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Concept for a Multi Megawatt Wind Turbine Gear and Field Experience

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Concept for a Multi Megawatt Wind Turbine Gear and Field Experience

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[The statements and opinions contained herein are those of the author and should not be construed as an official action or opinion of the American Gear Manufacturers Association.]

Abstract

The increasing call for the use of renewable energy in all industrial countries demands for the extension of wind power generation capacity. In central Europe as in parts of the Americas and Asia, such further expansion is only possible by re-powering -replacement of existing turbines by higher rated ones- or by developing locations in the open sea - offshore. To this end, the gear industry world wide is challenged to develop and supply the required No. of reliable 5 MW class wind turbine gears.

The paper summarizes the concept evaluation and design of the 5 MW Multibrid® wind turbine transmission arrangement, test bed measurements with the prototype as well as field experience over a test period of 3 years.

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Introduction

Continuous or even increasing demand for electrical power combined with concern about fossil fuel resources and CO₂ emission (Kyoto-protocol!) and a world wide tendency to step back from nuclear power are the basic reasons for increasing use of regenerative power in industrial countries. In Germany, as opposed to only 2.6% in 2000, renewable energy contributed 5.3% of the complete prime energy consumption in 2006. Wind energy herein covered a share of 0.85%, figure 1. Same tendencies apply to other European and world wide countries.

The total share of renewable energy to overall electrical power production in Germany was 11.8% in

2006. Goal by law is to increase this share to a minimum of 20 % in the year 2020. Similar regulation in other countries contributes to the resolutions of the Kyoto Protocol.

Development in wind energy

The tendencies may not apply exactly to all industrial countries, but the development of wind energy in Germany is certainly an example for a world wide change in power generation over the next 15 years. In the last decade, bio mass and wind energy were the most increasing sources in renewable energy. The only option to meet the mentioned challenging goals is to further significantly increase wind energy production in Germany, figure 2.

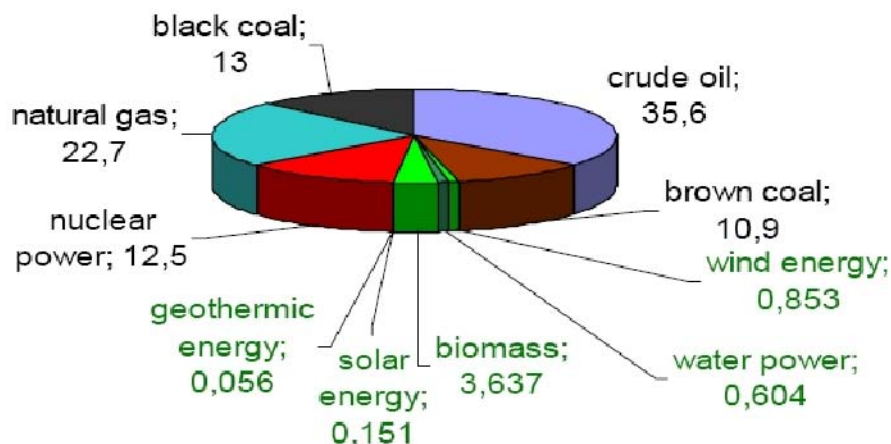


Figure 1. Prime energy supply in Germany 2006, total renewable (green labels): 5.3% [1]

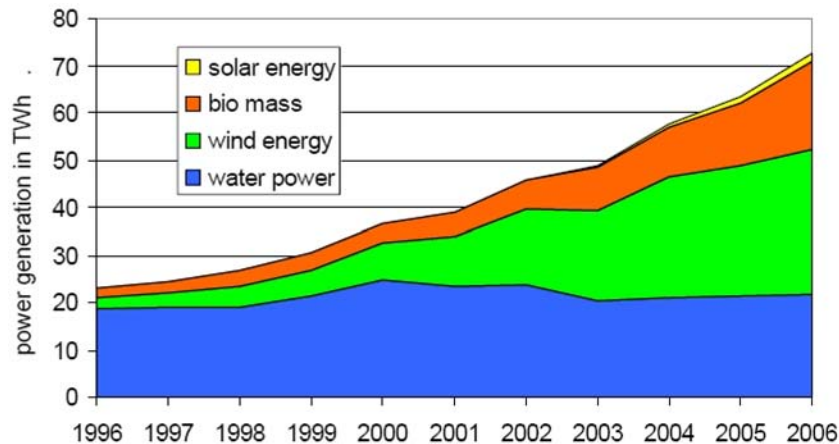


Figure 2. Contribution of renewable energy to power generation in Germany

Even if the demand for electrical power will not increase in the next decades, in order to reduce the share of nuclear power and fossil fuel power generation wind energy needs to significantly expand. A moderate extrapolation of the curves in figure 2 mean twice the power generation out of wind turbines before the year 2020. The prognosis of new installation in wind power [2] matches this requirement, figure 3. Other sources [3] predict up to twice as much growth especially in the field of offshore wind energy production.

