Centre for Energy and Environmental Markets

UNSW SYDNEY

Building a robust Disturbance Analysis Tool for Distributed Energy Resources (DERDAT) in an Electricity System

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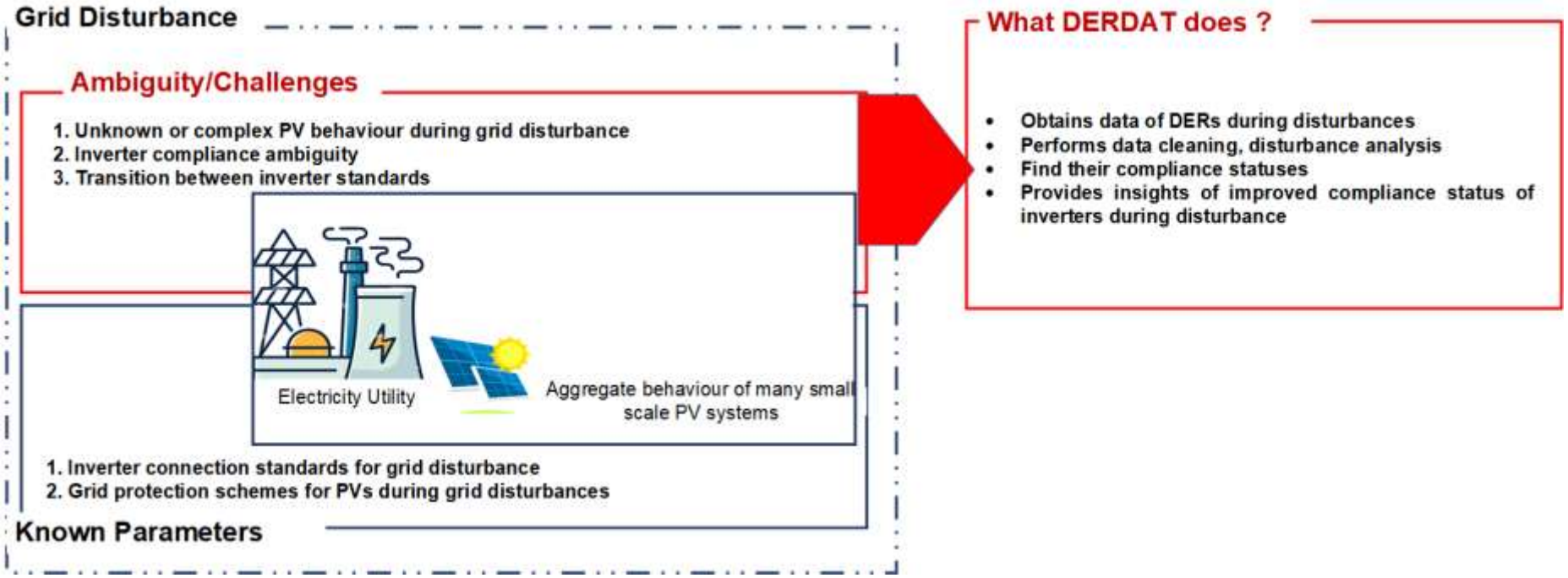
ASIA-PACIFIC SOLAR RESEARCH CONFERENCE

7th December 2023 – RMIT, Melbourne Australia

Increased DER in power system and its implications

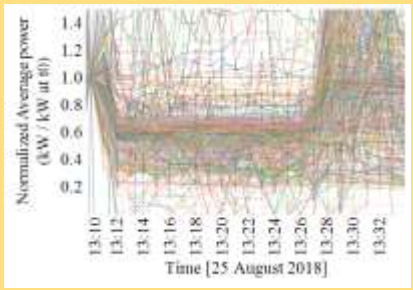
- World's highest rates of rooftop solar photovoltaic (PV) power is observed in Australia
- Increasing fleet of DERs during power system disturbances;
  - Pose security risks to power system if not coordinated appropriately
  - Nevertheless, they also present an opportunity to contribute to the power grid (AEMO, 2023).
- It mandates the need for a detailed analysis of DERs during power system disturbances
- Hence DERDAT is developed through "Project MATCH"
- This presentation includes;
  - How ambiguity in the power system is handled effectively in DERDAT
  - How DERDAT makes use of real-world data to produce outcomes of DER behaviour
  - Functionality of DERDAT
  - Case-study of an actual disturbance event and how it was analysed through DERDAT

How to handle ambiguity in power systems to create a robust electricity system in the future?

