Village of Northbrook
Solar Renewable Energy Potentials Study

September 2020

Prepared by:

making change personal
paleBLUEdot LLC

Table of Contents

Section 01

Introduction

Click to
Return to TOC

Introduction

Intent of This Study

The intent of this study is to support the Village in appropriate and effective renewable energy goalsetting within the Village's Climate Action Planning process. This study seeks also to support the Village establish strategies addressing renewable energy development. The primary focus of this study is to establish the Community-Wide rooftop solar pv potential throughout the Village, 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 Village-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 Village-wide solar pv goals.
6) Identify environmental and economic benefit of solar including economic development and job creation potential (NREL JEDI model)

About paleBLUEdot

paleBLUEdot, a Minnesota LLC and S/WBE Certified Business, is a climate action, carbon management, and renewable energy consultancy firm established in 2014. Our mission is to support the transition to a low-carbon economy through an array of sustainability assessments, consultancy, and planning services, and through education that increases awareness and enhances public dialogue.

paleBLUEdot has extensive renewable energy, carbon, and climate planning experience from the scale of individual sites to community wide efforts. Within the last two years alone, paleBLUEdot has produced solar feasibility assessments and concept designs on over 350 sites as well as 16 community-wide solar feasibility assessments for government and community clients.

Introduction

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

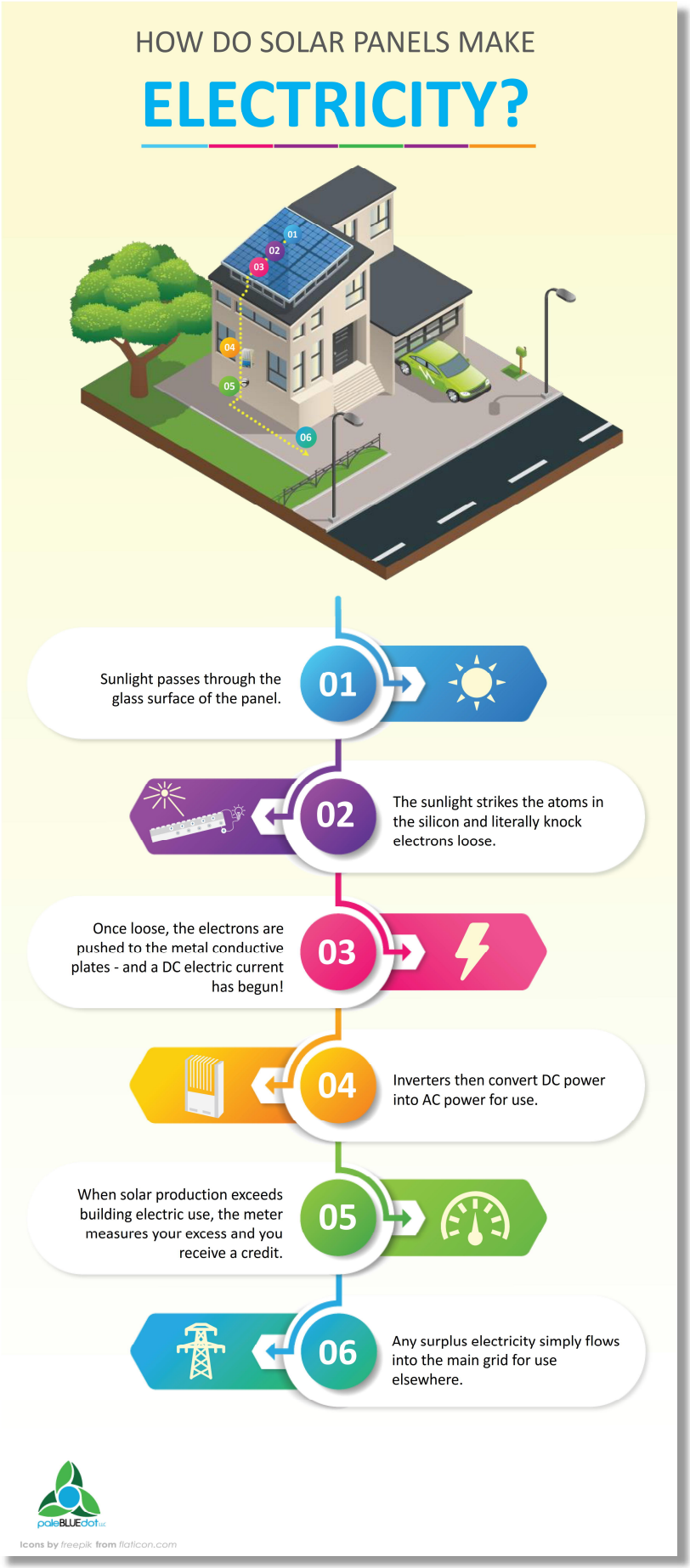
How Solar PV Works

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.



