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Turning the Wind

How Auren Energia Unlocked Portfolio Value Through Strategic Capital Allocation and Wind Assets Operational Excellence

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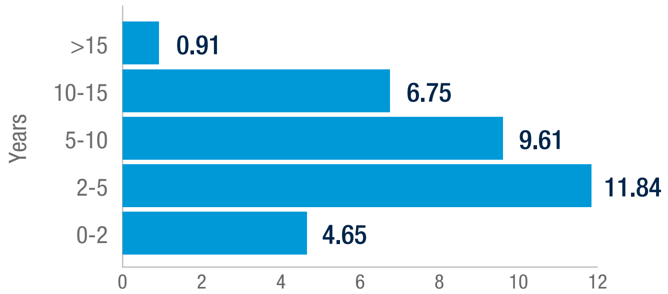
BRAZIL SCENARIO

01 THE MULTIPLE LAYERS OF OPERATIONAL CHALLENGES IN WIND FARMS

Brazil's wind power sector is entering a new phase, characterized by asset maturity, evolving operating models, and a reshaped supply chain. Following more than a decade of rapid expansion, early-generation wind farms are now reaching 10 to 15 years of operation. This shift demands a comprehensive reassessment of maintenance strategies, targeted reinvestment in asset life extension, and increased operational accountability from asset owners.

Installed Capacity by Asset Age (GW)



Asset Maturity and Expiry of O&M Agreements

Most Operation and Maintenance (O&M) contracts—particularly Full Service Agreements (FSAs) signed with turbine manufacturers—were originally structured with terms ranging from five to 10 years. As these agreements reach maturity, asset owners are confronted with strategic decisions: whether to renew with original equipment manufacturers (OEMs), often under less favorable conditions; transition to Operations Support Agreements (OSAs); engage independent service providers (ISPs); or fully internalize O&M activities through a dedicated in-house model.

This decision-making process demands a comprehensive technical, financial, and organizational assessment, factoring in total cost of ownership, performance guarantees, availability risk, and the internal capability to manage operations effectively.

Gap Between Operational Output and Expected Performance

Another critical challenge is the persistent underperformance of wind assets. Key contributing factors include unplanned outages, deviations from turbine power curves, degradation of critical components, and external constraints such as technical and regulatory curtailment.

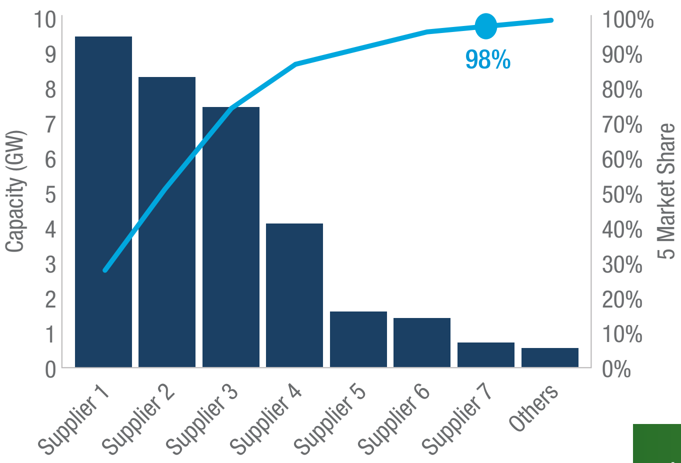
This scenario underscores the need for active performance management of wind farms through the systematic application of Maintenance Planning and Control (PCM) tools, robust tracking of reliability, availability, and productivity KPIs, and the implementation of life extension strategies for wind turbine generators (WTGs).

Supply Chain Reorganization

The exit of major OEMs from the Brazilian market has triggered a restructuring of the technical and logistical support ecosystem for operating wind farms. While some manufacturers opted to idle factories and scale back their local footprint, others began declining FSA renewals— effectively pushing asset owners toward direct operation models.

