

Solar Energy at MnDOT

This document is subject to frequent changes. Please check the MnDOT Sustainability website for most current version.

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 19-27.

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.

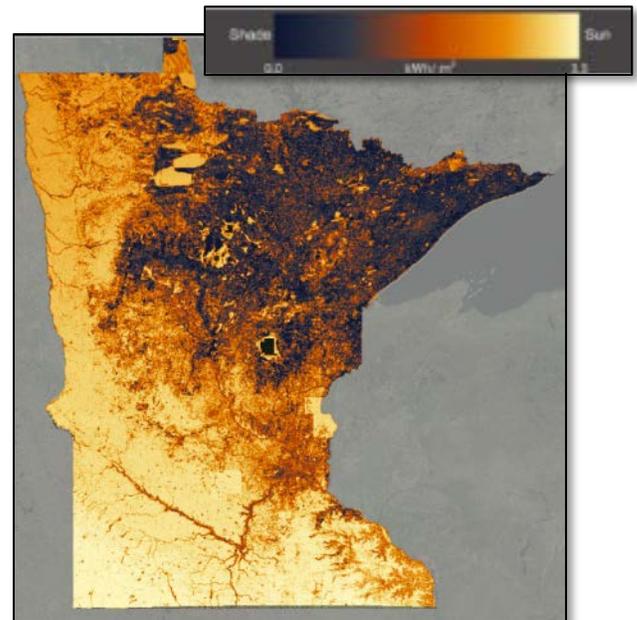


Figure 1: MN Solar Suitability Analysis App

- 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 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.

The MnDOT Sustainable Transportation Steering Committee (STSC), an internal leadership group provides leadership, strategic direction and oversight for sustainability activities. The MnDOT Office of Sustainability and Public Health leads implementation with support from Metro Maintenance and Operations, Office of Land Management, Partnerships Program, Office of Chief Counsel, and Office of Maintenance.

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 2020, the agency expanded the renewable energy target language as follows: "renewable energy subscribed to or used by MnDOT".

On November 21, 2017, then-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. [EO 19-27](#) is the related Walz-Flanagan administration directive.

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 19-27.

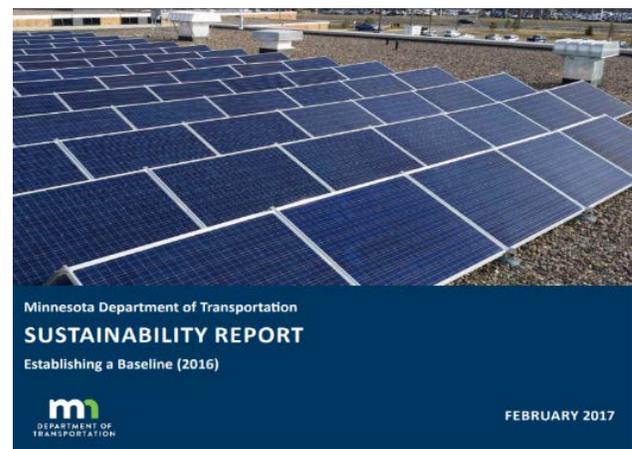


Figure 2: 2017 MnDOT Sustainability Report

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 (RECs) can help MnDOT meet agency sustainability goals for renewable energy and greenhouse gas emissions reductions. When RECs are available for a solar project, cost estimates should be calculated with and without RECs. Decisions about purchasing RECs or replacement RECs for solar projects should be made by weighing the cost of the RECs against potential GHG emissions reductions and the financial viability of the project. Solar projects without RECs advance MnDOT's internal renewable energy goal and the spirit of Executive Order 19-27, while solar projects with RECs make progress toward the GHG emissions reduction goal in Executive Order 19-27.
- 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.
- When MnDOT receives unsolicited solar proposals for the Right-of-Way, staff may gather additional information to explore new ideas. Once a potential project is identified, the agency may explore posting a competitive solicitation.

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. This is MnDOT's first solar project in agency right-of-way and first solar garden subscription. The solar garden uses 3,760 panels and is expected to produce 1.4 MWh of electricity each year. The elevated solar panels function like a carport above the parked cars and cover more than half the parking spaces on the top deck of Ramp A. No parking spaces were lost during construction.

CEF is a cooperative, commits to workforce targets for underrepresented populations, and markets subscriptions to lower income residential energy customers¹, all of which align with MnDOT equity goals. 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.



Ramp A in downtown Minneapolis

MnDOT is leasing the overhead space on the top deck of Ramp A and is a backup subscriber for 20% - 40% of the total subscriptions for 25 years. Bill credits will offset MnDOT Metro District electricity costs 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

The project was completed in October 2019.²

“MnDOT is always looking for new and innovative ways to be efficient with our agency’s resources and improve the environment,” said MnDOT Commissioner Margaret Anderson Kelliher. “Creating a community solar garden not only reduces carbon emissions, it also supports our economy by reducing the energy costs of home owners, businesses and our agency.”

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.

¹ 80% of subscriptions sold to residential households, including low- to moderate-income residents in affordable housing.

² tinyurl.com/ramp-a-media

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 began 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 will receive lease payments and subscribe 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 related to coordination with local government and internal coordination about solar development on MnDOT right-of-way.

- March 2019 – MnDOT executed a lease with a solar developer which allows them to enter into an interconnection agreement with Xcel Energy.
- Spring 2020 – Construction began

Community Solar Garden Subscriptions

MnDOT issued an RFP in spring 2019 to purchase community solar garden subscriptions to offset energy use for facilities within and adjacent to counties in Xcel territory. MnDOT was only looking for subscriptions through the value-of-solar program that guarantees costs savings for the subscriber.

