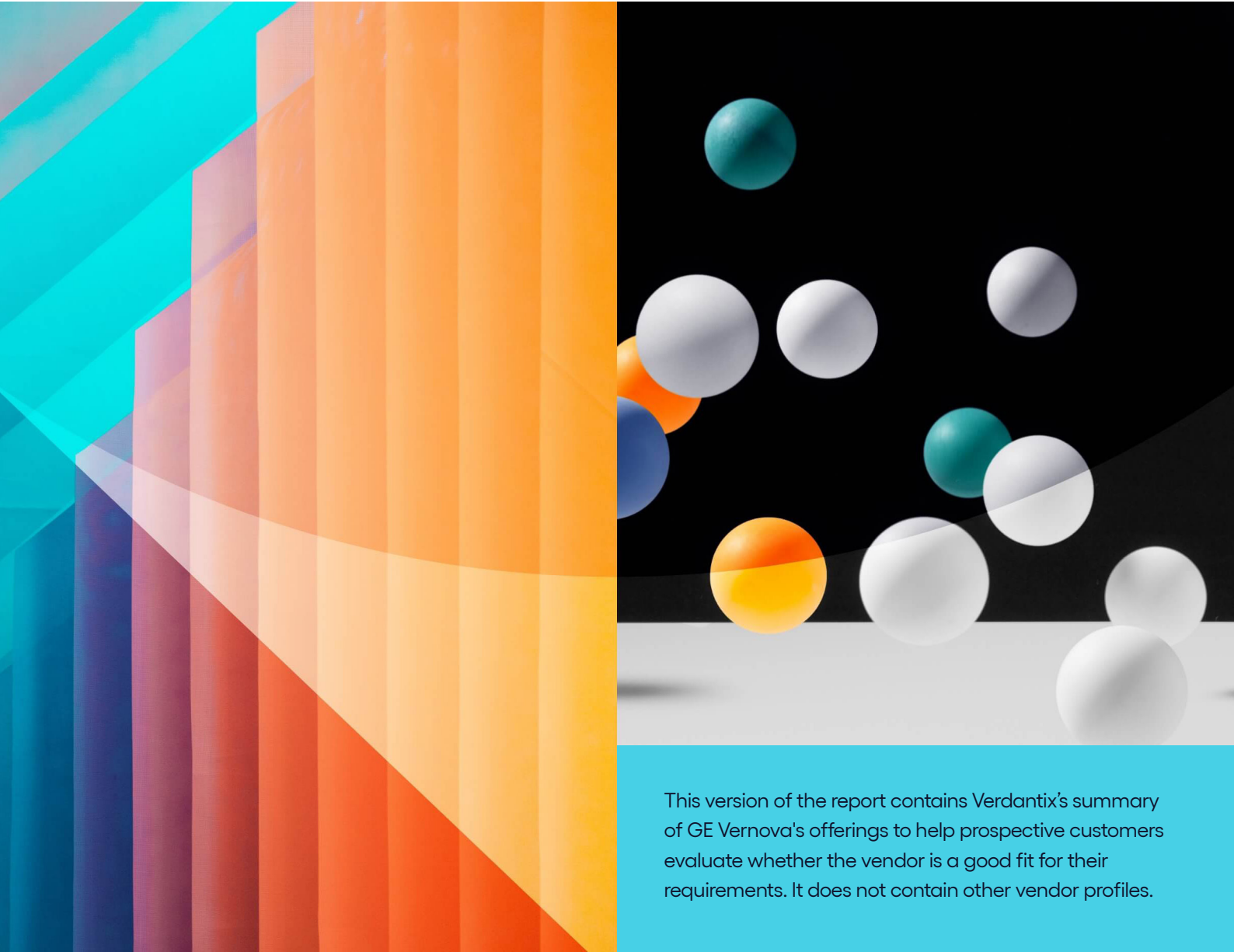# verdantix

Operational Excellence

Green Quadrant: Asset Performance Management Solutions 2024

By Kiran Darmasseelane, Sayanh Alam, Henry Kirkman
With Malavika Tohani

July 2024

This version of the report contains Verdantix's summary of GE Vernova's offerings to help prospective customers evaluate whether the vendor is a good fit for their requirements. It does not contain other vendor profiles.

Operational Excellence

Green Quadrant: Asset Performance Management Solutions 2024

By Kiran Darmasseelane, Sayanh Alam, Henry Kirkman
With Malavika Tohani   July 2024

This report provides a detailed fact-based comparison of the 20 most prominent asset performance management (APM) software providers in the market. Based on the proprietary Verdantix Green Quadrant methodology, our analysis comprised two-hour live product demonstrations with pre-set scenarios, desktop research and vendor responses to a 137-point questionnaire covering eight technical, 10 functional and nine market momentum categories. Verdantix also conducted interviews with 30 software users and reviewed the data from our global survey of 304 operational excellence decision-makers. Verdantix research finds that the APM software market consists of providers hailing from multiple backgrounds and operating in a competitive environment. Vendors are differentiating themselves by offering easily configurable and scalable APM software, leveraging the latest advancements in AI and generative AI (GenAI), and adjacent capabilities for asset lifecycle management, environmental performance and risk management. Among the firms analysed in this study, ten providers – ABB, AspenTech, AVEVA, Baker Hughes, Bentley Systems, C3 AI, GE Vernova, Honeywell, IBM and Yokogawa – demonstrated leading APM capabilities.

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Organizations mentioned

ABB, Accenture, ADM, ADNOC (Abu Dhabi National Oil Company), Advent International, Air Liquide, Aker BP, Alectra, Amazon Web Services (AMS), Ameren IL, American Petroleum Institute (API), Angular, ARMS Reliability, AsInt, AspenTech, Atonix Digital, ATT Tanjung Bin, Augury, AVEVA, Azima DLI, Baker Hughes, Baltimore Gas and Electric Company, BASF, Bayer, Bentley Systems, Bently Nevada, Bharat Petroleum, BHP, Blyncsy, BP, C3 AI, Canadian National Railway, Canary, Capgemini, Caserones, Cenosco, CERN, China National Petroleum Corporation (CNPC), Compressor Controls Corporation (CCC), Copperleaf, Deloitte, Delta-X, DNV, Doble, Dow, DS Smith, Duke Energy, Emerson, EPCOR, Equinor, Ericsson, Esri, Evolution Mining, Exelon, Expert Microsystems, Export Development Canada (EDC), Falkonry, Fidelis Group, FirstEnergy, Flint Hills Resources, FLIR, Fluke Reliability, Fractall, General Electric (GE), Genstar Capital, Georgia-Pacific, GE Vernova, Google, Greenbird, GSK, HCLTech, Helios Solutions, Hexagon, Hitachi Energy, Honeywell, IBM, Icon Water, IFS, IFS Energy & Resources (formerly P2), Indorama, InfluxData, Inmation, International Electrotechnical Commission (IEC), International Organization for Standardization (ISO), Itus Digital, Java, Jupyter, Juraj Dobrila University of Pula, Kal Tire, Kyowa Hakko Bio, Leonard Green & Partners, Limble CMMS, Lundin Energy Norway, MathWorks, MaxGrip, Microsoft, MOL Group, MongoDB, Nanoprecise Sci Corp, National Grid US, Nippon Gases, Node.js, NRG Energy, OCI Global, Open AI Energy Initiative, OQ (formerly Oman Oil Company), Oracle, Origin Energy, OSIsoft, Petrobras, Petroleum Energy Oman, PETRONAS, Pinnacle, PNM, Poka, Posit Software, PostgreSQL, Prayagraj Power Generation Company, Proceedix, Prometheus Group, ProSensus, PSE&G, PTT Exploration and Production (PTTEP), PTT Global Chemical (PTTGC), Python Software Foundation, QAFCO, Rockwell Automation, Samotics, Sandvik, Santos, SAP, Schneider Electric, Shell, Sirfull, SOCAR, South East Water, Suncor Energy, SymphonyAI Industrial (SAII), Tampa Electric, Tata Power, Tennessee Valley Authority (TVA), Tüpraş, TwinThread, UpKeep, UptimeAI, US Air Force, US Securities and Exchange Commission (SEC), Viewport.ai, Visionaize, Visual Studio Code, Wipro, Wood, Woodside Energy, Xcel Energy, Yokogawa, Zerynth.

Disclaimer

The state of the APM software market

Over the past two years, the market landscape for asset performance management (APM) software has undergone a considerable shift, with APM providers expanding their product offerings to meet maintenance, operations, engineering and environmental initiatives. APM software today sits closely alongside computerized maintenance management systems (CMMS) and enterprise asset management (EAM) and asset investment planning (AIP) solutions, offering capabilities to predict equipment failures, formulate the best strategy to remedy identified problems, minimize associated maintenance costs, maximize asset efficiency and optimize energy consumption. In addition, product innovation centred around advancements in generative AI (GenAI) and machine learning (ML) is redefining the functional possibilities of APM software. As the APM software market continues to grow, providers are turning to emerging technologies and improved usability as a point of differentiation, resulting in a series of benefits, such as cost savings by pivoting from preventative to predictive maintenance; elimination of unplanned downtime by intervening before assets fail; and a reduction in worker injuries and environmental damage by mitigating the risk of industrial accidents.

Vendors within the APM software space range from traditional APM software providers with a global customer base, to specialist AI firms with strong anomaly detection capabilities, and from services firms offering APM software, to EAM software vendors expanding their capabilities to encompass APM use cases (see **Figure 1**).

Figure 1
APM software provider landscape
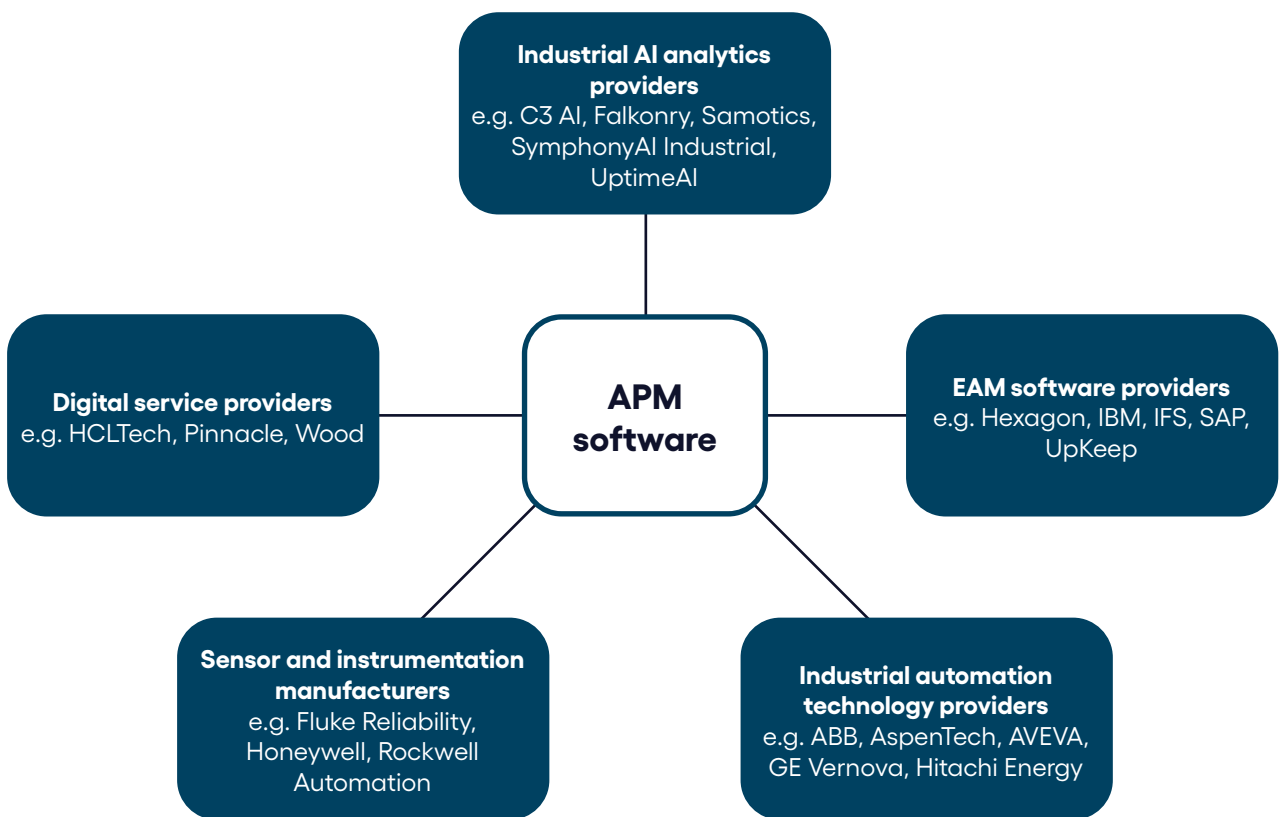
Source: Verdantix analysis