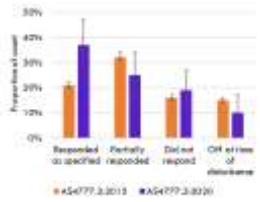


Use of real-world data to produce outcomes of DER behaviour through DERDAT

Inputs (data)



Timeseries and metadata
(1,000s sites)
Solar Analytics
Tesla
EQ/Luceo
Population data
CER register
Disturbance event conditions



Outputs

DER behaviours
Categorisation (disconnect, ride through etc.)
Freq-watt compliance
Reconnection compliance
UFLS detection

Grouping
Geographical
Standard version
Size (0-30kW, 30-100kW)
OEM

Upscaling to rest of fleet

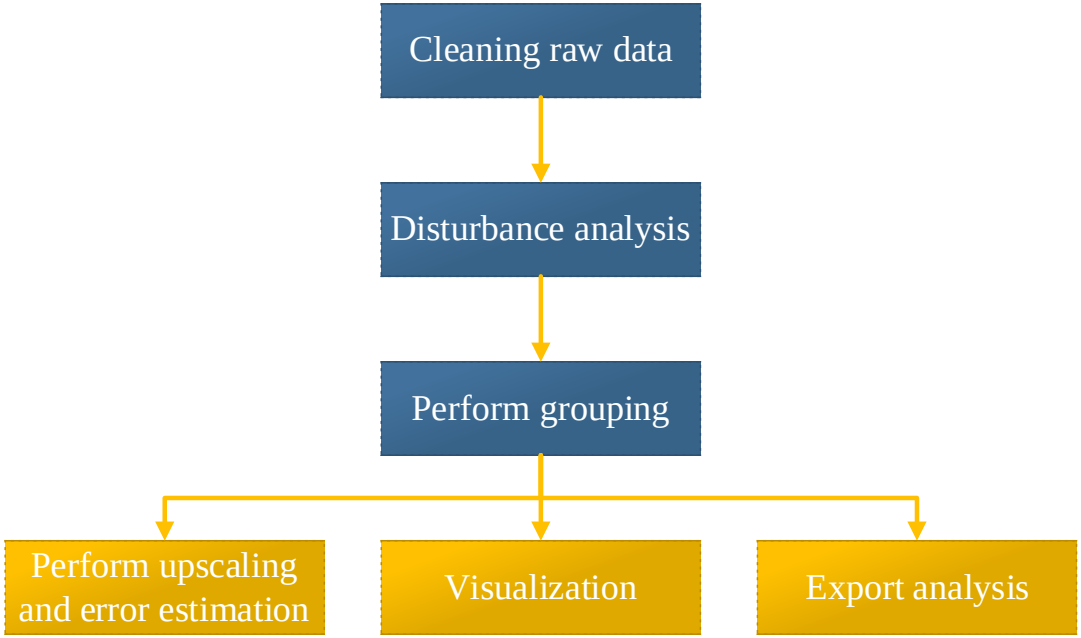
Applications

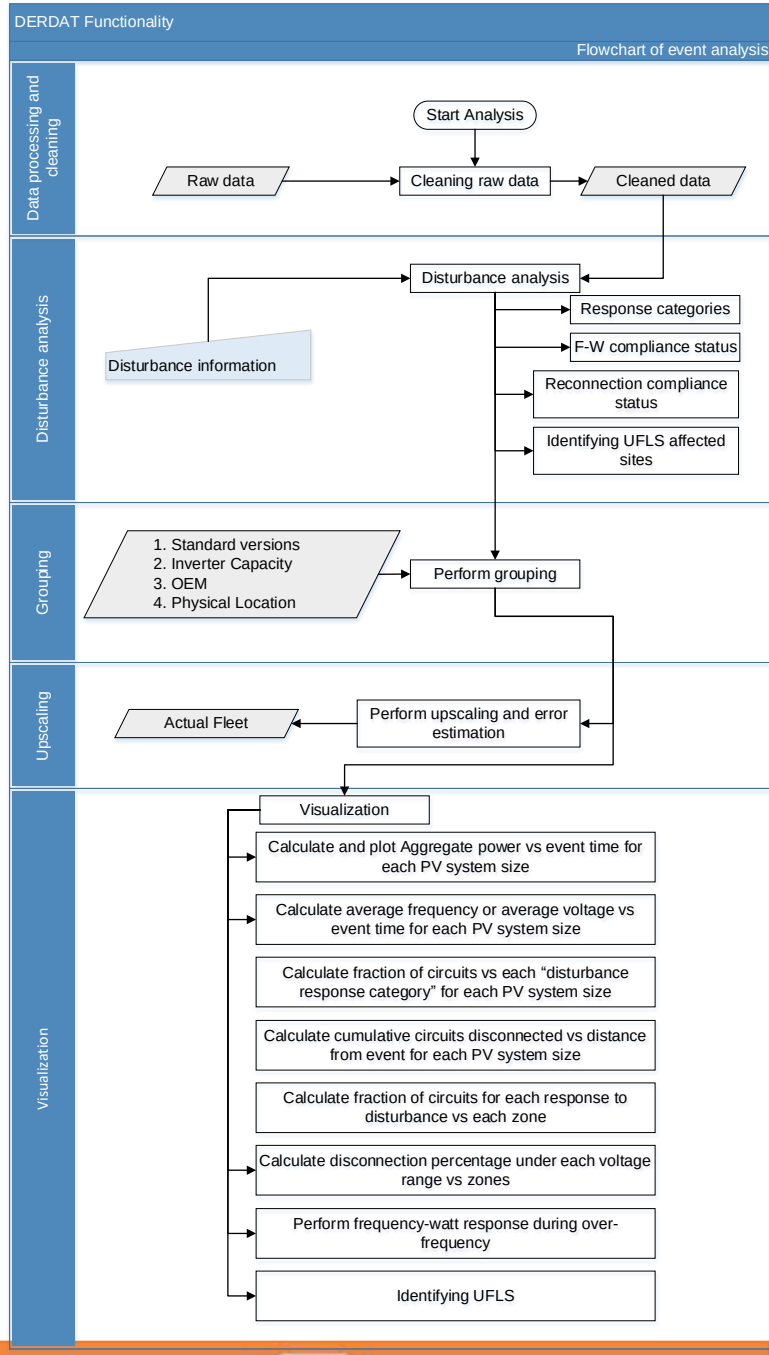
AEMO operational decision making, e.g.
Transmission constraints
FCAS procurement

