PO.003

Evaluating the performance of a wind generator in providing droop control during grid frequency increases – an independent analysis

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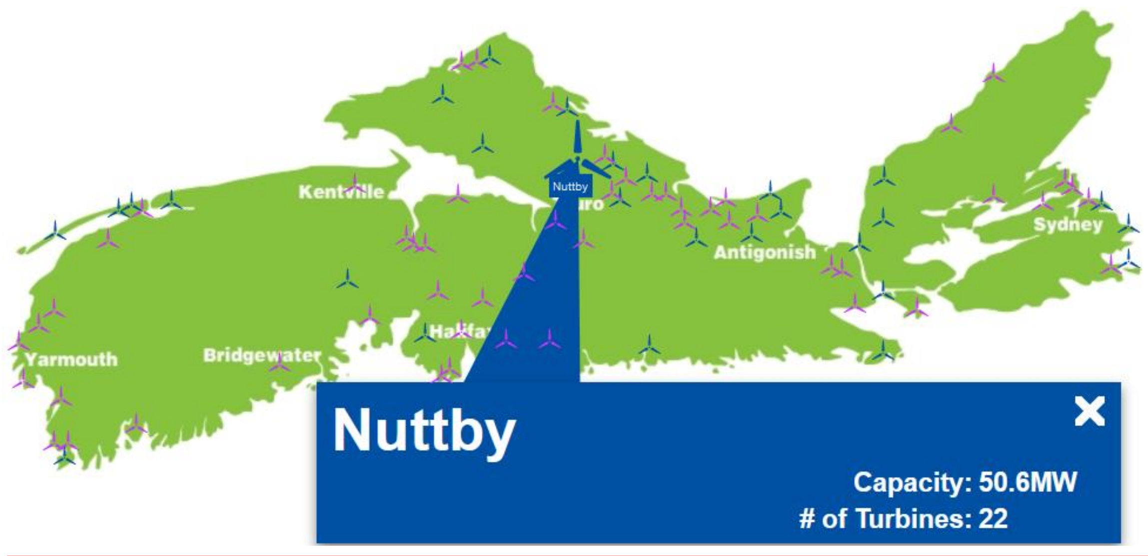
Abstract

More electrical energy from renewable sources means that more ancillary services and grid support services are provided by them. This work examines the ability of a commercial wind turbine to provide droop-frequency control i.e., a change in active power in inverse proportion to a change in grid frequency. Enercon refer to this as power-frequency control [1]. Similar to droop control in synchronous generators, a fall in grid frequency produces a rise in active power output and a rise in grid frequency causes a drop in active power output. This work was a collaboration between a system operator, a wind turbine OEM and an independent research institute. These results are useful to other grid operators as they represent the performance of commercially available wind turbines as opposed to a simulation.

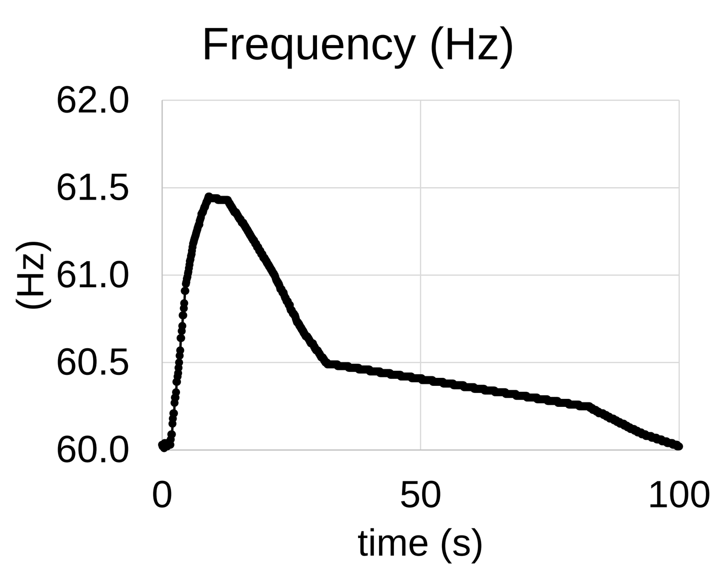


What	Droop-frequency control (frequency increase only)
Where	Nuttby Mountain Wind Farm, Nova Scotia, Canada
Turbines in farm	22
Single turbine rating	2.3 MW Enercon E82 IEC Type IV
Utility of results	Useful to other system operators; not a simulation
Note	Response to frequency **increases** tested; Response to frequency **decrease** not tested due to requirement of continuous power curtailment

