

Oscillation Events in the Great Britain Power System

Engineering Analysis Task Team

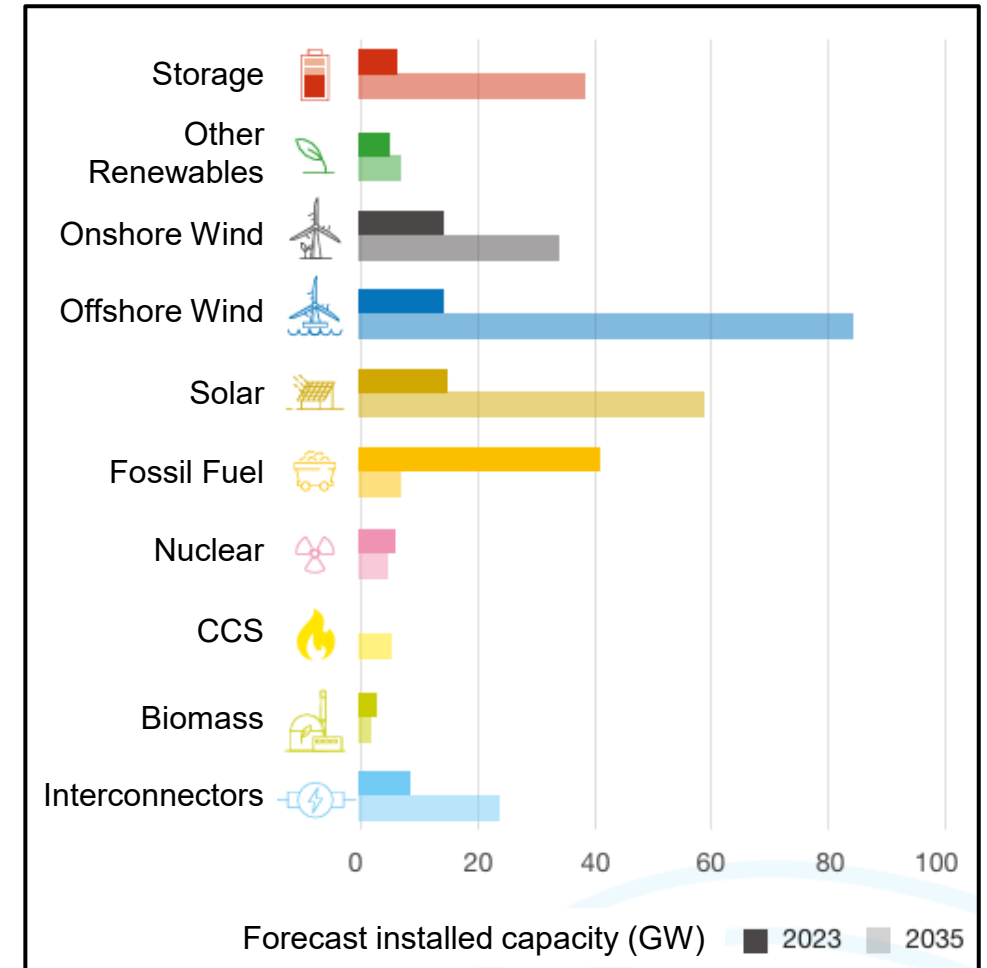
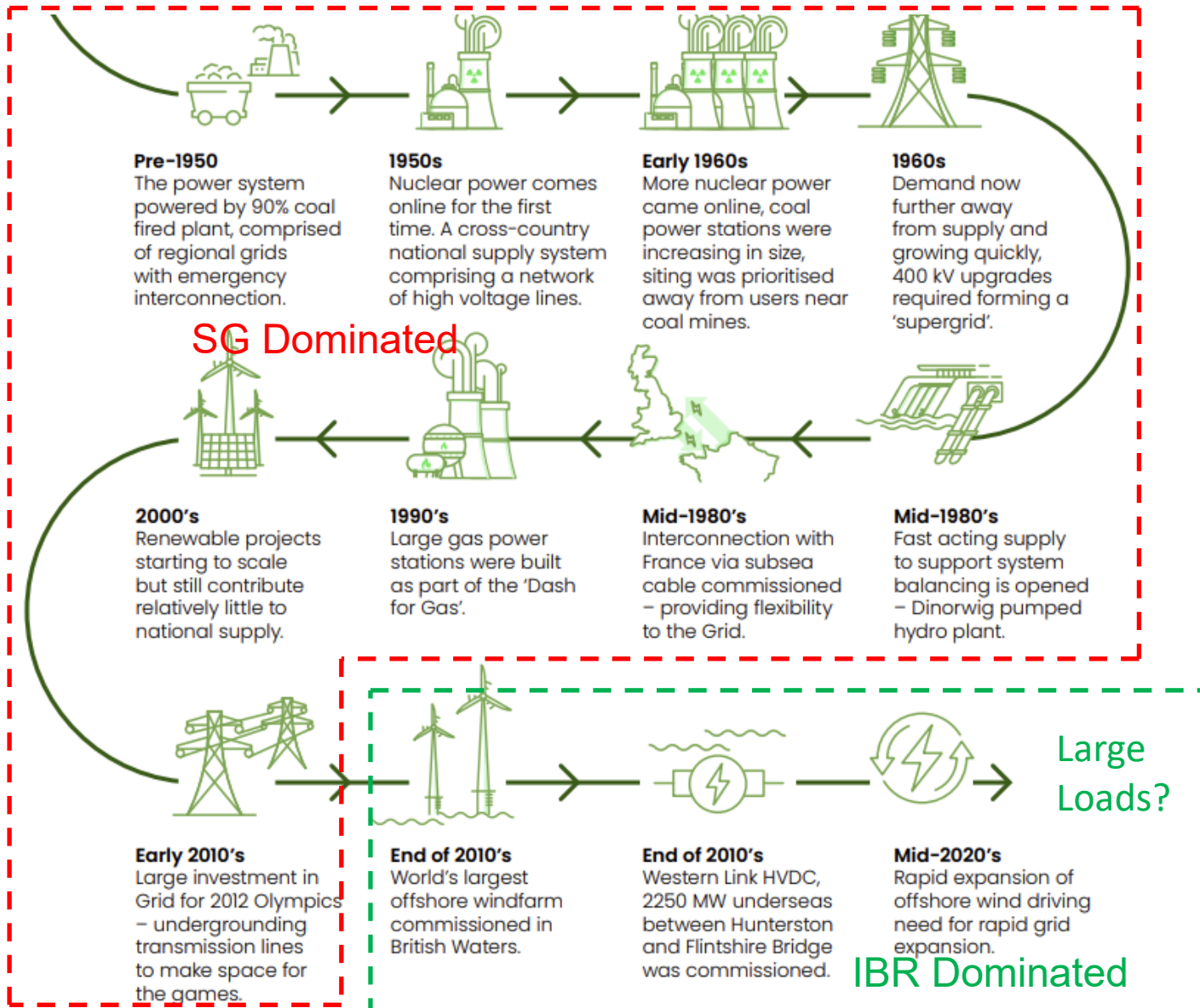
09th July 2026