Reporting and investigations
Incident reports
Compliance analysis

Open source tool is available at: https://github.com/UNSW-CEEM/DER_disturbance_analysis

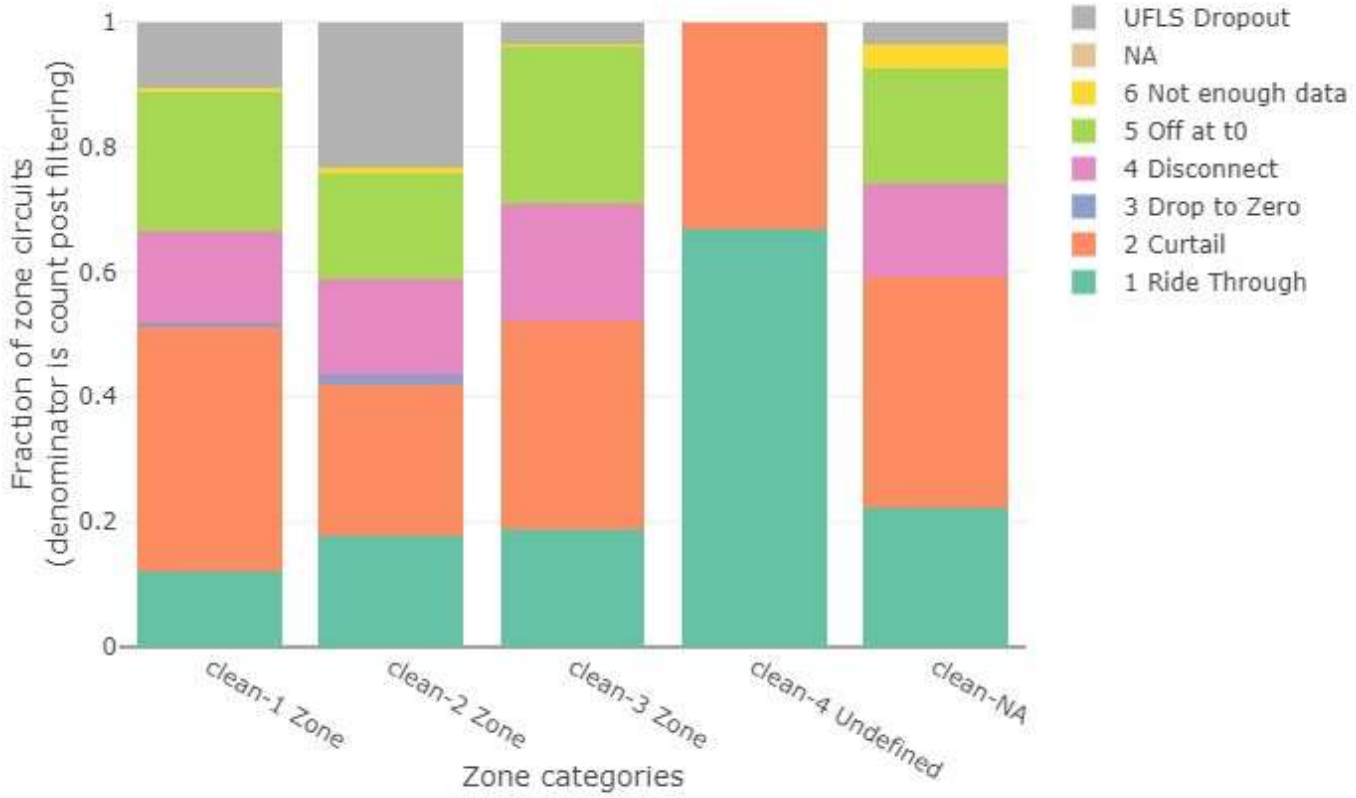
DERDAT functionality





