City of La Crosse
Solar Renewable Energy Potentials Study

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Introduction

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Introduction

Intent of This Study

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

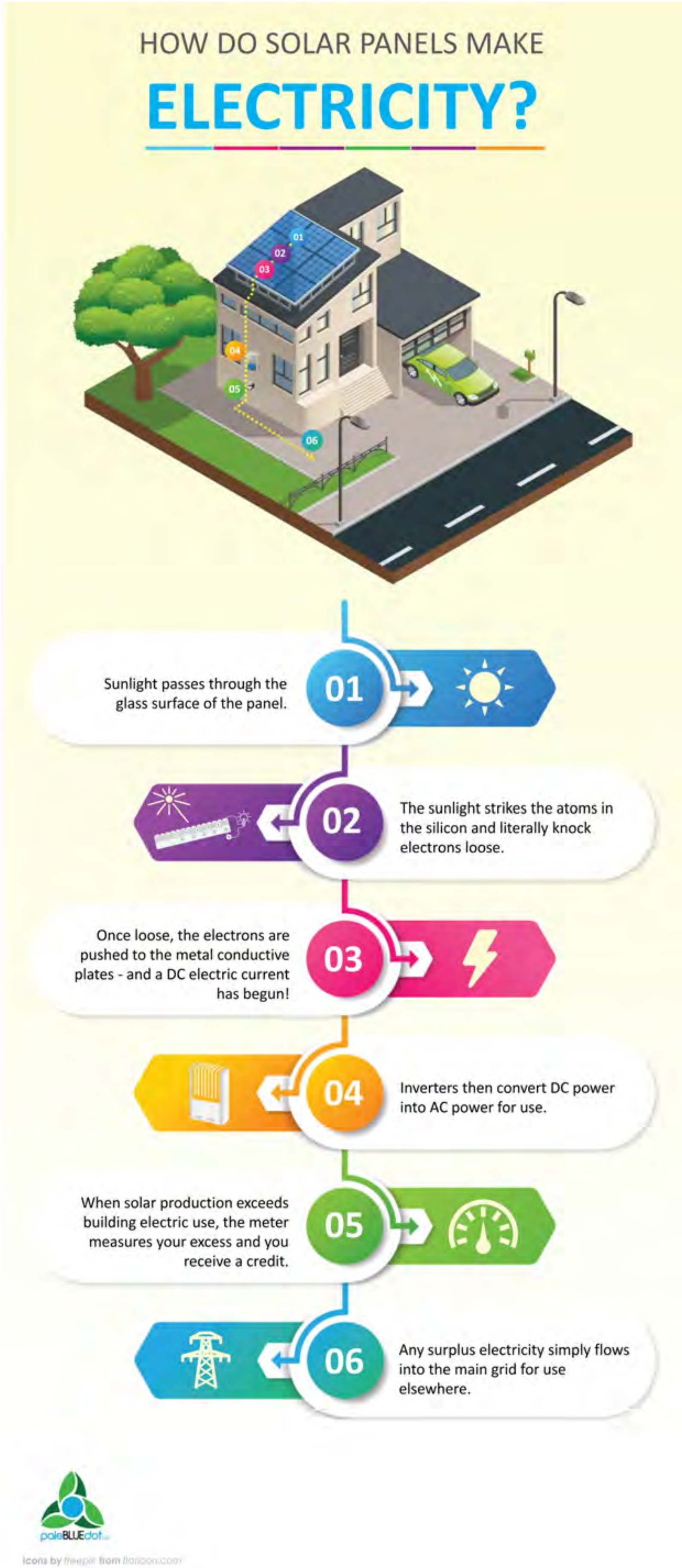
Solar electricity is created using Solar Photovoltaic panels, or Solar PV for short. The word photovoltaic, or PV, comes from the process of converting light (photons) to electricity (voltage), which is called the PV effect. The key to a solar PV panel is the semiconductor material.

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

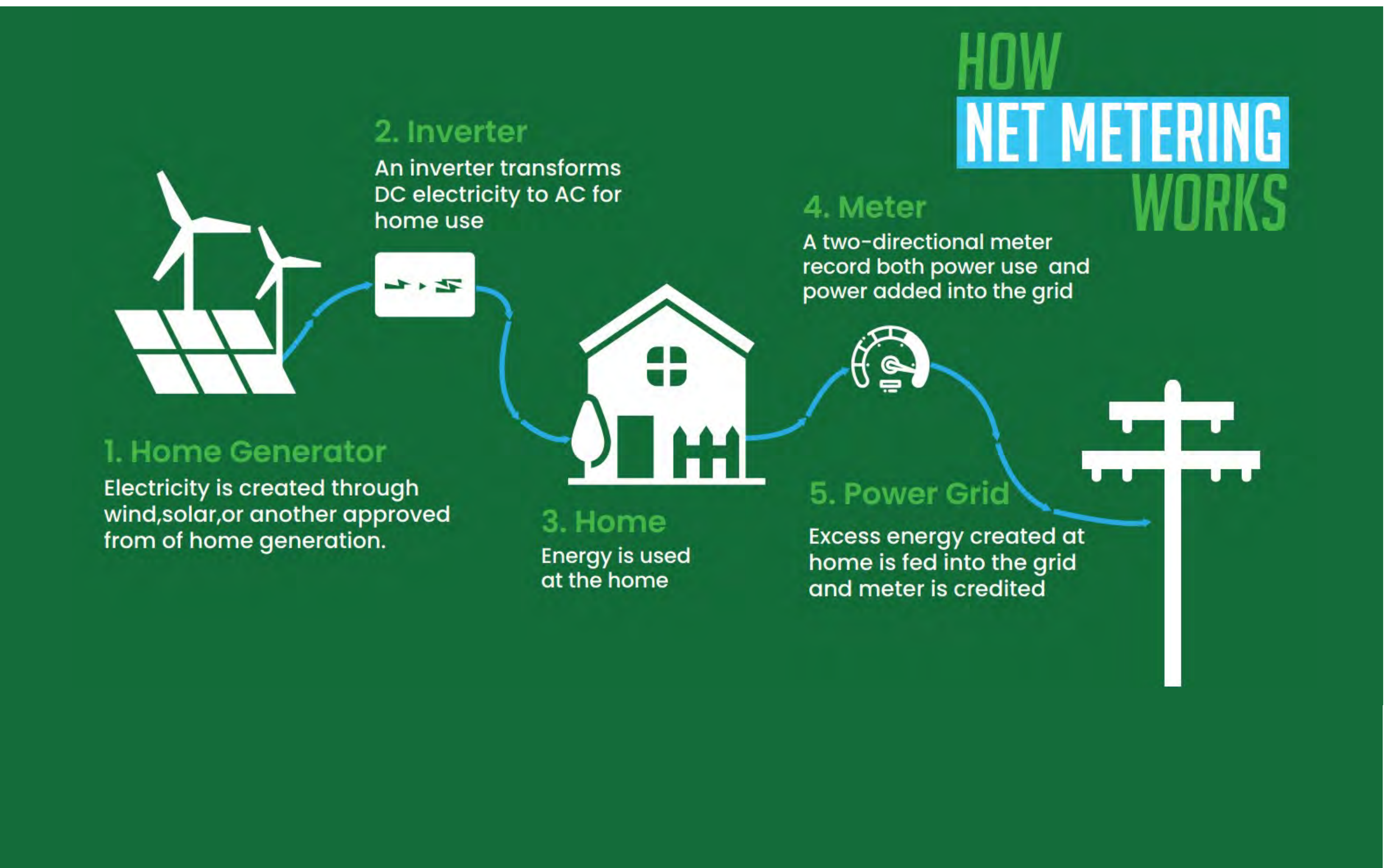
The site concepts in this report are based on grid-connected systems with net metering. Net metering tracks the amount of energy generated on site, as well as the amount of energy consumed from the grid. Net metering allows customers to get credit on their energy bill from excess energy generation, when 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).

Net Metering in La Crosse

According to the State of Wisconsin Public Service Commission:

> Net metering (also known as net energy billing) is available in Wisconsin for investor-owned utility and municipal utility customers who wish to install an electric generator 20-kilowatts or less in size. Electric providers may also offer other buy-back rates for electricity produced by a customer-owned facility that vary by technology and system size.

