30+ years of operation – a comprehensive review of the long-term performance of the Mont-Soleil PV power plant

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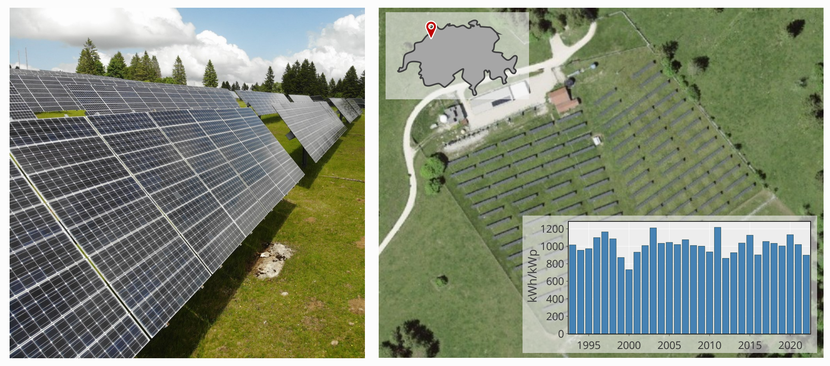
1 Context and goals

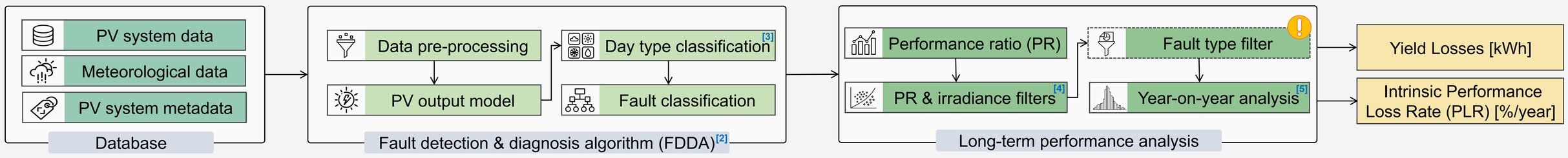
- Europe's oldest grid-connected +500 kWp PV system (Feb. 1992).[1]
- Combining fault detection & long-term performance analysis pipelines.

20+ years of monitoring data | Fault Detection & Diagnosis | Long-term performance analysis

Total DC capacity	554.592 kWp
Tilt angle	52°
Orientation	20° East / 35° East
Altitude	1270 m a.s.l.
Inverter type	ABB central inverter
Module type	Siemens SM55 55 Wp