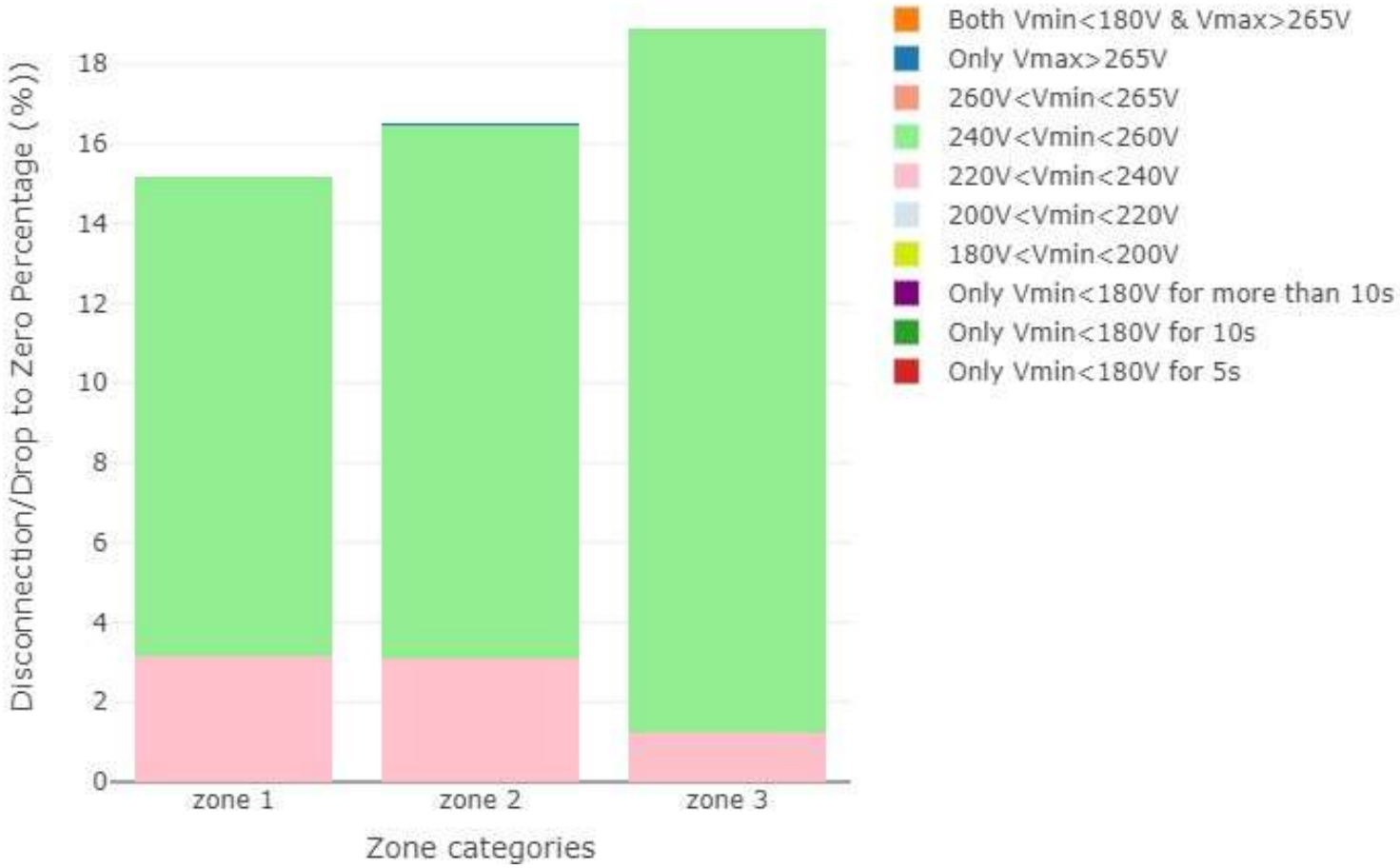
Case Study of DERDAT being used for disturbance analysis

- An event in Queensland on 25th May 2021 (AEMO, 2021) at 14:06:40 Hrs is analysed.
- Response categorization for this event is shown below.