This transition has led to increased reliance on imported spare parts, a growing—but still nascent—role for independent service providers (ISPs) and heightened complexity in supply chain management. These shifts have direct implications for maintenance costs and response times, particularly for corrective and predictive interventions.

Top 7 WTG Suppliers – 98% of Market (GW)



Enabling Asset Owners for Operational Transition

In this evolving landscape, asset owners must prepare to assume a more active and strategic role in operations.

This transition involves:

- Establishing in-house technical teams and Maintenance Planning and Control (PCM) capabilities
- Deploying remote monitoring and diagnostics systems
- Designing procurement and inventory strategies for critical spare parts
- Assessing existing contractual frameworks and challenges with OEMs

This paradigm shift requires not only technical know-how, but also robust managerial capabilities and a data-driven approach to asset performance and decision-making.

Maximizing Value in the Mid-to-Late Life Phase of Wind Assets

As wind farms progress into the second half of their operational life, it becomes increasingly critical to adopt lifecycle optimization strategies. These may include targeted retrofits of key components, renegotiation of grid connection agreements, technical and financial assessments for potential repowering.

The long-term sustainability of wind farms will hinge on the owners' ability to unlock value despite reduced OEM support, increasing pressure on energy prices and the growing need for reinvestment.

02 RESHAPING WIND FARMS OPERATING MODELS

In light of growing operational challenges faced by wind assets globally—driven by aging fleets, tighter margins, and reduced OEM support—there is a pressing need to reassess existing O&M models and contractual structures. Maximizing performance and ensuring long-term asset value will depend on selecting the right operational strategy, tailored to each portfolio's technical and financial context.

At one end of the spectrum is the Full Service Agreement (FSA), in which the supplier assumes most of the operational risk, offering the highest cost per turbine. Under this model, the OEM is responsible for preventive maintenance, corrective repairs (including major components), technical support, and availability guarantees. This structure is typically controlled by a small group of manufacturers, with inventory and maintenance services closely tied to proprietary supply chains—leaving little flexibility for alternative sourcing.

Key constraints of this model include:

- Long lead times due to part fabrication on a made-to-order basis, with no serial manufacturing in Brazil
- High dependency on OEM-specific logistics
- Availability losses triggered by a single turbine failure
- Crane mobilization requirements for large component replacements

At the opposite end of the spectrum is the fully internalized O&M model, where asset owners assume full operational responsibility for the wind farm. All risk management, maintenance planning, and execution are handled by in-house teams.

Increased requirement for Technical Knowledge and Risk Exposure by the Owner →

	FULL SERVICE AGREEMENT (FSA)	FSA–	OPERATIONS SUPPORT AGREEMENT (OSA)	IN-HOUSE OPERATIONS
Description	The asset owner delegates most operational responsibilities to the supplier, requiring minimal internal technical expertise and limited day-to-day involvement. In this model, operational risks are largely transferred to the service provider.	An intermediate model between the Full Service Agreement (FSA) and the Operations Support Agreement (OSA), this structure differs from a traditional FSA by excluding major corrective maintenance and the procurement of minor components.	The asset owner assumes greater control over day-to-day operations while still relying on the vendor for specialized technical support. This model requires increased internal technical capability and involves shared responsibility for risk management.	The full insourcing model places the asset owner in complete control of O&M activities, requiring deep technical expertise and the full internalization of operational and financial risks.
Owner (non-exhaustive)	▪ Support remote operations and performance monitoring ▪ Conduct quality assurance inspections ▪ Manage service and commercial contracts ▪ Oversee O&M activities for major components	▪ Support remote operations and monitor asset performance ▪ Conduct quality assurance inspections ▪ Manage service contracts ▪ Track O&M activities for major components ▪ Perform corrective maintenance on major components	▪ Execute remote operations and monitor asset performance ▪ Perform corrective maintenance ▪ Conduct quality assurance inspections ▪ Manage OSA contracts ▪ Perform O&M activities on major components	▪ Execute remote operations and monitor asset performance ▪ Perform preventive and corrective maintenance ▪ Manage performance and conduct failure analysis ▪ Conduct quality assurance inspections ▪ Develop and manage inventory strategies ▪ Oversee procurement and supplier development ▪ Manage OSA contracts ▪ Perform O&M activities on major components
Contractor	▪ Preventive maintenance ▪ Corrective maintenance – Minor components ▪ Corrective maintenance – Major components (procurement and execution) ▪ Technical support ▪ Availability guarantee	▪ Preventive maintenance ▪ Corrective maintenance (minor) ▪ Support in the contracting and acquisition process for major correctives ▪ Technical support and supply ▪ Availability guarantee	▪ Preventive maintenance ▪ Technical support ▪ Availability guarantee	

