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# Wind farm control to meet grid requirements

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## Abstract

- This research aims to design a wind farm controller to trade-off the grid requirements against the operators need to for optimal utilisation of their assets by using the Power Adjusting Controller (PAC).
- The PAC was developed for the 5MW Supergen Exemplar wind turbine [1] and allows the wind farm operator to manipulate the power outcome of each individual wind turbine, and consequently alter the power output of the wind farm. The PAC can be used to either reduce or increase the power output of a wind turbine, whilst keeping its operation within a safe operational region.
- The network wind farm controller acts in response to network related inputs. This controller is designed to provide ancillary services to the grid.
- The turbine wind farm controller acts in response to turbine related inputs.
- The decentralised structure of the wind farm controller ensures that the wind farm controller does not impede the operation of the individual turbine controllers.
- The controller was initially developed for a wind farm consisting of 10 wind turbines. The model was then expanded to a wind farm consisting of 40 wind turbines.

## Objectives

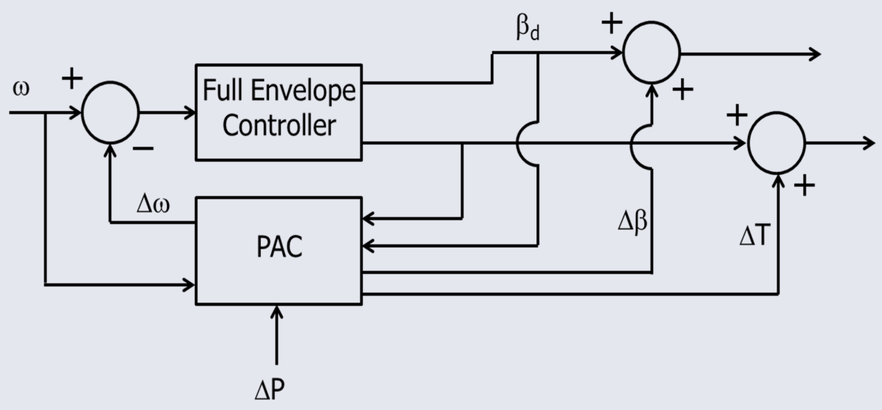
This research aims to achieve the following:

- Select suitable wind turbine and wind field models capable of representing wake interactions. Initially, the windfield representation will be modelled using the SimWindFarm wind field model [2].
- Construct a model of the Supergen Wind Exemplar Wind Farm of 169 5 MW turbines. It is proposed to use a distributed multi-processor facility on which to implement the simulation. Each turbine model will include dynamic inflow, a full envelope controller and a Power Adjusting Controller.
- Determine a suitable specification of the wind farm controller. Input for the specification will include O&M and repair strategies and future wind farm layouts with closer spacing.
- Design and assess performance of wind farm controller.

## PAC Concept

The PAC allows the wind farm operator to manipulate the power outcome of each individual wind turbine.

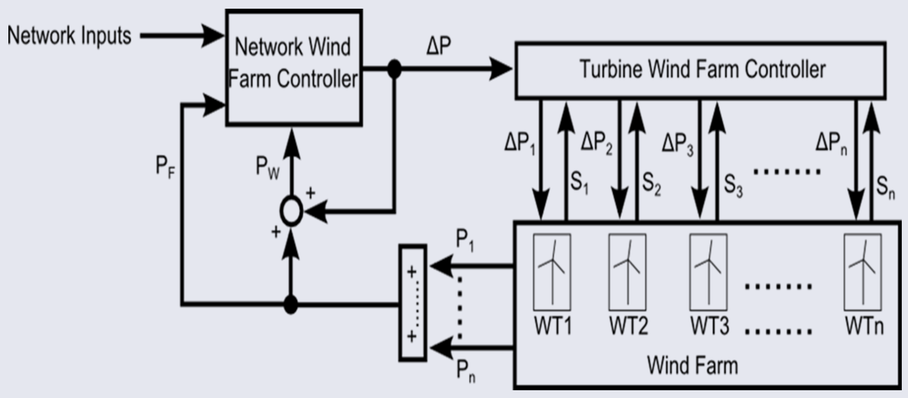
- It is configured as a jacket round the existing full envelope controller, hence, no modification to the wind turbine's central controller or converter design or operation is required [1].
- The PAC alters the power output of the turbine by a value ΔP [3].