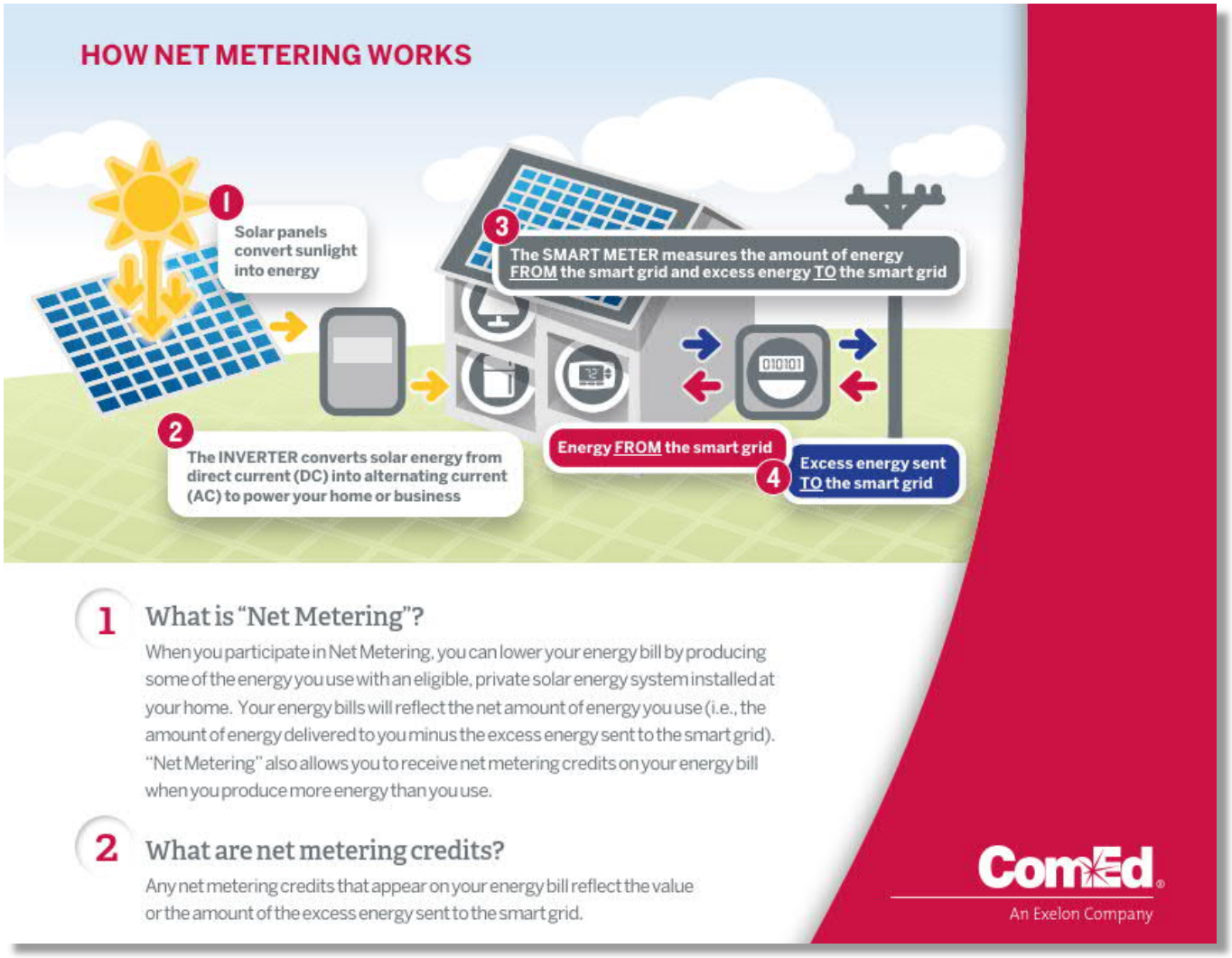
Introduction

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

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.

The owner and user of a Renewable Energy Certificate (REC) is the only party that can claim the environmental benefits of that REC and claim to be using renewable energy because of that REC. Naturally, issues of REC ownership, validity of certain claims and avoiding double counting are central to a robust voluntary renewable energy market.

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. When all such motivated organizations are engaging in the purchase of solar pv arrays or the purchase of solar power, 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. In those project delivery methods, the building owner would assume that all RECs will be purchased by the electric utility as a part of the finalized interconnection agreement. 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 Village's GHG Inventory will need to use the regional electric grid emissions factors for calculation of emissions.

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. The State of Illinois does allow 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.

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.

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

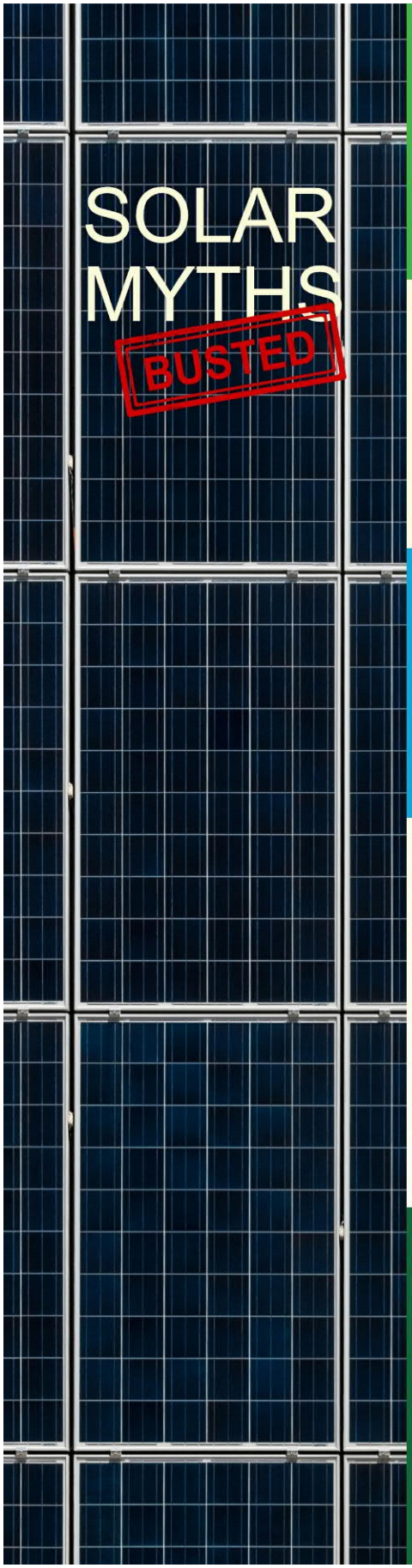
ComEd provides rebates for commercial and industrial (C&I) customers to help decrease the out-of-pocket costs of installing solar. ComEd customers who install solar on business properties are eligible for $250 per kilowatt (kW) of installed solar power (up to 2,000KW of installed capacity). (https://www.comed.com/SmartEnergy/MyGreenPowerConnection/Pages/SolarInc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

Federal Investment Tax Credit

The federal solar tax credit, also known as the investment tax credit (ITC), allows you to deduct 26 percent of the cost of installing a solar energy system from your federal taxes. The ITC applies to both residential and commercial systems, and there is no cap on its value. The deduction allowed by the ITC is currently scheduled to reduce 22% for projects in 2021 and 10% for projects in 2022 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)



