



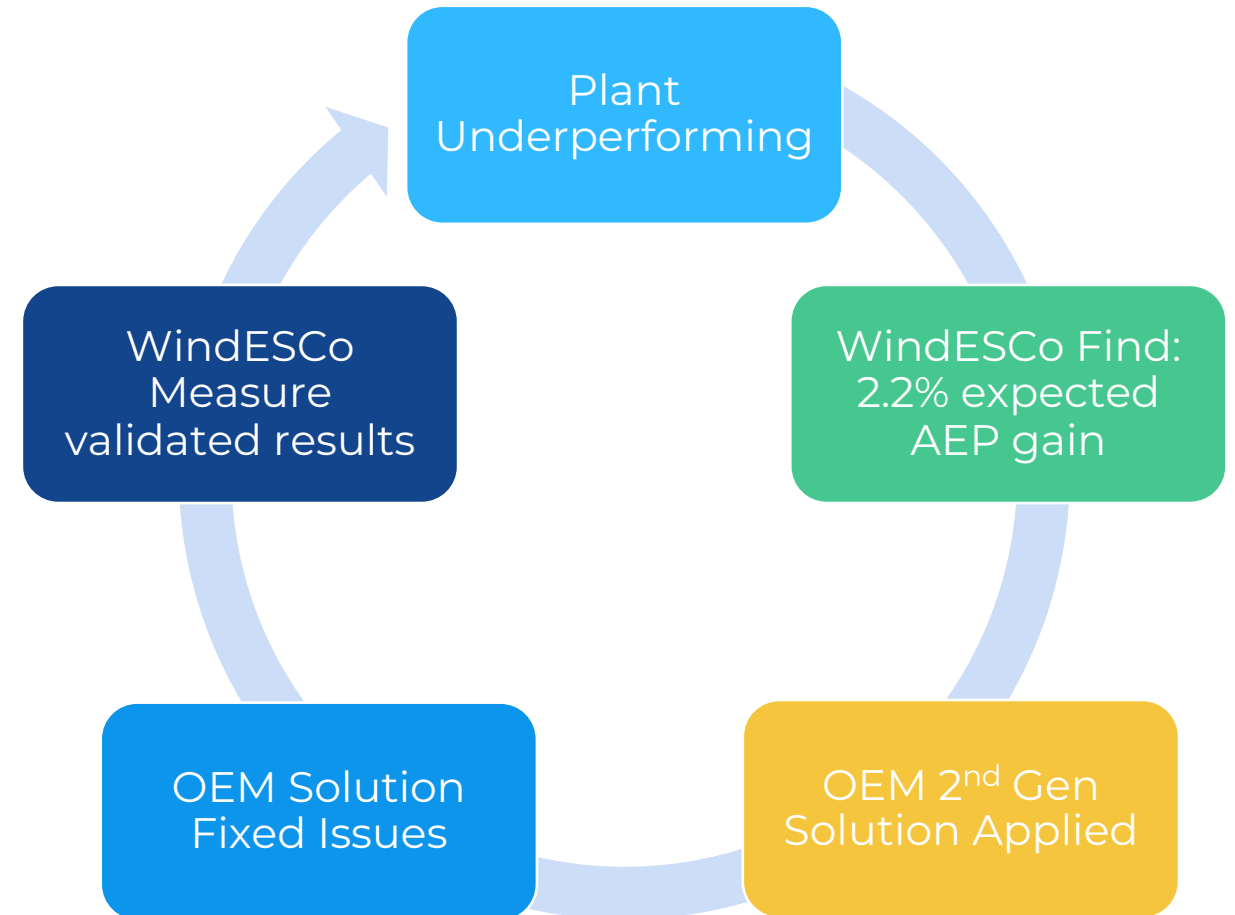
WindESCO

WindESCO Validates OEM Upgrade for Greencoat Case study

Case Overview

- Greencoat engaged WindESCo to increase plant output
- Solution selected was WindESCo Find, Fix, Measure
- WindESCo identified 2.2% improvement in plant output
- WindESCo supported Greencoat in OEM discussions
- The OEM applied its 2nd generation upgrade solution to the wind plant
- OEM's upgrade corrected issues and AEP gain was validated by WindESCo within 6 months

WindESCo validated the upgrade and calculated increase in plant revenue to be €3,700 per turbine annually



About Greencoat Capital



\$7B
Under
management

WindESCo
customer
since
2021

3GW
Aggregate
capacity

Greencoat Capital is one of Europe's largest renewables investment managers with over \$7bn under management, providing secure income for its clients whilst accelerating the transition to a low-carbon future

Introduction



- Greencoat Capital is an infrastructure fund manager
- As an infrastructure fund, Greencoat must manage its renewable plants efficiently
- The company needed a solution that highlights and helps fix plant performance related issues, instead of just a visualization tool
- The solution needed to cost-effectively turn data directly into value

Customer	Greencoat Capital
Project Location	Europe, Onshore
Turbine Capacity	3 to 4 MW
Year in operation	< 3
O&M Agreement	FSA with OEM

Greencoat Capital used WindESCo's Find, Fix, Measure solution to optimize their wind plant performance

WindESCo offers two distinct solutions.

