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Solar photovoltaic glare: Impacts and mitigation across aviation, transportation, agriculture, and the built environment

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Abstract

Solar photovoltaic (PV) systems are rapidly expanding to meet renewable energy demands, but specular reflections from panel surfaces can produce glint (momentary flashes) and glare (sustained bright light). These glare phenomena pose safety and operational challenges across multiple sectors. This paper reviews the mechanisms of PV glare, quantifies its impact on aviation (pilots and air traffic control), transportation (road and rail users), agriculture (crop and livestock effects), and the built environment (residential and commercial areas), and evaluates mitigation strategies. Drawing on regulatory guidelines, glare simulation tools, solar geometry analysis and case study evaluations, we demonstrate that while glare risks are real, they are predictable and manageable through site-specific design, anti-reflective coatings, orientation adjustments, and screening. The results indicate that PV glare can cause visual discomfort and potential safety concerns in aviation and road transportation, while in agricultural settings it may influence crop microclimates and worker visibility. In the urban environment, glare could impact nearby buildings. The importance of glare in the planning of PV installations with sensitive receptors is emphasized in the study. Recommendations for best practices, mitigation options and future research are provided.

Keywords*: agrivoltaics; anti-reflective coating; aviation safety; built environment; glare modelling; optical glare; solar photovoltaics; sustainable energy; transportation safety*

References:

1. “International Energy Agency (IEA), ”Renewables 2023: Analysis and Forecast to 2028," *IEA, Paris, Tech. Rep.*, 2023. [Online]. Available:

https://www.iea.org/reports/renewables-2023
Google Scholar

2. "*Snapshot 2024 - IEA-PVPS*."
Google Scholar

3. I. Phillpots and A. Ghosh, "Next Sustainability A critical review on the potential of urban (BIPV) and rural (AgriPV) solar hydrogen production," *Next Sustainability*, vol. 7, no. February, p. 100254, 2026, doi: 10.1016/j.nxsust.2026.100254.
CrossRef Google Scholar

4. X. Liao, S. Bresciani, C. Troise, W. A. A. Bukhari, and A. A. A. Bukhari, "How Solar, Wind, and Biomass Energy Create Sustainable Pathways Towards Green Economic Growth? Insights From the Top Five Global Renewable Energy Economies," *Sustainable Development*, vol. 33, no. 3, pp. 4265–4282, 2025, doi: 10.1002/sd.3345.
CrossRef Google Scholar

5. H. Ren, Z. Ma, A. B. Chan, and Y. Sun, "Optimal planning of municipal-scale distributed rooftop photovoltaic systems with maximized solar energy generation under constraints in high-density cities," *Energy*, vol. 263, no. PA, p. 125686, 2023, doi: 10.1016/j.energy.2022.125686.
CrossRef Google Scholar

6. H. Zhang, Z. Yu, C. Zhu, R. Yang, B. Yan, and G. Jiang, "Green or not? Environmental challenges from photovoltaic technology," *Environmental Pollution*, vol. 320, no. October 2022, p. 121066, 2023, doi: 10.1016/j.envpol.2023.121066.
CrossRef Google Scholar

7. S. Sreenath, K. Sudhakar, and A. F. Yusop, "Solar PV in the airport environment: A review of glare assessment approaches & metrics," *Solar Energy*, vol. 216, no. October 2020, pp. 439–451, 2021, doi: 10.1016/j.solener.2021.01.023.
CrossRef Google Scholar

8. R. Lenting, M. Ll, and P. S. Hobe, "Reduced Crew and Single Pilot Operations implemented on civil aircraft : a legal perspective By Mini-dissertation submitted in partial fulfilment of the requirements for the degree Master of Laws Supervised by," vol. 16084544.
Google Scholar

9. J. Yang et al., "Effects of high-speed rail illumination on traffic safety at night in a road-cum-railway section–Implications for the infrastructure design," *Journal of Transportation Safety and Security*, vol. 17, no. 2, pp. 177–207, 2025, doi: 10.1080/19439962.2024.2377154.
CrossRef Google Scholar

10. A. Boccalatte, "Analysis of Solar Energy Power Generation in Urban To cite this version : HAL Id : tel-04770873 Analyse de la production d'énergie solaire en milieu urbain," 2024.
Google Scholar

11. D. P. Cilliers, F. P. Retief, C. Roos, R. C. Alberts, H. J. Moolman, and A. Bond, "Towards glint and glare impact assessment best practice," *Impact Assessment and Project Appraisal*, vol. 42, no. 5, pp. 498–504, 2024, doi: 10.1080/14615517.2024.2420535.

CrossRef Google Scholar

12. S. Sreenath, K. Sudhakar, and A. F. Yusop, “Effect of PV material, texturing, orientation and tracking on glare impact: A simulation study from an Indian airport,” *Clean. Eng. Technol.*, vol. 4, p. 100236, 2021, doi: 10.1016/j.clet.2021.100236.
CrossRef Google Scholar

13. “*Back Contact + Low-Glare Materials_Solving Solar Panel Glare Problems*.”
Google Scholar

14. H. Ding et al., “Optimization Design of Agrivoltaic Systems Based on Light Environment Simulation,” *Agriculture (Switzerland)*, vol. 15, no. 23, pp. 1–21, 2025, doi: 10.3390/agriculture15232437.
CrossRef Google Scholar

15. Farnung and Boris, *Designing New Materials for Photovoltaics: Opportunities for Lowering Cost and Increasing Performance through Advanced Material Innovations, IEA PVPS Task 13Performance, Operation and Reliability of Photovoltaic Systems*. 2021. [Online]. Available: https://www.osti.gov/servlets/purl/1779380
Google Scholar

16. K.-A. W. & I. D. Cornelia Peike, Ingrid Hädrich, “Overview of PV module encapsulation materials,” no. c, 2015.
Google Scholar

17. S. Rani, S. Cavalli, and G. Grancini, “Chemical Science coatings bridging optics, materials, and performance in perovskite solar cells,” 2026, doi: 10.1039/d5sc09456a.
CrossRef Google Scholar

18. S. Qureshi, “Solar Photovoltaic Glint and Glare Study,” *Pager Power*, no. July, 2022.
Google Scholar

19. S. Qureshi, “Solar Photovoltaic Glint and Glare Study,” *Pager Power*, 2022.
Google Scholar

20. M. Jenčo, “Determination of the Solar Angle of Incidence Using an Equivalent Surface and the Possibility of Applying This Approach in Geosciences and Engineering,” *ISPRS Int. J. Geoinf.*, vol. 14, no. 9, 2025, doi: 10.3390/ijgi14090323.
CrossRef Google Scholar

21. “*PV-GlareCheck*.”
Google Scholar

22. “*windPRO - GLARE Module*.”
Google Scholar

23. “*Solar Glare Analysis Tools_ForgeSolar*.”
Google Scholar

24. R. Swayze, “No Title,” 2006.
Google Scholar

25. O. N. Limits, O. F. Exposure, T. O. Incoherent, and I. Radiation, “ICNIRP GUIDELINES,” 2013.
Google Scholar

26. "*DR As Nzs 4282 2018_PDF_Lighting_Standards Australia*."
Google Scholar