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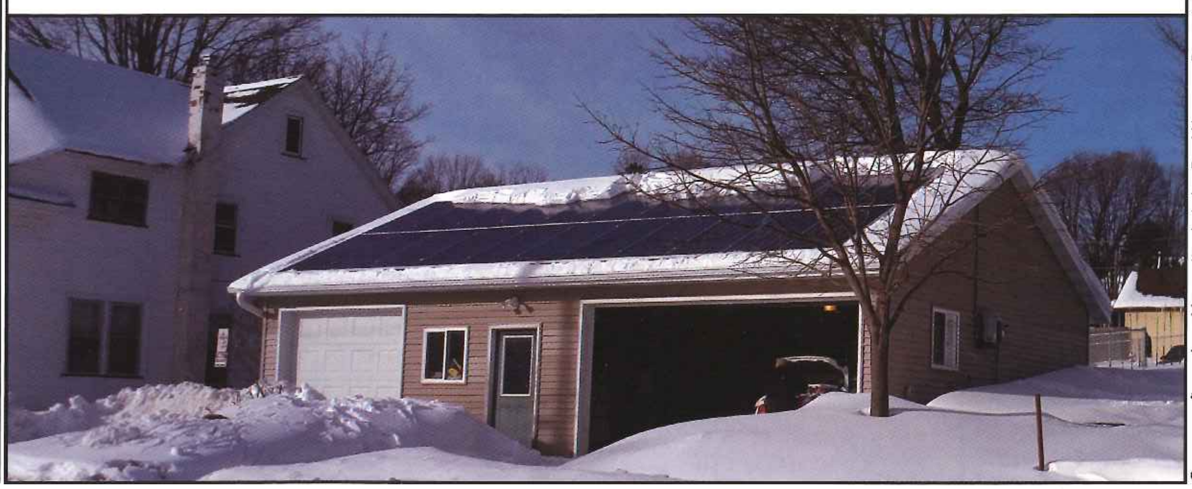
# SOLAR ENERGY



Garage rooftop solar – Marquette photo by: Brad Neuman; Barn photo by Pixabay, and MSU parking photo by Honda Carter

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# SOLAR ENERGY IS COMPETITIVE WITH OTHER ENERGY SOURCES – Is Your Community Ready?

*By* **Harmony Fierke-Gmazel, AICP, Brad Neumann, AICP,** *MSU Extension Government & Public Policy Educators*

## Introduction to Solar Energy

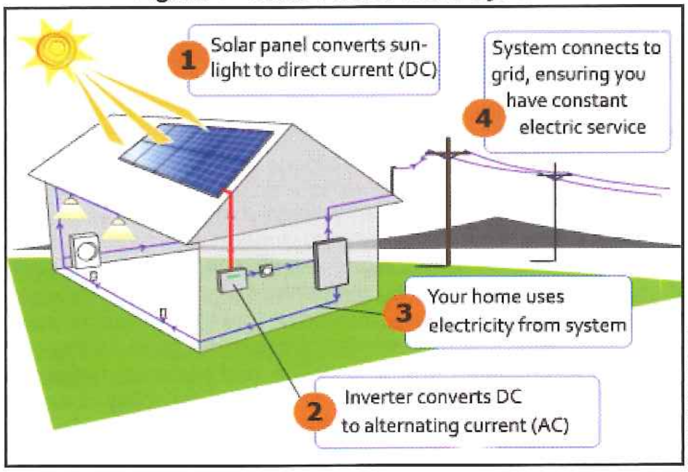
The idea of utilizing solar energy as a power source is not a new idea, and communities across Michigan are experiencing more interest in solar energy systems from residents, public utilities and solar development companies. Local governments are also playing a 'starring' role by planning for and using this renewable energy source. For those communities that have yet to see solar energy development proposals, there is much to learn. *What is solar energy? How does it work? What are the types of solar structures being installed? What are the structures made of?* These questions and others are answered in this article, which is an introduction to solar power installations.

The discovery of solar power was somewhat *"accidental."* In 1839, French physicist Edmond Becquerel noticed that selenium placed over a layer of gold would create a small voltage when it was exposed to sunlight, or in more scientific terms, it was *"photovoltaic."* Over the next 100 years, improvements were made to these photovoltaic properties until manufactured solar *"cells"* were made available in the 1950's. These early cells were sold at $25.00 per cell, meaning that an average sized solar array at the time could cost millions of dollars.[1] Due to the high cost, early solar cells were generally seen only on satellites and oil rigs.

However, it has long been recognized that the sun can provide heat without conversion to electricity. Residential and commercial buildings have been designed for thousands of years to take advantage of the power of *passive* solar energy elements. More recently, according to the United States Department of Energy, passive solar design incorporates south-facing windows, insulating building materials such as concrete and strategically placed roof overhangs that either collect solar energy or reflect it. Passive designs are guided by the movement of the sun, the movement of heat inside the home and heat storage techniques. These passive solar elements are very useful and are seen across the United States in many different building types.

Solar panels and passive solar designs are technologies that essentially harness *"solar energy."* According to the Solar Energy Industries Association or SEIA, *solar energy systems convert sunlight into a practical form of energy, used most commonly for electricity or heat.* In Michigan, we typically see two types of solar energy systems: *Solar Photovoltaic (PV), and Solar Thermal.* Solar PV systems include solar panel collectors, or cells, installed on or near a building that convert solar energy into a flow of electrons (direct current, or DC). This direct current leaves the solar panels and enters an inverter box that converts the DC to an alternating current, or AC. With this alternating current, a building can then use the electricity directly for lighting, appliances, etc. Most buildings with solar energy systems are still connected to the utility grid providing electricity only when needed.[2] Figure 1 is a depiction of a solar photovoltaic system.

**Figure 1 - Solar Photovoltaic System**




Source: Cssun.org.

According to the U.S. Department of Energy, solar PV cells are made from semiconductor materials such as polycrystalline, monocrystalline and amorphous silicon. Polycrystalline is the most common material used for solar cells as they are long lasting and generally more affordable. Monocrystalline cells are less affordable, but are very efficient in low light. Amorphous cells are made from molten silicon spread over steel, or some other substrate, using a manufacturing technique that allows it to be designed into unique architectural configurations. Energy Sage, which is a national online solar marketplace funded by the U.S. Department of Energy estimates that the cost to install a typical solar system of 5.7 kW for a single family house is about $18,000 in 2016, with a payback time of eight years.[3a] In other words, it could take eight years for the homeowner to break even between the investment cost and the subsequent utility bill savings. But this payback period can change rapidly based on energy prices of the electric provider and the costs of equipment and installation.

Solar thermal is a system that harnesses solar energy in order to directly heat water within a building or to heat interior airspaces. A solar thermal system is comprised of a set of shatterproof cells or tubes that capture sunlight and transfer that radiant heat directly into a flow of water. Once heated, the water in the tubes feeds into a hot water tank or heat exchanger within a building. The water can then flow directly to the water taps throughout the building. Water is continuously pumped through the solar thermal panels or tubes in order to keep the system flowing. Compared to Solar PV, solar thermal costs between $5,000 and $13,000 for a home system, and it will pay for itself within 5-10 years.[3b] Figure 2 is a depiction of a solar thermal system.


