DIGITAL THREAD:

Asset lifecycle management makes complex energy infrastructure projects manageable

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Infrastructure projects in the energy sector typically span several years—bringing with them significant risks. Over time, technical standards, market conditions, or even suppliers may change, potentially disrupting progress. Asset lifecycle management (ALM) addresses these challenges by providing all stakeholders with maximum transparency across the entire project lifecycle, linking previously isolated data silos. This reduces planning uncertainty, lowers costs, and accelerates execution. The digital thread established through ALM also supports plant operations, as demonstrated by the example of an offshore wind farm.

Today's energy infrastructure is shaped by highly dynamic processes that require continuous, agile adjustments over extended timeframes. The expansion of renewable energy, regulatory requirements, volatile load peaks driven by e-mobility, and decentralized generation plants—such as balcony power plants—increase the complexity to a level that overtaxes traditional project management methods. In this context, ALM is establishing itself as a key technology for controlling the planning, construction, and operation of energy infrastructures in real-time, thereby ensuring the long-term competitiveness of grid operators and energy companies.

A range of challenges must be considered. While regulatory requirements such as the EU Grid Expansion Directive are becoming more stringent, market changes and the integration of decentralized generators require completely new data logistics. Today, electricity traders or Transmission System Operators (TSOs) must not only coordinate large-scale projects such as offshore wind farms, but also manage the synchronization of millions of small feed-in points—a task far too complex for Excel spreadsheets and manual workflows. The implications are clear: delays due to undocumented changes, or unnecessary duplicated efforts, and an increased risk of compliance violations.

ALM systems address these weaknesses with end-to-end transparency and streamlined access to information. By digitally mapping and linking all project phases—from procurement to construction to operation—they create transparency across all disciplines. Contracts, technical specifications, and supplier communications are no longer static documents, but dynamically linked data elements. If, for example, the configuration of certain cables at the feed-in points of a wind farm changes, the system can automatically display all dependent components and identify risks. This applies from substation planning to the calculation of the operating reserve.

To meet these challenges, Aras, a leader in product lifecycle management (PLM) and digital thread solutions, has entered into a strategic partnership with AVEVA to deliver Asset Lifecycle Management solutions. The solutions built on the Aras platform will be developed and marketed in collaboration with AVEVA. As part of this collaboration, Aras Innovator was specifically adapted and successfully used in an ALM pilot project for an offshore wind farm. The result: reduced financial risk and a significantly shorter time-to-market—a decisive factor in view of the EU targets for the expansion of wind energy. After all, a single, unsynchronized change to the grid architecture can lead to additional costs in the millions. The ALM platform also provides the technical basis for the integration of AI-supported forecasting tools, for example, to identify bottlenecks in the supply chain at an early stage and suggest alternative scenarios.

CONCRETE BENEFITS FOR ONGOING PROJECTS

Clients and project participants can use an ALM system to eliminate many recurring pain points in the course of the project and benefit from economic advantages:

Control change requests, recognize dependencies

Change requests are not exceptions in large-scale projects—they're inherently driven by planning cycles that often span several years. The core issue: technical specifications that are current at the time of procurement may be outdated by the time the project is implemented. For example, a specific cable insulation might become unavailable due to changes in a manufacturer's standards. Such deviations can result in administrative inefficiencies and escalate risks like supply chain disruptions or cost increases.

This is where ALM comes in as a powerful mechanism. By digitally connecting all stakeholders and mapping requirements in real-time, the system enables a proactive change cascade analysis. Every change request is immediately assessed for its dependencies—for instance, how a cable modification will affect the network architecture, contract terms, or operating reserve. This level of transparency ensures the consequences of a change are identified early, avoiding costly, complex adjustments later in the project.

Change requests can be processed significantly faster, with affected components identified and alternative proposals generated. The system also offers options for customized release workflows, guiding changes through test validation steps such as technical feasibility, contractual compliance, and cost assessment before they are implemented. This approach provides greater planning reliability for everyone involved.

Integration of subcontractors

ALM systems streamline project coordination through real-time collaboration among all stakeholders on a centralized platform. This is especially valuable in large-scale projects with dozens of subcontractors—from the cable supplier to the approval expert to the wind turbine foundation builders—where digital integration enables seamless synchronization across all disciplines.