**PAC Overview**

## Methods

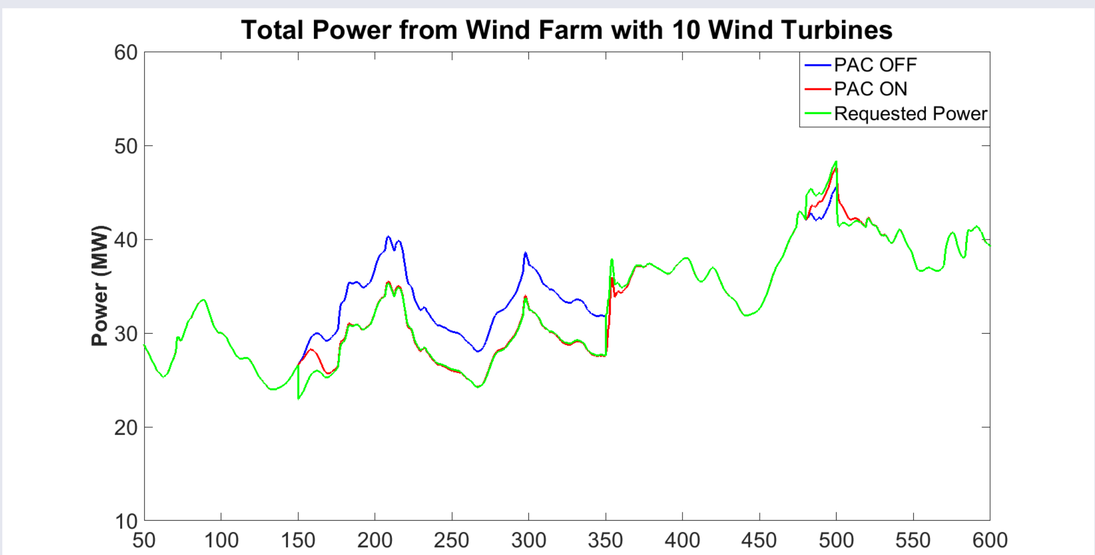
The wind farm controller is expected to be a highly decentralised controller.

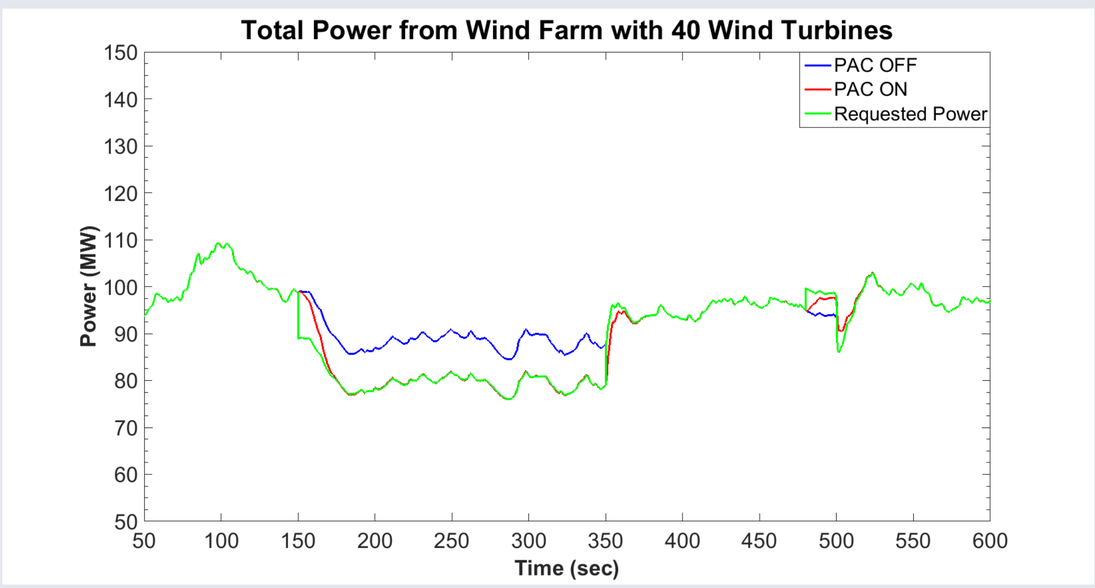



**Wind Farm Controller Overview**

## Results

- The simulations presented are performed in Simulink.
- For all the simulations, time varying wind speed is used.
- To avoid any transient effects, the plotting time starts at 50 seconds.
- The following graphs illustrate the outcome of simulations for wind farms consisting of 10 wind turbines (50 MW rated capacity) and 40 wind turbines (200 MW rated capacity). The mean wind speed for both simulations is 9 m/s. The controller is asked to provide a ΔP of ±10% with different durations.




## Conclusions

- The wind farm controller allows the operator to adjust the wind farm's power output if necessary.

Future work will include:

- Further development of the wind farm controller (i.e. include turbine health status/ optimize ΔP distribution based on O&M data).
- Upscaling of the wind farm model (i.e. include more wind turbines).

## References

1. A. Stock and W. E. Leithead, Providing Grid Frequency Support Using Variable Speed Wind Turbines with Augmented Control, EWEA Conference, Copenhagen, 2012.
2. Aeolus FP7(2014), SimWindFarm Toolbox, available at: http://www.ict-aeolus.eu/SimWindFarm/index.html, (accessed February 2015).
3. A. Stock and W. E. Leithead, Supergen Wind Sustainable Power Generation and Supply - Wind Energy Technologies Task 2.1.2: Flexibility of Operation For Theme 2: The Turbine, Glasgow, 2012.