DYNAMIC STABILITY MONTHLY REPORT

NORTH ISLAND – APRIL 2022

Transpower New Zealand Limited

April 2022

Keeping the energy flowing

TRANSPOWER

Version	Date	Change	
1.0	13/06/2022	Final	

	Position	Date
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Reviewed By:	Richard Sherry, Principal Engineer	13/06/2022

Contents

1   Executive summary

1.1   Purpose

The low frequency dynamic oscillatory stability of the power system has been analyzed using phasor measurement unit data for the month of April 2022. This monthly report presents these findings for April 2022 and follows the same methodology as other monthly reports. Together these reports can be used to track significant changes over time specifically aimed at drawing attention to changes of oscillation behavior.

If some oscillation modes have changed significantly, a more detailed investigation should be required to identify the cause (e.g. load growth, generator, controller, topology, etc.)

1.2   Objectives

This monthly report's objective is to highlight significant modes on the network to help continuously assess the changes of the modes over time and changes in system conditions in order to trigger more detailed investigations in case of poor damping events.

2   Current status and observations

Mode freq.	Signal	Comments	Observations in April 2022
0.04 Hz	All-f	Governor modes	No significant change over the month
0.25 Hz	All-f Most-p	Probably control modes, and not electro-mechanical	Relatively high number of occurrences Some periods of low damping
0.5 – 0.6 Hz	All-f Most-p	Possibly Inter area modes	Typically well damped
0.7-0.9 Hz	All-f Most-p	Inter-area and Inter-station modes	High number of occurrences
1.7-1.9 Hz	All-f All-p	Inter-station and Local modes	High number of occurrences

3   Detailed plots for April 2022

3.1   Mode frequency histograms

Remark: the frequency histograms are shown for a frequency range [0.05 2Hz]
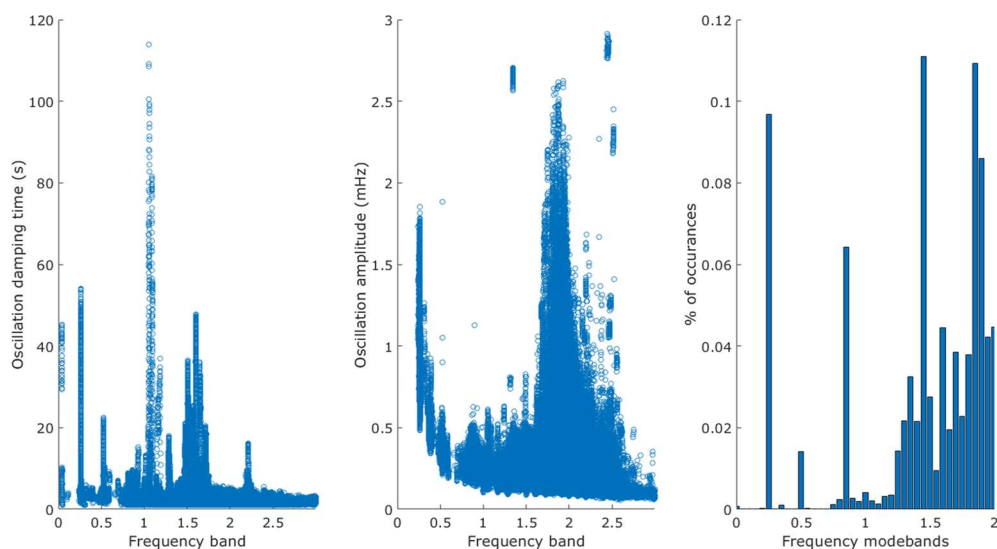
3.1.1   PMU Frequency Data

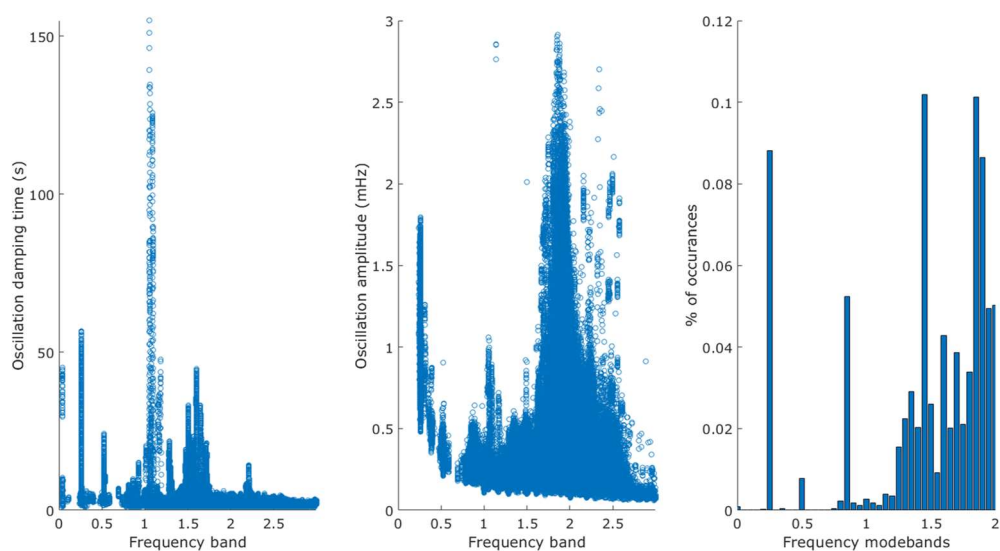**Figure 1: Bunnythorpe mode damping, mode amplitude, and frequency histogram using frequency data**

