

Sections of the mini-stadium's solar photovoltaic (left) and solar thermal (right) energy plants

Temperature sensors feed signals to the drives via the building management system (BMS) to ensure that they drive the rotors and fans at an appropriate speed to suit the ambient conditions.

The drives are powered by the photovoltaic system. Because they can alter their speed according to the demand, the drain on the PV supply is minimised. The system uses 1MW of renewable energy, compared to the 1.3 MW of conventionally generated energy that would be needed by a conventional mains-powered system.

Dessicant Dry Air sub-contracted Bromsgrove-based Siam Control and

Automation to supply the controls for the HPHW system. These ensure that the pressure in the network of pipes around the mirror field is maintained at a constant 12 bar. An Idec Pentra PLC was chosen for this duty because of its advanced PID and communication capabilities. The PLC was programmed to control two of the inverters in a duty/standby arrangement that maintains the water pressure during the wide variations in temperature as the sun travels across the sky.

The auto-tuning function of the PLC's PID algorithm ensures that the speed of the inverters and the subsequent system

pressure control is as smooth as possible. Modbus communications link the PLC and inverters to a Renu Electronics 5.6" TFT touchscreen HMI which is used for input, process visualisation and communications with a site-wide building management system. The HMI is configured as a Modbus master to facilitate communication between the inverters, while a second communication port is available as a Modbus slave to the BMS.

The mini-stadium was completed by the end of August 2010 and was able to keep maximum temperatures well below the guidelines issued by FIFA's medical committee to avoid players suffering significant heat stress. It also beat Ashrae comfort standards for spectators.

During an inspection visit by FIFA officials, the temperature on the pitch was recorded as 23°C, despite the external temperature having reached 44°C just two hours before. **D&C**

## Thames turbine could tap the tides worldwide

Part of the Thames has been illuminated using power generated by a prototype hydroelectric turbine that taps the flow of the river. The 1kW turbine, developed by Hales Marine Energy, based near Eastbourne, can generate power from water moving relatively slowly at 1–2m/s compared to the 3–4m/s required by most tidal turbine designs, which use slim propellers or foil blades. According to the new machine's designer, Paul Hales, these higher speeds occur at few locations around the world, limiting their deployment.

Hales' "side drive" design has a much larger blade area, allowing it to operate in the lower flow rates found in many tidal areas of the world, and in some ocean currents. It works in a similar way to a conventional waterwheel, but with its output shaft vertical, allowing the whole turbine to be immersed in the tidal flow.

On one side of the wheel the blades are trying to move against the flow of water, so they are shaped and hinged to present minimal resistance. The large blade area on the drive side produces high levels of torque at low speeds, in the range 10–16 rpm.

When coupled with permanent magnet generators that can start to produce electricity at speeds as low as 2 rpm, the Hales turbine could generate power from the tides at many sites around the world.

According to Hales, two companies currently at the forefront of tidal stream turbine development – UK-based MCT and US-based Verdant – have both had problems with propeller blades snapping off due to excessive stress on the single axis point of

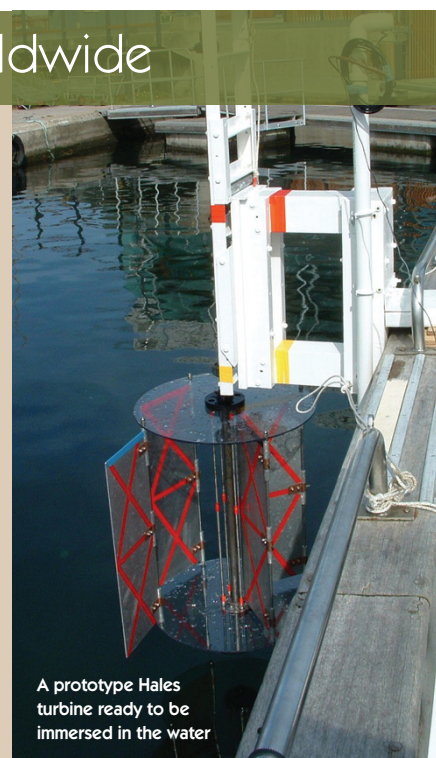
loading where the propeller joins the hub. He argues that his design overcomes this problem by having four points of support, one at each corner of the blade, allowing it to operate in strong and turbulent water flows.

Because side-drive turbines rotate slowly with the blades turning at the same speed as the water, they can withstand the high stress loads created by the water flow. By contrast, propellers and foils which use a lift effect to improve their performance, have to be finely shaped and angled because of their small contact area with the water, and are therefore more vulnerable.

Hales' 1kW turbine could be deployed in tidal seas or in rivers. It is designed to sit on a submersible tank on the seabed that could be floated to the surface when needed. The design is scalable: the 1m-diameter version produces about 1kW; 5m versions would generate around 20kW.

"Water is nearly 800 times denser than air so it carries far more energy, making water turbines a very attractive alternative to wind energy," Hales points out. "Seabed systems are not an impediment to shipping, nor do they have any visual impact and ecological issues are minimal for low-speed systems," he adds. Hales envisages arrays of his turbines being installed at every headland along the English Channel and at intervals down the Thames.