Find, Fix, Measure Turbine-level optimization

- ✔ Domain expertise combined with AI turns data into increased revenue
- ✔ Scalable and cost-effective solution to deliver a 1–2% increase in revenue
- ✔ Leverages high-speed data (600x more data than industry standard)
- ✔ Software-only solution; no warranty impact

The most advanced wind energy performance analytics platform

Swarm Wind plant-level optimization

- ✔ Autonomous, cooperative control system for wind plant-level optimization
- ✔ Delivering 3–5% increase in plant output
- ✔ OEM agnostic retrofit solution for both onshore and offshore wind plants
- ✔ Combined software and IoT hardware solution without warranty impact

First commercially available retrofit solution for plant level optimization

Greencoat Selected WindESCo Find, Fix, Measure

Why FFM?

- ✔ Data-only approach to increase AEP
- ✔ Cost-effective and low risk, ROI in months not years
- ✔ No false positives—all issues are verified by our experts
- ✔ Easily scales across the fleet

Find, Fix, Measure is a data-only solution that is scalable across fleets.



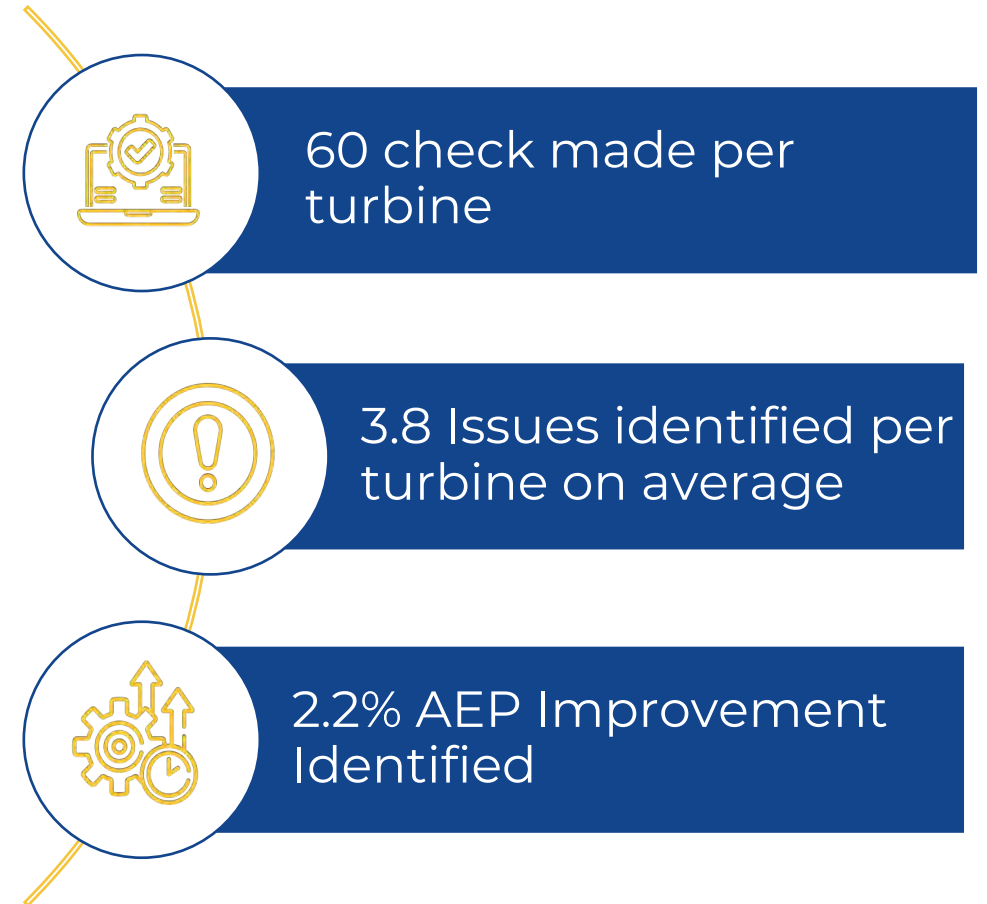
Managing a wind fleet of more than €1.5 billion with a modest staff has challenges. Working with WindESCo has allowed us to prioritize optimizations that make a real difference to our margins without taking focus away from other important parts of the business.

Ben Brooks,
Portfolio Management at Greencoat

Issues Identified by WindESCo Find

By analyzing high-speed data through the Find application, WindESCo identified 2.2% in potential AEP gains. Greencoat prioritized the issue with the biggest potential return: static yaw misalignment.

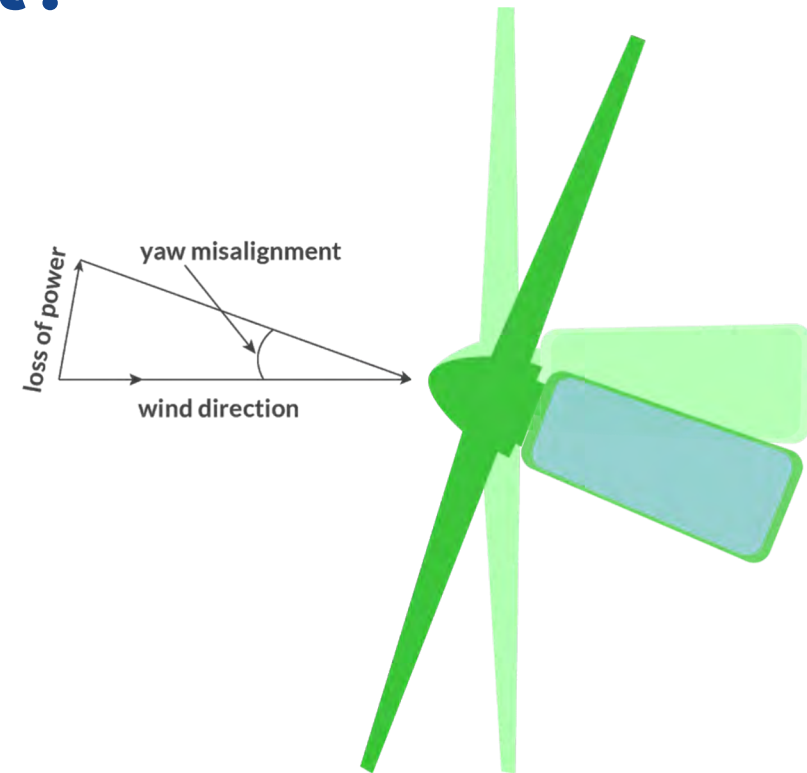
Issue	% of turbines	Plant AEP potential
Static yaw misalignment	85%	0.60%
Rated power anomaly	100%	0.35%
Pitch schedule issue	65%	0.65%
Pitch optimization	100%	0.60%
Total		2.2%