Figure 2: Haywards mode damping, mode amplitude, and frequency histogram using frequency data
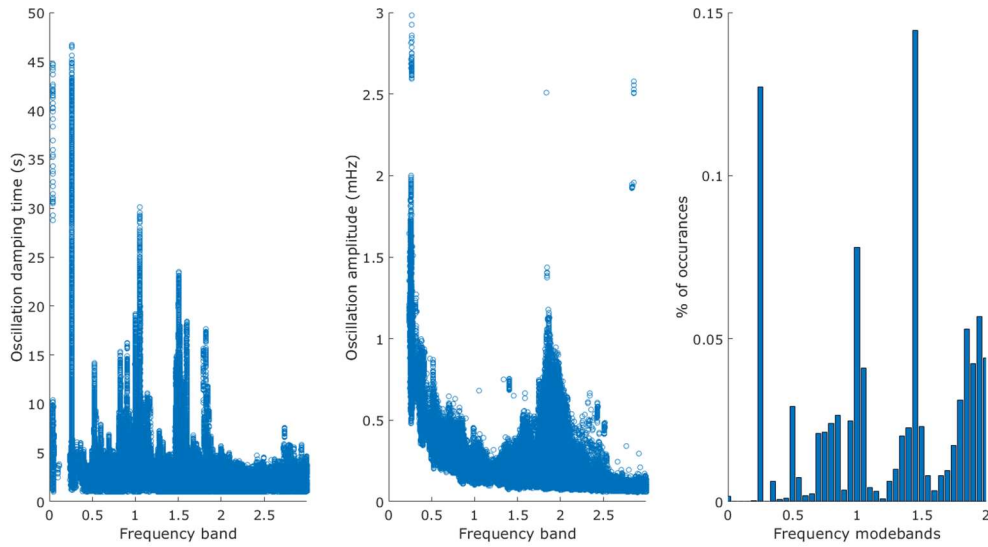
Figure 3: Huntly mode damping, mode amplitude, and frequency histogram using frequency data
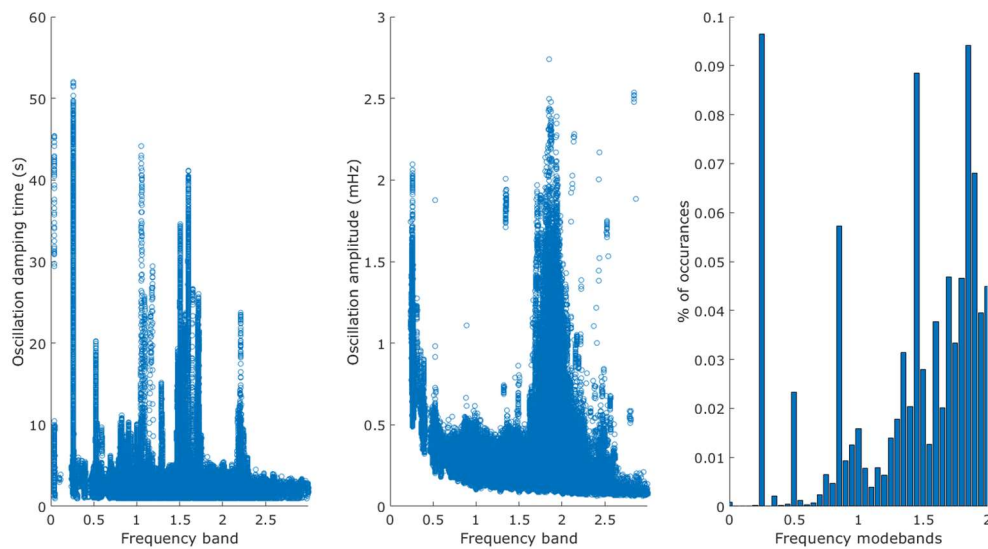

Figure 4: Stratford mode damping, mode amplitude, and frequency histogram using frequency data
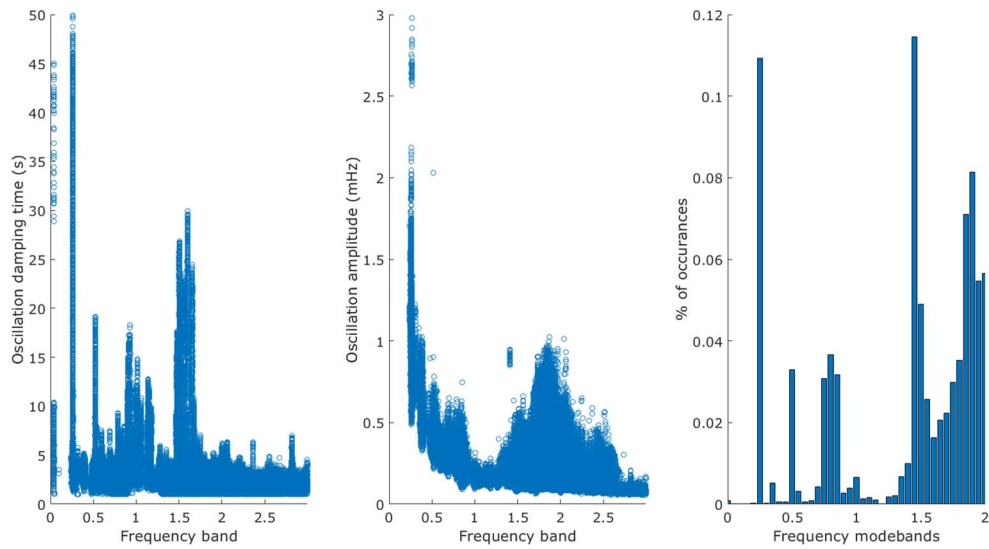
Figure 5: Wairakei mode damping, mode amplitude, and frequency histogram using frequency data
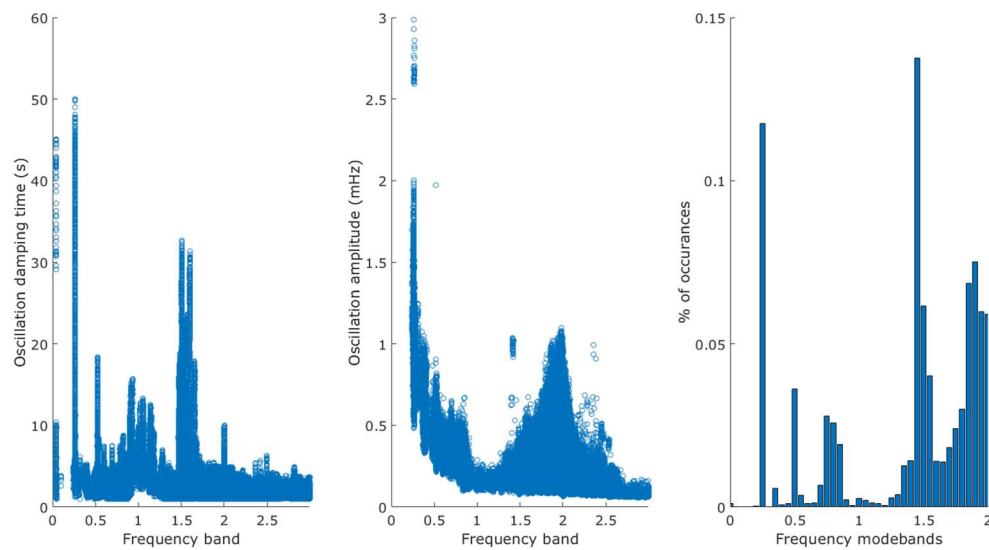