### About the Authors

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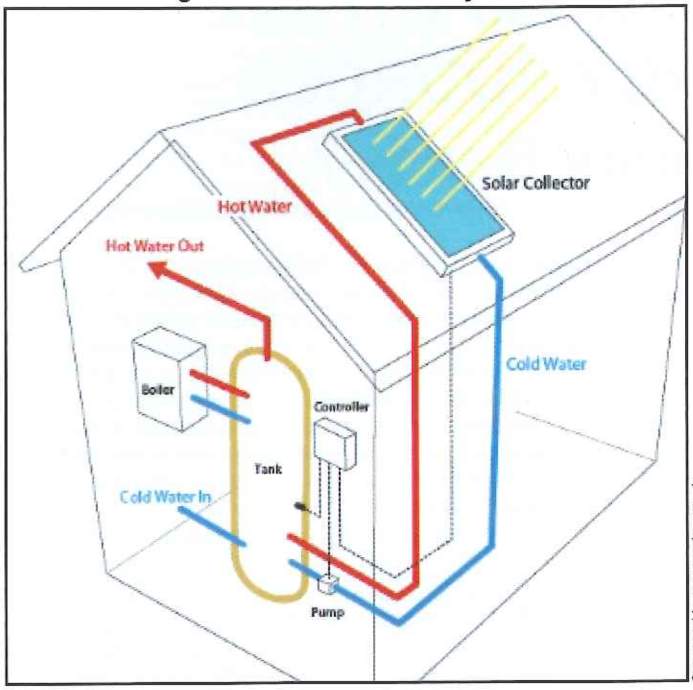
Figure 2 – Solar Thermal System




Source: Uenergysolar.co.uk

## Sunlight in Michigan

A statement that is heard many times over is that *"Michigan does not have enough sunny days to support solar energy systems."* This announcement is made at public hearings, by elected and appointed officials, and by residents. Yet, renewable energy experts and planning professionals know that the reverse is true. In order to understand the viability of solar energy in Michigan, it is critical to understand how to define and measure radiation and to know what Michigan's solar resource availability is compared to the nation and the rest of the world. Knowledge of solar availability on a daily basis will help communities understand how metered electricity plays a part in the system. It is also important to understand that the price of electricity in a given locale greatly influences the viability of solar for residential and commercial applications. The higher the cost of electricity, the more viable solar can be. In the Keweenaw Peninsula – one of the least sunny places in Michigan – there are also the highest energy costs in the state. So, the amount of solar radiation in a given area of the state may be less important than the costs associated with the project. Therefore, it is important for community planners to understand the solar resource and associated costs of solar when undertaking a related planning or zoning process.

First, solar energy is solar radiation that is received on Earth. *Radiation* is electromagnetic energy that emanates from the Sun and is harnessed to create heat and electricity. Once harnessed, solar radiation can be measured in *megawatts*, or MW. One MW equals one million watts of electricity. According to the Solar Energy Industries Association (SEIA), MWs are measured by the amount of watts used per hour, or what is called a *'megawatt hour'* (MWh). A MWh equals one million watts of electricity produced or used in one hour. It is a standard unit of power that is bought and sold at the wholesale utility-scale level, not an amount that a resident would see on their average electricity bill. To put it into perspective, *an average single family house uses approximately 9 MWh per year.* Solar is also measured in *kilowatts or kilowatt hours* (KW, or KWh). A KW is simply one thousand watts of electricity and a KWh is one thousand watts produced or used in an hour. It is a smaller unit of measurement than the MW or MWh.

Figure 3 below depicts the measured annual solar resource available within Michigan with the red areas receiving the most watt hours per square meter of land per day, and the yellow areas receiving less amounts of solar radiation. This is a range between over 3,000 MWh received in areas with the least amount of radiation and over 4,000 MWh received in areas with the highest amounts of radiation. Proper planning and siting of solar panels can produce electricity year-round in any of these areas. This is a topic that will be detailed later.

## Tapping Michigan's Solar Potential

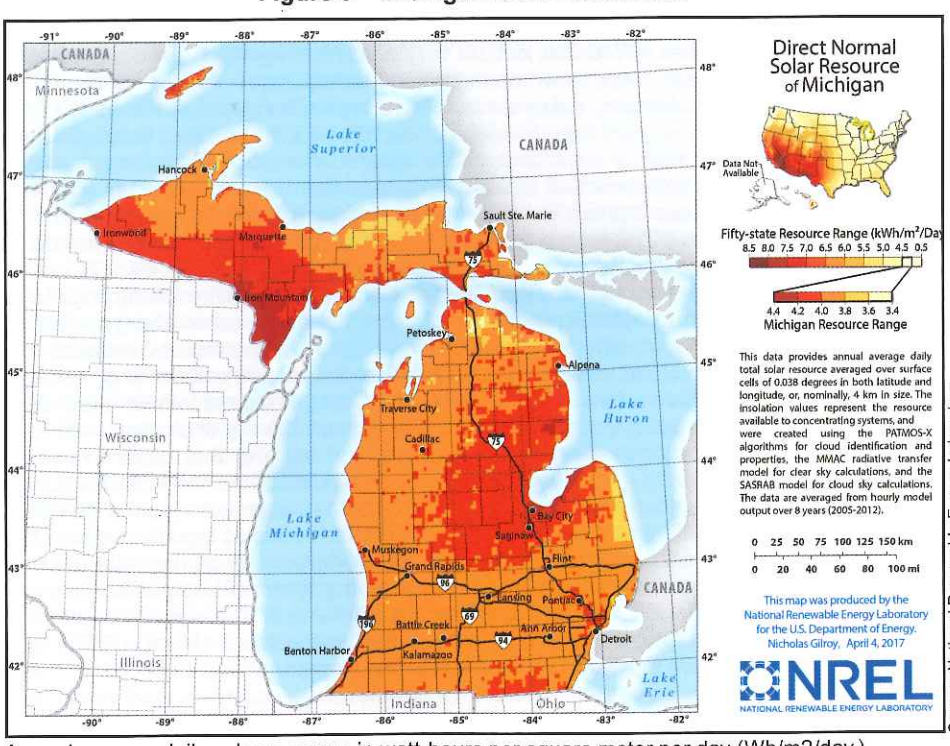
Solar photovoltaic systems require a minimum of 3.5 KWh of solar per day to generate sufficient electricity, Michigan just meets that minimum requirement. While Michigan is in a lower radiation area as compared to the rest of the nation, globally Michigan receives more solar radiation than Germany. This is significant because Germany receives 27% of its energy from solar and wind energy combined. It is a world leader in renewable energy.[4]

In terms of daily solar radiation levels, KWhs typically increase between 7:00am and 1:00pm, and decrease between 1:00pm and 7:00pm. During peak production times, solar energy is utilized in place of metered electricity from the local electric utility. In the evening and nighttime, metered electricity is used because solar radiation is at its lowest level.