03 WIND PORTFOLIO TURNAROUND PLAN

The methodology was developed to maximize asset availability, minimize energy losses, and optimize operating costs by integrating technical diagnostics, statistical failure modeling, and the definition of tailored O&M strategies. Structured in five sequential steps, the approach enables performance evaluation, identification of value levers, and the development of an operational maturity roadmap that can be applied across diverse generation portfolios.

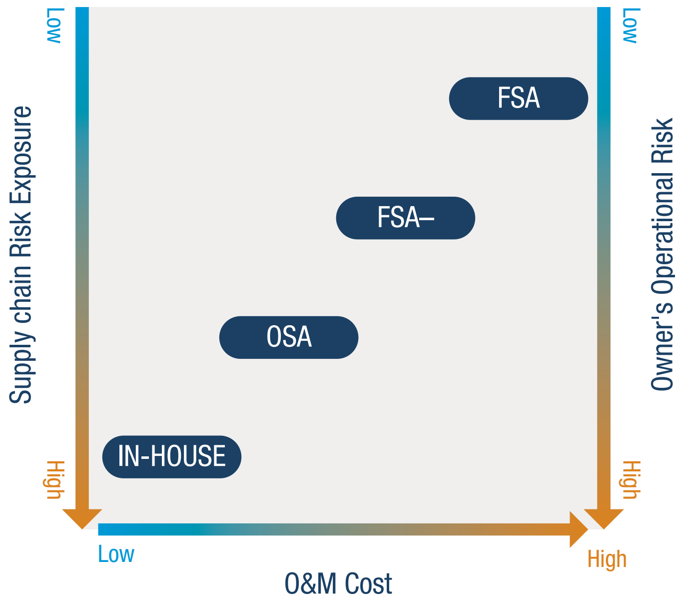
1. Asset Diagnosis	2. Performance Assessment	3. Failure Modeling	4. Target Operating Model	5. Turnaround Plan
Critical assessment of existing contracts and evaluation of the wind farm's maintenance condition.	Evaluation of wind farm performance against expected benchmarks, with a focus on identifying root causes of unavailability.	Structuring the baseline model for relative comparison across different operational scenarios.	Weighting of counterfactual scenarios to define the Target Operating Model (TOM).	Design of tailored interventions to capture availability gains at the individual wind farm level.

3.1 Asset Diagnosis

The diagnostic process begins with a qualitative assessment of the current (as-is) state of operations, which serves as the baseline for future performance comparisons. This mapping highlights existing contractual and technical gaps that may serve as levers for improving asset availability.

