



APPLIED INTELLIGENCE FOR **RENEWABLES**

**Services from
Accenture**



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POWERING BUSINESS AMBITIONS

What is Applied Intelligence?

Applied Intelligence is how Accenture uses artificial intelligence (AI), automation and analytics to reimagine business—enabling our clients to help drive digital transformation at the core of their business and enable new outcomes.

What is the world's most valuable resource? According to *the Economist*, it's not oil, but data.¹ We are now in the age where AI is driving disruption and bringing an abundance of previously hidden or unreachable new economic and social possibilities to businesses, governments and society. To be successful, companies must carefully manage the change AI can enable across their organizations—from reinventing business processes to creating entirely new ways of working. We believe AI must be embedded into the core of business to uncover untapped value and create new value.

We call this unique approach Applied Intelligence: intelligent technology and human ingenuity applied at the core of business—across every function and process—to address businesses' most complex challenges.

Accenture's Applied Intelligence practice brings together the power of AI with our deep industry, analytics and technology expertise to help capture business value from these new technologies. Accenture Applied Intelligence helps companies transform every facet of their business through AI to break down silos and create more agile, adaptive processes, enable better decision making, and empower businesses to identify and capture completely new opportunities.

APPLIED INTELLIGENCE FOR RENEWABLES

For renewables companies, Applied Intelligence can help enhance asset value across the entire value chain. As illustrated in Figure 1, business outcomes in wind could be maximized in optimizing production (powering remote operations monitoring, production optimization and predictive maintenance), optimizing resources (improving maintenance, supply chain and workforce management), better integrating energy management and operations and maintenance (O&M) (through advanced production forecasting), and enabling remote intelligence.

Figure 1: Illustration of digital capabilities for wind O&M.

Production optimization



Remote operations monitoring/
control room



Production optimization



Predictive maintenance

Resources optimization



Maintenance and supply chain management



Workforce management

Energy management and O&M optimization



Production forecasting and energy management



Remote intelligence

SAMPLE USE CASES FOR RENEWABLES

Applied Intelligence is already redefining possibilities and powering new outcomes across the value chain for renewables companies.

Digital wind hub: Advanced visual exploration

Not just optimizing production: A new environment to enter into renewables digital services.

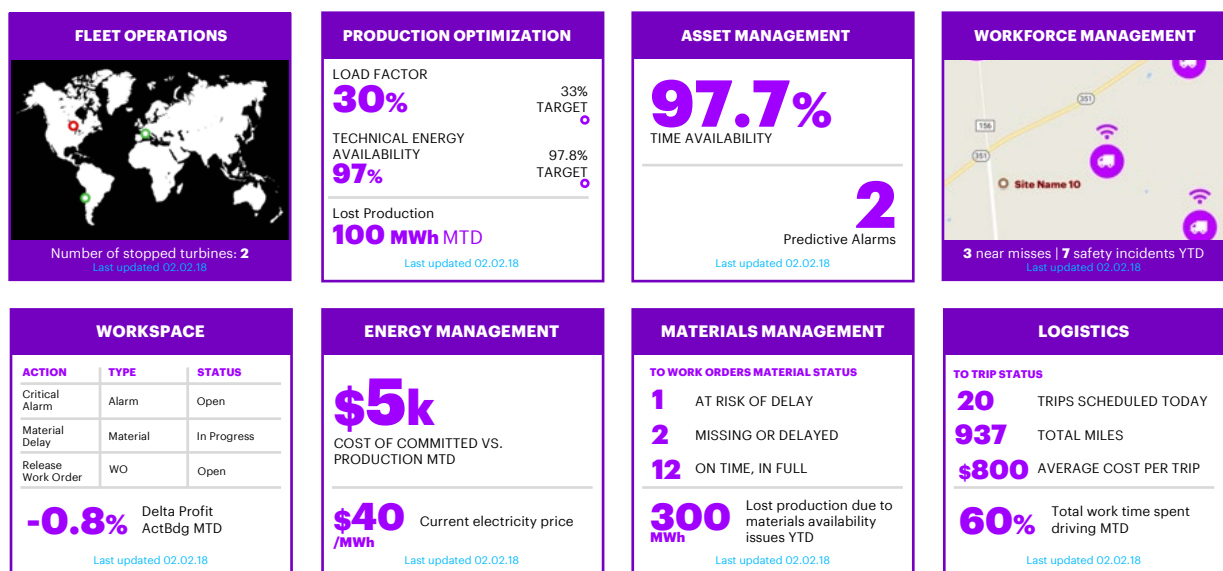
A holistic view of overall operational indicators of a fleet, together with the integration of external data and predicted key performance indicators, offers a real-time work environment for O&M managers to analyze, compare and anticipate performance, enable smarter decision making and drive the industrialization of renewables operations. Applied to wind energy, this is what we call a digital wind hub.