As previously stated, the costs associated with solar are perhaps more important than the amount of the solar resource at a given location. These costs have been steadily declining for the last decade. The National Renewable Energy Laboratory (NREL) reviewed residential photovoltaic system costs between 2010 and 2017. NREL found that the *"hard"* costs of solar, including the solar cells, AC/DC inverters and other hardware have decreased from approximately $3.50 to just over $1.00 per watt (for direct current or DC). The *"soft"* costs, such as installation, permitting, taxes and overhead also decreased from approximately $4.00 to $1.80 per watt. With this seven-year decrease in the hard and soft costs of solar, a watt now costs $2.80 (DC) (or $3.22 per watt AC). This is down from $7.24 per watt in 2009.[7]

Declining costs associated with solar systems has fueled major growth in the

Figure 3 – Michigan Solar Resources




Annual average daily solar resource in watt-hours per square meter per day (Wh/m2/day.)

Source: National Renewable Energy Laboratory.

**Economic Impacts of Solar are Growing**

It is important to note that the economic impacts of solar in Michigan are growing. *Michigan ranks 15th in the United States for solar-related jobs with over 4,000 jobs in 161 companies.* This statistic is up from 2015 when Michigan had 2,779 solar-related jobs. Contractors, installers and manufacturers are the largest sectors for jobs in the solar industry.[5]

Another reason for the growth of solar is the Investment Tax Credit (ITC) which was established in the Energy Policy Act of 2005. It is also known as the Federal Solar Tax Credit and allows residential and business property owners to deduct 30% of their solar power system installation costs.[6]

industry nationwide and Michigan is no exception. With a 64% decrease in costs for solar, over $96 million was invested in Michigan solar by April of 2017. In 2015-16, solar installations totaled 15 MW, while in 2016-17, the installations totaled 108 MW.[8] This increase represents a significant investment into Michigan's solar energy sector over a short period of time.

## Solar Energy Challenges and Public Perceptions

The solar energy sector in Michigan is full of untapped potential. Yet, many experts in the industry, community planning officials, and professionals are facing challenges to the successful development of large and small solar installations. The following list is a snapshot of typical issues that landowners and utility professionals face in Michigan:

- Many local zoning ordinances do not provide for, or they completely prohibit, solar developments. This creates a roadblock to potential investment in renewable energy in general.
  - *Solution: Amend local zoning ordinances to allow for solar installations in areas of the community where deemed appropriate. Small-scale solar can even be minimally regulated as an appurtenance.*
- Michigan does not offer many incentives for small and large-scale solar energy production.
  - *Energy agencies and industry specialists can provide analysis of a wide range of incentives that can be successful in appropriate locations.*
- The visual impacts of solar panels, especially in historic districts, are distracting to community visitors and residents.
  - *Through a thorough community planning and public engagement process, solar can be appropriately regulated in historic districts or on historic structures and the design of panels can match the architectural elements of the structures to minimize visual impacts.*

Source Pixabay.

The grasses and plantings underneath the solar installation shown here are pollinator and stormwater friendly, as compared to the mowed grass that is typically seen under an installation. Many types of native plantings do well in conjunction with solar arrays. Solar arrays are also compatible within cattle and sheep pasturelands.

- Michigan's weather is known to be cloudy, and this can impact electricity generation. Pollution, clouds, snow, rain etc. can limit solar radiation in Michigan.
  - *Solar radiation levels in Michigan are nationally and globally significant enough to warrant increased investment in solar. Particulates, snow, rain, clouds etc. are temporary and do not have a significant impact on the production of solar watts when averaged over an entire year or more.*
- Ground-mounted solar panels may negatively impact stormwater management efforts.
  - *Onsite retention of stormwater can still be practical when solar installations are present. In terms of stormwater management, tall native grasses are highly compatible with solar panels that are installed on the ground. Rooftop solar installations can also be placed over a green roof meant for stormwater retention.*
- Renters and condominium owners do not have the authority to install solar panels.
  - *Incentives for solar installations can be presented to local rental owners and condominium associations as a way to decrease energy costs and consumption over a period of time after the initial installation costs of the solar panels.*

Generally, the public positively recognizes the cost savings of solar and the reduction in overall greenhouse gas emissions that result from renewable solar energy. According to a recent survey from the University of Michigan, 74% of respondents agreed that state government should mandate a portion of all electricity be created by wind and solar energy.[9] The reasons why residents support solar and other renewable energy systems include: a desire to avoid rising or volatile energy prices; independence from the electrical grid system; and a desire to reduce their own personal carbon footprint.[10] Local governments can appropriately provide energy options for their residents especially through the adoption of proven planning and zoning techniques we will further discuss.

## Legislative Context

The Michigan Clean Renewable and Efficient Energy Act (Public Act 295 of 2008) set the stage nearly ten years ago for Michigan-regulated utilities to promote the development of renewable energy such as solar. At that time, Michigan set an energy standard that would effectively do the following: (a) diversify resources used to reliably meet the energy needs of consumers; (b) provide greater energy security through the use of indigenous energy resources available within Michigan; (c) encourage private investment in renewable energy and energy efficiency, and (d) provide improved air quality and other benefits to energy consumers and citizens in Michigan.[11]

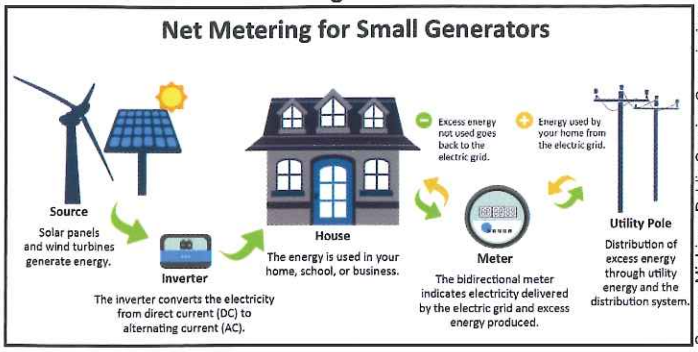
### *Renewable Portfolio Standard*

In order to achieve these goals, PA 295 required electric providers to meet a 10% renewable portfolio standard (RPS) by 2015. The RPS mandates public and private electric utilities to supply a specific percentage of their total supplied power originating from renewable sources such as solar or wind installations. Not only is an RPS a successful tool in the promotion of alternative energy, but it is also a very effective economic development tool that drives investment in the solar industry.[12] In late 2016, PA 342 amended the 2008 Michigan Clean Renewable and Efficient Energy Act (PA 295) increasing the amount of renewable energy required to be generated by utilities in Michigan to 15% by 2021.

### *Net Metering*

Part 5 of PA 295 defines *"net metering"* as a billing mechanism that allows electricity producers and solar customers to balance their input and output on the larger electric grid. When a solar power system is installed on a building, it collects solar energy and it powers the building's own electric or water heating systems. When a solar power system produces excess electricity beyond the needs of the building, that excess energy can be sent out onto the wider *"grid"* system that serves the region and a bill credit given to the property owner. See Figure 4. If, on any given day or night, the solar power system does not generate enough electricity to meet the building's needs, the building must pull electricity from the grid.