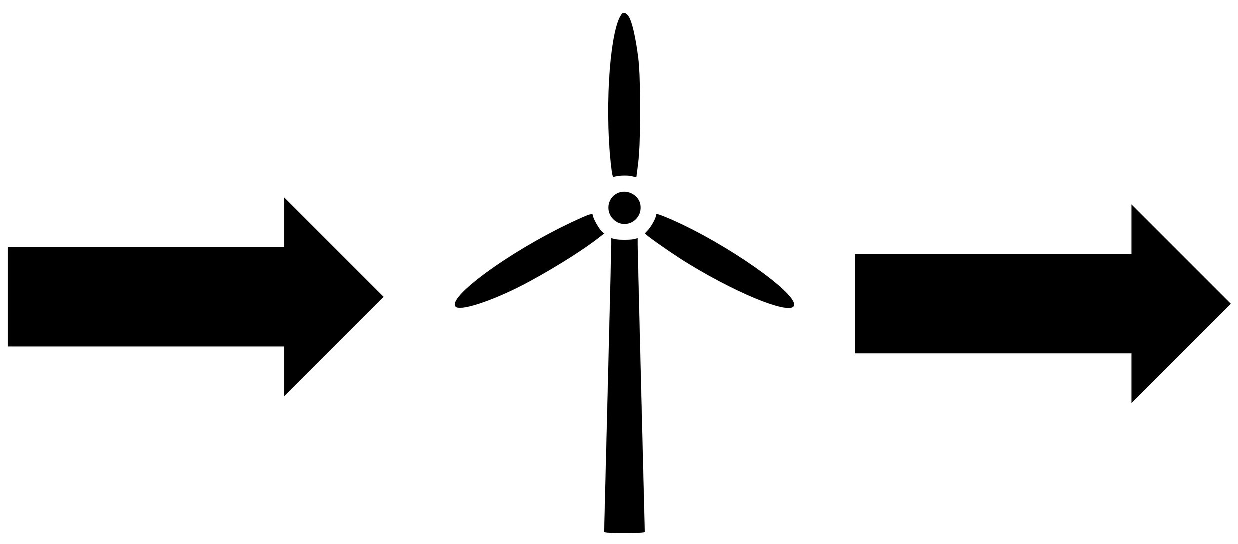
Objectives

Test droop frequency response from a single grid-connected wind turbine. Examine the performance at various active power levels.

Methods



Injected over-frequency signal (100 s)



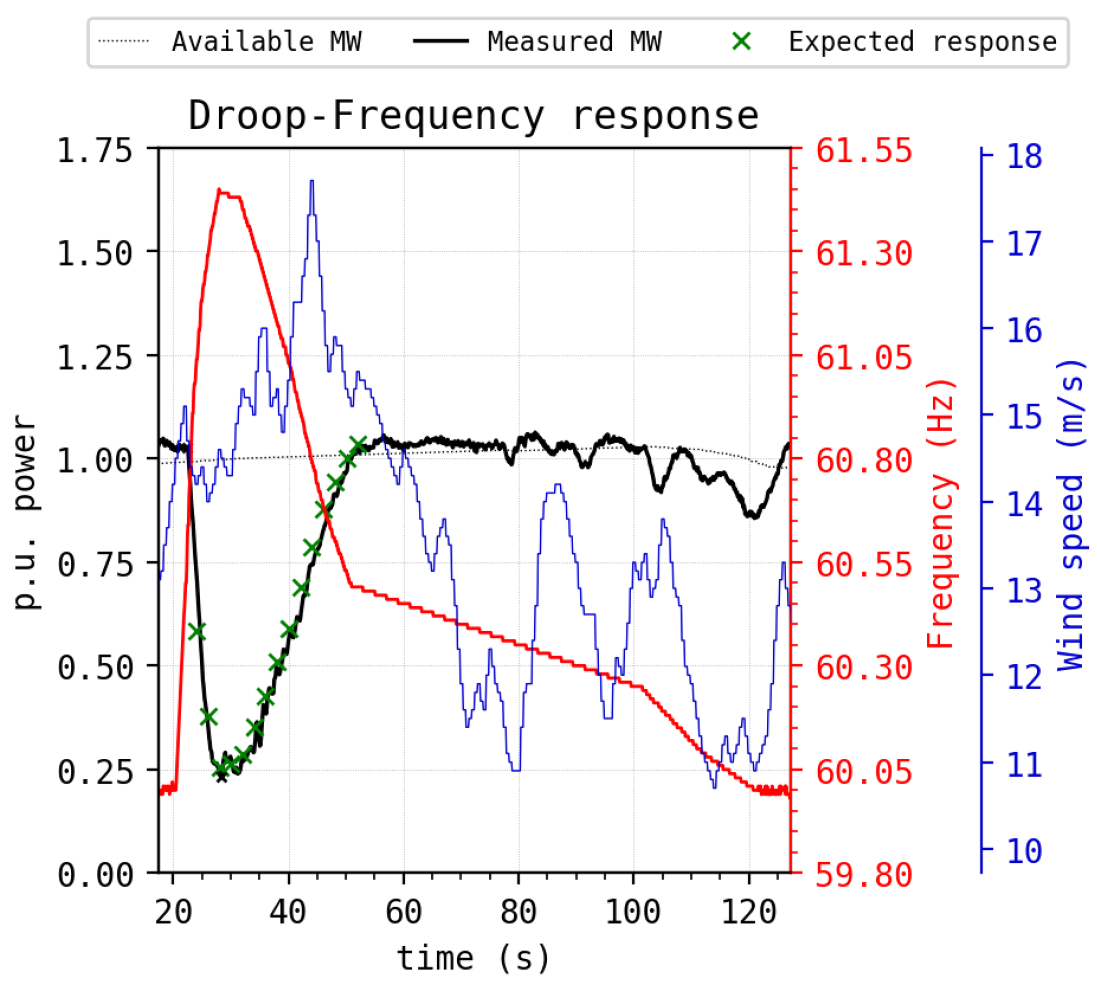
Wind turbine control system detects f > 60.5 Hz

