Fulcrum3D
WIND SOLAR FUTURES

Corporate Profile

Renewable energy
integration and
resource monitoring

Fulcrum3D is a leading Australian developer of innovative remote wind and solar measuring and monitoring technology for the renewable energy sector. It is a global leader in its field – with its wind, solar, and cloud monitoring and control systems being first class.

Sodar wind monitoring

Fulcrum3D was formed in 2011 by renewable energy specialists with the mission to create inventive technology and solutions for remote sensing and dependable data for renewable resources. The value of Fulcrum3D's unique products is validating investments, securing bankable assets and contributing to maximum deployment and output.

CloudCAM cloud monitoring and solar forcasting

Fulcrum3D offers:

▸ unique design, tailored for the requirements of developers, owners, operators and utilities

▸ proven performance, with systems installed in four continents and a variety of harsh environments

▸ control capability via SCADA interface

▸ Australian design, support & manufacture

The product range includes:

▸ Cloud tracking and solar forecasting using *CloudCAM*

▸ compact beam Fulcrum3D Sodar for wind monitoring

▸ Solar monitoring and soiling test stations

▸ integrated noise and weather monitoring

The technology is based on robust telemetry, designed for maintenance-free operation in remote environments.

All systems are supported by the *FlightDECK* web portal and allow direct SCADA access

Solar monitoring

Fulcrum3D CloudCAM
Cloud Detection, Tracking and Solar Forecasts

Short term forecasts of solar power station output add vital information for managing power systems, especially for islanded power stations with high solar energy contributions.

CloudCAM detects individual clouds, tracks their movement, and predicts future cloud locations. *CloudCAM* then measures cloud coverage; forecasts cloud shadow *events on local solar power stations; and predicts solar* irradiance and solar power output.

CloudCAM also provides typical solar resource data including irradiance, temperature and humidity measurements.

CloudCAM is designed to communicate with existing SCADA systems via Modbus, allowing cloud coverage or solar output predictions to be used in local plant control systems. *CloudCAM* data is also available for download via Fulcrum3D's *FlightDECK* web portal.

Solar forecasts are available up to 15-30 minutes ahead. As a unique added feature, *CloudCAM* provides real-time forecast confidence statistics which reflect the reliability of short term forecasts given the current weather conditions. This data is particularly useful for end users relying on CloudCAM forecasts for power system control.

Typical Configuration

CloudCAM systems use the Fulcrum3D FDL2 datalogger and include a *CloudCAM* all-sky sealed camera head which provides 180° sky coverage at a low cost.

Standard sensors include horizontal pyranometer, temperature and humidity sensor, and GPS receiver. Additional solar and weather sensors can be added.

CloudCAM is designed for temporary or permanent installation and remote operation, with various mounting, power supply and communications options available.


Raw image: Cloud detection:

Applications

Solar Power Plant Integration

Utilities may limit the rate of change of power output into the grid from solar power stations. The potential for significant and rapid changes in solar power output as clouds pass over can impact the entire electricity system.

The solar power forecasts provided by *CloudCAM* allow solar plant controls to predictively ramp down output at an acceptable rate prior to the onset of cloud events.
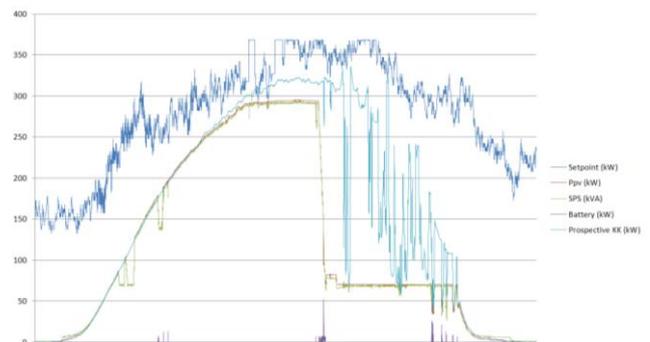
Optimized Power System Management

Power systems often require additional spinning reserve to compensate for variable solar power output, increasing generation costs.

CloudCAM allows system operators to reduce the amount of spinning reserve required to integrate solar energy into the grid. *CloudCAM* detects cloud cover and predicts the onset of cloudy periods - the SCADA then increases spinning reserve during cloudy periods only.

Cloud Measurement

CloudCAM allows universities, agricultural users and weather bureaux to automate cloud cover measurements and to improve their consistency and reliability.

Fulcrum3D Sodar
Reliable, Flexible Cost-Effective Wind Monitoring

Sodar wind monitoring systems provide accurate wind measurements at multiple heights above ground, all from a flexible and portable package.

The Fulcrum3D Sodar is a portable wind monitoring unit designed to measure wind speed, direction and inflow angle from 40m up to 200m above ground level. Optimised for the operating range of modern wind turbines, it is purposely designed for performance in both simple and complex terrain and to meet the stringent requirements of the wind energy industry.

The Fulcrum3D Sodar is delivered complete with its own trailer, solar power supply and communications system.

Applications include:

- Site measurement for 'bankable' energy yield studies
- Verifying wind shear above an existing met mast
- Low cost measurements for noise monitoring
- Complementing met masts with additional Sodar monitoring locations to reduce yield uncertainty
- Directly measuring inflow angles to confirm turbine suitability for the site
- Measuring power performance of operating wind turbines, e.g. for O&M diagnostics

Fulcrum3D's *FlightDECK* is a web-based data delivery interface allowing access, download and analysis of data.

Cold Climate Option

Fulcrum3D has a cold climate Sodar option which is operationally identical to the standard Sodar. This version includes snow and ice melt capability on the sound reflector plate in cold climates and can include a modular methanol fuel cell (45 or 110W) with over 6 months fuel storage to last the whole winter to avoid costly refuelling in the coldest months.