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Agenda

1. GB Energy Landscape
2. Oscillation Events
3. Live Grid Monitoring and Visualisation Platform
4. Analysis / Early Warning of Oscillation Events
5. Key Findings and Recommendations

GB Energy Landscape

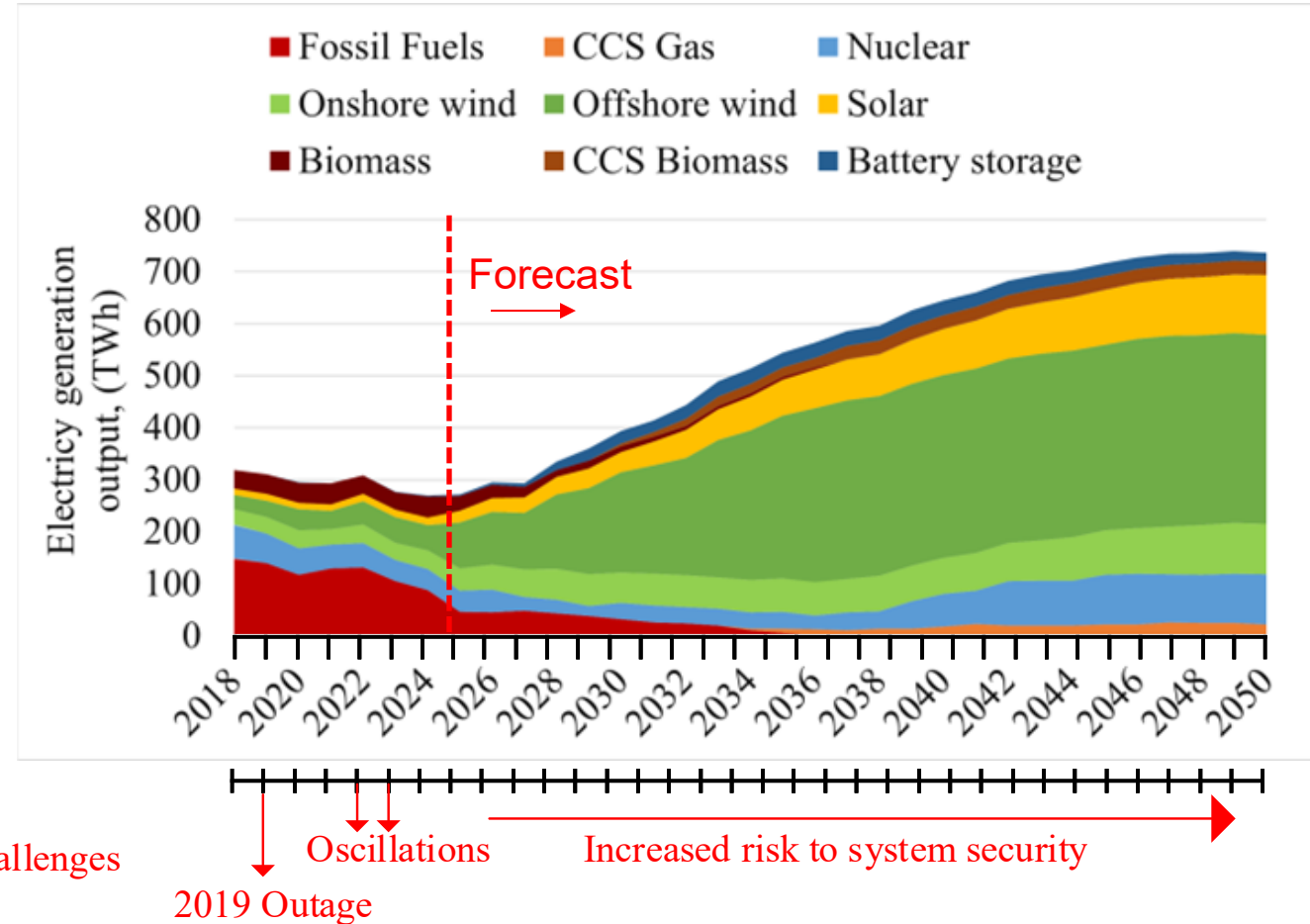
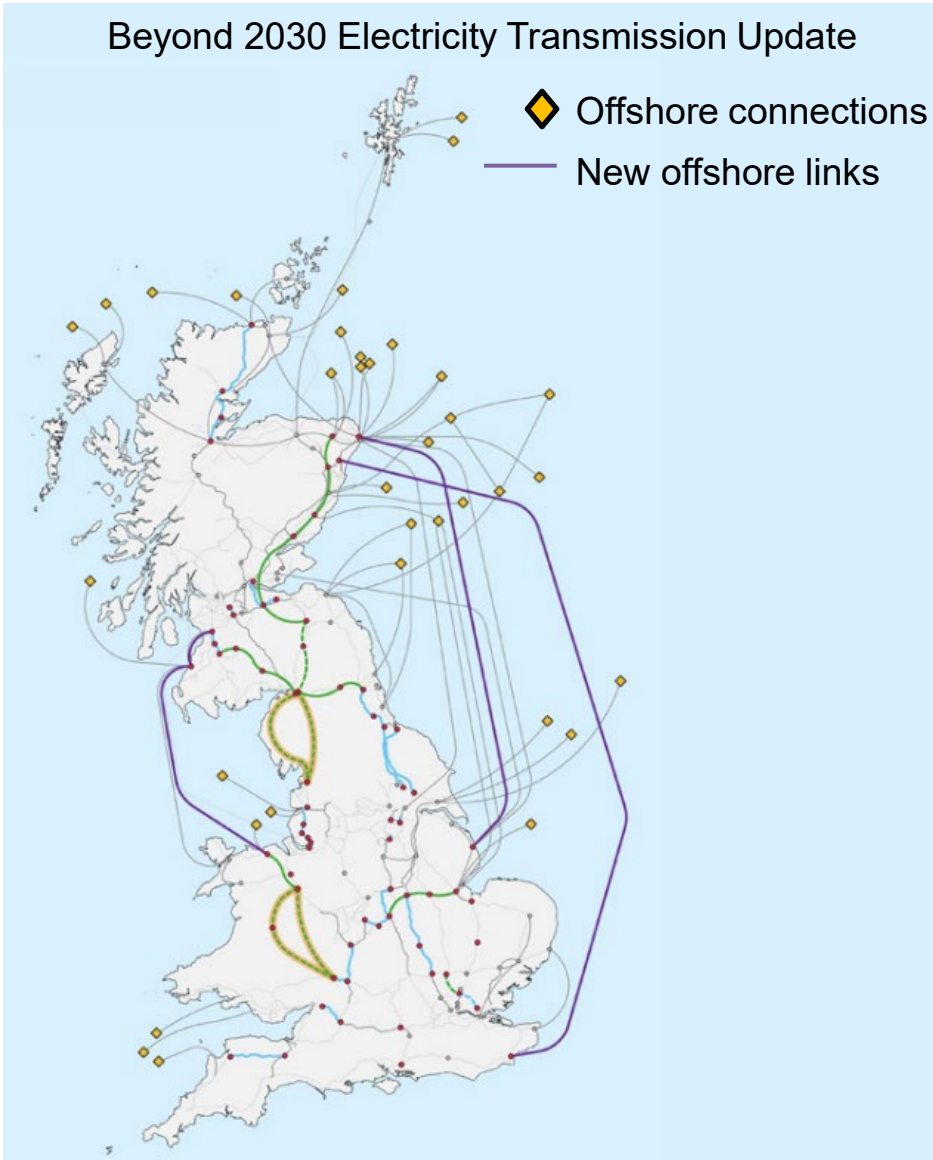