**Figure 4**



Source: Michigan Public Service Commission

At the end of 2016, the total capacity of net metering in Michigan was nearly 22,000kW. This was a 28% increase over the capacity in 2015.[13] The Michigan net metering program is broken into categories based on electric generator size - Category 1 includes projects up to 20kW; Category 2 includes projects greater than 20 kW and no larger than 150 kW and non-inverter based 20 kW and under projects; and Category 3 is for methane digester projects up to 550 kW. Category 1 Net Metering, which largely consists of residential applications, is available to customers until the program size reaches 0.5% of the electric provider's peak load during the previous year. Net metering caps have been reached by some utility companies, for instance the Upper Peninsula Power Company reached its cap in 2016, while other utilities have significant space remaining. Consumers Energy and DTE Electric have 33MW or 90% and 47MW or 82% of space remaining, respectively. Public Act 342 of 2016 will change the details of the net metering program, which will be known as the distributed generation program in the months ahead.

## Barriers to Solar Power Installations Across Michigan

Despite Michigan's RPS, net metering and various incentive programs in place at the state and federal level, solar power installations still face many barriers. The Michigan Public Service Commission identifies two significant barriers: 1) Inconsistent permitting processes by jurisdiction, and 2) Varying interpretations of the tax code related to solar energy systems.[14] When the permitting processes at the county, city, village or township level are inconsistent, it is burdensome to installers and system owners as well as to the jurisdictions that provide the permit reviews and approvals. When it comes to the tax code, residential system owners are not offered a tax exemption for photovoltaic systems. Further, the language of the General Property Tax Code has not been amended to provide clear categorization for solar such as that seen for wind energy systems.

## Solar Power Installation Types

To better understand solar power systems, it is important to recognize the three basic types of installations: *onsite, community and utility-scale.* *Onsite solar energy systems are an accessory placed either on a building or on the ground for the purpose of generating electricity for use by structures located on the same property.* The main purpose of an onsite installation is to collect, utilize, store and distribute electricity related to that site.[15] The photo on page 10 is an example of an onsite rooftop installation that serves an industrial building. Below is a *"ground-mounted"* system.


Source: Brad Neumann, MSUE

Community solar installation in Marquette.

*Community solar installations are supported by multiple owners, organizations or investors who support solar panel installations and who share the costs and benefits of the solar power collected there.* The financial benefits, such as cost savings on energy bills, are shared among all the partners. The photo above depicts a new community solar installation in Marquette, MI, supported by the municipal utility and local residents.

In this example, solar supporters sign a 25-year lease with the Marquette Board of Light and Power and pay a single up-front investment of $499 per solar panel. The municipal utility then provides a monthly credit to the members on their electric bill that reflects the amount of solar energy generated by their respective panel(s).

*"Utility-scale" energy installations are the principal use of a property as a large system that produces energy for sale back into an electrical energy grid system.* The energy produced is not primarily consumed onsite.[16] Generally, utility-scale installations are 1MW or larger in size, with each megawatt occupying approximately 5 acres and serving about 150 homes. The largest utility-scale installations in Michigan are the two Lapeer, MI sites operated by DTE. The aerial photos below depict 200,000 solar panels on 267 acres. The western (left) and eastern (right) sites combined create 58 MW of electricity and can power 9,000 homes annually. DTE worked with the landowner, the City of La-

Source: Inovateus Solar/DTE Energy.

The 267 acre DTE Energy solar installation is located in Lapeer, MI. It includes 200,000 solar panels that can power 9,000 homes annually. Source: Inovateus Solar/DTE Energy.

peer to permit the installation under a conditional rezoning before construction began in 2017. Nearby Mott Community College is connected to the installation with a trail supplemented with a solar energy educational display.

The City of Coldwater's Marmon Foundry site is another utility-scale installation that was completed this year. The site included brownfield issues that took six years to address. It will provide 1.6 MW of power to about 250 homes in Coldwater. This is an ideal example of reuse of a brownfield site, on what is sometimes called *"marginal land."* Marginal lands are ideal for solar installations because the acreage is encumbered in some way and while not suited for other redevelopment, may be suited for solar panel installations or other utility-type development – at least temporarily.

### Recommended Planning Approaches, Part I

Local communities have formally adopted policy documents that guide their growth and in turn, guide their capital investments. This section focuses on the master plan as the guiding policy document that can best address future growth of solar power at the local level. Master plan language, if worded correctly, can promote the potential for solar energy use, can set goals for new solar power development, and can provide solar-specific implementation strategies for a community. Master plans can outline important decisions related to access to solar energy, solar easements and siting provisions.

The best way to guide solar growth, access and siting through master planning is to first understand solar as a resource. Will solar panels provide enough energy to make the proposed investment viable? To answer that question in detail, the National Renewable Energy Laboratory (NREL) offers two highly recommended solar calculators that provide energy output and financial data related to solar installations. The first is a *free Photovoltaic (PV) Watts Calculator*. This calculator estimates the energy production and cost of energy for PV systems at or near any given address. Government officials, staff, and residents alike can visit pvwatts.nrel.gov, enter an address and be provided with the expected kilowatt hours (kWh) generated per year. The calculator also provides an estimated annual energy value of a solar installation at a given address.

NREL also offers a free *System Advisor Model (SAM)* for more in-depth technical calculations related to 12 various renewable energy systems including solar photovoltaic and solar thermal. Engineers, policy analysts and researchers can visit https://sam.nrel.gov/ to collect highly detailed performance and cost of energy estimates for custom future installations.

### Recommended Planning Approaches, Part II

When amending the master plan to address solar power installations, a community must understand its own geographic and political landscape pertaining to solar power. As with any other land use, solar power installations are appropriate in some locations, and not appropriate in others. In order to best address potential siting issues, it is up to the community to be proactive when planning for solar. Proactive planning is the best way to be ready to address public opposition and to best understand what solar means to your community. *The best way to be proactive is to have a vision for solar, to engage the public every step of the way, and to adopt meaningful master plan amendments and zoning regulations that address solar as a resource and a part of your landscape.* Future land use planning considerations should include:

- **Farm and forestland:** Know where the prime farm and forested areas are located. It is also important to know where the PA 116 properties (Farmland Preservation areas) are located. Other tax benefit program properties should be inventoried such as conservation easements or open space preservation areas. These properties may not be able to host solar installations without giving up their tax benefits first.
- **Brownfields:** The more your community understands about known or potential brownfield locations and related cleanup efforts, the more likely solar installations can be promoted in those areas.
- **Physical obstructions:** Structures, trees, surface water, and slopes can affect solar panel placement and access to solar light. A site needs at least six hours of sunlight measured on the shortest day of the year (the winter solstice) with slopes within 20-30 degrees of due south.
- **Wind loading:** Wind-induced loads are often inadequately addressed locally and must be considered in solar array design.
- **Geotechnical issues:** Soil composition, bearing capacity, groundwater level and surface water runoff will determine the appropriate foundation type, e.g., ballasts, ground-mounted, etc.
- **Proximity to the grid:** The potential location of a utility-scale or community solar installation must be able to successfully interconnect with the grid, fill in a gap in the grid, or be in a high-demand area.

Source: Pixabay.

Solar installations fit in very well along the edges of working lands or on marginal farmland as shown here. It's important that the panels not be overly shaded by nearby wooded areas, nor placed on land that is under the PA 116 Farmland Preservation program due to tax benefit issues.

