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Industries: Renewable energy
Region: Germany

PROJECT TYPE
Web platform for IoT monitoring, analytics, and predictive maintenance, integrated with the existing SCADA

TECHNOLOGIES
Node.js, Python, React, TypeScript, PostgreSQL, TimescaleDB, Redis, MQTT, REST API, Modbus/OPC UA connectors, Python ML models, anomaly detection, Docker, Kubernetes, cloud (AWS / Azure)

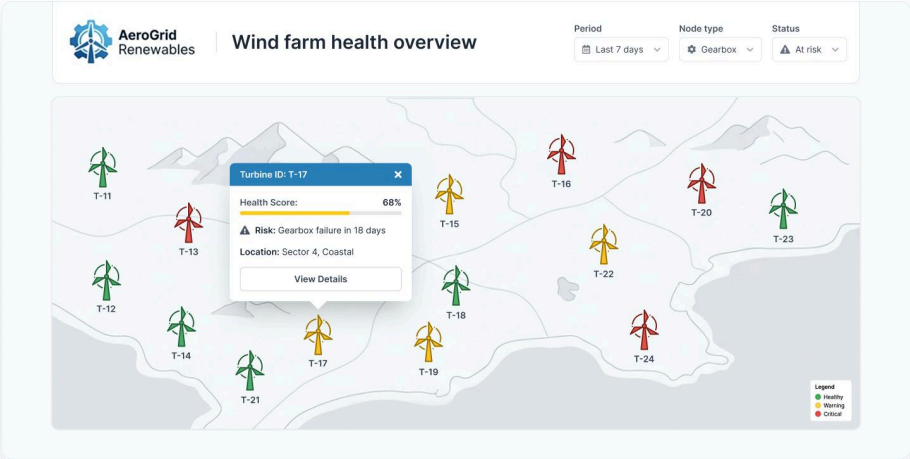
DURATION
10 months

TEAM
1 System Architect/Team Lead
1 Business Analyst/Product Owner
2 Backend Developers
1 Frontend Developer
1 ML Engineer
1 QA Engineer

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IoT and ML predictive maintenance for a wind farm

A predictive maintenance platform built on top of the Client's existing SCADA. The system pulls signals from vibration, temperature, and generator-current sensors, then runs ML models that learn each turbine's baseline under varying wind and load conditions. Wear-related deviations surface as alerts 4 to 6 weeks before the replacement threshold, and confirmed issues flow into the Client's CMMS via an open API. After 12 months on the full fleet, unplanned downtime dropped by 38%, fleet availability rose to 97.7%, and the €640,000 investment was repaid in 9.8 months.



Project background

The Client manages a 28-turbine onshore wind farm spread across roughly 80 km² of rural German farmland. Access to each turbine depends on weather and on contractor schedules for cranes and special equipment. The company relied on scheduled maintenance based on operating hours and on standard SCADA alarms. Damage typically surfaced only after a turbine had entered emergency mode, at which point the gearbox or generator had to come out within days. Baseline metrics across the fleet averaged 165 unplanned downtime hours per turbine per year, around 330 MWh of lost generation per turbine, €82,000 in annual maintenance spend per turbine, and €220,000 for a single emergency gearbox event, once parts, crane, crew, and lost output were counted. Fleet availability stood at 96.4%.

Project Distinctive Features

- ✓ Analytics layered on the existing SCADA stream, with no equipment swap

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We brought SumatoSoft in to cut unplanned downtime, and a year on, we can see component wear weeks before it would have stopped a turbine. Crane bookings sit in our planning calendar and are not done as an emergency.

