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CFD MODELLING AND VALIDATION OF WIND FLOW OVER A FOREST CANOPY

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Some wind farms are now being sited in less ideal places, including in and around forests. The forest canopy can significantly alter the wind shear profile and reduce the overall resource available, as well as increasing turbulence levels. This paper will present a computational fluid dynamics (CFD) simulation of the wind flow over a small forested region, Hill Holt Wood, in Lincolnshire, UK. The intention is to show that accurate modelling of wind flow over a forest can be achieved for a relatively small forest but attention must be paid to variation in canopy density for accurate results.

The added complexities of forests and forest canopies on the incoming wind profile is still an area of uncertainty in the wind energy sector. For many reasons wind farm developers are having to look at erecting wind farms in less than ideal terrain types, including in and around forest canopies. Past work has shown that forest canopies will reduce the total wind resource seen at the site as well as increasing the amount of turbulence, which are undesirable characteristics for erecting a wind farm. If a better understanding of the canopy effects can be achieved this could help when erecting wind farms in the vicinity of forest canopies. It will help in producing more accurate predictions of a site?s total available wind resource and allow for more efficient turbine design and siting in this type of terrain. Due to the difficulty in getting accurate measurements from many forested regions, as with many other complex sites, a computational fluid dynamics (CFD) model, CFX11, is used for this work. CFD provides a mechanism to gain an insight into the wind conditions over a large volume at a site which would not be feasible by measurement alone provided that there is a sufficiently accurate understanding of the physics and fluid behaviour. This work compares measured data from a site at Hill Holt Wood, Lincolnshire, UK, with CFD modelling of the wind profile at the site. The CFD simulations are based on the idea of modelling a forest as a resistive porous volume. The results highlight the sensitivity of the predicted wind speed values to the porosity which is assigned to the variation in canopy coverage with height, particularly where the height of interest is close to the canopy top. This emphasises the importance of modelling the canopy in layers to simulate the effect of varying leaf density with height, particularly where the density of trees is quite small.