Learn more about Net Metering in the State of Wisconsin here:
https://psc.wi.gov/Pages/ForUtilities/Energy/NetMeteringandBuyBackTariffs.aspx



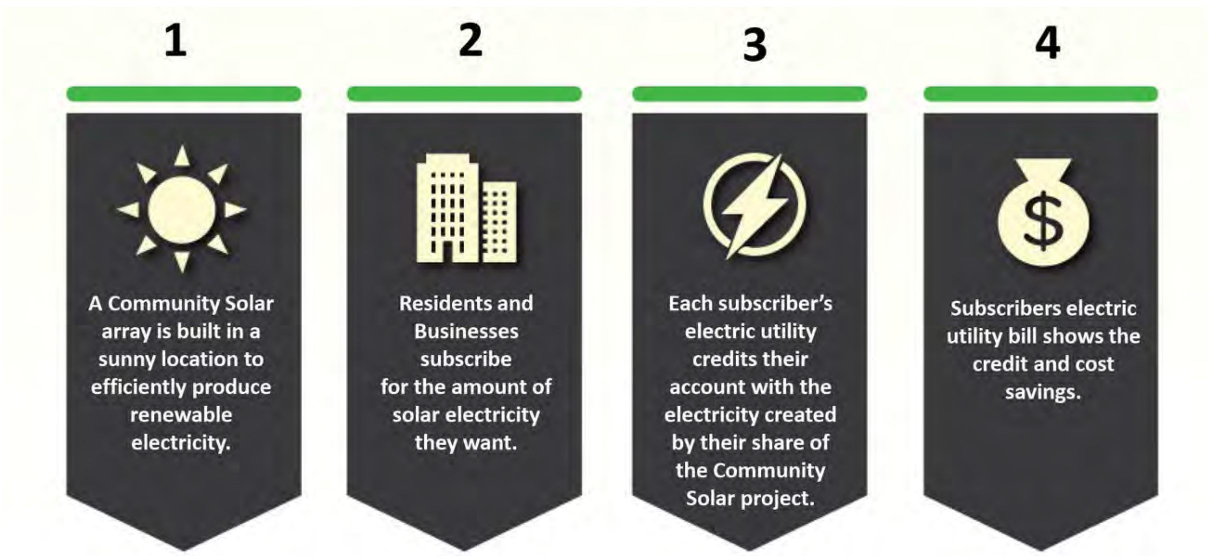
Introduction

Community Solar in Wiscsonin

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 Wisconsin, only regulated utilities and cooperatives can provide energy from community solar installations to customers. Some utilities, like Xcel Energy's Solar Connect program or Madison Gas and Electric, offer a shared solar service for customers to subscribe to. However, most Wisconsin utilities do not currently have a comparable program available for their customers.

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 City'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 Wisconsin 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 Wisconsin 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 Wisconsin:

Focus on Energy renewable rewards

The State of Wisconsin offers rebates to help decrease the costs associated with installing a solar panel system. The incentives available vary based on customer type as follows: Residential up to $500, Commercial up to $50,000, Agricultural up to $60,000, Special sectors (nonprofits, schools, government and Native American tribes and nations) up to $81,000. Learn more about Focus on Energy renewable programs here:
https://www.focusonenergy.com/residential#program-renewable-energy

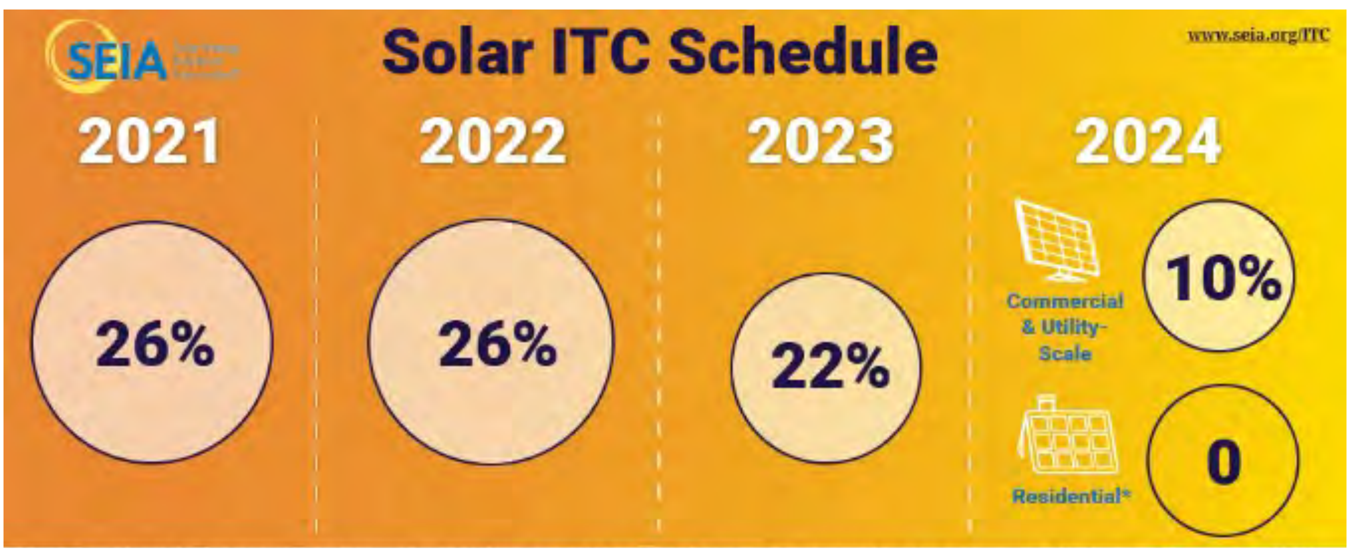
Wisconsin Solar Tax Exemptions

Wisconsin has two sales tax exemptions that apply to renewable energy which can be applied to a number of technologies including Solar Water Heat, Solar Space Heat, Solar Thermal Process Heat, Solar Photovoltaics. This means that when you install solar panels on your home or business in Wisconsin, you don't have to pay any sales tax on your solar purchase.

In Wisconsin, any value added by a biogas, or synthetic gas energy system, solar-energy system, or a wind-energy system is exempt from general property taxes. The exemption applies regardless of whether the equipment is deemed real property or personal property.

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 ITC credit is currently equal to 26% of the project costs in 2022 and will be stepping down to 10% by year 2024 and beyond (for commercial only - residential will be eliminated in 2024). (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.

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.

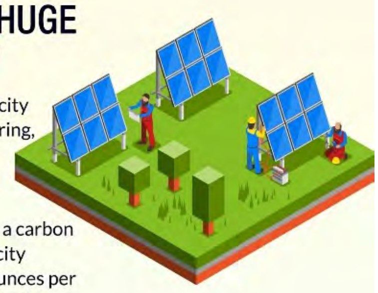
3 SOLAR PANELS ARE TOXIC.

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 Wisconsin

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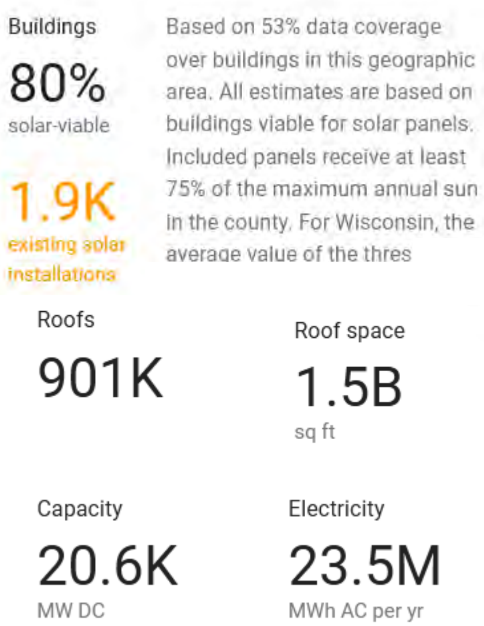
Solar in Wisconsin

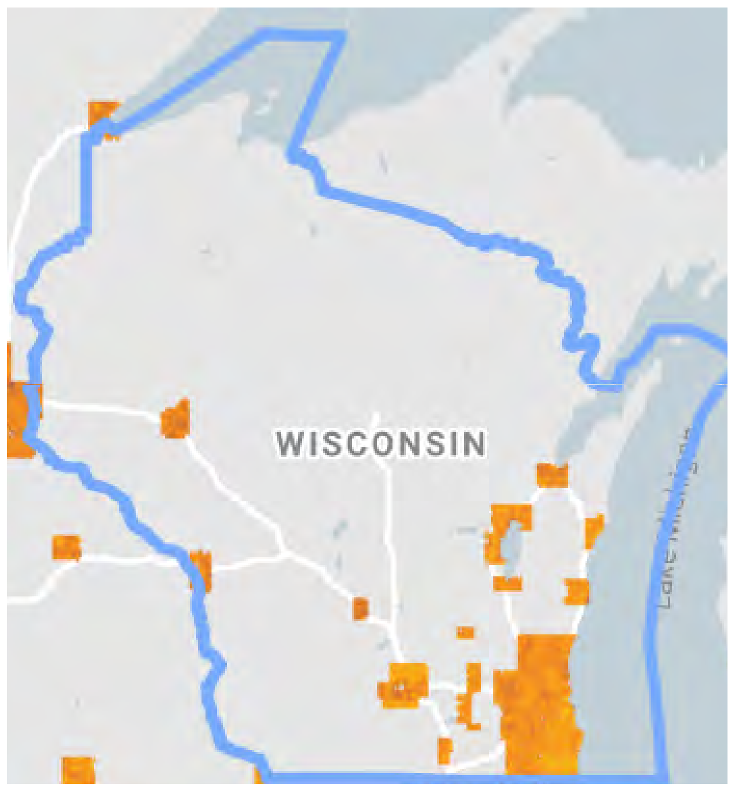
As of December 2021, Wisconsin has a total of 624.8 megawatts (624,800,000 watts) of solar capacity installed statewide. There are a total of 9,223 solar installations in the State. The State of Wisconsin ranks 25th nationally for total solar energy production capacity.

The State's solar installation total is enough to power 106,663 homes. The share of the State's total electricity use that comes from solar power is 0.75%. Current solar growth projections for the State equal an additional 3,959 MW over the next 5 years - a growth rate that ranks 10^{th} nationally.