1 SOLAR PANELS WILL DAMAGE MY ROOF. MYTH

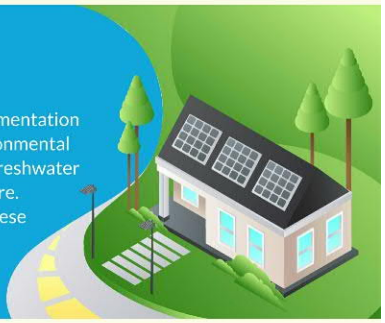
Fact: The solar PV cells attached to rooftops use modern materials perfected in labs. Holes need to be drilled into a roof to attach solar panels, but your roof can still be protected. Reputable solar panel installation companies follow industry best practices, like using quality flashed mounts to waterproof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

2 SOLAR PANELS DON'T WORK IN COLD CLIMATES MYTH

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. MYTH

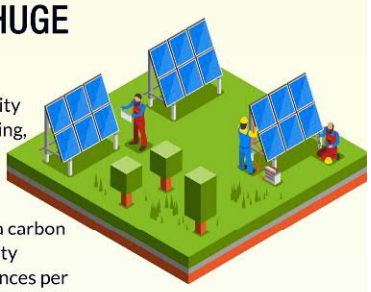
Fact: Detailed analysis indicates that the large-scale implementation of solar has the potential to reduce pollution-related environmental impacts of electricity production, such as GHG emissions, freshwater ecotoxicity, eutrophication, and particulate-matter exposure. The pollution caused by higher 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 MYTH

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".

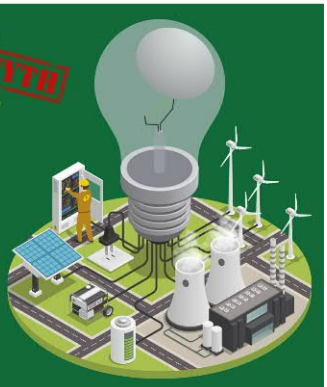
The lifecycle emissions of electricity generated by coal has a carbon footprint of 35.3 ounces per KWh generated, while electricity generated by natural gas has a carbon footprint of 17.65 ounces per KWh generated. Meanwhile, the lifecycle emissions for Solar PV equates to an average of 1.4 ounces of 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 MYTH

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

Click to
Return to TOC

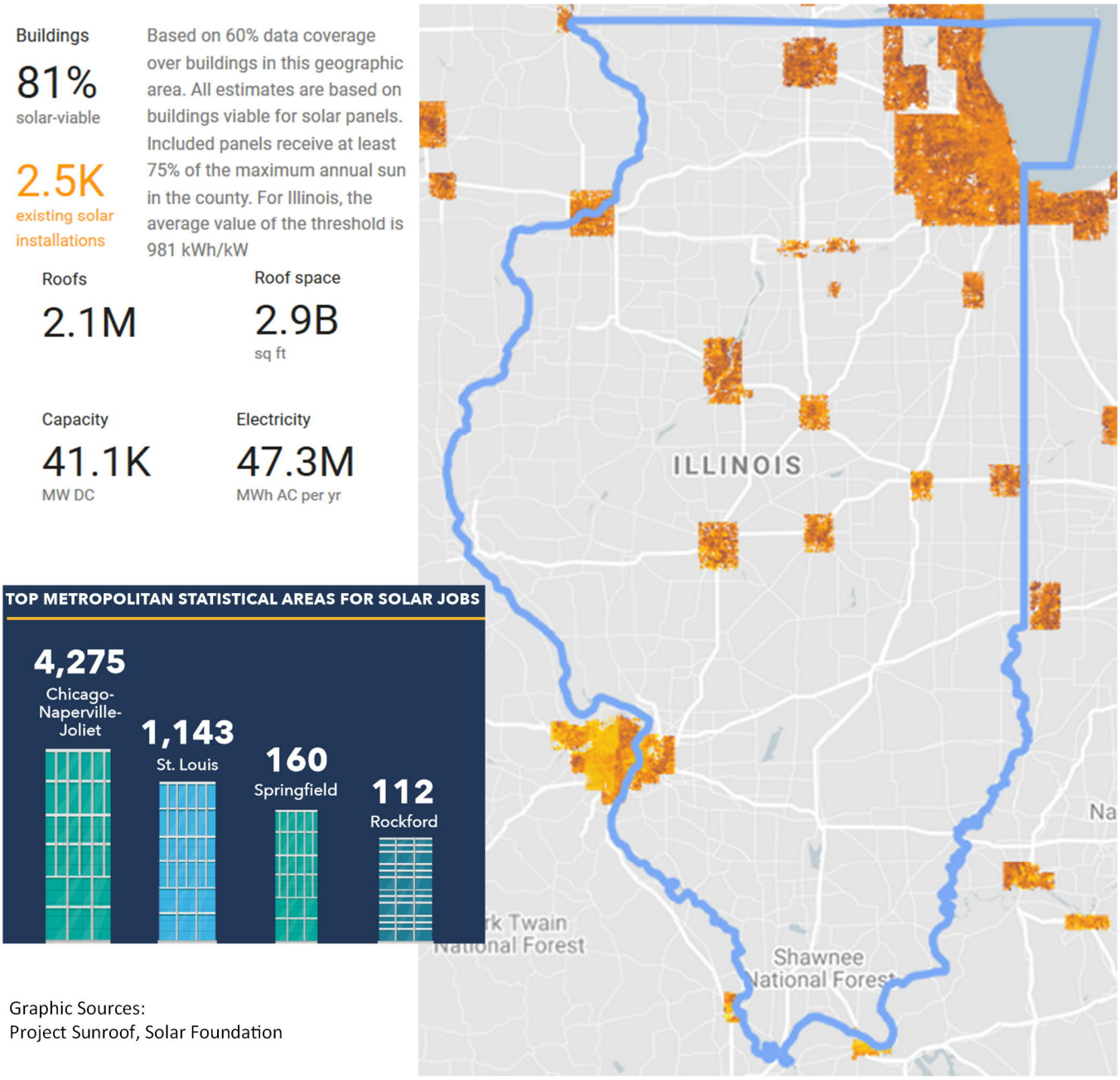
Solar in Illinois

As of December 2019, Illinois has a total of 302 megawatts (302,000,000 watts) of solar capacity installed statewide. There are a total of 17,113 solar installations in the State. The State of Illinois ranks 21st nationally for total solar energy production capacity.