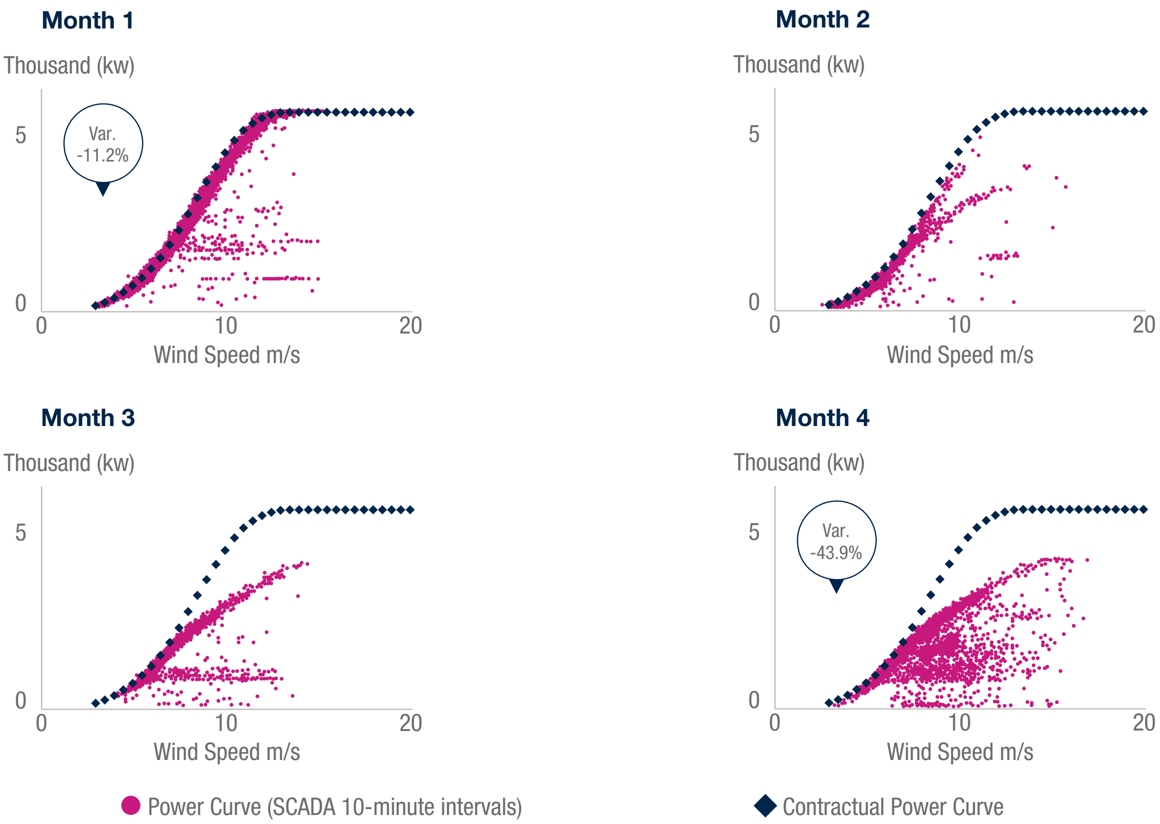
A detailed review of the existing operation and maintenance (O&M) contract is the starting point of the analysis. It involves evaluating contractual responsibilities, adherence to maintenance schedules, and the operational impact of turbine downtime caused by interventions.

Part of the qualitative value of the analysis is derived from the on-site visit to the wind farm. The evaluation of operational workflows, the technical condition of equipment, and adherence to the maintenance plan all have indirect but significant impacts on failure rates and overall asset availability.



3.2 Historical Performance Assessment

The Performance Evaluation phase focuses on identifying the key drivers of energy losses and operational unavailability across wind assets. This step integrates SCADA data analysis with the comparison of actual turbine performance against OEM power curves, enabling a comprehensive assessment of both turbine-level and sitewide operational efficiency.



For illustrative purposes only.

The outcomes of this stage inform the calibration of failure models and the design of targeted tactical actions, ensuring that efforts are focused on the assets with the highest potential for energy recovery and performance improvement.

- **Power Curve Analysis:** Monthly comparison of actual turbine performance against manufacturer power curves to identify progressive deviations and sudden anomalies
- **Outlier Identification:** Detection of turbines exhibiting nonstandard behavior, enabling prioritization of targeted inspections and root cause investigations
- **Technical KPIs:** Calculation of key technical indicators, such as availability and failure rates, benchmarked against internal targets and industry standards
- **Energy Loss Mapping:** Assessment of the gap between actual generation, modeled energy output, and contractual expectations, including the impact of curtailment (both technical and regulatory)

3.3 Failure Modeling

Additionally, the technical characteristics of each wind farm are considered—particularly the failure history of major components, which is used to anchor the failure rate assumptions within the statistical model. As each site operates equipment from different OEMs, portfoliowide management becomes increasingly complex.