Figure 6: Whakamaru mode damping, mode amplitude, and frequency histogram using frequency data
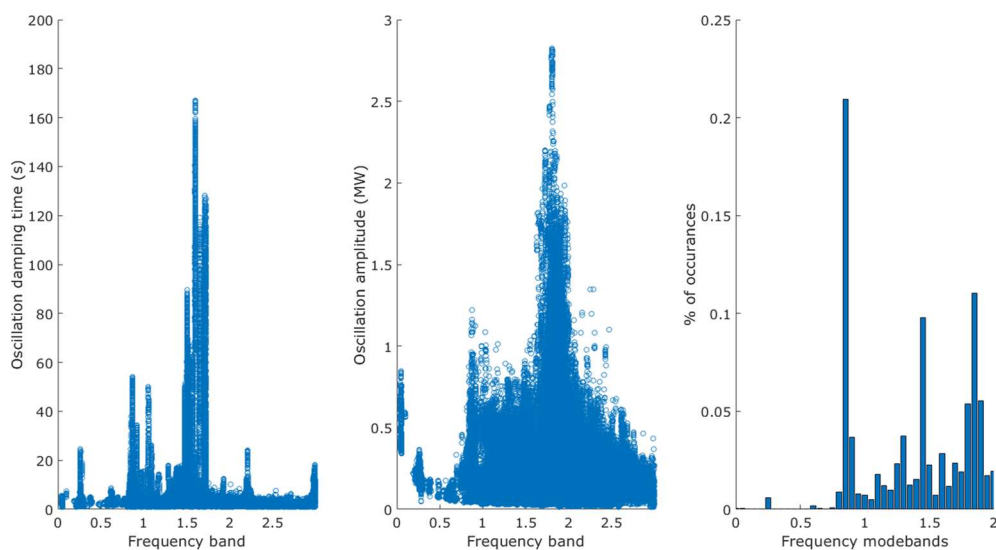
3.1.2 PMU Active Power Data

Figure 7: Bunnythorpe mode damping, mode amplitude, and frequency histogram using active power data
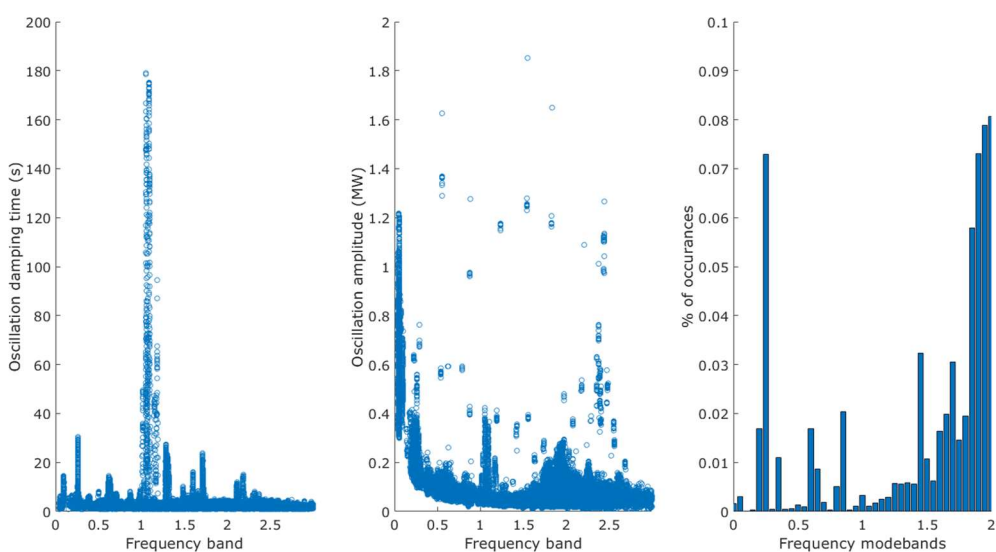

Figure 8: Haywards mode damping, mode amplitude, and frequency histogram using active power data

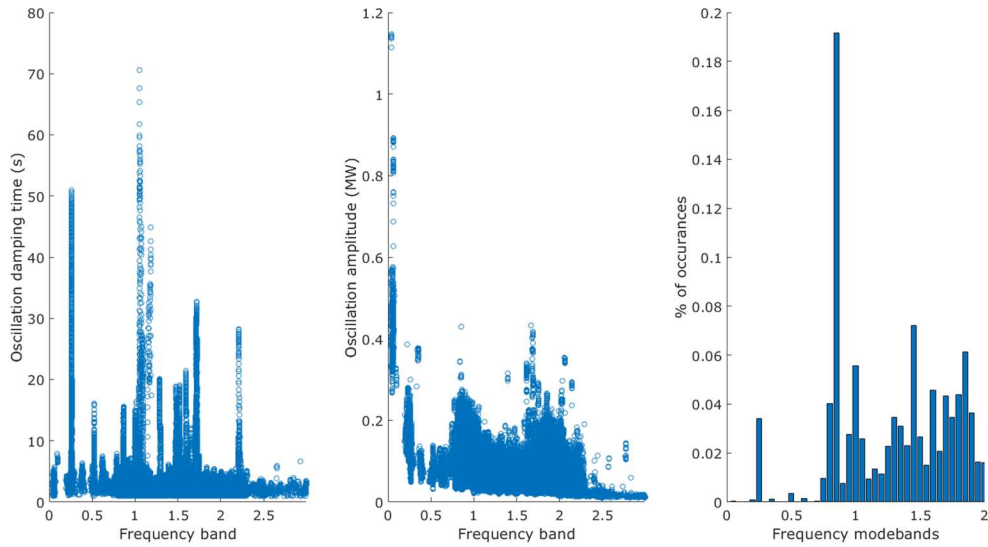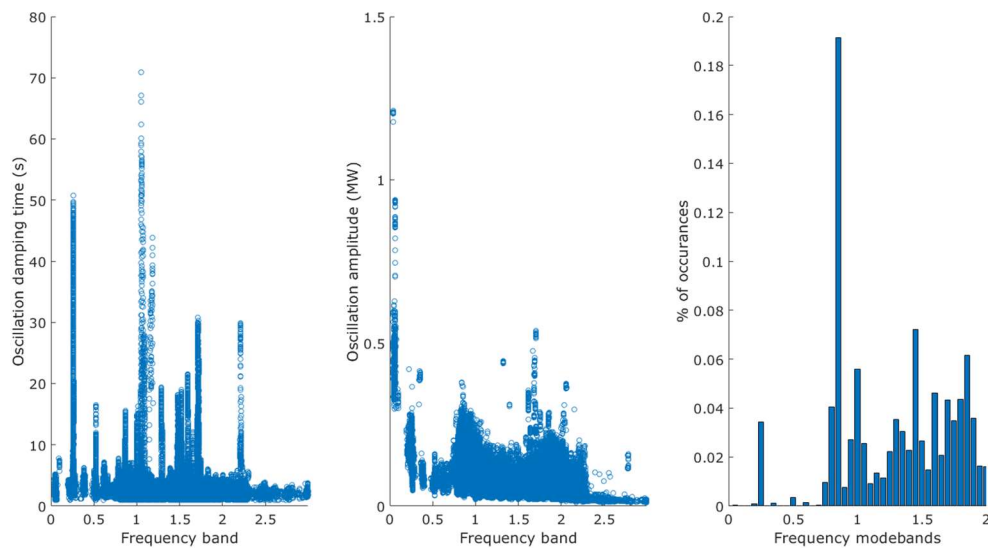**Figure 9: Huntly mode damping, mode amplitude, and frequency histogram using active power data**