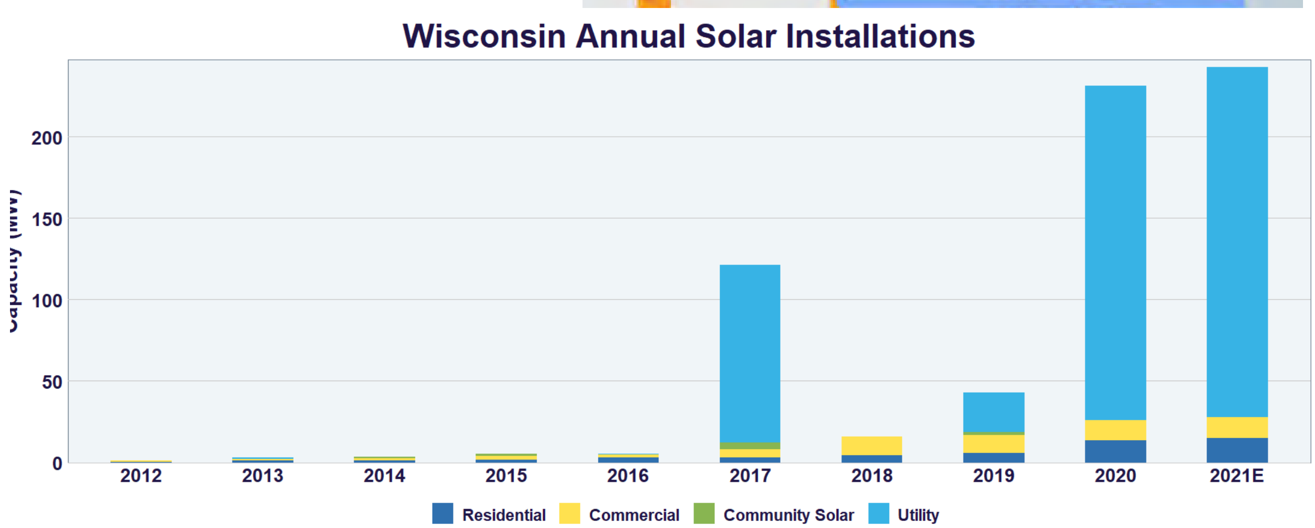
Costs for Solar PV installation in the State have declined 11% since 2017. Price declines have been accompanied with increasing rate of investment in solar energy. A total of $808,000,000 has been invested in Solar PV installations. The industry currently employs approximately 2,910 people in 150 companies Statewide (41 Manufacturers, 66 Installers/Developers, 43 Others).

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

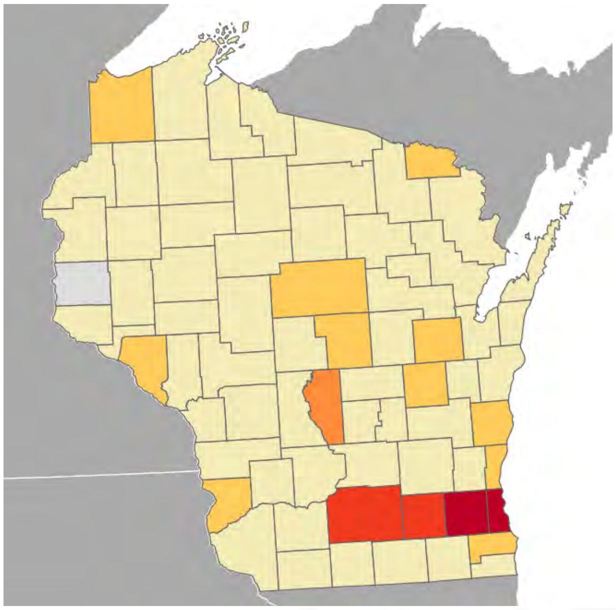




Graphic Sources:
Project Sunroof, Solar Foundation



Solar Jobs in Wisconsin



		rank among states
2,871	Solar jobs	26/51
1,802	Installation jobs	28/51
523	Manufacturing jobs	19/51
369	Wholesale Trade & Distribution jobs	21/51
95	Operations and Maintenance jobs	31/51
79	Other jobs	28/51

62.8% Installation
18.2% Manufacturing
12.9% Wholesale Trade & Distribution
3.3% Operations and Maintenance
2.8% Other

-135	New solar jobs since 2018
-4.5%	Solar jobs growth rate in 2019
32nd	Solar jobs per capita rank

Top Ten Counties

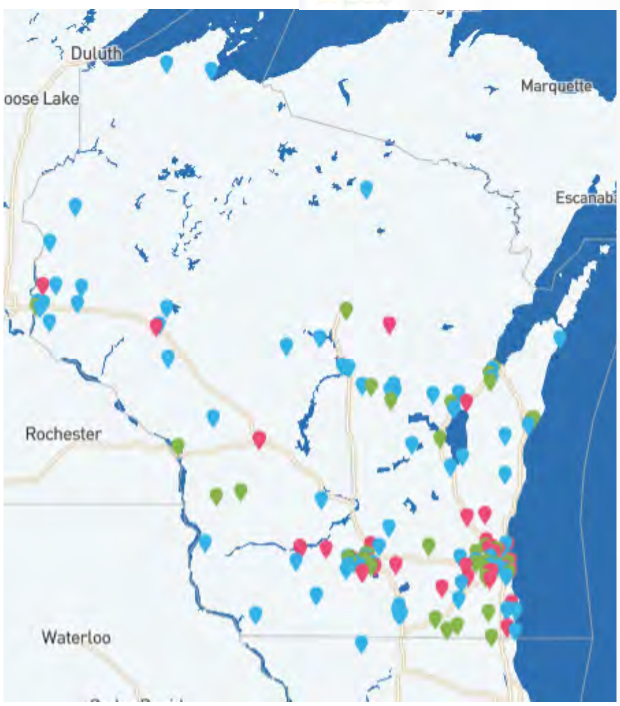
County	Jobs
Waukesha	432
Milwaukee	420
Dane	369
Jefferson	368
Adams	126
Winnebago	87
Portage	87
Outagamie	64
Buffalo	62
Florence	57

Solar Worker Demographics

Female	26.9%
Gender Non-Binary	0.0%
Latino or Hispanic	5.6%
Am. Indian or Alaskan	0.2%
Asian	3.7%
Black or African American	6.0%
Hawaiian/Other Pacific Islander	0.5%
White	83.6%
Two or More Races	5.9%
Veteran of U.S. Armed Forces	11.5%
55 and Over	13.1%

Solar Companies in Wisconsin

National Solar Database:
- Manufacturer
- Installer
- Other



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

Section 03

Solar in La Crosse

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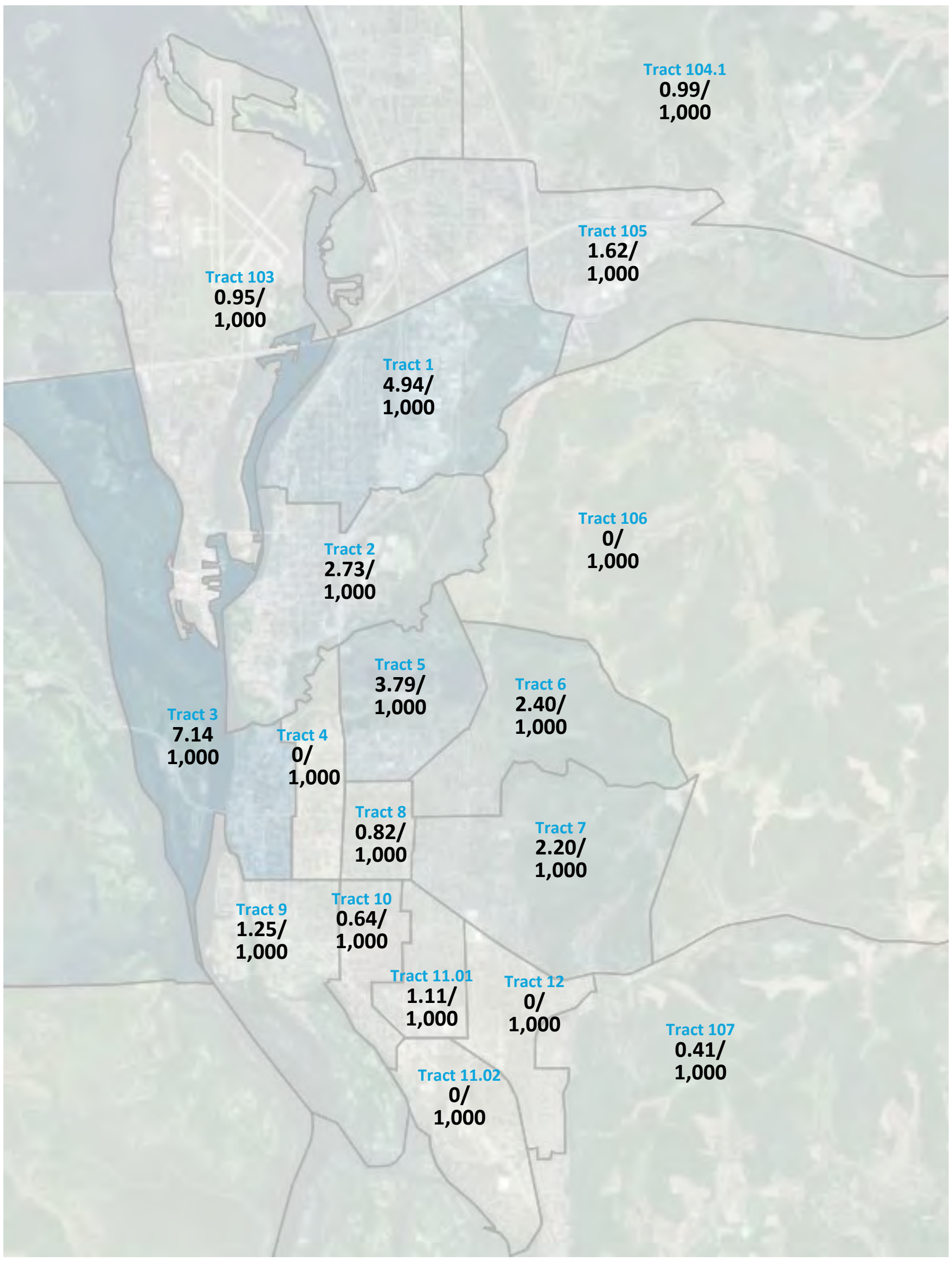
Solar in La Crosse

Based on information available from Project Sunroof, it is estimated that the City of La Crosse has 200 solar installations with a generating capacity of 1.5 MW. This is equal to 0.24% of the total solar generating capacity in the State, compared to the City's 0.89% share of State population. According to the Stanford University DeepSolar analysis project, La Crosse County has an average of 1.34 solar PV installations per 1,000 homes. This is approximately 105% of the State average. Within the City of La Crosse, neighborhoods range from 0 to 7.14 solar PV installations per 1,000 homes. (see "City of La Crosse Solar Installations Per 1,000 Homes" and "City of La Crosse's Solar Share" chart).

