

Solar Energy at MnDOT

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Summary

The Minnesota Department of Transportation (MnDOT) is pursuing solar energy development on our property and through community solar garden subscriptions to reduce greenhouse gas (GHG) emissions from agency operations, meet agency energy needs, reduce long-term operational costs, support operational cost planning, and improve agency resilience. Expanding our use of solar energy is critical to meeting renewable energy targets in the MnDOT Sustainability Report and Executive Order 17-12.

This document describes past, present, and future MnDOT solar projects and guiding principles for this effort.

This document will evolve over time. Please check the MnDOT Sustainability [website](#) to ensure you have the most current version.

Background and Overview

The State of Minnesota has substantial solar energy potential (Figure 1) and solar energy development grew rapidly in recent years. Minnesota added enough solar panels in 2017 to power about 53,000 homes, and strong growth is expected to continue in 2018. Overall, Minnesota has more than [700 megawatts](#) of solar capacity installed. The growing market is lowering solar energy costs. Between 2011 and 2017, commercial solar photovoltaic (PV) prices dropped 15 percent to [\\$1.85 per watt](#). Solar PV prices in Minnesota have similarly declined.

MnDOT plans to leverage the growing solar energy market and competitive prices. While emissions reductions targets for our agency operations are driving the effort, solar energy has other tangible benefits. Solar energy will help meet agency energy needs, reduce long-term operational costs, support operational cost planning, and improve agency resilience.

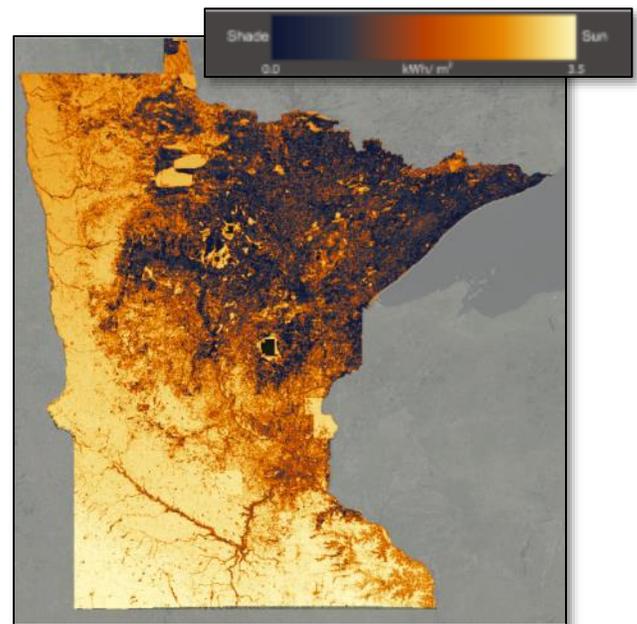


Figure 1: MN Solar Suitability Analysis App

- Solar energy costs are dropping rapidly and some existing programs offer guaranteed cost savings over conventional electricity purchases.
- The typical 25-year term for a solar energy contract will also help MnDOT budget planning by providing a known cost of energy instead of being subject to fluctuations in electricity prices.
- Solar energy can help MnDOT meet our targets to reduce facility energy use by 20% from 2008 levels by 2025.
- Solar energy has the potential to improve service reliability, especially when paired with energy storage.

MnDOT actively pursues cost-effective energy efficiency measures, but has limited experience installing solar on MnDOT property or purchasing solar subscriptions or credits. In 2019, MnDOT plans to pursue at least four solar projects, all of which have unique characteristics that will inform future solar energy projects.

The MnDOT Sustainable Transportation Steering Committee (STSC), an internal leadership group provides leadership, strategic direction and oversight for sustainability activities. The MnDOT Sustainability Office leads implementation with support from the internal “Solar Team” that includes representative from Metro Maintenance and Operations, Office of Land Management, Partnerships Program, Office of Chief Counsel, and Office of Maintenance¹.

Target Setting

In 2017, MnDOT published the [2017 MnDOT Sustainability Report](#) outlining the agency’s sustainability efforts and performance targets. MnDOT set a target for 25% of agency energy to come from renewable sources by 2025. In 2016, about 0.3% of all MnDOT energy for electricity and heat came from renewable sources. That means that an annual increase of 2.5% percentage points is needed to achieve the 2025 target.