This step change requires a transformation away from the use of local control rooms, enterprise resource planning (ERP) and legacy systems toward a new digital architecture that integrates a variety of external and internal factors and datasets to drive asset value maximization.

Beyond better coordination of the O&M and production aspects of the business, by setting up such a digital architecture with advanced visual exploration of all variables influencing the renewables case, operators can also enter and offer new O&M and energy management digital services as market aggregators and position themselves as disruptors in digital innovation.

Figure 2 illustrates a digital wind hub prototype created by Accenture that visualizes key metrics and manages and executes processes across fleet operations, production optimization, asset management, workforce management, energy management, materials management and logistics.

Figure 2: Digital wind hub (illustrative).



Production improvement through power curve optimization

The optimal turbine does not necessarily have the highest annual energy production.

Minimizing power generation cost over the asset lifetime (levelized cost of energy, or LCOE) by detecting and correcting avoidable losses of production is the key metric for wind operational excellence.

The power curve is a measure of wind turbine performance that indicates the expected power a turbine will produce for each instantaneous wind speed. Predictive models and mathematical optimization algorithms allow simulation of the expected production under different circumstances and anomalies. Comparison of actual power to expected values, identification of displacements of the power curve for those circumstances, and analysis of key variables to detect root causes of the anomalies could all be improved through Applied Intelligence.

By detecting the reason for displacements, AI algorithms can offer early-warning recommendations to correct the deviation and improve load factor and energy production. Based on our analysis, we estimate that such early-warning alerts and consequent prompt remedy could contribute to production improvements within ranges of 1% to 4% depending on the root cause, whether it be yaw misalignment, pitch misalignment, wake effect, rotor unbalance, soiled blades or other cause.

Early-warning anomaly detection and time-to-failure models

**Knowing something is going wrong is good.
Knowing it ahead of time is even better.**

Based on our research, most maintenance for renewables assets is still currently either planned or unplanned, with less than 20% of maintenance activity being predictive.

Advanced analytics can be used to create predictive models for key components and subsystems of renewable assets. Those models can detect deviations from the expected operating conditions and predict expected time to failure (TTF).

TTF models not only identify when a failure may occur but can also pinpoint probable cause and highlight recommendations for required remediation. By highlighting in advance the probability of failure over time and related estimated impacts, operators can analyze risk-benefit scenarios and optimize their maintenance and logistics strategy.



Research in collaboration with MIT and a global renewables operator

Accenture collaborated with MIT and a global renewables operator to conduct research to assess the value of predictive maintenance for wind farms. Based on the rationale that turbine operating time needs to be maximized versus the need to avoid catastrophic failures, MIT and Accenture investigated how more robust decision making could be achieved, distinguishing between internal and external factors influencing equipment health. A new statistical model for reliability analysis was developed to distinguish between the latent internal vulnerability of the equipment from the vulnerability caused by temporary external sources, resulting in increased plant availability and a reduction in unplanned maintenance costs.²

Hydro turbination and pumping optimization

Pumped storage hydro can be optimized to access multiple value pools to maximize revenue.

Hydropower plants either store the natural flow of water in dams or pump water into an elevated reservoir to be able to release the water and produce electricity when needed. To date, pumped storage systems are the largest form of electricity storage available at competitive costs.

Applied Intelligence-led opportunities cover a wide range of applications for hydro. Inflow forecasting models are a key starting point to predict future availability of water resources and allow optimized planning and management of energy production.

Depending on each market, pumped hydro plants could also provide grid stabilization services such as voltage and frequency control, and decision making on providing such services could be optimized through intelligent algorithms. Advanced analytics algorithms could also be use for trading on energy wholesale markets.

