

Improved Performance of Wind Turbines Using Fibre Optic Structural Monitoring

OBJECTIVES

- Design, develop and demonstrate a cost effective fibre optic based strain and temperature sensing system that is suitable for long term deployment in an operational wind turbine.
- Ensure short and long term measurement accuracy of the system through functional and environmental stress testing during the program.
- Develop a reliable and cost effective deployment technique for embedding fibre optic sensors in composite wind turbine blades during manufacturing.
- Develop a reliable and cost effective deployment technique for retrofitting fibre optic sensors to existing wind turbine structures.

SUMMARY

Manufacturers of utility class wind turbines have recently started to deploy condition monitoring systems in their latest wind turbine designs.

These systems typically monitor the condition of the driveshaft, gearbox and the drive bearings during operation and this is starting



Demanding conditions for wind turbines on a Spanish hillside (courtesy of LM Glasfiber A/S)

to reduce the cost of turbine ownership by reducing operational downtime and allowing dynamic maintenance scheduling.

There are currently other key turbine components that are not actively monitored including the turbine blades and turbine hub. The active monitoring of these components is currently prevented by the lack of available technology.

To combat this lack of technology turbine designers routinely over-design these components with large safety margins being applied.

Routine manual maintenance inspections are required to ascertain the structural condition of these components over their lifetime.

This project is aimed at developing a complete fibre optic structural monitoring system for the wind turbine blades and hub structure.

The proposed system will enable active monitoring of operational loads and structural condition of these parts during operation. The proposed system will have significant operational benefits for the developers and users of utility scale wind turbines including;

- Improved turbine reliability and lifetime due to reduced fatigue loading
- Improved maintenance scheduling and reduced operational downtime
- Improved turbine efficiency using real time load measurement and active blade control
- Improved turbine safety through active health monitoring
- Turbine cost reduction through better understanding of the turbine design loads and materials

The structural monitoring systems currently available for blade monitoring are not appropriate for long term wind turbine deployment due to the harsh turbine operational environment and the

incompatibility with the composite materials used in wind turbine production. They present issues with longevity due to cyclic fatigue, EMI and lightning strike issues and are not compatible with the composite materials used in turbine blade construction leading to local defects and point stresses.

Optical fibres have been shown to effectively monitor the strain in a structure without the problems associated with electrical strain gauges.

Current optical fibre measurement systems are expensive approximately £50,000, large, have high power consumption and are not rugged enough for turbine operation. The optical sensing fibre itself can also be difficult to install and little commercial development work has been directed at simplifying this process.

Insensys has the core technology to develop a fibre optic measurement system for the wind energy industry that is capable of meeting the harsh environmental, performance and cost targets required by the industry.

A successful development program will deliver a condition monitoring solution suitable for mass deployment across the wind industry leading to reduced cost of operation, better design load understanding, reduced turbine parts cost, improved operational efficiency,

improved reliability and
improved public safety.

CONTRACTOR

Insensys Limited
6 & 7 Compass Point, Ensign Way,
Hamble, Southampton, S031 4RA
Tel: +44 (0)2380 604300
Fax: +44 (0)2380 604301

Contract Number:
W/43/00651/00/00
URN Number URN 05/587

COLLABORATORS

WindForce GmbH
Stresemann Straße 46
27570 Bremerhaven
Germany
Tel: +49(0)471-140560
Fax: +49(0)471-140566

Energie Kontor AG
Mary-Somerville-
Straße 5
28359 Bremen
Germany
Tel: +49 (0)421/3304-0
Fax: +49(0)421/3304-444

COST

The total cost of this project is
£427,925 with the Department of
Trade and Industry (DTI)
contributing £139,970, and
Insensys and WindForce the
balance.

DURATION

22 months – December 2004 to
September 2006.

**Further renewable energy information from the
DTI Technology Programme: New and Renewable
Energy, and copies of publications, can be
obtained from:**

*Renewable Energy Helpline
Tel: +44 (0)870 190 6349
E-mail: NRE-enquiries@aeat.co.uk*