Given the complexity, breadth and pace of change in the APM software market, this report provides individuals who are responsible for selecting, implementing and deriving value from asset management software applications with a detailed assessment of 20 prominent APM solution providers and their product offerings. The customer questions answered by this report include:

- **What is the current state of the APM software market?**

- **Which APM software applications lead the market?**

- **Which APM software applications will best match the requirements of my firm?**

- **How can I benchmark the capabilities of APM software applications?**

- **What factors indicate that an APM software vendor is a reliable partner for the future?**

To answer these questions, Verdantix assessed 20 suppliers using a 137-point questionnaire, two-hour live demonstrations, and interviews with 30 existing APM software customers. The resulting analysis is based on the proprietary Verdantix Green Quadrant methodology, which is designed to provide an evidence-based, objective assessment of vendors offering comparable products or services.

Digitization, net zero and operational performance are driving APM up the corporate agenda

Spend on the APM software market will grow from $2.8 billion in 2023, at a CAGR of 11.9%, to reach nearly $5 billion in 2028 (see **Figure 2**) (see Verdantix Market Size And Forecast: Asset Performance Management Software 2022-2028 (Global)). Growth in the APM software market is being driven by (see **Figure 3**):

- **Strategic objectives to improve profitability and efficiency.**
  Industrial firms are challenged by rising expenses, caused by increasing energy and raw material prices, supply chain disruptions, aging assets and expanding labour costs. Efficiency improvement and cost reduction programmes are identified as a 'very significant' or 'significant' factor driving the digital transformation of plant operations by 84% of decision-makers in operations in our annual global corporate survey (see Verdantix Global Corporate Survey 2023: Operational Excellence Budgets, Priorities And Tech Preferences) (see **Figure 4**). APM software alleviates these concerns through a data-driven approach, to minimize downtime, optimize maintenance and increase asset longevity, leading to reduced operating expenditure.

- **Increased accessibility of APM solutions.**
  Engineers, machine operators and maintenance workers need quick and easy-to-use solutions to help them with their day-to-day activities. APM software vendors are addressing this through low-code/no-code (LCNC) development features that empower less tech-savvy users to build, train and refine failure models; streamline data integration and preparation for AI/ML models; and easily configure rules, workflows and dashboards (see Verdantix Strategic Focus: Low-Code Industrial Analytics Enabled By Generative AI). These quality-of-life improvements are driving uptake and usage of APM software across industrial firms.

- **Requirement for a single centralized solution.**
  Ninety-three per cent of executives responding to the 2023 Verdantix operational excellence global corporate survey see integrating data from multiple sources as a 'very significant' or 'significant' challenge for their firm. APM software acts as a single source of truth (SSOT) for asset data, managing all asset information via integrations with EAM software, sensor data and integrity data from images. This enables subject-matter experts (SMEs) to understand the relationship between assets and processes and increases collaboration across disciplines.

Figure 2

Industrial APM software forecast by software functionality: 2022-2028

	CAGR (2021-26)
Total	11.9%
Other	11.1%
Environmental performance	12.1%
Performance optimization	11.8%
Integrity management	11.8%
Reliability management	11.8%
Failure prediction	12.9%
Condition monitoring	11.4%
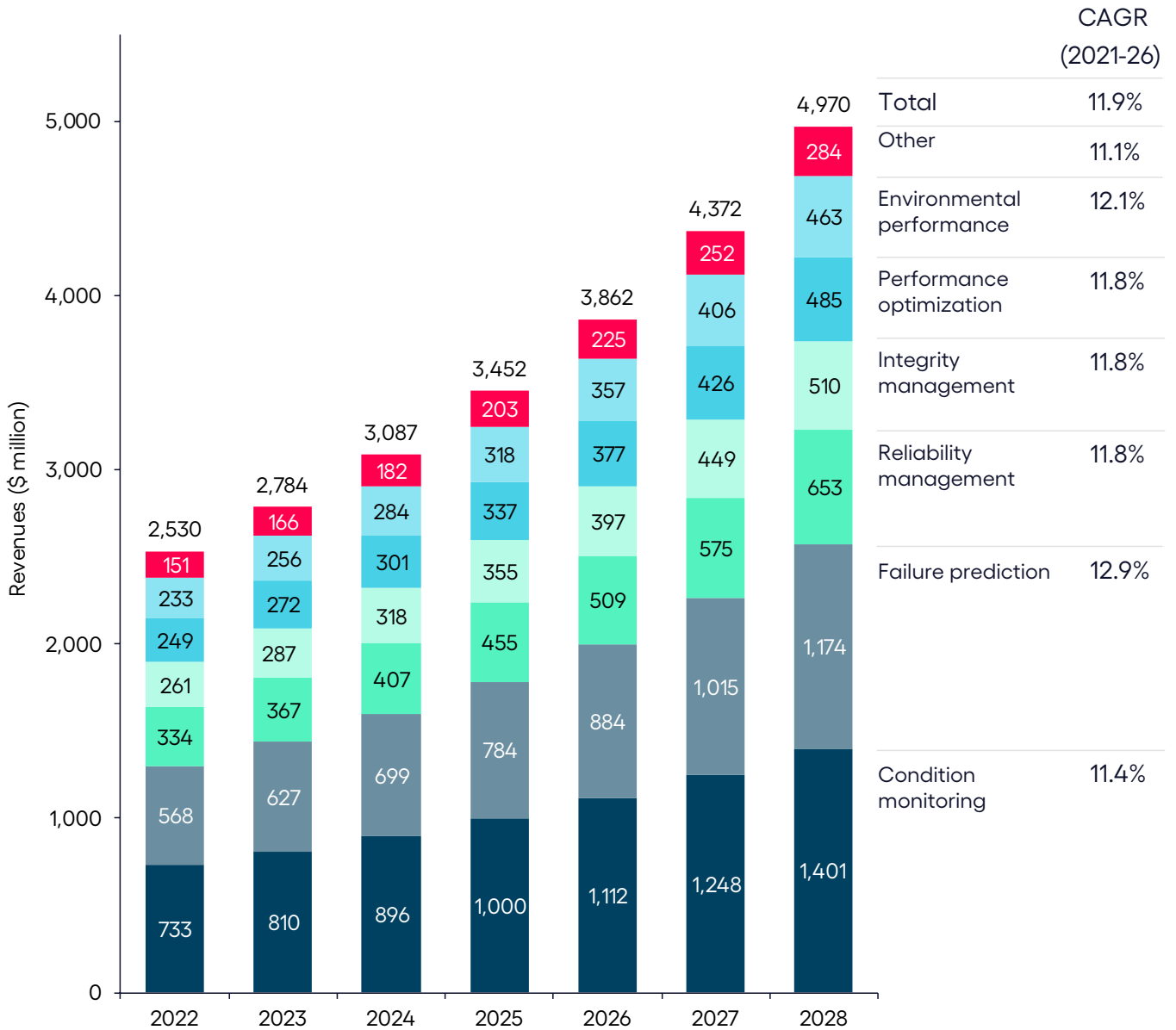
Note: Data labels are subject to rounding.

Source: Verdantix Market Size And Forecast: Asset Performance Management Software 2022-2028 (Global)
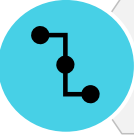
- **Proliferation of AI analytics.**
  Easier access to large-scale AI models through cloud services such as Amazon Web Services (AWS), Google Cloud Platform (GCP) and Microsoft Azure has driven the development of industrial AI analytics solutions, focusing in particular on asset condition monitoring and predictive maintenance (see Verdantix Market Size And Forecast: Industrial AI Analytics 2022-2028 (Global)). These models are easy to deploy and quick to scale, making APM solutions more cost-effective and therefore easier to access.

- **Efforts to achieve net zero objectives.**
  Regulations – such as the EU's Corporate Sustainability Reporting Directive (CSRD) and the recently approved climate-related disclosures from the US Securities and Exchange Commission (SEC) – are requiring firms to report on Scope 1, 2 and 3 emissions and pressuring organizations to operationalize their net zero strategies. In fact, 62% of 304 decision-makers in our annual operational excellence global corporate survey are planning to boost spend on decarbonization initiatives in 2024. APM software indirectly reduces energy consumption and emissions by operating assets as efficiently as possible and, more recently, by developing dedicated functionality to track, monitor and lower emissions and consumption (see Verdantix The Role Of Operations Managers In Implementing Net Zero Strategies).