This case study focuses on static yaw misalignment
Remaining improvement will be covered in a future case study

What is Static Yaw Misalignment?

- **Static yaw misalignment** occurs when measured yaw error is 0° , but the turbine is not pointing directly into the wind.
- The turbine cannot see the difference between measurement and reality, making the misalignment invisible to the turbine controller.
- This type of misalignment reduces AEP and increases lifetime consumption.
- Static yaw misalignment is just one of many issues identified by WindESCo Find, Fix, Measure



measurement	●	yaw error value - 0°
actual	●	static yaw misalignment

FFM detects static yaw misalignment using only SCADA data

Static Yaw Misalignment Findings for Greencoat



Initial Issue Selected for Correction

Actionable yaw misalignment ($>3^\circ$) existed on **85%** of the turbines



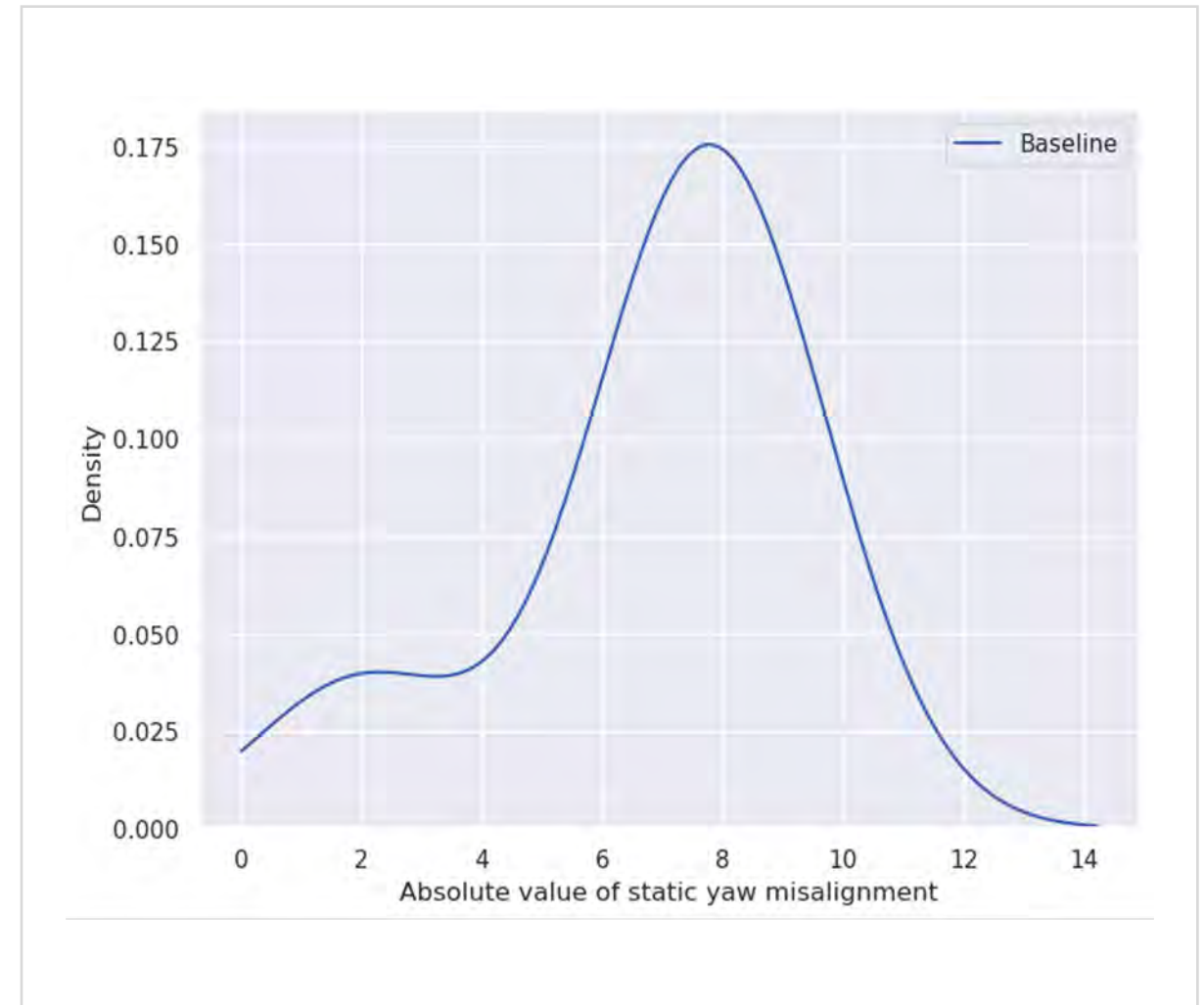
