





Commission of the European Communities

The book is based on work done in several R&D projects in the framework of an ongoing programme of the COMMISSION OF THE EUROPEAN COMMUNITIES. This programme, called JOULE, supports research and development into renewable energy technologies. It is managed by the Directorate General XII for Science, Research and Development. The synopsis report of three large wind turbine projects, as published in this book, is supported by the Commission under CEC-Contract JOUR-0146-DK.

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WEGA Large Wind Turbines

With 115 Figures

Springer-Verlag
Berlin Heidelberg GmbH

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ISBN 978-3-642-52131-7 ISBN 978-3-642-52129-4 (eBook)
DOI 10.1007/978-3-642-52129-4

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© Springer-Verlag Berlin Heidelberg 1993
Originally published by Springer-Verlag Berlin Heidelberg New York in 1993
Softcover reprint of the hardcover 1st edition 1993

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Typesetting: Camera ready by author

Preface

For almost a decade now, the Commission has been supporting R+D into large wind turbines in Europe within multi-national and pluri-annual programmes in non nuclear energy. The main objective of this action is to further the development of utility-type turbines for mainland electric grid generation and to maintain European leadership in this technology.

The first phase of this action, named WEGA (from the German 'Wind Energie Große Anlagen') has led to the development of three large wind turbines rated at 1.0 to 2.0MW and having rotor sizes, measuring 55 to 60 meters in diameter. The first one, the Tjaereborg 2MW machine, was installed at Tjaereborg near Esbjerg on the west coast of Jutland under the leadership of Elsamprojekt. A short time later, the Spanish-German industrial consortium AWEC-60, joining Union Fenosa with MAN, completed the erection of the second turbine at Cabo Villano, a beautiful cape in the upper western elbow of Spain. Lastly, came the third project, the 1MW machine at Richborough developed by the Scottish firm James Howden with the former UK electricity board CEGB.

These machines have many similarities in their configurations, e.g. they all have three blades and are approximately of the same size, but each of them has different elements of innovation when compared to the previous concepts, either in the electric system, blade design or control philosophy. Also a great effort was devoted to the development of a common data measurement system and programme. For example, the data formats have been fully harmonised and the same software has been running on the three plants to compile periodic operation reports and statistics. Furthermore, all the machines have been instrumented with the same type of equipment, e.g. sensors, strain gauges, that have been mounted

at similar locations on the turbine components. By doing so, the errors and distortion imputable to differences in the measurement systems have been prevented. Also the new highly innovative turbine GAMMA 60, which was constructed by WEST in Sardinia, has been equipped with a data measurement system fully compatible with that of WEGA.

Linked to the WEGA programme, a project was therefore set up to define, harmonise, assemble and supervise its measurement programmes. Another important project is underway to gain further experience from the design and operation of these machines. Also the 3-MW machine of Orkney by Wind Energy Group and Scottish Hydro Electric participates in this action. A value-engineering exercise will be carried out on these concepts with a view to single out the most important results and to identify the potential for further design improvement.

During the first year of operation, all three WEGA machines suffered from a major problem which caused some delays in the measurement programmes and additional preoccupations for the project teams. The gearbox of the Tjaereborg machine had to be dismantled when a crack was found in the outer casing. One of the blades of the AWEC-60 had a profound crack and was lifted down and repaired in the nearby workshop. The generator of Richborough machines was removed and repaired due to a earth fault. Now all three machines are operating in good form and are accruing data from the operation and measurement programmes.

Following these activities, the Commission launched a major study involving the best European expertise in large wind energy technology to investigate the potential of advanced large wind turbines to become cost competitive in the medium term. The encouraging results of this work, which will be soon published in the form of a book, prompted the Commission to launch an action to develop a second generation of large wind turbines. This was named WEGA II. While the machines in WEGA were merely experimental machines, this second programme takes into account more the needs of the market and involves major industries in the field. Five completely new prototypes of large horizontal-axis turbines and an other one of a large vertical-axis turbine will be developed in the time frame 1993-1995. From the WEGA I to the WEGA II, an enormous progress has been made in reducing the machine weights and cost. As an example, the blades of this second generation weigh 2 to 4 tonnes vs. 6 to 9 tonnes previously.

In parallel to WEGA II, an extensive R+D programme is being conducted to investigate many unresolved research aspects of large wind turbine technology. This includes projects on aerodynamics, structural analysis, design tools, fatigue, materials and component development. These actions shall provide the technology development for a third generation of large wind turbines (WEGA III) which will eventually constitute the prototypes of commercial large turbines. It must be stressed that for many projects in this programme, WEGA provides the baseline experimental data needed to validate the assumptions made in their models.

This book is an attempt to describe to the general public the WEGA programme and to provide researchers of the field with basic data of scientific and technical relevance. The Commission is very thankful to the authors for having succeeded in this task in a very quick and effective manner. The Commission wishes to congratulate the participants in the WEGA action, and in particular the leaders of the project team - Peter Christiansen from Elsamprojekt, Alfonso Cano and Andres Matas from Union Fenosa, Erich Hau formerly MAN, David Milborrow from National Power and John Rea from PowerGen and their colleagues who have spent an enormous time and effort for the success of WEGA.

Dr. Giancarlo Caratti

Acknowledgements

The authors are very grateful to Mr. Peter Christiansen and Mrs. Peggy Friis from ELSAMPROJEKT, to Mr. Andres Matas from UNION FENOSA, to Mr. Felix Avia and Enrique Soria from CIEMAT-IER, to Mr. Dave Pearce of POWERGEN and to Mr. Peter Simpson from WIND ENERGY GROUP for providing the material of this book. Many thanks also to Prof. Robert Harrison from the University of Sunderland for his assistance with the English translation.

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