Figure 10: Stratford mode damping, mode amplitude, and frequency histogram using active power data
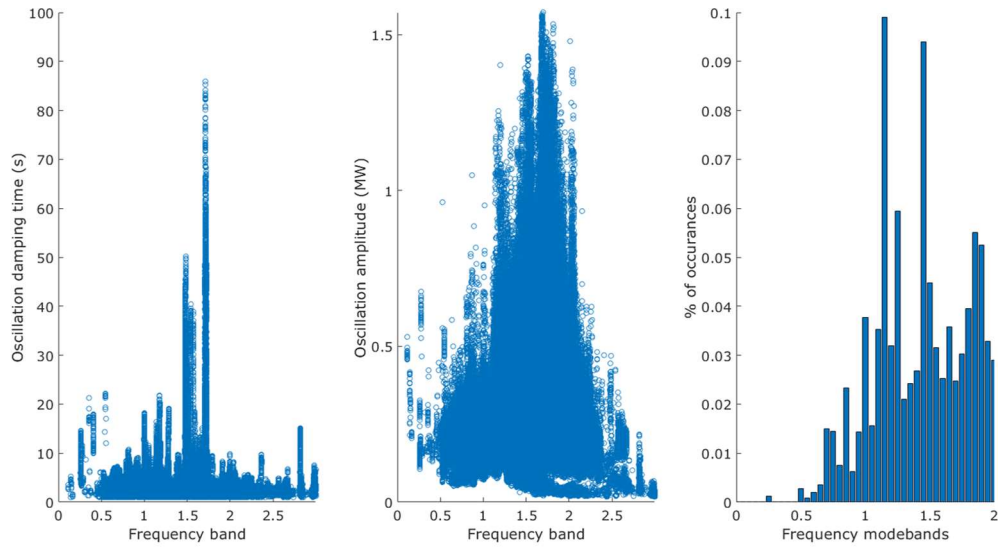
Figure 11: Wairakei mode damping, mode amplitude, and frequency histogram using active power data
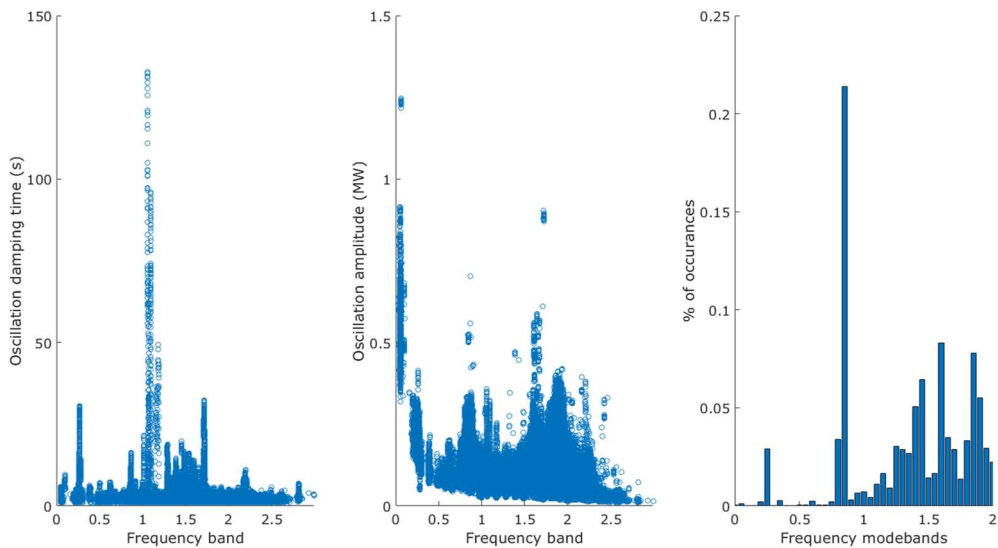

Figure 12: Whakamaru mode damping, mode amplitude, and frequency histogram using active power data

3.1.3   Observations using the frequency histograms

From the histograms, it can be observed that some modes have a large percentage of occurrences. One distinct mode at approximately 1.8 Hz can be observed in the April data. An additional mode observed in April data is 1.0 Hz with high oscillation damping time however it is not a concern at this level.

The frequency histograms usually do not contain enough information to precisely define all modes of interest however, the following approximate modes are observed from the data:

0.25 Hz

0.9 Hz

1.45 Hz

1.8 Hz

3.2   Defining mode bands

Mode bands are used to separate the different oscillating modes. Nevertheless, using the mode frequency is not a restrictive enough criterion to separate modes. Hence, several modes can still coexist in the same frequency band.