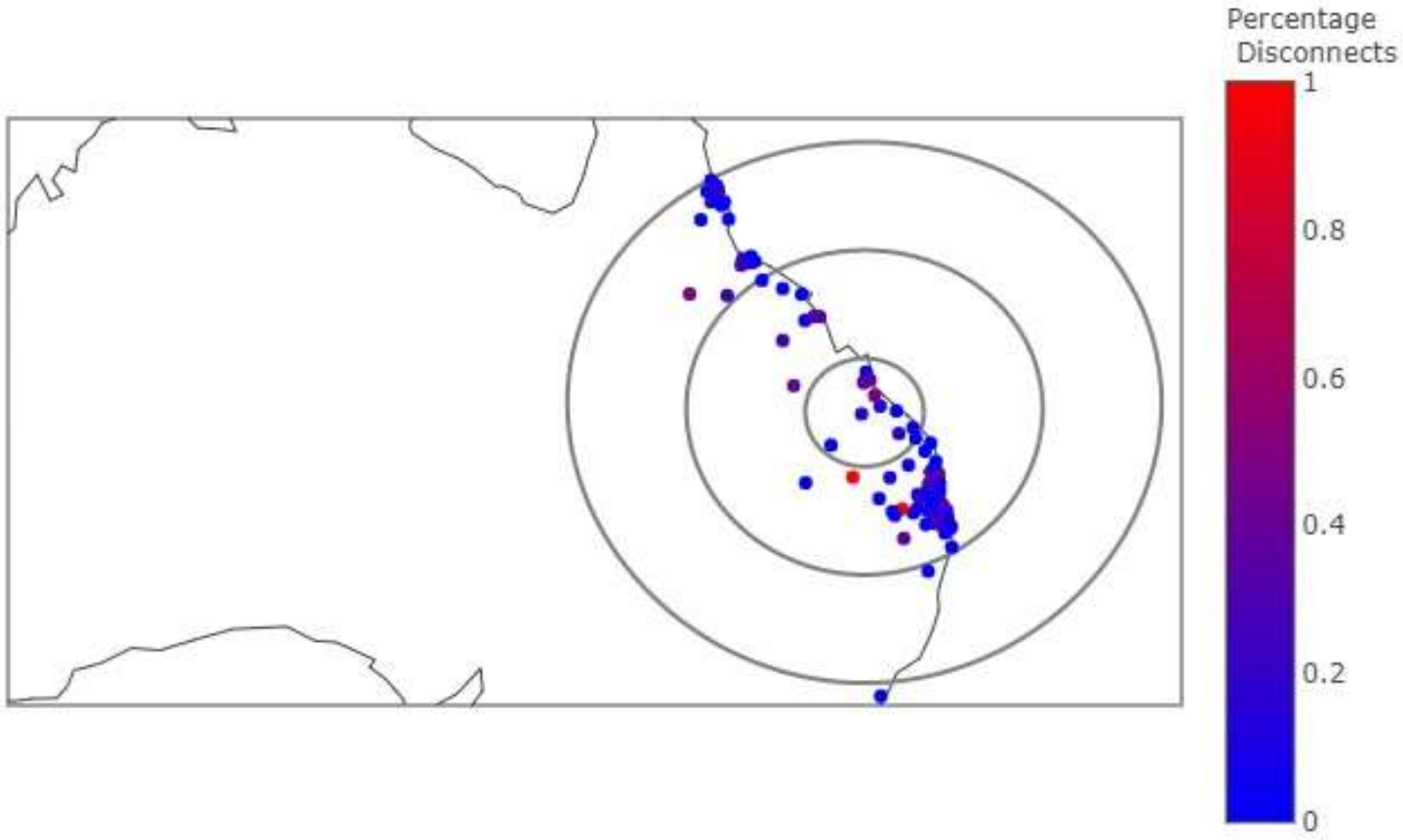
Case Study of DERDAT being used for disturbance analysis

Other outcomes from DERDAT such as “voltage visualization” can be seen here.



