Powerco's Aeolian Vibration Trial

- What lead to the trial
- Steps taken
- Observations
- Future steps

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POWERCO

Challenges

- Aging fleet of distribution conductors
- Data is sparse
- Multiple conductor types
- Different installation methods and repair history
- Varying environmental conditions

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- Aging fleet of distribution conductors
- Data is sparse
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What lead to starting the trial

- Unknown locations
- Installing dampers is not feasible for entire network
- Seen damage
- Heard and seen the vibration

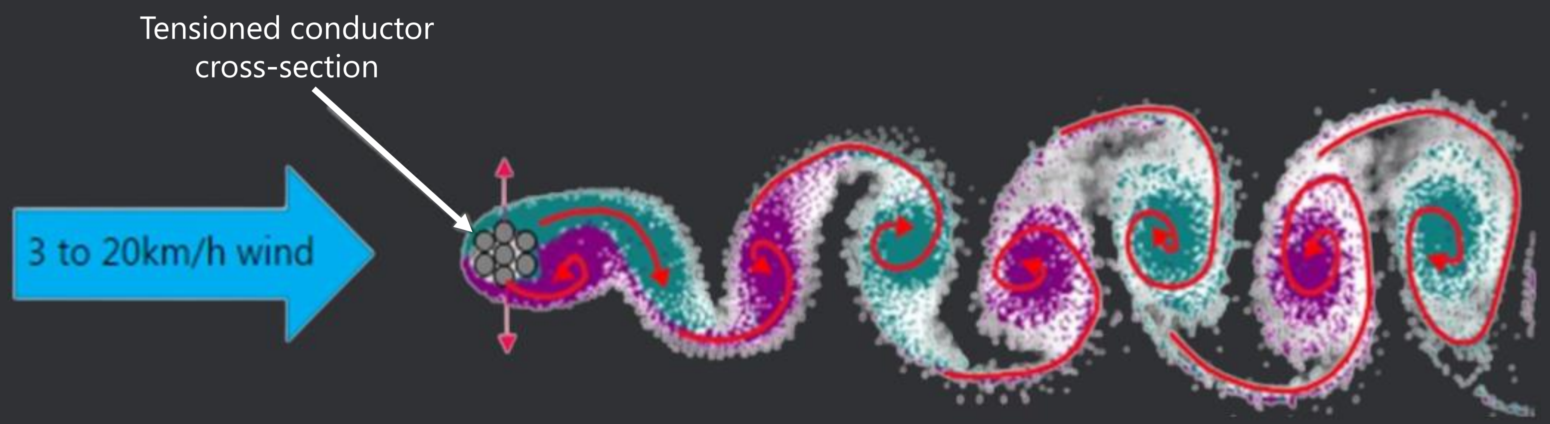
Aeolian Vibration

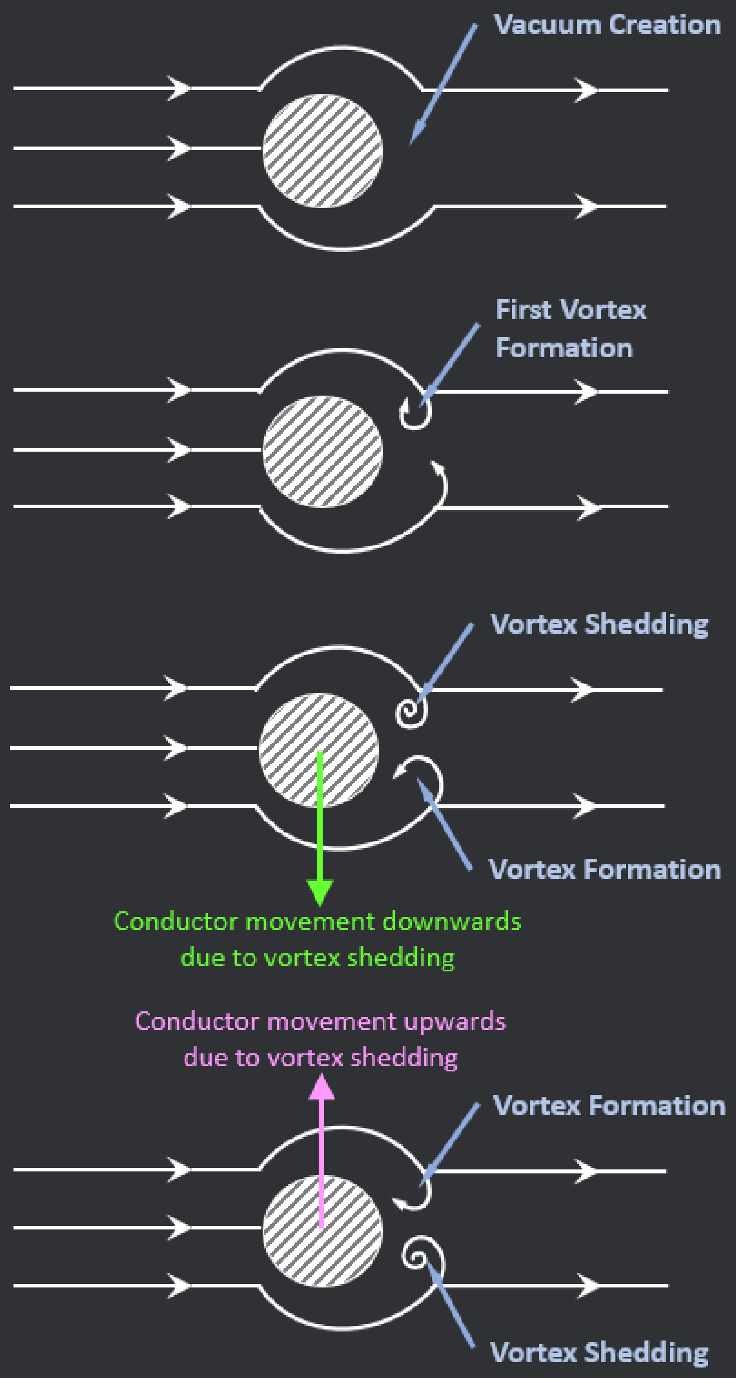
Smooth laminar wind flows past the overhead conductor.

Vortices form and shed, alternating top to bottom. This causes an alternating up and down movement in the conductor.

If the alternating forces match the natural frequency of the conductor, then sustained aeolian vibration can occur.

