subtotal: Flat Roof**		**Subtotal: Low Tilt**		**Subtotal: Mid-Low Tilt**		**Subtotal: Mid-High Tilt**		**Subtotal: High Tilt**	
Suitable Buildings	138,186		25,099	18.16%	21,726	15.72%	74,000	53.55%	17,292	12.51%	69	0.05%
Suitable Roof Planes	254,251		46,180	18.16%	39,974	15.72%	136,154	53.55%	31,816	12.51%	127	0.05%
Square Footage	80,386,152		14,598,565	18.16%	12,636,828	15.72%	43,043,047	53.55%	10,064,007	12.52%	43,706	0.05%
Capacity (KW dc)	714,209		129,704	18.16%	112,275	15.72%	382,425	53.55%	89,416	12.52%	388	0.05%
Generation (KWH)	770,558,768		161,870,826	21.01%	113,234,385	14.70%	396,580,692	51.47%	98,464,103	12.78%	408,763	0.05%

Region Wide Solar Potentials

Optimized Generation Capacity In Kane County

Though the total energy generation outlined above is reasonably feasible, for purposes of establishing Region Wide potentials expectations it is appropriate to modify the total generation to reflect the likely most cost efficient installation potentials given current technologies and cost parameters. Solar PV installations which have less than ideal orientations capture less light per panel and therefore generate less energy per dollar spent. Establishing an Optimized Capacity establishes the cost effective solar PV installation potential based on current technology.

Identifying the installations most likely to be highly cost effective ultimately requires a site-by-site assessment, however, typical installation performance characteristics can be extrapolated to establish reasonable Region-wide estimates. For the latitude and geography of Kane County, it can be assumed that all solar suitable roof planes that are flat or south facing should ultimately be reasonably cost effective installations.

For West and Southwest facing roof planes, it is likely that all low and mid-low roof tilt installations would be cost effective, while mid-high and high roof tilt installations with West or Southwest orientation may produce self-shading for many of the solar productive hours making those installations viable on a case-by-case basis. Like wise, for East and Southeast facing roof planes, it is likely that all low roof tilt installations would be cost effective, while mid-low, mid-high, and high roof tilt installations facing East may tend to have limited timeframes during which their solar exposure is optimal, making those installations also viable on a case-by-case basis.

On the chart below, all solar suitable roof planes with roof tilt and azimuth orientation combinations likely to be consistently cost effective are shown and are considered to be the County's Optimized Generation Capacity. **It should be noted that installations outside of these selections may still be cost effective but require individual feasibility assessment**. The total Optimized Rooftop Solar Generation Capacity in Kane County is estimated to be 573,752,231 KWH annually, approximately 10.5% of the County's total electric consumption.

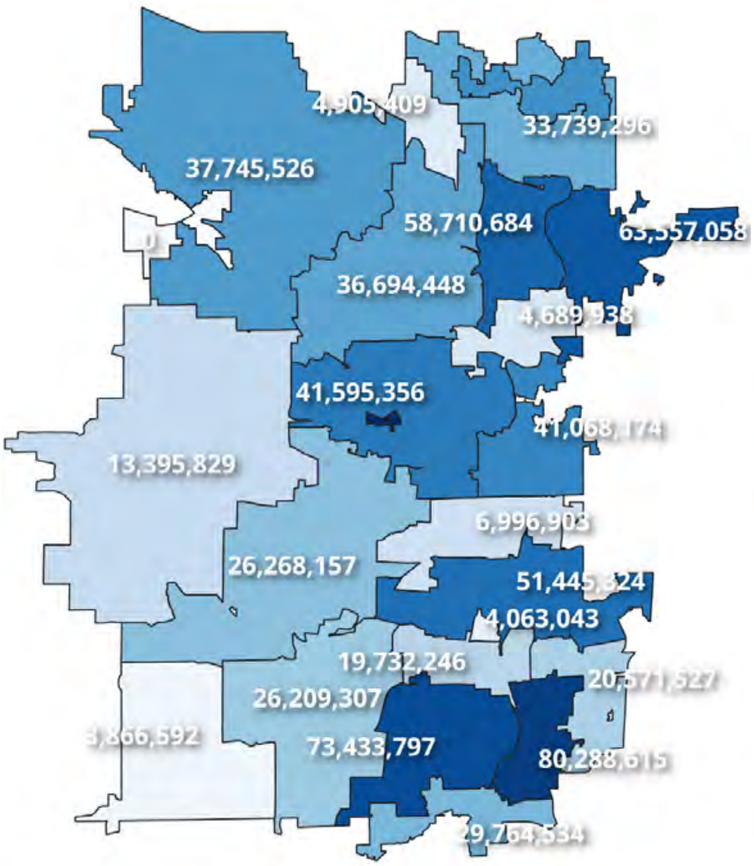
Optimized Rooftop Capacity In Kane County

			Flat	Low Tilt	Mid-Low Tilt	Mid-High Tilt	High Tilt
Subtotal Flat							
Suitable Buildings	25,099	24.91%	**25,099**	-	-	-	-
Suitable Roof Planes	46,180	24.91%	**46,180**	-	-	-	-
Square Footage	14,598,565	24.91%	**14,598,565**	-	-	-	-
Capacity (KW dc)	129,704	24.91%	**129,704**	-	-	-	-
Generation (KWH)	161,870,826	28.21%	**161,870,826**	-	-	-	-
Subtotal South Facing							
Suitable Buildings	36,434	36.16%	-	**7,857**	**23,394**	**5,165**	**18**
Suitable Roof Planes	67,036	36.16%	-	**14,456**	**43,043**	**9,504**	**33**
Square Footage	21,193,031	36.16%	-	**4,569,770**	**13,607,469**	**3,004,620**	**11,172**
Capacity (KW dc)	188,294	36.16%	-	**40,601**	**120,899**	**26,695**	**99**
Generation (KWH)	209,425,430	36.50%	-	**43,621,333**	**134,174,021**	**31,517,572**	**112,503**
West + Southwest							
Suitable Buildings	32,244	32.00%	-	**6,887**	**25,357**	-	-
Suitable Roof Planes	59,326	32.00%	-	**12,672**	**46,654**	-	-
Square Footage	18,755,346	32.00%	-	**4,005,950**	**14,749,396**	-	-
Capacity (KW dc)	166,636	32.00%	-	**35,592**	**131,044**	-	-
Generation (KWH)	167,771,694	29.24%	-	**34,928,772**	**132,842,923**	-	-
East + Southeast							
Suitable Buildings	6,982	6.93%	-	**6,982**	-	-	-
Suitable Roof Planes	12,846	6.93%	-	**12,846**	-	-	-
Square Footage	4,061,108	6.93%	-	**4,061,108**	-	-	-
Capacity (KW dc)	36,082	6.93%	-	**36,082**	-	-	-
Generation (KWH)	34,684,280	6.05%	-	**34,684,280**	-	-	-

