Wind power is a clean, renewable and cost-effective method of generating power. As system production costs decrease and the world turns to renewable energy, larger wind power farms are being built and are starting to encounter challenges in safety and operation efficiency.

### The Solution
Yokogawa Wind Power Solutions can improve your plant assets by monitoring, controlling and optimizing the operation from field to community level with comprehensive communication interfaces that can be connected to third-party equipment in your plant. Of course, as with any Yokogawa system, the highest level of reliability is attained to ensure that your plant assets operate at their maximum potential.

#### Enterprise Automation Solution
Safety and compliance are becoming increasingly important in industrial plants. In order to help improve management, Yokogawa offers an enterprise system that can integrate, monitor and control the customer's entire plant from a single remote location with redundancy provided.

#### Wind Turbine Control System (STARDOM FCN)
Yokogawa's highly-reliable hybrid PLC is used in large numbers in many countries and diverse industries. The high-speed CPU supports a wide range of interfaces such as CANopen, DNP3, Modbus, dedicated pulse module for rotation speed measurement, and SOE function, making it suitable for wind turbine control.

#### Data collection and local control
Yokogawa's edge controller “e-RT3” is made to run 24/7 and is ideal for long-term stable operation. This PLC, with built-in LINUX CPU, can collect data, monitor and control the plant, and issue alarms. Integrated data on wind power such as generated power, battery status, lightning events, weather information and substation abnormalities can be monitored and, in case of abnormality, the switchgear or circuit breaker can be quickly operated and alarms issued.

#### Energy Management System
The objective of the Renewable Energy Management System is to minimize disruption to renewable generation. To increase the inclusion of renewable energy in electrical power grids, its supply must be stabilized.

#### Battery Energy Storage System
To ensure a stable supply of power to the grid, a renewable energy farm may use batteries. Yokogawa's network-based control systems play an important role in smoothing out the supply of this power to the grid. A power monitoring & control system and a battery control system are both configured in the dual-redundant controllers.

#### Cybersecurity
- Centralized and standardized cybersecurity management
- Distribution of OS security patches and anti-virus signature files

#### IIoT Solutions (IoT: Industrial Internet of Things)
- Remote CCTV plant monitoring
- Weather data collection
- Operations management
- Wireless sensors
- Production Dashboard System (such as KPI management)

1  Yokogawa Renewable Solutions WIND POWER
Wind turbine monitoring and control

Yokogawa’s network based controller “STARDOM” has a huge installed base throughout industry and across global markets. The dedicated and redundant CPU for wind turbine control complies with ANSI/ISA S71.04 corrosion resistance and thus ensures extremely reliable operation even in harsh environments.

When it functions as a main controller, STARDOM can be integrated with other systems such as pitch controllers, tower base controllers and inverter controllers thanks to its wide range of interface protocols. This flexible option allows the control system to be fully integrated and optimized.

Key Features
- Extremely reliable operation
- High reliability dual redundant CPU as an option
- Anti-corrosion coating compliant with ANSI/ISA S71.04 G3 standard
- Excellent local support throughout the world
- Quick delivery

Example display of wind turbine monitoring

REMOTE MONITORING OF WIND TURBINES

Yokogawa’s SCADA “FAST/TOOLS” based monitoring system provides consolidated data of multiple turbines as well as relevant information such as environmental conditions and grid status. The system can function as a secondary SCADA and acquire integrated data from local control systems to provide their consolidated information in the remote monitoring room.

Available data includes:
- Power generation/operating status and record
- Ambient temperature, wind speed, wind direction
- Nacelle condition, including rotor speed, rotor vibration, tower vibration
- Detection, alarm issuance, and recording for lightning and fire
- Natural conditions e.g. wind speed, direction, number/time of lightning strikes

Some components are designed for use in offshore wind farms and their installation is rapidly growing.
Offshore wind turbine solutions

Offshore wind turbines face a higher risk of accident compared to onshore ones. Yokogawa is able to offer early-detection solutions so that countermeasures can be taken before the accident escalates to a serious level.

Wave level sensing
Abnormally high ocean waves can cause significant damage to wind turbine operations. Yokogawa’s wind turbine control system comes with a fully integrated wave level sensor and ensures suitable operations to avoid serious damage to the turbines.

External monitoring by anti-corrosion CCTV
Wind turbines are often located near or in the sea, making it difficult for field cameras to survive in such harsh conditions. Yokogawa’s CCTV FIELDEYE II is corrosion-resistant and offers 360° viewing. External monitoring enables detection of abnormalities.

Wide-area fire detection by Distributed Temperature Sensor (DTS)
Yokogawa’s DTS, a fiber optic cable type of temperature sensor, can cover the whole area where there is a risk of fire such as Power Cable. It provides 24/7/365 monitoring along the entire length of the cable.

Robust Features
Dual Redundant CPU
Anti-corrosion coating compliant with ANSI/ISA S71.04 G3 standard

Battery Energy Storage System

To ensure the stable supply of power to the grid even when there is a dip in power generation, many renewable energy farms use a battery energy storage system (BESS) as a backup power supply. Yokogawa’s network-based control system play a key role in smoothing out the supply of this power to the grid.

The following key functions of BESS monitoring and control help you to achieve stable and profit-maximized operation.

Operation planning and monitoring:
Using the power generation scheduling system, operators can access the weekly operation plan data they need to draw up an operation plan for the next day. At their stations, operators can view graphic displays showing the power sales target, power generation plan and battery charge-discharge plan.

Associated power monitoring:
Operators can view data on total power output for the entire facility, battery charge status, and transformer operation status.