"Of course, that is just the start," he continues. "The simplicity of the design, its robustness, its low maintenance, and relative ease of installation, all add up to making it suitable for deployment in remote and less



A prototype Hales turbine ready to be immersed in the water

developed areas. Its low ecological footprint addresses many of the issues raised by environmentalists. And its continuous and utterly predictable power output overcomes the intermittency associated with wind, wave and solar power."

• The prototype turbine, installed on a pontoon on the Thames, has been monitored by an array of sensors, including a TorqSense wireless torque sensor from Sensor Technology

**G**loucestershire-based Lister Shearing, one of the world's oldest suppliers of animal shearing and clipping equipment, can trace its roots as an agricultural equipment manufacturer back as far as 1860. In 1909, it produced its first sheep-shearing machine and its products now are sold in more than 60 countries.

Lister Shearing invests heavily in product development. This includes sending engineers to work with grooms and shearers around the world to learn about their problems and to devise innovative solutions which are translated into practical products at the company's UK development facility.

A common issue with powered handtools is sourcing motors that combine high efficiency and high torque output with smooth operation and a long life. This situation is complicated by the high operating speed required from the shearing motors – up to 20,000 rpm in some applications.

To address these issues and to help develop a new type of handheld sheep shear, Lister Shearing decided to set up a motor test rig that would allow it to compare the performance of motors from different suppliers.

A key requirement was that the rig should be able to determine accurately the speed and torque produced by each motor under a wide range of operating conditions. Initially, it seemed that this would be difficult to achieve because most torque sensors were either unable to cope with the high speeds or required wired connections that would have been inconvenient or impossible to provide.

Fortunately, one of Lister's development engineers saw a magazine article on Sensor Technology's novel TorqSense sensors and realised that they could solve the company's dilemma. These sensors depend on surface acoustic wave (SAW) transducers comprising two thin metal electrodes, in the form of interlocking "fingers", on a piezoelectric substrate. When an RF signal is applied to the transducer, surface waves are set up and the transducer behaves as a resonant circuit. If the substrate is deformed, the resonant frequency changes.

If the transducer is attached to a motor driveshaft, the deformation of the substrate and hence the change in resonant frequency is related to the torque applied to the shaft. In effect, the transducer becomes a frequency-dependent strain gauge.

Because the transducers operate at radio frequencies, it is easy to couple signals to them wirelessly. Hence, sensors incorporating the SAW technology can be used on rotating shafts and can provide data continuously without needing unreliable brushes and sliprings often used for traditional torque



## Wireless torque sensor is a shear marvel

measurement systems.

The TorqSense sensors are available in versions that can operate at shaft speeds well above 20,000 rpm and thus met Lister Shearing's requirements. As well as measuring torque, they provide data on speed and power.

In the Lister motor test rig application, the sensors are being used with Sensor Technology's TorqView software which combines data acquisition with a real-time display of torque, motor shaft speed, power and temperature.

According to Robin Howell, Lister Shearing's chief development engineer, the motor data collected so far has been "interesting and, in some cases, rather surprising."

"After using the rig for some time," he adds, "I have no doubt at all that it will help us to produce equipment that will set new standards for performance in sheep shearing. Thanks, at least in part to Sensor Technology, sheep around the world will soon be shorn more swiftly!"

## Angle sensors help to keep unmanned sub on track

Chichester-based ASV designs and builds unmanned marine vehicle systems for commercial and military applications such as hydrographic surveys, surveillance, gunnery training and mine-hunting. When designing its ASV 6000 semi-submersible vehicle, ASV chose hollow-shaft potentiometric angle sensors to provide rotary position feedback for actuators that form part of the steering and ride stabilisation control system

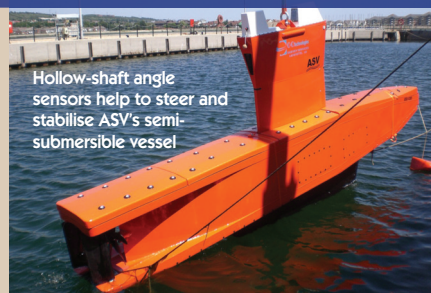
The 6m-long vessel, developed for survey and surveillance work in shallow coastal waters, is operated remotely via a GPS communications link. It operates just below the surface and has a payload capacity of 300kg for sonars, computers, sensors, winches and camera equipment. Its diesel propulsion system provides a 640km range at four knots.

The relatively shallow operation of the ASV 6000

means that actuators designed for sub-sea use at much greater depths, are over-engineered and too expensive. Other commercially available actuators either did not provide angle position feedback or were not waterproof.

To drive down the costs, ASV decided to build the actuators in-house. This also allowed it to accommodate the design within the restricted space available, freeing up more room for the payload.

ASV chose commercial brushless servomotors for the steering and ride control actuators and fitted a sealed, waterproof casing around each assembly, encasing the motor and angle sensor, and including connectors for motor power, commutation and sensor feedback. The hollow-shaft Novotechnik GL angle sensors, supplied by Variohm Eurosensor, are fitted onto the actuator motor shaft, reducing



Hollow-shaft angle sensors help to steer and stabilise ASV's semi-submersible vessel

the assembly length compared to rear shaft-mounted variants with couplings.

The angle sensors' high-resolution output provides the steering and pitch angular positions to ASV's control system as a proportional voltage output covering a 0–340 degree range. A linearity of  $\pm 0.25\%$  is more than sufficient to steer and stabilise the vessel.