Figure 3
APM software market drivers

Driver	Driver strength	3-year change
Strategic objectives to improve profitability and efficiency APM software is crucial for data-driven decisions, minimizing downtime and prolonging asset life, leading to cost savings and enhancements in product quality, process efficiency and maintenance.	HIGH	↗
Increased accessibility of APM solutions APM software breaks down silos in data, increasing cross-practice collaboration. The market has seen the entry of various firms supporting low-code/no-code environments, empowering engineering to harness complex AI models without the need for data scientists.	HIGH	↗
Requirement for a single centralized solution The need for improved team communication has spotlighted the challenges of siloed data and software functional misalignments. APM solutions facilitate a connected digital ecosystem that dissolves data silos and fosters interdepartmental collaboration.	HIGH	↗
Proliferation of AI analytics The rise of industrial AI specialists providing deployable APM solutions with anomaly detection and predictive ML capabilities, coupled with affordable data acquisition and the expansive capabilities of cloud based big data processing, have been key to enhancing the accessibility and uptake of APM software.	HIGH	↑
Efforts to achieve net zero objectives With the pivot from downtime reduction to sustainability, EHS and compliance, APM has become central to firms' digital and sustainability strategies.	MEDIUM	↗

Source: Verdantix analysis

Figure 4

Factors driving the digital transformation of plant operations
How significant are the following factors in driving the digital transformation of your plant operations?
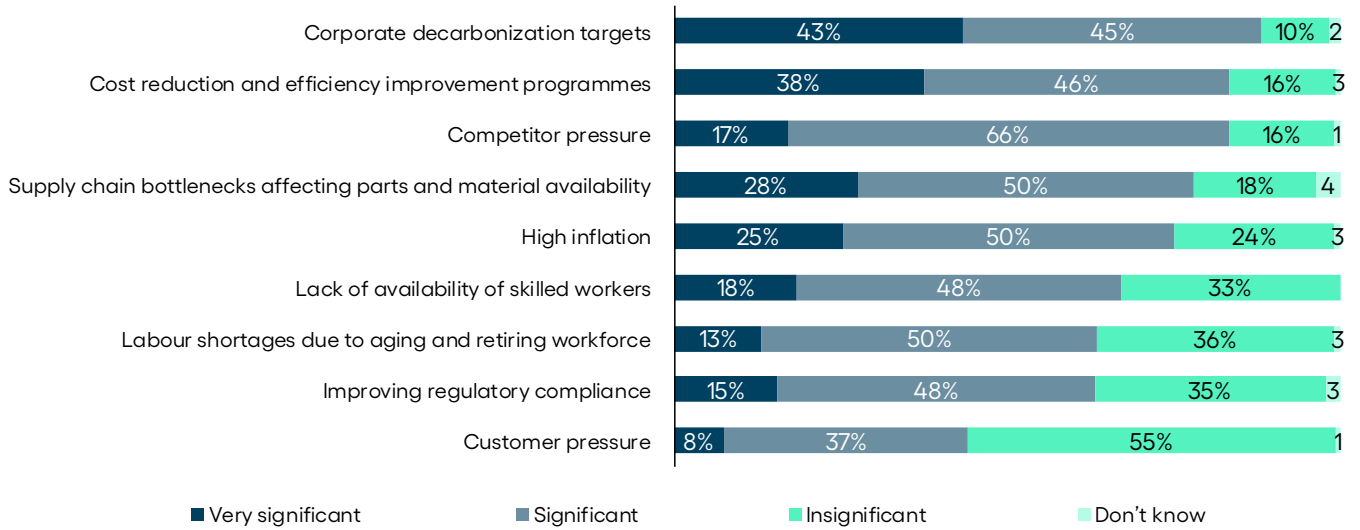
Factor	Very significant	Significant	Insignificant	Don't know
Corporate decarbonization targets	43%	45%	10%	2
Cost reduction and efficiency improvement programmes	38%	46%	16%	3
Competitor pressure	17%	66%	16%	1
Supply chain bottlenecks affecting parts and material availability	28%	50%	18%	4
High inflation	25%	50%	24%	3
Lack of availability of skilled workers	18%	48%	33%	
Labour shortages due to aging and retiring workforce	13%	50%	36%	3
Improving regulatory compliance	15%	48%	35%	3
Customer pressure	8%	37%	55%	1

■ Very significant   ■ Significant   ■ Insignificant   ■ Don't know

Note: Data labels are subject to rounding; percentages less than 5% are written as numbers.
Source: Verdantix Global Corporate Survey 2023: Operational Excellence Budgets, Priorities And Tech Preferences   N=304

Growing demand for APM software has spurred vendor interest over the last two years

Reliable growth in the face of economic strain, a desire to improve efficiency, the proliferation of AI analytics and the development of net zero agendas have accelerated growth in APM software applications in recent years. Healthy growth has fuelled competition, resulting in increased fragmentation across the APM vendor landscape and expanded market activity since the Verdantix 2022 APM Green Quadrant (see Verdantix Green Quadrant: Asset Performance Management Solutions 2022). Based on our analysis of APM software market trends and vendor strategies over the last two years, Verdantix finds that:

- **AI-focused anomaly detection providers are prime acquisition targets.**
  Spend on industrial AI analytics solutions has burgeoned in the last few years, with predictive maintenance and asset condition monitoring use cases accounting for over 50% of the total $2.03 billion spend in 2024 (see Verdantix Market Size And Forecast: Industrial AI Analytics 2022-2028 (Global)). This has resulted in a proliferation of vendors offering AI analytics, with out-of-the-box ML models for key use cases that are quick to implement as well as scale. However, over the last 24 months, there has been a rise in acquisitions of these AI analytics vendors by incumbent industrial as well as enterprise software providers, to enhance their predictive analytics capabilities. Notable acquisitions are those of Itus Digital by Hexagon in April 2024 and Atonix Digital by Prometheus Group in March 2023 (see **Figure 5**).

Figure 5

Key APM transactions over the last two years

Year	Month	Transaction	Description
2022	Jun	PARTNERSHIP	GE Vernova partners with 3D digital twin software provider Visionaize
2022	Oct	ACQUISITION	AspenTech acquires industrial data management provider Inmation
2022	Nov	ACQUISITION	IFS acquires P2 Energy Solutions
2023	Jan	ACQUISITION	Schneider Electric acquires AVEVA for $11.6 billion
2023	Jan	STRATEGIC INVESTMENT	Nanoprecise Sci Corp raises $10 million in Series B funding led by Export Development Canada (EDC), with participation from Honeywell Ventures
2023	Jan	ACQUISITION	IFS announces acquisition of connected worker software firm Poka
2023	Jan	PARTNERSHIP	Cenosco partners with industrial asset management services firm MaxGrip
2023	Feb	PARTNERSHIP	Yokogawa enters a partnership with industrial data management provider Viewport.ai
2023	Mar	ACQUISITION	Prometheus Group acquires Atonix Digital and launches Prometheus APM
2023	May	PARTNERSHIP	SymphonyAI Industrial expands partnership with Microsoft for GenAI applications
2023	Jun	ACQUISITION	Honeywell acquires Compressor Controls Corporation (CCC) for $670 million
2023	Jun	PARTNERSHIP	IFS partners with industrial asset management services firm MaxGrip
2023	Jun	PARTNERSHIP	Cenosco enters a technology partnership with Hexagon
2023	Jul	PARTNERSHIP	ABB forms an innovation partnership with Microsoft
2023	Aug	ACQUISITION	Bentley Systems acquires computer vision software provider Blyncsy
2023	Aug	ACQUISITION	GE Vernova acquires data management software provider Greenbird
2023	Aug	ACQUISITION	IFS announces acquisition of industrial AI analytics software provider Falkonry
2023	Nov	PARTNERSHIP	IFS partners with industrial AI analytics provider Augury
2023	Dec	ACQUISITION	Cenosco acquires complete IP rights of the Integrity Management System (IMS) platform
2024	Apr	ACQUISITION	Hexagon acquires Itus Digital
2024	Jun	STRATEGIC INVESTMENT	Prometheus Group receives investment from Advent International and Leonard Green & Partners
2024	Jun	ACQUISITION	IFS announces acquisition of asset investment planning software firm Copperleaf

Source: Verdantix analysis

Industrial technologies to achieve net zero goals
How do you see the role of the following industrial technologies in achieving your firm's net zero goals?
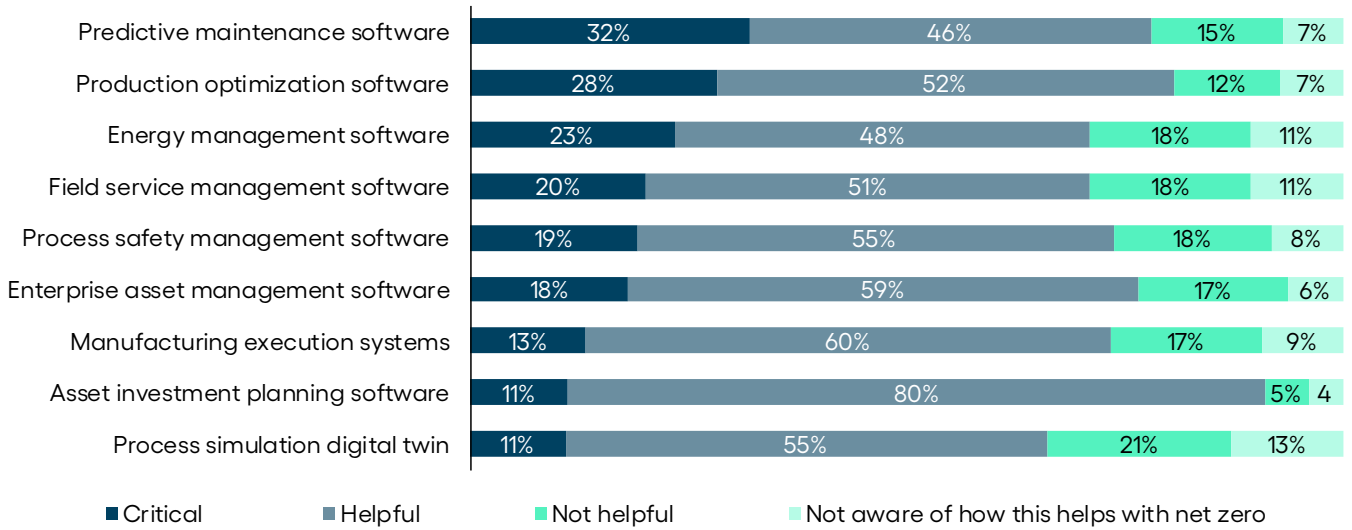
Technology	Critical	Helpful	Not helpful	Not aware of how this helps with net zero
Predictive maintenance software	32%	46%	15%	7%
Production optimization software	28%	52%	12%	7%
Energy management software	23%	48%	18%	11%
Field service management software	20%	51%	18%	11%
Process safety management software	19%	55%	18%	8%
Enterprise asset management software	18%	59%	17%	6%
Manufacturing execution systems	13%	60%	17%	9%
Asset investment planning software	11%	80%	5%	4
Process simulation digital twin	11%	55%	21%	13%

■ Critical ■ Helpful ■ Not helpful ■ Not aware of how this helps with net zero

Note: Data labels are subject to rounding; percentages less than 5% are written as numbers.
Source: Verdantix Global Corporate Survey 2023: Operational Excellence Budgets, Priorities And Tech Preferences   N=304

- **APM software providers are turning to partnerships to leverage innovative technologies.**
  In the 2022 Verdantix global corporate survey, 87% of the 301 respondents stated the availability of new technologies such as AI, computer vision, wearables and industrial Internet of Things (IIoT) sensors as a 'very significant' factor driving the digital transformation of their plant operations (see Verdantix Global Corporate Survey 2022: Operational Excellence Budgets, Priorities & Tech Preferences). APM software vendors are entering into partnerships to leverage the latest technologies, to enhance the value proposition for their customers. For example, GE Vernova now offers 3D visualization capabilities through its partnership with Visionaize. Risk, corrosion and thickness data can be presented on a 3D model within GE's APM Integrity module, thereby improving decision-making and resolution time. Honeywell has partnerships with Expert Microsystems for AI-driven anomaly detection, Nanoprecise Sci Corp for AI-based condition monitoring, and Sirfull for risk-based inspections (RBIs).