On November 21, 2017, Governor Mark Dayton issued [Executive Order \(EO\) 17-12](#) to improve energy efficiency, reduce water usage and enhance sustainable purchasing processes and directs state agencies to reduce greenhouse gas emissions by 30% in 2025, from a 2005 baseline, and energy consumption per square foot by 30% in 2027, from a 2017 baseline.

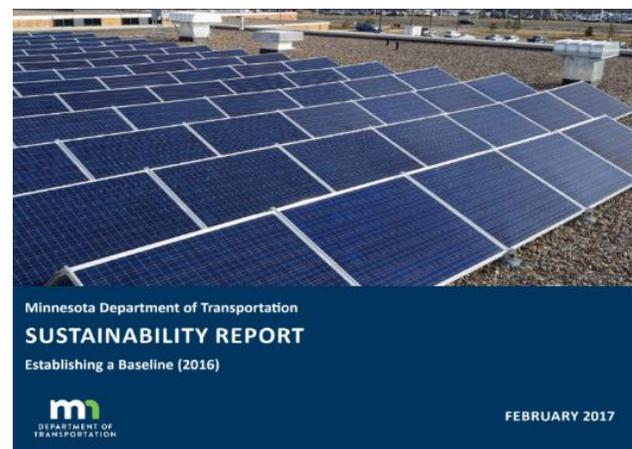


Figure 2: 2017 MnDOT Sustainability Report

¹ MnDOT Solar Team: Bryan Dodds, Ryan Gaulke, Mark Moehlenbrock, Jessica Oh, Joe Pignato, Tim Sexton, Siri Simons, and Adam Smith

Both the agency and EO targets are ambitious but achievable. For this action plan, MnDOT will focus on our agency target as the performance measure, which also supports targets in EO 17-12.

Guiding Principles

MnDOT is still developing experience in solar projects and identified the following guiding principles to frame the effort, encourage consistency with the broader MnDOT Vision and Mission, and support sustainability goals outlined in the annual MnDOT Sustainability Report. The following principles will evolve as more experience and input is received.

- Solar projects should generally be cost-neutral or save money for the agency.
- MnDOT may pursue solar projects with higher costs if the project supports our broader agency Vision (e.g., support access to renewable energy by low-income residents).
- Solar projects should support agency goals around equity and diversity in contracting.
- Renewable energy credits have monetary value to utilities but not to the state, so the credits will generally not be pursued at this time.
- MnDOT solar projects should offset as much annual average energy load as possible, while minimizing excess energy returned to the grid. We do not want to become net energy producers.
- All new building projects and roof upgrades should evaluate the potential to install cost effective solar.

Past Experience with Solar

- 2010:** MnDOT and the Minnesota Department of Natural Resources (DNR) partnered to construct the Grand Portage Visitor Center in MnDOT District 1 near the Canadian border. The project included ground mounted 7.4kW array solar panels by the truck parking lot. The array consists of 32 panels mounted in landscape orientation 8' wide by 4' high with a ground footprint 45' x 12'.
- Goal: Reduce annual energy consumption.
 - Outcome: \$920 annual energy savings, 7.3 metric tons of annual CO₂ prevented and 98,803 pounds of CO₂ saved to date.
- 2013:** MnDOT and DNR partnered to reconstruct the Tettegouche Visitor Center in MnDOT District 1. The project included a ground mounted 24.3 kW solar panel array near the visitor center.
- Goal: Reduce annual energy consumption.
 - Outcome: \$3,200 annual energy savings, 25.3 metric tons of annual CO₂ prevented and 233,097 pounds of CO₂ saved to date.
- 2014:** MnDOT released a request for proposal for ground-mounted solar installation and lease.
- Goal: Lease one or more sites to 1) demonstrate the feasibility of using MnDOT right-of-way for solar power generation; and 2) develop criteria for selecting and using right-of-way for 1 MW or greater solar arrays.
 - Outcome: 13 potential sites narrowed down to one site in Greater Minnesota, the selected firm was unable to secure financing and the project did not advance.

2016: Rochester HQ - MnDOT constructed a 40 kW solar array during construction of the new MnDOT District 6 Headquarters building in Rochester (pictured in Figure 2). The array is wholly owned and operated by MnDOT.