The following mode bands are defined:

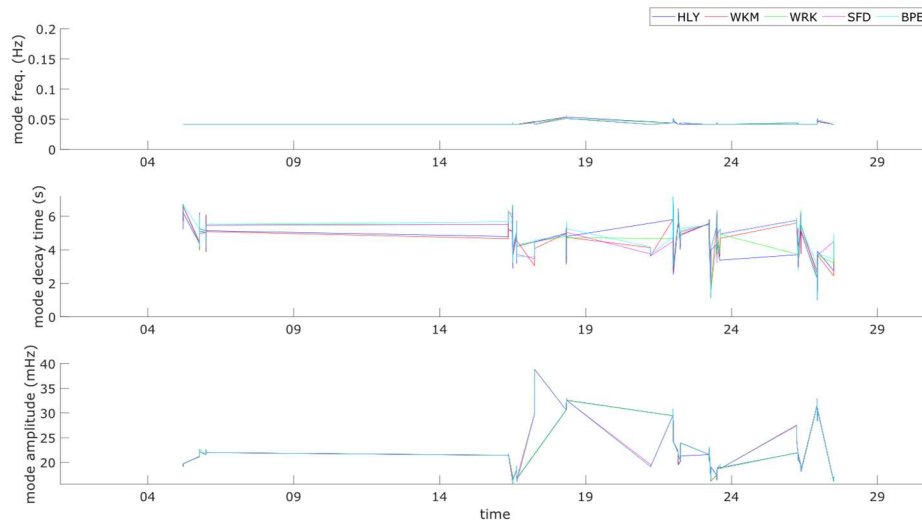| 0.0-0.2 Hz	0.2-0.6 Hz	0.6-0.9 Hz	0.9-1.2 Hz	1.2-1.8 Hz	1.8-2.4 Hz

3.3   Mode band 1: [0.0 – 0.2 Hz]

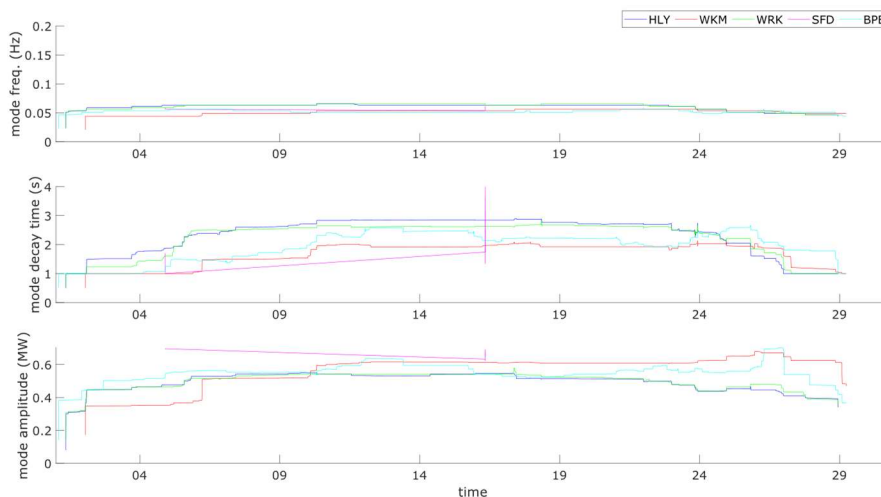**Figure 13: PhasorPoint results for the modeband [0.0 0.2 Hz] using PMU frequency data**

Figure 14: PhasorPoint results for the modeband [0.0, 0.2 Hz] using PMU active power data

Using PMU frequency

- 0.04 Hz (governor) mode observed.
- For these persistent very low frequency modes the envelope decay times reported by the software are misleadingly short.
- Maximum oscillation amplitude ~40 mHz at certain period.

Using active power:

- 0.05 Hz mode at all substations.
- Decay time ranges from 2 seconds to 4 seconds for individual modes.
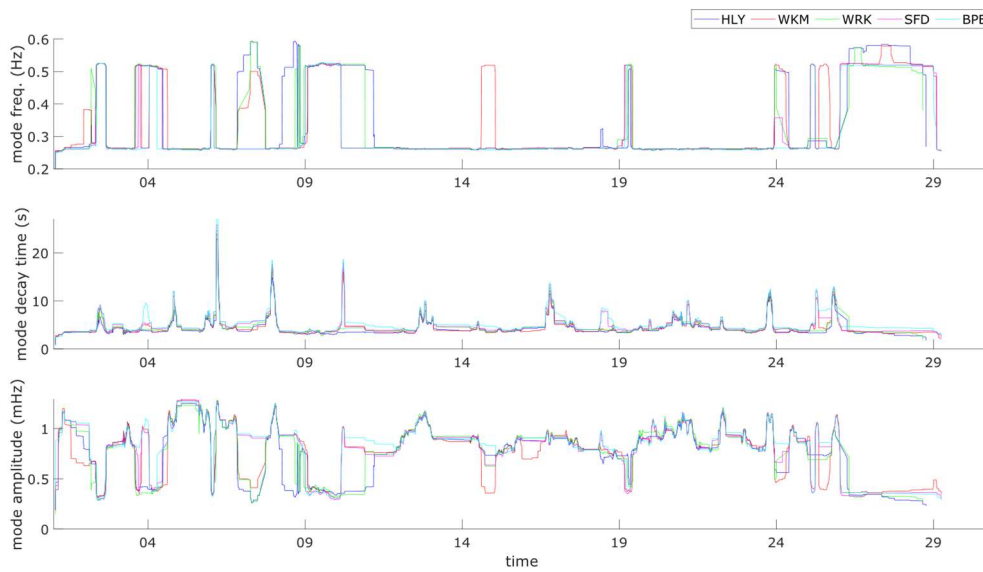- Maximum oscillation amplitude ~600 kW.