Aeolian vibration tends to be more prevalent in cold conditions when conductor tension increases.





Damage Caused to Conductor

Damage occurs at intermediate structure attachment points that are clamped or tied where the conductor has an abrupt inability to flex.

The restrained movement at these points will fatigue and cause fretting of the conductor stands.

Fretting damage tends to occur on internal stands that are hidden by line guards & armour rods.

Trial method

- Site selection
- Modelling presence of aeolian vibration
- Installing the vibration sensors and weather station
- Analysing the results

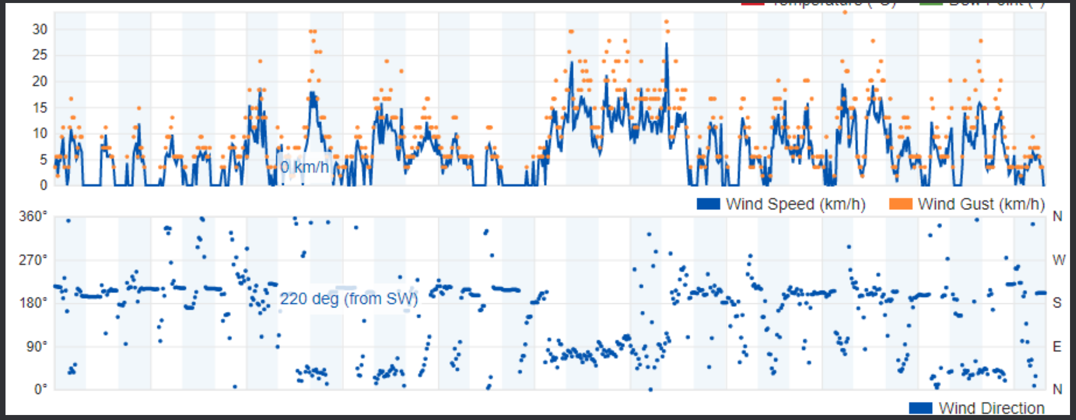
Characteristics for Site Selection

Topographic and Environmental Characteristics

- Conductor situated near large water bodies or flat land having no obstacles to disrupt wind flow
- Weather records showing constant wind speeds regularly flow perpendicular to the conductor during colder temperatures

