

RAL

DESIGN & DISCOVERY

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RUTHERFORD APPLETON LABORATORY

SCIENCE AND ENGINEERING RESEARCH COUNCIL

WIND ENERGY

INTRODUCTION

Wind energy is now recognised as being one of the most promising of the renewable energy resources, in particular for electricity generation. Present wind turbine design utilises a combination of the best approaches from modern aerodynamics, materials science and microprocessor control.

Countries such as USA and Denmark took the lead initially in developing wind energy as a viable alternative to nuclear and fossil fuel generation but in the last few years UK companies involved in wind energy have secured substantial export orders, and have begun to compete with other countries to harness this cheap and clean renewable resource. The potential of the UK wind resource is itself significant, particularly in Scotland and offshore, in areas such as the southern North Sea; this has led the large UK power utilities to investigate the use of wind generated electricity and to undertake several multi-million pound projects.

WIND ENERGY RESEARCH AT RUTHERFORD APPLETON LABORATORY

The Energy Research Unit (ERU) of the Rutherford Appleton Laboratory has been involved in wind energy related research since 1977. Some work is also carried out on energy strategy and there is a programme of work on energy in buildings. Including university personnel on secondment to the site, there are currently some 15 scientists and engineers who actively participate in joint projects with UK research groups and make use of the Wind Turbine Test Site. ERU is able to draw upon the extensive facilities of the Laboratory, such as the engineering work-

shops and the highly developed computing resources.

In addition to the research activities, members of the Unit are active in providing inputs to both the British and European Wind Energy Associations, BWEA and EWEA, and also contribute to the Commission of European Countries' (CEC) and International Energy Agency's (IEA) wind energy programmes.

THE RAL WIND TURBINE TEST SITE

The RAL Wind Turbine Test Site is operated by the Energy Research Unit as the wind energy research centre for UK university groups working in the field. Experimental work is carried out on the site and in addition various computing facilities are made available. The latter include an extensive wind database and also a number of computer models developed by members of ERU and visiting universities. The experimental equipment on the site includes five wind turbines, ranging in size from 50W to 60kW, two diesel generators and two flywheel systems for short-term energy storage. Three 18m meteorological towers are available for support of projects at the site. The wind regime of the site is now monitored constantly and the results can be accessed by site users. Comprehensive data acquisition facilities are available on the site and, in addition, facilities have been developed for the transfer of data from various data loggers, data recorders and microcomputers onto the RAL mainframe computer. These data can then be accessed directly by universities via the Joint Academic Network (JANET) or SERCNET.

RESEARCH PROGRAMME

The emphasis towards projects undertaken through collaboration between academic institutions, RAL and industry, or related organisations, has been increasingly evident in recent years and the current research programme involves a number of UK industrial organisations, including Dale Electric of GB Limited, Clayton Energy System Limited, Windharvester Limited, Marlec Engineering Limited, AEA Technology, Scottish Hydro Electric and Sir Robert McAlpine and Sons Limited. Academic institutions actively involved in the programme include Imperial College, University College London, Heriot-Watt University, University of Leicester, University of Nottingham, University of Manchester Institute of Science and Technology (UMIST) and University of Strathclyde. Other collaborative work is being undertaken within 6 CEC-funded programmes.

Among major projects undertaken during recent years have been the following:-

- . Autonomous wind/diesel system
- . Shetland meso-scale wind integration
- . Variable speed, constant frequency wind energy system
- . Wind climatology
- . Predictive control of a wind turbine
- . Wind/diesel system modelling
- . Unsteady aerodynamics of a vertical axis wind turbine.

Current projects include:-

- . Wind/diesel/flywheel energy storage
- . An extension of the Shetland wind integration project
- . Rotor 3-dimensional flow
- . Condition monitoring of wind turbines
- . Windfarm meteorology
- . Greek Island wind integration

. Embedded Renewable Energy Generators

Wind/diesel integration

The wind/diesel integration project has been the largest of those undertaken by the Laboratory in the wind energy programme and has involved three phases, the current one being jointly funded by SERC, DTI and industry.

The primary objective of the research in the first two phases was to provide a fully operational integrated wind/diesel system suitable for application in isolated communities where a relatively wide frequency fluctuation of up to $\pm 5\text{Hz}$ can be tolerated. The current follow-on programme is aimed at achieving a frequency stability of $\pm 0.2\text{Hz}$.

A major objective of the project was achieved in October 1987 with the first fully automatic operation of the system under computer control. Since that time many hours of running have taken place under varying wind conditions and the data acquired showed that the rate of diesel fuel consumption, in litres per hour, was reduced by a factor of nine over a wind speed range of 4m/s to 10m/s , with a corresponding reduction in diesel running time, and hence also in wear.

Wind Meteorology

One of the most important topics in wind energy is the estimation of the wind resource at a given site. The Energy Research Unit has been involved in a number of collaborative programmes over many years and more recently has been working on a joint Department of Energy/ National Power contract to carry out intensive meteorology monitoring at the proposed site of the UK's first windfarm.

For further information contact:-

Professor N H Lipman
Energy Research Unit
Building R63
Rutherford Appleton Laboratory
Chilton
Didcot Oxon OX11 0QX

Telephone Number: 0235 821900 Ext 5302