With browser-based, role-specific access to relevant data, suppliers and partners can interact efficiently, accelerating complex contract negotiations with globally distributed partners. For example, a supplier in Asia can align on technical specifications directly with the TSO in Germany, while at the same time, a consultant in the UK comments on contract clauses in the same document. This collaboration eliminates physical boundaries and also reduces inefficiencies. Discussions, change requests, and approvals take place in a standardized workflow—from the first version to the final signature. For project managers, this means replacing weeks of email chains or cumbersome SharePoint queries with instant visibility via the ALM dashboard, showing real-time status of all negotiations.

Additionally, every offer and agreement is digitally traceable, leaving no room for interpretation later on. ALM ensures consistent, transparent communication from project initiation to project completion, with the added flexibility of signing off individual completed sub-projects separately. By reducing manual coordination, negotiation phases and approval cycles are significantly shortened, and legal certainty increases.

Long-term knowledge retention across project generations

Systematic knowledge transfer is especially valuable in the complex TSO environment, where several large infrastructure projects often run in parallel. Continuous exchange of insights across project phases becomes crucial, particularly when project timelines span several years. A consistent ALM data model, supported by a digital thread, ensures transparency across project cycles, secures important decisions through documentation, and provides decision-makers with the necessary context for well-founded strategic decisions.

Reduce costs with standardized parts

Individual solutions in large-scale projects often prove to be a weak point. Although customized components often appear to be optimal for the specific requirements in the planning phase, deficits become apparent in the long term. During maintenance work, technicians often need to source specialized spare parts that may no longer be in production, while network expansions are made more difficult by incompatible interfaces. ALM systems provide the platform to initiate the necessary standardization by allowing the technical requirements to be used in modules for subsequent procurements. A practical advantage: when certain systems are standardized across several projects, organizations gain purchasing efficiencies that reduce cost during construction and long-term operation. At the same time, engineering costs are reduced as existing specifications can be adapted.

Strategic importance goes beyond immediate cost savings. Standardized components and interfaces enable modular grid expansion, as required for the integration of decentralized generation plants. Over time, this approach will drive the renewal of energy infrastructure. Much like platform strategies in the automotive industry have transformed development cycles, standardization enabled by ALM unlocks industry-wide synergies.

Another advantage is increased resilience. Standard components with a broad supplier base minimize the risk of bottlenecks. At the same time, the simplified availability of spare parts accelerates troubleshooting. This transformation towards a collaborative ecosystem strategy is made possible by ALM as a technology enabler.

Set up new contracts faster and more reliably

Contract management through ALM systems addresses one of the biggest pain points: increasing contract complexity combined with mounting cost pressure. Modules from a centralized template library supplement manual document creation. Recurring clauses—such as those relating to limitations of liability or warranty periods—are stored as digital modules and can be flexibly combined.

This approach significantly reduces the effort required to draft contracts, allowing teams to reuse pre-validated language and accelerate approvals. At the same time, the system facilitates compliance with public procurement and EU state aid law. The resulting dynamic knowledge database develops into a strategic corporate asset in which every contract can be systematically analyzed after it has been concluded: Which clauses have led to renegotiations? Where were there delays in delivery? The knowledge gained flows into future contract designs and optimizes them continuously. By systematically scaling project experience, the knowledge of individual project managers is no longer tied up in silos but becomes accessible and usable for everyone as a structured corporate memory.

Ensure compliance and inform suppliers

EU directives—such as the Grid Expansion Regulation or the Renewable Energy Directive—set the overarching framework, while local environmental requirements or municipal building regulations narrow the scope for new energy infrastructure projects. Conventional compliance mechanisms or manual checklists fail due to the increasingly complex landscape. ALM systems transform compliance—not as a reactive control mechanism, but as an integrated, proactive element embedded throughout the project lifecycle. Every component, from the transformer station to the underground cable, can be compared with the relevant regulations via ALM. Technical specifications are linked to standards catalogs, and suppliers have real-time visibility into the certifications required for their components. This approach also offers the regulatory agility essential for the energy transition. When new EU regulations are introduced, ALM-controlled projects adapt quickly by updating the compliance rules.