Impact

Estimated increase in plant AEP of **0.5-0.8%**



Corrective Action

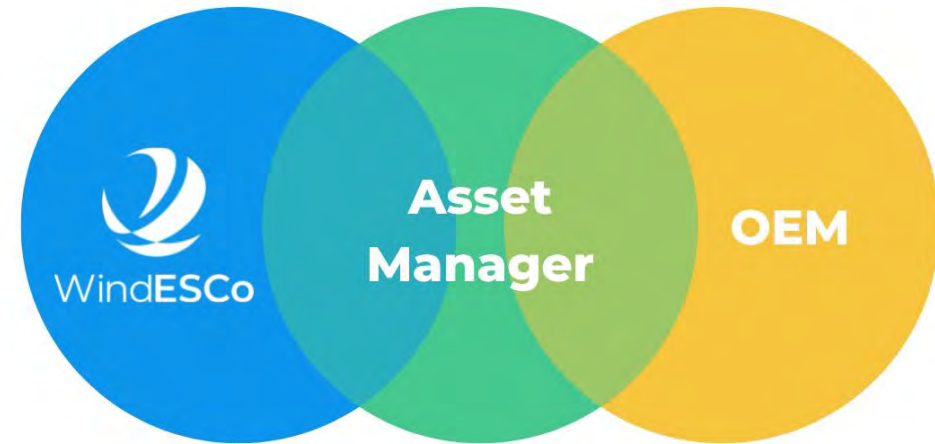
Apply yaw correction using **WindESCo** supplied correction values



Correcting yaw misalignment on 85% of the turbines will increase farm AEP by **0.5 to 0.8%**

Discussions with OEM

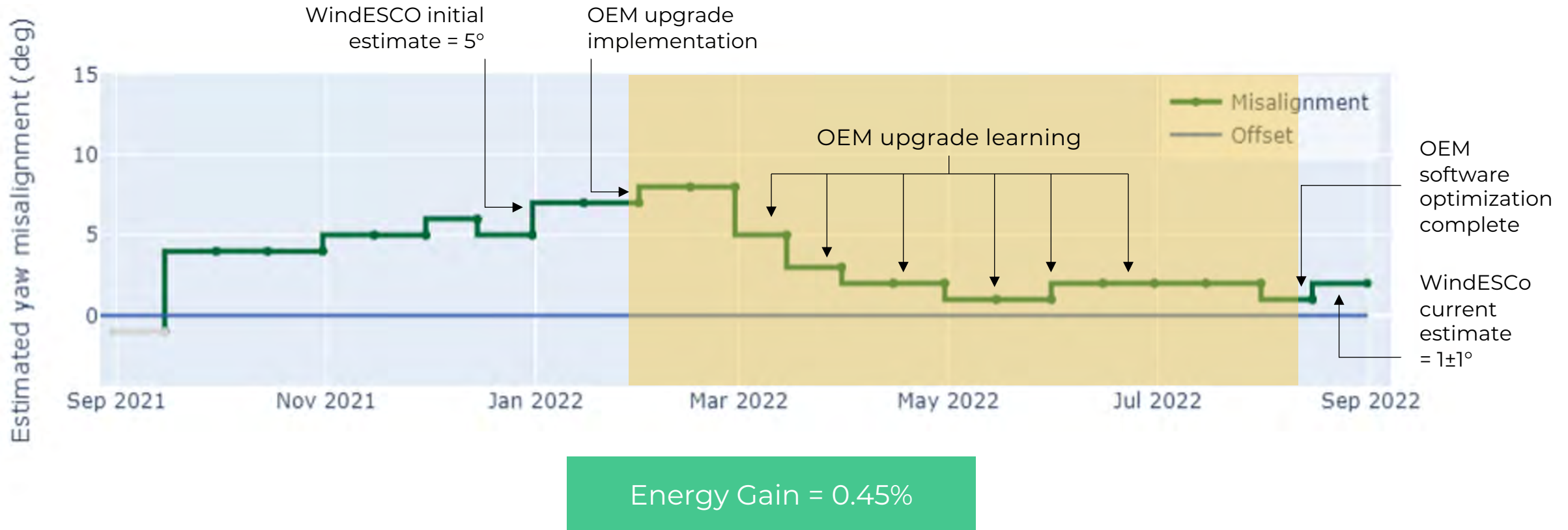
- Wind plant is under OEM FSA
- WindESCo supported Greencoat Capital in discussions with the OEM
- Greencoat Capital highlighted the loss due to yaw misalignment and requested the OEM to implement corrections provided by WindESCo
- The OEM recognized the problem and recommended their proprietary yaw correction algorithm as an alternative to modifying parameters



- There was agreement to proceed with OEM-correction, but with WindESCo validating the OEM solution
- WindESCo made bi-weekly checks on yaw misalignment using a time-weighted data analysis approach