The problem is framed around the objective of maximizing availability at the individual wind farm level. In an idealized scenario, this would imply substantial capital tied up in spare parts inventory for large components, which is often economically unfeasible—making trade-offs necessary.

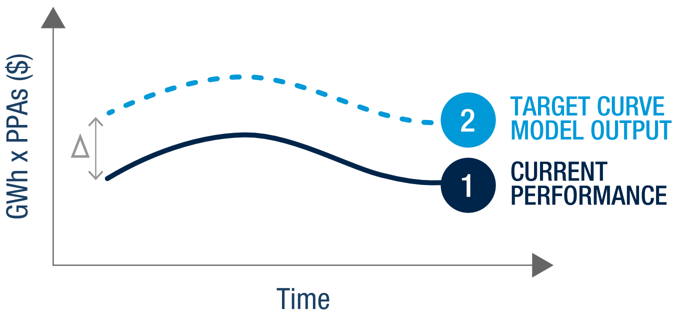
The methodology evaluates this availability-versus-cost trade-off by quantifying both operational expenditures and capital requirements for spare parts inventory. For each wind farm with n wind turbine generators (WTGs), the available time is calculated as follows: Availability=∑1_(i=0)^n (Available Hours-Stochastic Unavailability-Deterministic Intervention Downtime)

Where: Stochastic unavailability refers to the simulated downtime derived from a Monte Carlo analysis based on the failure rates of major components for each wind turbine, and deterministic unavailability corresponds to the contractual hours allocated for scheduled maintenance activities per turbine.

The resulting availability, expressed in energy volume, is financially quantified by multiplying it by the applicable energy price for each wind farm—yielding an estimate of gross operating revenue.

Each failure event generates direct costs, including the purchase of replacement components and crane mobilization. Additionally, turbine downtime incurs an opportunity cost due to foregone revenue. The net operating result is calculated as the gross operating revenue minus the associated operational and failure-related costs.

Based on the initial diagnostic, a baseline scenario is developed to reflect the current operational burdens and identified gaps. This baseline serves as a reference point for evaluating counterfactual scenarios generated through adjustments to key levers in the wind farm's operating model. Notable inference levers include the following:



- Availability
- Failure frequency
- Lead time of major components
- Crane mobilization
- Repair time of major components
- CaPex of major components
- OpEx
- Capital opportunity cost in inventory
- Optimal spare parts stock level
- Implied capacity factor

The baseline scenario is established through a combination of qualitative and quantitative analyses. On the qualitative side, the process includes contract reviews and on-site technical assessments. Quantitatively, it incorporates historical data related to failure events, downtime, and alarm logs associated with major turbine components.

This integrated approach provides a robust operational snapshot and supports the identification of systemic risks and performance improvement opportunities across the asset base.

3.4 Target Operating Model and Capital Allocation Decisions

The primary capital allocation decision emerging from the methodology is the investment in incremental CapEx to establish a strategic inventory level at the wind farm. The model aims to balance the trade-off between unavailability caused by major component failures and the lead time required for their replacement, through the definition of an optimal spare parts inventory. This decision is driven primarily by the cost of replacement components, procurement difficulty, delivery timelines, and the historical failure rate of each component.

In a theoretical scenario of unlimited inventory, wind farm availability would be maximized—but at an economically unfeasible cost. To address this capital constraint, the model compares the marginal cost of holding inventory with the marginal cost of lost revenue due to turbine downtime.