An Innovative Design

The Fulcrum3D Sodar is the most advanced design available:

Compact-Beam Design
Its narrow beam angle maximises performance when the wind vector is not constant across the beams, such as in complex terrain.

Variable Operating Frequency
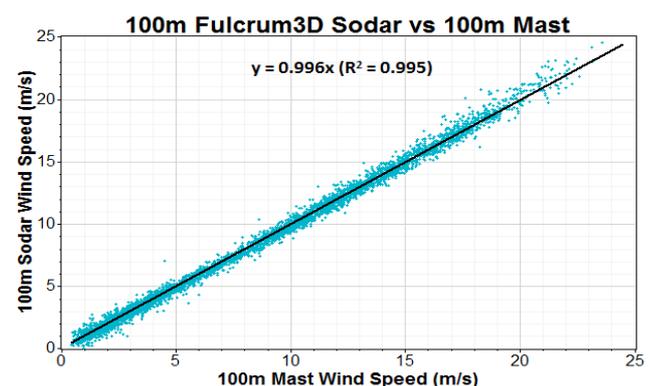Allows multiple units to be co-located without interference.

Multi-Beam Sampling
Three independent sound beams can be pulsed simultaneously to provide more data points per period and higher data quality and availability.

Full Data Traceability
The entire signal and noise data is sent to Fulcrum3D's secure servers, allowing a consistent and fully traceable dataset for verification & analysis.

Proven Performance

The Fulcrum3D Sodar has been independently verified in different climates, topography, locations and elevations by internationally recognised wind energy experts. Performance against high quality tall met masts is excellent (typical R2 >0.98 at IEC Class 1 Terrain sites). The Fulcrum3D Sodar has demonstrated higher accuracy and availability than its competitors in side by side trials.

100m Fulcrum3D Sodar vs 100m Mast

$y = 0.996x$ ($R^2 = 0.995$)

x-axis: 100m Mast Wind Speed (m/s)
y-axis: 100m Sodar Wind Speed (m/s)

DNV GL concludes:

"the Fulcrum 3D Sodar…is able to reproduce cup anemometer wind speeds and wind vane directions at a very accurate level".

"for little to moderately complex terrain sites, data from the Fulcrum3D device may be used in a quantitative sense with reasonable error bars for the purpose of the assessment of the wind regime at potential wind farm sites".

DNV·GL

Fulcrum3D Measurements
Solar, Wind and Cloud Monitoring

Reliable and accurate wind and solar resource monitoring is essential for the development of renewable energy projects.

Fulcrum3D has many years of experience in supplying resource and weather monitoring stations in more than four continents, often in remote locations, and in environments ranging from coastal to desert to high mountains.

Fulcrum3D monitoring systems have included:

- Wind monitoring using Fulcrum3D Sodar or tall met masts
- Solar monitoring
- Solar PV module soiling test stations
- Background noise monitoring systems
- Cloud monitoring systems

Many systems have been custom designed to suit the requirements of the client.

High Speed FDL2 Datalogger

Fulcrum3D systems use the proprietary FDL2 high speed datalogger, capable of taking multiple measurements at sampling frequencies of up to 200Hz.

The FDL2 system is designed to be fully portable and operated remotely, with an IP68 enclosure to survive in the harshest environments:

- GSM/3G/4G or satellite communication with automatic data upload to Fulcrum3D's secure servers
- continuous remote interrogation ensures reliability
- GPS receiver provides exact location and timestamp and acts as a security device (theft protection)

Each system can include an integrated solar/battery system for continuous power supply.

All data including system status indicators can be accessed remotely via the *FlightDECK* web portal, as well as via direct SCADA connection if available.

Reference Sites

Epuron – Ti Tree / Kalkarindji Solar Power Plants (NT, Australia)
Fulcrum3D's *CloudCAM* has been integrated into the control systems of Epuron's islanded solar power stations, optimizing ramp rate control of the system. Each solar power station ranges from 250kW to 450kW and includes battery storage for ramp rate control and grid stabilization, with up to 85% instantaneous power penetration into the local grid to support existing diesel power stations.

Ecotricity – Sodar Wind Monitoring (various sites, UK)
Fulcrum3D has supplied three FS1 Sodar systems to Ecotricity in the UK. The systems include Fulcrum3D's cold-climate unit which includes heaters for clearing frost and snow, as well as a fuel cell for power in low light conditions. Ecotricity is using the systems for short term wind monitoring during noise tests; while seeking approvals for permanent met masts; and for initial site investigations. All data is provided via Fulcrum3D's *FlightDECK* web portal.

APA – Emu Downs Solar Monitoring and Sodar (WA, Australia)
Fulcrum3D has supplied and installed a solar monitoring system and wind monitoring Sodar system for the APA Group. The systems have since been gathering data (including solar data collected at a 1 second sampling rate) which is provided to the client via the *FlightDECK* web portal. Minor maintenance involves Fulcrum3D providing parts, detailed instructions and remote support, allowing the client to maintain their equipment at a low cost.

Genex – Kidston Gold Mine (Qld, Australia)
Fulcrum3D supplied and installed a solar monitoring and soiling test station in remote Queensland for Genex. In addition to standard solar and weather sensors, Fulcrum3D installed its PV soiling test station, complete with clean and soiled reference modules, surface temperature and wet leaf sensors. Due to the remoteness of the location, satellite communications are used, with all data provided via Fulcrum3D's *FlightDECK* web portal.

Head Office Unit 4/76 Reserve Rd, Artarmon NSW 2064, Australia
European Office Jungfrauenthal 22, 20149 Hamburg, Germany
T +61 2 8381 4200 **F** +61 2 9922 6645 info@fulcrum3d.com
fulcrum3d.com