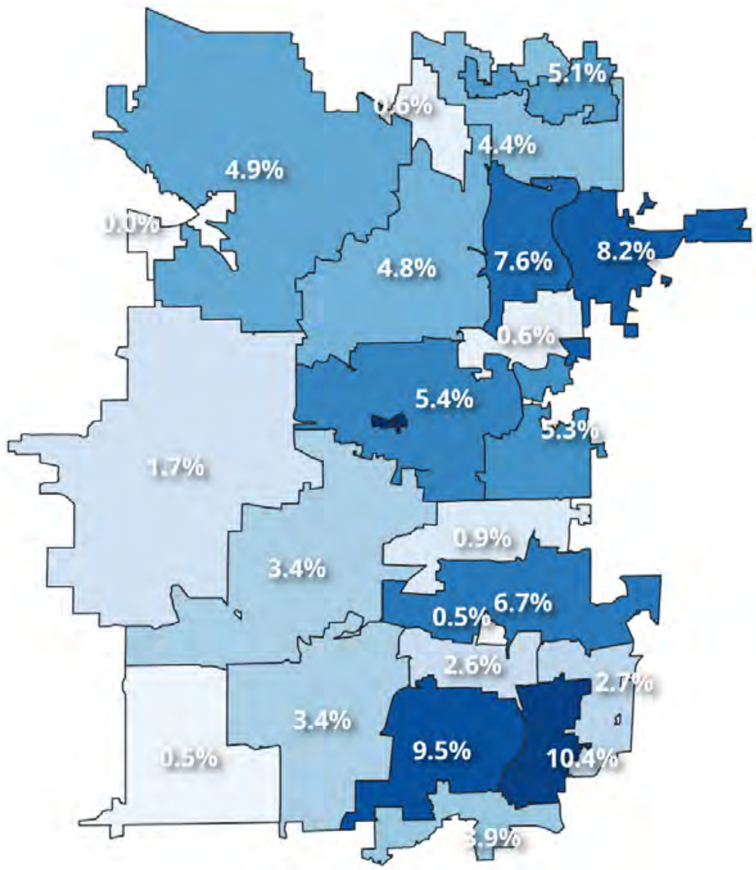
Grand Total		Subtotal: Flat Roof		Subtotal: Low Tilt		Subtotal: Mid-Low Tilt		Subtotal: Mid-High Tilt		Subtotal: High Tilt	
Suitable Buildings	100,759	25,099	24.91%	21,726	21.56%	48,751	48.38%	5,165	5.13%	18	0.02%
Suitable Roof Planes	185,388	46,180	24.91%	39,974	21.56%	89,697	48.38%	9,504	5.13%	33	0.02%
Square Footage	58,608,050	14,598,565	24.91%	12,636,828	21.56%	28,356,865	48.38%	3,004,620	5.13%	11,172	0.02%
Capacity (KW dc)	520,716	129,704	24.91%	112,275	21.56%	251,943	48.38%	26,695	5.13%	99	0.02%
Generation (KWH)	573,752,231	161,870,826	28.21%	113,234,385	19.74%	267,016,944	46.54%	31,517,572	5.49%	112,503	0.02%

Region Wide Solar Potentials

Estimated Generation Capacity in kWh annually



Estimated Share of Region's Generation Capacity



Region Wide Solar Potentials

Market Capacity

Adequately anticipating the potential for new solar PV installations must consider not only the potential technical and generation capacities, but also the likely market Capacity. As an emerging energy sector, there is little data upon which to base projections for likely installation of rooftop solar PV in the private sector. Additionally, the solar PV market is rapidly changing in both sophistication as well as in pricing and cost effectiveness. As noted in the Solar in Illinois section of this report, the installed cost of solar PV in the state has dropped 4% since 2016 and is expected to continue to decline in the coming years. Projections of solar PV installations should anticipate a continued increase in the number of solar PV installations year over year.

Market History

According to the Department of Energy, since 2005 the residential solar PV market has grown at an annual rate of 51%. A growth rate that has resulted in a residential solar PV Capacity 95 times larger in just 12 years. In the State of Illinois, the new installed Capacity that went on line in 2021 was nearly 550 MW; equal to 49% of the cumulative total of all solar PV installations in the state for **all previous years**.

State Market Projections

The Solar Energy Industries Association (SEIA) projects solar PV installation Capacity in the State to increase 4,943 MW by 2028. This is equal to a sustained compound increase of installed Capacity of over 29% annually. The timeframe of this projection overlaps with the currently established Federal Income Tax incentive program. With the recent passage of the Inflation Reduction Act it is possible, if not likely, that the Statewide solar installation growth projections will begin to rise in the coming years.

Region Wide Solar Potentials

Kane County Market Absorption Projections

Growth Scenario: Share of Projected Statewide Annual Increase Based on Population Share

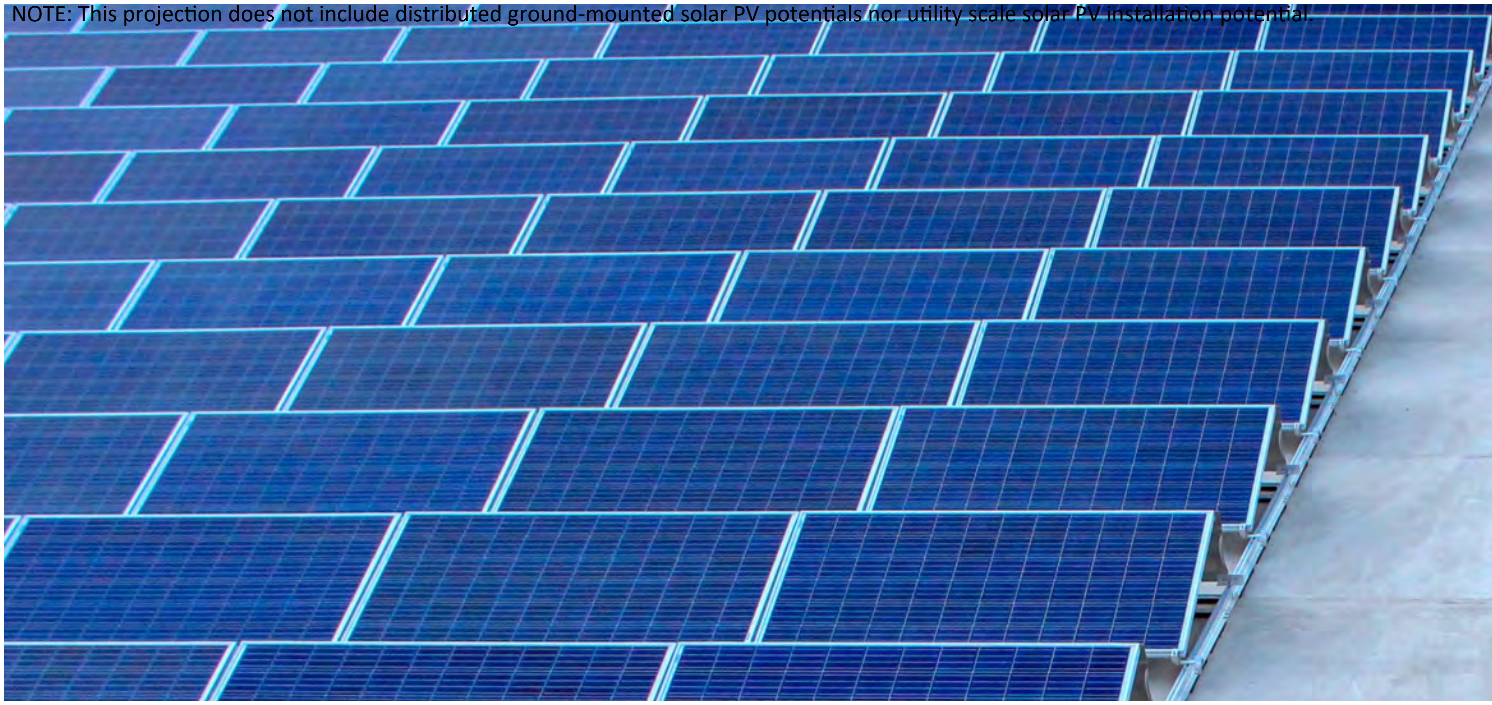
This scenario anticipates the County’s rate of increase in solar PV installed capacity matches the projected 5 year Statewide annual rate of increase of 29.5%. This scenario would mean an increase of approximately 85,300 KW of installed capacity resulting in a total of 98,000 KW, equivalent to 19% of the optimized capacity potential within the County by 2030.

As the market continues to mature through the 2030’s it may be reasonable to assume a reduction in the growth rate of new installed Capacity beginning in year 2031. For purposes of this study, we use an annual growth rate of 40% reduction of the scenario growth rate years 2031 through 2040. The chart below shows projections through 2040 using the assumptions outlined above.