The total solar installation capacity in the City of La Crosse is estimated to generate 1,700,000 kWh annually - enough to power 260 homes. As noted in Section 2, costs for Solar PV installation in the State have declined significantly since 2015. The City of La Crosse currently has an estimated total of 1 solar companies, or approximately 0.7% of the State's total solar business entities— less than the community's share of State population.

City of La Crosse Solar Installations Per 1,000 Homes



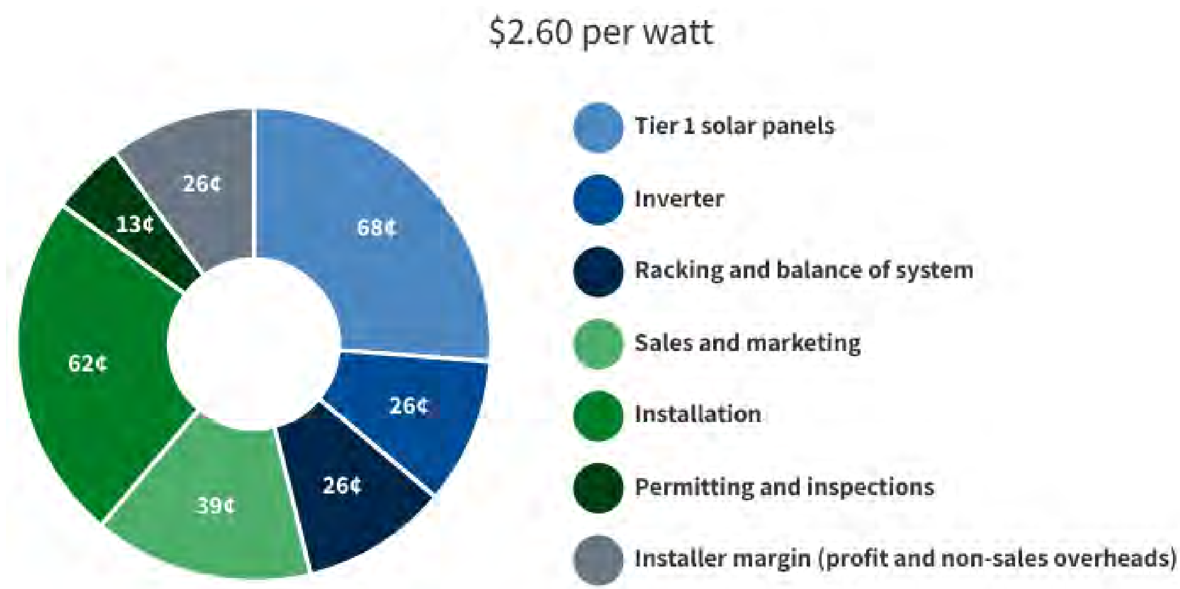
Source: DeepSolar

Solar in La Crosse

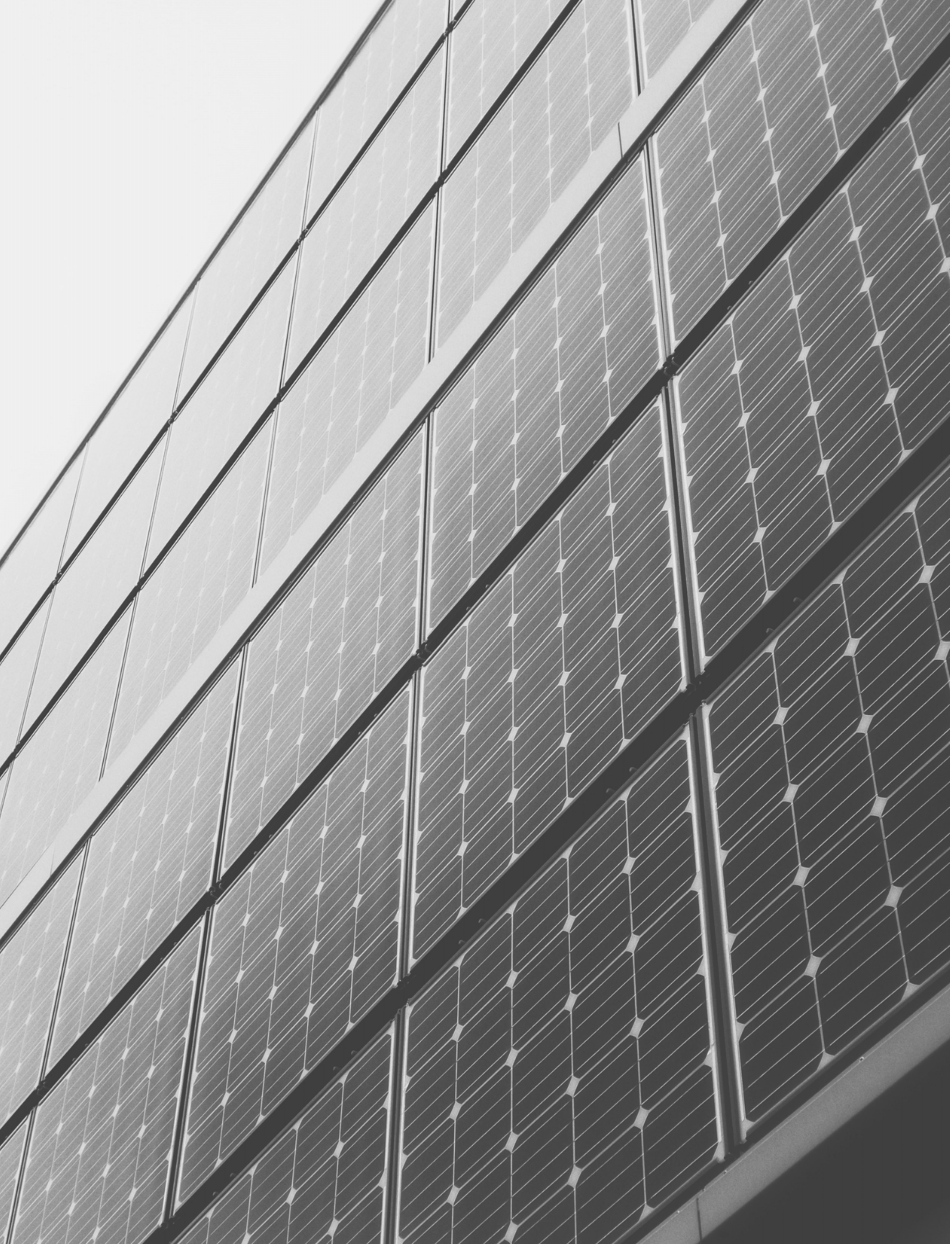
City of La Crosse's Solar Share

	State	Community	Community
Population	5,822,000	51,666	**0.89%**
Number of Solar Installations	9,223	204	**2.21%**
Average Solar Installations / 1,000 households	1.28	0.02	**1.64%**
Estimated Solar Generating Capacity (MW)	624.80	1.53	**0.24%**
Average Array Size (KW)	67.74	7.50	**11%**
Solar Industry Businesses	150	1	**0.67%**

Estimated Solar PV Installation Cost by Component in La Crosse



Graphic Source: SolarReviews.com



Section 04

City Wide

Solar Potential

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City Wide Solar Potentials

Methodology and Data

This section calculates the total technical capacity and total generation potential for rooftop solar in the City. 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 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

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 codes 54601, and 55603 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.