The State's solar installation total is enough to power 45,325 homes. The share of the State's total electricity use that comes from solar power, however, is less than 0.22%. This indicates great potential for growth throughout the State. Current solar growth projections for the State equal an additional 1,673 MW over the next 5 years - a growth rate that ranks 14th nationally.

Costs for Solar PV installation in the State have declined 40% since 2015. Price declines have been accompanied with increasing rate of investment in solar energy. A total of $753,390,000 has been invested in Solar PV installations. The industry currently employs 5,513 people in 301 companies Statewide.

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



Graphic Sources:
Project Sunroof, Solar Foundation

The SOLAR FOUNDATION™ for a bright future

ILLINOIS

SOLAR JOBS CENSUS 2018

There are 242,343 Americans working in solar as of 2018, according to The Solar Foundation's latest *National Solar Jobs Census*. Visit SolarStates.org to view an interactive map of solar jobs in 2018 by state, county, metro area, and congressional district.

Illinois is emerging as a leading state for solar job growth, thanks to strong support for renewable energy at the state and local levels.

STATE SOLAR JOBS: 4,879

13 STATE RANKING FOR SOLAR JOBS

36 STATE RANKING FOR SOLAR JOBS PER CAPITA

1,308 New Solar Jobs, 2018

36.6% Solar Jobs Growth, 2018

2 State Rank by Net Solar Jobs Added, 2018

11.4% Projected Jobs Growth, 2019

8.6% Percentage of State Solar Workers Who Are **Veterans**

SOLAR JOBS BY SECTOR

INSTALLATION

2,986 *(42% increase)*

MANUFACTURING

601 *(32% increase)*

WHOLESALE TRADE & DISTRIBUTION

745 *(15% increase)*

OPERATIONS & MAINTENANCE

222

OTHER

324 *(10% decrease)*

SOLAR POLICY CONTEXT

A Net Metering Policy Grade[6]

A Interconnection Policy Grade[6]

Solar installations up to 2 MW deemed non-competitive receive compensation for solar sent back to the grid credited at the retail rate, while those installations deemed competitive are credited at the avoided cost rate. The limit to the number of systems covered under net metering is set at 5% of a utility's peak demand in the previous year.

RENEWABLE PORTFOLIO STANDARD[10]

25% by 2025

RENEWABLE PORTFOLIO STANDARD CARVEOUTS[10]

1.5% Solar PV

0.25% Distributed Generation

COMMUNITY SOLAR[8]

Legislation Enacted

COMMUNITY CHOICE AGGREGATION STATUS[9]

CCA Enabling Legislation

LEGAL STATUS OF THIRD PARTY OWNERSHIP[10]

Authorized by state, at least in certain jurisdictions

PROPERTY ASSESSED CLEAN ENERGY FINANCING (PACE) STATUS[11]

PACE-enabling Legislation; In Development Commercial PACE Programs

STATE INSTALLER LICENSING REQUIREMENTS[7]

Electrician's License, NABCEP PV Installation Professional, Underwriters Laboratories DG Technology Certification, Electronics Technicians Association DG Certification, or Associate in Applied Science Degree

29%

Employers Reporting It Was "Very Difficult" to Hire Qualified Employees

34

STATE RANKING FOR AVERAGE ELECTRICITY PRICE[3]

(Highest to Lowest)

9.46 CENTS/kWh

AVERAGE ELECTRICITY PRICE[3]