Figures adapted from

<https://www.neso.energy/publications/beyond-2030>

GB Energy Landscape

Beyond 2030 Electricity Transmission Update



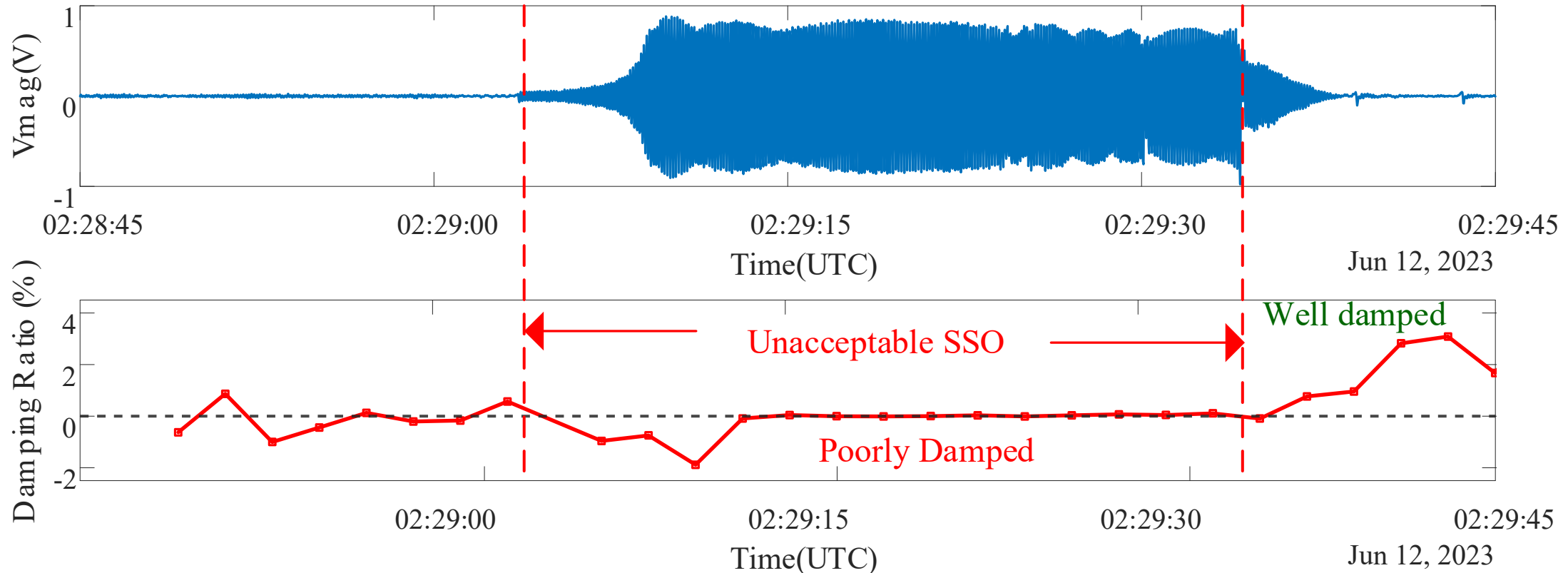
Oscillation Events in the GB Network

nationalgrid

National Electricity Transmission System Security
and Quality of Supply Standards (NETS SQSS)
and Grid Code