In order to keep up with this growth and at the same time consider cost for foundation and maintenance, wind turbines in the 5 MW class are most important. In developing these turbines, German manufacturers are in the lead world wide. The major share of the German offshore wind farms will be equipped with turbines out of local production. The manufacturers are already today facing an additional international request for deliveries. Considering similar plans with offshore wind farms in e.g. UK, Denmark and France and world wide, an export share of more than 50 % seems realistic for the near future. Therefore, the numbers in figure 3 may even be larger by a factor of 2 to 3.

With the predicted growth German wind power industry has rapidly increased its capacity. In parallel with a certain saturation of the German onshore demand international demand was growing. So the export rate rose from only 59% in 2004 to close to

82% in 2008, is expected to grow up to 90% in 2009 and should then be influenced to some extent by the increasing German demand for offshore plants in the North Sea from 2010.

Wind turbines for offshore-application

German wind turbine manufacturers have been working for long in developing plants, specifically designed for the use on the open ocean, i.e. the North Sea with medium water depth around 20 m outside natural parks with low water depth, figure 4. This is an exceptional challenge which may not be the same in most other countries. This development is necessary due to the fact that in Germany only limited space is available onshore and in areas where an average of annual wind speeds in the range of 10 m/s is available so that wind power really is economical.

With the offshore variant of the N 90 with 2.5 MW Nordex provided the first wind turbine being installed under offshore-like conditions. With the successful installation of several REpower 5M on the German and British coast line and 4 units Multi-brid M5000 on the coast line of Bremerhaven/Germany, the German wind turbine manufacturers proved their leading roll in the development of 5 MW wind turbines. Enercon has built their first direct drive 4.5 MW units already in 2002 but has been reluctant for years with respect to offshore application for not taking additional risk and an ongoing demand for onshore applications.

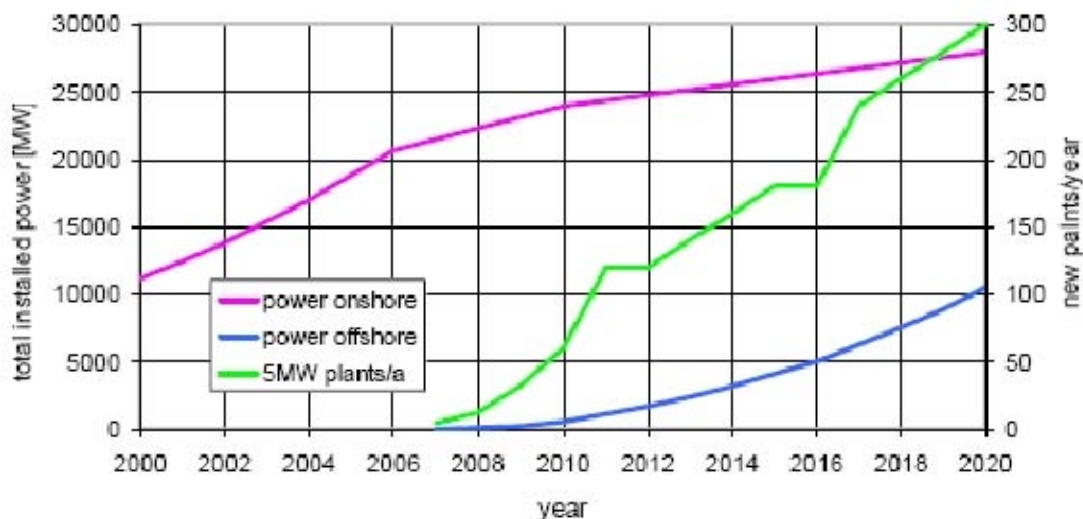


Figure 3. Total power of wind turbines in Germany before 2020; moderate assumptions [2]