3.4 Mode band 2: [0.2 – 0.6 Hz]

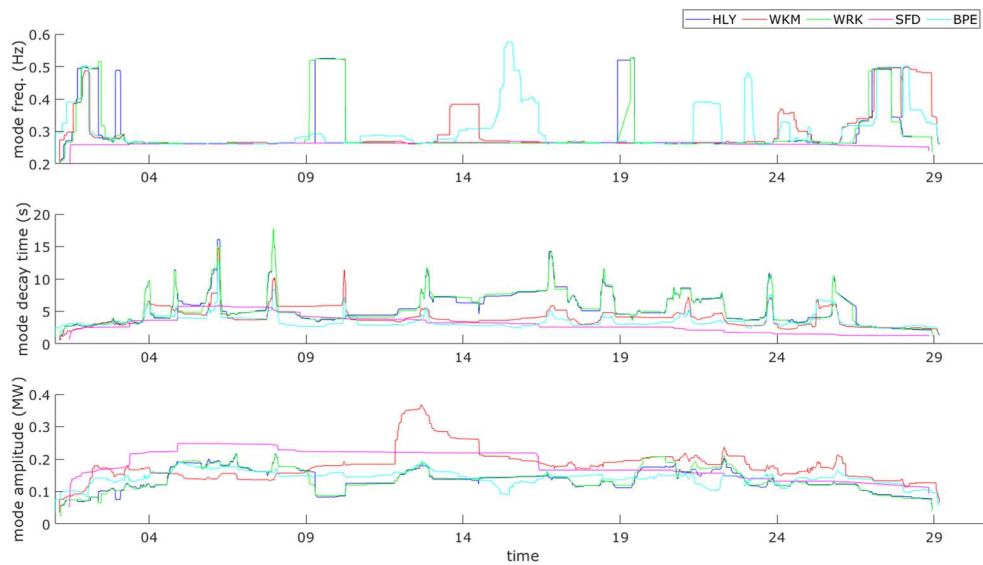**Figure 15: PhasorPoint results for the modeband [0.2, 0.6 Hz] using PMU frequency data**

Figure 16: PhasorPoint results for the modeband [0.2, 0.6 Hz] using PMU active power data.

Using PMU frequency

- 0.25 Hz and 0.5 Hz modes observed at all stations. Decay time around 5-10 seconds, increasing to 15-25 seconds at certain periods for individual modes.

Using active power:

- 0.25 Hz modes observed at all stations, and 0.4 Hz, 0.6 Hz modes observed at certain stations.

- Decay time around 5-10 seconds, increasing to 20 seconds at certain periods.

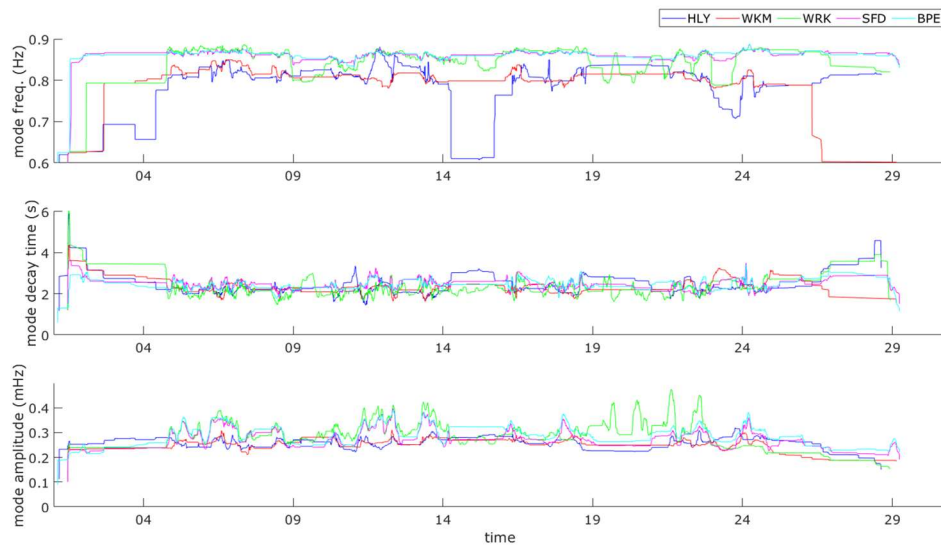- Maximum oscillation amplitude ~350 kW.

3.5 Mode band 3: [0.6 – 0.9 Hz]

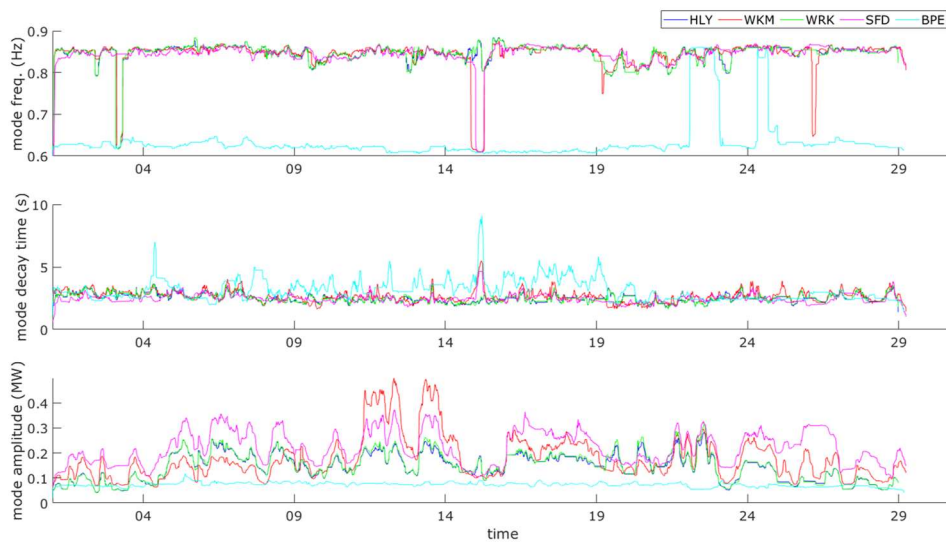**Figure 17: PhasorPoint results for the modeband [0.6, 0.9 Hz] using PMU frequency data**

Figure 18: PhasorPoint results for the modeband [0.6, 0.9 Hz] using PMU active power data

Using PMU frequency:

- Modes 0.65, 0.8, and ~0.9 Hz observed.
- Decay time typically between 2-4 seconds at most sites occasionally peaking as high as 6 seconds.