GSR018/GC0077: Sub- Synchronous Oscillations (SSO)

- ☐ Unacceptable SSO conditions: negative or insufficient damping
- ☐ Interactions between
 - Generation and Series compensation
 - Sub-synchronous control interactions



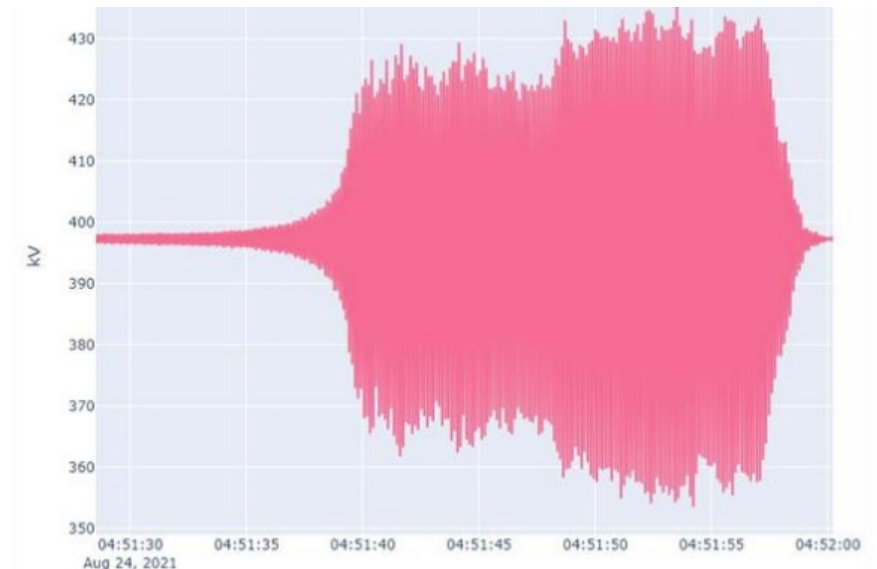
Oscillation Events in the GB Network

- ❑ Several SSO events occurred between 2021 to 2023
 - Frequency range 3 -20Hz
 - Control interactions
 - Mistuning of units' controllers
 - Phase-locked loop issues
- ❑ Summer 2023 SSO event
 - Higher magnitude and impact on the Scottish transmission network
 - Particular asset was the major contributor
 - Other assets unexpectedly disconnected or de-loaded
- ❑ Mitigation measures
 - Improved (EMT) modelling and screening studies
 - Real time monitoring and Situational awareness
 - Improved PMU coverage /
 - ***Tools and systems to provide early warning / oscillation monitoring***

Sub-synchronous oscillations in GB

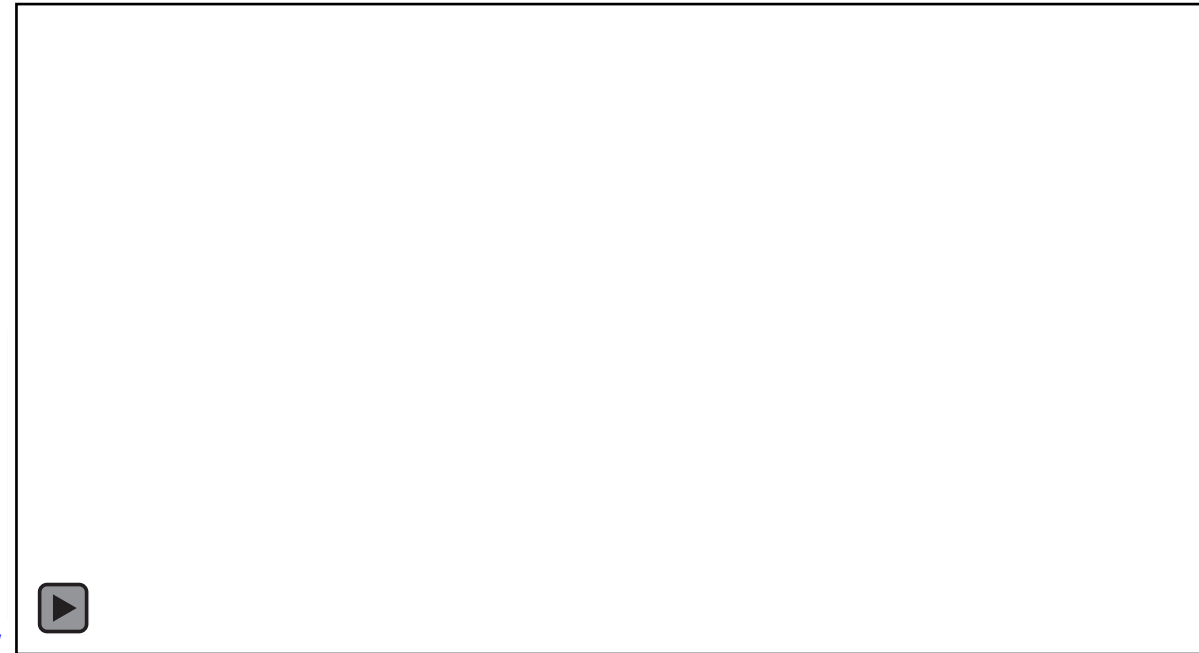
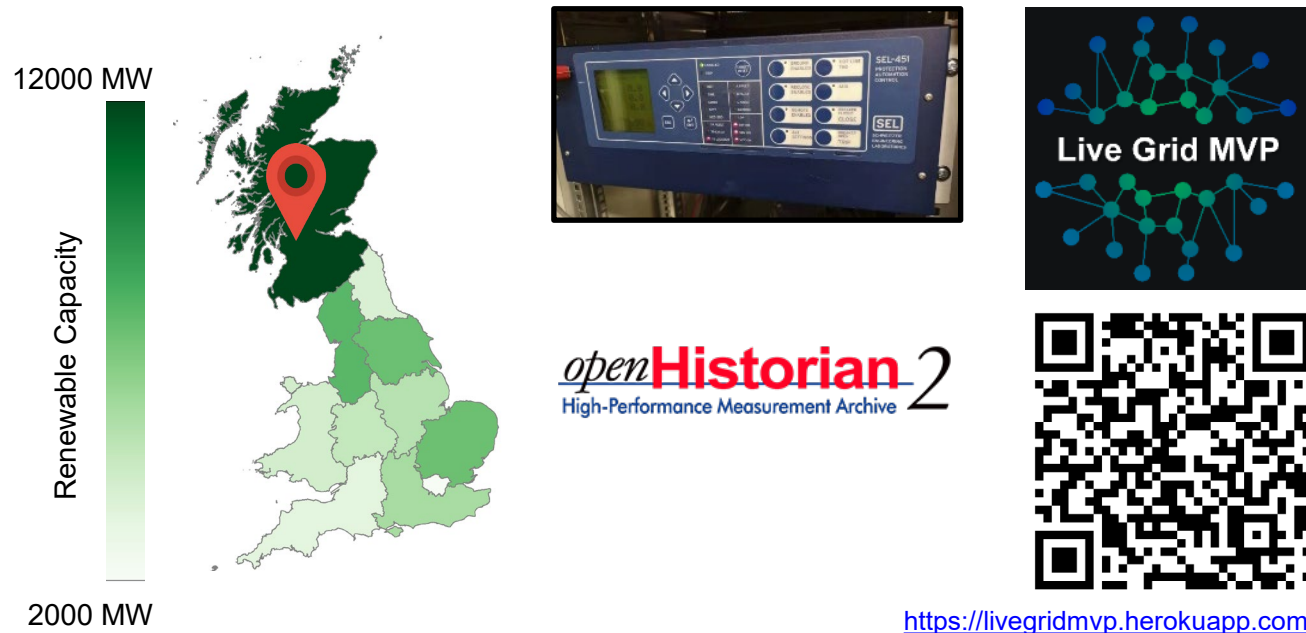
Current state and plans for future management
May 2024