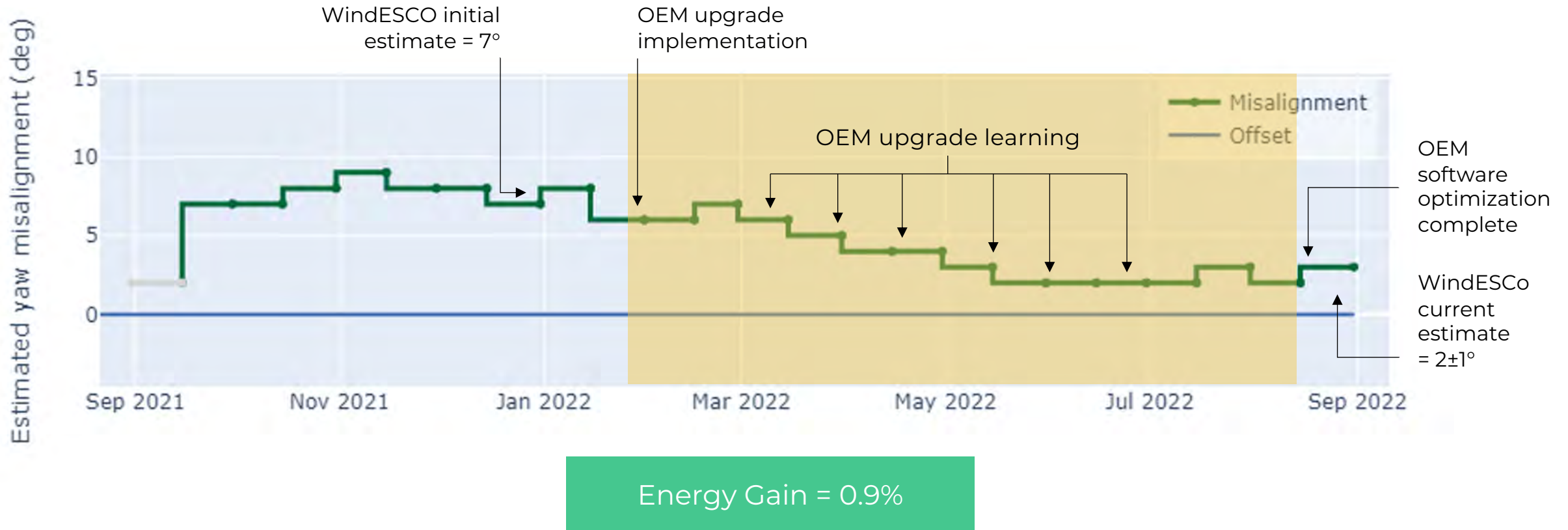
OEM upgrade was implemented after FFM provided specific recommendations

Results - Turbine 1 Yaw Misalignment Evolution



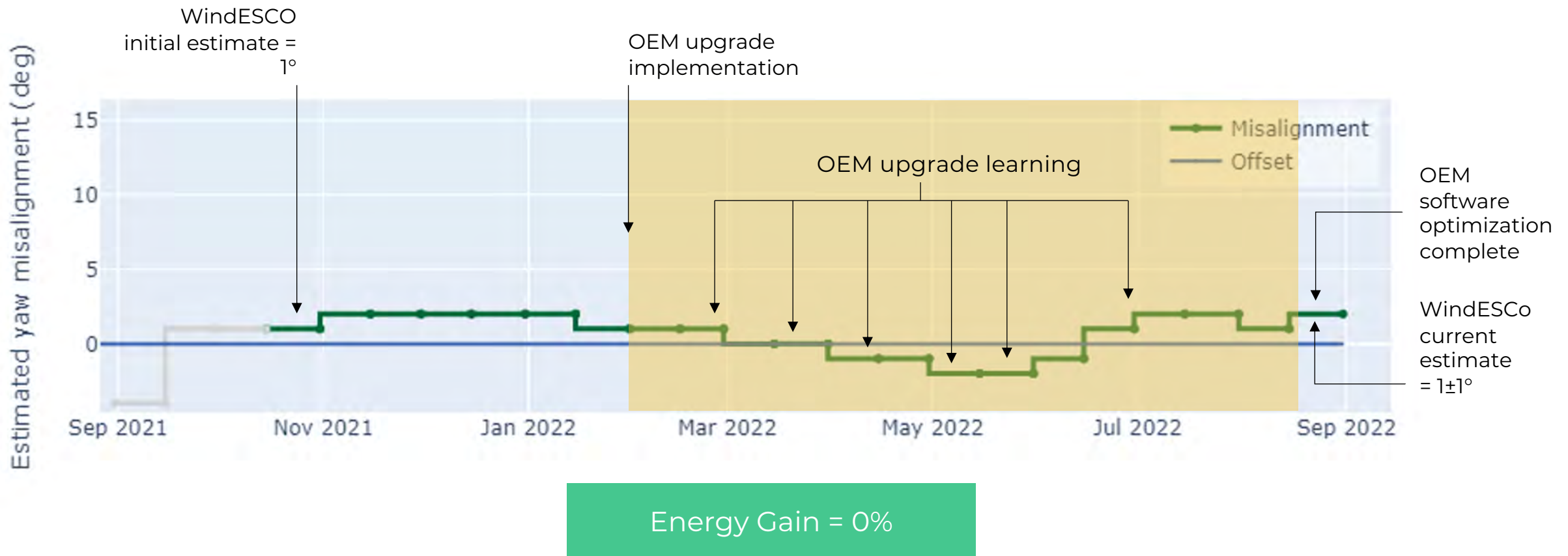
OEM upgrade converged to within 1° of WindESCO recommended value in 6 months