Many of the landscape characteristics or features detailed above can be mapped in a Geographic Information System (GIS) and a spatial analysis can be performed to better visualize where these key areas correspond or overlap and are therefore more appropriate or less appropriate for solar energy development. These areas should be compared to existing and future land use categories and language should be added to the master plan supporting solar development in those land use categories where most appropriate.

Marginal lands may be best suited for solar installations because of their proximity to existing infrastructure and the fact that their (re)use has fewer environmental and/or economic impacts. Marginal lands are properties that have limitations on their use due to current condition, ownership, proximity to utility infrastruc-

Source: Pixabay.

Solar installations are an ideal land use on paved or pervious brownfield areas. A community must address contamination and cleanup issues, connectivity to the grid, installation techniques, decommissioning, fencing and maintenance of the site during the local review process.

Part of Wolverine Power Cooperative solar array. East of Cadillac on M-55.

Photo by Mark Wyckoff.

ture and more. Examples include areas around airports, freeway rights-of-way, brownfields, and farmland that is not productive. In order to plan for solar installations on marginalized land, a community must first inventory properties that are defined as marginalized. Once a community understands its landscape options for solar, special zoning standards must be put in place, incentives can be created, and a brownfield authority may need to be developed.

As a community undertakes a solar planning process, the political landscape must also be researched and understood. A few considerations include:

- **Economic barriers:** Appropriating tax dollars for solar projects can be a contentious battle; and large scale solar arrays often require new transmission infrastructure.
- **Legal barriers:** Litigation over lease and easement agreements and circumventing restrictive covenants; ground and mineral rights issues need to be addressed.
- **Local opposition:** Local leaders, residents, and businesses may object to solar on aesthetic grounds.

In order to best address these barriers, it may be desirable to create a Solar Advisory Committee. Planning commissions are empowered to create advisory committees (MCL 125.3817) and its members can include those not serving on the planning commission. Consider involving government staff, local developers, utility representatives, environmental agencies, large landowners and resource managers, fire and building code administrators, homeowner/neighborhood associations, historic preservation commissioners, neighboring community leaders, staff and others who may be involved at every step in your master plan amendment process.

Source: Pixabay.

The rooftops of municipal, commercial, industrial and institutional buildings are ideal locations for solar installations. Not only can the rooftop be gravel, as shown here, but green roofs do very well under solar installations as well.

### Zoning Approaches to Solar, Part I

Once a community has completed its future land use map and master planning for solar, the zoning ordinance must be amended. Zoning ordinance amendments are the key ways for communities to begin implementing their master plans. This section offers examples of how to address a solar installation as a principal use, an accessory use, a permitted use by right, and as a special land use. Specific standards can be adopted for onsite systems that serve as accessory uses to a primary structure. Likewise, specific standards can be adopted that address utility-scale or community solar that are principal uses of land. Above, the top photo depicts a large-scale solar installation that is the primary use of the site. Principal solar uses are generally large arrays installed in appropriate zoning districts. Principal solar uses sometimes follow the same height, size and setback standards as other principal uses in the same zoning district.

Accessory solar uses offer support or energy benefits to an existing onsite principal use, such as a residential, commercial, office, institutional, industrial or open space use. A best practice approach is to permit small-scale ground or roof-mounted solar installations as an accessory or accessory use in all zoning districts.

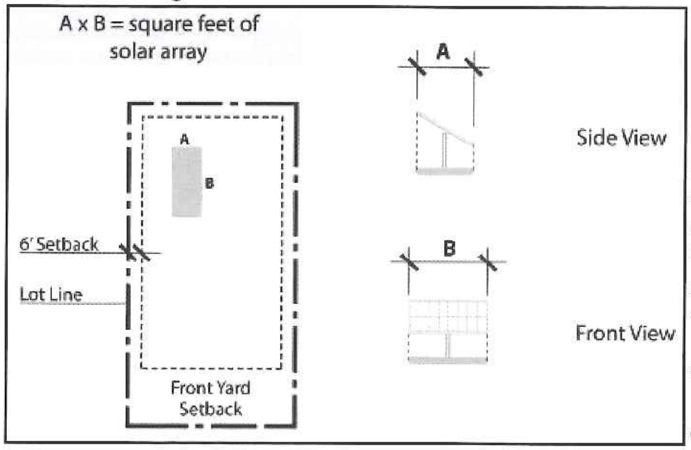
Solar installations can be considered a *'Use by Right'* when the structure is operating in a manner consistent with other permitted uses listed in the zoning district regulations. In this case, a solar installation would not be subject to special review and approval by a local government. The middle photo above depicts a rooftop installation that is an accessory to the primary industrial use. It could easily be allowed *'by right"* and not subject to separate review and approval by a government office or board if it is deemed to be in keeping with the uses allowed in that respective zoning district.

Source: Pixabay.

Solar panels can be shaped and sized to preserve the character of any zoning district. As you can see from this view of waterfront rooftops, there is plenty of opportunity for the local government to incentivize solar installations in this neighborhood. A survey of solar access and building types in your community can aid you in better understanding how to best incentivize solar across your community. Allowing on residential rooftops as a Use by Right is a strong incentive.

Finally, a solar installation can be made subject to a special use permit, or special land use review when it is uncertain whether it will be compatible with the uses allowed in its respective zoning district. During a master plan update, a community will identify general areas where solar installations may or may not be deemed appropriate considering the surrounding land uses and the intent of the future land use map. In this case, special standards would be listed in the zoning ordinance to address solar facilities. These special permits are approved only if all of the zoning ordinance standards are met.

**Figure 5 – Solar Panel Setbacks**




Source: Grosse Ile Twp. Zoning Ordinance

## Zoning Approaches to Solar, Part II

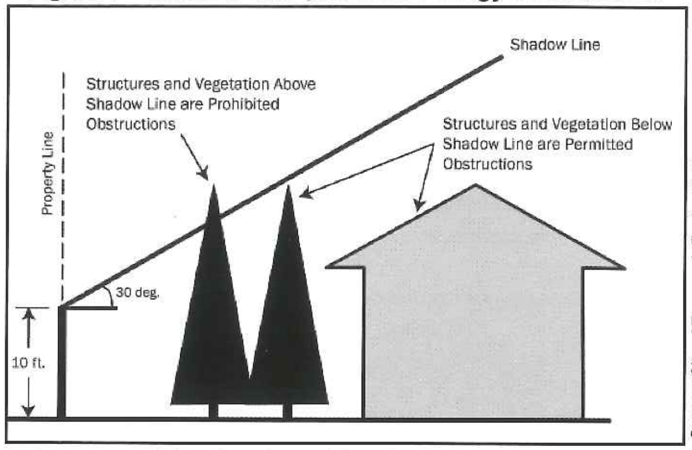
Standards and conditions for principal and accessory solar installations are detailed in zoning ordinances and can also be added into other guidance or policy documents. These can include the site plan review process, subdivision regulations, building codes (where applicable), inspection procedures and expedited permitting processes. There are many considerations when it comes to permitting solar installations that should be addressed in a zoning ordinance including setbacks, solar access and historic considerations.