ESO



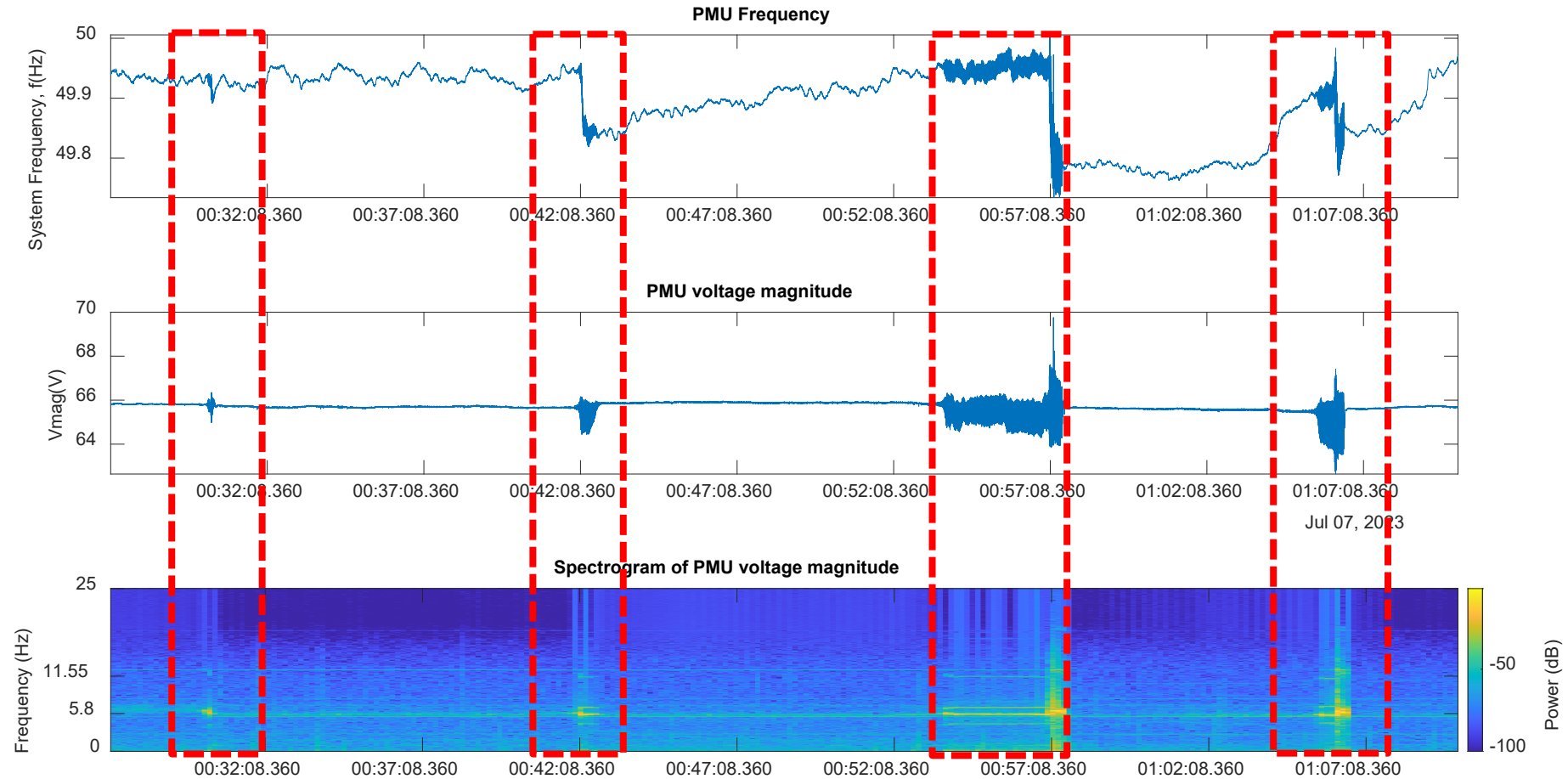
Live Grid Monitoring and Visualisation Platform (LGMVP)