Using Monte Carlo statistical simulations, the model estimates the expected number of failures per component over the analysis horizon. Based on these projections, it tests the initial inventory allocation at Day Zero, measuring the incremental impact on both operational availability and financial performance. The outcome is a recommended inventory level for each major component—calibrated to maximize long-term asset value while accounting for the opportunity cost of capital tied up in inventory.

Recommended repair

	# Components					
	0	1	2	3	4	5
Δ Financial Impact $	0,00%	0,35%	0,50%	0,51%	0,55%	0,50%
Δ % Availability	0,00%	0,40%	0,51%	0,53%	0,57%	0,55%

The recommended operating model for each wind farm is defined based on a scenario-based assessment of alternative O&M strategies. This includes different combinations of optimal inventory levels, O&M contracting structures, operating cost profiles, and the implicit impact of each configuration on the site's capacity factor. Ultimately, by evaluating these scenarios through the lens of risk, performance, and capital allocation, the methodology supports the selection of the most efficient and value-maximizing future operating model for each asset.

3.5 Asset-Level Turnaround Plan

The Tactical Plan translates the diagnostic findings into structured actions designed to capture value and mitigate operational risk. It serves as a bridge between technical analysis and the practical implementation of improvements in the field.

- Capital Allocation Plan: Detailed CapEx program based on component criticality and its impact on energy output
- Quick Wins Implementation Plan: Immediate implementation of low-investment, high-impact actions to improve availability and generation
- Operational Model and O&M Contract Optimization: Redesign of operational workflows and revision of O&M contract structures to enhance efficiency, accountability, and service responsiveness

To illustrate the application of this methodology, a real-world case study from a wind generation portfolio in Brazil is presented, showcasing how a structured, data-driven approach enabled measurable improvements in availability, cost efficiency, and operational governance.

04 CASE

The acquisition of AES Brasil by Auren Energia—controlled by the Votorantim Group and the Canadian pension fund CPPIB—represented a strategic milestone for the company, positioning it as the third-largest power generator in Brazil. The integration added 25 assets to Auren's portfolio, bringing the total to 39 operational and under-construction assets across wind, solar, and hydropower sources (approx. 8.8GW under operation).

This expansion significantly increased the complexity of fleet management, given the broader diversity in asset age, contractual structures, turbine technologies, and geographic dispersion—requiring a more integrated and data-driven approach to operational optimization.

4.1 Addressing Complexity in Auren's Wind Asset Expansion

Alvarez & Marsal was engaged by Auren Energia in August, 2024 to jointly design and implement a structured turnaround program for its wind asset portfolio. The objective was to address the growing complexity of the fleet and unlock value through operational excellence. The program was built collaboratively and structured into the following key phases:

CAPITAL ALLOCATION PROGRAM	TARGET OPERATING MODEL DESIGN	ASSET TURNAROUND PLAN	CHANGE MANAGEMENT
Analysis of historical failure rates of major components, developed with Engineering and O&M teams to define the optimal spare parts strategy. The study included inventory forecasting, expected failure behavior, and the design of focused CapEx programs.	Design of asset-level operational plans based on availability optimization principles, incorporating manufacturer-specific failure data, O&M contract structures, and site technical conditions to define the most efficient operating model for each asset.	Development of a turnaround plan to accelerate the recovery of idle wind turbine generators (WTGs), with the goal of restoring availability, increasing generation capacity, and boosting operating revenue. Over 200 integration initiatives were identified and organized into execution waves, balancing quick wins with long-term structural actions.	Implementation of management and governance routines, including performance monitoring of the company's asset portfolio, tracking of contractual availability metrics, and review of procedures and technical instructions to support the creation of the Performance Area Manual. The initiative also included the training of over 200