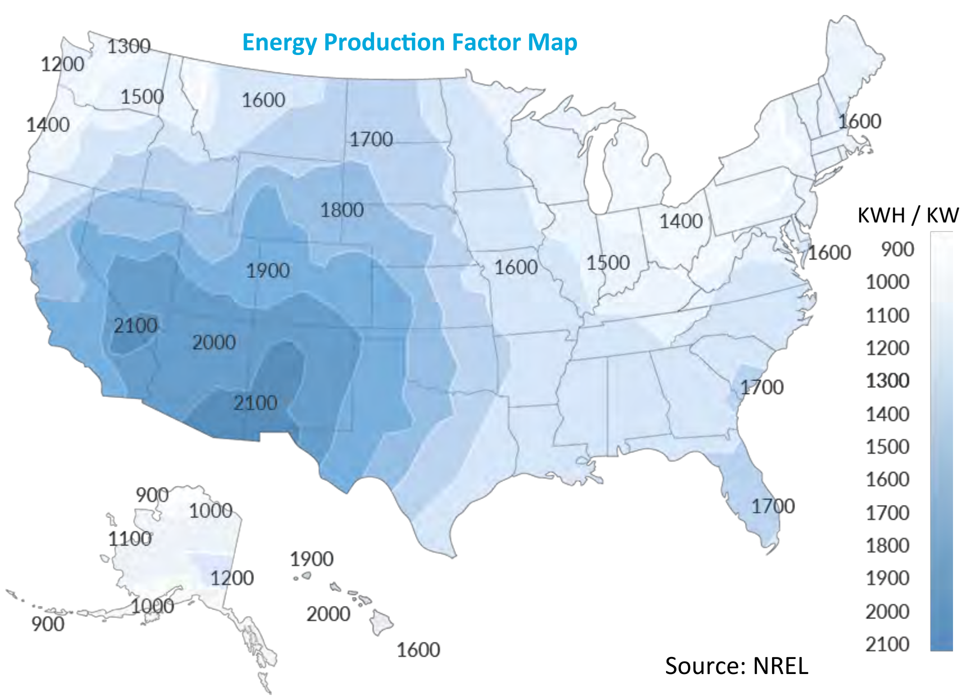
Generation Potential

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

City Wide Solar Potentials

Rooftop Technical Capacity In La Crosse

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 18,722 total buildings in La Crosse, of those, it is estimated that 14,510 are "solar suitable" buildings.

These solar suitable buildings have an estimated 26,764 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 8.4 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 86.25 Megawatts DC.

Rooftop Generation Capacity In La Crosse

Generation capacity represents the total amount of energy generation potential of the total Technical Capacity of the City. As previously outlined, the generation capacity is calculated using City-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 City is 94,387,122 KWH annually. This is estimated to be approximately 13.1% of the City's total electric consumption (based on US Energy Information Agency data).

Rooftop Technical and Generation Capacity In La Crosse

			Flat	Low Tilt	Mid-Low Tilt	Mid-High Tilt	High Tilt
Subtotal Flat							
Suitable Buildings	3,683	25.32%	**3,683**	-	-	-	-
Suitable Roof Planes	6,776	25.32%	**6,776**	-	-	-	-
Square Footage	2,142,165	25.38%	**2,142,165**	-	-	-	-
Capacity (KW dc)	21,887	25.38%	**21,887**	-	-	-	-
Generation (KWH)	27,315,505	28.94%	**27,315,505**	-	-	-	-
Subtotal South Facing							
Suitable Buildings	3,615	24.85%	-	**817**	**2,300**	**495**	**3**
Suitable Roof Planes	6,652	24.85%	-	**1,504**	**4,232**	**911**	**5**
Square Footage	2,102,901	24.91%	-	**475,425**	**1,337,879**	**287,987**	**1,610**
Capacity (KW dc)	21,486	24.91%	-	**4,858**	**13,670**	**2,942**	**16**
Generation (KWH)	23,882,348	25.30%	-	**5,218,962**	**15,170,708**	**3,474,030**	**18,648**
West + Southwest							
Suitable Buildings	3,598	24.73%	-	**700**	**2,302**	**592**	**4**
Suitable Roof Planes	6,620	24.73%	-	**1,288**	**4,235**	**1,090**	**7**
Square Footage	2,092,616	24.79%	-	**407,076**	**1,338,657**	**344,545**	**2,338**
Capacity (KW dc)	21,381	24.79%	-	**4,159**	**13,678**	**3,520**	**24**
Generation (KWH)	21,768,366	23.06%	-	**4,081,794**	**13,865,367**	**3,796,473**	**24,733**
East + Southeast							
Suitable Buildings	3,650	25.09%	-	**699**	**2,356**	**592**	**3**
Suitable Roof Planes	6,716	25.09%	-	**1,286**	**4,335**	**1,090**	**5**
Square Footage	2,103,579	24.92%	-	**406,453**	**1,370,548**	**324,758**	**1,820**
Capacity (KW dc)	21,493	24.92%	-	**4,153**	**14,003**	**3,318**	**19**
Generation (KWH)	21,420,904	22.69%	-	**3,992,051**	**13,904,863**	**3,505,137**	**18,854**

Grand Total		Subtotal: Flat Roof		Subtotal: Low Tilt		Subtotal: Mid-Low Tilt		Subtotal: Mid-High Tilt		Subtotal: High Tilt	
Suitable Buildings	14,546	3,683	25.32%	2,216	15.24%	6,958	47.83%	1,680	11.55%	9	0.06%
Suitable Roof Planes	26,764	6,776	25.32%	4,078	15.24%	12,802	47.83%	3,091	11.55%	17	0.06%
Square Footage	8,441,261	2,142,165	25.38%	1,288,953	15.27%	4,047,084	47.94%	957,290	11.34%	5,768	0.07%
Capacity (KW dc)	86,248	21,887	25.38%	13,170	15.27%	41,351	47.94%	9,781	11.34%	59	0.07%
Generation (KWH)	94,387,122	27,315,505	28.94%	13,292,807	14.08%	42,940,937	45.49%	10,775,640	11.42%	62,234	0.07%

City Wide Solar Potentials

Optimized Generation Capacity In La Crosse

Though the total energy generation outlined above is reasonably feasible, for purposes of establishing City 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 City-wide estimates. For the latitude and geography of La Crosse, 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 City'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 La Crosse is estimated to be 73,137,063 KWH annually, approximately 10.1% of the City's total electric consumption.

Optimized Rooftop Capacity In La Crosse

			Flat	Low Tilt	Mid-Low Tilt	Mid-High Tilt	High Tilt
Subtotal Flat							
Suitable Buildings	3,683	33.48%	**3,683**	-	-	-	-
Suitable Roof Planes	6,776	33.48%	**6,776**	-	-	-	-
Square Footage	2,142,165	33.49%	**2,142,165**	-	-	-	-
Capacity (KW dc)	21,887	33.49%	**21,887**	-	-	-	-
Generation (KWH)	27,315,505	37.35%	**27,315,505**	-	-	-	-
Subtotal South Facing							
Suitable Buildings	3,615	32.87%	-	**817**	**2,300**	**495**	**3**
Suitable Roof Planes	6,652	32.87%	-	**1,504**	**4,232**	**911**	**5**
Square Footage	2,102,901	32.87%	-	**475,425**	**1,337,879**	**287,987**	**1,610**
Capacity (KW dc)	21,486	32.87%	-	**4,858**	**13,670**	**2,942**	**16**
Generation (KWH)	23,882,348	32.65%	-	**5,218,962**	**15,170,708**	**3,474,030**	**18,648**
West + Southwest							
Suitable Buildings	3,002	27.29%	-	**700**	**2,302**	-	-
Suitable Roof Planes	5,523	27.29%	-	**1,288**	**4,235**	-	-
Square Footage	1,745,733	27.29%	-	**407,076**	**1,338,657**	-	-
Capacity (KW dc)	17,837	27.29%	-	**4,159**	**13,678**	-	-
Generation (KWH)	17,947,160	24.54%	-	**4,081,794**	**13,865,367**	-	-
East + Southeast							
Suitable Buildings	699	6.35%	-	**699**	-	-	-
Suitable Roof Planes	1,286	6.35%	-	**1,286**	-	-	-
Square Footage	406,453	6.35%	-	**406,453**	-	-	-
Capacity (KW dc)	4,153	6.35%	-	**4,153**	-	-	-
Generation (KWH)	3,992,051	5.46%	-	**3,992,051**	-	-	-

Grand Total		Subtotal: Flat Roof		Subtotal: Low Tilt		Subtotal: Mid-Low Tilt		Subtotal: Mid-High Tilt		Subtotal: High Tilt	
Suitable Buildings	10,999	3,683	33.48%	2,216	20.15%	4,602	41.84%	495	4.50%	3	0.02%
Suitable Roof Planes	20,237	6,776	33.48%	4,078	20.15%	8,467	41.84%	911	4.50%	5	0.02%
Square Footage	6,397,252	2,142,165	33.49%	1,288,953	20.15%	2,676,536	41.84%	287,987	4.50%	1,610	0.03%
Capacity (KW dc)	65,363	21,887	33.49%	13,170	20.15%	27,347	41.84%	2,942	4.50%	16	0.03%
Generation (KWH)	73,137,063	27,315,505	37.35%	13,292,807	18.18%	29,036,074	39.70%	3,474,030	4.75%	18,648	0.03%

City 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 Wisconsin section of this report, the installed cost of solar PV in the state has dropped 11% since 2017 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 Wisconsin, the new installed capacity that went on line in 2020 was nearly 231 MW; equal to 37% of the cumulative total of all solar PV installations in the state for **all previous years**.

Based on information available from Project Sunroof, it is estimated that the City of La Crosse has 200 solar installations with a generating capacity of 1.5 MW. This is equal to 2.21% of the total number of arrays or 0.24% of the total solar generating capacity installed in the State. These can be compared against the City's share of the total State population of 0.89% - meaning that when reviewed by the number of arrays installed, the City is almost 2.5 times the State average on a per capita basis, but when reviewed by the total generating capacity, it is estimated that the city may be closer to 30% of the State per capita average.

State Market Projections

The Solar Energy Industries Association (SEIA) projects solar PV installation capacity in the State to increase 3,959 MW by 2027. This is equal to a sustained compound increase of installed capacity of 49% annually. The timeframe of this projection overlaps with the currently established Federal Income Tax incentive program. For years 2024 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.