Solar installation setbacks are meant to maximize solar energy input. In Figure 5 above, taken from Grosse Ile Township, MI, setback calculations will minimize solar panel interactions with shadows cast by nearby structures. The slope of the panels, angle of the sun and size of the property must all be taken into account.

Solar glare is when sunlight is reflected back from the panels onto neighboring structures, roadways or properties. The City of Dundee addresses solar glare in their zoning ordinance by requiring a study that proves glare will not be projected in a way that impacts neighboring properties.

An ordinance must also address access to solar energy, through limiting activities, land uses, structures, and or/tree growth that interfere with access to sunlight. In Figure 6 above taken from the City of Tecumseh's Zoning Ordinance, a 30-degree 'shadow line' is shown from a point ten feet above the property line. Any structures or landscaping below the shadow line do not pose a problem to the solar system on the neighboring property (to the left in the image). Any obstructions above the shadow line will cast a shadow on the neighboring solar system at certain times of the year and day. In some communities, like Tecumseh, once a solar system is installed, the owner is granted a solar access right and neighboring properties are prohibited from obstructing the solar system's access to sunlight. In other words, a neighbor to a solar energy system may not be able to add on to their home or allow their trees to grow beyond the shadow line. An alternative arrangement is to require a property owner interested in installing a solar energy system to obtain a solar access easement from one or more neighboring property owners in order to protect their access to sunlight indefinitely. Solar access easements, as those used in by the City of Milan, MI can be required as a way to protect access to the 'solar skyscape.'

**Figure 6 – Shadow Line and Solar Energy Obstructions**




Source: City of Tecumseh Zoning Ordinance

In communities that have historic districts, solar installations may have to undergo review by the historic district commission for consistency with specific criteria that respects the look and character of the historic structure. Due to the technology available in solar panel design, sizes and types of materials, solar energy systems can be small and inconspicuous. Panels can also be shaped to follow unique rooflines. For more examples, the City of Ypsilanti Historic Preservation Program and the City of Grand Rapids *Guidelines for Historic Districts* each offer example language for addressing visibility, design, replacement, installation and de-installation of solar panels on historic properties.

For ground-mounted small scale installations or large utility-scale and community solar installations, there are basic ordinance requirements that can proactively avoid future issues worth mentioning here. These requirements include a decommissioning plan, compliance with all local, state and federal permitting, compliance with electrical and building codes, performance guarantees, fencing, native plantings under the installations which will help meet low-impact development goals, appropriate height restrictions and a waiver for lot coverage. There are many resources at the end of this article that provide specific ordinance guidelines related to these topics.

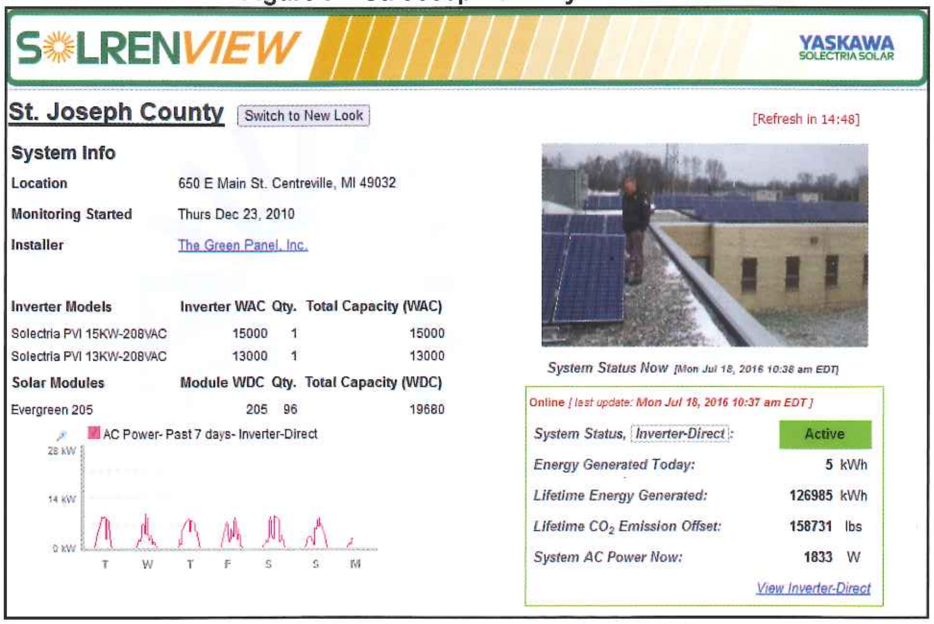
## Solar Power Planning in Action

Solar power installations across Michigan are the result of an interest by public and private investors in renewable energy. Very often as a result of this interest, large utility-scale and community solar arrays were proposed to local governments that were not prepared to review or even understand what the impacts would be to their communities. As time has passed communities are educating themselves, updating their master plans and aligning their zoning ordinances in order to address and promote solar. To date, there are many unique plans and programs being developed across Michigan. A few examples are outlined here.

A Capital Improvements Program (CIP), also often referred to as a 'capital improvement plan', can play a critical role in promoting solar. A CIP is a valuable financial planning tool for local governments that focuses on large investments or purchases, usually over a 6 year span. When it comes to budgeting for a more efficient and renewable energy system, solar can play a large role. The Michigan Planning Enabling Act authorizes the creation of CIPs, and it is one way a public entity can plan for investing in its own solar installations. In Figure 7 on the next page, St. Joseph County provides an online CIP that details its municipal solar investment plan.

A Climate Action Plan is another tool for promoting solar investment. According to the Institute for Local Government, a climate action plan is a comprehensive roadmap that outlines specific actions a government will take to reduce greenhouse gas emissions. Solar investment is one element of a climate action plan. The City

Figure 7 – St. Joseph County Solar CIP




of Ypsilanti's Climate Action Plan includes a goal of 1,000 solar roofs or 5 MW installed by 2020. In 2017, Ypsilanti established a 'Sustainability Commission' to implement the goals of the Climate Action Plan. Many other jurisdictions across Michigan have climate action plans that address renewable energy goals.

An Energy Performance Contract, based on Michigan's Tax-Exempt Lease Purchase program (TELP), is a tool that is becoming more common. Under TELP, energy efficiency projects are paid for with tax-exempt borrowing that is not considered long-term debt. The financing is paid off over time with the avoided energy costs. As an example, the City of Marquette entered into a $28 million contract with Johnson Controls to install HVAC upgrades, energy use upgrades and renewable energy installations such as geothermal and solar. The 20-year agreement will save the city $42 million once all the upgrades are installed. Once a project or projects are installed, Johnson Controls provides a performance guarantee amount based on annual energy savings.