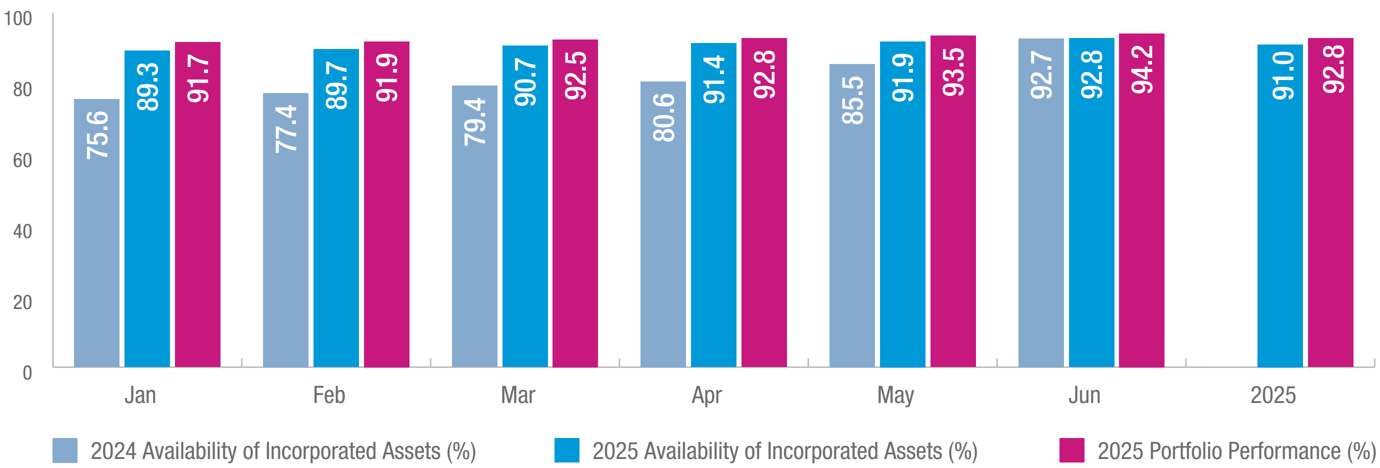
4.2 Key Outcomes From the Performance Optimization Program

A. Operational Availability Gains Across the Fleet

Wind asset availability increased from 75.6% to 89.3% by the end of January 2025, representing a 13.7 percentage point improvement compared to the same period of the previous year.

By June 2025, reflecting the sustained recovery in availability and generation performance, the average availability of the selected wind assets reached 92.8%. Total portfolio availability—including both Auren's original and newly integrated assets—also showed a significant increase, reaching 94.2% in June 2025.

Among the performance highlights are the Cajuína assets, which showed a marked recovery during the first half of 2025—particularly in January and June—when compared to the same period of the previous year.



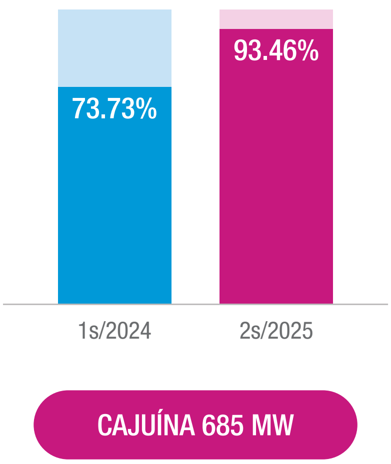
Source: Auren Day, Auren Q1 2025 Release, Auren Q2 2025 Results

> Total portfolio availability—including both Auren's original and newly integrated assets—showed a significant increase, reaching 94.2% in June 2025.