	Min. Temp	Av. Temp	Av. Wind Speed (km/h)	Av. Wind Direction
Jan-22	12.9	20.4	2.6	SSE
Feb-22	9.7	19.9	1.8	SE
Mar-22	9.6	18.9	2.2	SSE
Apr-22	7.3	16.6	1.8	SSE
May-22	4.3	14.6	1.3	S
Jun-22	3.3	12.7	1.9	SSE
Jul-22	3.3	12.4	2.8	SSE
Aug-22	2.6	**11.7**	1.4	SSE
Sep-22	1.4	12.3	1.9	SSE
Oct-22	0.7	14.3	2.2	SE
Nov-22	10.9	17	3.2	SE
Dec-22	10.5	18.6	2.5	ESE

Vibration sensor trail location at Rangipo Road, Opoutere Beach- flat land and has a water body at high-tide



Historical weather data recorded at Rangipo Road, Opoutere Beach

AS/NZS7000 Table Y1 Conductor Parameters

AS/NZS7000 Table Y1 parameters were used to see if aeolian vibration was probable at each of the 10 vibration sensor trial sites

- Conductor types- AAC, AAAC & ACSR
- Clamp Category- Type A or Type B, post of pin insulators with or without armour rods
- Sites with no vibration dampers
- Terrain Category- Type 1, flat exposed terrain, near large water bodies

Ten selected vibration sensor trial locations

Conductor Modelling

We modelled conductor tensions using overhead line design software

- Tensions were calculated from conductor sags captured during Lidar survey
- A vibration environmental load case was setup to model tension increasing during temperature changes
- The Rangipo Road model showed aeolian vibration is likely to occur when local temperatures fall below 11.7°C and tension increases above 16.5% CBL

Trial Location:	Rangipo Road, Opoutere Beach
Pole ID's:	R13104 - R13103
Perpendicular Wind Directions:	NE or SW
Conductor Type:	AAAC Fluorine (7/3.00 stranding)
Lidar Capture Tension:	13.43%CBL at 23.6°C
Base Case Tension- Table Y1: (Clamp Category- Type B & Terrain Category- Type 1)	16.5%CBL
Likely occurance of vibration:	<11.7°C
Local Minimum Temperatures:	0.7°C in October
Local Wind Speed Range:	1-7 m/s

Tension and environmental conditions likely to produce aeolian vibration

Modelling within overhead line design software

Devices used

- Vibration recorders and weather stations to capture conductor movement due to aeolian vibration.
- The intention is to gather data on conductors under aeolian vibration conditions to better engineer for protection of conductors.
- Cost efficiently and without shutdowns during installation.

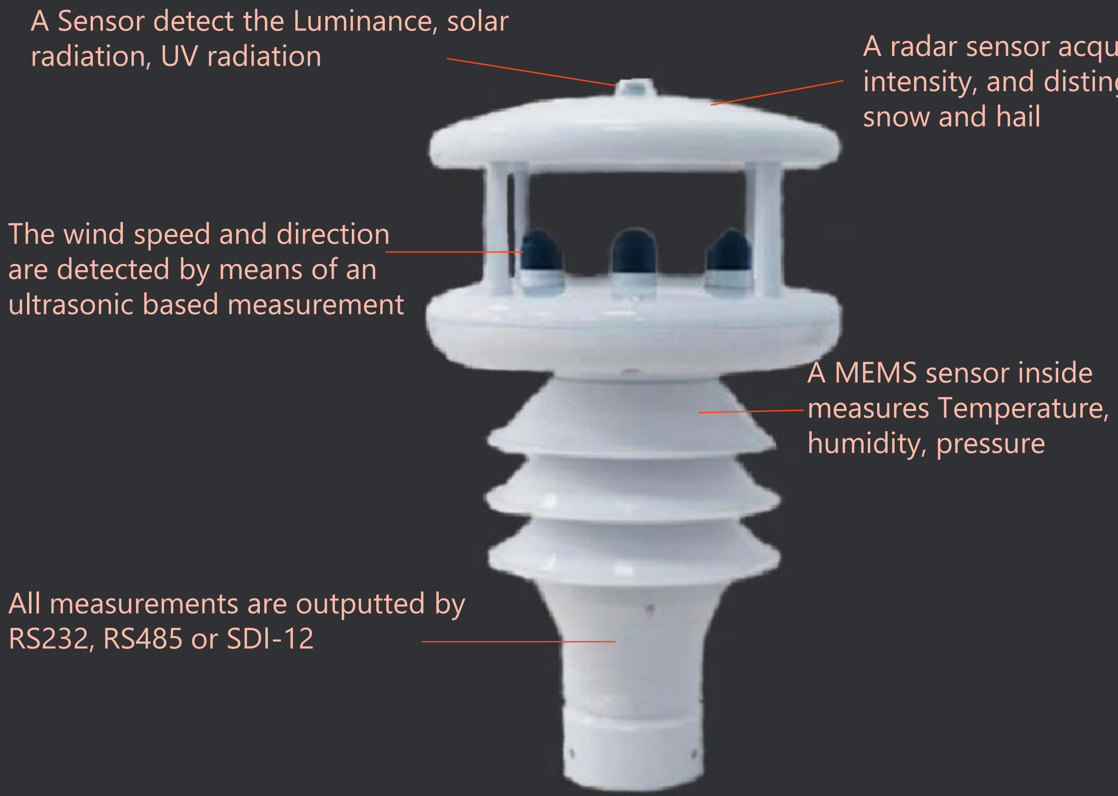
The conditions we looked at were:
- Types of conductor
- Different span lengths
- Different tensions