Markus Keller
Head of Operations

- Gearbox and generator wear predicted from vibration, temperature, generator current, and rotor-speed patterns
- A single web interface for operations engineers and maintenance planners
- ML pipeline trained on per-turbine baselines conditional on wind speed and load

Business challenge

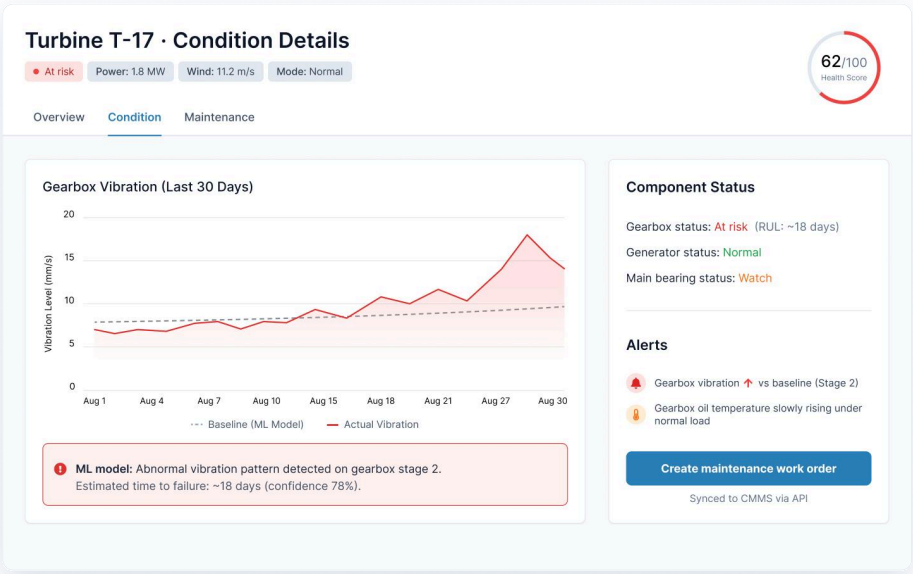
The Client wanted to:

- Monitor turbine component condition remotely
- Predict gearbox and generator wear before failure
- Schedule maintenance during low-output and favorable-weather windows
- Reduce emergency callouts and crane operations
- Keep the existing SCADA and cable network rather than rebuild the infrastructure

Our solution

SumatoSoft built an IoT and ML predictive maintenance platform that runs on top of the Client's existing SCADA. Together with the Client's engineers, we mapped the critical components, pulled signals from existing vibration and temperature sensors, and added generator-current readings on the high-voltage side where they were missing.

Each turbine sends data through an IoT gateway to a cloud pipeline that handles ingestion, cleaning, and normalization. On top of this layer, ML models learn the per-turbine baseline under varying wind and load conditions, then monitor deviations that indicate wear in the gearbox, generator, or bearings. Anomaly detection runs across vibration, temperature, generator current, and rotor speed signals simultaneously.



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On six months of held-out data, the models reached 91% precision and 84% recall on critical-wear alerts, with an F1 of 0.87 and a median lead time of four to six weeks before the replacement threshold. The pipeline also handles unstable communication on the western part of the site: the gateway buffers data locally during connection loss and pushes the backlog once the link returns.

Engineers open the web application and see a fleet map, per-turbine health summary, component signal traces, and risk-level filters. Confirmed issues are entered as work orders in the Client's CMMS via an open API, and planners book repairs alongside other planned work. The full stack runs on Docker and Kubernetes in the Client's preferred cloud (AWS or Azure), and reuses the existing SCADA and cable network rather than replacing them.

Customer’s benefits

After twelve months on the full fleet, the Client reports the following gains against baseline:

- Unplanned downtime: 38% lower, from 165 to 102 hours per turbine per year
- Fleet availability: up 1.3 points, from 96.4% to 97.7%
- OPEX: €504,000 saved across the fleet, around 22%
- Recovered generation: ~3,500 MWh per year, around €280,000 at current offtake prices
- Emergency crane callouts: down from 9 per year to 3
- Average gearbox event cost: from €220,000 reactive to €70,000 planned
- ROI: total investment around €640,000, payback in 9.8 months

What’s happening with the project right now?

The system runs across the entire wind farm. The Client is bringing additional sites online, and SumatoSoft maintains the solution while adding analytics scenarios and integrations with other internal company systems.

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