Case Study of DERDAT being used for disturbance analysis

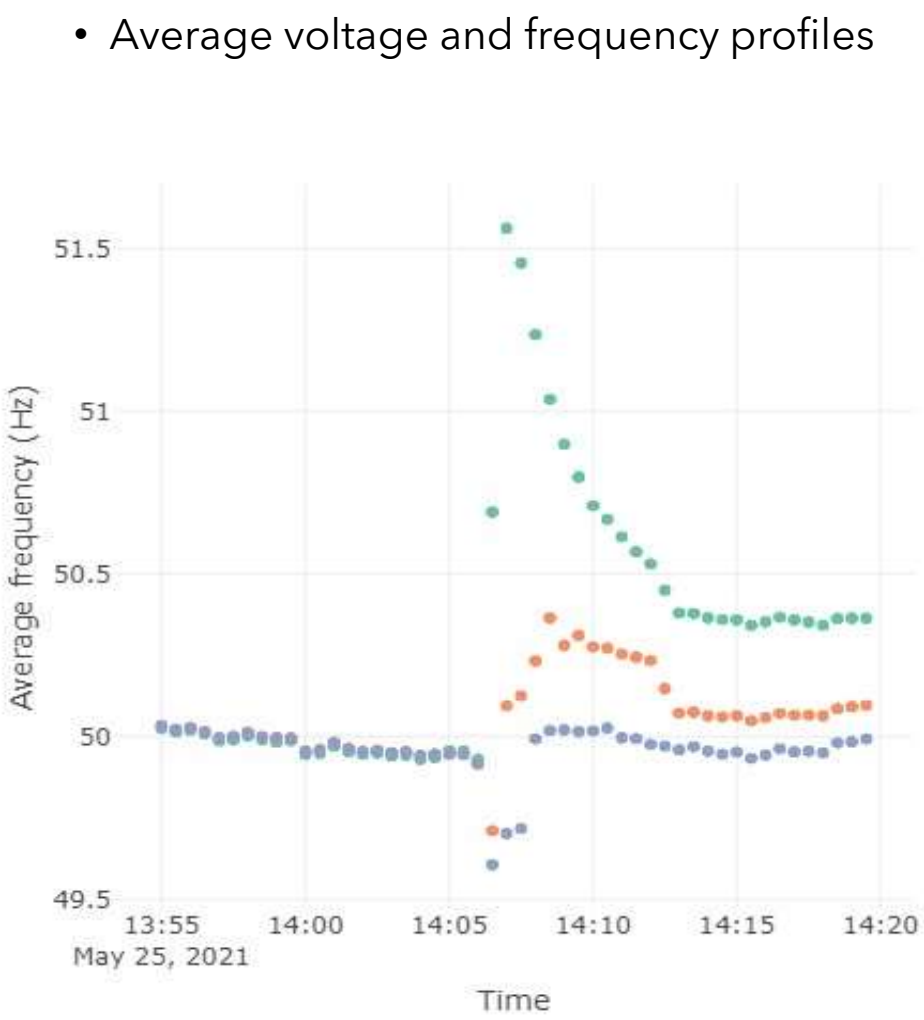
- Disconnection percentages of DERs can be seen here.

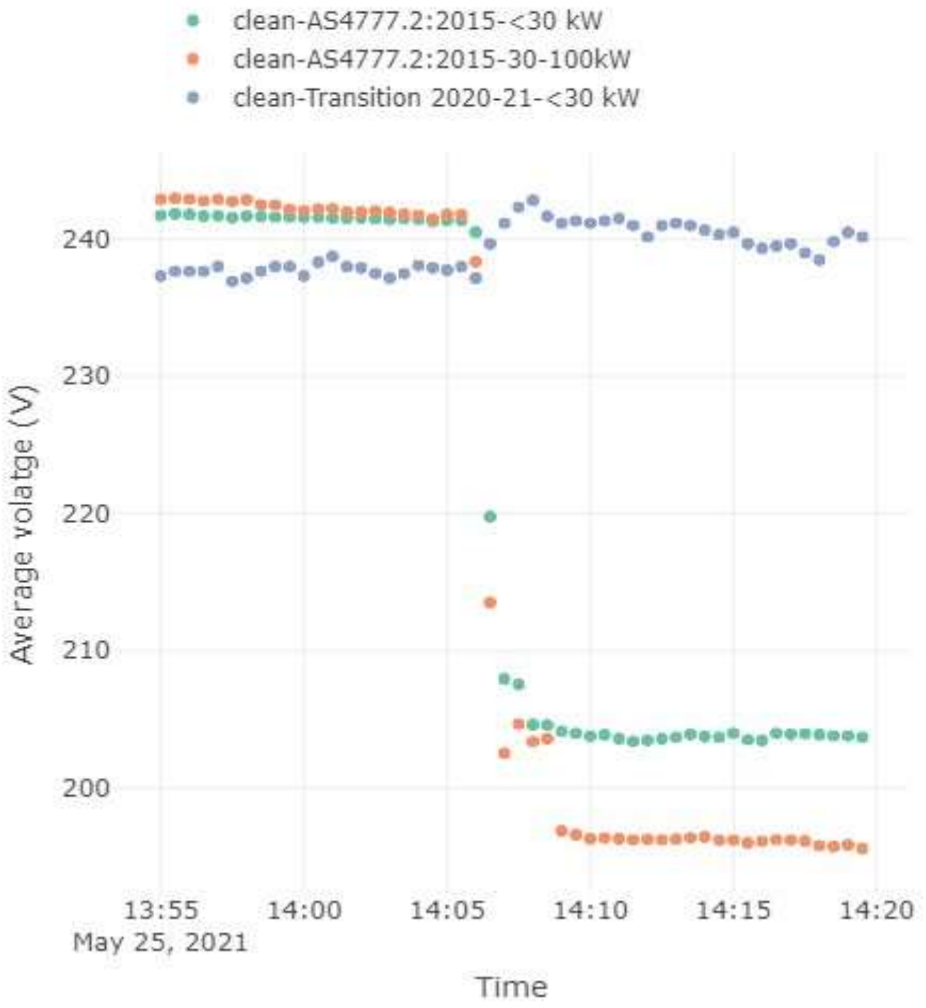


Note: pecentage disconnects includes categories 3 and 4.