Section 03

Solar in Northbrook

Click to
Return to TOC

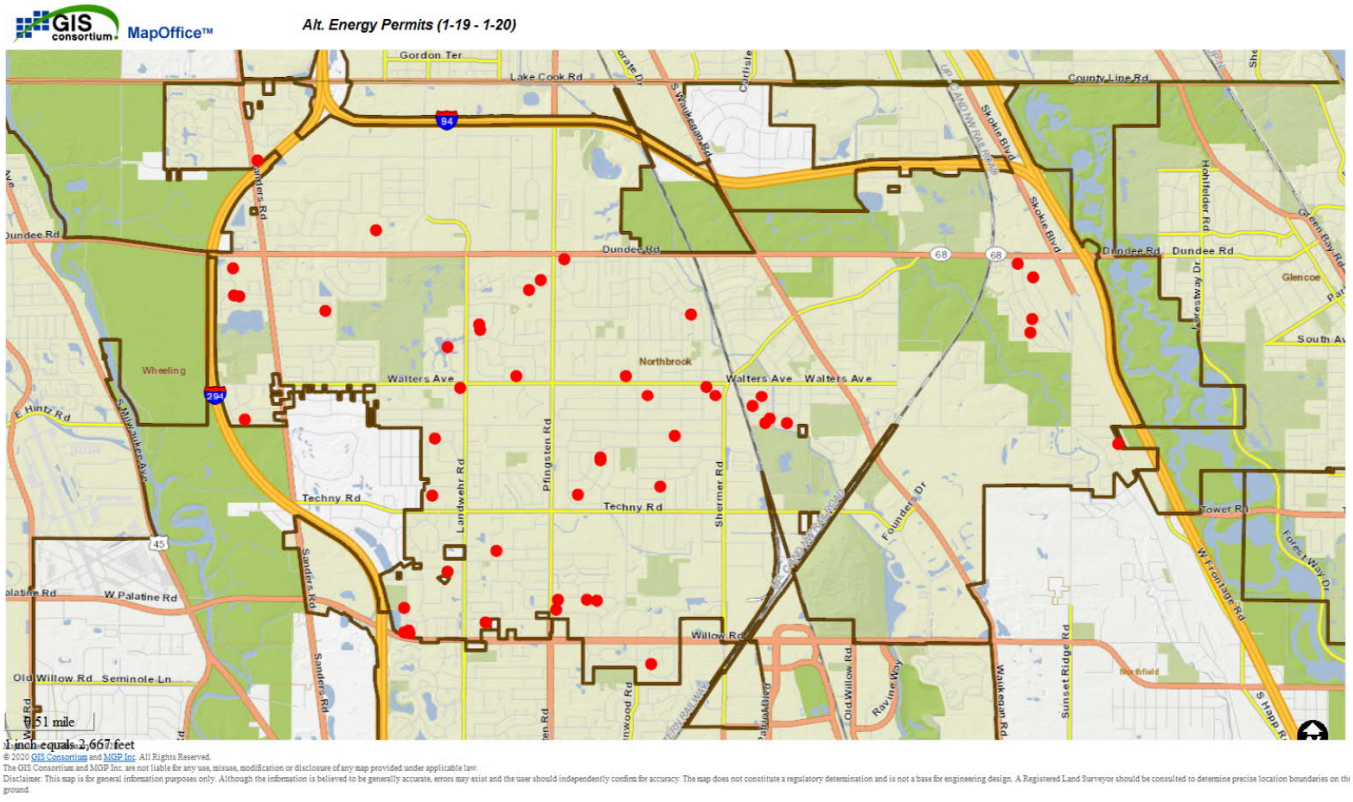
Solar in Northbrook

As of August 2020, according to permit records, Northbrook has a total of 76 solar installations totaling 2.07 megawatts (2,070,000 watts) of installed solar generating capacity. This is equal to 0.54% of all solar installations and 0.75% of the total solar generating capacity in the State, compared to the Village's 0.26% share of State population (see "Village of Northbrook's Solar Share" chart).

The total solar installation capacity in the Village of Northbrook is estimated to generate 2,600,000 kWh annually or more - enough to power 237 homes. The total share of the Village's total electricity use that comes from solar power, however, is less than 0.65%. This indicates great potential for solar pv growth in the Village. The actual breakdown of total installed capacity in the Village by market sector is shown on the next page (see "Estimated Breakdown of Northbrook's Solar Installations by Sector").

As noted in Section 2, costs for Solar PV installation in the State have declined 40% since 2015. The Village of Northbrook currently has an estimated total of 5 solar companies including 1 installer, 1 project developer, 2 manufacturers, and 1 distributor, or approximately 1.6% of the State's total solar business entities (approximately 6 times the community's share of State population).

Map of Northbrook Solar Installations For 12 Month Period from January 2019 through January 2020



Solar in Northbrook

Village of Northbrook's Solar Share

	State	Northbrook	Nothbrook's Share
Population	12,670,000	33,167	**0.26%**
Number of Solar Installations	14,188	76	**0.54%**
Estimated Solar Generating Capacity (MW)	275.77	2.07	**0.75%**
Average Array Size (KW)	19.44	27.25	**140%**

Estimated Breakdown of Northbrook's Solar Installations by Sector

Sector	Installed Capacity	Number of Array Installations	Average Array Size (kW)	Estimated Share of Sector's Electricity Use
Residential	704.8 kW	74	9.5	0.59%
Utility Company	0.0 kW	0	N/A	
Government	0.0 kW	0	N/A	
Commercial	314.3 kW	1	314.3	0.19%
Industrial / Large Commercial	1052.3 kW	1	1,052.3	2.51%
Total Installed Capaicty	**2,071 kW**	**76**	**27.3**	**0.18%**

Section 04

Village Wide Solar Potential

Click to Return to TOC

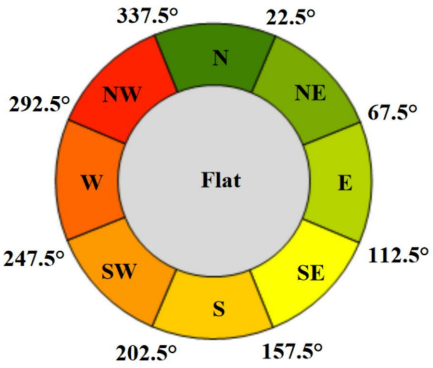
Village Wide Solar Potentials

Methodology and Data

This section calculates the total technical capacity and total generation potential for rooftop solar in the Village. Total solar PV potential was calculated based on the following input, data, and methodology:

Input Data

Roof plane survey data is provided by National Renewable 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

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 zip code 60062 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.

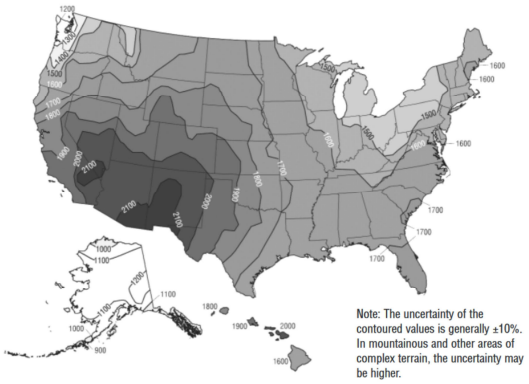
All roof planes with Northwest, North, and Northeast azimuths were excluded from this study.

Generation Potential

The potential "Nameplate capacity" potential per square foot of roof plane area was calculated. This calculation assumed a typical 350 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.



2018 Village Wide Electric Use

	kWh	Share of Total
Residential	156,067,105	36.6%
Utility Company	0	0.0%
Government	3,656,815	0.9%
Streetlights / Freeway Lights	1,820,501	0.4%
Commercial	210,392,954	49.3%
Industrial / Large Commercial	54,473,658	12.8%
Total	**426,411,033**	

Village Wide Solar Potentials

Technical Capacity In Northbrook

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 12,759 total buildings in Northbrook, of those, it is estimated that 10,433 are "solar suitable" buildings.

These solar suitable buildings have an estimated 19198 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 6.07 million square feet. The chart below shows a further breakdown of roof orientation by roof tilt classifications as well. The potential installed technical energy capacity for all rooftops meeting selection criteria totals 113.54 Megawatts DC.

Generation Capacity In Northbrook

Generation capacity represents the total amount of energy generation potential of the total Technical Capacity of the Village. As previously outlined, the generation capacity is calculated using Village-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 solar PV energy generation potential for the Village is 122,576,956 KWH annually, approximately 29% of the Village's total electric consumption (based on US Energy Information Agency data, ComEd Village of Northbrook community wide energy consumption data).