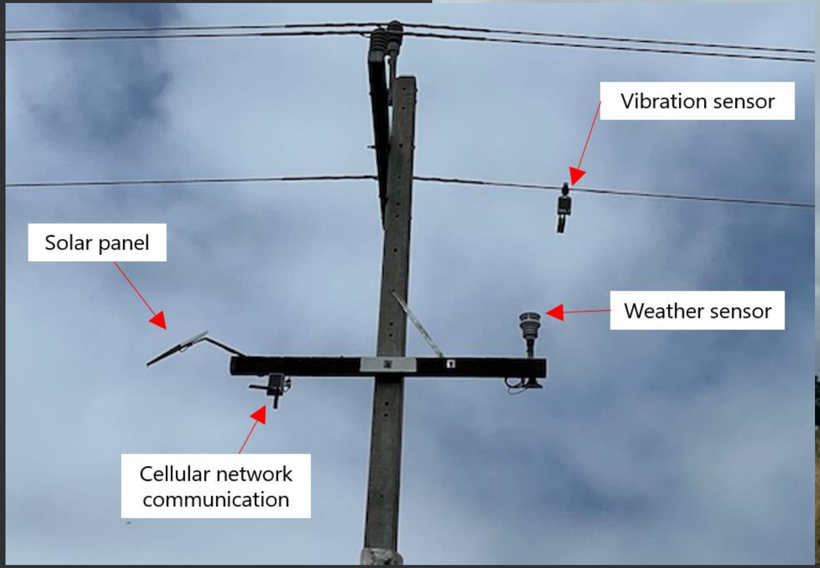
The monitors we have decided to use are capable of monitoring multiple situations, such as broken cables, fallen towers, strong winds, inclination and sag monitoring, and aeolian vibration.

The logger has the following features:
- Two solar panels
- Two antennas
- Snap fast clamps for easy installation on live lines

Devices used

- Although there are weather stations in the regions, we needed to get local weather conditions on the span of the selected sites.
- The weather stations we installed can monitor solar radiation, precipitation, air temperature, barometric pressure, relative humidity, wind speed and wind direction.
- No moving parts allowing for robusticity and suitable for long term installations.





