

Global Problem

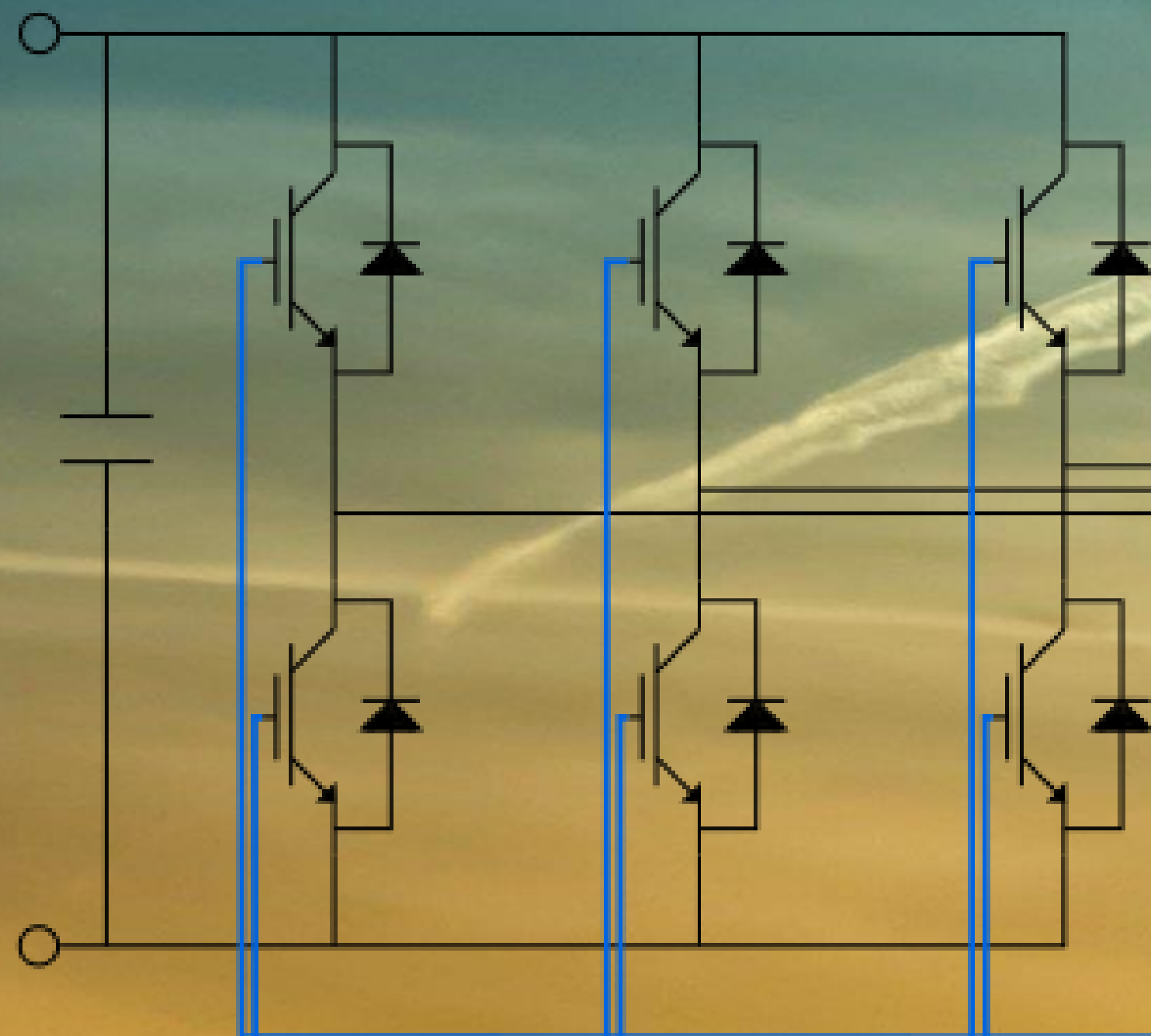
To meet carbon reduction targets, it is necessary to move towards distributed renewable generation. However, the grid was designed around centralised and flexible generation, located near large demand centres. Adapting the existing and aging grid to accommodate remote renewable generation is one of the greatest engineering challenges of today.

Part of the Solution

Whilst there is no magic “one size fits all” solution, the implementation of smarter controllers can help keep costs down whilst increasing renewable energy penetration.

PhD Objectives

- Using a combination of time domain and linear state-space models, it is possible to build, optimise and to a certain extent, validate the models of individual inverter controllers and inverter controller networks.
- Explore impedance measurement and estimation methods.
- Ensure grid codes fully adhered to.
- Build and fully validate in the lab.



Yesterday's Controller

Inverters are almost always controlled using a variation of Vector Current Control. Whilst VCC is excellent at faithfully following strong and stable voltages, it struggles with low apparent short circuit ratios.

Today's Controller (yesterday's solution?)

The current “hot topic” in the world of inverter control is the grid forming VSM, short for Virtual Synchronous Machine. The idea is to replicate the synchronous generators that are being displaced. Whilst this is possibly an interim solution, it is far from ideal. New stability issues occur when using VSM in high concentrations.

“Coordination and control of fast-changing grids with high penetrations of renewable power are a paramount need for achieving climate goals.” [1]

Tomorrow's Controller

If only there was already a solution! Here are some ideas...

- With the use of novel impedance measurement or estimation methods, a VCC can be adapted to suit a large range of SCRs.
- The growing number of Phasor Measurement Units being installed across the country could allow additional controller gain selection support.
- The smart distribution of different controllers on a network could allow them to work together, improving the local grid conditions.

[1] P. Alsone et al, *Decentralized energy systems for clean electricity access*. Nature Climate Change, 2015
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Loss of stability in a weak grid