- ☐ LV connected, 50 fps PMU
- ☐ Three-phase voltage phasors
- ☐ Demand and generation data
- ☐ Frequency and oscillation events



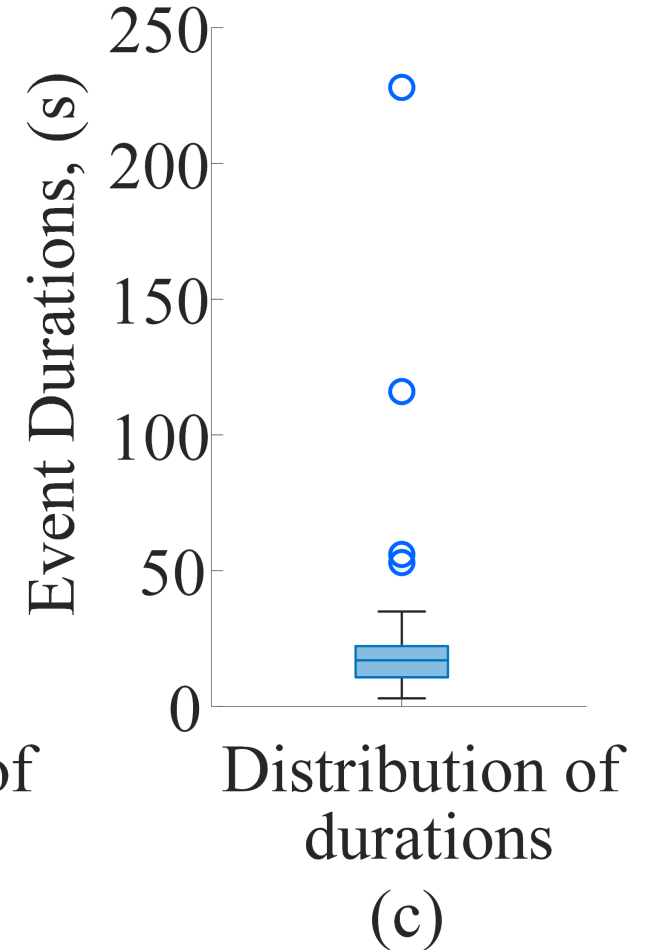
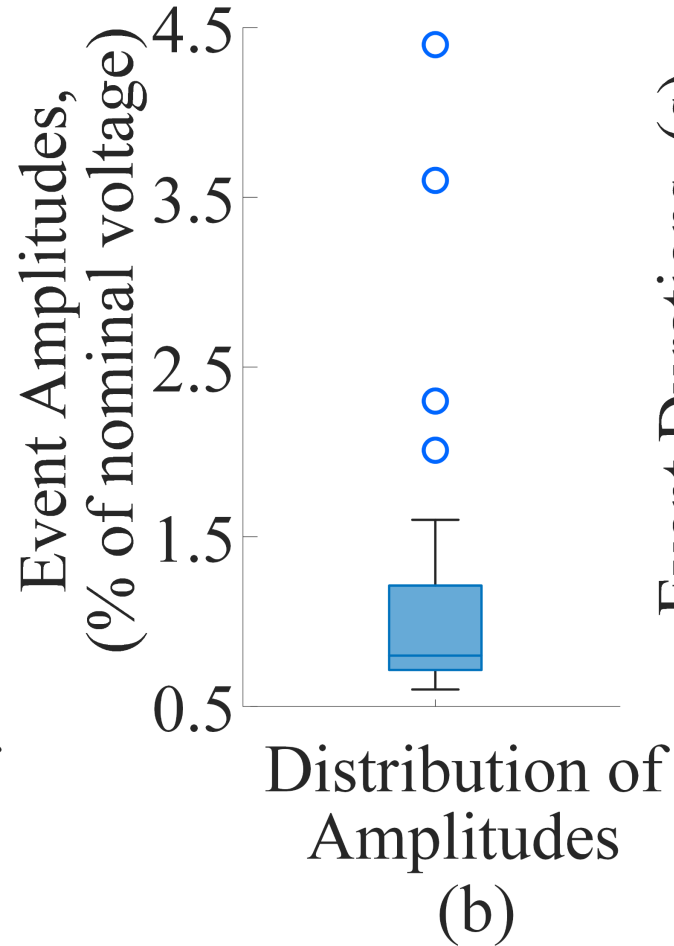
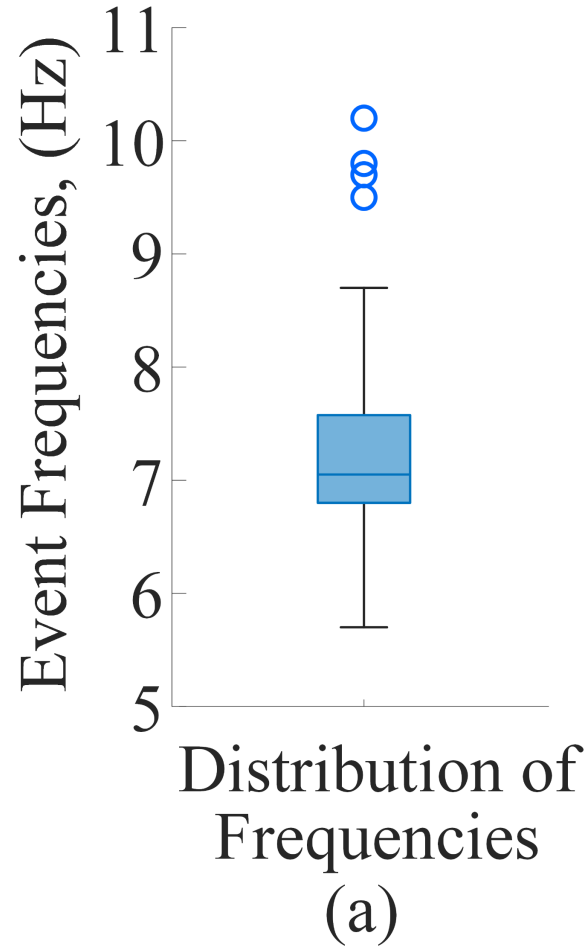
Analysis of Oscillation Events

