## HAIL RISK TO PV SYSTEMS

## **NEW RESEARCH PROJECT 2026-2027:**

CREATING ACTIONABLE KNOWLEDGE ABOUT **CURRENT AND FUTURE HAIL RISK TO PV SYSTEMS** IN SWITZERLAND COMBINING EXPERTISE ON CLIMATE HAZARDS, RISK ASSESSMENT AND ENGINEERING

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## INTRODUCTION

IN SWITZERLAND HAIL FREQUENCY AND INTENSITY HAVE INCREASED OVER THE PAST ~60 YEARS (WILHELM ET AL. 2024)



THIS TREND WILL CONTINUE IN
A WARMING CLIMATE
(THURNHERR ET AL. 2025)



RISING NUMBER OF PV INSTALLATIONS



RISING DAMAGE COSTS FOR PV
INFRASTRUCTURE

WHERE IS THE HIGHEST RISK?
HOW WILL IT CHANGE IN THE FUTURE?
WHAT CAN WE DO ABOUT IT?

## RESEARCH QUESTIONS

- What physical and technical factors determine the **vulnerability of PVs** to hail damage (e.g., glass thickness, orientation, angle..)?
- What are **minimum hail sizes causing real-world damage** and which losses + degradation is expected at which size?
- How often do hail events exceed current building and SIA standards?
- How will the hail risk to PV change in the future?
- Where are **low-risk**, **high-potential regions** for future PV installations?

### FIRST RESULTS

Where are hotspots of large hail occurrence?

→ Hail (> 3cm) frequency hotspots are in southern Ticino, Emmental, Entlebuch, the Napf region and along the Jura.

Where do these regions coincide with high numbers of PV installations?

→ Currently, the PV hail damage potential is highest in Basel, Thun and southern Ticino (Fig. 1).

How do hail events affect the average lifetime of PV systems?

→ Hail is driving early decommissioning of PV installations! Among investigated end-of-life PV systems, the mean lifetime of PV systems is significantly lower (>2 years).

## Damage to PV eyelem from large hail stones in Switzerland. Source https://solektra.ch/hagelschaden/

# Big hait stones from a storm in Switzerland Source: https://www.sri.cri/meteo/meteo/stores/schauerwetter.kommt-hagel-oder-graupel-sus-dieser-dunkten-worke

## PV HAIL DAMAGE HOTSPOTS IN SWITZERLAND

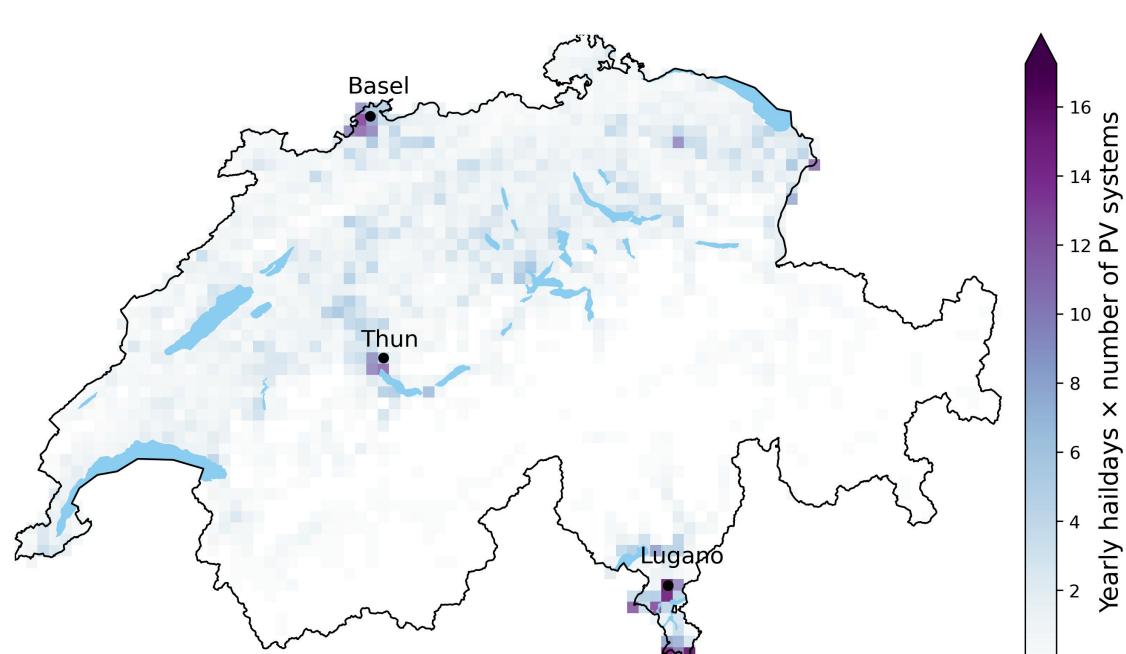


Fig. 1: Hotspots of possible damage to PV systems by hail > 3cm. The plot shows the radar-based mean number of haildays per year over the last 20 years, multiplied by the number of current PV installations per square kilometer.

## PLANNED PROJECT OUTPUTS

- 1. High-resolution hail risk assessments for present and future climate conditions
- 2. A validated PV hail-damage model
- 3. Worst-case scenarios and ecological impact assessments
- 4. An ML-based tool for **automated detection of PV hail damage**
- 5. Recommendations for resilient PV systems, siting, and repair strategies and adaptation strategies
- 6. Public open-source dashboards for hail risk and postevent assessments

## WE ARE HAPPY FOR YOUR FEEDBACK

What are relevant research questions for you? Which project outputs would be useful to you? Are you interested in a collaboration?



Survey (4

CONTACT US!

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Wilhelm, L., Schwierz, C., Schröer, K., Taszarek, M., and Martius, O.: Reconstructing hail days in Switzerland with statistical models (1959–2022), Nat. Hazards Earth Syst. Sci., 24, 3869–3894, https://doi.org/10.5194/nhess-24-3869-2024, 2024 Thurnherr, I., Cui, R., Velasquez, P., Wernli, H., and Schär, C.: The effect of 3°C global warming on hail over Europe. Authorea, doi: 10.22541/au.173809555.59545480/v1, 2025 Gupta, V., Sharma, M., Pachauri, R., and Babu, K. N. D.: Impact of hailstorm on the performance of PV module: a review. Energy Sources, Part A: Recovery, Utilization, and Environmental Effects, 44(1), 1923–1944, https://doi.org/10.1080/15567036.2019.1648597