Battery monitoring:
The charge-discharge rate, charge status and operation status of each battery are displayed.

60 wind farms, 3.0 gigawatts applied for, and more than 2,000 wind turbines in China

25 Wind farms, 380 megawatts, and more than 176 wind turbines in Japan
From field maintenance to enterprise decision-making

## YOKOGAWA Solutions for wind power

### Enterprise system

- **Consolidated monitoring**
  - Consolidated monitoring of equipment differing in manufacturer and generation
    - Turbine monitor
    - Substation monitor
    - Overhaul monitor
    - Trend monitor
    - Alarm monitor

- **Actual-versus-forecast monitoring**
  - Weather forecasts
  - Generation plans
  - Turbine operation plans
  - Generation performance
  - Power output limit
  - Daily and monthly reports
  - KPI management

- **Prediction and predictive maintenance**
  - Weather forecasts (inc. wind conditions, lightning, thunder)
  - Generation forecasts
  - Predictive analyses (vibration, temperature, stress)
  - Equipment trend analysis
  - Positive economic effect from efficiency increases

- **Maintenance and repair management**
  - Equipment operation data mgmt.
  - Alarm data mgmt.
  - Abnormal shutdown decisions
  - Trend monitoring
  - Predictive maintenance (vibration, temperature, leakage)
  - Decreased equipment failure by early detection and fault prediction

- **Data warehouse (DWH)**
  - Turbine facility data
  - Substation facility data
  - Generation data
  - Maintenance and repair data
  - Statistical analysis data
  - Use of big data

- **Consolidating the dynamic maintenance and repair data and maintenance work data**

### Controllers

- **Data acquisition and control devices**
  - Main Control:
    - Main control with various data integrated
  - Functions:
    1. **Data acquisition**
       - Yokogawa products
       - PLCs (e.g., MM80G and SYSMAC)
       - Modbus
       - OPC
       - BACnet
    2. **Data storage**: Various data acquisition interfaces
    3. **Control**: Output control
       - Plant disconnection control
  - Interfaces for upper levels:
    - Database link
    - Socket communication
    - FTP
    - OPC
    - Other various equipment interfaces

- **Maintenance and repair work**
  - Functions:
    - Various reports
  - Engineering tools:
    - Troubleshooting
    - Configuration
    - Automation
    - Alarm (H/L) setting
    - Screen editor

### Protocol

- **Edge controllers which realize IoT and IT, gateways which enable connection to various equipment and devices**

- **Other Products**

### Equipment and facilities

- **CDT**
  - Cyclic data transfer, etc. (HV)
  - Power company
    - Grid monitoring
    - Grid stabilization
    - Output control commands

- **Battery**
  - Battery energy storage
    - Output stabilization
    - Charge/discharge control

- **Grid**
  - Energy storage system
  - Power company
    - Wind turbine towers
    - Substation
    - Power monitors
    - Diverse devices
      - Breakers, disconnectors, etc.
Production control and safety instrumented systems

- Control and safety system
- Control improvement software
- Control devices
- Quality control system

Field instruments, analytical instruments, and recorders

- Data acquisition
- Field instruments
- Analyzers
- Components

Transformation

Comprehensive solutions that take the broad view in driving operational excellence throughout an enterprise’s business activities, from production through to supply chain optimization, and risk and business management.

- Enterprise business optimization
- Supply chain optimization
- Asset operations and optimization
- Asset management and integrity

Execution

Flexible, agile project implementation services, built on a strong global track record.

- Agile project execution services
- MAC and MAC services

Lifecycles

Maintenance and development services designed to deliver optimized operations over the entire plant lifecycle while working side by side with customers.

- Lifecycle performance care services
- Safety and security
- Asset performance monitoring

Yokogawa Renewable Solutions WIND POWER

Renewable Solutions for Solar PV
Bulletin 53T01A02-02EN

Renewable Solutions for Wind Power
Bulletin 53T01A02-02EN

COMING SOON

Renewable Solutions for Hydro
Bulletin 53T01A02-03EN

Renewable Solutions for Solar CSP
Bulletin 53T01A02-03EN

COMING SOON

Renewable Solutions for Geothermal
Bulletin 53T01A02-03EN

COMING SOON

Renewable Solutions for WtE/Biomass
Bulletin 53T01A02-04EN

COMING SOON

Renewable Solutions for Energy Management Systems EMS
Bulletin 53T01A02-04EN

COMING SOON
Yokogawa’s renewable energy projects

- **Russia**: 2 x 12.5 MW Hydro, 2 x 24 MW Hydro
- **Japan**: 380 MW Wind, 34 MW Hydro
- **Scotland**: 23 MW Waste-to-Energy
- **Spain**: 30 MW Waste-to-Energy
- **South Africa**: 100 MW Solar
- **UAE**: 100 kW Solar
- **France**: 16 MW Waste-to-Energy
- **UK**: 23 MW Waste-to-Energy
- **India**: 38 MW Biomass
- **Philippines**: 95 MW, 55 MW Geothermal, 20 MW, 12 MW Geothermal
- **Japan**: 80 MW Geothermal
- **Mexico**: Geothermal
- **USA**: 30 MW Hydro
- **Brazil**: 2 x 60 MW Biomass
- **Australia**: Solar
- **UAE**: 100 kW Solar
- **France**: 16 MW Waste-to-Energy

Synaptic Business Automation underlies a process of co-innovation and collaboration with customers that leverages Yokogawa’s domain knowledge and digital automation technologies to create sustainable value.