Integration of battery storage to optimize wind and solar production

Battery capacity could improve control over renewables delivered to the grid.

As battery costs continue to decline, more renewables installations are complementing their farms with battery storage to release energy according to market demand, transmission service operator needs, to provide balancing and reliability services or to better control unbalance costs.

Applied Intelligence plays a role in improving battery operation in combination with intermittent renewables production units, considering hours, minutes and seconds of storage to deliver enhanced programs that maximize renewables revenues considering the committed forecasts and market prices.

Based on our experience, imbalance costs could be reduced by 10% to 20%, due to smarter decision making enabled by improvement on forecasting model accuracy.

Flexible grid services/dynamic energy management and optimization

New grid management mechanisms, market evolution and regulation require increasingly smarter solutions for ideal decision making in such a complex, evolving environment.

For instance, aggregated and collaborative management of spatially distributed renewables plants allows greater opportunities to improve overall profitability—considering operations, market and grid aspects. For operators providing grid services, the joint provision of energy and balancing services means decisions about one affect the other. Intelligent optimization solutions aim to enhance overall revenues, controlling costs; for example, with the following applications in terms of business challenges:

- **Improve response** to curtailment orders as opportunities to schedule pending maintenance activities on assets with more critical needs.
- **Improve response** to reactive power needs of the transmission service operator altering set points of the most “inductive” fleet assets.
- **Exploit the reduction** in aggregate power output variability, obtainable through geographical diversity, to reduce commitment deviation penalty cost.

SMART CAPABILITIES FROM OTHER INDUSTRIES

Other asset-intensive industries such as oil and gas are already relatively mature in building digital capabilities and applying advanced analytics on unstructured data to more effectively address asset reliability challenges. Following are some examples with clear synergies for the renewables space.



VIBRATION ANALYTICS

Rotating equipments (especially pumps) in oil and gas facilities generally suffer high failure rates. Due to the critical consequences of such failures, companies need solutions that help them proactively mitigate failure risk through corrective and maintenance actions adapted to the operator's needs. For instance, in-depth analysis can help modify the operating parameters under which equipment is operated to prolong equipment health and efficiency.

Predictive failure analysis solutions through spectral analysis on vibration signals from acceleration sensors installed on top of assets help identify the main failure modes patterns, whether root cause is mechanical or operational, and enhance accuracy of early-warning and time-to-failure solutions.

This capability is fully relevant and replicable for wind operators to tackle issues on generator drive train, blade misalignment and, by extension, on any bearing with accelerometer on top of it.



CORROSION ANALYTICS

Advanced analytics are used to predict, with high level of accuracy, the zones/lines/surfaces most at risk of corrosion. These predictive analytics allow operators to carry out targeted inspections at the appropriate time on the proper areas, as well as to use the correct amount of corrosion inhibitors.

Through data-driven decision making, inspection scope and frequency could be reduced while enhancing asset integrity. Using a richer data set, including multiple data sources, it is possible to accurately determine where and when inspection is needed. This allows companies to significantly increase the value-to-effort ratio, while more quickly running down the risk factor.

Innovative technologies allow identification of potential corrosion without removal of insulation and excessive scaffolding, which reduces downtime and costs. For example, image analytics are used to identify corrosion on a pipe from inspection report pictures, which reduces human analysis time, or facilitate better exhaustivity of the inspection. Previously, inspectors would only target the most probable zones, potentially missing some relevant issues.

Besides limiting the number of inspections, additional techniques can be used to enhance worker safety—the use of video analytics is one example. Using drones or fixed cameras, workers would no longer need to access hazardous areas or work from heights. This remote view could reduce an organization's risk exposure and related costs.

In offshore wind, corrosion is a significant challenge. Sea water, salt in the air, temperature variation and biological contamination can seriously damage various asset components. By exploiting data from a variety of specific sensors and techniques; for instance, electronical impedance spectroscopy and video analytics, new advanced analytics models can be developed to empower prognosis capabilities and data-driven maintenance strategies.

HOW IS APPLIED INTELLIGENCE BUILT?