City Wide Solar Potentials

La Crosse Market Absorption Projections

Scenario A: Share of Projected Statewide Annual Increase Based on Current City Share of Statewide Generating Capacity Installed

Scenario A anticipates the City's rate of increase in solar PV installed capacity lags behind the projected 5 year Statewide annual rate of increase based on the City's estimated lower per capita adoption rate when reviewed by the total generating capacity (see "City of La Crosse's Solar Share" Section 3). This scenario would mean an increase of approximately 707 KW of installed capacity within the City by 2025. Based on the City's current lower-than-average share of existing installed solar pv capacity, this would result in a continued lower-than-average per capita share of total statewide solar in 2025 (24% of average). This scenario would result in around 2,236 KW of installed capacity by 2025, equivalent to 3.2% of the optimized capacity potential within the City and 4,215 KW of installed capacity by 2030 equivalent to 6.5% of optimized capacity potential.

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 use an annual growth rate of 10% for years 2031 through 2040. The chart below shows projections through 2040 using the assumptions outlined above.

Scenario A: Share of Projected Statewide Annual Increase Based on Current Citywide Share of Statewide Generating Capacity Installed

(13.5% Initial Annual Increase)

Year	Cumulative Installed (KW)	Annual Generation (KWH)	% of City Electric Consumption	This is Equivalent to adding (x) Average Residential Arrays Annually:	Or Equivalent to adding (x) Commercial Arrays Annually:
2025	2,236	2,502,467	**0.35%**	**21**	**3.5**
2030	4,215	4,716,243	**0.65%**	**58**	**10**
2040	10,933	12,232,720	**1.70%**	**99**	**17**

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

City Wide Solar Potentials

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

Scenario B anticipates the City's rate of increase in solar PV installed capacity matches the projected 5 year Statewide annual rate of increase of 49%. This scenario would mean an increase of approximately 3,500 KW of installed capacity resulting in a total of 5,058 KW, equivalent to 7.8% of the optimized capacity potential within the City by 2025.

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 2026 and again at 2031. For purposes of this study, we recommend a 50% reduction of the annual rate of growth for years 2026 through 2030 and then an annual growth rate of 10% for years 2031 through 2040. This results in 15,130 KW of installed capacity, equivalent to 23% of the optimized capacity potential within the City by 2030 and 39,243 KW of installed capacity by 2040 equivalent to 60% of optimized capacity potential.. The chart below shows projections through 2040 using the assumptions outlined above.

Scenario B: Share of Projected Statewide Annual Increase Based on Population Share
(49% Initial Annual Increase)

Year	Cumulative Installed (KW)	Annual Generation (KWH)	% of City Electric Consumption	This is Equivalent to adding (x) Average Residential Arrays Annually:	Or Equivalent to adding (x) Commercial Arrays Annually:
2025	5,058	5,659,660	**0.79%**	**104**	**17.6**
2030	15,130	16,929,227	**2.35%**	**296**	**42**
2040	39,243	43,910,054	**6.09%**	**355**	**60**

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

City Wide Solar Potentials

Scenario C: Share of Projected Statewide Annual Increase Based on Current City Share of Statewide Number of Arrays Installed

Scenario C anticipates the City's rate of increase in solar PV installed capacity surpasses the projected 5 year Statewide annual rate of increase based on the City's estimated higher adoption rate when reviewed by the number of arrays installed per capita (see "City of La Crosse's Solar Share" Section 3). This scenario would mean an increase of approximately 15,213 KW of installed capacity within the City by 2025. Based on the City's current higher-than-average per capita share of number of installed arrays, this would result in a higher-than-average per capita share of total statewide solar in 2025 (185% of average). This scenario would result in around 16,742 KW of installed capacity by 2025, equivalent to 25.6% of the optimized capacity potential within the City and 49,902 KW of installed capacity by 2030 equivalent to 76.3% of optimized capacity potential.

For this scenario, we project an 80% reduction in the annual growth rate for 2025-2030 and then an annual growth rate of 10% for years 2031 through 2040. The chart below shows projections through 2040 using the assumptions outlined above.

Scenario C: Share of Projected Statewide Annual Increase Based on Current Citywide Share of Statewide Number of Arrays Installed

(250% State Per Capita)

Year	Cumulative Installed (KW)	Annual Generation (KWH)	% of City Electric Consumption	This is Equivalent to adding (x) Average Residential Arrays Annually:	Or Equivalent to adding (x) Commercial Arrays Annually:
2025	16,742	18,733,507	**2.60%**	**447**	**76.1**
2030	49,902	55,836,281	**7.75%**	**975**	**138**
2040	129,432	144,824,932	**20.10%**	**1,170**	**199**

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

City Wide Solar Potentials

Suggested Rooftop Targeted Scenario

Based on the City's current lower-than-average per capita installed solar capacity (when measured by KW installed rather than number of arrays installed), we recommend striving for a higher rate of increase than that illustrated in Scenario A. On the other hand, though Scenario C may be ideal, the rate of increase may be extremely challenging to meet. Scenario B, however, would achieve a significant increase in the City's solar installations, achieve a notable increase in the City's share of Statewide installations, and the required pace of 100-300 new residential scaled installations annually should be achievable.

Estimating Additional Capacity

In addition to roof mounted solar PV potential, the City of La Crosse 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 La Crosse 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 City of La Crosse is estimated to be 5,571 acres—just under 9% of all land in the City. We estimate parking takes up 40% 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 a modest 1/2% assumed near-term availability and suitability rate, this still represents up to 480,000 square feet of near-term carport solar array coverage potential. Based on the above calculation factors, this would result in a total of 4,896 KW of installed capacity producing 6,168,000 KWH annually by 2030, approximately 1% of the City's total electric consumption.

Ground Mounted Capacity

The total lawn and "bare ground" area within the City of La Crosse, excluding tree canopy coverage areas, is estimated to be 19,046 acres—approximately 30% of all land in the City. 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 a modest 0.1% assumed near-term availability and suitability rate, this still represents up to 830,000 square feet of near-term ground mounted array coverage potential. Based on the above calculation factors, this would result in a total of 8,477 KW of installed capacity producing 10,680,000 KWH annually, approximately 1.5% of the City's total electric consumption.

City 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 City of La Crosse to increase its distributed solar capacity by 2030. For the Rooftop potential, we anticipate Scenario C to likely be overly aggressive and difficult to meet, while Scenario A may not represent a strong enough vision to support the City's Climate Action goals. Consequently, we suggest considering a Citywide distributed solar capacity target similar to Scenario B, which when 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
Scenario B Rooftop	15,130 KW	16,929,227 KWH	2.35%
Carport	4,896 KW	6,168,000 KWH	1%
Ground Mounted	8,477 KW	10,680,000 KWH	1.5%
Total Potential	**28,503 KW**	**33,777,227 KWH**	**4.85%**

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

Rooftop Coverage	1.5 Million SF
Parking Lot Coverage	11 Acres
Bare Ground Coverage	19 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.

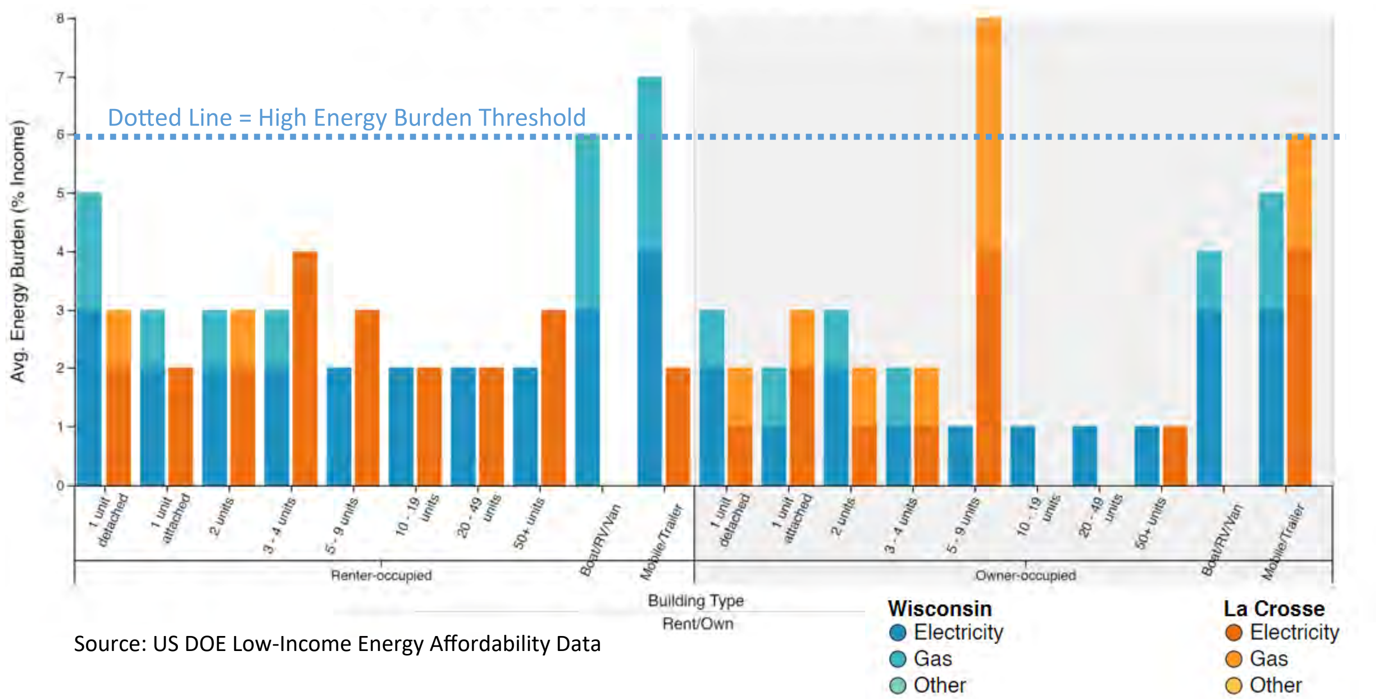
Energy Burden In La Crosse

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.