- ❑ SSO events between April 2023 to October 2024
- ❑ SSOs observed in Voltage phasors and phasor frequency measurements



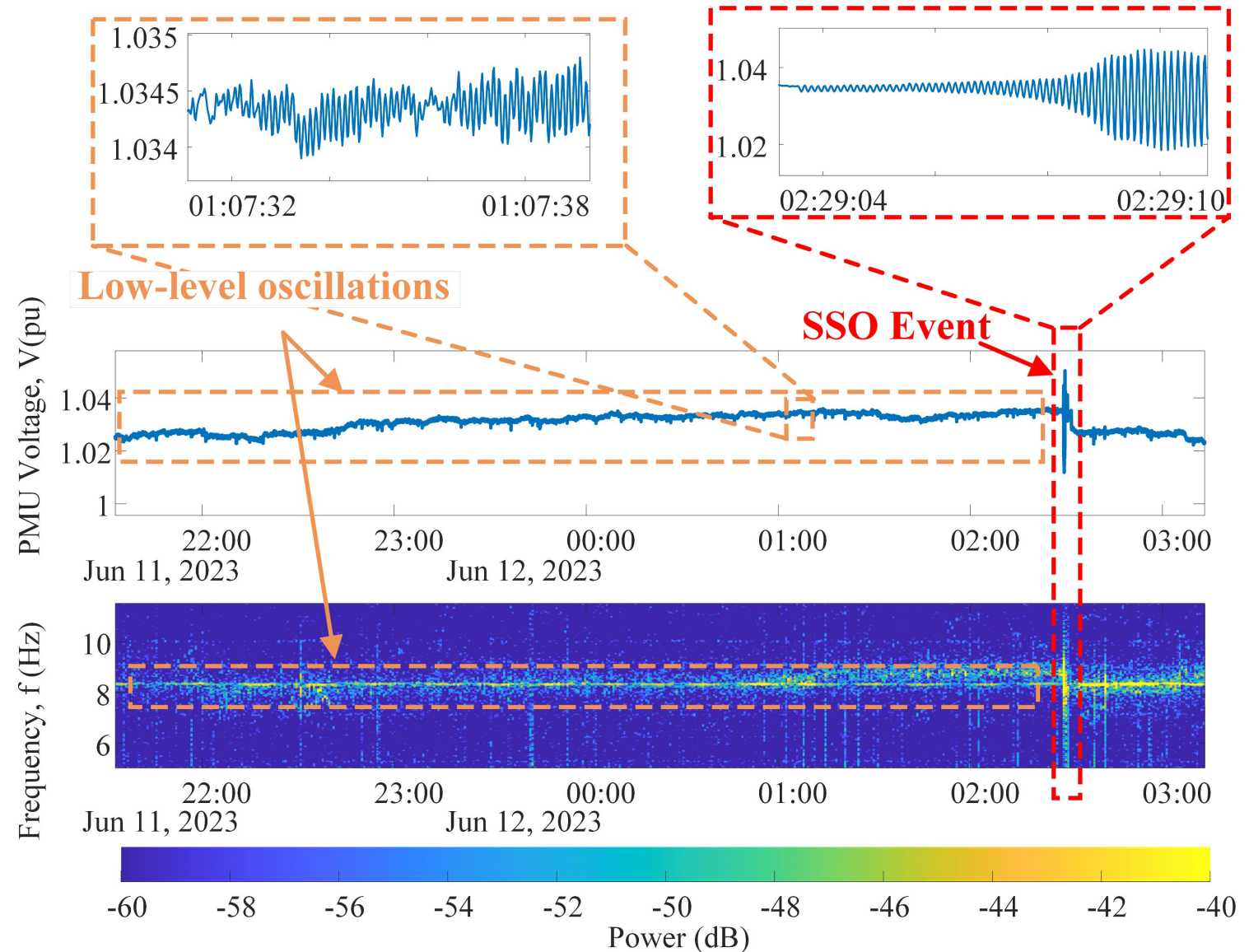
Analysis of Oscillation Events

- SSO events between April 2023 to October 2024
- ~5 to ~12 Hz SSO in rms phasor measurements observed
- Events between 0.5 – 1.5% of nominal voltage amplitude
- Events persist for several seconds

