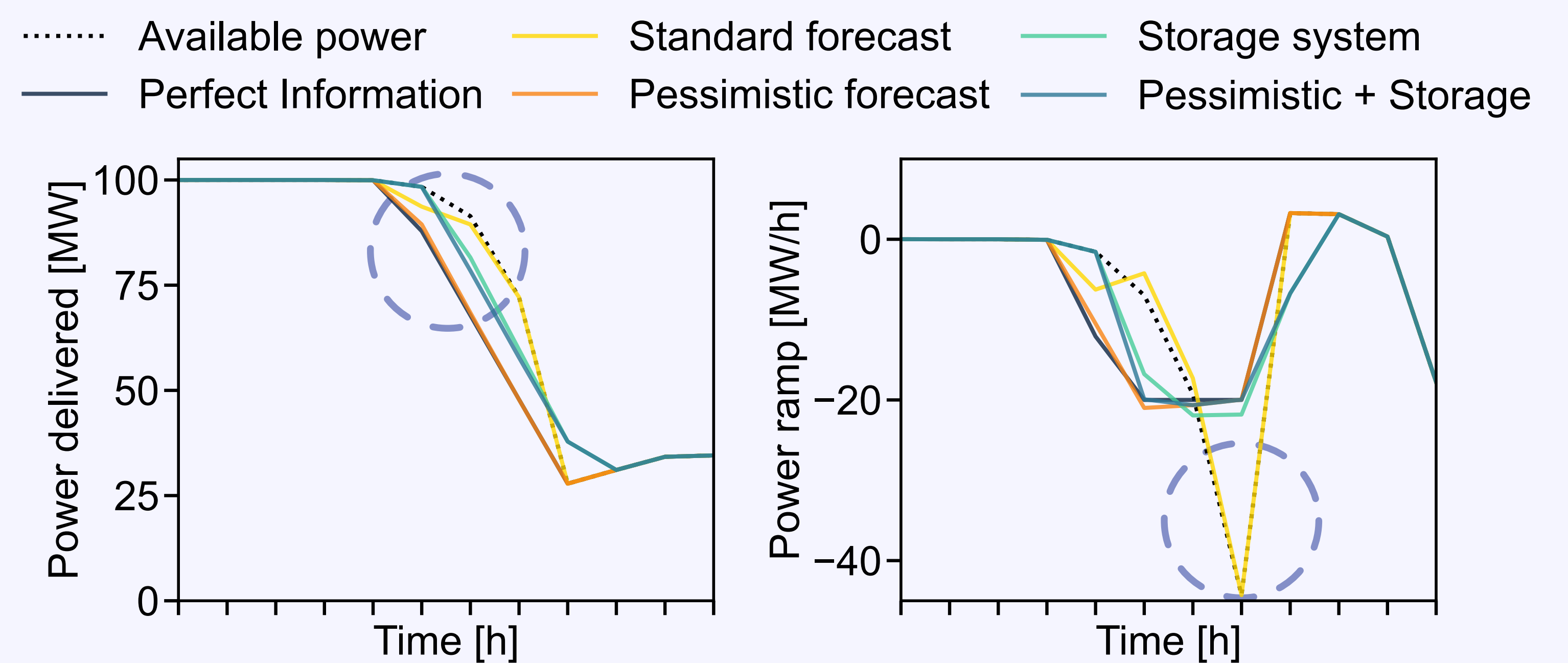


Introduction

Power ramp events are particularly challenging for grid stability. To mitigate these events, wind farm operators can adjust their power delivery using **curtailment**.

However, curtailment is decided based on **forecast information**, which includes uncertainties. When the power ramp is incorrectly forecasted, the power is not curtailed sufficiently, leading to an **extreme ramp event!**



Methodology

- Hourly simulation of wind farm operation
- **Online dispatch optimization problem**
- Power modeled with an engineering wake model

Comparison of three approaches:



How to best reduce the impact of forecast uncertainties?

