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Extreme weather events and PV systems impact

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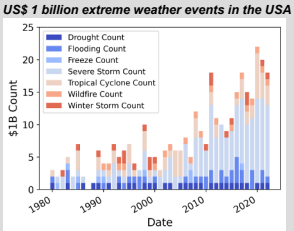
1 Introduction

Frequency & impact of extreme weather events is increasing

US$ 1 billion extreme weather events in the USA

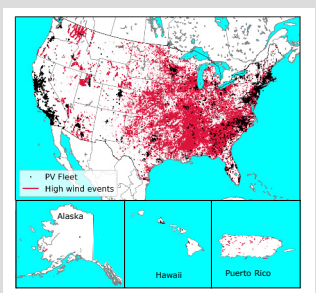


NOAA National Centers for Environmental Information (NCEI) U.S. Billion-Dollar Weather and Climate Disasters (2023).

Some case studies have been published but little is known about overall countrywide impact

2 Method

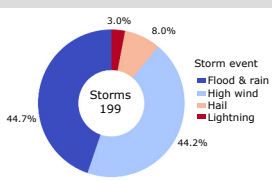
Compare NOAA database on extreme weather with PV Fleet time series



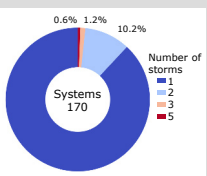
Determine events that came within 10 km of an existing PV system

3 Extreme Weather Pareto

Pareto of weather events



Number of storms impacting the same system



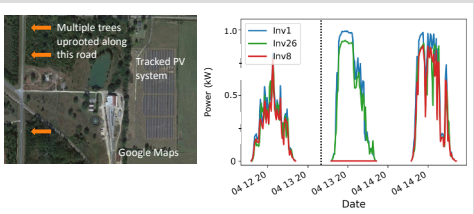
1 system was impacted by 5 severe weather events!

Flooding & high wind events are the most common storm types

Most systems were impacted by a single extreme weather event

4 Example

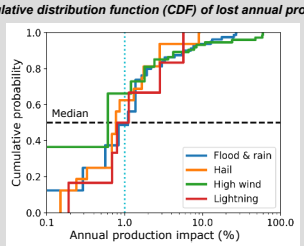
Tracked system affected by wind storm



1 inverter out of 26 impacted for 1 day

5 Short-term Impact

Cumulative distribution function (CDF) of lost annual production (%)



Median lost production is around 1% of annual production

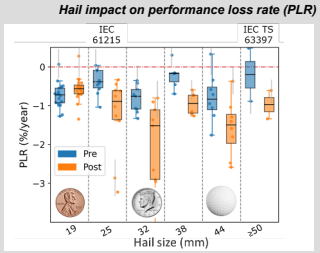
Long tail for flooding & high wind events (up to 60% lost production)

Statistically extreme weather leads to ca. 1% lost production

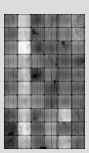
High risk manifested in long tail.

6 Long-term Impact - Hail

Hail impact on performance loss rate (PLR)



Using 2+ years of data before & after impact

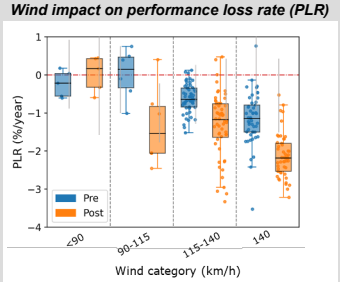


Larger hail sizes may not necessarily lead to higher PLRs. Rather, higher PLRs occur if a minimum damage threshold is exceeded

Supports the development of better hail resistance testing

7 Long-term Impact - Wind

Wind impact on performance loss rate (PLR)



Needed 2 years of data before & after impact for RdTools analysis

High wind → statistically significant higher PLR after storm

8 Installation Quality

Wind speed: 90 – 115 km/h

Result: Modules blown from roof

Top-clamp fails in high wind

Partly threaded bolt

Mounting strength insufficient → bent bracket

9 Conclusion

The Good

- ***Quantified impact of extreme weather events of PV systems from a fleet perspective***
- ***Short-term impact (outages) lead to ca. 1% of annual lost production, at the median.***
- ***Installation quality can influence impact***

The Bad

- ***Distributions have a long tail that can lead to substantial annual losses (60%!)***
- ***Systems impacted by hail exceeding current IEC 61215 showed higher Performance loss after storm → need better hail testing (already in development)***
- ***All systems impacted by "storm" to "violent storm" on Beaufort wind scale showed higher PLR after storm.***

The Ugly

- ***We have only begun to quantify the impact.***
- ***Results may change as PV deployment increases and extreme weather events become more common.***
- ***Results may be different on different continents.***

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