The Applied Intelligence solutions we design aim to sense, comprehend, act and learn—providing machines the ability to act in a logical manner and simulating cognitive behavior as humans would do:



SENSE: Perceive the world by capturing and forecasting—in real time when needed—structured and unstructured data from signals, text, images and speech.



COMPREHEND: Make logical inferences and analyze information based on a given knowledge base and rules to draw logical conclusions, enabling scenario simulations of different operatives and decisions within the perceived scenario.



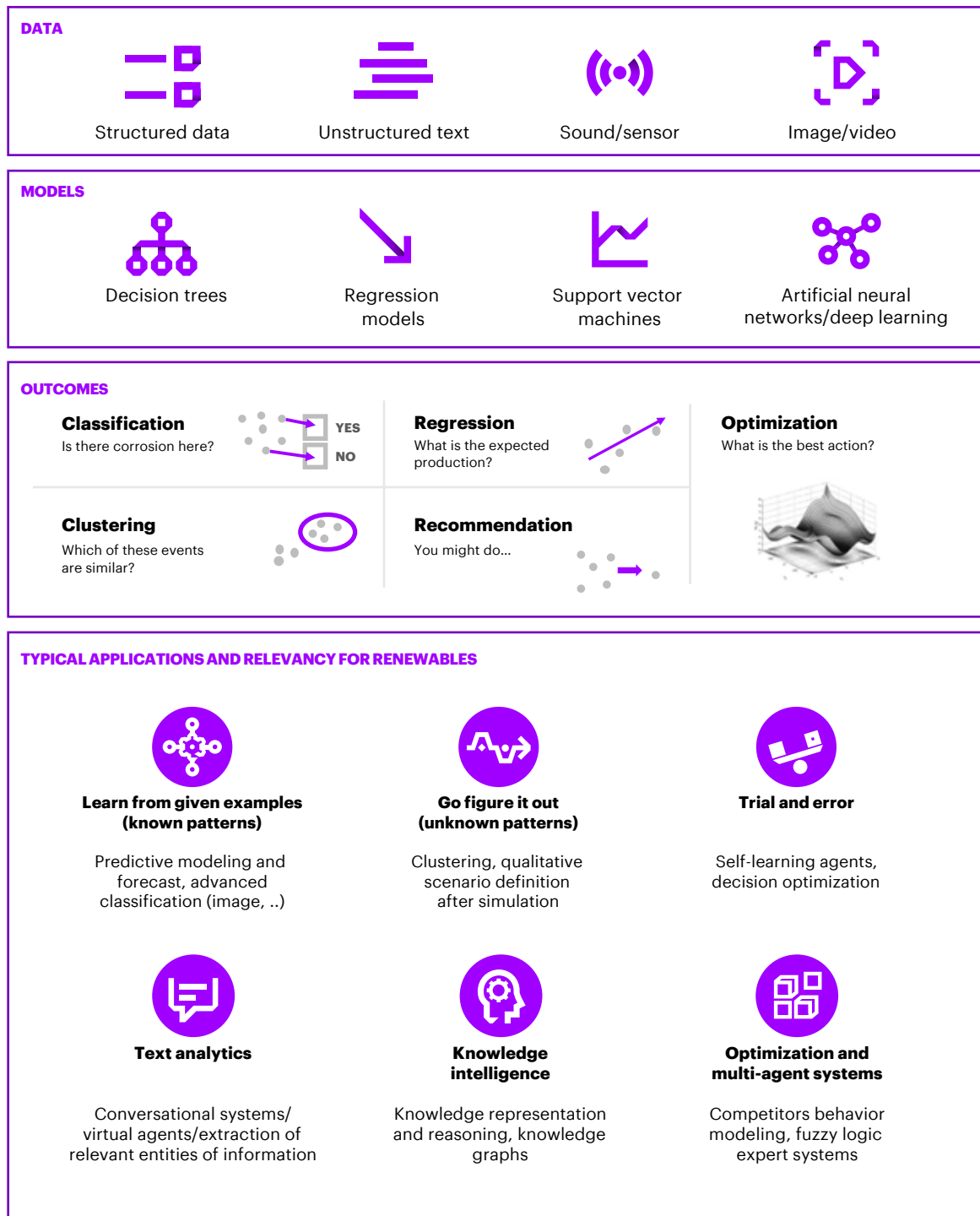
ACT: Take actions in the physical world, based on comprehension and understanding. For instance, take decisions by returning the ideal operative based on perceived data, comprehension and understanding.