Using active power

- Distinct modes 0.65 Hz, 0.8 Hz, and 0.85 Hz observed.
- Decay time typically between 2-5 seconds at most sites occasionally increasing to 10 seconds for individual modes.
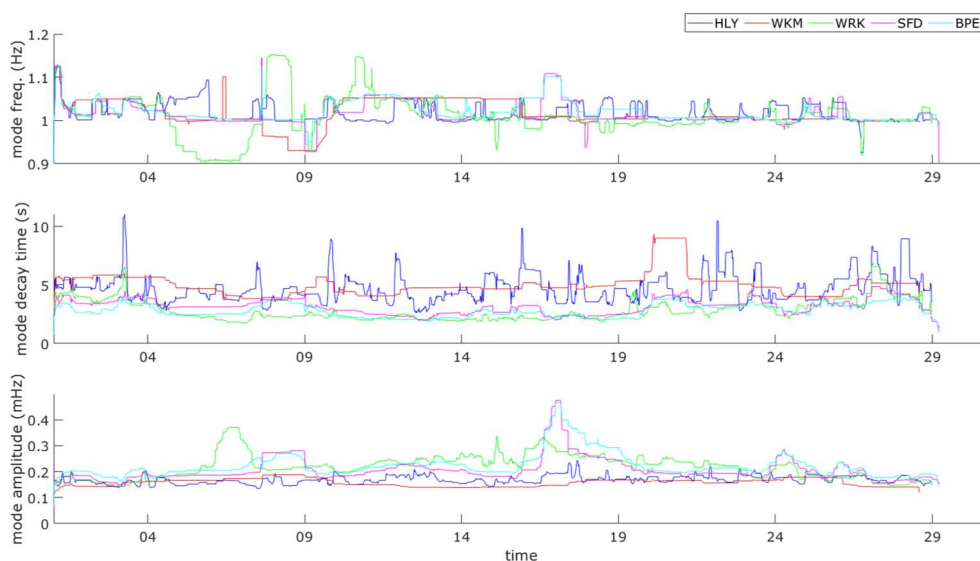- Maximum oscillation amplitude ~500 kW.

3.6 Mode band 4: [0.9 – 1.2 Hz]

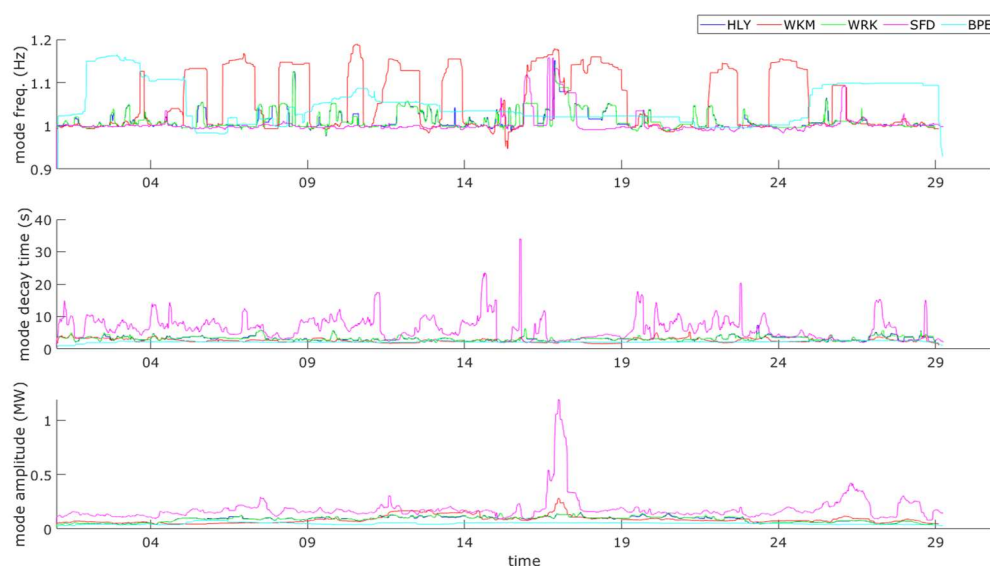**Figure 19: PhasorPoint results for the modeband [0.9, 1.2 Hz] using PMU frequency data**

Figure 20: PhasorPoint results for the modeband [0.9, 1.2 Hz] using PMU active power data

Using PMU frequency:

- Distinct modes observed 0.95 Hz, 1.0 Hz, 1.05 Hz, and 1.1 Hz

- Most modes decay time between 2-5 seconds increasing to 10 seconds for individual modes.

Using active power

- Most modes are typically well damped except 1.0 Hz exhibited a relatively high decay time around 10 seconds increasing to 30 seconds at certain periods.

- Maximum oscillation amplitude ~1 MW reported briefly.
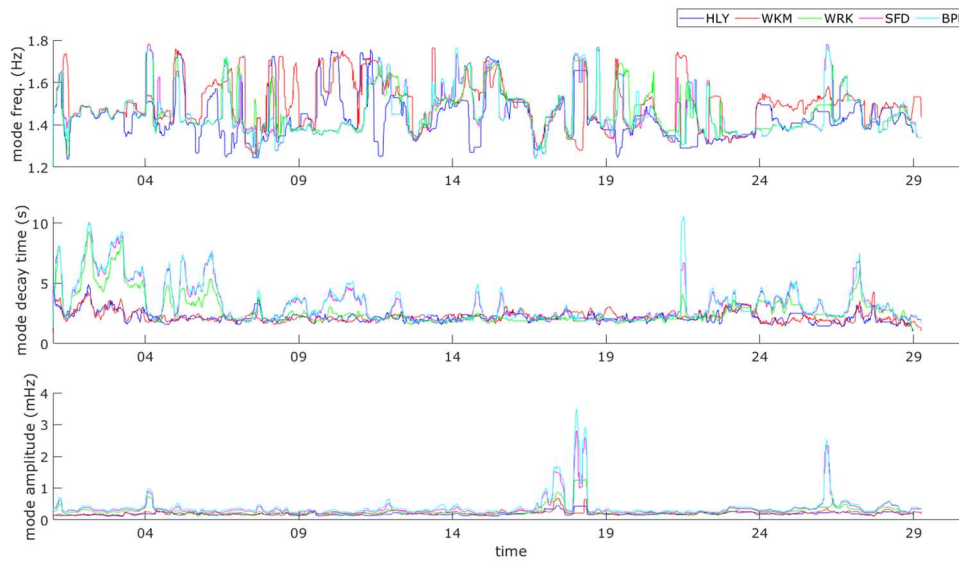
3.7 Mode band 5: [1.2 - 1.8 Hz]