Case Study of DERDAT being used for disturbance analysis

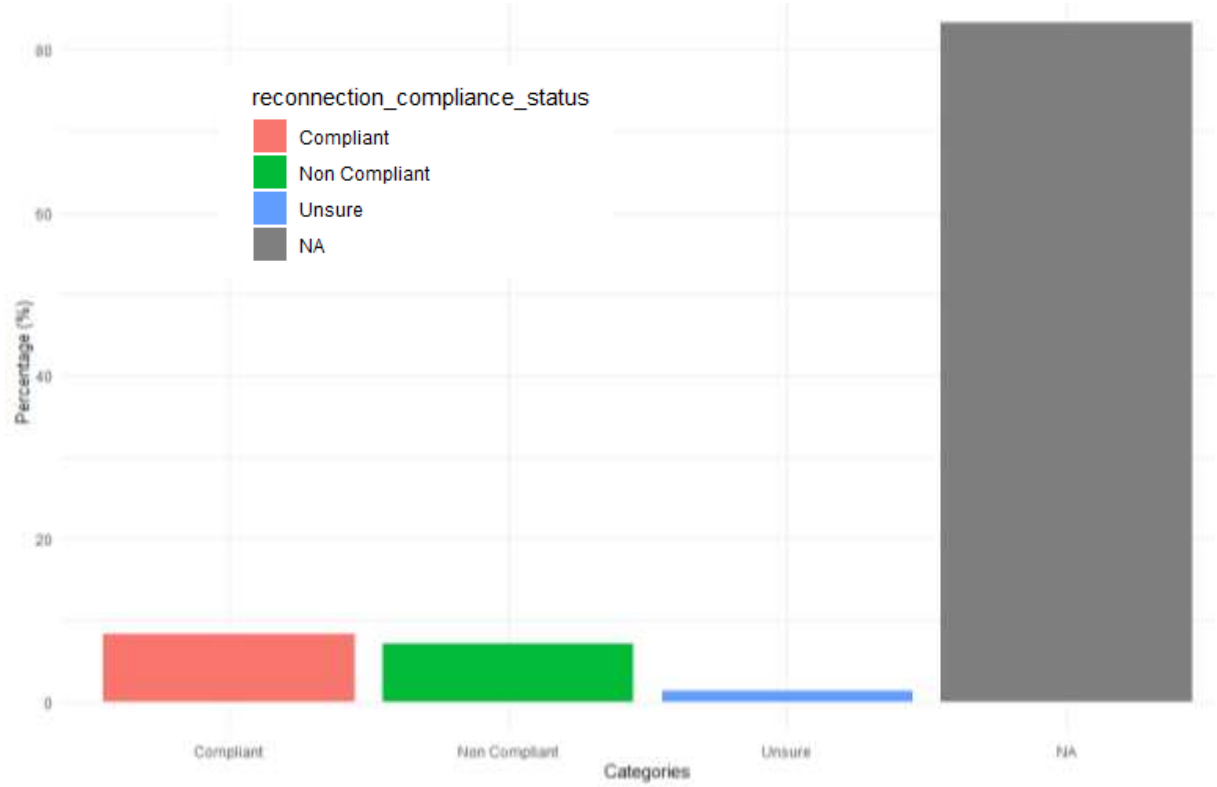
- Average voltage and frequency profiles