High Solar Potential Sites - MnDOT hired a consultant to conduct a solar feasibility assessment of MnDOT properties.

- Goal: Identify highest potential sites for solar to help us prioritize resources for solar development.
- Outcome: 350 sites narrowed to 10 rooftop sites based on utility connections, peak energy demands, available space, facility energy needs, and expected energy generation potential. The analysis helped inform future solar project development.

Pilot Projects – Community Solar Gardens

The efforts described below cover a range of variables associated with community solar gardens (CSG), including ground mounting, rooftop mounting, rooftop carport mounting, third-party financing, joint-procurement and MnDOT RFP; for-profit and nonprofit developers; and evaluating cost and availability of renewable energy credits.

In 2013, Minnesota legislation directed Xcel Energy to create a CSG program regulated by the Public Utility Commission. CSGs allow individuals, businesses, and government agencies to purchase solar energy that is produced in their same or adjacent county, but does not require the solar array to be installed on their property and requires no upfront cost to install the equipment. Instead, subscribers agree to a certain contract length, typically 25 years, and receive bill credits for the energy produced. Solar gardens must have a minimum of five subscribers with no single entity subscribing to receive more than 40% of the energy produced. Renewable energy credits are retained by the servicing utility.

Ramp A, Minneapolis

ABC Parking Ramps are owned by MnDOT and managed by the City of Minneapolis. MnDOT finalized an agreement with Cooperative Energy Futures (CEF) for a CSG on Ramp A in downtown Minneapolis. CEF is a cooperative, commits to workforce targets for underrepresented populations, and markets subscriptions to lower income residential energy customers, all of which align with MnDOT equity goals. The elevated solar panels would function like a carport above the parked cars. Having a flexible backup subscriber allows CEF to promote their mission while recognizing that their subscription base may be dynamic and there may be periods with lower numbers of residential subscribers.

MnDOT agreed to lease the overhead space on the top deck of Ramp A and to be a backup subscriber for 20% - 40% of the total subscriptions for 25 years. Bill credits will offset MnDOT Metro District meters for lighting on I-394 in Hennepin County.

MnDOT expects to learn valuable lessons from the project. It will be the first CSG subscription for MnDOT, the first CSG installed on MnDOT property, the first elevated CSG installed on a multi-story parking structure in Minnesota, and our first CSG partnership with a mission driven organization.

- November 2018 – construction is scheduled to begin in spring 2019



Figure 3: Design Visualization of CSG canopy on Ramp A

Faribault

This is a ground mounted array on non-MnDOT property. MnDOT finalized a 25-year agreement with CEF to be a backup subscriber for 10% - 40% (131 kW – 524 kW) of total subscriptions at this ground mounted site. The bill credits will offset lighting from MnDOT Metro District meters in Dakota County.

There will be some shared learning from the ABC ramps and new lessons learned as a backup subscriber for a lower cost ground mounted array on non-MnDOT owned property.

- October 2018 – MnDOT and CEF signed subscription agreement. Construction scheduled to begin in spring 2019

I-94 Gravel Pit (Afton vicinity)

MnDOT is working with a solar developer to construct one to three 1 MW community solar garden(s) on MnDOT property, a former gravel pit site south of I-94, near the city of Afton. MnDOT would receive lease payments and be eligible to subscribe to up to 40% of the total subscriptions for energy produced at the site. The project has been in development since 2016.

This will be the first ground-mounted CSG project on MnDOT-owned property. A number of lessons have already been learned about solar development such as local coordination, and internal coordination at MnDOT about solar development on MnDOT right-of-way.

- November 2018 - coordination continues with the goal to have a signed lease and subscription agreement before January 31, 2019.

MnDOT Solar Projects

MnDOT is also pursuing solar projects where we contract directly to install solar on MnDOT property and use all the energy produced to offset MnDOT energy costs. Our focus is on third-party financed projects where the developer manages the capital investment and long-term maintenance. This eliminates the need for MnDOT to make a capital investment, allows the agency to leverage private industry solar maintenance and operations experience, and allows a private entity to maximize renewable energy tax credits unavailable to a government agency.