Technical and Generation Capacity In Northbrook

			Flat	Low Tilt	Mid-Low Tilt	Mid-High Tilt	High Tilt
Subtotal Flat							
Suitable Buildings	1,944	18.64%	**1,944**	0	0	0	0
Suitable Roof Planes	3,577	18.64%	**3,577**	0	0	0	0
Square Footage	1,130,809	18.64%	**1,130,809**	0	0	0	0
Capacity (KW dc)	21,159	18.64%	**21,159**	0	0	0	0
Generation (KWH)	26,406,713	21.54%	**26,406,713**	0	0	0	0
Subtotal South Facing							
Suitable Buildings	2,719	26.07%	0	**592**	**1,746**	**379**	**2**
Suitable Roof Planes	5,004	26.07%	0	**1,090**	**3,213**	**697**	**4**
Square Footage	1,581,876	26.07%	0	**344,545**	**1,015,718**	**220,366**	**1,246**
Capacity (KW dc)	29,599	26.07%	0	**6,447**	**19,006**	**4,123**	**23**
Generation (KWH)	32,913,891	26.85%	0	**6,926,556**	**21,092,638**	**4,868,265**	**26,432**
West + Southwest							
Suitable Buildings	2,891	27.72%	0	**522**	**1,918**	449	3
Suitable Roof Planes	5,320	27.72%	0	**960**	**3,529**	826	5
Square Footage	1,681,801	27.72%	0	**303,516**	**1,115,644**	261,031	1,610
Capacity (KW dc)	31,469	27.72%	0	**5,679**	**20,875**	4,884	30
Generation (KWH)	32,034,038	26.13%	0	**5,573,473**	**21,161,983**	5,267,387	31,194
East + Southeast							
Suitable Buildings	2,875	27.57%	0	**525**	1,899	449	3
Suitable Roof Planes	5,291	27.57%	0	**966**	3,494	826	5
Square Footage	1,673,441	27.58%	0	**305,385**	1,104,581	261,864	1,610
Capacity (KW dc)	31,313	27.58%	0	**5,714**	20,668	4,900	30
Generation (KWH)	31,222,315	25.47%	0	**5,492,918**	20,522,910	5,175,932	30,555
Grand Total			**Subtotal: Flat Roof**		**Subtotal: Low Tilt**		**Subtotal: Mid-Low Tilt**		**Subtotal: Mid-High Tilt**		**Subtotal: High Tilt**	
Suitable Buildings	10,430		1,944	18.64%	1,639	15.71%	5,563	53.33%	1,277	12.24%	8	0.07%
Suitable Roof Planes	19,192		3,577	18.64%	3,016	15.71%	10,236	53.33%	2,349	12.24%	14	0.07%
Square Footage	6,067,927		1,130,809	18.64%	953,447	15.71%	3,235,944	53.33%	743,261	12.25%	4,467	0.07%
Capacity (KW dc)	113,540		21,159	18.64%	17,840	15.71%	60,550	53.33%	13,908	12.25%	84	0.07%
Generation (KWH)	122,576,956		26,406,713	21.54%	17,992,947	14.68%	62,777,531	51.21%	15,311,585	12.49%	88,181	0.07%

Village Wide Solar Potentials

Optimized Generation Capacity In Northbrook

Though the total energy generation outlined above is reasonably feasible, for purposes of establishing Village 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 Village-wide estimates. For the latitude and geography of Northbrook, 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 produce self-shading, 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 Village'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 Generation Capacity in Northbrook is estimated to be 91,548,978 KWH annually, approximately 21% of the Village's total electric consumption.

Optimized Capacity In Northbrook

			Flat	Low Tilt	Mid-Low Tilt	Mid-High Tilt	High Tilt
Subtotal Flat							
Suitable Buildings	1,944	25.48%	**1,944**	0	0	0	0
Suitable Roof Planes	3,577	25.48%	**3,577**	0	0	0	0
Square Footage	1,130,809	25.48%	**1,130,809**	0	0	0	0
Capacity (KW dc)	21,159	25.48%	**21,159**	0	0	0	0
Generation (KWH)	26,406,713	28.84%	**26,406,713**	0	0	0	0
Subtotal South Facing							
Suitable Buildings	2,719	35.65%	0	**592**	**1,746**	**379**	**2**
Suitable Roof Planes	5,004	35.65%	0	**1,090**	**3,213**	**697**	**4**
Square Footage	1,581,876	35.65%	0	**344,545**	**1,015,718**	**220,366**	**1,246**
Capacity (KW dc)	29,599	35.65%	0	**6,447**	**19,006**	**4,123**	**23**
Generation (KWH)	32,913,891	35.95%	0	**6,926,556**	**21,092,638**	**4,868,265**	**26,432**
West + Southwest							
Suitable Buildings	2,440	31.98%	0	**522**	**1,918**		
Suitable Roof Planes	4,489	31.98%	0	**960**	**3,529**		
Square Footage	1,419,160	31.98%	0	**303,516**	**1,115,644**		
Capacity (KW dc)	26,555	31.98%	0	**5,679**	**20,875**		
Generation (KWH)	26,735,456	29.20%	0	**5,573,473**	**21,161,983**		
East + Southeast							
Suitable Buildings	525	6.88%	0	**525**			
Suitable Roof Planes	966	6.88%	0	**966**			
Square Footage	305,385	6.88%	0	**305,385**			
Capacity (KW dc)	5,714	6.88%	0	**5,714**			
Generation (KWH)	5,492,918	6.00%	0	**5,492,918**			
Grand Total			**Subtotal: Flat Roof**		**Subtotal: Low Tilt**		**Subtotal: Mid-Low Tilt**		**Subtotal: Mid-High Tilt**		**Subtotal: High Tilt**	
Suitable Buildings	7,628		1,944	25.48%	1,639	21.49%	3,664	48.03%	379	4.97%	2	0.03%
Suitable Roof Planes	14,036		3,577	25.48%	3,016	21.49%	6,742	48.03%	697	4.97%	4	0.03%
Square Footage	4,437,230		1,130,809	25.48%	953,447	21.49%	2,131,362	48.03%	220,366	4.97%	1,246	0.03%
Capacity (KW dc)	83,028		21,159	25.48%	17,840	21.49%	39,881	48.03%	4,123	4.97%	23	0.03%
Generation (KWH)	91,548,978		26,406,713	28.84%	17,992,947	19.65%	42,254,621	46.16%	4,868,265	5.32%	26,432	0.03%

Village 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 40% since 2015 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 2019 was nearly 106 MW; equal to 63% of the cumulative total of all solar PV installations in the state for **all previous years**.

