

# Wind persistence analysis for expansion of the Te Āpiti wind farm in New Zealand

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## **Abbreviated abstract:**

Hourly in New Zealand, wind turbines and weather stations have been collecting information for over two decades. The objective is to examine wind speed persistence with a view to allocating new wind farms and possible expansion of existing ones. Te Āpiti wind farm was used as a case study. Combining persistence probability (PP), conditional probability (CPA) and wind speed duration curves (WSDC) indicates where winds are more persistent. This approach shows possible directions for expansion.

## **Related publications:**

– Silva, A. R.; Stosic, T.; Stosic, B. Wind speed persistence at the Fernando de Noronha archipelago, Brazil. *Theoretical and Applied Climatology*, Springer, v. 144, n. 1, p. 723–730, (2021)



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# Problem and Data

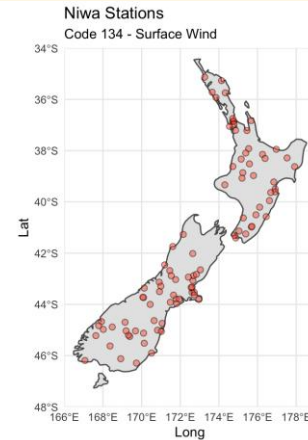
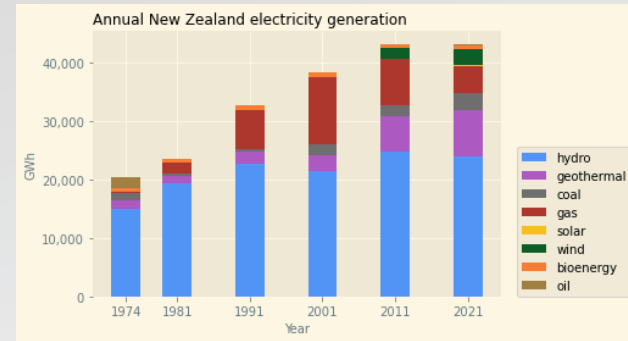
## Problem:

- Assist a feasible option to replace carbon-based fuels.
- Increase the wind share in electricity generation.

## Open data available:

- 512 weather stations with wind speed records.  
More than 89 million wind speed records.  
512 stations x 24 hours x 365 days x 20 years
- Only 9 wind farms with electricity generation records.

The main objective is to examine wind persistence with a view to allocating new wind farms and possible expansion of existing ones.



# Methods

The Te Āpiti wind farm case study:

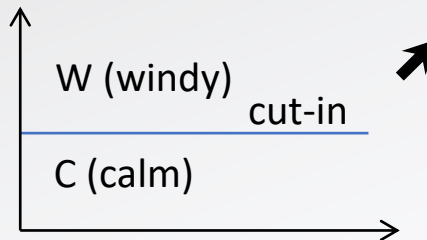
- 90.75 Megawatt,
- 55 turbines,
- 2003 construction begins,
- 2004 fully operational,
- Surrounded by weather stations.

Data classification:

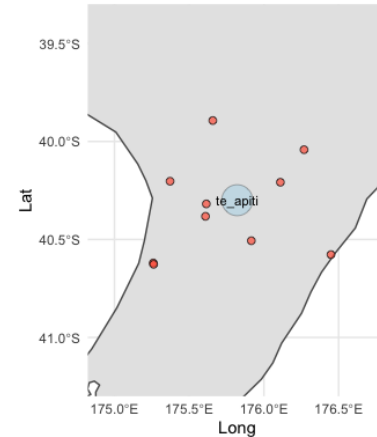
- cut-in wind speed at which a turbine starts generating electricity.
- Windy and Calm represent each hour's rating.

Wind persistence assessment:

- Persistence probability (PP)
- Conditional probability approach (CPA)
- Wind speed duration curves (WSDC)



Niwa Stations  
Close to Te Apiti

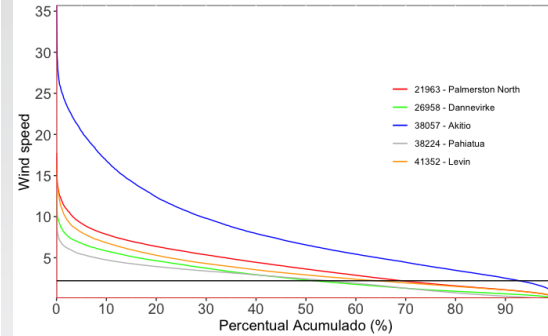
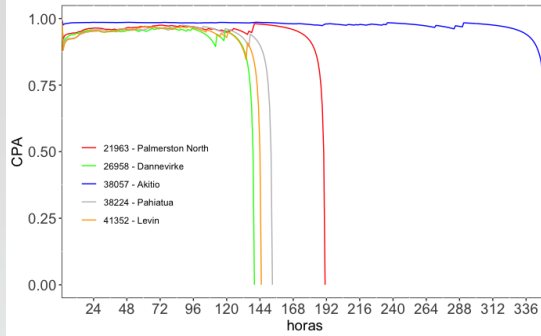
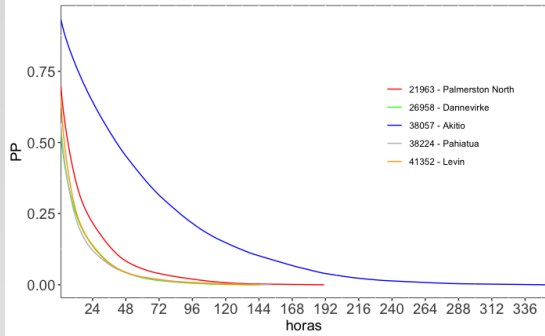


Sequences:

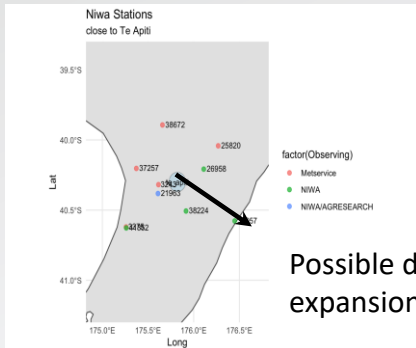
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# Results and Conclusions



- Windy persistence assessment indicates greater persistency near the Akitio weather station.
- New database was created by consolidating data from multiple sources.



Possible direction for expansion of the plant.

## Further studies:

- Analysis can be used to allocate new wind farms.
- Crossing wind and generation records can be used for complex analysis.
- Effects on wind generation related to seasons of the year, wind direction, topography and climate change.

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