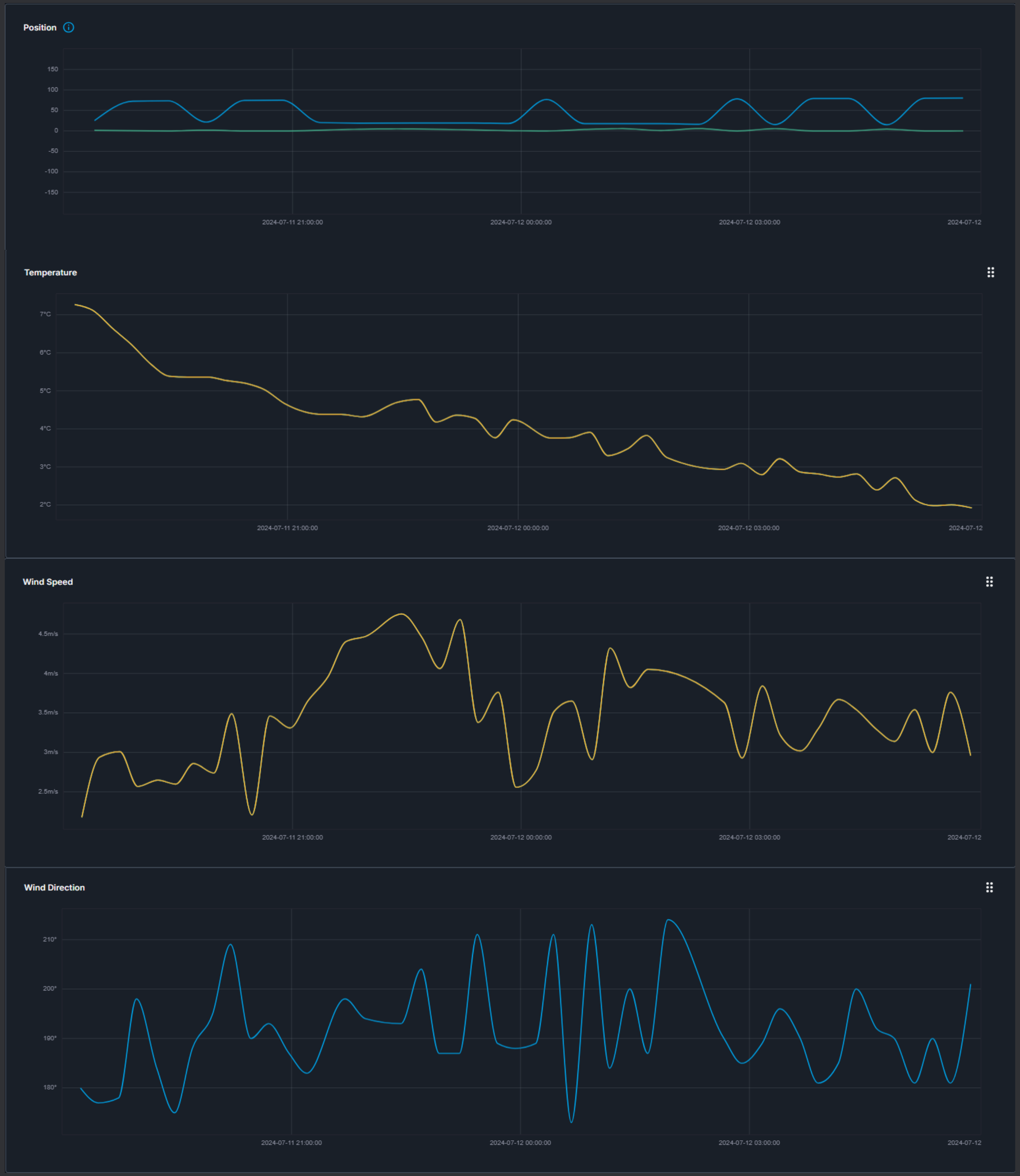
Observations

So far, some of the selected sites have shown environmental patterns that correlate to periods of conductor motion which could relate to aeolian vibration.