According to Village of Northbrook permit records, there are a total of 76 existing solar PV installations totaling 2,071 KW capacity, approximately 0.54% of the State total number of installations, or 0.75% of total generation capacity (compared to the Village of Northbrook's population at 0.26% of State total). These numbers indicate the Village of Northbrook's solar pv adoption rates are approximately 2 times higher than the State average adoption rates in terms of numbers of installations per capita and nearly three times higher in terms of installed capacity per capita.

State Market Projections

The Solar Energy Industries Association (SEIA) projects solar PV installation capacity in the State to increase 1,710 MW by 2025. This is equal to a sustained compound increase of installed capacity of 62% annually. The timeframe of this projection overlaps with the currently established Federal Income Tax incentive program. For years 2022 and beyond, the tax incentive is expected to be phased out for residential solar pv installations, but a smaller incentive (10%) will remain for commercial property owners while cost projections anticipate a continued decrease in installation costs.

Village Wide Solar Potentials

Northbrook Market Absorption Projections

Scenario A: Northbrook Rooftop Solar PV Projection Based on Population Share of Statewide KW Installed Projections

Scenario A simply anticipating the Village's future solar pv installation rates match the projected State-wide increase in solar installations based on a per-capita share. This scenario would mean an increase of approximately 4,500 KW of installed capacity within the Village by 2025, approximately 33% annual increase over that timeframe. This would result in around 6,500 KW of installed capacity, equivalent to approximately 5.7 of the total rooftop technical capacity potential or 7.8% of the optimized capacity potential within the Village.

As the market continues to mature through the 2020'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 recommend a 50% reduction of the annual rate of growth for 2030. This would result in a growth rate of 16.5% through 2030 and a 8.3% growth rate for years 2030 through 2040. The chart below shows projections through 2040 using the assumptions outlined above.

Scenario A: Northbrook Rooftop Solar PV Projection Based on Population Share of Statewide KW Installed Projections
(33% Initial Annual Increase)

Year	Cumulative Installed (KW)	Annual Generation (KWH)	% of Village Electric Consumption	This is Equivalent to adding (x) Average Residential Arrays Annually:	Or Equivalent to adding (x) Commercial Arrays Annually:	Or Equivalent to adding (x) Arrays Annually with Average Array Size Equal to Current Community Ave:
2025	6,480	6,995,918	1.64%	130	22.0	32.4
2030	13,906	15,013,238	3.52%	218	37	54.5
2040	30,725	33,170,607	7.78%	247	42	61.7

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

Village Wide Solar Potentials

Scenario B: Northbrook Rooftop Solar PV Share of Statewide Projections Based on Current Share of Installed Arrays

As noted earlier, the Village of Northbrook has a higher than State average adoption rate in terms of ***number*** of arrays installed per capita, as well as ***generating capacity*** (KW) installed per capita. Scenario B assumes maintaining the Village's leadership position in its share of the statewide **number** of arrays anticipated over the next 5 years, but decreasing, slightly, the Village's leading pace in terms of share of the statewide ***generating capacity*** (KW) installed per capita. This scenario results in an increase of nearly 6,900 KW of installed capacity within the City by 2025 for a total of 8,960 KW Village Wide. This is equivalent to approximately 7.9% of the total rooftop technical capacity potential or 10.8% of the optimized capacity potential within the Village.

As with Scenario A, we recommend a 50% reduction of the annual rate of growth for 2030. This would result in a growth rate of 22% through 2030 and a 11% growth rate for years 2030 through 2040. The chart below shows projections through 2040 using the assumptions outlined above.

Scenario B: Northbrook Rooftop Solar PV Share of Statewide Projections Based on Current Share of Installed Arrays
(44% Initial Annual Increase)

Year	Cumulative Installed (KW)	Annual Generation (KWH)	% of Village Electric Consumption	This is Equivalent to adding (x) Average Residential Arrays Annually:	Or Equivalent to adding (x) Commercial Arrays Annually:	Or Equivalent to adding (x) Arrays Annually with Average Array Size Equal to Current Community Ave:
2025	8,960	9,673,413	2.27%	203	34.4	50.6
2030	24,328	26,264,257	6.16%	525	64	112.8
2040	69,426	74,951,171	17.58%	816	113	165.5

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

Scenario C: Northbrook Rooftop Solar PV Share of Statewide Projections Based on Current Share of Installed KW

Similar to Scenario B, this scenario also assumes maintaining the City's leadership position in its share of the statewide ***number*** of arrays anticipated over the next 5 years while also maintaining the Village's leadership position in terms of its share of the statewide installed ***generating capacity*** (KW). By 2025, this Scenario results in a total installed capacity equal to approximately 12.6% of the total rooftop technical capacity potential or 17.2% of the optimized capacity potential within the Village.

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

Scenario C: Northbrook Rooftop Solar PV Share of Statewide Projections Based on Current Share of Installed KW Capacity
(62% Initial Annual Increase)

Year	Cumulative Installed (KW)	Annual Generation (KWH)	% of Village Electric Consumption	This is Equivalent to adding (x) Average Residential Arrays Annually:	Or Equivalent to adding (x) Commercial Arrays Annually:	Or Equivalent to adding (x) Arrays Annually with Average Array Size Equal to Current Community Ave:
2024	14,264	15,399,202	3.61%	359	61.0	89.5
2030	38,728	41,810,332	9.81%	948	124	179.6
2040	110,519	119,315,514	27.98%	1,421	215	263.5

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

Section 05

Village Wide Solar Benefits

Click to Return to TOC

Village 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 Northbrook

According to the National Renewable Energy Laboratory (NREL), the additional solar pv capacity which could be installed in the Village by 2040 has a total construction value of $185 million (2020 dollars). The potential share of those investments for the local economy totals 212 jobs and $19 million in local income potential during construction and 42 jobs and $2.9 million in local income potential for maintenance annually through the lifetime of the installations. Below is a breakout of the Northbrook Economic Development potential of new installed solar pv capacity through 2040 based on population share of Statewide market absorption projection numbers:

Northbrook Local Economic Impacts - Summary Results Based on Scenario B

	Jobs	Earnings	Output	Value Added
During construction period		**Million$ 2020**	**Million$ 2020**	**Million$ 2020**
Project Development and Onsite Labor Impacts	74	$10.34	$14.11	$11.51
Construction and Interconnection Labor	48	$8.91		
Construction Related Services	27	$1.43		
Equipment and Supply Chain Impacts	74	$4.88	$19.89	$9.81
Induced Impacts	64	$3.87	$10.71	$5.83
Total Impacts	**212**	**$19.09**	**$44.71**	**$27.15**

	Annual Jobs	Annual Earnings	Annual Output	Annual Output
During operating years (annual)		**Million$ 2020**	**Million$ 2020**	**Million$ 2020**
Onsite Labor Impacts	30	$2.10	$2.10	$2.10
Local Revenue and Supply Chain Impacts	5	$0.37	$1.09	$0.72
Induced Impacts	6	$0.42	$1.15	$0.62
Total Impacts	**42**	**$2.88**	**$4.33**	**$3.43**

Additional Economic Benefit

In addition to the local re-investment share of the construction and maintenance costs, Northbrook 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 Village 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 10-26% of the cost of installation. At the projected additional installation through 2022 outlined in the previous section, this could mean $2.2 million up to $5 million in savings and local re-investment potential.

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 Northbrook is $97,000 to $200,000 annually by 2025 (assuming third party ownership structure, long-term savings for direct ownership can be significantly higher).

Village Wide Solar Benefits

Environmental Benefits for Northbrook

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 the US EPA, based on the Electricity Supply by Energy Source for their Upper Midwest region, the average greenhouse gas emissions per 1 Gwh of electricity is 365 Metric Tonnes. Using the River Network average fresh water use by fuel type, the average water use per 1 Gwh of electricity in the city is 5,306,500 gallons.

Based on these numbers, by 2025 the additional solar pv installed in the Village of Northbrook can reduce its Greenhouse Gas emissions by 6,588 metric tons (130,722,448 cubic feet of man-made greenhouse atmosphere), and its water footprint by 51.31 Million Gallons.

Scenario B: 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)
2024	9.67	6,588	130,722,448	51.31
2030	26.26	17,888	354,924,155	139.32
2040	74.95	51,048	1,012,858,693	397.58


DETOUR
net
zero
energy
DETOUR

Section 06

Recommendations

Click to
Return to TOC

Recommendations

Community-Wide Solar Recommendations

In support of the Village's interest in Greenhouse Gas emissions reductions and increase in renewable energy generation, we recommend the following:

1)Maximize new installations in years 2021 and 2022 for both Residential and Commercial scale projects in order to leverage the greatest potential for local cost savings from the Federal Solar Investment Tax Credit. Actions to support this include:

a) Develop and distribute information on the advantages of solar with a particular focus on the current tax incentive savings available for both homeowners and businesses. Information should also include detailed information on incentives and opportunities for financing.

b) Develop and provide a solar benefits educational seminar for residents and businesses, content to include information on the tax incentive savings potential as well as tools and resources for solar procurement and financing.

c) Conduct a "Solar Top 50" study to identify the top 50 commercial and industrial properties for on-site solar generation. Develop feasibility assessments for each property illustrating energy generation potential and estimated return on investment. Combine feasibility information with information developed in item a above and provide to each subject property owner.

d) Organize and lead a Commercial Group Purchasing campaign in 2021 and 2022 to competitively bid contractors to offer maximum cost savings based on power of quantity buying. This program could focus on the Solar Top 50 sites identified in item c above as well as combined with municipal facilities. Program should explore the inclusion of cash purchase as well as third party purchase options.

e) Organize and lead a Residential Group Purchasing campaign in 2021 and 2022 to competitively bid contractors to offer maximum cost savings based on power of quantity buying.

f) Develop and distribute a "Solar Ready Guide" outlining steps building owners can take for new construction and renovation projects to make buildings solar ready and decrease the cost of future installations.

g) Establish a requirement that all municipal owned new construction projects and significant renovation projects as well as any projects which receive Village funding are to be Solar Ready (based on City's Solar Ready Guide see item f above).

h) Establish a requirement that all municipal owned new construction projects and significant renovation projects as well as any projects which receive Village funding are to include a detailed solar feasibility assessment with projected financial payback (cash purchase and 3rd party ownership options) to be included at time of building permit application. (Strategy encourages awareness of solar potential and potential long-term economic savings)

Recommendations

Community-Wide Solar Recommendations (continued)

2) Maximize new installations in years 2023 and beyond. Actions to support this include:

i) Begin the process to become a SolSmart Gold designated community in by 2023.

j) Establish an incentive for all privately owned new construction projects and significant renovation projects that are designed to Village's Solar Ready Guidelines developed in item f above (incentive may include credit on building permit application and/or expedited permit processing)

k) Establish a requirement that all new construction projects requiring a Conditional Use Permit or Planned Unit Development be designed to the Village's Solar Ready Guidelines developed in item f on previous page.

l) Establish a requirement that new construction projects and significant renovation projects within the Village (private and publicly owned) are to include a detailed solar feasibility assessment with projected financial payback (cash purchase and 3rd party ownership options) to be included at time of building permit application. (Strategy encourages awareness of solar potential and potential long-term economic savings)

m) Establish a requirement that all private or public projects receiving Village funding be constructed as fully solar ready and include an on-site solar pv array.

n) Coordinate with County to explore the development of new incentive programs, particularly those aimed at low and moderate income residents. Program opportunities may include development of Low Income Home Energy Assistance Program (LIHEAP) based funding sources.

p) Conduct a Green Economy Business and Economic Development Potentials study to identify strategies in leveraging economic opportunities in the Green Economy and emerging renewable energy field. Study should focus not only on national, state, and metro area trends, but should identify strengths, weaknesses, opportunities, and threats unique to the community. The goal of establishing a robust business atmosphere capable not only of serving the community's renewable energy and green economy needs but fulfilling a unique economic niche within the region.

Prepared by:

making change personal
paleBLUEdot LLC

2515 White Bear Ave, A8
Suite 177
Maplewood, MN 55109

Contact:
Ted Redmond
tredmond@paleBLUEdot.llc