Executive Summary

Currently the analyses and measurements performed on wind turbine prototypes, are rather detailed when looking at the blades and tower, but the mechanical components such as the pitch system, the yaw system and the drive train are not up to those standards. The fact that these components do not have a large safety impact, when they fail, the turbine will usually stay in one piece, has resulted in some neglect in the certification. There are many standards available for components such as bearings, but these standards are not suitable for wind turbines, there are no wind specific standards for bearings.

The failure of any of these components has a significant financial effect, the costs of energy of a wind turbine can be significantly decreased if these failures are substantially reduced. Especially now that wind turbines are placed offshore, the costs becomes much larger as it will not be possible to perform the repair immediately, which results in a longer time that the turbine is not delivering power. Also the actual costs will be higher offshore, as the installations that will be needed are more expensive to use.

The PROTEST project was a pre-normative project, that has resulted in first suggestions to improve the standards concerning the wind turbine prototype testing focusing on the mechanical components. First the current approach has been looked at and weak points were pointed out. A major weak point is that the current aeroelastic tools do not include the necessary details of the mechanical components. For this reason three cases were identified that need further simulation to improve the current standards. These are the case of Low Voltage Ride Through, where an electrical fault in the grid can have a large impact on the loads of a turbine. Though electrical faults are included in the current standards, the simulations do not have the real capability to simulate these cases sufficiently. The possibility of resonance concerning the gearbox should be investigated in different frequency ranges. And finally the possible misalignment in the drive train should be taken into account, when the misalignment is kept within the prescribed amount, simulations should be performed to include the maximum allowed misalignment.

Another chance for improvement was found in the question how should the loads be communicated between the component manufacturer and the wind turbine manufacturer? A description has been given of what loads (in the broadest sense of the word, this therefore includes e.g. deformations) should be supplied to the component manufacturer.

The results of this project also include a flexible approach that could be followed in order to set-up and use a prototype measurement campaign to validate the model and possibly improve the model parameters. As the build up of these mechanical components vary widely in wind turbines and at the same time the models that are available have large variations in detail, it was concluded that only a flexible method would be useful, it does not seem possible to describe strict standards, similar to the blade and tower standards. This six steps approach has been used for the three mechanical components that were investigated in PROTEST: drive train, pitch system and yaw system. Measurements were performed on three existing wind turbines in the field and the results were compared to the analyses of the components. This exercise showed that the six steps approach is a useful and flexible way to improve the reliability of the wind turbine mechanical components.

The main results that are suitable for the different standards committees have been submitted and some have been included in the new 2010 GL guidelines.