- **Digitally enabled service providers are commercializing their industry expertise.**
  Spend by industrial firms on third-party service providers for asset management tech implementation projects is on the rise, with consultants bringing with them ample industry or domain expertise, along with technical knowhow (see Verdantix Market Size And Forecast: Industrial Asset Management Services 2022-2028 (Global)). Many of these service providers have also developed robust digital solutions to help deliver services to customers more efficiently and cost-effectively (see Verdantix Green Quadrant: Industrial Asset Management Technology Implementation Services 2024). In addition to providing a range of services for asset maintenance, operations, decommissioning and decarbonization – as well as third-party asset management software implementation – Wood offers oil and gas firms its own asset integrity software, NEXUS IC. Similarly, Pinnacle has developed Newton, its reliability management solution.

- **Expansion into sustainability and net zero functionality has become a strategic priority.**
  Sixty one per cent of the 304 respondents in the Verdantix 2023 global corporate survey plan
  double- or single-digit increases in spend on decarbonizing their plant operations. Nearly a third (32%)
  of respondents describe predictive maintenance software as 'critical' in achieving their firm's net zero
  goals, while a further 46% consider it 'helpful' – and one in four respondents see energy management
  software as critical for their net zero goals (see **Figure 6**). APM software capabilities have thus expanded
  from being purely maintenance- and reliability-focused, to encompass environmental and sustainability
  capabilities. IBM Envizi's emissions management software has capabilities to collect and visualize operational
  emissions data, as well as to connect emissions reduction work with maintenance activities. GE Vernova
  launched its carbon emissions management software, CERius, in 2023, to automate accurate GHG data
  collection, provide insights and recommend actions to operationalize carbon abatement plans, while
  supporting carbon reporting and accounting for Scope 1, 2 and 3 emissions.

APM product development will converge around enhanced product functionality, net zero challenges and improved accessibility through AI

In recent years, the asset management market has been upended by the decarbonization megatrend and AI wave.
Whilst we have already seen notable developments in this area – such as early deployments of GenAI co-pilot
solutions, and the introduction of energy management software – the market is at a precipice of significant change.
To establish a clear view of buyers' evolving needs, Verdantix interviewed both vendors and customers, alongside
conducting extensive research into publicly available case studies. We supplemented this with insights from the
2023 Verdantix operational excellence global corporate survey.

APM software buyers have a long wish-list when choosing their vendor and solution

With demand for APM software on the rise, Verdantix has taken a buyer-centric approach, to understand which
features and competencies prospective customers will prioritize when choosing an APM solution and vendor over
the next two years. Our research finds that buyers have appetite for:

- **Experienced vendors with a proven track record in their industry.**
  Customer interviews for this Green Quadrant analysis reveal that industry expertise plays a significant role
  in procurement decisions. Buyers are seeking industry-specific asset libraries, with failure mode and
  prescriptive actions aligned with the equipment they operate, to easily and efficiently scale deployments.
  They also prefer to select software with specific functionality to address the particular challenges they are
  facing. For instance, oil and gas firms, which we expect to account for 26% of the APM software market spend
  in 2024, prioritize asset integrity, corrosion and process safety management capabilities, to better manage
  risks across their plants and avoid major incidents. Catering to this need, vendors such as Bentley Systems,
  Cenosco, GE Vernova, SAP and Wood offer RBI functionality compliant with the API 581 standards set by the
  American Petroleum Institute. Similarly, energy-intensive industries are looking for functionality to support
  the transition to renewable energy sources. GE Vernova has developed APM Accelerators – pre-built industry
  models for monitoring and benchmarking the performance of solar and wind assets.
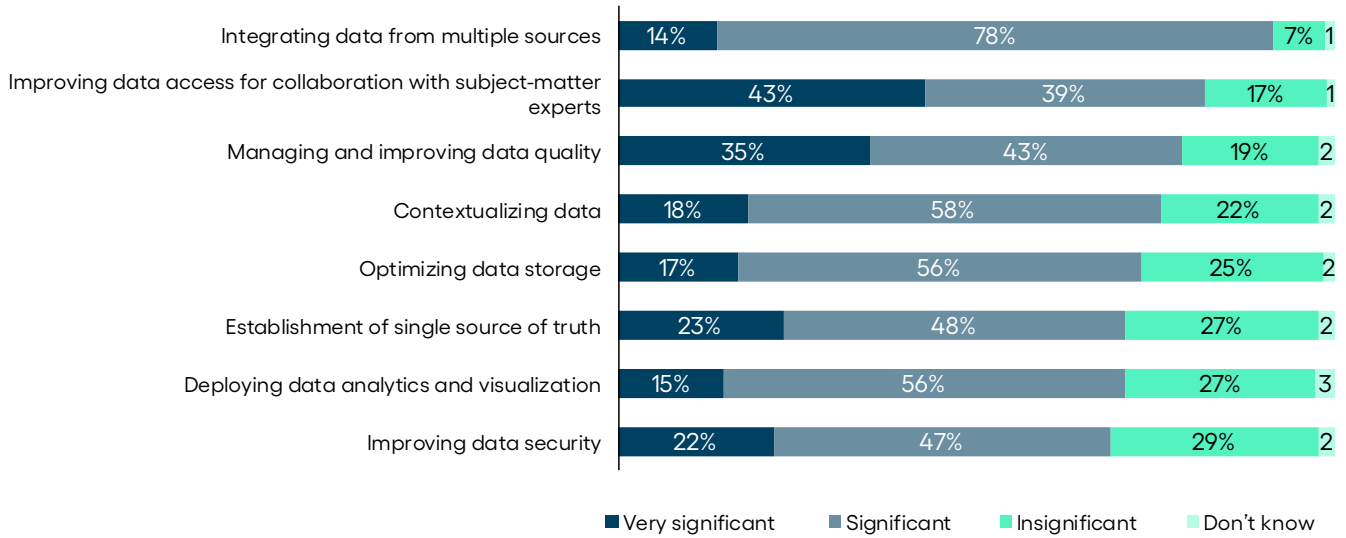
  *"As part of the RFP [request for proposal] process, we worked with consultants and interviewed other utilities,
  to shortlist vendors that have the most experience working with power utilities, and can offer industry-specific
  functionality"* – IT Leader, Utilities

Industrial data management challenges

How significant are the following data management challenges for your firm?

Challenge	Very significant	Significant	Insignificant	Don't know
Integrating data from multiple sources	14%	78%	7%	1
Improving data access for collaboration with subject-matter experts	43%	39%	17%	1
Managing and improving data quality	35%	43%	19%	2
Contextualizing data	18%	58%	22%	2
Optimizing data storage	17%	56%	25%	2
Establishment of single source of truth	23%	48%	27%	2
Deploying data analytics and visualization	15%	56%	27%	3
Improving data security	22%	47%	29%	2

■ Very significant ■ Significant ■ Insignificant ■ Don't know

Note: Data labels are subject to rounding; percentages less than 5% are written as numbers.
Source: Verdantix Global Corporate Survey 2023: Operational Excellence Budgets, Priorities And Tech Preferences   N=304

- **Robust data management underpinning asset performance analytics.**
  Our 2023 survey of 304 decision-makers across operations, maintenance and engineering shows over three-quarters of industrial firms facing significant challenges with data integration, especially between old systems; with improving data access for collaboration with SMEs; and with enhancing data quality – which is instrumental in reducing false positives from failure prediction models (see **Figure 7**). To combat these issues, IT leaders should shortlist vendors offering out-of-the-box connectors to extract data in near-real time from the systems they operate, and with experience in integrating both new and legacy systems. In addition, customers should consider vendors that offer AI/ML tools for mapping data, detecting stale and anomalous data, and filling in missing values. SymphonyAI's Industrial Reasoning and Insights (IRIS) platform uses ML models to clean, format and transform data, with rigorous data quality monitoring to prepare the data for downstream APM analytics (see Verdantix Buyer's Guide: Industrial Data Management Solutions (2024)).

  "We are having to investigate so many false positives that we see almost no difference in our maintenance strategy before and after implementing the software. We want a solution that helps us integrate all our data sources, improves the quality, and makes it easy to retrain our AI/ML models." – Monitoring and Diagnostics Leader, Oil and Gas.

- **Out-of-the-box functionality and easy configuration to rapidly scale deployments.**
  Even within the same organization, sites can differ significantly in terms of the assets and sensors they operate, their IT infrastructure, and their workforce culture. These factors all present challenges for scaling APM software deployments, with many firms reporting being stuck in 'pilot purgatory'. As such, buyers are selecting vendors that can offer asset libraries encompassing a large variety of failure modes and conditions, KPIs and preventative and prescriptive actions – whilst also prioritizing easy and highly flexible configuration. Industrial decision-makers should consider solutions that incorporate Python and R integrated

development environments (IDEs), to enable users with such skills to modify, build and deploy their own AI/ML models; as well as LCNC development tools, to easily configure business rules, dashboards, forms, models and workflows. AVEVA's Asset Library comprises over 1,500 failure causes, more than 2,000 preventative tasks and 5,000 prescriptive tasks out of the box; whilst also integrating with Jupyter Notebook through application programming interfaces (APIs), and providing a LCNC environment, so that any engineer can build AI/ML-based models with little training (see Verdantix Strategic Focus: Low-Code Industrial Analytics Enabled By Generative AI).

"Our engineers are able to easily build and deploy predictive maintenance analytics with drag-and-drop features and Python." – Team Leader of Advanced Analytics, Oil and Gas

- **Streamlined workflows to empower frontline workers.**
  Increasing the efficiency of inspections and operator rounds is a top priority for senior managers at industrial firms, with 84% of respondents to our annual operational excellence global corporate survey indicating that cost reduction and efficiency improvement programmes are 'significant' or 'very significant' drivers for digitizing plant operations. Interviews with APM software users reveal that they are using mobile applications to help workers record data while in the field, as well as to manage their schedules, and to provide instructions and operational insights in real time. However, we also heard that managers struggle with inspection planning, especially when managing numerous alerts that require investigation, and with poor work order management. When selecting an APM solution, buyers should shortlist vendors that offer strong alert and case management features, focusing on AI-enabled criticality-based alert prioritization, and bi-directional integration with CMMS and EAM software. AspenTech, AVEVA, C3 AI, GE Vernova and Prometheus Group have the ability to manage alerts and cases from inception to completion within their respective APM solutions, while also syncing with CMMS and EAM software.

  "A four-hour inspection used to take four hours to write up. Now, we are able to complete each inspection in half of the time with our provider's mobile app, and we can generate a report in minutes using the software." – Chief Inspector, Oil and Gas

- **AI capabilities to improve prescriptive and root cause analyses.**
  Whilst ML models for failure prediction are becoming increasingly easy to build and deploy, users are looking for more than just an awareness of when their assets may fail. As firms transition from predictive to prescriptive maintenance, they are seeking APM tools that provide accurate and precise suggestions to delay or eliminate the risk of failure, and that can help them understand the root causes underpinning failure. Most APM solutions are equipped with extensive libraries encompassing failure mode and effects analysis (FMEA) and prescriptive actions, but buyers should shortlist solutions that facilitate access to this information. ABB, C3 AI, IBM and SymphonyAI have developed GenAI-based co-pilots, empowering engineers with a natural language interface to query these information sources and receive contextually relevant suggestions (see Verdantix Market Insight: Ten Applications Of Large Language Models For Industry).