Show construction progress transparently

During the construction phase, ALM systems can synchronize progress checks, defect resolutions, and acceptance reports in real-time. Instead of relying on manual Excel spreadsheets or fragmented email communication, all stakeholders involved document their status directly in the central system. Once a construction task is marked complete, a workflow is triggered covering everything from quality control to acceptance. If defects are detected, an escalation path can also be triggered in which the responsible parties receive prioritized tasks, and the correction phase is logged. This drastically reduces the time required to rectify defects.

Unlike traditional project management approaches—where critical data is often buried in unstructured SharePoint folders or local PDFs—ALM systems store information as version-controlled, BIM-compliant data sets. This not only reduces the risk of costly errors but also ensures full traceability for auditors. The result: improved deadline adherence, fewer rework cycles, and greater project efficiency.

CONTINUOUS DATA FLOW FROM START TO FINISH

ALM systems are becoming a strategic game changer for TSOs and other stakeholders in the energy industry. Faced with massive challenges—ranging from the expansion of offshore wind connections to the integration of volatile renewable energy sources—these platforms are evolving into essential management tools for critical infrastructure.

This is because ALM systems link previously isolated data sources (e.g. contract documents, BIM models, IoT sensor data, and maintenance logs) into a real-time data stream. This integration provides the perfect basis for an end-to-end digital thread, i.e., seamless data networking across the entire asset lifecycle. Seamless traceability of all planning and decision-making processes ensures that knowledge can be efficiently reused, reducing project risks over the long term. For example, if the specification of a substation changes, all dependent processes can be adapted—some automatically—from material planning and cost calculation through to compliance testing.

DIGITAL TWIN SHOWS OPTIMIZATION POTENTIAL

The digital thread also forms the data foundation for a potential digital twin that extends beyond pure 3D visualization. It decodes complex dependencies and potential risks, enables new dimensions of pattern recognition, and connects planning data, operating sensors, performance data, weather data from the wind turbines, and maintenance histories to create a dynamic, holistic model.

This results in an exact virtual representation of the physical system. This enables simulation, control, and continuous optimization. At the same time, AI applications can continuously gain new insights from this wealth of data and improve the quality of the analysis. In practice, this real-time linking of operating data with historical maintenance information and external influencing factors such as weather forecasts opens up decisive opportunities:

- **Predictive maintenance:**
  AI applications detect subtle anomalies in systems like substations or wind turbines in advance of potential failure, using data such as temperature changes or abnormal noise patterns.
- **Strategic innovation potential:**
  In the digital twin, innovations and enhancements can be virtually simulated, tested, and implemented on a trial basis, without physical intervention or risks for the running system.
- **Advanced simulation:** Before integrating a new wind farm, grid operators can evaluate and optimize the systemic effects on grid stability and balancing energy requirements in virtual environments.

THE ENERGY TRANSITION IS BECOMING TECHNICALLY AND ECONOMICALLY SCALABLE

Flexible ALM systems serve as a digital hub for all planning and operating processes—making them suitable for managing individual assets and comprehensive grid simulations. Unlike isolated software solutions, their key advantage lies in the real-time linking of the physical infrastructure (transformers, wind turbines, etc.) with dynamic external factors such as regulatory requirements, fluctuating electricity demand patterns, supplier agreements, and weather-related fluctuations in renewable energy input. This interconnected data environment creates a 360-degree view that not only visualizes complex dependencies but also enables predictive analytics.

Modern solutions—such as AVEVA's asset lifecycle management solutions, powered by Aras Innovator—enable real-time data integration to automate processes. In the long term, the combination of ALM, digital twin, and AI-driven data analysis will enable the transformation from network operator to system architect. Asset lifecycle management is far more than just an IT tool—it serves as the operational basis for a resilient energy infrastructure. Only this holistic data-driven approach enables stakeholders in the energy industry to meet the dual challenge of rapidly expanding renewable capacities while ensuring the stability of an increasingly decentralized grid. This makes the energy transition not only technically feasible but also economically scalable.