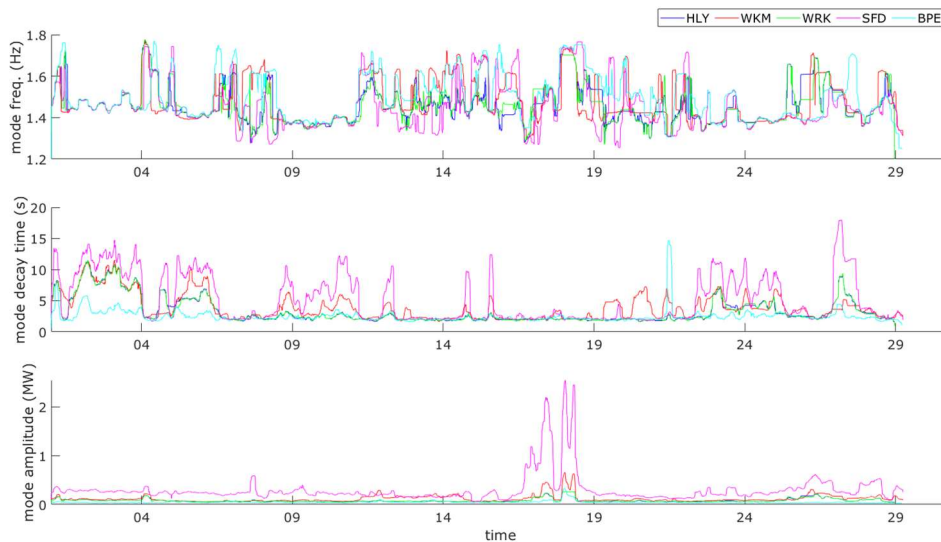**Figure 21: PhasorPoint results for the modeband [1.2, 1.8 Hz] using PMU frequency data**

Figure 22: PhasorPoint results for the modeband [1.2, 1.8 Hz] using PMU active power data

Using PMU frequency:

▪ Distinct modes around ~1.3 Hz, 1.4, 1.5 Hz, and 1.8 Hz

▪ Most modes decay time is around 2 seconds increasing to 10 seconds for individual modes.

Using active power:

▪ Distinct modes around ~1.3 Hz, 1.5 Hz, and 1.6, and 1.8 Hz

▪ Decay time around 2 seconds for all modes increasing to 15-20 seconds for individual modes.

▪ Maximum oscillation amplitude around 2.5 MW reported briefly.
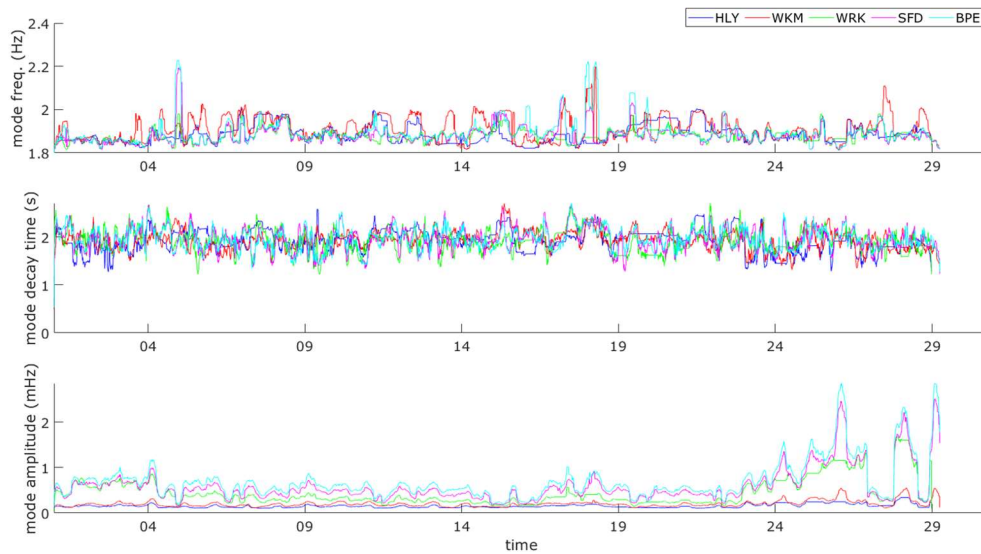
3.8 Mode band 6: [1.8 – 2.4 Hz]

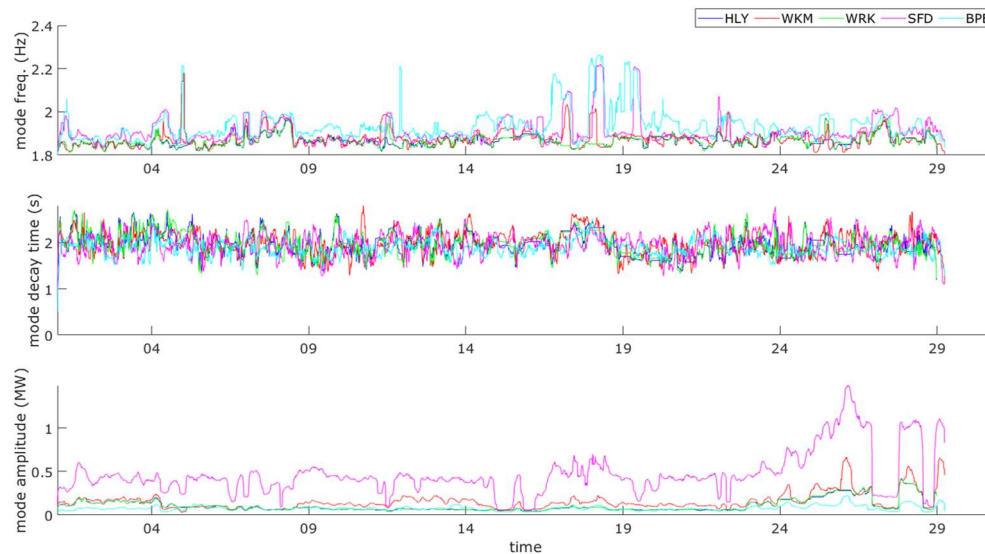**Figure 23: PhasorPoint results for the modeband [1.8, 2.4 Hz] using PMU frequency data**

Figure 24: PhasorPoint results for the modeband [1.8, 2.4 Hz] using PMU active power data

Using PMU frequency:

- Modes 1.9 Hz, 2.0 Hz, and 2.2 Hz observed.
- All modes in this band are relatively well-damped.

Using active power:

- Maximum oscillation amplitude ~1.5 MW predominantly at Bunnythorpe.