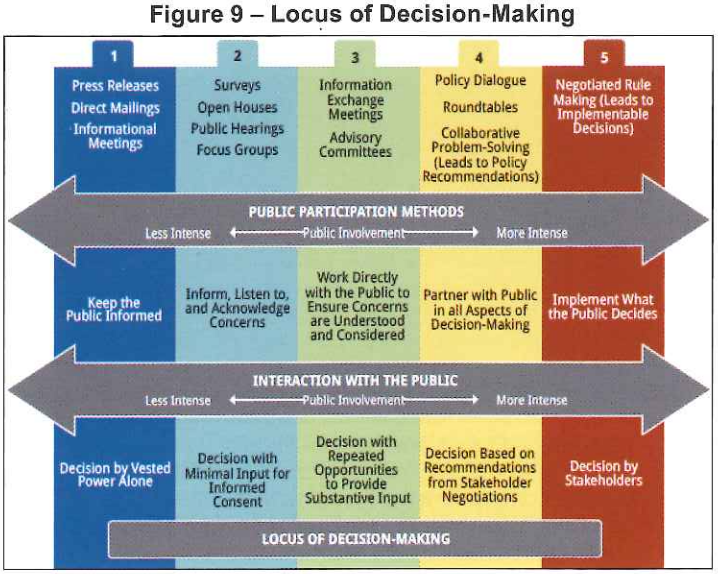
### Starting a Community Conversation around Solar

Solar power is a growing planning and zoning topic. As with any unique land use, solar comes with its own community impacts and benefits. Community leaders, residents, industry professionals, and utility representatives each have their own understanding and assumptions about solar installations, large and small. An important aspect of planning and zoning for solar stems from public conversations about it. What can a community do to not only educate itself about solar, but to also invite stakeholders to the table for a healthy dialogue? Brad Neumann, a senior government and public policy educator at MSU Extension, developed *A Sample Planning Process for Solar Energy* to shed light on possible answers to that question. The process is depicted in Figure 8 on page 13.

This process is a clear pathway for local government officials and staff who are prioritizing solar energy development in their community. First, the planning commission prepares a Notice of Intent to Plan (NOI), and it convenes an advisory committee. It is at this early stage of creating a committee where the community conversation should be strengthened with a diverse team of stakeholders from across public, non-profit, academic and private sectors. The process continues with recommended data collection and research techniques, followed by planning and zoning determinations and finally, the preparation of a draft plan and public workshops.

It is critical to engage people with differing perspectives throughout the entire process. Of those stakeholders listed in the process flow chart above, who else in your community should be invited to the table? The solar advisory committee and the planning commission need to fairly listen to all sides of the solar issue. To hear all sides of the solar issue, the community conversation needs to be more intense than hosting one or two public hearings. As shown in Figure 9 below, as one moves from left to right, the public engagement activities become more intensive. When shaping a community conversation around solar, it is recommended that the public be deeply engaged through techniques such as those detailed in columns three or four and this can happen with the greatest success if the local planning commission and solar advisory committee partner with the public every step of the way.

Figure 9 – Locus of Decision-Making




Smutko, Perrin, Beggs, & North Carolina Cooperative Extension Service, 2004

### Acknowledgements and Additional Resources

This article's content is based on the research, time and effort of an entire team of educators, specialists and industry leaders convened in 2017, including:

- Wayne Beyea, J.D. AICP, MSU Senior MSU Extension Specialist
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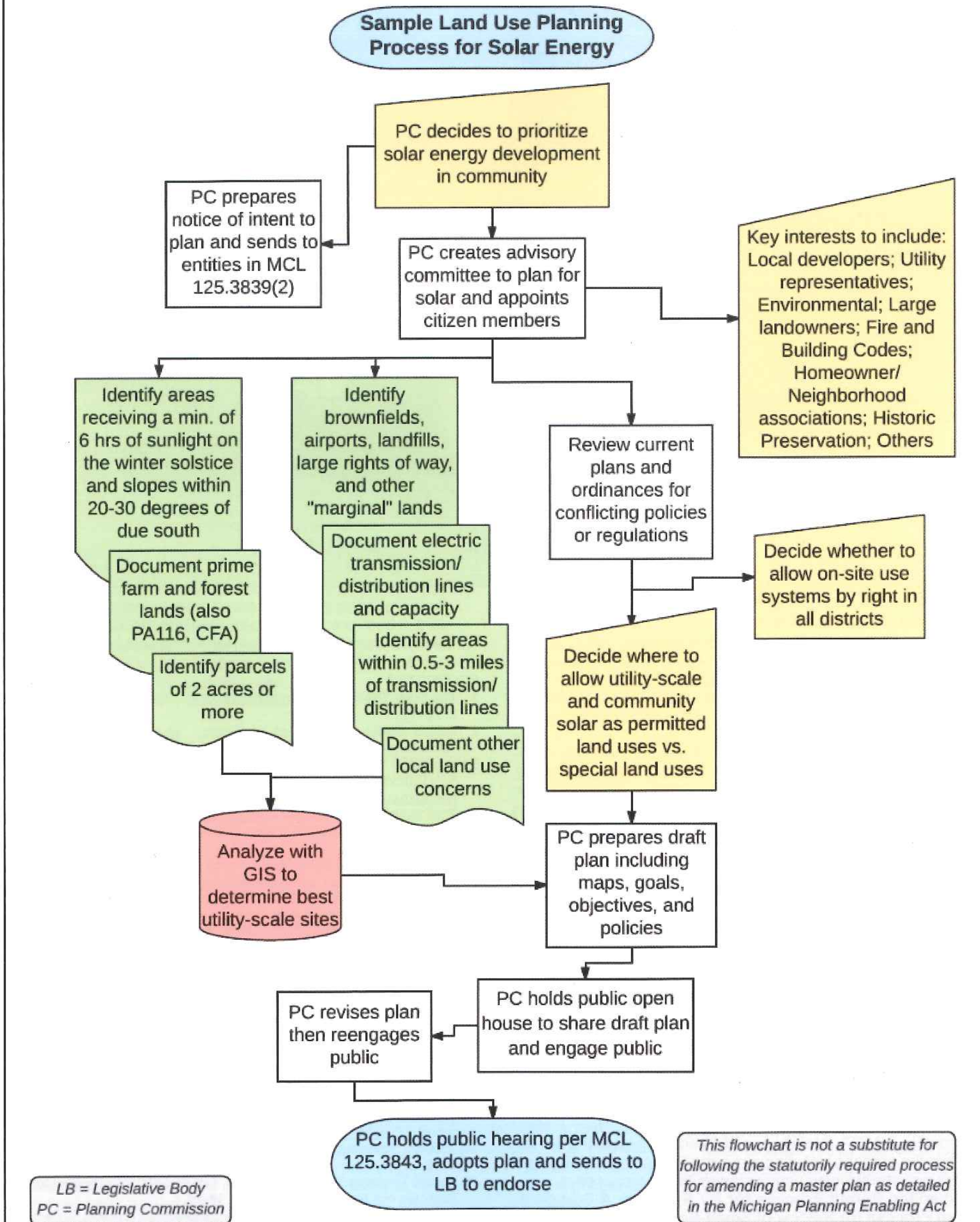
- John Kinch, Ph.D., Executive Director of Michigan Energy Options
- Sean Campbell, Planning Research Assistant at the MSU School of Planning, Design and Construction.
- Michael Larson, MPA, Upper Peninsula Operations Manager at Michigan Energy Options

For additional resources, please visit the following:

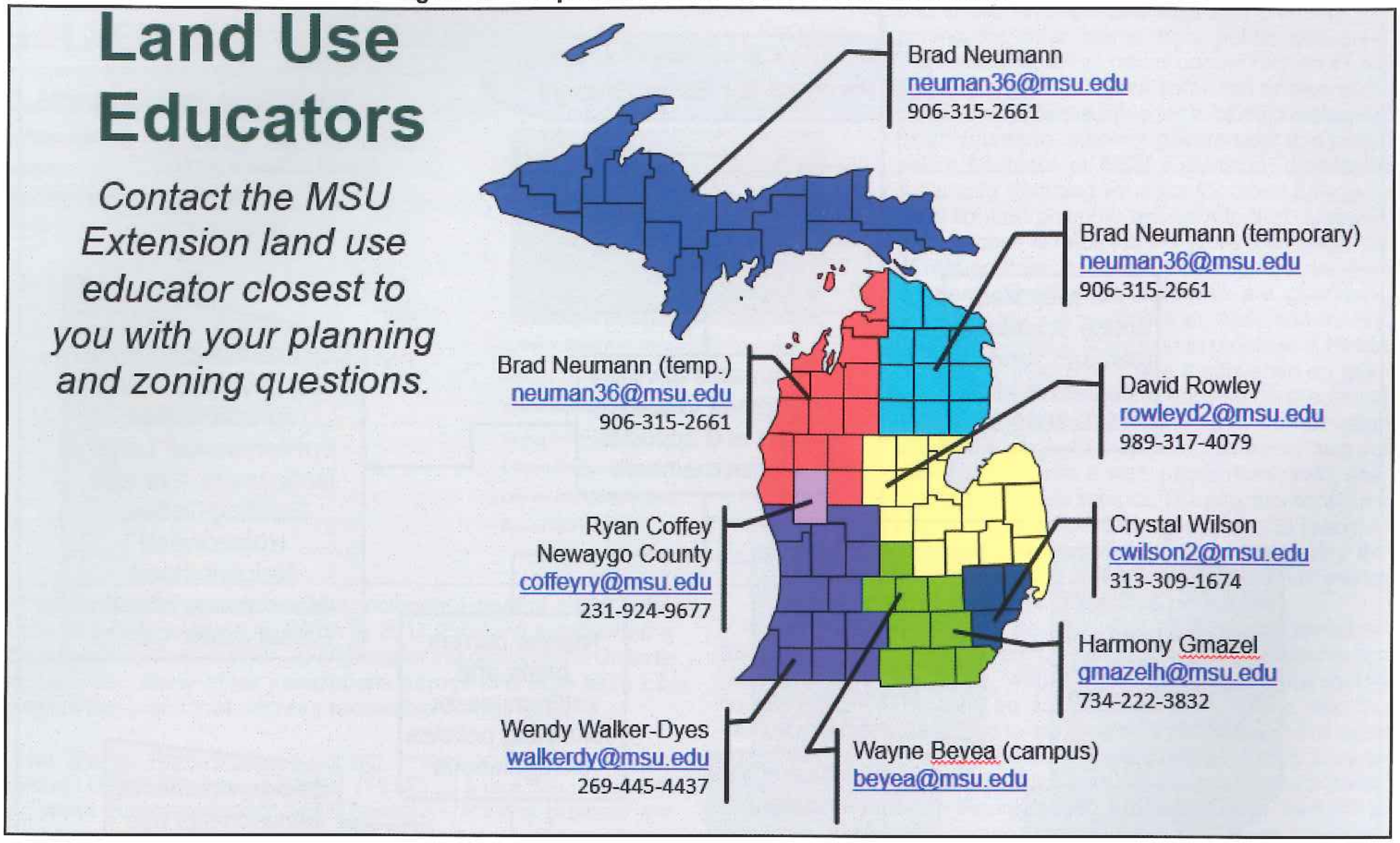
- **Becoming a Solar-Ready Community: A Guide for Michigan Local Governments**. Sept. 2013. *Clean Energy Coalition.* http://cec-mi.org/wp-content/uploads/2013/09/Guide-Book_Solar_FINAL_web.pdf
- **A Guidebook for Community Solar Programs in Michigan Communities**. Feb. 2014. *Great Lakes Renewable Energy Association.* https://www.michigan.gov/documents/mdcd/Michigan_Community_Solar_Guidebook_437888_7.pdf
- **White Paper: Market Barriers to Solar in Michigan**. Jan. 2012. *National Renewable Energy Laboratory.* http://www.michigan.gov/documents/mpsc/marketbarrierssolar-inmi_394662_7.pdf
- **Advancing Solar: Great Lakes Bay Region**. Oct. 2012. *Clean Energy Coalition.* http://cec-mi.org/wp-content/uploads/2014/02/GLBR-Final-Report-FINAL-2-2014-edit.pdf

**Figure 8 – Sample Planning Process for Solar Energy**




*This flowchart provided as a supplemental handout for the MSU Extension 'Planning & Zoning for Solar in Michigan: A Primer for Local Government' program*

**Figure 10 – Map of MSU Extension Land Use Educators**




- **Best Practices for Siting Solar Photovoltaics on Municipal Solid Waste Landfills.** *Environmental Protection Agency; National Renewable Energy Laboratory.* Feb. 2013. https://www.epa.gov/sites/production/files/2015-03/documents/best_practices_siting_solar_photovoltaic_final.pdf
- **Implementing Solar PV Projects on Historic Buildings and in Historic Districts**. Sept. 2011. *NREL*. https://www.nrel.gov/docs/fy11osti/51297.pdf
- **Planning for Solar Energy**. 2014. *American Planning Association* Planning Advisory Service Report 575. https://www.planning.org/publications/report/9117592/
- **Planning and Zoning for Solar Energy**. 2014. *American Planning Association* Essential Info Packet 30. https://planning-org-uploaded-media.s3.amazonaws.com/document/product_EIP_E_IP30.pdf
- **Emerging Approaches to Efficient Rooftop Solar Permitting**. May 2012. *Interstate Renewable Energy Council.* Summarizes general steps in the permitting process and gives examples of cities/counties/states widely cited as having the best model in each step.
- **Solar Electric Permit Fees in Northern California: A Comparative Study**. July 2011. Loma Prieta Chapter, Sierra Club. Makes permitting reform recommendations including: flat permit fees, not valuation based, standardizing permitting requirements across jurisdictions, and fast-track application for solar installers
- **Taking the Red Tape Out of Green Power** (Sept. 2008); **Freeing the Grid: Best and Worst Practices in Interconnection Standards** (2011 ed.). *Network for New Energy Choices (NNEC).* Makes specific recommendations to improve the process including removing PV zoning/building barriers and streamlining approval/permitting processes
- **Expedited Permit Process for PV Systems: A Standardized Process for Review of Small-Scale PV Systems**. Oct. 2011. *Solar ABCs* (Solar America Board for Codes & Standards). Detailed technical report outlines an expedited permitting process, including sample electronic permitting forms that can be used and/or customized by a jurisdiction. It is widely cited in best-practices reports (SunRun, IREC) as the starting place for standardizing solar permitting across the U.S.

**FOOTNOTES**

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16. Howell Township Zoning Ordinance, *Onsite Solar Energy Systems and Solar Energy Farms.* Art. XVI, Sec. 16-19. ❑