Results-Turbine 2 Yaw Misalignment Evolution



OEM upgrade converged to within 2° of WindESCO recommended value in 6 months

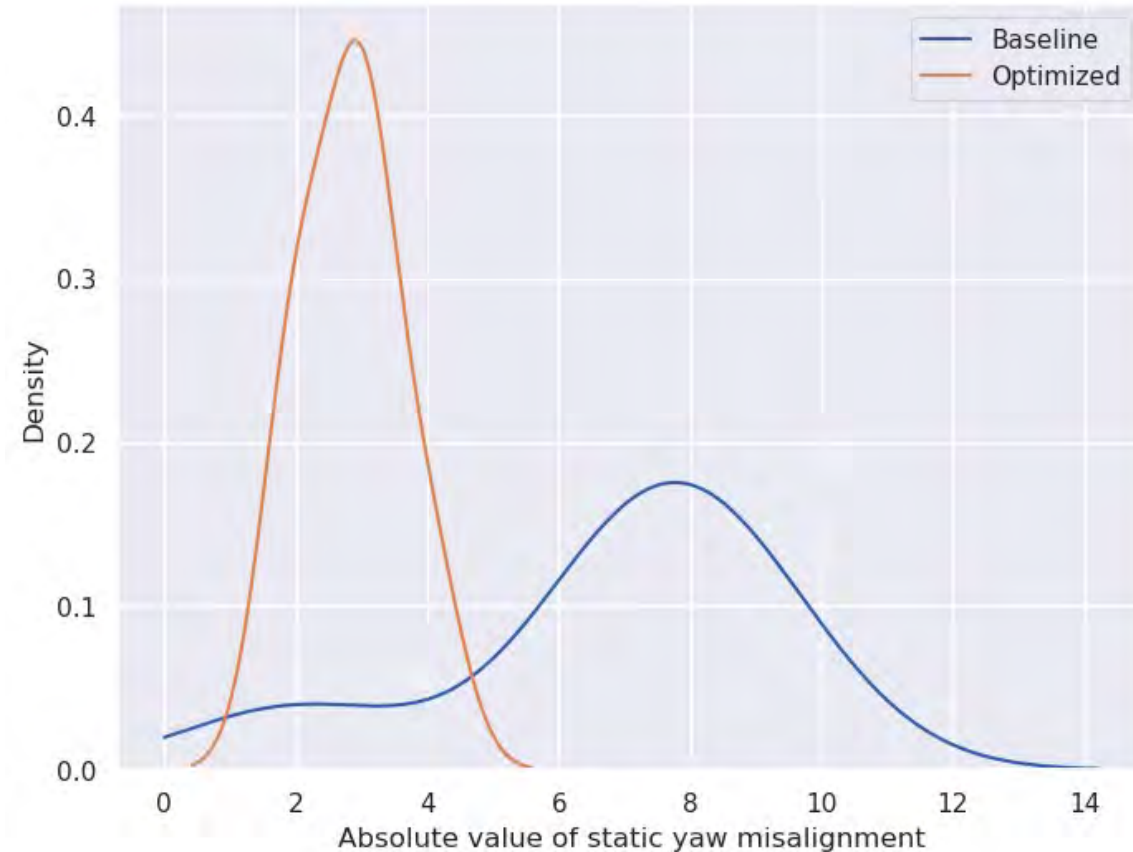
Results- Turbine 3 Yaw Misalignment Evolution



OEM upgrade did not introduce misalignment, where low misalignment was detected by WindESCO

Final results: Distribution of Yaw Misalignments

Following the OEM's application of 2nd Generation solutions, absolute static yaw misalignment was significantly reduced across the wind fleet, validating WindESCo's findings and improving plant performance.



Distribution of yaw misalignments significantly improved
Most values are less than the threshold tolerance of 3°

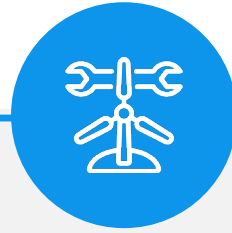
Working Successfully with Your OEM

Greencoat, WindESCo and the OEM worked together to improve plant performance.



Find

WindESCo found issues leading to lower plant performance



Fix

OEM deployed their solution to fix the highlighted problem



Measure

WindESCo validated the OEM solution and measured the improvement in plant output

OEMs solution fixed the problem identified by WindESCo Find
Greencoat will expand FFM solution across its regional portfolio

WindESCo works with all major OEMs

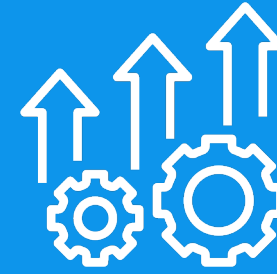
Project Outcome



WindESCo provided the support and expertise we needed to work collaboratively with the OEM to make improvements on assets under an LTSA – something we hadn't considered possible before.

Ben Brooks,

Portfolio Management at Greencoat



FFM improved plant revenue by **€3700** per turbine per year, which translates into a present value of **€14,400** over 5 years

For a **50** turbine project, this translates into a gain of **€720,000** over **5 years**

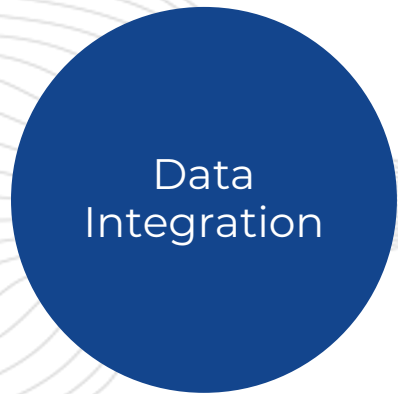
How Find, Fix, Measure Turns Data into Value

WindESCo Find, Fix, Measure™ (FFM)

The most advanced performance optimization solution offering analytics at scale

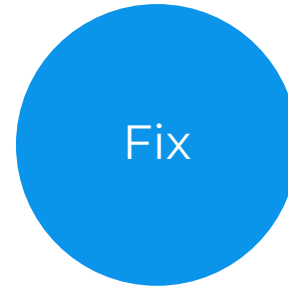


One time integration with high-speed SCADA data
600x more data analyzed per turbine