  "We are cautiously excited by the opportunities offered by GenAI. We are already working on some pilot projects centred around generating prescriptive recommendations to improve our maintenance strategy." – Head of Smart Operations, Infrastructure

- **Process safety and risk management capabilities.**
  Achieving safer operations emerged as one of the top investment areas in the Verdantix 2023 operational excellence global survey, with 61% of respondents planning to increase spend on this area in 2024. The adoption of an APM solution plays a significant role in avoiding incidents, due to its ability to predict and reduce the risk of asset failure. Senior decision-makers across operations and process safety also value the capacity to integrate real-time asset condition data with process and worker safety information

in a 'data digital twin', to plan operator rounds, whilst evaluating the risks posed by compromised assets and simultaneous operations (SIMOPS). Cenosco's APM solution, IMS Suite, enables safer operations by integrating asset integrity monitoring; planning and scheduling risk-based inspections; and streamlining workflows to complete hazard and operability (HAZOP), layers of protection analysis (LOPA) and safety instrumented function (SIF) studies (see [Verdantix Cenosco Embeds Deep Asset Integrity Knowledge In Its IMS Suite](#)).

"We have consolidated most of our PSM [process safety management] processes, and now we are looking to integrate real-time asset condition data to understand the risks from equipment that's still running in the background while work is being carried out." – Process Safety Manager, Oil and Gas

- **Emissions and energy management functionality.**
  Almost a third of industrial decision-makers in our annual survey see implementing digital technologies for emissions reduction as a high priority. The primary objective of APM software is to maximize the efficiency of assets and processes, which inherently leads to energy and emissions reduction. However, proactively optimizing processes for reduced environmental impact has itself become a medium-term priority for many industrial firms. Alongside offering energy, waste and emissions management capabilities within its APM solution, AspenTech's Sustainability Pathways consolidate over 100 out-of-the-box models for those use cases, as well as facilitating adoption of carbon capture, utilization and storage (CCUS) solutions, renewable energy sources, hydrogen projects and bio-based feedstocks (see [Verdantix AspenTech's Sustainability Pathways Accelerate Net Zero Initiatives For The Process Industries](#)).

"Sustainability will be a top priority going forward, so it made sense for us to choose a solution which helps reduce failures and increase operational efficiency, and also gives us an understanding of and helps us lower our energy consumption and emissions." – Asset Management Technology Director, Oil and Gas

- **Vendors that can also provide strong implementation services.**
  Complex extant IT and operational technology (OT) architecture, and the broad spectrum of capabilities offered by APM software, have spurred a growing need for expertise to support systems integration, data collection and mapping, training, and change management. Wood, alongside offering NEXUS, its asset integrity software solution, provides best-in-class implementation services for condition monitoring, predictive maintenance, asset integrity and energy management. It emerged as a Leader in the Verdantix Green Quadrant benchmark for industrial asset management services (see [Verdantix Green Quadrant: Industrial Asset Management Technology Implementation Services 2024](#)).

"We were really pleased with our chosen APM vendor's services, because they firstly helped us present a compelling business case to our executives, and also invested significant time and resources to train our engineers. This increased engagement across our other digital transformation initiatives too."
– IT Project Manager, Oil and Gas

APM software vendor product strategies focus on enhancing flexibility, scalability and adoption

Buyers of APM solutions are choosing APM software vendors with industry as well as tech implementation services expertise, while demanding solutions with a strong data management foundation. To satisfy customer requirements and gain market share, APM software providers are:

- **Investing in strengthening data management capabilities for better asset performance analytics.**
  Industrial firms notoriously have a variety of data (real-time, event-driven and time-series), collected from hundreds of assets across their facilities, which need to be aggregated, cleaned and contextualized to obtain accurate and reliable insights from advanced analytics (see [Verdantix Buyer's Guide: Industrial Data Management Solutions (2024)](#)). APM software providers realize the value of a strong data management
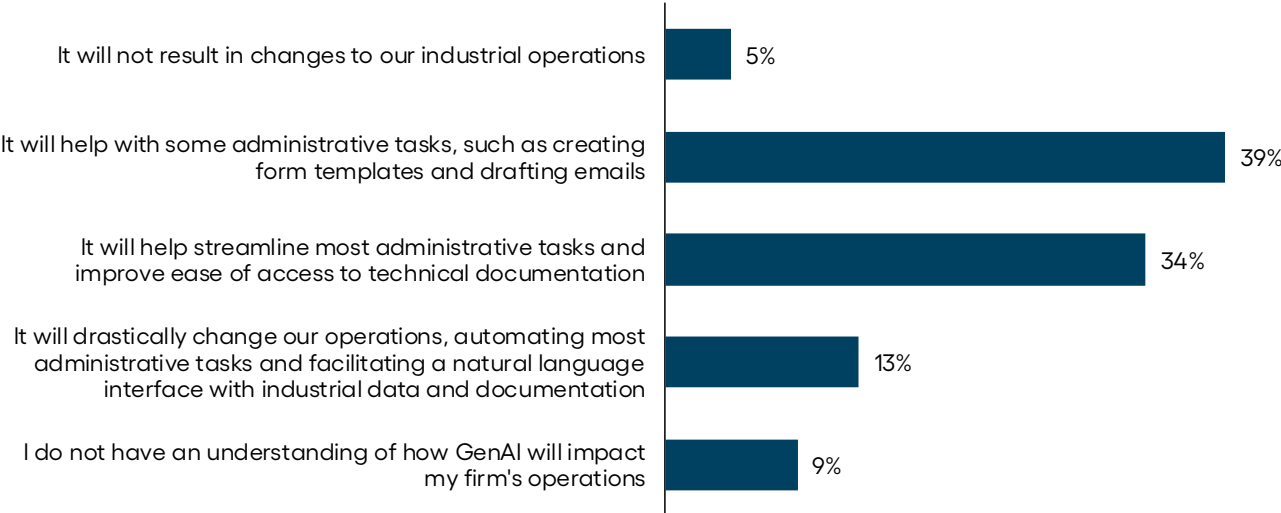
layer and hence have undertaken investments to enhance their capabilities. For example, AspenTech acquired industrial DataOps provider Inmation in 2022, and launched its DataWorks platform in February 2023. The ABB Ability Genix APM Suite, which embeds ABB's Genix APM platform capabilities, offers pre-built industry-standard data models, along with asset templates, to provide a standardized framework for classifying and categorizing data. AVEVA launched its CONNECT industrial intelligence platform in April 2024, with CONNECT data services (previously AVEVA Data Hub) aggregating and storing near-real-time industrial data and contextual information in the cloud.

- **Augmenting APM software capabilities and accelerating adoption through GenAI.**
  GenAI has transformed the way content is created, accessed and understood, since the launch of ChatGPT in November 2022 (see Verdantix Market Insight: Understanding The Rapidly Evolving Landscape Of Generative AI). Seventy-three per cent of respondents in the 2023 Verdantix global corporate survey believe that GenAI will help streamline some or most of their firm's administrative tasks, while 13% say that it will drastically change operations (see **Figure 8**). APM software providers are incorporating GenAI capabilities mainly to improve adoption, as well as to deliver prescriptive insights. C3 AI's modular platform, along with C3 Generative AI, first launched in January 2023, offers users the ability to build data ingestion, sensor quality management, data lineage and visualization through a fully graphical interface. It also enables keyword search, all the way up to agent-based retrieval and knowledge graph contextualization. SymphonyAI Industrial's GenAI-driven co-pilots, meanwhile, provide deeper context and insights on assets, including unseen systemic patterns leading to the possible degradation of asset performance. AVEVA's industrial AI assistant, launched in April 2024, leverages large language models (LLMs) to extract insights from multiple data sets, to answer complex questions.

Figure 8
Perceived effects of GenAI on industrial operations
Which statement best describes how GenAI will affect your firm's operations over the next two years?

It will not result in changes to our industrial operations	5%
It will help with some administrative tasks, such as creating form templates and drafting emails	39%
It will help streamline most administrative tasks and improve ease of access to technical documentation	34%
It will drastically change our operations, automating most administrative tasks and facilitating a natural language interface with industrial data and documentation	13%
I do not have an understanding of how GenAI will impact my firm's operations	9%

Note: Data labels are rounded to zero decimal places.
Source: Verdantix Global Corporate Survey 2023: Operational Excellence Budgets, Priorities And Tech Preferences   N=304

- **Developing industry-specific content.**
  A rich library of out-of-the-box failure modes for industry-specific asset classes enables robust predictive – and, more importantly, prescriptive – analytics capabilities of APM software, whilst also helping with quickly scaling deployment. Honeywell offers packaged solutions such as the Honeywell UOP Polybed PSA Process Technology Analytics for Pressure Swing Adsorption Units, used in hydrogen recovery operations in refining and chemicals industries. Similarly, DNV's Cascade APM software has direct interfaces with third-party electric grid asset diagnostic test results, such as Doble power factor and Delta-X TOA4 dissolved gas analysis. IBM offers analytics models for electric transformers for KPIs such as energy loss, CO_2 equivalent emissions and anomaly detection.

- **Offering self-service analytics by leveraging R and Python library solutions.**
  Increasingly, industrial firms – and especially, reliability engineers – are demanding LCNC development environments to create their own analytics models. AI Expert from UptimeAI, for example, provides a no-code environment for its advanced users, which allows them to create and tune predictive models. AspenTech offers its customers the flexibility to create custom models within R and Python and integrate these into Aspen Mtell using web APIs. GE Vernova's customers can develop their AI/ML models with preferred tooling, such as Amazon SageMaker, Microsoft Azure ML or Vertex, and deploy those models in the provider's APM Analytics solution, quickly scaling across multiple assets with Python, Java and MATLAB languages support.

- **Developing quick-to-build reliability models.**
  Reliability-centred maintenance (RCM) strategies are integral to achieving the goals of increased asset uptime, along with net zero KPIs and regulatory compliance (see Verdantix Best Practices: Transitioning To Predictive Maintenance For Enhanced Asset Management). APM software providers are enabling this transition by offering reliability models that are quick to build and deploy. Hitachi Energy's Lumada APM allows users to configure their own models for reliability analysis in a step-by-step process using a LCNC approach. For instance, users can configure a Weibull distribution, or any other lifetime distribution, to analyse life data and model failure times. They can also incorporate the impact of current asset condition on the overall probability of failure and remaining useful life.

Green Quadrant for APM software 2024

Buyers of APM software from both heavy and light industries seek comprehensive, configurable and scalable solutions that build strong foundations for asset information, asset health, failure prediction, reliability analysis, maintenance optimization and integrity management, alongside adjacent functionality such as risk management, asset lifecycle management and environmental performance management. For the purposes of this report, Verdantix defines APM software as:

> *"Industrial software applications and associated asset content that monitor asset performance, predict failures and synchronize with IT and operational technology (OT) systems to generate insights that help optimize production, reliability, maintenance and environmental KPIs."*

This definition does not include software services related to implementation, integration, training and consulting, or software or applications with a focus on a single or a select few impact areas. The assessment encompasses both applications deployed on-premises and those that are single- or multi-tenant cloud-hosted.

Green Quadrant methodology

The Verdantix Green Quadrant methodology provides buyers of specific products or services with a structured assessment of comparable offerings at a certain point in time. The methodology supports purchase decisions by identifying potential vendors, structuring relevant purchase criteria through discussions with buyers and providing an evidence-based assessment of the products or services in the market. To ensure objectivity of the study results, the research process is guided by:

- **Transparent inclusion.**
  We aim to analyse all providers that qualify for inclusion in the research. For those providers that offer insufficient information or are unwilling to cooperate fully on the 137-point questionnaire and two-hour product demonstration, we include them in the report based on public information, where this provides an accurate analysis of their market positioning.

