

## The electrical grid is undergoing a huge transformation...

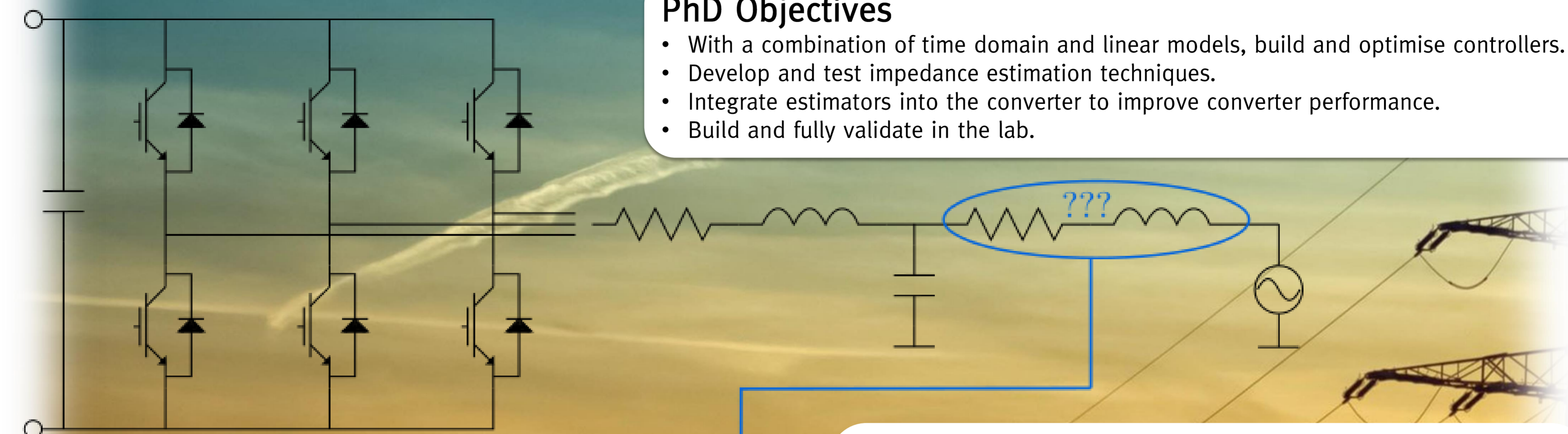
To meet carbon reduction targets, it is necessary to move towards distributed renewable generation. However, the grid was designed around centralised and flexible generation, located near large demand centres. Adapting the existing and aging grid to accommodate remote renewable generation is one of the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

## Motivation of PhD

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

- With a combination of time domain and linear models, build and optimise controllers.
- Develop and test impedance estimation techniques.
- Integrate estimators into the converter to improve converter performance.
- Build and fully validate in the lab.



## Standard Controller

Inverters are almost always controlled using a variation of Vector Current Control. VCC works extremely well, except that it is normally tuned for very specific grid conditions. What happens when grid conditions change?

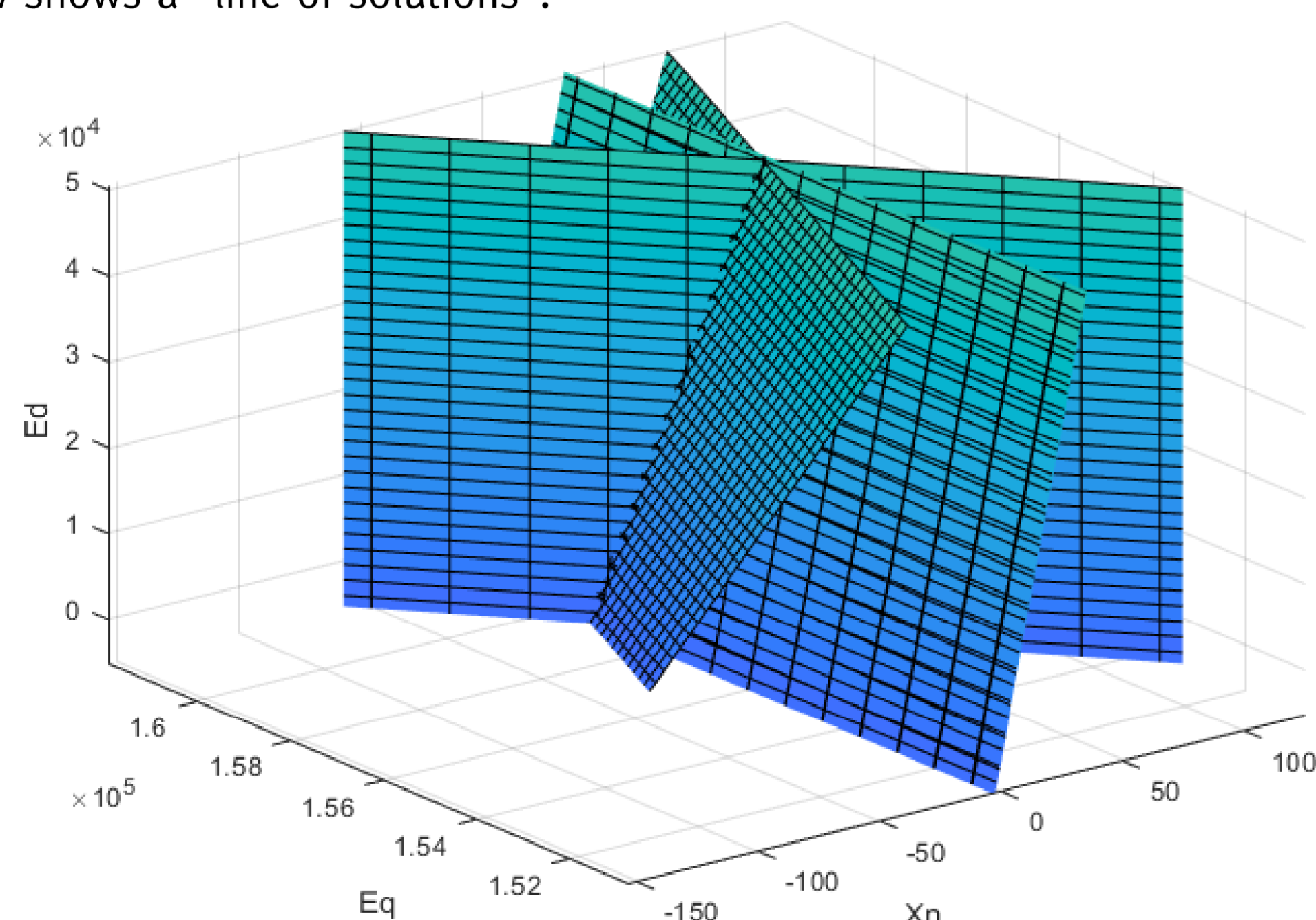
## Grid impedance – why is it a problem?

A high grid impedance will affect power transfer limits, introduce coupling between converter loops, and cause alignment problems. The grid impedance may contain resonances that can interact with the converter filter and the control. A variable impedance can quickly affect the tuning of the converter.

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

## System Identification Techniques

Special techniques are required because it is impossible to directly measure or calculate grid impedance from the converter’s local connection point. The figure below shows a “line of solutions”.



[1] P. Alsone et al, *Decentralized energy systems for clean electricity access*. Nature Climate Change, 2015

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## Impedance Estimation Techniques