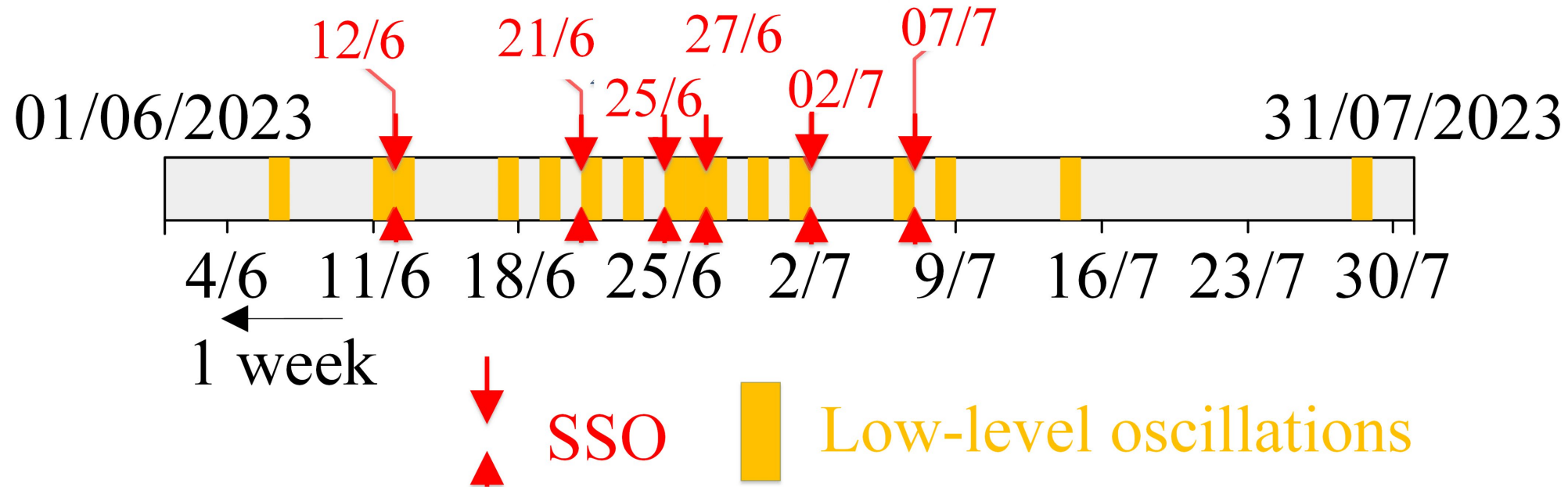


Analysis of Oscillation Events

- ☐ Low-amplitude, intermittent oscillations
- ☐ Close to noise level in time-domain
- ☐ Visible in frequency domain
- ☐ Low-level oscillations persist minutes to hours in summer 2023 SSO events



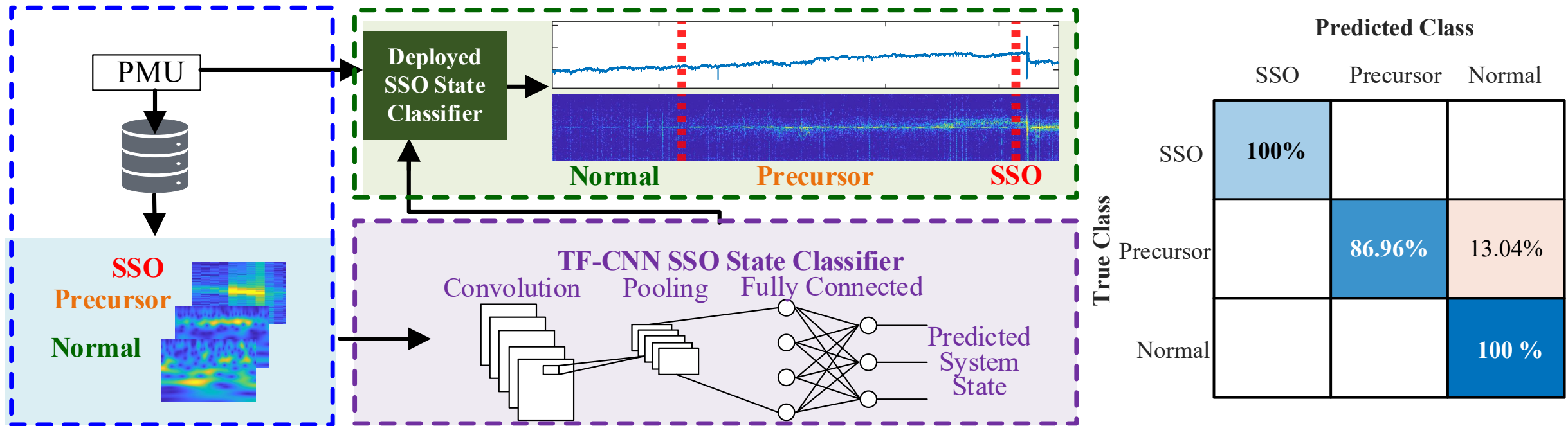
Analysis of Oscillation Events



- ❑ Low-level oscillations occur before SSO events
- ❑ Detection of low level oscillations can provide early warning of SSO conditions
- ❑ Low-level oscillations difficult to detect via time-domain / modal analysis
 - ❑ Close to noise level, makes threshold based detection difficult
 - ❑ Can frequency domain analysis and data-driven approach help?

Early Warning of Oscillation Events

- ❑ Pattern recognition based on PMU measurement spectrograms
- ❑ Proof of concept using real PMU measurement data



Limitations

- ❑ Need more data
 - Multiple PMU measurements
 - Waveform measurements – potential sub/super-synchronous components?
 - Incorporate system operating conditions

K. Kawal et al., "Data-driven Early Warning of Power System Oscillations in Great Britain," 2025 IEEE Power & Energy Society General Meeting (PESGM), Austin, TX, USA, 2025, pp. 1-5.

Key Findings

- ❑ Several SSO events in GB power system since 2021
 - Larger impacts in IBR rich Scotland transmission system
- ❑ Wide SSO frequency range ~3 to ~20 Hz
- ❑ Two 'distinct' phases of SSOs observed in past events
 - Large amplitude SSO event, easily detected in time-domain PMU measurements
 - Low-level, intermittent SSOs, close to noise level but visible in frequency domain measurements
- ❑ Low-level SSOs sometimes precede larger SSO events
 - ❑ Indication of marginal instability excited by 'normal' events?
 - ❑ Potential for early warning of oscillatory conditions
- ❑ PMU based early warning of SSOs possible
 - ❑ Frequency domain analysis and pattern recognition

Recommendations / Future Work

Recommendations

- ☐ Valuable insights on emerging SSOs can be gained in analysing historic PMU datasets
- ☐ Need for collaboration and data-sharing between academia and industry

Future Work

- ☐ Make LGMVP SSO event data open
- ☐ Discussions held with System Operator (SO) and (Scottish) Transmission Owners (TOs)
- ☐ Research project to analyse / incorporate multiple transmission PMUs ongoing.

THANK YOU

Questions?