Power curtailment response;

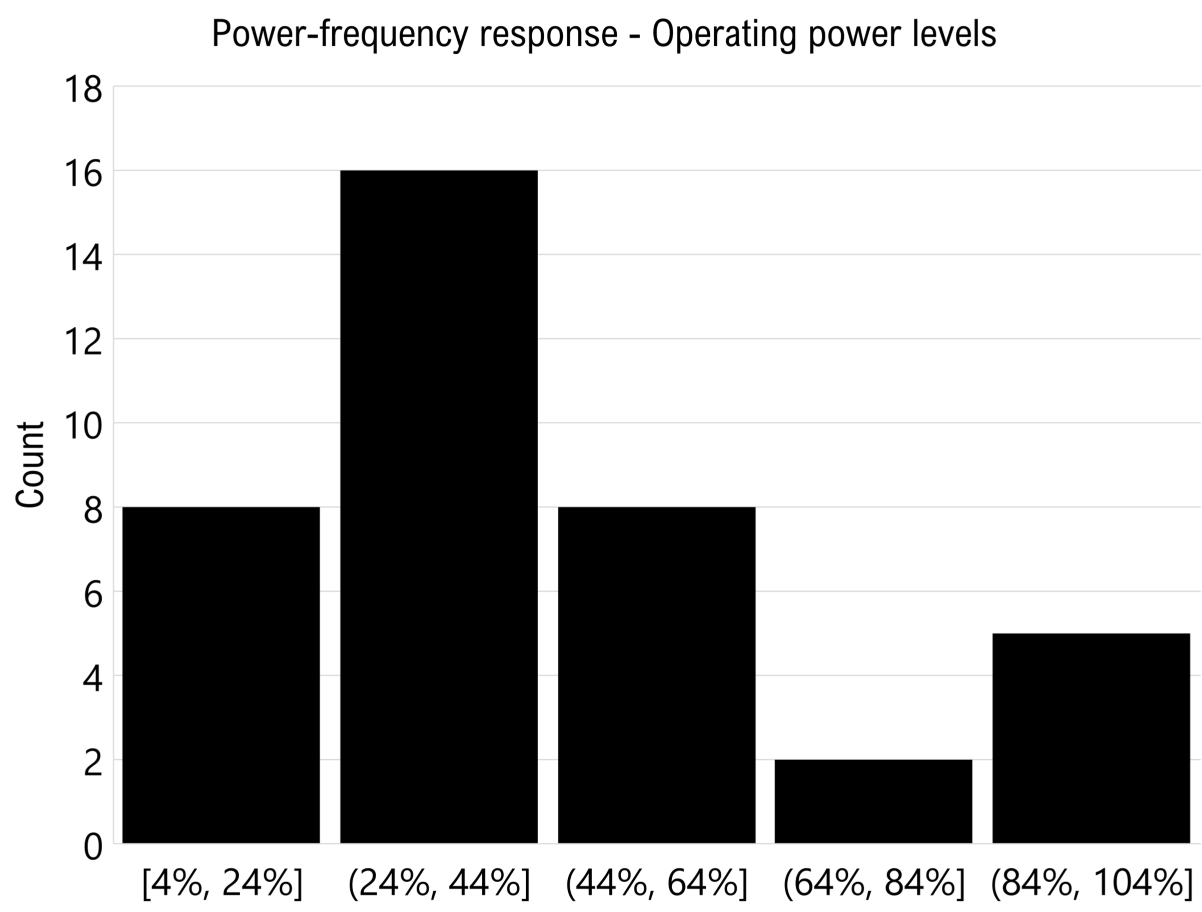
Gather data;