LEARN: Improve performance on real-world experiences. For instance, improve by learning from incorrect decisions and ideal predictions. Continuously adapting and learning.

Implementing Applied Intelligence requires a wide range of analytical techniques, to bring the expected benefits for the multiple use cases in renewables, as illustrated in Figure 3.

Figure 3: Applied Intelligence In Renewables.



HOW TO START THE JOURNEY

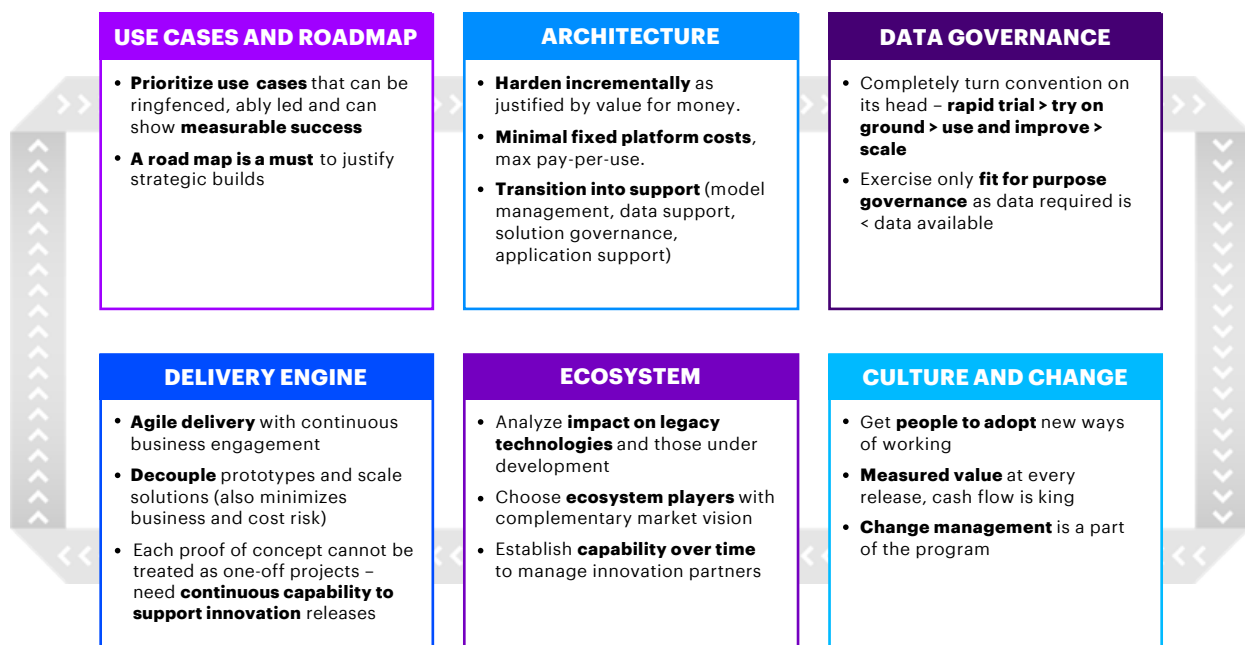
Build a data-driven approach. We believe a data-driven organization is the one that puts data and analysis in the foreground and at the core of the business, embedding information-based decision making in the business as part of daily operations.

The availability of relevant data, combining IT, operational technology (OT), external and unstructured data with the appropriate depth and quality is essential and may involve transformation across the organization.

Adopting a pragmatic approach is critical as the evolution of capabilities is constrained by data availability and quality. Gaps should be addressed by a plan to capture the needed relevant information. The evolution of data capabilities allows adopting new ways of collaborative working.

To successfully start the journey and promote cultural change, a vision—a company global initiative—is the key and preliminary step to lay the foundation of a common understanding.

Figure 4: High-level approach to developing a data analytics capability (illustrative).



ENGAGING BUSINESS WITH AGILE MINDSET

Our approach is to start small and scale fast once value has been proven—from inception to delivery with a data-driven mindset.