Storage system

- Discharge energy to reduce the magnitude of ramp events.
- Charge instead of curtailing

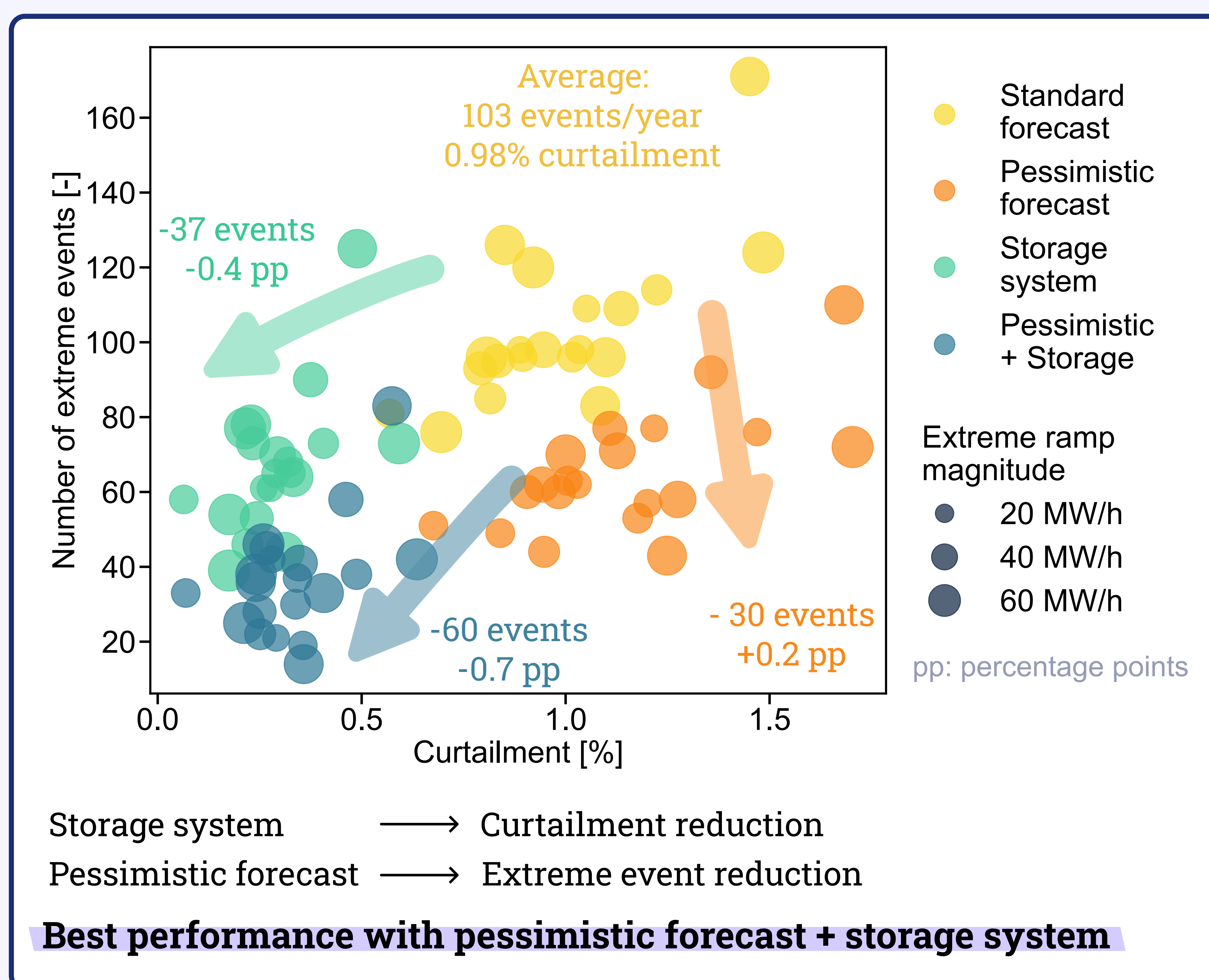
Pessimistic forecast

- Force a conservative behavior by using a "worse" forecast input
- Inspired from robust optimization

Pessimistic forecast + Storage system

- Curtailment and storage dispatch decided simultaneously
- Force a conservative behavior and avoid curtailment by charging

Results



Pessimistic forecast generation

$$\hat{u}_{i|j}^- = \hat{u}_{i-1|j}^- + (1 - \alpha)(\hat{u}_{i|j} - \hat{u}_{i-1|j})$$

Labels: Pessimistic forecast, Pessimism factor, Ramp of input forecast

Case studies