- **Analysis from the market perspective.**
  We integrated findings from our latest global corporate operational excellence survey of 304 decision-makers, many of whom have bought or plan to buy software products such as those analysed in this Green Quadrant. The data-driven survey findings inform how we define the relevant software categories, sub-categories and weightings that propel the Green Quadrant graphical output.

- **Reliance on professional integrity.**
  As it is not feasible to check all data and claims made by vendors, we emphasize the need for professional integrity. Assertions made by software providers are put in the public domain via this Verdantix report and can be checked by competitors and existing customers. Verdantix also retains previous iterations of vendors' Green Quadrant questionnaire responses and makes comparisons and scoring adjustments as needed, to ensure accuracy.

- **Scores based on evidence, briefings and customer interviews.**
  To assess software vendors' expertise, resources, business results and strategies, we gather evidence from public sources and conduct interviews with multiple spokespeople and industry experts. When providers claim to be 'best in class', we challenge them to present supporting evidence.

- **Scores based on relative comparisons.**
  We construct measurement scales ranging from 'worst in class' to 'best in class' performance at a certain point in time. A provider's position in the market can change over time, depending on how its offering and success evolves relative to its competitors. As a result, a vendor's Quadrant positioning may not necessarily improve – even if it adds new applications, makes a strategic acquisition or receives investment – as the assessment is relative to what other vendors are offering or have been doing since the previous Green Quadrant study. The Green Quadrant analysis is typically repeated every one-and-a-half to two years.

Scope and methodology for the 2024 Green Quadrant APM software study

Verdantix studies reflect the current state of customer requirements and product capabilities. As such, we have developed assessment criteria to ensure alignment with the present state of the market. In this iteration of the 2024 Green Quadrant APM software study, Verdantix:

- **Developed APM scenarios from capability assessments.**
  For this study, we established a set of the most important and relevant capability areas in which customers expect vendor functionality. Using the 2022 Green Quadrant APM software study, and feedback from vendors and customers, we developed a framework of eight technical and 10 functional capability areas.

- **Weighted the questionnaire categories to reflect market priorities.**
  The Verdantix Green Quadrant evaluates the latest customer technology preferences, to ensure that the weightings of all high-level criteria reflect global buyers' current priorities across all APM software components. Following extensive interviews with 304 senior operational excellence decision-makers, we applied adjusted weightings for each high-level capability criterion to mimic its relative priority for improvement and to reflect APM software spending plans for 2024 amongst customers.

- **Included coverage of customer success and adoption.**
  A key, and oftentimes overlooked, criterion into which customers require insight relates to the customer success strategies that vendors implement in the market. To account for these, Verdantix included questions around total customer count, renewal rates and strategy. Furthermore, we undertook 30 customer interviews with users of vendor solutions highlighted in this Green Quadrant.

Evaluated providers: selection criteria

Verdantix defines vendor inclusion criteria to ensure that the Green Quadrant analysis only compares firms providing similar services. The 20 APM software providers included in this study were selected because they have:

- **Strong functionality to offer more than three out of five of the core APM capabilities assessed.**
  We scanned the market to identify those vendors that offer more comprehensive APM applications, able to manage the broad spectrum of asset management needs being assessed, alongside additional functionality in areas adjacent to asset performance. Participating vendors were selected based on their ability to offer robust functionality in at least three of the following five capability areas: asset health; failure prediction; reliability analysis; process safety and risk management; and integrity management. In addition, for inclusion in the study, we determined that vendors must not exclusively rely on AI analytics for asset health condition monitoring and failure prediction; rather, they should incorporate physics-based models or the equivalent, to enhance support for various failure modes. To ensure comparability, this criterion eliminates numerous software products focused on only one, or a few, areas.

- **A minimum of 50 employees, annual APM software revenues over $5 million, and five named customers.**
  The Verdantix Green Quadrant APM software study is intended to assess the most prominent vendors offering APM platform solutions. The vendors included in this study have employee numbers ranging from above 50 to nearly 700, and annual APM software revenues ranging from above $5 million to $150 million. All vendors disclosed at least five named customers who adopted and deployed their software for APM use cases in 2023.

- **Resources to deliver a broad APM suite.**
  We focused the study on vendors with the human, financial and technological resources to meet the needs of diverse customers for the foreseeable future. This reflects the desire of most customers to ultimately use a comprehensive and integrated platform to manage all asset management requirements globally.

Based on the inclusion criteria above, this report looks in depth at the APM software platforms available from 20 vendors: ABB, AspenTech, AVEVA, Baker Hughes, Bentley Systems, C3 AI, Cenosco, DNV, GE Vernova, Hexagon, Hitachi Energy, Honeywell, IBM, IFS Energy & Resources (formerly P2), Prometheus Group, SAP, SymphonyAI Industrial, UptimeAI, Wood and Yokogawa. With the exception of SAP, which was invited to take part but did not respond, all vendors actively participated in the research through responses to a 137-point questionnaire and by providing a two-hour product demonstration.

Evaluation criteria for APM software

Verdantix defined the evaluation criteria for the Green Quadrant for APM software using a combination of interviews with corporate practice managers and software executives, desk research, discussions with multiple customers and staff expertise. Our analysis was also informed by responses to the Verdantix global corporate operational excellence surveys. In full, this year's Green Quadrant analysis compares offerings from 20 software vendors, using a 137-point questionnaire covering eight categories of technical capabilities, 10 categories of functional capabilities and nine categories of market momentum. In our analysis:

- **Capabilities measure the breadth and depth of functionality.**
  The Capabilities dimension, plotted on the vertical axis of the Green Quadrant graphic, is a measure of the breadth and depth of each software provider's functionality. To assess this, we evaluated data for eight technical capabilities and 10 functional capabilities. The technical capabilities were: platform interoperability and integrations; data capture and delivery – mobile devices and connected worker solutions; data management; platform – configurability; platform – business intelligence; platform – deployment options; platform – development environment; and user interfaces. The functional capabilities were: information management; asset health; failure prediction; reliability analysis; performance optimization; process safety and risk management; integrity management; asset investment planning; environmental performance; and alert/case management (see **Figure 9** and **Figure 10**).

- **Momentum measures strategic success factors.**
  The Momentum dimension, plotted on the horizontal axis of the Green Quadrant graphic, measures each software vendor on a range of strategic success factors. The criteria that make up the Momentum score are grouped into nine high-level categories: brand preference; vision and strategy; product strategy; innovation process; financial resources; acquisitions; organizational resources and growth; revenue growth; and customers (see **Figure 11**).

The evidence provided by all the software vendors was assessed using a quantitative model that started with the sub-criteria scores. Each sub-criterion was individually weighted to generate the overall score for each capability area. For example, failure prediction is one of the high-level criteria evaluated in the Capabilities section, but is also composed of four weighted sub-criteria that determine the overall failure prediction score.

All sub-criteria were scored between the values of zero ('no capability') and three ('best in class'). Subsequently, each high-level criterion was allocated a percentage weighting that determined its contribution to the overall score for the specific capability. Weightings were based on customer survey data regarding the APM software functionality that is most widely used, along with analyst perceptions of the broader APM software landscape. The combination of high-level criteria scores in the Capabilities and Momentum sections generated the Green Quadrant rankings (see **Figure 12** and **Figure 13**) and graphic (see **Figure 14**).

Figure 9
Technical capabilities criteria for APM software

Capabilities	Questions
Platform interoperability & integrations (6%)	Provide details on integration capabilities with: 1) EAM, CMMS, ERP, AIP, SCADA, historian, and distributed control systems; 2) sensors (e.g. equipment-attached monitors, environmental sensors), wearable devices (e.g. glasses, smart garments, headsets) and with drones/robots; 3) with EHS, PSM, ERP, LIMS, PPM and GIS tools; and examples of integrations and use cases. What capabilities do you offer for capturing data from sensors, wearable devices, drones and cameras to monitor an asset's physical condition? How do you capture EPC data during handover processes and support design, FEED and construction stages? What capabilities do you offer to capture data from non-pre-installed factory sensors? Explain cross-modular workflow functionality, including linking APM data, separate sign-in requirements, integration extent and user visualization. Describe any partnerships and their value.
Data capture & delivery - mobile devices & connected worker solutions (5%)	What capabilities do you offer to capture data from mobile inspection rounds, incident reports, safety observations and integrity certification inspections? What capabilities are available to initiate the completion of inspections and maintenance? How are workflows and work orders triggered from APM? How can the execution of work instructions, inspection checklists, SOPs (standard operating procedures), etc. be optimized? What capabilities facilitate real-time collaboration between field workers and remote personnel? Provide one named customer case study of how your solution is capturing and delivering data to frontline workers.
Data management (5%)	Describe functionality for continuous data ingest, data quality management, validation, contextualization and transformation. How scalable is your data management system and can it handle increasing data volumes and variety? What are the data-processing bottlenecks in your system? Where and how are data stored? Are they stored on-premises, in the cloud, or a hybrid solution? What storage options do you provide for historical data, and how is data archiving managed in terms of security and back-ups? What storage and data archiving options do you provide? How does your system facilitate user collaboration in data discovery, cleaning and analysis? What access controls and permissions are in place? Do you use a graph database for asset and operational data modelling? If so, describe its effectiveness and support for APM.
Platform - configurability (6%)	How can forms, business rules, role-based user rights, user interface and workflows be (re)configured?
Platform - business intelligence (5%)	Does the app have its own BI tool or integrate with third-party BI tools? What out-of-the-box charting, data visualization and reporting tools are available? What advanced visualization tools (such as digital twins, 3D visualizations, map views and heat maps) do you offer? Provide a customer case study on integrated BI and advanced visualization deployment.
Platform - deployment options (1%)	What is your multi-tenant-hosted offering? What % of customers use it? What is your single-instance-hosted offering? What % of customers use it? What is your on-premise offering? What % of customers use it?
Platform - development environment (2%)	What development tools can clients use for custom application development? What development tools can clients use for custom analytics models? What is your development environment?
User interfaces (5%)	Describe the usability and user-friendliness of the enterprise app interface, including mobile functionality. Do you offer accessibility functionality? How many languages are available out of the box? Can users switch metrics easily? How do you engage customers for feedback and ensure the inclusion of user experience in software design?