Share of Projected Statewide Annual Increase Based on Population Share
(29.2% Initial Annual Increase)

Year	Cumulative Installed (KW)	Annual Generation (KWH)	% of Community Electric Consumption	This is Equivalent to adding (x) Average 9KW Residential Arrays Annually:	Or Equivalent to adding (x) 40KW Commercial Arrays Annually:
2025	27,280	30,058,401	**0.55%**	**541**	**121.8**
2030	98,020	108,003,524	**1.97%**	**1,855**	**417**
2040	491,274	541,311,139	**9.87%**	**5,254**	**1,182**

NOTE: This projection does not include distributed ground-mounted solar PV potentials nor utility scale solar PV installation potential.



Region Wide Solar Potentials

Kane County Market Absorption Projections

Recommended Minimum Rooftop Solar Growth Target

Based on this market study, simply matching the projected growth in solar installations for Kane County would achieve a notable increase in the County's share of Statewide installations, while the initial pace of 540 new residential scaled installations annually required to achieve this growth rate—less than 0.3% of region's households—should be achievable. Meanwhile, recognizing the significant incentives anticipated to be implemented in the coming years due to recent legislation such as the Inflation Reduction Act, growth rates that surpass the current annual growth rate for the State may be reasonable. As such, we recommend an increase to the initial growth based on adjusting anticipated Statewide growth rates based on the County's median household income compared to the lower statewide median household income. This would result in an initial growth rate of 35.5%. This scenario would mean an increase of approximately 130,000 KW of installed capacity resulting in a total of 144,048 KW, equivalent to 27.7% of the optimized capacity potential within the County by 2030.

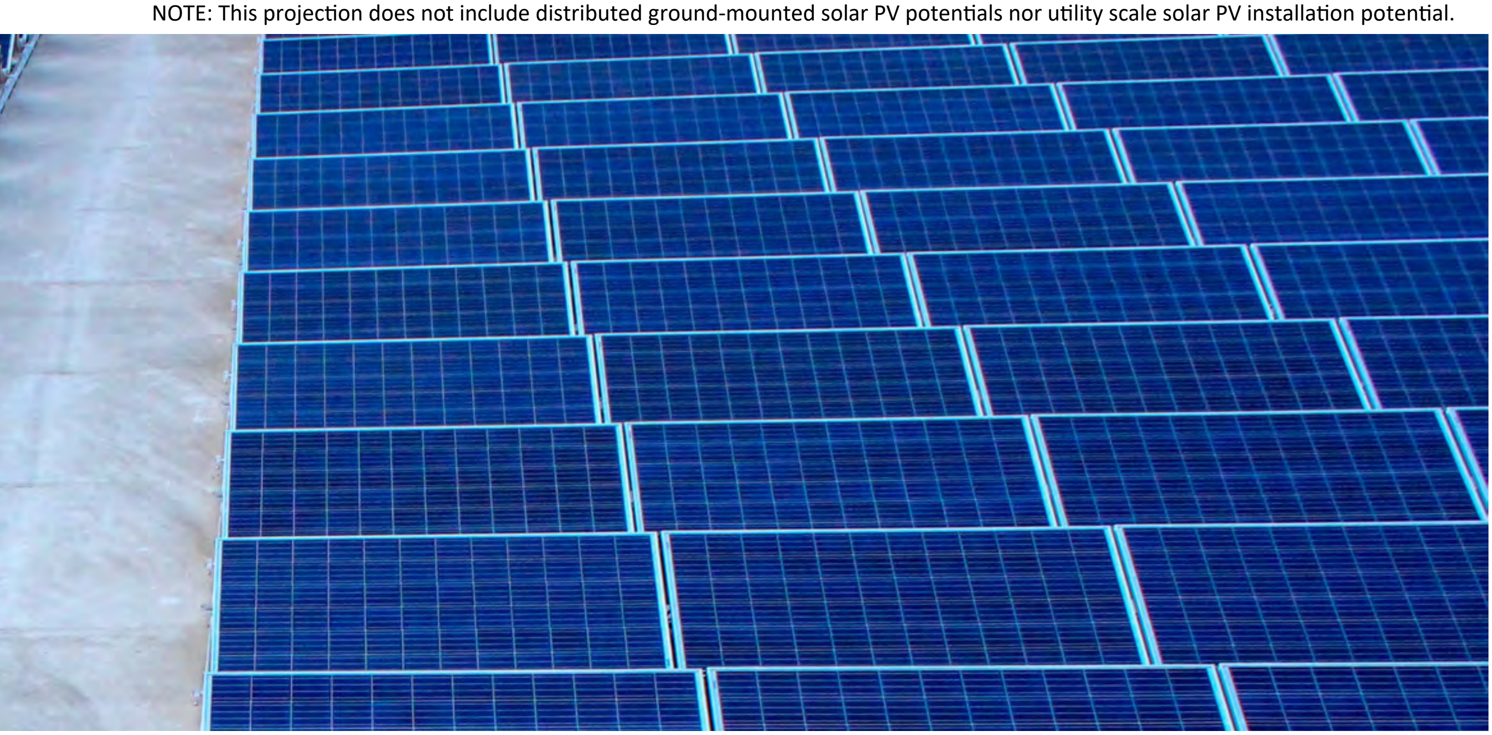
The chart below shows projections through 2040 using the assumptions outlined above.

Recommended Minimum Rooftop Growth Target Based on Population Share, Adjusted for Community Ave Household Income Compared to State Ave Household Income

(35.5% Initial Annual Increase)

Year	Cumulative Installed (KW)	Annual Generation (KWH)	% of Community Electric Consumption	This is Equivalent to adding (x) Average 9KW Residential Arrays Annually:	Or Equivalent to adding (x) 40KW Commercial Arrays Annually:
2025	31,517	34,726,679	**0.63%**	**698**	**157.1**
2030	144,048	158,719,737	**2.89%**	**2,877**	**647**
2040	994,212	1,095,475,065	**19.96%**	**10,843**	**2,440**

NOTE: This projection does not include distributed ground-mounted solar PV potentials nor utility scale solar PV installation potential.



Region Wide Solar Potentials

Estimating Additional Capacity

In addition to roof mounted solar PV potential, the Kane County has significant solar PV potential associated with ground mounted arrays as well as arrays mounted over parking—known as “Carport” arrays. Compiling a detailed estimate of the reasonable Capacity for ground mounted or carport arrays requires a much higher level of understanding of each potential subject site in order to determine the feasibility of a ground mounted or carport array at that site than what is feasible within the scope of this project effort. Some of the site use considerations on the feasibility of ground mounted arrays for specific sites include:

- Land status and planned future use
- Land quality and alternative use options
- Distance to electric grid interconnection
- Accessibility and security
- Slop and configuration
- Flooding and wetland considerations
- Proximity to primary air traffic lanes and air traffic control jurisdictions relative to glare concerns

For this report, however, we have estimated the percentage of “bare ground” and share of parking pavement which may potentially be anticipated to receive solar PV installations. The total acreage of ground and parking pavement is estimated from ground cover survey readings conducted for the Kane County Ground Cover, Heat Island, and Carbon Sequestration Study.

For both Carport and Ground Mounted arrays, the “Nameplate Capacity” potential per square foot of covered ground or parking plane area was calculated. This calculation assumed a typical 400 watt Capacity panel with a footprint of 79” x 40” with an assumed panel tilt angle of 22 degrees and 35.6” spacing between panel rows to avoid shading at winter solstice conditions. Next, this nameplate Capacity was adjusted for assumed system losses including shading, heat loss, mismatch, snow, dirt, etc. Additionally, losses were calculated for tilt classifications based on the System Advisor Model. Lastly, generation potential was calculated using the base Energy Production Factor for the region (annual KWH production/KW nameplate Capacity), modified by the loss factors outlined earlier.

