**Since not only the so called industrialized countries but also the emerging ones need every year more and more energy, the elctric power demand is increasing every year. Such a big demand cannot be satisfied without taking into account the environment, this is a reason why new forms of energy productions that do not pollute are studied. Wind energy is exploited in order to produce some of the power requested thanks to wind turbines that can be arranged either singularly or in small groups or in big wind farms composed of tens of wind turbines. It is in these big wind farms that the major control problems arise since some turbines modifing the speed of the wind blowing, can influence others and decrease their power yeld. Here is presented a method that allows us to predict these modifications in wind speed so that they can be taken into account for a better control of the turbines in the wind farm.**
The first two sections of this summary describe how the problem has been solved. The last section deals with the thesis results

In order to solve this problem several measurements coming from 10 different turbines in Thanet Wind Farm (England) and provided by Vestas Wind Systems A/S have been taken into account. These measurements are used by the turbines during their operation in order to work properly and are shown in Table 1.

| **Wind turbine** | **Measure** |
|---|---|
| | Generator RPM |
| | Nacelle Direction |
| | Pitch Angle |
| | Power |
| | Power Reference |
| | Rotor RPM |
| | System State |
| | Tower Acc Long |
| | Tower Acc Trans |
| | Wind Direction |
| | Wind Speed |
| **Met. Mast** | **Measure** |
| | Air Temperature |
| | Wind Direction |
| | Wind Speed |

Table 1: Measurement specifications

Among all these measurements, wind speed is not reliable because of the way it is measured: an anemomether positioned behind the rotor measures this quantity. The two major problems that arise are:

- the noisiness of these measurement since wind immediately behind the rotor is swirling and turbulent

- the anemomether measures the wind in one point that hardly can represent the real wind speed profile hitting the turbine in one moment since wind speed in general varies from point to point.

Since basically wind speed is the measurement we are interested in the first problem to solve is to find a better way to understand the wind hitting the turbine in one moment. In order to do so, thanks to a special algorithm (Extended Kalman Filter) and exploiting all the other measurements available together with the equations that describe how the turbine behaves have been used to calculate what wind speed could cause the system to behave in such a way. We will refer to this newly calculated wind speed as Effective Wind Speed This have been done for each turbine available. In order to understand whether the estimate was correct or not, through a simulation it has been checked that the power produced by the turbine considering Effecting Wind Speed acting on it can be compared with the real, measured, power. Since this happens, we can state Effective Wind Speed to be a good and reliable estimate of wind speed.

Once wind speed measures are available it is possible to estimate the dynamic system relating wind speed at turbine $i$ with turbine $i + 1$. This is done in two different approaches: the first approach minimizes a cost function which depends on the parameters of the model taken into account. The second approach takes into account the spectra of wind speed and through a frequency analysis computes the best dynamical model that can explain how the wind is transformed along its way between two turbines. The model structure has been chosen so that wind speed spectrum both at input and output of the model are preserved and according to some considerations on what ahppens to wind speed components along their way. In both this approaches only the first 2000 samples of Effective Wind Speed belonging to turbine 3 and 4 calculated previously are taken into account.
The models identified are than validated, that is we check that they work also with the rest of the sequences belonging to turbine 3 and 4 and with other wind sequences which were not taken into account during identification.

After validation phase both approaches return models that are similar. Out of them we calculate a predictor whose purpose is to forecast the value of the wind speed at one turbine some seconds ahead given the measurements at the same turbine and at the previous turbine till the present moment.

Finally it is shown how the availability of predictions can be beneficial to turbine control, improving power yeld and minimizing vibrations on the tower. These results are achieved with a very simple PI controller.