From only:		To also include:
Relying on the wisdom of “been there, done that” to make decisions	→	Combining experience with quantitative and qualitative data to make decisions
Analyzing reactive data in complex spreadsheets	→	Making data visual and malleable so it can be analyzed from different perspectives
Narrow client and benchmarking data	→	Larger and multiple data sets
One-off analysis	→	Repeatable algorithms and machine learning

Being data-driven means using data and analytics to inform decisions and tell a story rather than relying solely on previous experiences and expert intuition. This new way of working requires real-time access to relevant, accurate datasets and the appropriate tools to collect, understand and act on the data.

The first step in our Applied Intelligence approach is to collaborate with companies to identify business needs and opportunities. The result is a catalog of use cases or projects to develop. The development itself follows agile methodologies, relying on the concept of minimum viable products (MVPs) that facilitate rapid delivery of value, and the ability to iterate. Rapid delivery of the use cases and value is crucial as well for a successful project.

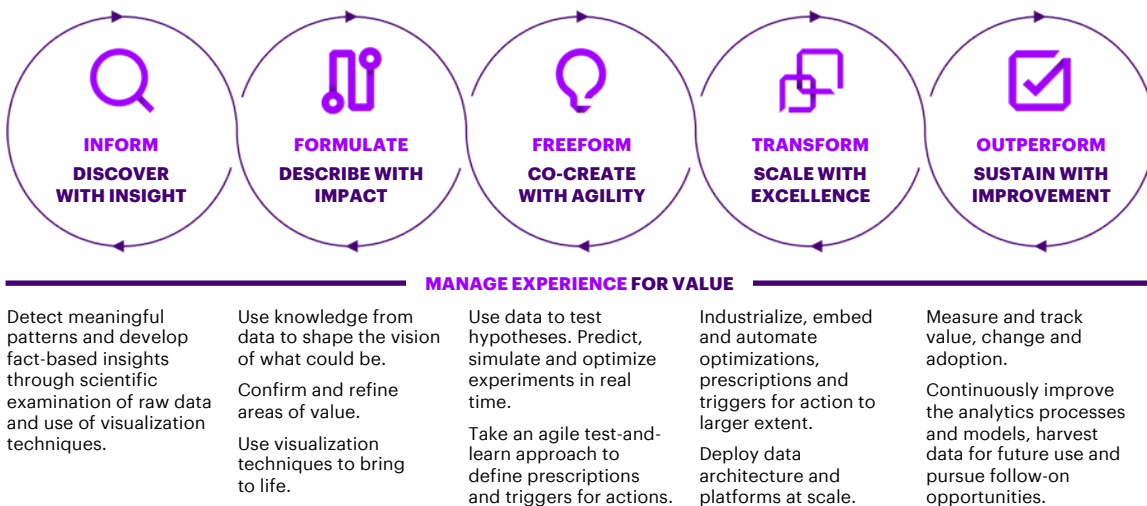
Figure 5: Use-case driven approach.



Sample case: A good example of data-driven approach, applied to a major global player in renewables generation, is the implementation of an integrated data model and dashboarding solution related to the worldwide wind competence centers, with the objective of creating a plant analytical record (PAR) leveraging on big data technology.

Main figures of the project:	Achieved results:	The project facilitated:
<ul style="list-style-type: none"> • 24 meetings held with business stakeholders • +35 people interviewed belonging to different business units • +22 data extractions from legacy systems and reporting sample for approximately 15 plants 	<ul style="list-style-type: none"> • Approximately 120 KPIs divided in four categories (plant master data, economic performances, energy performances, maintenance-related performances) • 11 data sources identified • Approximately 400 data fields collected, as an input to the generation of a set of thousands of combined variables with high predictive power. 	<ul style="list-style-type: none"> • Exploration of the relationship between efficiency and profitability of different technologies, geographies and systems • Deep dives into the most relevant energy plant parameters • Monitoring effectiveness of maintenance processes and service provider performance • Analysis of energy production

Figure 6: Accenture _FORM_ Methodology.