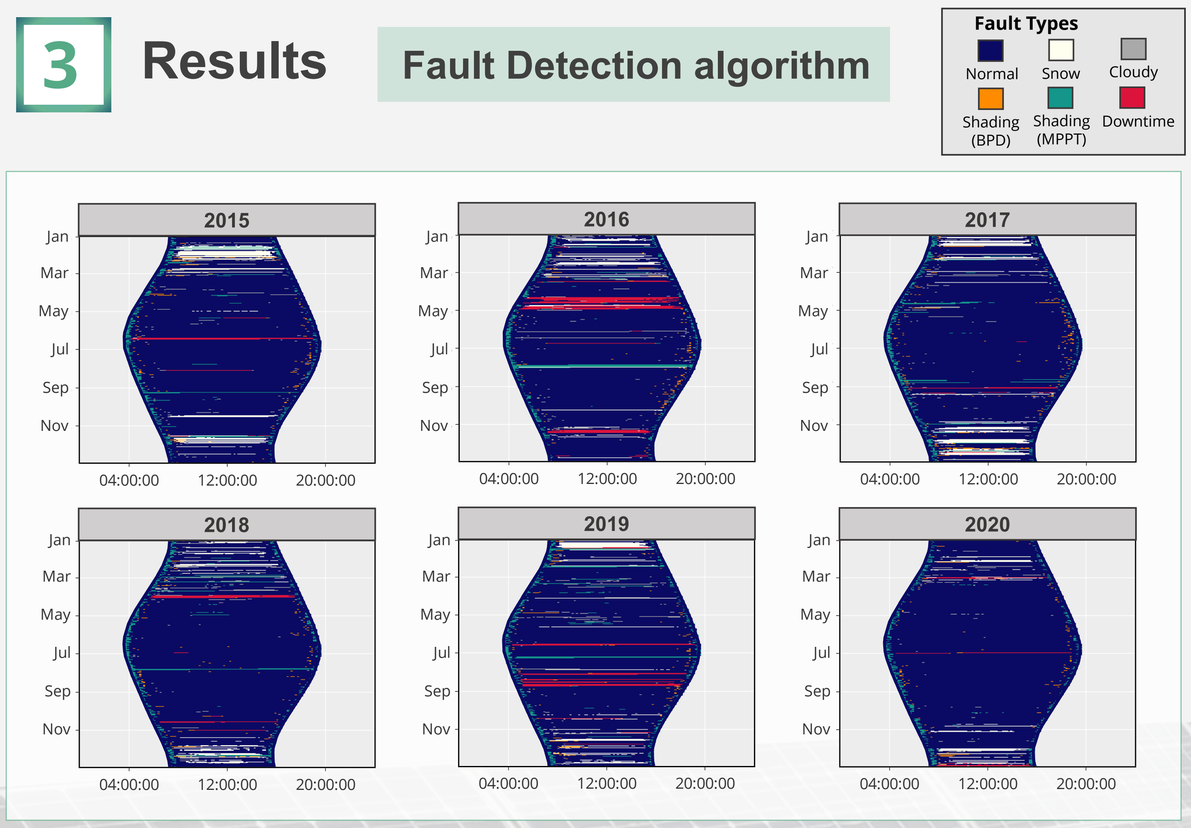


2 Methodology

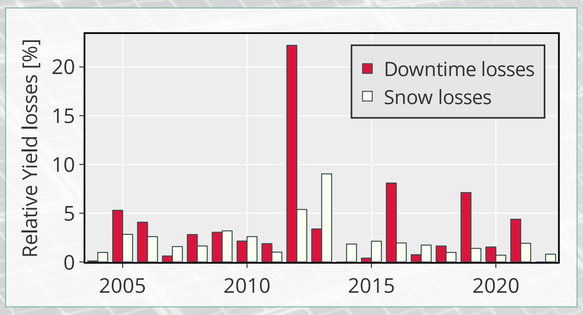


3 Results

Fault Detection algorithm



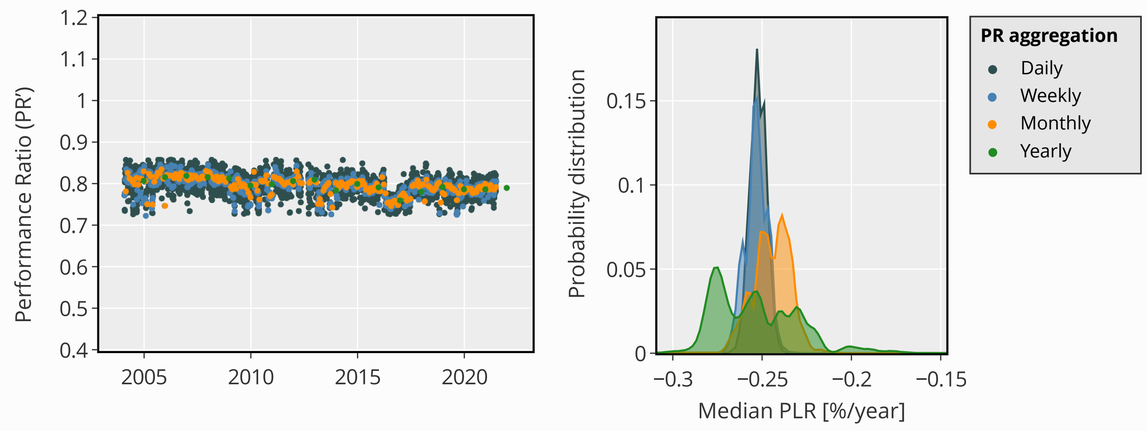
- Fault detection and diagnosis algorithm applied to each year w/ all data (2004-2021).
- Fault heatmaps show patterns in fault occurrences.



- Main detected fault types: snow and downtime. Estimated losses up to 20% of yearly yield.
- Between 2004 and 2021, an estimated **~370 MWh** and **~230 MWh** are lost to downtime and snow losses, respectively. This amounts to almost a full year of average production for the power plant.

Long-term performance analysis

Full monitoring dataset only available for 2004 – 2021



- Faults are filtered out based on the fault detection algorithm results (e.g., snow & downtime).
- Standard and multi-annual year-on-year (multi-YoY) pipelines applied to extract system performance loss rates (PLR). Multi-YoY offers lower uncertainties[5].
- Overall, the Mont-Soleil power plant is found to have a PLR of approximately **-0.25 %/year**.

Aggregation	Intrinsic PLR [%/year]	
	Standard YoY	Multi-YoY
daily	-0.321	-0.252
weekly	-0.291	-0.253
monthly	-0.299	-0.245
yearly	0.356	-0.256

4 Conclusion

- Fault detection algorithm shows mainly downtime and snow faults, with **~600 MWh** estimated yield losses (2004 – 2021).
- Robust long-term performance analysis pipeline with fault pre-processing shows a system PLR of **-0.25 %/year**.
- On-site analysis and indoor measurements will further correlate detected degradation to system components.
- Assuming PLR value is valid for the 30 years of operation: modules compliant with warranty of **90% nameplate power**.

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References

[1] El Boujdaini et al. (2022), 'Analysis of non-linear long-term degradation of PV systems', WCPEC-8
[2] Fairbrother et al. (2021), doi: 10.1002/solr.202100583
[3] Quest et al. (2023), doi: 10.13140/RG.2.2.12033.12644
[4] Özkalay et al. (2021), doi: 10.4229/EUPVSEC20212021-5DO.2.1
[5] Quest et al. (2023), doi: 10.4229/EUPVSEC2023/4CV.1.14

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