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DEPARTMENT OF TRANSPORTATION

OFFICE OF RESEARCH & INNOVATION

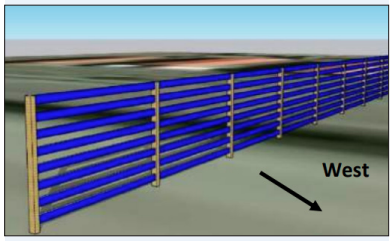
TECHNICAL SUMMARY

Questions?
Contact research.dot@state.mn.us.

Technical Liaison:
Daniel Gullickson, MnDOT
Daniel.Gullickson@state.mn.us

Investigator:
Mijia Yang,
North Dakota State University

PROJECT COST:
$149, 060



Several snow fence designs and orientations were created for this project, including this design of an 8-foot-high fence with PV panels that cover 50% of the fence.

Using Noise Barriers and Snow Fencing to Capture Solar Energy

Researchers designed and constructed a prototype system using solar panels with noise barriers and snow fencing. Harvesting solar energy through otherwise single-function installations could offset their costs and provide financial surplus for the agency after several years.

What Was the Need?

During the past decade, MnDOT has been developing solar projects and actively pursuing cost-effective energy-efficiency measures. Transforming single-function installations such as noise barriers and snow fences to multifunction installations by adding solar panels to these structures is an effective energy-efficiency innovation.

MnDOT has hundreds of noise barriers and the need for thousands of miles of snow fencing. The surfaces of these structures could accommodate more than 1,000 300-watt solar panels per mile, which could potentially generate hundreds of thousands of kilowatt-hours of energy each year for each mile of panels. This energy gain has the potential to reduce some of the installation cost of these structures through power purchase agreements with utility companies and produce a possible surplus after several years.

More information was needed by MnDOT about implementing this concept, including public perceptions, system design, connections to public utilities and cost–benefit projections.

What Was Our Goal?

The project's goal was to investigate the feasibility of installing photovoltaic (PV) panels on noise barriers and snow fences as add-on pieces or in integrated designs. The project's overall objective was to provide a comprehensive proof of concept to determine if the idea was sound—socially, economically and functionally—and a reasonable route for MnDOT and local agencies to take.

What Did We Do?

According to the Federal Highway Administration, using the highway right of way for public utilities facilities is in the public interest. Consequently, many states have implemented PV demonstration projects, which researchers examined through a literature search of PV projects completed by transportation agencies.

To learn stakeholders' opinion of using PV panels with noise barriers and snow fences, researchers distributed online surveys to members of more than 50 households familiar with noise barrier walls and representatives from 21 utility companies. They also interviewed 20 landowners with farmland where snow fences could be installed.

The research team then constructed a prototype solar noise barrier and snow fence system. Because the system would be near traffic and could influence safety, researchers conducted laboratory testing and computer modeling to investigate the possible effects of these systems and regulatory aspects of implementation, including:

- Effect of solar panels on noise barrier performance
- Potential for glare from the solar panels, which could hinder motorists
- Change in the effectiveness of PV snow fence in reducing blowing and drifting snow
- Impact on traffic safety resulting from vehicle collisions with solar panels
- Potential electrical hazards to motorists involved in a crash with a solar highway system

continued

"Harvesting solar energy from right of way structures was shown to be within our reach through this project, which asked and answered important questions and showed a clear path forward."

—Daniel Gullickson,
Blowing Snow Control Supervisor, MnDOT Operations Division

"Minnesota's long miles of snow fences and hundreds of noise barriers could be doing double duty, performing their first function while harvesting solar energy simultaneously. This project's comprehensive investigations show that possibility is real and reachable."

—Mijia Yang,
Associate Professor, North Dakota State University Department of Civil, Construction and Environmental Engineering

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of Transportation
Office of Research & Innovation
MS 330, First Floor
395 John Ireland Blvd.
St. Paul, MN 55155-1899
651-366-3780
www.mndot.gov/research

The research team developed and constructed this prototype of a PV noise barrier system using 8-by-4-foot solar panels.

The team developed a system of electrical connections between panels. To attach the system to the power gird, they designed a controller and inverter system to convert the system's DC voltage to an AC charge usable by the local utility company. Researchers also created a cost–benefit model to calculate breakeven points for the system under various scenarios.

What Did We Learn?

The literature search revealed that many states have installed PV demonstration projects, and PV panels on noise barriers have been investigated in Europe, but researchers found no projects resembling this effort.

The surveys showed the general public was overwhelmingly positive about the concept (90%); however, that percentage dropped to about half if solar panels reduced noise barrier effectiveness.

Testing showed that the prototype performed its functions seamlessly as it also gathered solar energy to convey to the power grid. Computer modeling of PV panels on noise barriers showed the noise dampening effect of barriers would be reduced only 2%. A simulation of sunlight glaring revealed a minimum of glare (373 minutes per year) for the system. In addition, fluid analysis of snow motion indicated that terrain most affected performance, not the solar panels. In the lab, low- and high-velocity impacts to the PV panels recorded with a high-resolution camera showed that fragments from broken panels moved relatively slowly and did not pose a safety hazard to travelers. Further, the system was not an electrocution hazard.

The team's cost–benefit analysis indicated that in some installations, the system could reach the breakeven point in less than a year.

What's Next?

Researchers would like to build a quarter mile of solar snow fence near Moorhead, Minnesota, with the help of MnDOT engineers if the agency approves the project. Implementing the current project's findings will require collaboration across the agency to understand the technical, regulatory and environmental aspects.

This Technical Summary pertains to Report 2021-20, "Harnessing Solar Energy Through Noise Barriers and Structural Snow Fencing," published July 2021. The full report can be accessed at mndot.gov/research/reports/2021/202120.pdf.