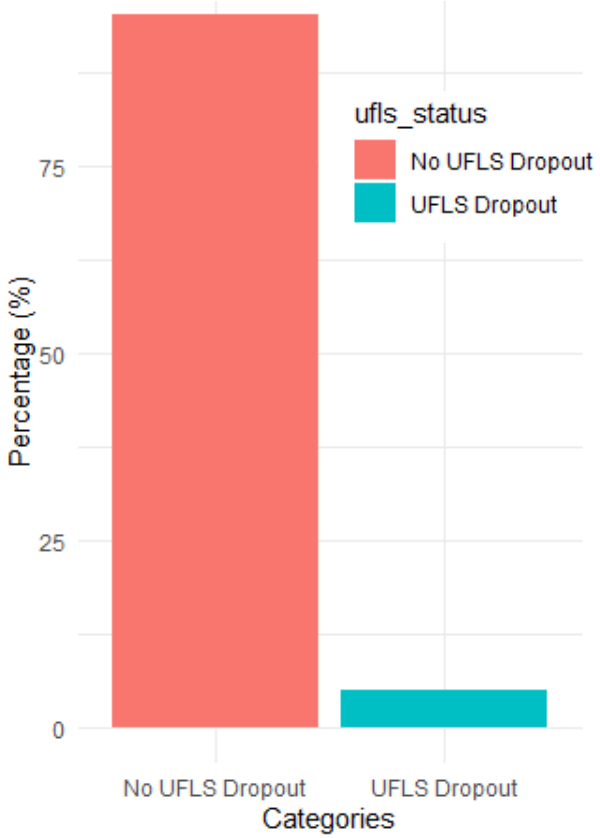




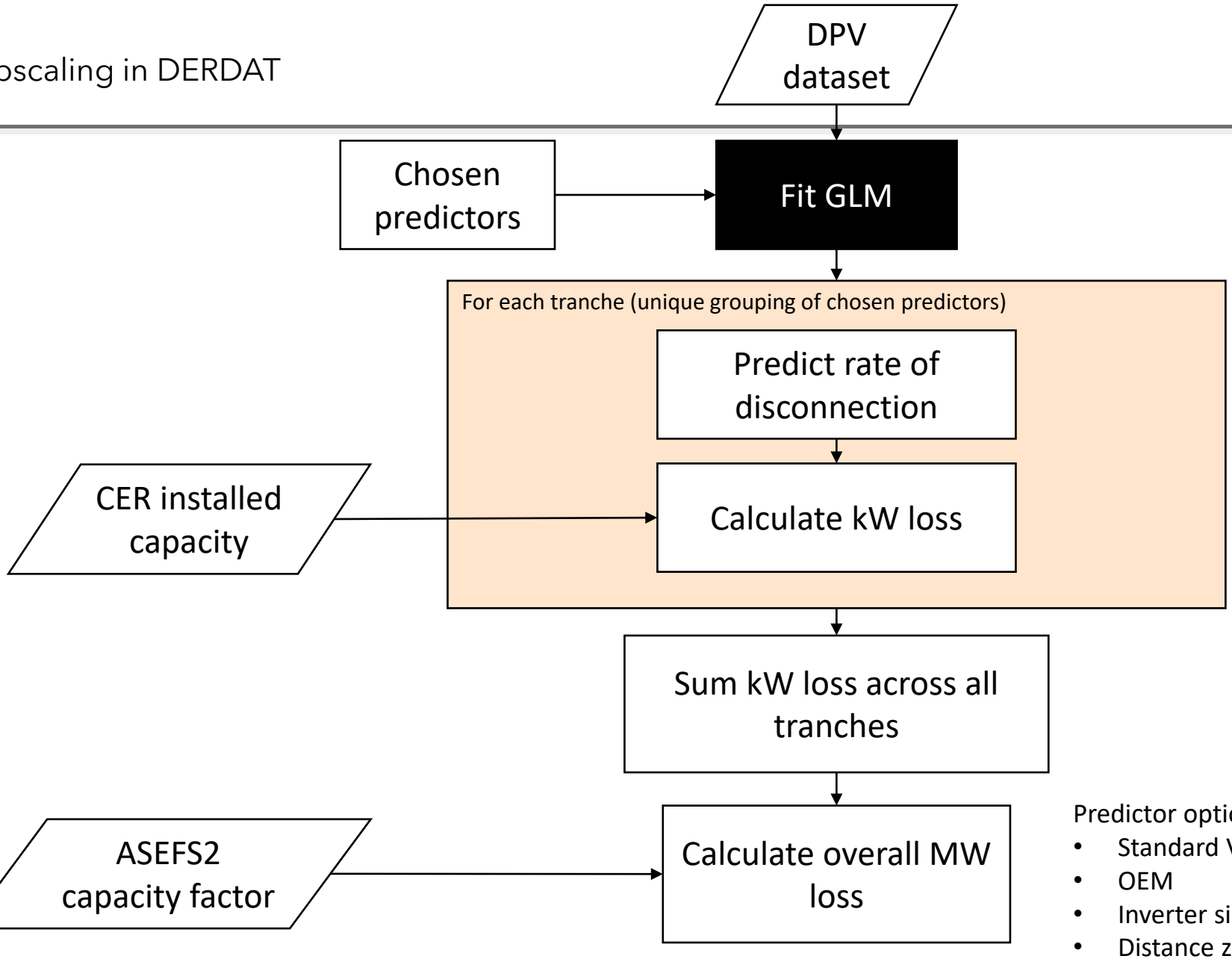
Case Study of DERDAT being used for disturbance analysis

Reconnection compliance status and UFLS dropout status are also identified





Upscaling in DERDAT



Predictor options

- Standard Version
- OEM
- Inverter size
- Distance zone

Summary

- To the author's knowledge, DERDAT is indeed the first ever tool developed to prioritize disturbance analysis for an electricity system with DERs.
  - It provides insight of possible security threats where mitigative measures could be proposed.
  - Nevertheless, DER also presents an opportunity to contribute to power grid
- Following are the primary outcomes from DERDAT
  - Defining the response category
  - Determining the reconnection status
  - Calculating disconnection percentages of DERs during disturbances
  - Analysing frequency-watt response during over-frequency
  - Identifying DERs with UFLS dropout
  - Upscaling and error estimation, visualization, export analysis
- Findings through DERDAT are used for:
  - Incident reports of AEMO
  - Inputs useful in AEMO "Operational decision making"
  - Provide inputs to improve the inverter compliance to improve system security.

Thank you

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