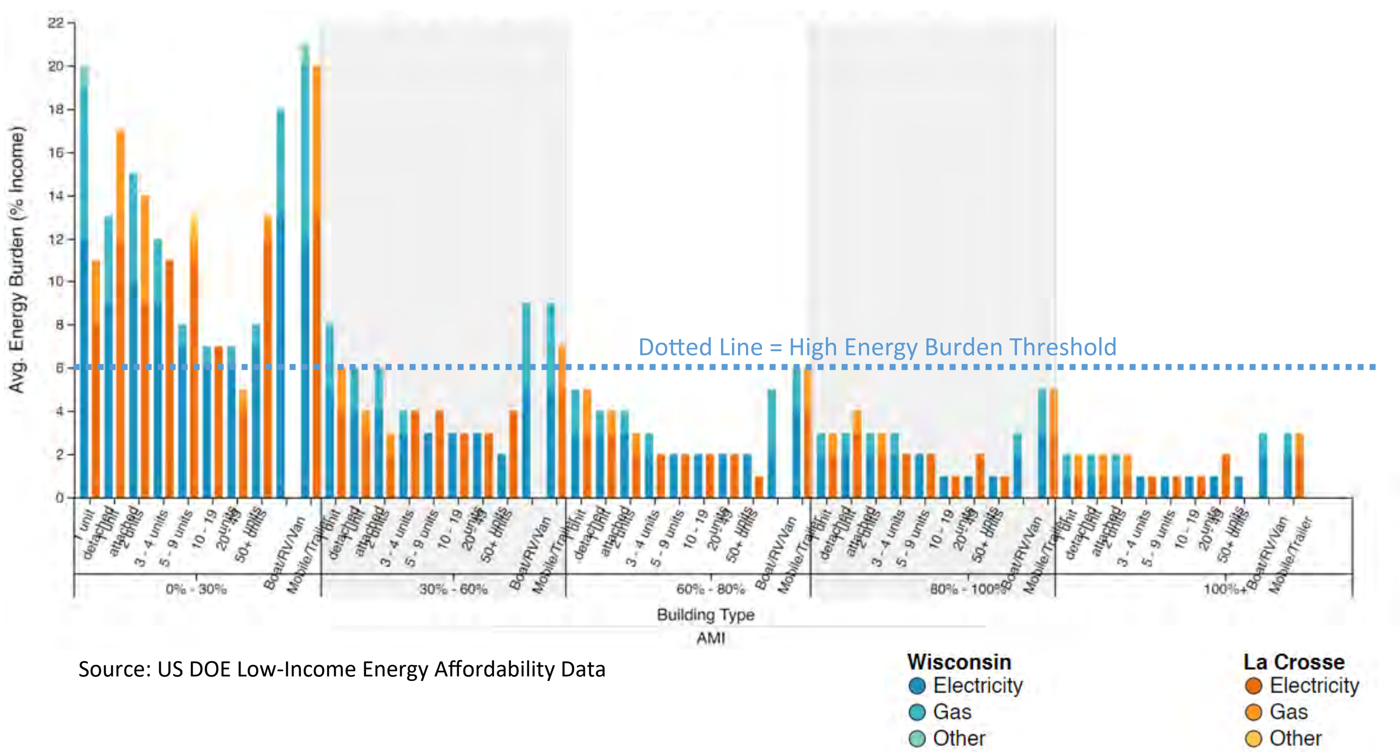
Low to Medium Potentials

Energy Burden In La Crosse—Energy Burden by Housing Type and Ownership



Source: US DOE Low-Income Energy Affordability Data

Energy Burden In La Crosse—Energy Burden by Income and Housing Type



Source: US DOE Low-Income Energy Affordability Data

Low to Medium Potentials

Energy Burden In La Crosse (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 La Crosse tend to be homeowners rather than renters. Over 31% of LMI households in the community have high energy burden, comprising 5.2% of all households in La Crosse. 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 City with High Energy Burden	Share of Income Category Total	Share of Total LMI Households with High Energy Burden
Income 0-30% AMI:	**1,731**		**49.19%**
Single Family Household detached	853	49.3%	24.24%
Single Family Household Attached	130	7.5%	3.69%
2 Unit Buildings	365	21.1%	10.37%
3-4 Unit Buildings	-		
5-9 Unit Buildings	301	17.4%	8.55%
10-19 Unit Buildings	-		
20-49 Unit Buildings	-		
50+ Unit Buildings	-		
Mobile Home/Trailer	82	4.7%	2.33%
Income 30-60% AMI:	**1,788**		**50.81%**
Single Family Household detached	1788	103.3%	50.81%
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	-		
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:	**3,519**		
Total LMI Households in Community:	11,058	**% of LMI Households in Community with High Energy Burden:**	**31.8%**
Total Households in Community:	21,410	**Total LMI Households in Community:**	**16.4%**

Low to Medium Potentials

Solar Potential of LMI Buildings in La Crosse

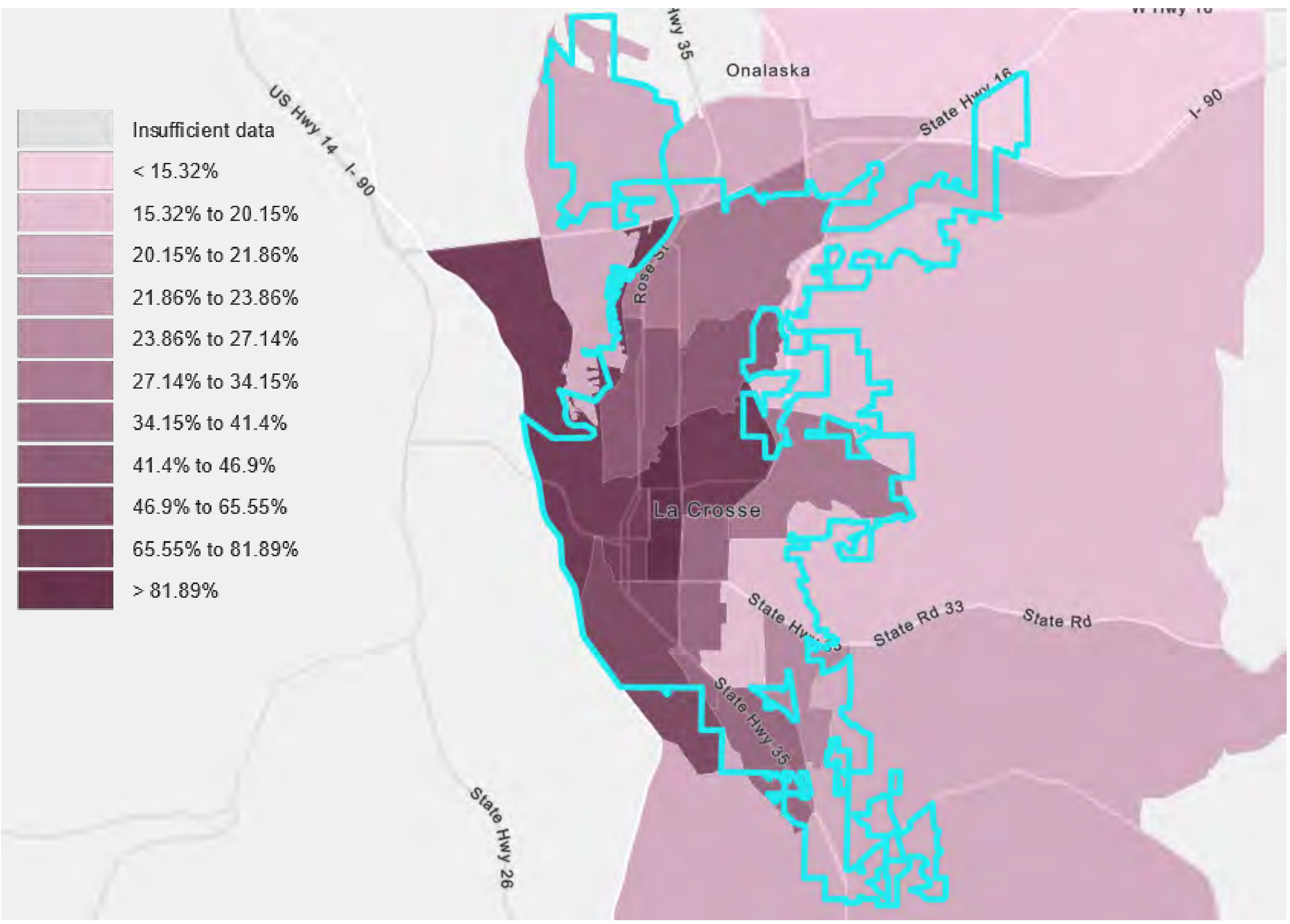
According to the study "Rooftop Solar Technical Potential for Low-to-Moderate Income Households in the United States" by NREL, the 14,705 LMI households live in 7,158 buildings. These LMI residential buildings are estimated to have a optimized solar generation capacity of 131,813,000 kWh annually.