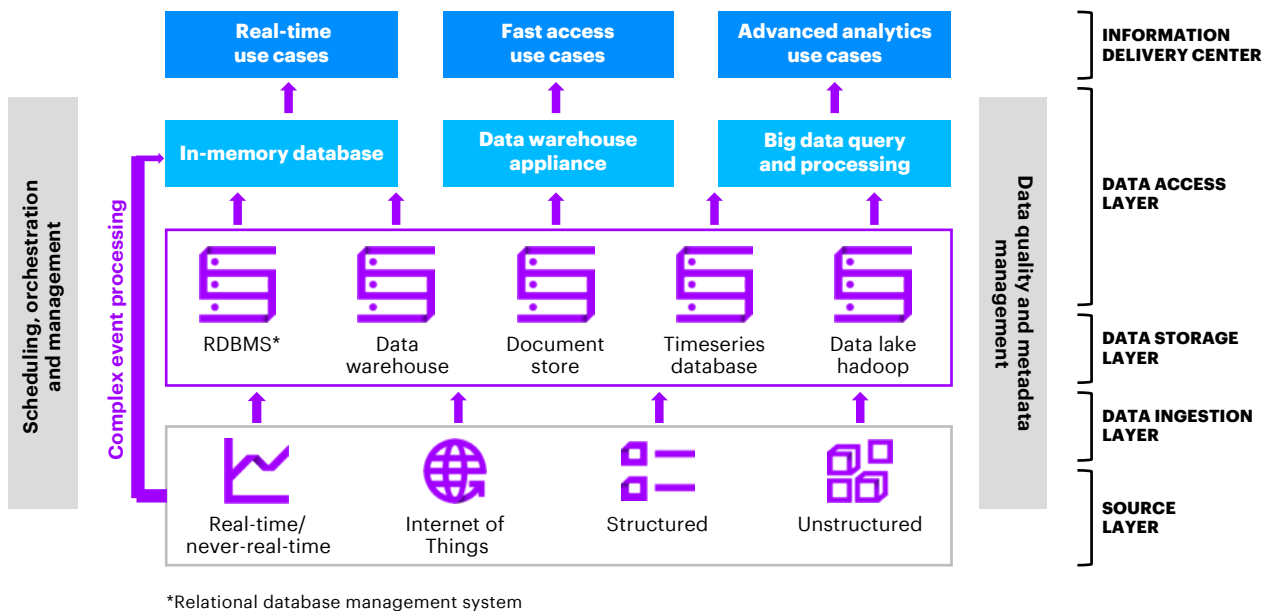


Adopting a data-driven approach combined with a lean-agile mindset is a deep culture change for a company—a correct level of change management should be considered and addressed.

... ON THE TECHNOLOGICAL SIDE

Aligned to the Accenture _FORM_ methodology, we take a similar approach to the technology required to achieve data-driven outcomes. Digital requires the ability to innovate continuously with a “start small, scale fast” approach. Accenture has helped accelerate this journey by developing a digital foundation to facilitate streamlining technology choices. The digital foundation is aligned to business case development and confirms a target architecture is built and understood as part of the journey (see Figure 7).

Figure 7: High-level view of a hybrid architecture.



Companies often have many parts of this digital foundation and Accenture recommends a hybrid approach to building out digital architectures based on ecosystem platforms, on-premise enterprise systems and custom-built applications where appropriate. Doing so allows a rapid start to delivering business value on an evolving architecture that is enhanced and scaled as analytical maturity increases.

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References

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Accenture Applied Intelligence helps clients apply new data science and intelligent technology across their business, and into every function, so they can transform their business and achieve new outcomes at speed and scale. Recognized as a leader by industry analysts, the company helps clients create new intelligence using artificial intelligence, machine learning, proprietary algorithms and app-based solutions.

We collaborate with a powerful alliance and delivery network to help clients operationalize within any market and industry with a focus on speed to value.

Combining expertise across industries, analytics, technology and design, Accenture is uniquely qualified to drive new business outcomes with precision, at scale.

Visit us at www.accenture.com/appliedintelligence.

About Accenture

Accenture is a leading global professional services company, providing a broad range of services and solutions in strategy, consulting, digital, technology and operations. Combining unmatched experience and specialized skills across more than 40 industries and all business functions—underpinned by the world's largest delivery network—Accenture works at the intersection of business and technology to help clients improve their performance and create sustainable value for their stakeholders. With approximately 477,000 people serving clients in more than 120 countries, Accenture drives innovation to improve the way the world works and lives.

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