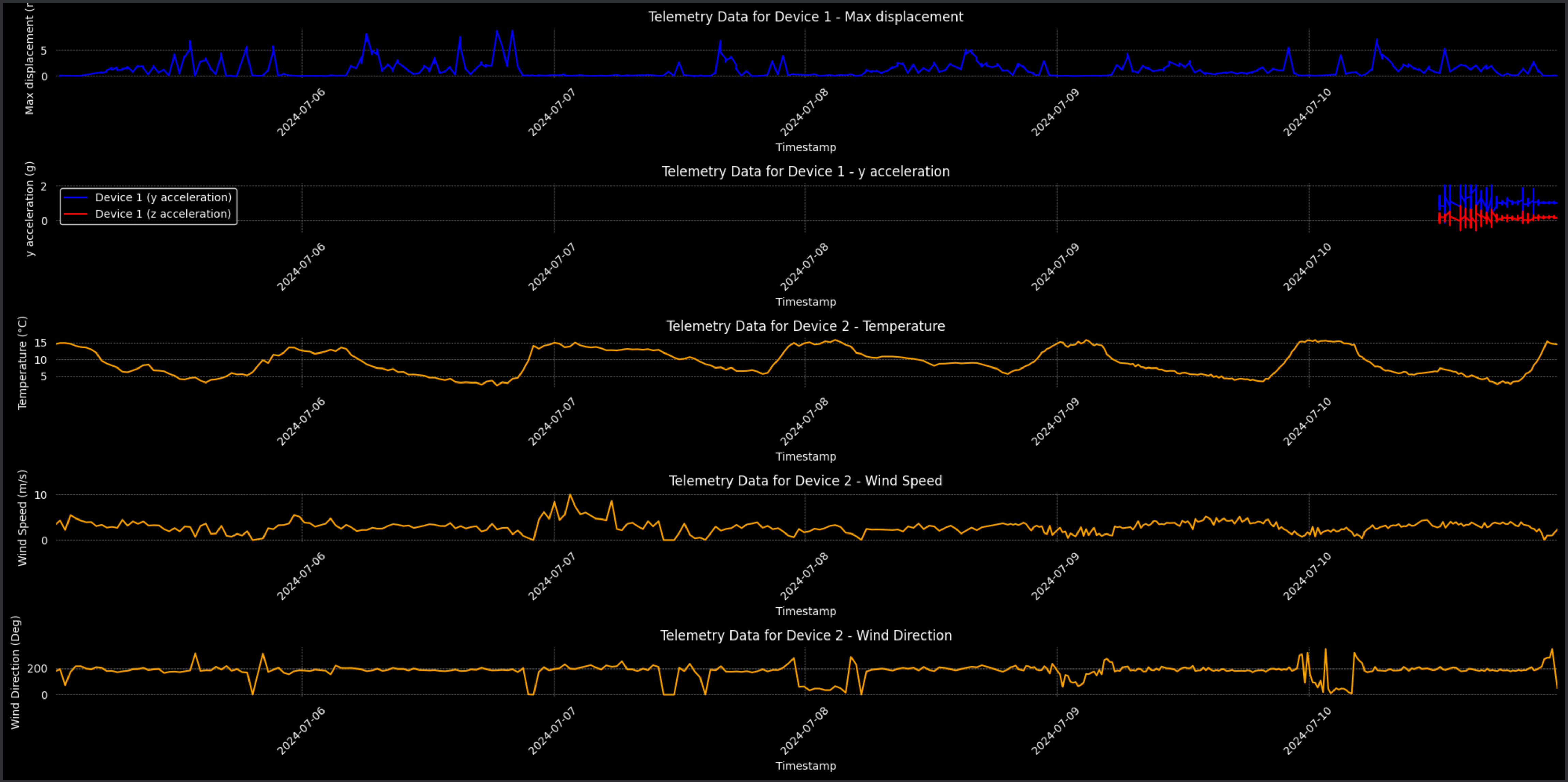
As seen here:

- Wind direction was approximately 180° to 210° (southwest)
- The wind speed recorded was (3m/s to 5m/s) and with cold temperature (2°C to 5°C)
- We can also see that the conductor experiences horizontal (blue) and vertical (green) motion

These weather conditions and conductor motions combined indicate a possibility of aeolian vibration. However, further study and development is needed to analyze the amplitude and frequency to then conclude the presence of aeolian vibration.



Observations



Challenges faced through the trial so far

Conclusion

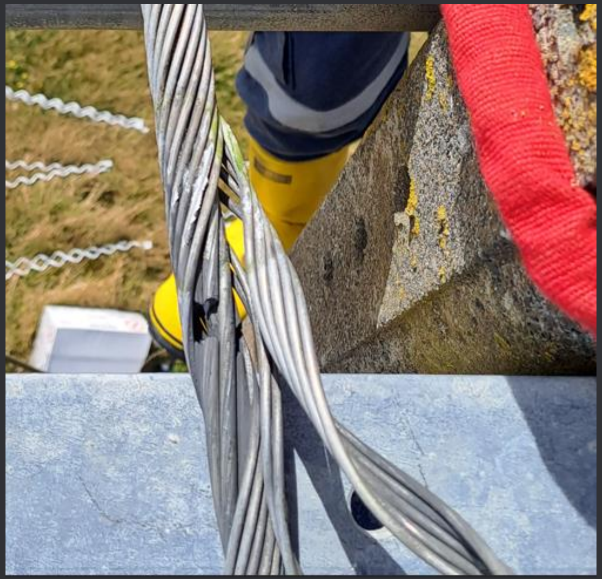
The aeolian vibration significantly impact the lifecycle of conductor.

The insights gained from this trial will help us better understand conditions that correspond to aeolian vibration and where this is present on our network.

Allowing us to better engineer methods help protect the conductors from the impacts of aeolian vibration.

Modelling these different parameters has provided a deeper understanding of conductor lifecycle compared to our previous approach of location, age and material.

We aim to continue our trial to learn more about conductor failure mechanisms and to improve performance and reliability of the network for our customers.



Aeolian vibration damage

Vibration trial

Thank you

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