Carport Capacity

The total paved area within the Kane County is estimated to be 32,430 acres—just under 10% of all land in the County. We estimate parking may be as much as 20% of this number. From a technical standpoint, much of this area is likely to be reasonably suitable for carport solar arrays, however, many locations may not perform well financially based on use and utility rate cases. Using an assumed near-term availability and suitability rate of 1% of county-wide parking area, this still represents up to 2,825,000 square feet of near-term carport solar array coverage potential. Based on the above calculation factors, this would result in a total of 25,200 KW of installed capacity producing 31,125,000 KWH annually by 2030, approximately 0.6% of the County’s total electric consumption.

Ground Mounted Capacity

The total lawn and “bare ground” area within the Kane County, excluding tree canopy coverage areas, is estimated to be 53,750 acres—approximately 26.5% of all land in the county. From a technical standpoint, much of this area is likely to be reasonably suitable for ground mounted solar arrays, however, many locations may not be appropriate for ground mounted arrays due to one or more of the site use considerations outlined above. Using an assumed near-term availability and suitability rate of 1% of region wide lawn area, this still represents up to 25,400,000 square feet of near-term ground mounted array coverage potential. Based on the above calculation factors, this would result in a total of 70,000 KW of installed capacity producing 86,300,000 KWH annually, approximately 1.6% of the county’s total electric consumption.

Region Wide Solar Potentials

Potential Distributed Solar Goal by 2030

Summarizing the calculations for the Optimized Rooftop Solar Potential, Carport Potential, and Ground Mounted Potential outlined previously illustrates a potential pathway for the Kane County to increase its distributed solar Capacity by 2030. Using the Recommended Minimum Rooftop Solar Growth Target outlined previously, combined with the Carport and Ground Mounted potential indicates a potential 2030 goal as follows:

Source Potential	Cumulative Installed	Annual Generation Estimate	Share of Demand
Estimated Existing	12,000 KW	13,950,000 KWH	0.25%
Rooftop	131,400 KW	144,750,000 KWH	2.65%
Carport	25,200 KW	31,125,000 KWH	0.6%
Ground Mounted	70,000 KW	86,300,000 KWH	1.6%
Total Potential	**238,600 KW**	**246,125,000 KWH**	**5.1%**

To achieve this solar PV generation Capacity, the Region would need to achieve the following solar PV installation coverage by 2030:

Rooftop Coverage	14.8 Million SF
Parking Lot Coverage	65 Acres
Lawn / Bare Ground Coverage	538 Acres

Section 05

Low to Medium Income Potentials

Click to Return to TOC

Low to Medium Potentials

The Need to Focus on Low and Moderate Income Solar Potential

Solar PV systems provide a wide range of potential benefits, including long-term energy cost savings, energy resilience, and reductions in air pollution including particulate matter and greenhouse gas (GHG) emissions – with positive implications for environmental and human health. Currently, most of the solar customers in the United States are in the same demographic -middle to upper class, middle-aged, and usually male. "Rooftop Solar Technical Potential for Low-to-Moderate Income Households in the United States", a recent study by NREL, found that the median income of households that install solar panels in some states was roughly $32,000 higher than the median household income in those states.

The growth of solar in the United States provides a tremendous opportunity to address some of the greatest challenges faced by lower-income communities: the high cost of housing, unemployment, and pollution. Solar can provide long-term financial relief to families struggling with high and unpredictable energy costs, living-wage jobs in an industry where the workforce has increased 168% over the past seven years, and a source of clean, local energy sited in communities that have been disproportionately impacted by traditional power generation. Yet, access to distributed solar power remains elusive for a significant slice of the U.S. population, particularly low- and moderate-income (LMI) communities— households whose income is 80% or less of the area's median.

Although solar PV costs have dropped significantly in recent years, upfront installation costs are still persistently out of reach for most LMI populations, which, by definition, have less disposable income. Beyond having limited cash-on-hand for solar power purchases, LMI populations face other obstacles in pursuing distributed solar systems, including:

- frequently lower credit scores, making it difficult to attain a loan for solar investments;
- insufficient tax burden to benefit from state and federal solar tax incentives; and
- lower rates of homeownership and higher likelihood of living in multifamily housing units—making for limited control over decisions about utilities, especially rooftop solar.

The solar potential for LMI communities is a critical market that must be developed within any community seeking to significantly advance renewable energy, energy resilience, or Climate Action goals. Increasing access for LMI communities is important not only in order to help address some of the challenges outlined above, it is likely necessary in order to meet long-term community-wide renewable energy goals. Nationally, half of all residential solar potential is on LMI households. Solar Capacity on LMI households could total 320 GW—over thirty times the total new solar in 2017.

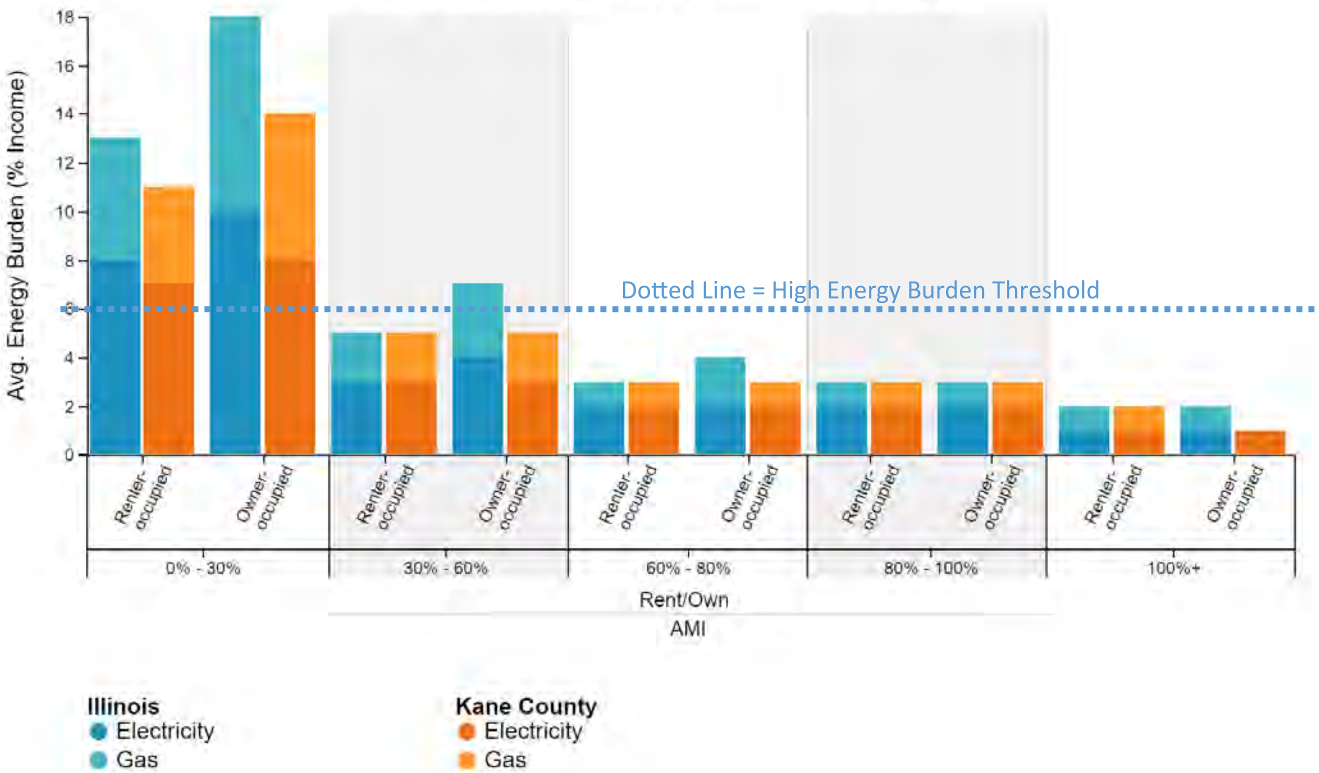
Energy Burden In Kane County

A household's energy burden—the percentage of household income spent on energy bills—provides an indication of energy affordability. Researchers define households with a 6% energy burden or higher to experience a high burden. Factors that may increase energy burdens include the physical condition of a home, a household's ability to invest in energy-efficient upgrades, and the availability of energy efficiency programs and incentives.

