Wake modelling is used widely in the Wind Industry to predict turbine loads and to optimize wind farm layouts for AEP. High-fidelity CFD solvers provide time-resolved solutions of the velocity field but come at large computational costs that limit their usefulness for applications like load prediction and wind farm optimization for AEP. On the other hand, low-fidelity and purely empirical wake models are often severely constrained in their assumptions and only provide coarse estimates. This leaves a niche for specialized, medium-fidelity wake solvers that are fast enough and provide accurate solutions within a set of simplifying assumptions (axisymmetric, stationary). These solvers can be used for turbine load simulations in the framework of models like the Dynamic Wake Meandering model.

This thesis is about developing a higher-order Finite Element solver for the axisymmetric and stationary Navier-Stokes equation with a prescribed eddy viscosity and the pressure term neglected (Ainslie model). The Ainslie wake model will be extended to incorporate more physical aspects by adding a pressure term and incorporating a solver for the pressure Poisson equation. Moreover, actuator disk forcing will be implemented to further extend the model to a generic solver, such that only the eddy viscosity will remain prescribed. Based on the progress it could be possible to add a transport equation for the turbulent kinetic energy and dissipation rate (k-epsilon model) to obtain in the end a full axisymmetric RANS solver.