Fort Snelling/Central Shop

MnDOT wants to offset as much of the site's average monthly demand (70-145 kW) as possible with solar, without producing excess energy. This will be the first solar RFP issued by MnDOT.

- November 2018 - MnDOT released RFP in November and received proposals on December 20, 2018.

Solar Possible

The Minnesota Department of Administration and the nonprofit Great Plains Institute facilitated a collaborative solar procurement process for state and local agencies. MnDOT submitted three sites for the joint site-specific RFP and received proposals from pre-qualified vendors with direct ownership and third-party financed cost estimates. There was no commitment to participate or respond to the selected vendors. MnDOT submitted ground mounted sites at St. Cloud headquarters (D3) and Waters Edge (Metro) and rooftop solar for the Mankato headquarters (D7).

November 2018 - The Department of Administration recommended different vendors for each of the three MnDOT sites. We are refining the details with the vendors and coordinating internally to address outstanding questions before moving forward to contracting for any of the sites.

Maplewood Lab

MnDOT is exploring opportunities for solar energy to offset a portion of the energy for one of MnDOT's highest energy consuming sites. Initial scoping suggests that portions of the roof may be new enough to support placement of solar panels for a 25-year duration, which could offset an estimated 25% of the total building energy use.

- November 2018 – early conversations and a site visit occurred and the hope is to have a draft RFP for solar on the site within the next 60 days.

Solar Site and Energy Potential

Building or Site	Estimated Module Size (kW)	Status	Project Type
I-94 Gravel Pit	714 kW – 1.428 MW	In review	CSG + lease, ground mount
ABC Ramps	274 -578 kW	Under contract	CSG backup subscriber + lease, elevated rooftop
Faribault	131 kW – 524 kW	Under contract	CSG backup subscriber, ground mount
Mankato HQ	400 kW	In review	PPA, ground-mount
Fort Snelling	300 kW	RFP released	PPA, rooftop
Waters Edge	240 kW	In review	PPA, ground-mount
St. Cloud HQ	120 kW	In review	lease-to-own, ground-mount
Rochester HQ	40 kW	Complete	Direct ownership, rooftop
Tettegouche rest area	24.3 kW	Complete	Direct ownership, ground mount
Grand Portage rest area	7.4 kW	Complete	Direct ownership, ground mount
Total	2.25 MW – 3.66 MW		

MnDOT Solar Program – Next Steps

For the projects described previously, MnDOT expects to have executed contracts, or will have decided not to move forward, by spring 2019.

MnDOT is also exploring additional opportunities to participate in CSGs statewide or purchase renewable energy credits through utility programs.

As stated previously, we are currently at approximately 0.3% of energy being renewable, which is a long way from our 2025 target of 25%. This document focuses on solar energy but we recognize a broader approach to renewable energy may also include wind, geothermal, and energy efficiency. Efficiency improvements (e.g., lighting conversion, temperature set-points) reduce amount of renewable energy needed to meet agency energy needs. MnDOT will develop a draft Renewable Energy action plan by May 1, 2019, with specific agency recommendations to achieve our 2025 target.

Attachment A: Financing Options

Third-Party Ownership

Power Purchase Agreement (Fixed or Escalator)

A power purchase agreement (PPA) is a long-term contract to buy power from a project developer at a negotiated rate (\$/kWh) without taking ownership of the system. A PPA is between two or three parties: the developer, the recipient or customer, and an investor. The developer procures, builds, and operates the system, and can either invest tax equity into the project themselves or sell the system to a tax equity investor. The investor monetizes the tax incentives and leases the project to the developer, who passes on the savings to the customer in the form of lower electricity prices.

Advantages of Third-Party Ownership

- No upfront cost
- Lower cost of electricity for 15-25 yrs.
- Not responsible for O&M
- Allows tax-exempt entity to benefit from federal tax incentives
- PPA only – Because rate is based on power produced, payments will decrease if panels are not working

The PPA specifies the annual escalator, or annual price increase of electricity, which is often 20%-30% less than the price of electricity. The rate typically escalates at a fixed percentage (2-5%) per year. As an alternative, a fixed rate for the entire length of the contract can be negotiated. While the rate for a fixed PPA may be lower than an escalating PPA, the additional cost of buying the solar system is significantly reduced or avoided with an escalating PPA.