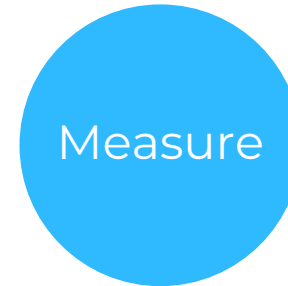


60+ automated checks running continuously for each turbine

Improved and new analytics added every month



We go beyond finding issues to supporting owners in fixing issues



Continuous tracking of increase in plant output helps provide accurate ROI to owners

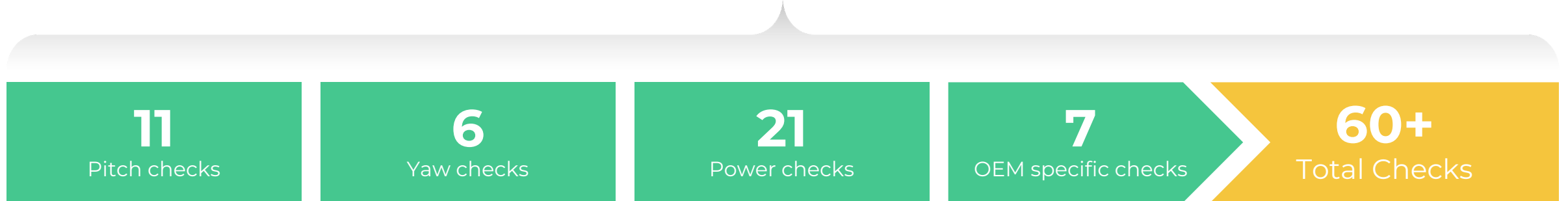


FFM is scalable, cost-effective, and provides peace of mind

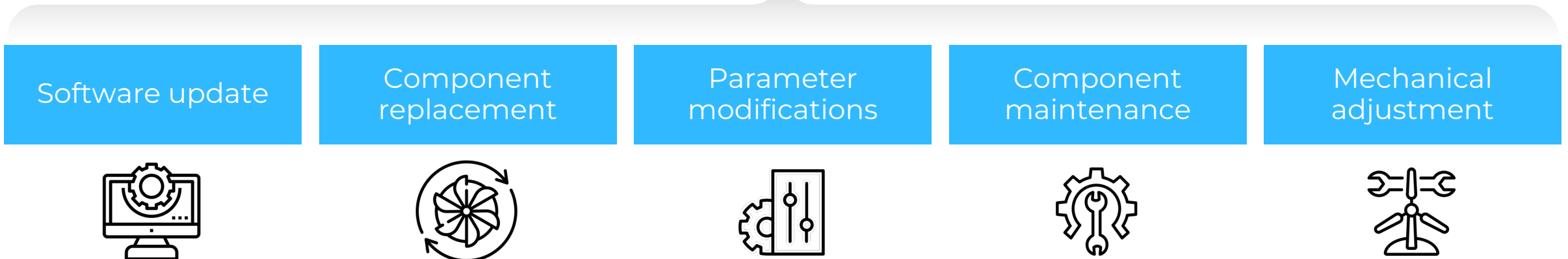
WindESCo FFM Database

Our SaaS solution is constantly evolving to provide additional value to our customers

Our “Finds” detect performance issues leading to loss in AEP



Our “Fixes” provide prescriptive actions to address performance issues



WindESCo Customer Portal – Always on

Identify and highlight what matters

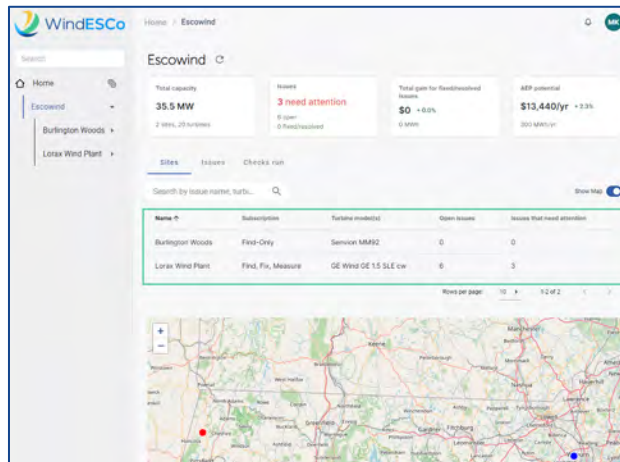
Customers can view all issues identified across their portfolio at a glance as well as in detail

Track gains and losses

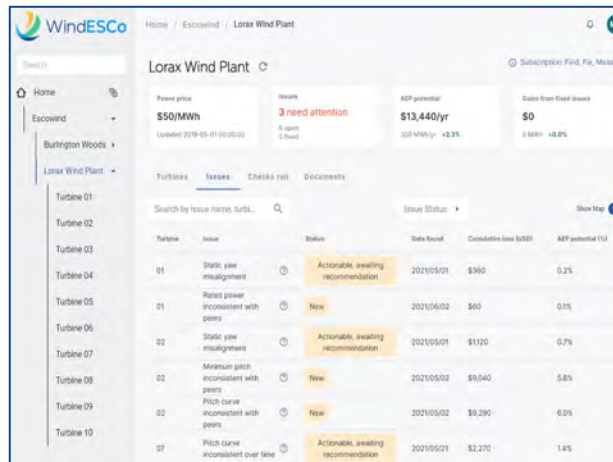
Transparent return on investment with ongoing tracking of gains from addressed issues and losses from unaddressed issues