Repeat at several power levels

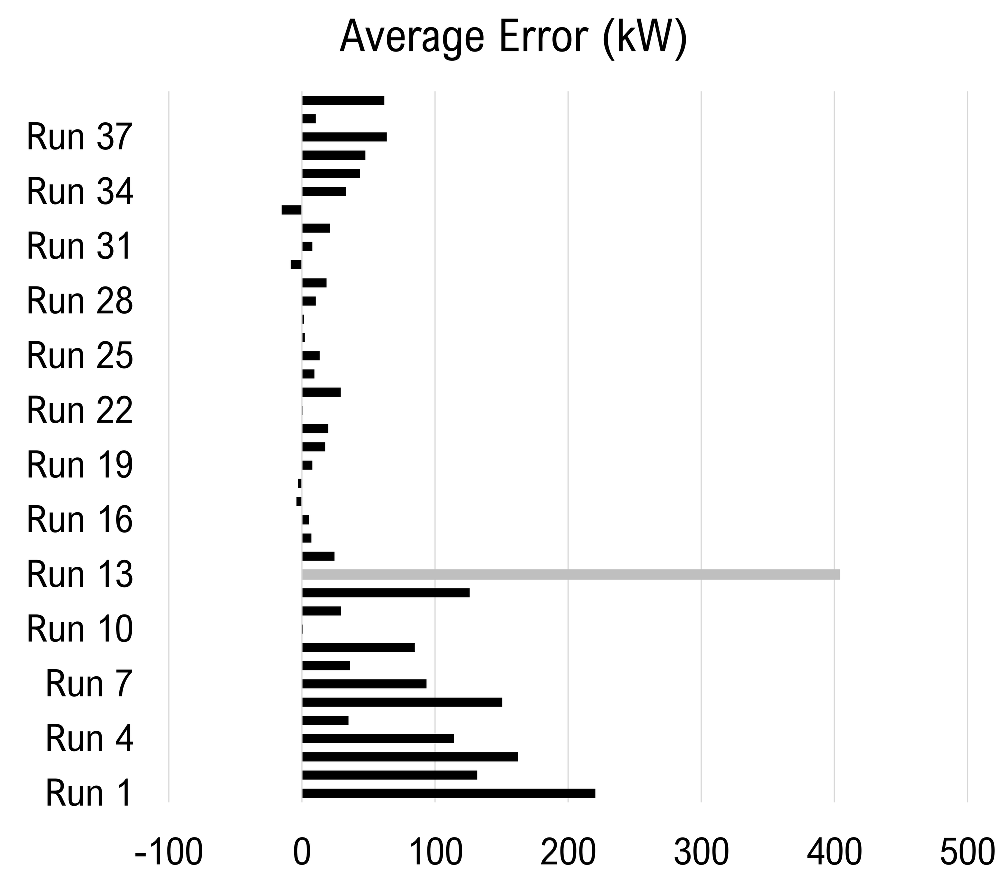
Results



Injected frequency in red. Expected response is calculated based on frequency deviation from 60 Hz and initial power level. Data is normalized.



Histogram showing a good spread of operating power levels.



Mean error across all data is 50 kW or 2% of rated power.

Outliers are due to falling wind speeds during frequency event.

Conclusions

The results are as expected and this is useful data for other grid operators in evaluating whether such a response from wind farms can be used on their grids to improve frequency stability.

References

1. Enercon GmbH, "Grid Integration and Wind Farm Management," 08 2018. [Online]. Available: https://www.enercon.de/fileadmin/Redakteur/Medien-Portal/broschueren/pdf/EC_Netztechnologie_en_web.pdf. [Accessed 02 2021].
2. Power Advisory LLC for Offshore Energy Research Association (OERA), "Nova Scotia Ancillary Service Provision by Variable Output Renewable Energy Resources," 2020. [Online]. Available: https://oera.ca/sites/default/files/2020-09/Valuation%20Method%20for%20Electric%20Ancillary%20Services%20-%20Final%20Report_0.pdf.

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