Lease

Solar PPAs and solar leasing are very similar in practice. However, a solar lease agreement sets a monthly rate for “rent” based on the amount of electricity a system will produce, while a PPA sets a monthly rate for power generated by the system at a per-kWh price. In a lease purchase model, the agency is responsible for the system at the end of the lease, including operation and maintenance.

Direct Ownership

MnDOT also has the option to directly purchase the solar array. Under this scenario, MnDOT can choose to enroll in a bill credit program to receive compensation for excess electricity generated. An agency can also retain ownership of the Renewable Energy Credits (RECs) – tradable, nontangible energy commodities – that its project generates. Under a direct purchase scenario, operations and maintenance can be handled by the developer, for a fee, or remain under MnDOT control. MnDOT will be responsible for removing the system at the end of its life.

Direct Ownership

- Direct control over assets
- Retain Renewable Energy Certificates, which allow MnDOT to legally get “credit” for renewable energy

Cost Comparison

A preliminary estimate finds a PPA to be a more cost-effective model for financing solar arrays at MnDOT, compared direct ownership (Table 1). This is only an estimate and is based on several assumptions, such as a \$.074 electricity rate, 3% utility escalation rate, and PPA rate that is 80% of the electricity rate (For additional assumptions, see Table 2). The RFP process will provide a clearer financial model cost comparison. Lease-Purchase is included for scholarly reasons but there is very limited experience with this model in the marketplace and the only known examples are relatively small sites. It should be investigated further, potentially included as an option in an RFP, but its scalability for a larger application is unknown.

Table 1: Cumulative Advantage or Disadvantage over 25 Years per kWh

Year	Lease-Purchase	20-Year PPA (Fixed)	20-Year PPA (Escalator)	Direct Ownership
1	\$10	\$18	\$18	-(\$2,875)
5	\$47	\$110	\$91	-(\$2,479)
10	\$90	\$255	\$179	-(\$2,232)
15	\$300	\$424	\$263	-(\$1,834)
20	\$603	\$478	\$399	-(\$1,633)
25	\$886	\$812	\$733	-(\$1,310)
30	\$1,149	\$1,123	\$1,044	-(\$1,018)

Table 2: Model Assumptions

Proposal Type	Lease-Purchase	20-Year PPA (Fixed)	Direct Ownership	20-Year PPA (Escalator)
System Size (kW DC)	40	601	250	601
Expected Year 1 Production (kWh)	47,000	750,000	305,000	750,000
Starting Rate (\$/kWh)	\$0.0592	\$0.0592	\$0.0000	\$0.0592
Rate Escalation	3.00%	0.00%	3.00%	2.80%
Term (yrs)	12	20	30	19

Attachment B: Potential Solar Site Selection

Using the 10 sites identified in the 2016 Solar Feasibility Assessment, the solar team conducted additional suitability analysis based on roof age and peak energy demand levels.

Site	Avg. Feasibility Score*	System Size, Generation	Finding
Fort Snelling Office	High	250 kW, 375 MWh	Suitable roof
Plymouth Truck Station	High	170 kW, 272 MWh	Low peak demand (30kW)
District 3A HQ	Medium	210 kW, 320 MWh	Not eligible for Solar Possible
West Metro HQ	Medium	290 kW, 429 MWh	Old roof (10 years)
Maryland Ave Truck Station	Medium	200 kW, 300 MWh	Low peak demand
Richfield Truck Station	Medium	270 kW, 403 MWh	Low peak demand
District 3B HQ	Medium	320 kW, 479 MWh	Suitable ground mount
Eden Prairie Truck Station	Low	60 kW, 90 MWh	Low peak demand
Bridge Office	Low	300 kW, 446 MWh	Old roof (19/12 years)
Spring Lake Park Truck Station	Low	100 kW, 153 MWh	Low peak demand

**The Average Feasibility score was developed for MnDOT's solar feasibility assessment. The score is based on an average of the following criteria: energy potential, electrical equipment capacity, quality of roof (type and age), and constructability.*

The team also identified Mankato Headquarters as a potential site for a rooftop solar array based on the relatively new roof and the Waters Edge facility as a potential site for a ground-mounted solar array based on the available right-of-way and high energy intensity use of the building.