According to NREL, the generating capacity of these LMI buildings alone is capable of meeting 300% or more of the total Annual Solar Generation for 2040 as projected by Scenario B (see Section 4) - meaning strategies which result in significant increases in solar PV options for LMI communities could not only provide significant benefit for relief from energy burden impacts, but also meaningfully contribute to the City's long-term renewable energy goals. Put simply, there is more potential for solar generation on LMI rooftops than what LMI residents would use. Below is a breakdown of optimized solar generation by building type:

Building Type	Estimated Optimized Generation Potential	Average LMI Household Savings Potential
LMI Single Family:	**49,632,000** kWh Annually	**$1,200** Annually
LMI Multi-Family:	**72,181,000** kWh Annually	

Mapping LMI Household Potential In La Crosse

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

City Wide

Solar Benefits

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City 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 La Crosse

According to the National Renewable Energy Laboratory (NREL), the additional solar pv capacity which could be installed in the City by 2030 (Scenario B as well as the estimated ground mounted and carport arrays) has a total construction value of $70.2 million (2021 dollars). The potential share of those investments for the local economy totals 85 jobs and $7.65 million in local income potential during construction and 17 jobs and $1.5 million in local income potential for maintenance annually through the lifetime of the installations. Below is a breakout of the La Crosse Economic Development potential of new installed solar pv capacity through 2030 based on population share of Statewide market absorption projection numbers:

La Crosse Local Economic Impacts Through 2030
Summary Results Based on Scenario B*

	Jobs	Earnings	Output	Value Added
During construction period		**Million $ 2021**	**Million $ 2021**	**Million $ 2021**
Project Development and Onsite Labor Impacts	30	$4.15	$5.66	$4.61
Construction and Interconnection Labor	19	$3.57		
Construction Related Services	11	$0.57		
Equipment and Supply Chain Impacts	30	$1.96	$7.97	$3.93
Induced Impacts	26	$1.55	$4.29	$2.34
Total Impacts	**85**	**$7.65**	**$17.92**	**$10.89**

	Annual Jobs	Annual Earnings	Annual Output	Annual Output
During operating years (annual)		**Million $ 2021**	**Million $ 2021**	**Million $ 2021**
Onsite Labor Impacts	12	$0.84	$0.84	$0.84
Local Revenue and Supply Chain Impacts	2	$0.15	$0.44	$0.29
Induced Impacts	3	$0.17	$0.46	$0.25
Total Impacts	**17**	**$1.15**	**$1.74**	**$1.38**

*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, La Crosse 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 City 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. In addition, all commercial solar pv owners can harvest additional tax benefits through the federal accelerated depreciation. At the projected additional installation through 2025 outlined in the previous section, this could mean $1 million to $2.5 million or more 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 La Crosse is $300,000 to $400,000 annually by 2030 (based on a third party ownership structure, long-term savings for direct ownership can be significantly higher).

City Wide Solar Benefits

Environmental Benefits for La Crosse

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 Xcel Energy, the total GHG emissions per MWH equal 0.274 metric tons. 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 City of La Crosse can reduce its annual Greenhouse Gas emissions by 2,313 metric tons (45,383,646 cubic feet of man-made greenhouse atmosphere), and its annual water footprint by 34.46 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)
2025	22.51	6,168	122,371,974	119.40
2030	33.78	9,255	183,639,463	179.18
2040	60.76	16,648	330,321,906	322.30

*Includes estimated Ground Mounted and Carport array potential through 2030

Section 07

City Wide Municipal Solid Waste Plasma Gasification Potential

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City 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?

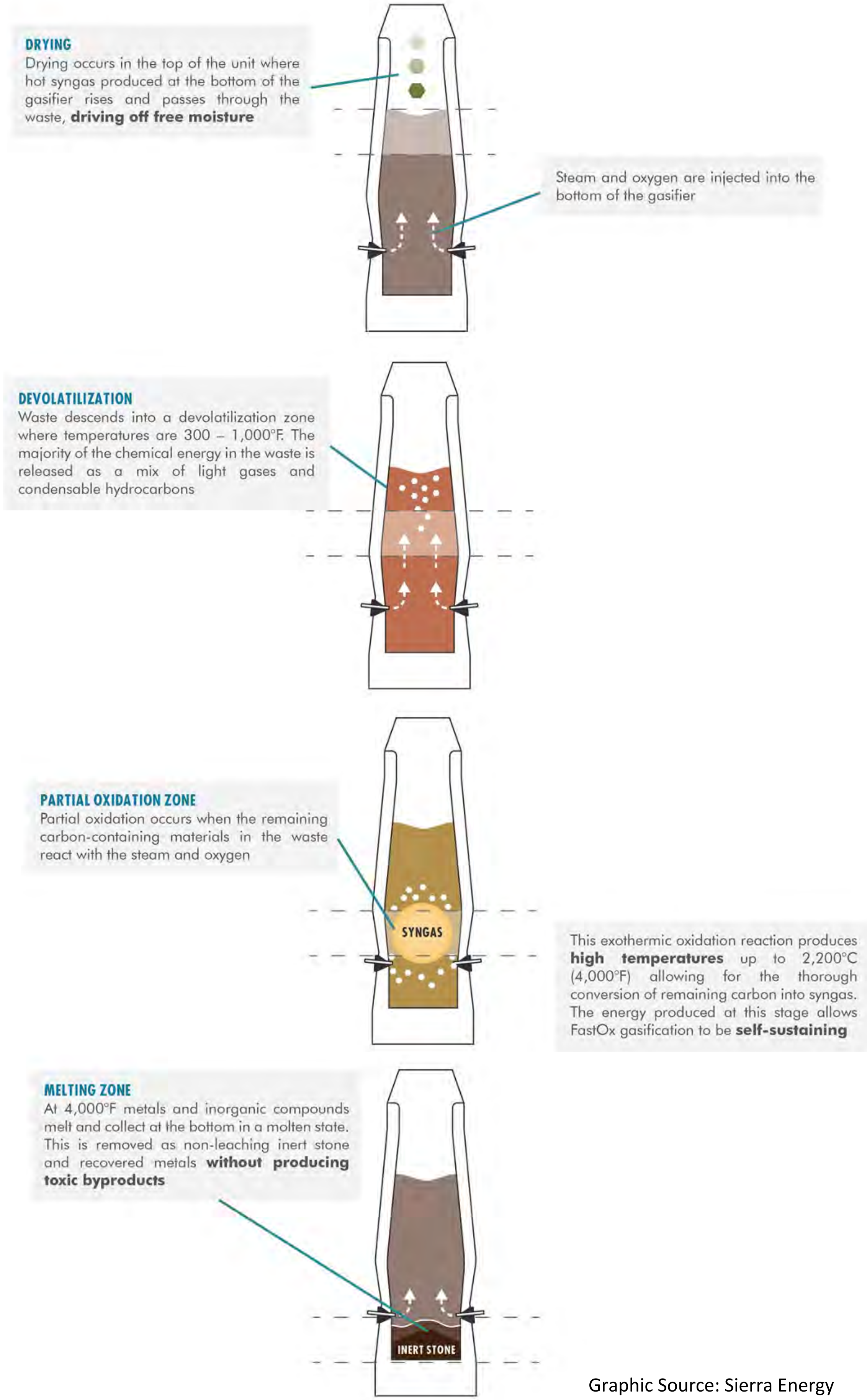
Waste is fed into the top of the gasifier vessel through an airlock. Purified oxygen and steam are injected into the base. The gasification reaction occurs at temperatures around 2,200°C (4,000°F). As the waste descends within the gasifier, it passes through several reaction zones reaching the hottest 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 gasfiier 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

City 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 City of La Crosse

According to Sierra Energy, based on the City of La Crosse's total landfilled municipal solid waste, the current waste stream within La Crosse could support 100 metric tons per day waste stream for gasification. This volume could generate:

La Crosse Total

25,541,667 **kWh Electricity**
annually
(3.5% of La Crosse citywide electric consumption)

or

1,678,200 **Pounds Hydrogen Fuel**
annually

or

460,870 **Gallons of Biodiesel**
annually
(190% of City of La Crosse fleet diesel consumption)

Source: Sierra Energy

Section 08

Recommendations

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Recommendations

Community-Wide Solar Recommendations

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

1) Maximize new installations through 2023 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 annually 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 annually 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 City 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 City 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)

2) Maximize new installations in years 2024 and beyond. Actions to support this include:

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

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

   k) Establish a requirement that new construction projects and significant renovation projects within the City (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)

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

   l) 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.

Recommendations

Community-Wide Solar Recommendations (continued)

3) Maximize Solar benefits for Low and Moderate Income (LMI) communities:

    o) Collaborate with County to explore opportunities to adapt local utilization of energy assistance programs, like the Low Income Home Energy Assistance Program (LIHEAP) and the Weatherization Assistance Program (WAP), to include solar power as approved cost-effective measures.

    q) Identify municipally controlled properties suitable to house large ground-mounted community solar arrays and issue RFP for community solar developer offering use of property at no cost in exchange for achievement of minimum LMI participation.

    r) Explore the potential of establishing a Community Development Financing Institution (CDFI) or Community Development Entity (CDE) to identify and expand accessing to low income solar financial mechanisms.

4) Explore the potential for plasma gasification diverting all existing landfilled municipal solid waste for the development of renewable energy, particularly for the production of hydrogen, renewable natural gas, or biodiesel for use in the community to reduce fossil fuel combustion within the building or transportation sector.

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