Note: Figures in brackets represent the weighting given to each criterion in the flexible multi-criteria model that generates the Green Quadrant graphical analysis.
Source: Verdantix analysis

Figure 10

Functional capabilities criteria for APM software

Capabilities	Questions
Information management (7%)	What capabilities are available to create and manage an asset database? What functionality is available to build and manage an asset hierarchy, including changes? What functionality ensures asset information is up to date and consistent across the organization, including asset procedures and maintenance history? How many out-of-the-box asset classes can you support, including pre-defined failure modes and maintenance activities? What industry-specific functionality do you offer for asset information management? Provide a customer case study for asset information management deployment, including quantifiable benefits.
Asset health (8%)	What functionality is available to support building and maintaining an asset health database? What capabilities support health overview, failure diagnostics based on thresholds/rules, alerts and notifications? What out-of-the-box and configurable KPIs and metrics are available? What industry-specific functionality do you have for asset health? How does the tool integrate real-time asset performance and health data to provide alerts? Provide one named customer case study for the deployment of the asset health functionality.
Failure prediction (12%)	What predictive analytics methods and tools are available to forecast asset failure and time-to-action? What feature/pattern recognition methods are available? What testing/training is required (data type, data capture frequency/duration, historical data, etc.)? What is the typical time-to-value? What are the asset types available? Do you have any features for improving prediction accuracy? What prescriptive analytics support APM? What functionality identifies anomalies or false positives? How does your software develop and integrate AI/ML-based and physics-based failure models? What industry-specific functionality do you offer for asset failure prediction? Does the software provide functionality to seamlessly integrate externally developed custom failure models into the system? Provide a customer case study for asset failure prediction functionality deployment, including quantifiable benefits.
Reliability analysis (10%)	What functionality supports reliability life data analysis and industry standards? What capabilities support asset criticality analysis and failure mode building? What functionality helps users understand the consequences of failure and perform scenario analysis? What capabilities support failure reporting, analysis and corrective action systems (FRACAS)? How does your system support maintenance strategy optimization, including cost and EHS considerations? What industry-specific functionality do you offer for reliability analysis? Provide a customer case study for reliability analysis functionality deployment, including quantifiable benefits.
Performance optimization (4%)	What functionality supports availability analysis and throughput calculation? What capabilities support production loss analysis and identify production bottlenecks? How does your system support production optimization and simulate solutions? What functionality provides insights into operational performance, including business intelligence and benchmarking? What industry-specific functionality do you offer for production optimization? Provide a customer case study for production optimization functionality deployment, including quantifiable benefits.

Figure 10 (continued)

Process safety & risk management (6%)	What functionality supports quantitative assessment of asset failure risks in terms of fatalities, injuries and environmental damage? What capabilities support hazard analysis, including vulnerability analysis assessment (VAA), process hazard analysis (PHA) and lock-out tag-out (LOTO) processes, as well as more quantitative methods such as layers of protection analysis (LOPA) and fault/event tree analysis (FTA/ETA)? How are safety procedures triggered and communicated to the EHS and PSM system in critical situations such as hazardous material containment failure? How does your system manage and report asset-related incidents? What industry-specific functionality do you offer for risk management? Provide a customer case study for process safety and risk management functionality deployment, including quantifiable benefits.
Integrity management (10%)	What functionality supports inspection scheduling, data capture and shift handover? What functionality is offered to collect, store, manage and analyse data generated from the inspection and testing of equipment or assets? How are innovative technologies such as AR, VR, computer vision and drones, etc. used to support this? How does your system assess failure likelihood and consequences, to optimize inspection rigour based on overall risk? What capabilities support digital twins and visualizations? What integrations does your integrity module support? What functionality monitors technical integrity related to material degradation? How does your system support integrity operating windows programmes? What functionality do you offer for compliance with global standards? What industry-specific functionality do you offer for integrity management? Provide a customer case study for integrity management functionality deployment, including quantifiable benefits.
Asset investment planning (3%)	What functionality integrates lifecycle costing principles into decision-making, considering total cost of ownership? How does the tool align asset performance and maintenance strategies with strategic goals and investment priorities? What capabilities create an optimized list of asset intervention projects and a multi-year investment planning strategy? What industry-specific functionality do you offer for asset lifecycle strategy? Provide a customer case study for asset investment planning functionality deployment, including quantifiable benefits.
Environmental performance (3%)	What functionality determines the environmental impact of asset performance, supports carbon emissions monitoring/reduction and optimizes energy consumption? How does the tool promote a circular economy? What capabilities support Scope 1 and 2 data collection and compliance reporting? What industry-specific functionality do you offer for environmental performance? Provide a customer case study for environmental performance functionality deployment, including quantifiable benefits.
Alert/case management (2%)	Does the software have an integrated or third-party case management tool? What collaboration and workflow features are available? How does the system support case lifecycle management, including alert configuration and customization? What measures are in place to minimize false positives and enhance alert accuracy? Can users set up automated responses and define alert severity levels? Is there a comprehensive audit trail, and how does the system define priority, criticality and severity, and escalate alerts? What functionality tracks the value of preventing a failure detected by the predictive capability? How does the tool track predictive alerts from inception to remediation? Can users generate reports on asset performance, resolution times and other key metrics? What collaborative functionality is available for users during the resolution of a case? What industry-specific functionality do you have for case management? Provide a customer case study for case management functionality deployment, including quantifiable benefits.

Note: Figures in brackets represent the weighting given to each criterion in the flexible multi-criteria model that generates the Green Quadrant graphical analysis.
Source: Verdantix analysis

Green Quadrant: Asset Performance Management Solutions 2024
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Figure 11
Momentum criteria for APM software

Capabilities	Questions
Brand preference (15%)	Based on Verdantix analysis
Vision & strategy (10%)	What is your firm's vision for the target customers/addressable market opportunity you seek to target over the next five years? How do you intend to achieve the vision? What is your firm's strategy to meet the needs of your target customers over the next five years?
Product strategy (15%)	What is your firm's APM product strategy for the next two to five years? What does your product roadmap look like?
Innovation process (10%)	What is your firm's innovation framework and strategy? Comment on whether your firm has global innovation hubs, or runs hackathons and other initiatives. What is your firm's strategy when it comes to R&D investment allocations to support long-term viability and maintain competitive advantage(s)?
Financial resources (10%)	Based on Verdantix analysis
Acquisitions (5%)	How many acquisitions have you made over the past two years? Please provide details of the acquisition(s). How many formalized partnerships have you made over the past two years?
Organizational resources & growth (10%)	What is your total number of employees? How many employees are dedicated to APM? In how many/which countries does your firm have an office?
Revenue growth (13%)	What were your firm's annual revenues for your most recent reporting year? What were your firm's revenues from APM software for your most recent reporting year? By how much did your firm's total revenues grow in the most recent reporting year compared with the previous year?
Customers (12%)	How many of your customers/accounts (not individual users) are using your firm's APM solutions? How many customers/logos have you added over the past 12 months? Who are the key buyer personas/stakeholders you target? How does your GTM messaging vary with different stakeholders?

Note: Figures in brackets represent the weighting given to each criterion in the flexible multi-criteria model that generates the Green Quadrant graphical analysis.
Source: Verdantix analysis

Figure 12

Vendor category scores (Capabilities)

	ABB	AspenTech	AVEVA	Baker Hughes	Bentley Systems	C3 AI	Cenosco	DNV	GE Vernova	Hexagon	Hitachi Energy	Honeywell	IBM	IFS Energy & Resources (formerly P2)	Prometheus Group	SAP	SymphonyAI Industrial	UptimeAI	Wood	Yokogawa
Platform interoperability & integrations	2.6	1.6	2.2	2.0	2.0	2.6	1.9	1.3	2.3	1.4	2.1	1.8	2.1	1.8	1.6	2.1	1.8	1.9	1.3	1.9
Data capture & delivery	2.5	1.5	2.0	1.3	1.5	2.3	1.8	1.3	1.8	2.0	2.3	1.8	3.0	1.8	1.5	1.3	1.8	1.0	1.3	1.5
Data management	2.8	2.1	2.2	1.6	1.4	2.9	0.9	1.2	1.7	1.6	1.8	1.8	1.9	0.8	1.2	1.1	2.4	2.1	1.1	1.4
Platform - configurability	2.4	1.9	1.9	1.9	2.4	2.1	1.7	1.6	2.5	1.7	1.9	0.9	1.9	1.4	1.8	1.9	1.9	2.1	1.7	1.4
Platform - business intelligence	2.8	2.3	2.3	1.3	1.5	2.8	2.0	1.8	2.3	1.8	2.3	1.0	2.0	1.0	1.8	1.8	2.0	1.8	2.3	1.5
Platform - deployment options	1.5	1.6	2.5	1.8	0.7	2.0	1.1	0.7	1.3	1.5	1.6	1.2	0.7	1.3	1.9	1.0	2.1	1.3	1.1	2.0
Platform - development environment	3.0	2.0	2.3	1.5	1.5	2.9	1.5	1.1	2.1	1.5	2.4	2.2	2.6	1.0	1.4	1.4	2.0	2.9	1.0	1.9
User interfaces	2.0	1.4	2.2	2.6	1.2	2.8	2.0	1.2	3.0	1.4	2.0	1.8	2.2	1.6	1.6	1.6	2.0	2.4	1.2	1.4
Information management	1.6	1.6	2.8	1.6	2.6	1.8	1.6	1.4	2.2	2.6	1.8	1.4	2.8	2.2	2.0	1.6	1.8	1.8	1.4	1.8
Asset health	2.0	3.0	2.7	2.3	2.0	2.7	1.3	2.0	3.0	2.0	2.3	2.7	2.0	1.7	1.3	2.0	2.0	2.3	1.3	2.3
Failure prediction	1.5	2.7	2.6	1.9	1.8	2.2	1.3	1.1	2.2	2.0	2.0	2.3	2.0	1.0	2.0	1.4	2.0	2.3	1.3	2.0
Reliability analysis	1.6	2.0	2.4	2.2	1.2	1.8	2.0	1.4	2.8	2.2	2.2	1.0	2.0	1.4	1.2	1.2	0.8	1.4	1.6	1.4
Performance optimization	1.4	2.9	2.7	1.4	1.4	2.3	1.0	0.6	1.9	0.5	1.5	2.1	1.3	0.9	0.7	0.5	1.5	1.5	1.3	1.5

Figure 12 (continued)

Process safety & risk management	1.8	1.2	1.4	1.4	1.8	1.2	2.8	1.4	2.4	1.8	0.4	1.4	1.6	0.2	2.4	1.4	0.0	0.4	1.8	1.6
Integrity management	1.5	1.8	2.1	1.7	2.2	1.9	2.6	1.7	3.0	1.2	1.7	1.6	1.6	0.8	1.3	1.7	0.6	0.4	2.3	1.8
Asset investment planning	1.3	2.5	2.0	1.5	1.3	1.0	1.3	1.3	1.5	1.3	2.3	0.0	1.8	0.0	1.5	1.0	0.0	0.0	0.0	0.0
Environmental performance	0.7	2.4	1.7	1.7	1.1	2.0	0.4	0.7	2.6	1.0	1.6	1.7	2.0	1.0	1.0	0.7	0.6	0.3	0.4	1.3
Alert/case management	2.0	2.6	2.8	2.2	1.4	2.8	1.4	0.4	2.6	1.8	1.8	0.8	0.8	2.0	2.4	1.4	0.8	1.4	0.8	1.0