Stay covered

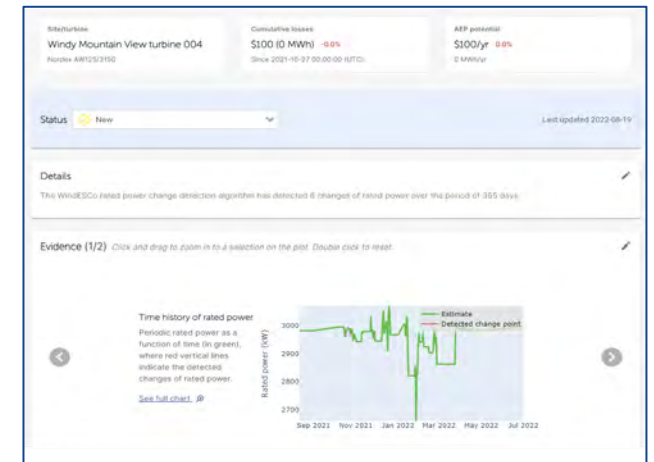
Customers gain the benefit of continuous checks with new checks, developments, and updates being developed monthly



Portfolio View



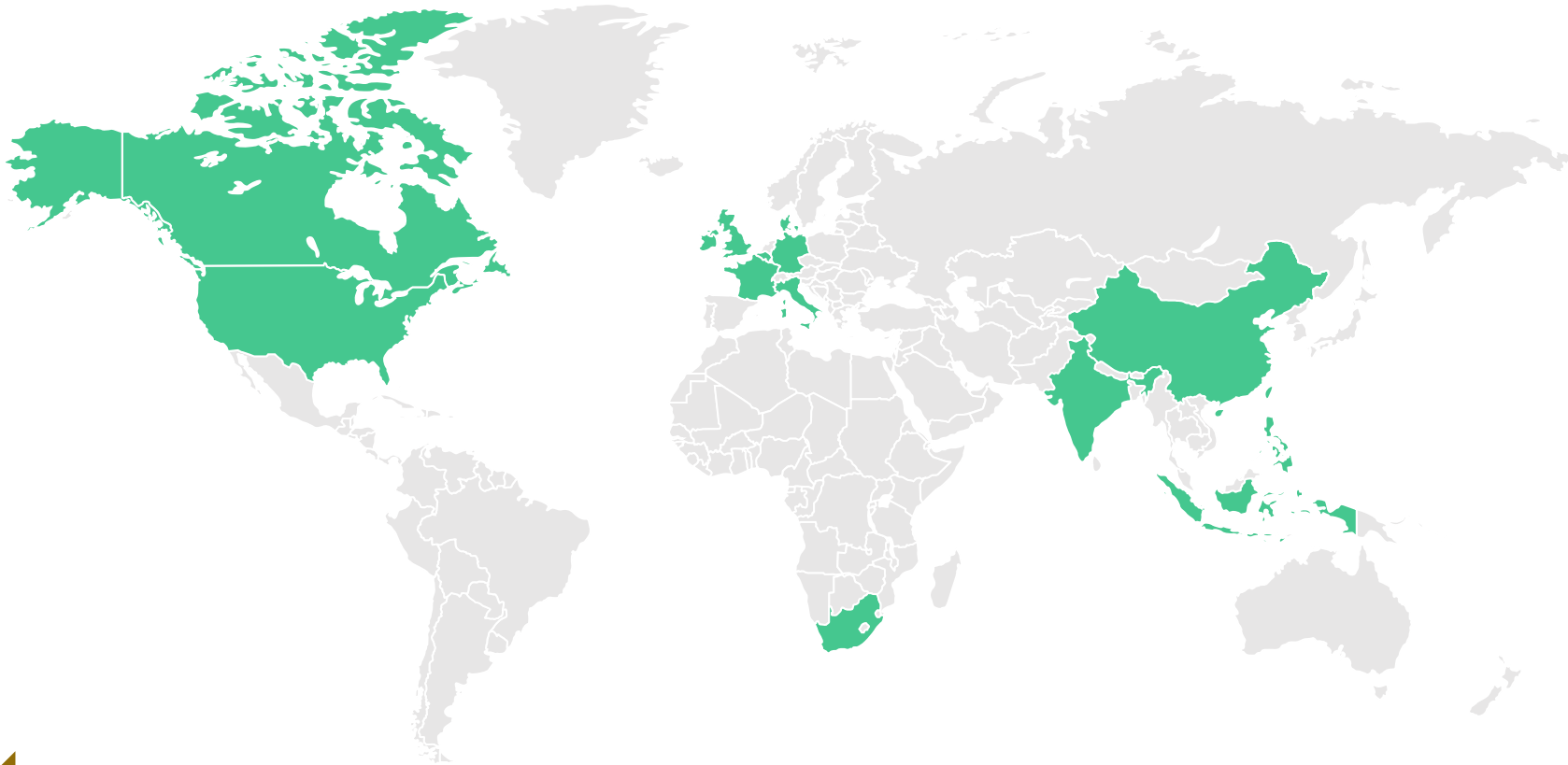
Project View



Issue View

About WindESCo

Trusted by the largest wind energy operators globally



Unlocking value for wind energy

14 Countries



42 Customers



58 Turbine Models Analyzed



19 Optimized OEMs



65% Wind Experts





**Ready to learn more?
Request a demo
today.**

windesco.com/contact