See the charts on the following page for a breakdown of households with high energy burden.

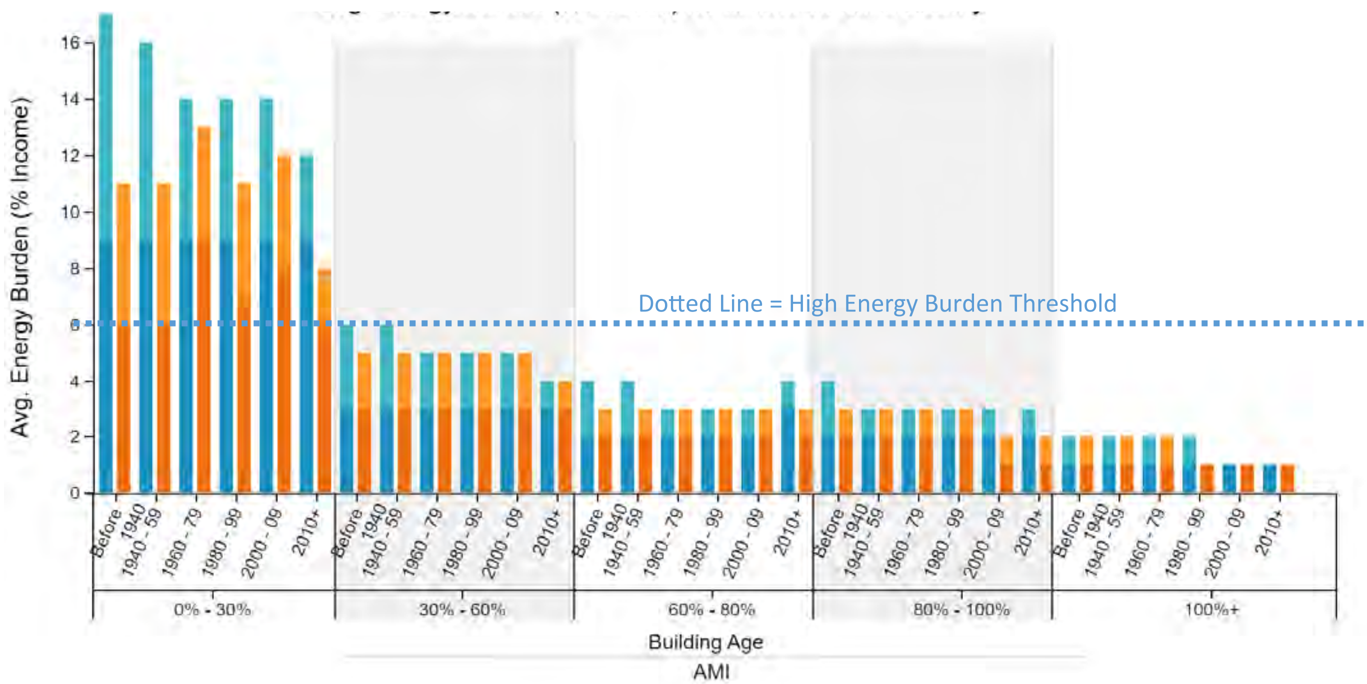
Low to Medium Potentials

Energy Burden In Kane County—Energy Burden by Income and Occupancy Type (Ownership)



Source: US DOE Low-Income Energy Affordability Data

Energy Burden In Kane County—Energy Burden by Income and Housing Age



Source: US DOE Low-Income Energy Affordability Data

Low to Medium Potentials

Energy Burden In Kane County (continued)

As illustrated in the charts on the previous page, the households with the most significant housing burden over 6% across all income levels in Kane County tend to be equally likely to be renters or homeowners. Over 28% of LMI households in the community have high energy burden, comprising 10.6% of all households in Kane County. The LMI households, by income as a percentage of Area Median Income (AMI) and housing type, which are effected by high (over 6%) energy burden are:

Share of Total LMI Households with High Energy Burden

Housing Type By Income Level	Total in Kane County with High Energy Burden	Share of Income Category Total	Share of Total LMI Households with High Energy Burden
Income 0-30% AMI:	**18,611**		**98.83%**
Single Family Household detached	8507	45.7%	45.18%
Single Family Household Attached	1947	10.5%	10.34%
2 Unit Buildings	1752	9.4%	9.30%
3-4 Unit Buildings	1406	7.6%	7.47%
5-9 Unit Buildings	1137	6.1%	6.04%
10-19 Unit Buildings	1200	6.4%	6.37%
20-49 Unit Buildings	795	4.3%	4.22%
50+ Unit Buildings	1662	8.9%	8.83%
Mobile Home/Trailer	205	1.1%	1.09%
Income 30-60% AMI:	**220**		**1.17%**
Single Family Household detached	-		
Single Family Household Attached	-		
2 Unit Buildings	-		
3-4 Unit Buildings	-		
5-9 Unit Buildings	-		
10-19 Unit Buildings	-		
20-49 Unit Buildings	-		
50+ Unit Buildings	-		
Mobile Home/Trailer	220	1.2%	1.17%
Income 60-80% AMI:	**0**		**0.00%**
Single Family Household detached	-		
Single Family Household Attached	-		
2 Unit Buildings	-		
3-4 Unit Buildings	-		
5-9 Unit Buildings	-		
10-19 Unit Buildings	-		
20-49 Unit Buildings	-		
50+ Unit Buildings	-		
Mobile Home/Trailer	-		
Total LMI Households With High Energy Burden:	**18,831**		
Total LMI Households in Community:	67,246	**% of LMI Households in Community with High Energy Burden:**	**28.0%**
Total Households in Community:	178,044	**% of Total Households with High Energy Burden:**	**10.6%**

Low to Medium Potentials

Solar Potential of LMI Buildings in Kane County

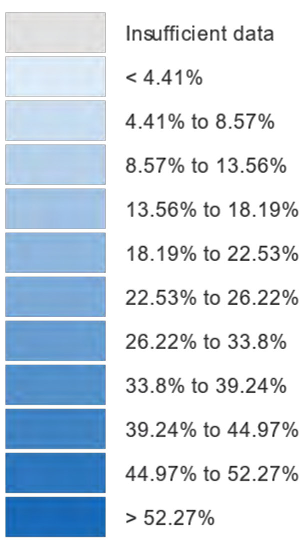
According to the study "Rooftop Solar Technical Potential for Low-to-Moderate Income Households in the United States" by NREL, the 67,246 LMI households live in 38,023 buildings (4,747 multi-family buildings and 33,726 single family buildings). These LMI residential buildings are estimated to have a optimized solar generation capacity of 648,500,000 kWh annually.