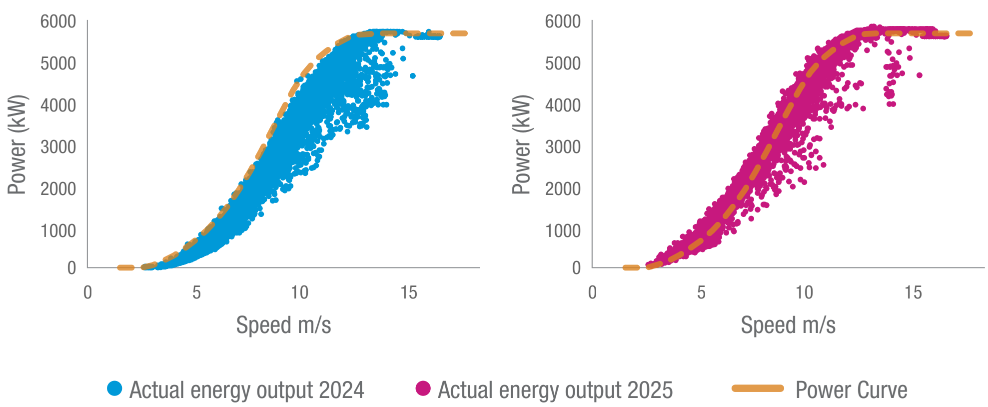
Several key initiatives defined in the Tactical Plan—developed during the turnaround effort led by Alvarez & Marsal and subsequently implemented—contributed to these results, including:

- Implementation of FSA contract monitoring routines to ensure compliance and service adherence
- Deployment of a real-time performance monitoring system
- Proactive availability and performance management
- Training and upskilling of operational teams

Improvement in Technical Availability Over Time (%)

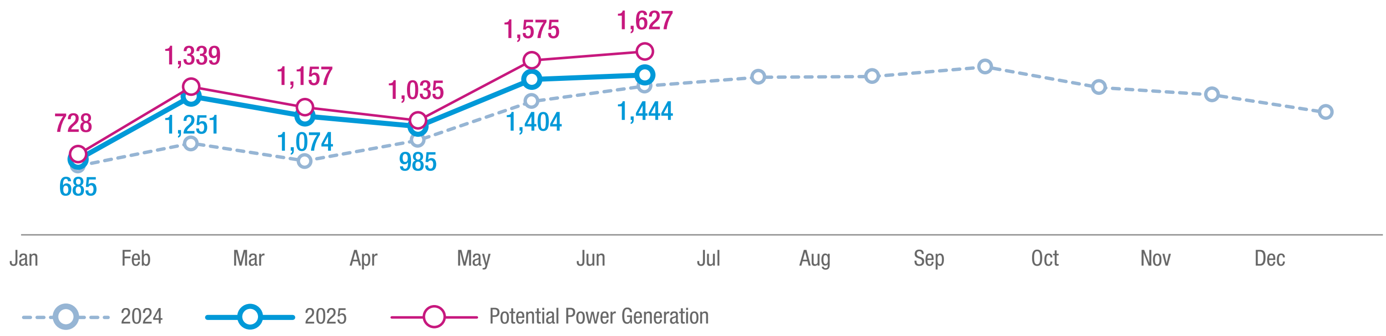


Performance Improvement Cajuína Contractual Power Curve (%)



Source: Auren Day

Generation of Wind Assets (in Average MW)



Source: Auren Q2 2025 Results

> Total wind portfolio generation reached 1,100 average MW in the first half of 2025, 20% increase compared to 2024.

B. Improvements in Energy Generation Performance

As a result of increased availability in the incorporated assets, total wind portfolio generation reached 1,100 average MW in the first half of 2025—a 20% increase compared to the same period in 2024. This generation level also exceeded the certified P90 energy forecast by 2.0%, driven primarily by the improved performance of assets included in the turnaround program.

C. Post-Implementation Financial Results

Auren's adjusted EBITDA in the first quarter of 2025 reached BRL 1.2 billion, representing a 66% increase compared to the same period of the previous year, with the generation segment contributing BRL 1.1 billion. Net revenue totaled BRL 3.0 billion, up 34% year-over-year.

The turnaround of Auren's wind assets demonstrates how a structured approach—grounded in workforce training, advanced technology adoption, and the disciplined execution of a robust tactical plan—can convert operational challenges into measurable results. The successful integration of AES's portfolio has strengthened Auren's position as a leader in Brazil's renewable energy sector, generating meaningful operational and financial improvements.

All monetary values are expressed in BRL (Brazilian Real).

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