This paper combines the currently relevant research methodologies of scaled wind turbine model experiments in wind tunnels with remote-sensing short-range WindScanner Lidar measurement technology. The wind tunnel of the Politecnico di Milano was equipped with three wind turbine models and two short-range WindScanner Liders to demonstrate the benefits of synchronised scanning Liders in such experimental surroundings for the first time. The dual-lidar system can provide fully synchronised trajectory scans with sampling time scales ranging from seconds to minutes. First, staring mode measurements were compared to hot wire probe measurements commonly used in wind tunnels. This yielded goodness of fit coefficients of 0.969 and 0.902 for the 1 Hz averaged u- and v-components of the wind speed, respectively, validating the 2D measurement capability of the Lidar scanners. Subsequently, the measurement of wake profiles on a line as well as wake area scans were executed to illustrate the applicability of Lidar scanning to measuring small scale wind flow effects. The downsides of Lidar with respect to the hot wire probes are the larger measurement probe volume and the loss of some measurements due to moving blades. In contrast, the benefits are the high flexibility in conducting both point measurements and area scanning, and the fact that remote sensing techniques do not disturb the flow while measuring. The research campaign revealed a high potential for using short-range WindScanner Lidar for accurately measuring small scale flow structures in a wind tunnel.