Source: Verdantix analysis

Figure 13
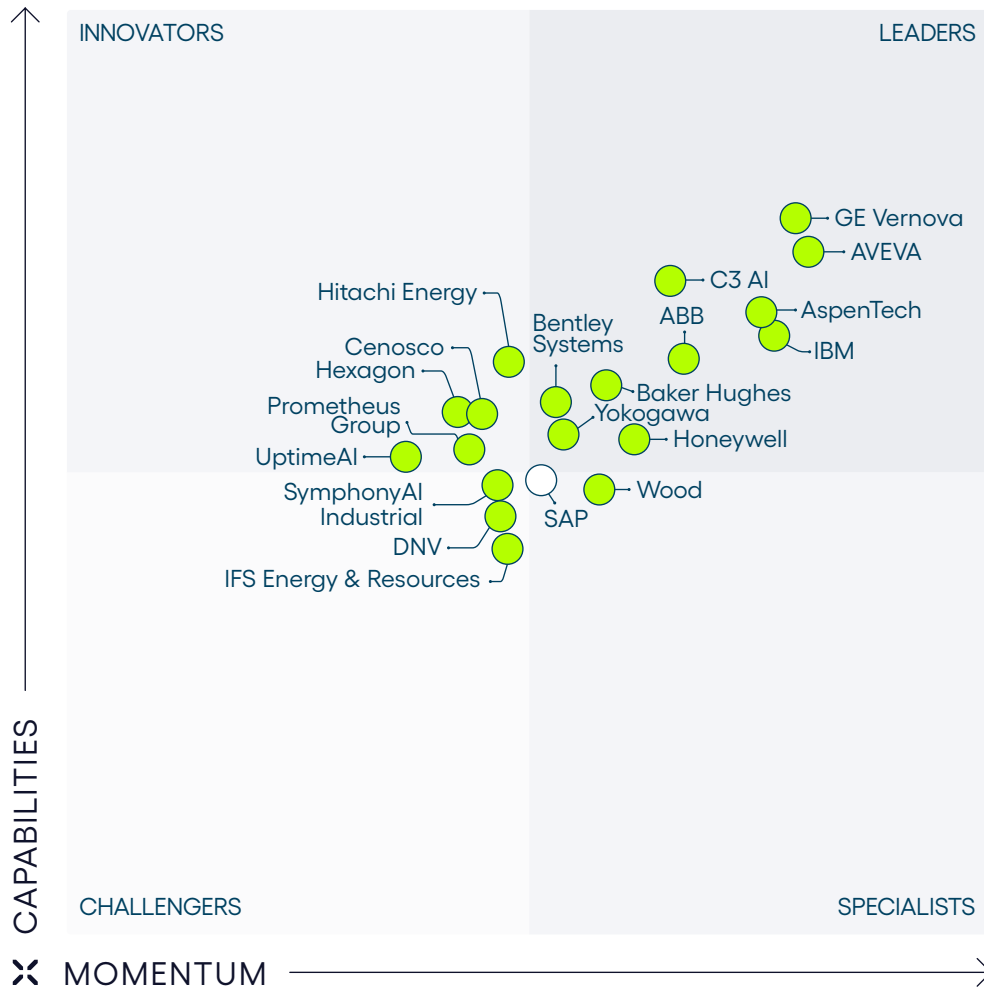## Vendor category scores (Momentum)

	ABB	AspenTech	AVEVA	Baker Hughes	Bentley Systems	C3 AI	Cenosco	DNV	GE Vernova	Hexagon	Hitachi Energy	Honeywell	IBM	IFS Energy & Resources (formerly P2)	Prometheus Group	SAP	SymphonyAI Industrial	UptimeAI	Wood	Yokogawa
Brand preference	2.3	2.3	2.5	2.0	1.8	1.0	0.8	0.8	3.0	1.3	1.5	2.0	2.8	1.0	1.0	2.3	1.0	0.8	2.0	1.3
Vision & strategy	1.5	2.0	2.5	2.0	1.0	2.0	1.5	1.5	3.0	2.0	1.0	2.0	2.5	1.0	1.0	1.5	1.5	1.5	2.5	2.0
Product strategy	3.0	2.0	3.0	2.0	2.0	3.0	2.0	2.0	2.0	1.0	2.0	3.0	3.0	2.0	2.0	1.0	2.0	1.0	2.0	2.0
Innovation process	2.0	2.0	2.5	1.0	1.5	2.5	1.5	1.0	2.0	0.5	1.0	1.0	2.5	1.0	1.0	1.0	1.0	1.0	1.5	1.0
Financial resources	2.0	3.0	2.0	2.0	2.0	2.0	1.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.0	2.0	2.0
Acquisitions	1.0	3.0	2.7	1.0	1.3	1.4	1.7	0.7	2.0	1.6	1.3	1.3	2.7	2.3	1.6	1.4	1.4	1.4	1.4	1.7
Organizational resources & growth	1.9	2.0	1.8	2.0	1.4	1.7	1.7	1.7	2.3	1.7	2.1	1.7	1.7	1.6	0.9	1.7	1.4	1.7	1.8	1.5
Revenue growth	1.9	2.5	2.5	1.7	1.5	1.8	1.3	1.3	2.2	0.9	0.9	1.4	1.4	1.5	1.3	1.4	1.3	1.0	1.2	1.2
Customers	1.5	2.0	2.0	1.5	1.5	2.0	1.0	1.5	2.5	1.0	1.0	1.5	2.0	1.0	1.0	1.5	1.0	1.0	1.0	2.0

Source: Verdantix analysis

Figure 14

Green Quadrant for APM software 2024

Figure 14: Green Quadrant for APM software 2024

Quadrants: INNOVATORS (top-left), LEADERS (top-right), CHALLENGERS (bottom-left), SPECIALISTS (bottom-right). Axes: CAPABILITIES (vertical), MOMENTUM (horizontal).

Vendors plotted: GE Vernova, AVEVA, C3 AI, AspenTech, ABB, IBM, Bentley Systems, Baker Hughes, Hitachi Energy, Yokogawa, Cenosco, Hexagon, Honeywell, Prometheus Group, UptimeAI, Wood, SymphonyAI Industrial, SAP, DNV, IFS Energy & Resources.

Capabilities

This dimension measures each service provider on the breadth and depth of its implementation services across 18 capability areas, as outlined in **Figures 9** and **10**.

Momentum

This dimension measures each service provider on nine strategic success factors, as outlined in **Figure 11**.

Note: A white plot indicates a non-participating vendor.
Source: Verdantix analysis

GE Vernova APM software overview

Information

GE Vernova, formed in 2024 following General Electric's 2021 restructuring plan, encompasses GE's historic energy and software businesses. With an installed base of more than 7,000 gas turbines and 400GW of renewable energy equipment, GE Vernova is focused on delivering industrial software to accelerate electrification and decarbonization across the entire energy ecosystem. One of its core offerings is its APM software solution, which was initially established following the acquisition of Meridium in 2016. Today, GE Vernova's APM solution is used by over 400 industrial firms worldwide, across the oil and gas, power generation, mining, aviation and manufacturing industries.

Vendor info

Firm name	GE Vernova
Headquarters	Cambridge, US
Employees	80,000
Revenues	$10bn to $50bn
No. of offices	100+
Example customers	PETRONAS, SOCAR, Xcel Energy

Customer regional presence

Asia	◐
Oceania	◔
Europe	◐
Middle East and Africa	◐
Latin America and the Caribbean	◔
North America	◕

% Customer base

○ 0%   ◔ <10%   ◐ 10%-25%   ◕ 25%-50%   ● above 50%

GE Vernova's top three industry penetration

1. Utilities

2. Oil and gas

3. Chemical manufacturing

Technical capability scores

0

0.50

1

1.50

2

2.50

3

- Platform interoperability & integrations
- Data capture & delivery
- Data management
- Platform - configurability
- Platform - business intelligence
- Platform - deployment options
- Platform - development environment
- User interfaces

Functional capability scores

0

0.50

1

1.50

2

2.50

3

- Information management
- Asset health
- Failure prediction
- Reliability analysis
- Performance optimization
- Process safety & risk management
- Integrity management
- Asset investment planning
- Environmental performance
- Alert/case management

Capability scores on a 0 to 3 scale.
A score of 0 means no capability and
3 means market-leading capability.

Analyst insight: GE Vernova's market-leading APM software supports industrial firms' energy transition efforts

Achieving the highest score of all the vendors in the Green Quadrant analysis for its functional capabilities, with particular strengths across asset health, reliability and integrity workflows, GE Vernova delivers a market-leading APM solution and deep subject-matter expertise across the oil and gas and power utilities industries. This section takes a deeper dive into GE Vernova's specific products and use cases, demonstrating capabilities, differentiators, customers and innovation strategy. Based on the Green Quadrant analysis, Verdantix finds that GE Vernova offers:

- **Industry-leading asset integrity management capabilities.**
  Scoring a perfect 3.0/3.0 for integrity management, GE Vernova's mechanical integrity application utilizes advanced risk-based inspection (RBI) methodologies, providing robust capabilities for inspection management, failure risk assessment, corrosion management, integrity operating windows and compliance management. It includes an extensive library of qualitative and quantitative damage mechanisms compliant with API 581, enabling users to manage inspection plans, document asset condition on mobile devices, track recommendations to closure, capture inspection confidence, and seamlessly integrate with enterprise asset management (EAM) solutions. The firm's Autonomous Inspection application smoothly integrates with its APM solution, and leverages AI/ML (machine learning) algorithms with image-capturing devices to support automated gauge-reading, corrosion management and thermal profiling. GE Vernova enables users to embed thickness monitoring data in 2D and, through close partnerships with Visionaize, visualize this information on a 3D model, and conduct deep analysis of thickness and corrosion monitoring in a single view. OQ, formerly known as Oman Oil Company, achieved approximately $59 million in savings by leveraging GE Vernova's APM Integrity solution. Through RBI analysis, OQ avoided three turnaround events, optimized assets, and enhanced compliance and safety measures.

- **Leading reliability analysis capabilities.**
  GE Vernova scored 2.8/3.0 for reliability analysis, the highest score in the Green Quadrant analysis. The tool's reliability-centred maintenance (RCM) capabilities comply with SAE JA1011/1012 standards, as well as the RCM1, RCM2 and RCM3 methodologies. Users can quickly build failure modes and run simulations to assess risks and associated mitigating actions. Weibull Analysis and Goodness of Fit (GOF) testing are offered to assess life data analysis, while Monte Carlo simulations can model the future reliability of systems under varying scenarios and the effect on supply chains and inventory optimization. The firm also offers users a dedicated asset criticality analysis module to support criticality assessments via a configurable risk matrix. The criticality analysis module is integrated with failure mode, effect and criticality analysis (FMECA), RCM and asset strategy management modules. The Asset Strategy Optimization module integrates with the rest of the platform, facilitating simulations for various scenarios to select the optimal strategy. GE Vernova also offers the ability to generate out-of-the-box ISO-compliant reports that support failure reporting, analysis and corrective action system (FRACAS) and corrective and preventive action (CAPA) processes.

- **Applications designed for accelerating energy transition.**
  GE Vernova plans to evolve its APM solution to reduce ESG risk from fugitive emissions, better support decarbonization investment decisions, and consolidate data for supply chain management. GE Vernova, receiving the top score of 2.6/3.0 for environmental performance, has already made substantial progress in using its APM application to support energy transition. This includes APM accelerators – a product line of pre-built industry models for renewables such as wind and solar – as well as traditional utilities assets, helping firms quickly set up asset reliability and performance programmes. Firms such as Tampa Electric use GE Vernova's APM Solar Accelerators for solar asset monitoring, performance benchmarking and identifying degradation sources for improved farm efficiency. Beyond APM, GE Vernova's generation optimization solutions, such as Performance Predictions, use AI/ML and real-time data to manage and optimize mixed-generation fleets; the Autonomous Tuning software optimizes gas turbine combustion by determining the ideal flame temperatures and fuel splits; BoilerOpt adjusts fuel and air biases for optimal boiler performance; and carbon management software CERius addresses energy firms' decarbonization challenges through GHG collection, monitoring, reporting and strategy development.

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