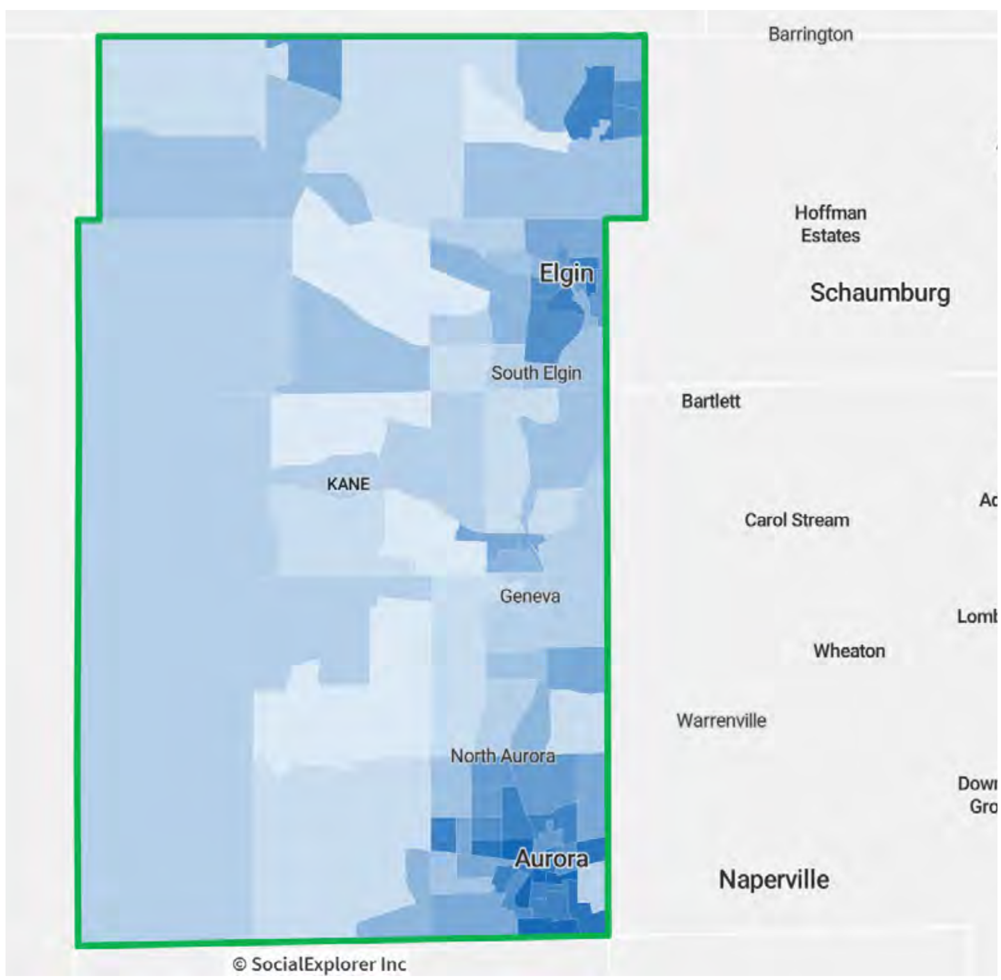
According to NREL, the generating capacity of these LMI buildings alone is capable of meeting nearly 60% of the total Annual Solar Generation for 2040 as projected by the recommended rooftop solar scenario (see Section 4) - meaning **strategies which result in significant increases in solar PV options for LMI communities would not only provide a significant benefit for relief from energy burden impacts, but would also meaningfully contribute to the County's long-term renewable energy goals**. Below is a breakdown of optimized solar generation by building type:

Building Type	Est. Optimized Generation Potential	Ave LMI Household Savings Potential
LMI Single Family:	**316,900,000** kWh Annually	**$1,233** Annually
LMI Multi-Family:	**331,600,000** kWh Annually	

Mapping LMI Household Potential In Kane County

The map below illustrates the total LMI households as a share of total households by census tract. Census tracts with higher share of LMI households may offer significant opportunities for actions which advance LMI solar PV programs.



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Section 06

County Wide Solar Benefits

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County Wide Solar Benefits

Economic Potential

As with all energy sources, solar PV installations require investment up-front for construction and installation as well as annual maintenance costs. When measured on a per unit of energy consumed, these costs are similar, or more competitive than, the costs associated with other energy sources. Unlike almost all other forms of electricity, however, a significant portion of the initial and on-going costs associated with solar PV are capable of remaining in the local economy. This means that for communities who plan carefully for the increase in renewable energy, a local economic development potential exists.

Economic Potential for Kane County

According to the National Renewable Energy Laboratory (NREL), the additional solar PV capacity which could be installed in the County by 2030 (Recommended rooftop scenario as well as the estimated ground mounted and carport arrays) has a total construction value of $450 million (2023 dollars). The potential share of those investments for the local economy totals 515 jobs and $46.37 million in local income potential during construction and 101 jobs and $6.99 million in local income potential for maintenance annually through the lifetime of the installations. Below is a breakout of the Kane County Economic Development potential of new installed solar PV capacity through 2030 based on population share of Statewide market absorption projection numbers:

Local Economic Impacts Through 2030
Summary Results Based on Recommended Scenario*

	Jobs	Earnings	Output	Value Added
During construction period		**Million $ 2021**	**Million $ 2021**	**Million $ 2021**
Project Development and Onsite Labor Impacts	180	$25.12	$34.27	$27.95
Construction and Interconnection Labor	116	$21.64		
Construction Related Services	64	$3.48		
Equipment and Supply Chain Impacts	180	$11.85	$48.31	$23.83
Induced Impacts	155	$9.40	$26.02	$14.17
Total Impacts	**515**	**$46.37**	**$108.59**	**$65.96**

	Annual Jobs	Annual Earnings	Annual Output	Annual Output
During operating years (annual)		**Million $ 2021**	**Million $ 2021**	**Million $ 2021**
Onsite Labor Impacts	74	$5.09	$5.09	$5.09
Local Revenue and Supply Chain Impacts	12	$0.89	$2.64	$1.75
Induced Impacts	15	$1.01	$2.79	$1.50
Total Impacts	**101**	**$6.99**	**$10.52**	**$8.34**

*Includes estimated Ground Mounted and Carport array potential through 2030

Additional Economic Benefit

In addition to the local re-investment share of the construction and maintenance costs, Kane County residents and business owners who invest in solar PV will have direct economic benefit in the form of savings. These savings represent increased economic potential within the County and include:

1) All residents and businesses who install solar PV prior to the phase out of the Federal Tax Incentive will be able to save 30% of the cost of installation. In addition, all commercial solar PV owners can harvest additional tax benefits through the federal accelerated depreciation. At the projected additional installation through 2030 outlined in the previous section, this could mean $135 million in savings and local re-investment potential through 2030.
2) Many owners who install solar PV see a decrease in their annual energy costs (including solar PV project finance costs). Though savings vary, a reasonable estimate of the out-of-pocket savings for residents and businesses in Kane County is $1.5 to $2.5 million annually by 2030 (based on a third party ownership structure, long-term savings for direct ownership can be significantly higher).

County Wide Solar Benefits

Environmental Benefits for Kane County

The core environmental benefits of Solar PV electric energy generation relate to improved air quality, reduced greenhouse gas emissions, and reduced water consumption.

Greenhouse Gas and Electricity

Greenhouse gas emissions form, primarily, from the burning of fossil fuels. The carbon footprint of electricity is the total greenhouse gas emissions throughout the life-cycle from source fuel extraction through to end user electricity. According to the Intergovernmental Panel on Climate Change (IPCC), the median greenhouse gas emission, measured in metric tonnes, for 1 Gwh of electricity by fuel type is as follows:

Electricity Source	Metric Tonnes GHG/GWh
Hydroelectric	4
Wind	12
Nuclear	16
Biomass	18
Geothermal	45
Solar PV	46
Natural gas	469
Coal	1001

The Water/Energy Nexus

Water and energy are inextricably linked in our current modern infrastructure. Water is used in all phases of energy production. Energy is required to extract, pump and deliver water for use, and to treat waste-water so it can be safely returned to the environment. The cumulative impact of electricity generation on our water sources can be significant, and varies by fuel source. According to The River Network, the average fresh water use for 1 Gwh of electricity by fuel type is as follows:

Electricity Source	Gallons/GWh
Hydroelectric	29,920,000
Wind	1,000
Nuclear	2,995,000
Biomass	2,000
Geothermal	2,000
Solar PV	2,000
Natural gas	1,512,000
Coal	7,143,000

Current Electric Grid Profile

According to CMAP, the total GHG emissions per MWH equal approximately 0.439 metric tons (2019 reporting). Using the River Network average fresh water use by fuel type, the average water use per 1 Gwh of electricity in the County is 5,306,500 gallons.