In October 2019, MnDOT finalized contracts with two solar companies for 25-year agreements to purchase CSG 7.4 million kWh annually from community solar gardens located throughout Minnesota. This is equivalent to approximately 24% of the agency's total annual electricity use. MnDOT did not elect to purchase renewable energy credits (RECs) with the subscriptions because the cost of RECs would have eliminated most/all of the cost savings from CSG subscriptions. Therefore, we cannot state that this energy is "renewable" and it does not move the agency towards our renewable energy goals.

The agency will subscribe to 14 CSGs owned by US Solar and 9 CSGs owned by Nokomis Partners. The subscriptions are estimated to save MnDOT over \$7,000,000 through bill credits for agency facilities and operations in 18 counties spread across 6 MnDOT Districts.

The first solar gardens are expected to come online by early 2020 and the final gardens are expected to be constructed by 2022.

MnDOT Solar Projects

MnDOT pursued three solar projects in the winter of 2018-2019 to directly to install solar on MnDOT property and use all the energy produced to offset MnDOT energy costs. Our focus was 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. MnDOT issued our first solar RFP in fall 2018 that was left open to any financing model, including direct ownership.

- January 2019 - MnDOT received one proposal, which was for direct ownership, and elected not to move forward because of uncertainty about the payback period, installation challenges, and the cost of the capital investment required.

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). The Department of Administration recommended different vendors for each of the three MnDOT sites.

- February 2019 - After further evaluation of utility costs at Mankato and Waters Edge, MnDOT discovered that both locations participate in demand respond programs where buildings curtail grid power in exchange for lower electricity rates. These lower rates make solar not cost effective. For St. Cloud, direct ownership was proposed and determined to be cost prohibitive at this time.

Maplewood Lab

MnDOT explored opportunities for solar energy to offset a portion of the energy for one of MnDOT's highest energy consuming sites. Initial scoping suggested 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.

- February 2019 – MnDOT learned that this location participates in Xcel Energy's demand respond program in return for very low electricity rates, making solar not cost-effective at this time.

Designing MnDOT Facilities for Solar

MnDOT worked with LHB Inc. to evaluate our standard building designs for truck stations located throughout the state to identify changes that are needed to accommodate solar on the rooftop or on ground mounted installations near the buildings. The study found that where utility rules permit, installing a 120 kW array will produce enough electricity annually to off-set a typical truck station's energy use. To take advantage of the energy production potential, the standard truck station design and specifications for mechanical systems should be modified to electric heating and hot water systems. Each site could also add an electric vehicle charging station for employee use.

The study also included a cost summary that shows a 40 kW array could be cost-neutral, while a larger 120 kW array would cost an additional \$85,000 - \$274,000 over the 25 year lifecycle of the PV panels (Table 1).

Table 1. Solar Cost Estimate

	System Size (kw)	Avoided Utility Cost (annually)	Initial Cost	Full Electric System Cost Difference**	Compounded Maintenance	10 year Refresh	25 year cost
Favorable Estimate	40	\$4,081	\$72,000	\$ -	\$17,762	\$7,200	\$(42,165)
	120	\$7,450	\$216,000	\$49,000	\$53,286	\$21,600	\$85,700
Conservative Estimate	40	\$4,081	\$120,000	\$ -	\$17,762	\$12,000	\$27,229
	120	\$7,450	\$360,000	\$49,000	\$53,286	\$36,000	\$274,418

*Favorable Estimate assumes \$1.8/watt, 3% utility price escalation, and 2.5% inflation. Conservative Estimate assumes \$3.0/watt, 2% utility price escalation, and 2%inflation.

Solar Site and Energy Potential

Table 2. Solar Site and Energy Potential

Building or Site	Estimated Module Size (kW)	Status	Project Type
Statewide CSG RFP	4 MW	Under contract	CSG
I-94 Gravel Pit	714 kW – 1.428 MW	In progress	CSG + lease, ground mount (assume 1 MW only)
ABC Ramps	274 -578 kW	In progress	CSG backup subscriber + lease, elevated rooftop

Building or Site	Estimated Module Size (kW)	Status	Project Type
Faribault	131 kW – 524 kW	Under contract	CSG backup subscriber, 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	5.19 MW – 6.60 MW		

MnDOT Solar Program – Next Steps

As stated previously, approximately 0.3% of the energy MnDOT uses is “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.

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

2016 Feasibility Assessment

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.

FHWA Requirements for Renewable Energy Projects in ROW

Several states have installed renewable energy generation projects such as solar arrays and wind turbines along highway ROW, and other states are considering doing so. In Minnesota, the state definition of utility allows for renewable energy to be considered a utility facility. To be regulated as a utility facility, the facility must directly or indirectly serve the public. Renewable energy projects that are connected to the public electricity grid or provide electricity used by a public agency such as MnDOT would generally be considered as serving the public. MnDOT's Utility Accommodation Policy outlines the procedures criteria, and standards it uses to evaluate and approve individual applications for utility facilities within the ROW. MnDOT can approve a utility project installation in accordance with the process without referral to FHWA. For more information on the process, see [Quick Guide: Federal Highway Administration \(FHWA\) Requirements for Renewable Energy Projects in Highway Right-Of-Way \(ROW\)](#).