One of the main cost drivers for offshore wind energy today are the operation and maintenance costs ("O&M costs"). For onshore and offshore wind energy, 21% to 24% respectively of the total costs of energy relate to operational expenses ("OPEX"). With new sensor technologies the physical condition of wind turbines can be accurately monitored, which will enable better scheduling of maintenance work and will help prevent breakdowns and consequential damage. Since most of the loads on the wind turbine are introduced through the rotor blades, measuring the load there provides the best early indicator of wear & tear.

Key words: condition based maintenance, load monitoring, load sensor, asset management, O&M cost reduction, fiber optics, Bragg gratings, strain measurement, load control, individual pitch control.

Description

- A highly accurate Fiber Optical Blade Monitoring ("FOBM") sensor to measure the loads on rotor blades of wind turbines.
- The sensor can be used:
  1. To support condition based maintenance; and
  2. As feedback mechanism for turbine control systems ("load control").
- ECN estimates that an increase in availability of >0.5% is realistic for off-shore wind farms. An average sized wind farm could potentially save € 1 million per year.
- Load control is a key R&D topic for all leading wind turbine manufacturers to increase yield and reduce loads, mainly because it allows for relatively larger rotor diameters (resulting in annual yield increases of 10-15%).

New and innovative aspects

- The combination of a fiber optical sensor supported by a carrier on two studs is new and has successfully been patented.

Main advantages of its use

- The conventional method to measure loads is by using electrical (copper) strain gages. The advantages of the FOBM sensor are displayed below.

	Strain gages	*FOBM*
Easy to install and replace	✘	✔
Reliable	✘	✔
Long durability (lifetime)	✘	✔
Application on uneven surfaces	✘	✔
No need for periodical calibration	✘	✔
EMC immunity	✘	✔
Sensing over inhomogenenious strained surface	✘	✔

Specifications

- The FOBM system requires four sensors per blade to determine the blade load bending moments in edgewise and flapwise direction.
- The sensor data is read out by a commercially available interrogator unit.
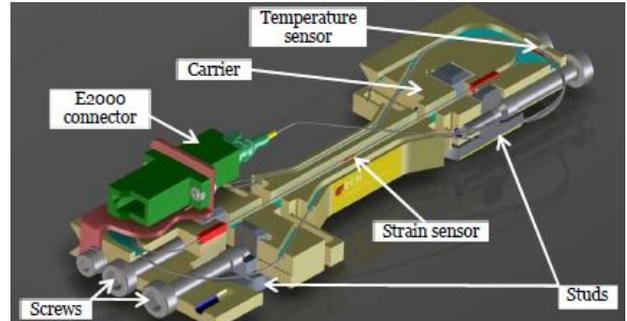
▲Fig. 1. FOBM sensor

- The FOBM software uses the turbine's SCADA data to generate load statistics for all major components of the turbine and provides the operator with a dashboard for O&M optimization.

Potential applications

- Condition based maintenance of wind turbines
- Active load control of wind turbines (e.g. individual pitch control)
- Outside the wind industry (potentially): construction, railways, infrastructural works, oil & gas, transport and heavy lifting (we would like to test and validate these opportunities)

State of development

- Prototypes tested in wind farms. Market traction from several of the large turbine manufacturers. Next step is to industrialize the prototype and develop a commercial product.

Transaction type and partner profile

- Preferred transaction: license agreement
- ECN is interested to get in contact with:
  - Companies with a sufficient track record in selling sensors and/or providing condition based maintenance solutions.
  - End users that would like to test the FOBM sensor for their application(s).

Patent information

- Patent WO2010117260, click here for more details