Based on these numbers, by 2030 the additional solar PV installed in the Kane County can reduce its annual Greenhouse Gas emissions by 100,800 metric tons (2 billion cubic feet of human-made greenhouse atmosphere), and its annual water footprint by 1,465 Million Gallons.

Recommended Scenario: Carbon and Water Footprint Reduction Potential*

Year	Annual Generation (GWH)	GHG Emission Reduction (mTons)	GHG Emission Reduction (Cubic Feet of Atmosphere)	Water Footprint Reduction (Mgallons)
2025	93.44	34,106	676,710,211	496
2030	276.15	100,794	1,999,897,447	1465
2040	1,212.90	442,710	8,783,983,515	6434

*Includes estimated Ground Mounted and Carport array potential through 2030

Section 07

County Wide Municipal Solid Waste Plasma Gasification Potential

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County Wide Municipal Solid Waste Plasma Gasification Potential

Exploration of gasification of Municipal Solid Waste for energy and beneficial use bi-products should not be instituted in competition with traditional goals of waste reduction, reuse, and recycling efforts. Gasification works in conjunction with this established waste hierarchy - even after efforts to reduce, reuse, recycle and compost, there is still residual waste generated. Rather than send this residual waste to a landfill where harmful greenhouse gas emissions are released, capture the energy value of the waste through plasma gasification energy recovery facilities. This approach to energy generation may be a potential for any community that generates solid waste, regardless of whether or not that solid waste is currently landfilled within the community's boundaries. For communities that currently export their solid waste to locations outside of the community, it may be possible to create a gasification plant within the community, or to explore partnering with the existing site handling the community's solid waste.

What is Gasification?

Gasification can be defined as a thermochemical process that uses heat and a low-oxygen environment to transform carbonaceous feedstock such as biomass or MSW through partial oxidation to release other forms of energy. This means that oxygen is injected but not enough to cause complete combustion as it does in waste incinerators. Unlike incineration, gasification converts solid or liquid waste feedstock into gaseous product by exposing it to a range of high temperatures in a controlled supply of oxygen without actually burning it. At such elevated temperatures, bonds in solid and liquid wastes are broken, releasing simple gaseous molecules, which are mainly a mixture of carbon monoxide (CO) and hydrogen (H2) known as synthesis gas (syngas), which has energy content and can be used to generate electrical power in fuel cells or as a fuel in gas engines and turbines after cleaning.

How Does a Gasification System Work?

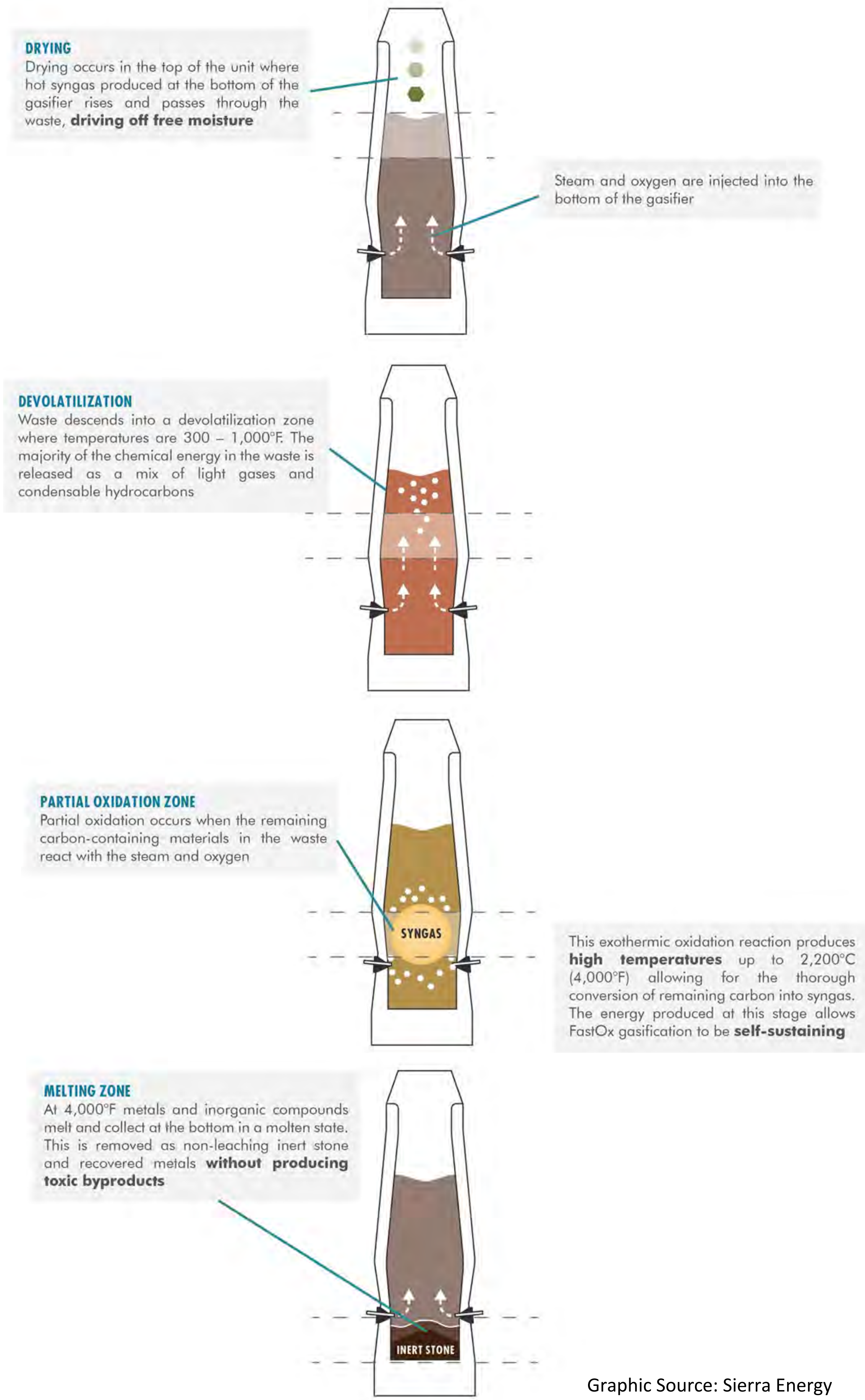
Waste is fed into the top of the gasifier vessel through an airlock. Purified oxygen and steam are injected into the base. The gasification reaction occurs at temperatures around 2,200°C (4,000°F). As the waste descends within the gasifier, it passes through several reaction zones reaching the hottest area at the base. In each zone, different materials are driven off. At the lowest point of the gasifier, the waste is reduced to carbon char, inorganic materials, and metals. Injected oxygen and steam react with the carbon char to produce a synthesis gas (syngas), comprised predominately of carbon monoxide and hydrogen. This reaction is highly exothermic, meaning that it releases a large amount of energy in the form of heat. The syngas and heat rise through the gasifier, interacting with the waste as it descends through the vessel. Syngas then exits the top of the gasifier vessel. At the base of the gasifier, inorganic materials and metals collect in a molten state. This molten liquid is periodically tapped out and cools into a vitrified stone that is very similar in appearance to volcanic rock and suitable for use in landscaping or as construction material aggregate. Systems which use ultra high temperatures and purified oxygen (as opposed to nitrogen-rich ambient air) avoids greenhouse gas emissions because it eliminates nitrogen from the process and preventing the formation of harmful substances such as nitrogen oxides.

Use of Municipal Solid Waste as Feedstock for Gasification

Systems which use ultra high temperatures and purified oxygen, similar to Serria Energy's FastOx, system can accept most waste, with the exception of radioactive and explosive materials. This includes municipal solid waste, biomass, construction and demolition waste, industrial waste, and even complex wastes, such as hazardous, toxic and medical wastes without any additional treatment requirements. The process requires minimal pre-treatment of feedstock. After waste material is delivered to the site, it is shredded prior to gasification. The gasifier can handle wastes with moisture contents of up to 50% by weight although optimal moisture content is 20% and below. MSW is ideal feedstocks for systems which use ultra high temperatures and purified oxygen. The EPA defines MSW as waste consisting of everyday items "used and then thrown away, such as product packaging, grass clippings, furniture, clothing, bottles, food scraps, newspapers, appliances, paint, and batteries," which come from "homes, schools, hospitals, and businesses" (US Environmental Protection Agency, 2013). MSW makes a great feedstock for these types of gasification systems due to its abundance and its variable composition which tends to optimize the gasification process. Use of MSW as gasification feedstock should focus on converting non-recyclable trash into energy. Therefore, processing MSW waste to extract all recyclable content should occur prior to entering the gasification process.

End-product Creation

Gasifiers produce a high-quality syngas that can be converted into a number of valuable end products. The most common end products are syngas which can be used to generate electricity, and solids including biochar, and vitrified stone that is very similar in appearance to volcanic rock and suitable for use in landscaping or as construction material aggregate. To generate electricity, syngas must be cleaned to the degree at which it can be used to power an electrical generation engine. The production of diesel, hydrogen fuel, and other end products, requires additional syngas cleaning efforts, as their purity requirements are more stringent than that of electricity production. As a result, each desired end-product may require a unique syngas cleaning and conditioning process.



Graphic Source: Sierra Energy

County Wide Municipal Solid Waste Plasma Gasification Potential

What Emissions are Produced through Gasification?

Environmental performance in a MSW thermal treatment technology is important for the feasibility of the whole process. Recent research has shown that the operation of thermo-chemical and biochemical solid waste conversion processes poses little risk to human health or the environment compared to other commercial processes. Biochemical processes and those of anaerobic digestion have gained a wider acceptance in recent years. The strong opposition to gasification processes from environmental organizations is the result of misunderstanding that these processes are only minor variations of incineration.

The type of thermal chemical conversion that occurs in gasification, as outlined above, has several important aspects that make it different from conventional MSW incineration. The technology makes air pollution control easier and cheaper compared with the conventional combustion processes. Exhaust gas cleanup of thermochemical conversion processes is easier compared with incineration process, though still requires a proper process and emission control system design to satisfy safety and health requirements.

University of California researchers conducted a limited study in 2005 of three prototype thermochemical conversion technologies. Results from the analysis indicate that pyrolysis and gasification facilities currently operating throughout the world with waste feedstocks meet each of their respective air quality emission limits. With few exceptions, most meet all of the current emission limits mandated in California, the United States, the European Union, and Japan. In the case of toxic air contaminants (dioxins/furans and mercury), every process evaluated met the most stringent emission standards worldwide.

Systems which use ultra high temperatures and purified oxygen have zero direct emissions. It is a closed loop system that converts waste into syngas, which is processed at the back end of the system into useful energy.

Plasma Gasification Potential in Kane County

According to Sierra Energy, based on the Kane County's total landfilled municipal solid waste, the current waste stream within Kane County could support 1,100 tons per day waste stream for gasification. This volume could generate:

Kane County Total

331,900,000 — **kWh Electricity**
annually

or

73,500,000 — **Pounds Hydrogen Fuel**
annually
Usable as a fuel alternative for fuel cells or engine generator sets

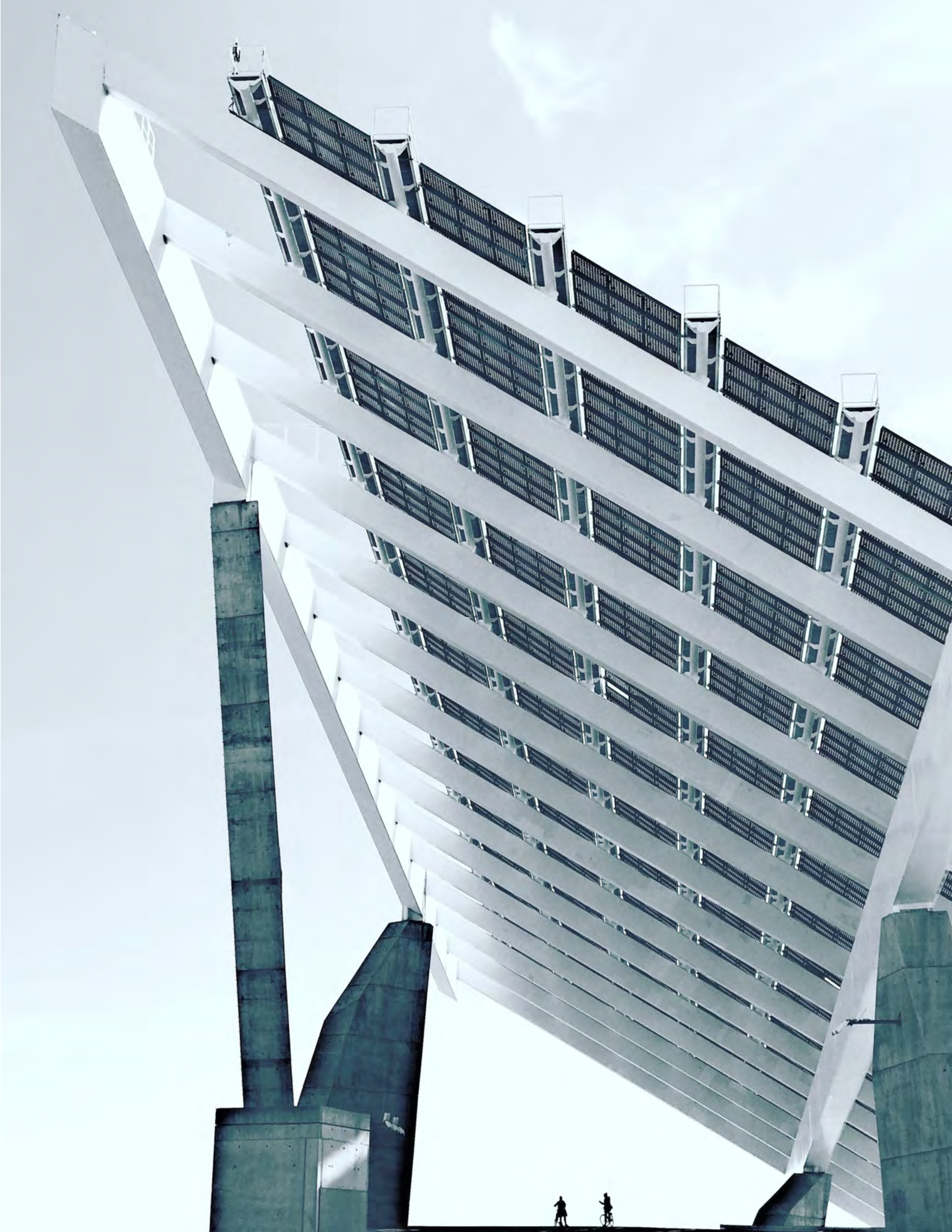
or

18,300,000 — **Gallons of Renewable Diesel**
annually
Usable as a fuel alternative for vehicles

or

413,200,000 — **Pounds of Ammonia**
annually
Usable as a fuel alternative for fuel cells or engine generator sets

Source: Sierra Energy



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