Breaking Barriers to Hydrogen Profitability

Asset Performance Management for Continuous Improvement

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The Hydrogen Challenge

The current hydrogen market can be characterized as having a “chicken and egg” problem.

The nascent industry has yet to deliver on its full potential, and further growth is being hampered by a series of technical and procedural obstacles. Without reliable service and a consistently available hydrogen supply, customers may grow dissatisfi ed, rendering many projects unsuccessful. This in turn could lead to a low rate of adoption in the market, and a lack of incentive for improvement. We cannot move forward into profitability until we identify the underlying causes of these hindrances.

The urgent need to address climate change, the desire for carbon footprint reduction, and various geopolitical incentives for clean energy all act as strong drivers, but companies are still facing many technical, safety, and reliability issues that make final investment decisions on hydrogen projects difficult. Compounding these problems are a lack of communication amongst partners, poor data collection, insufficient reportage, and incompatibility between various proprietary systems.

When it comes to improving performance, the question that often emerges is, “Where do we start?” A better question to ask is, “How can we shift from a cycle of underperformance to a cycle of continuous improvement?”

Though inspiring opportunities await in the hydrogen industry, operators and asset owners must establish key performance indicators (**KPIs**) beforehand to determine operational viability. A well-designed asset performance management (**APM**) system is the best approach for utilizing and achieving these KPIs.

Barriers to a Turnkey Solution

Due to their complexity, hydrogen projects are rarely based on turnkey programs. When designing for hydrogen, there is no "one-size-fits-all" solution. While a broad range of hydrogen-suitable equipment already exists, systems and supply chains are often unintegrated, with no clear path for defining KPIs. In many cases, the interfaces between system components have not been designed for compatibility or customized to meet the specific needs of a particular customer. This results in many projects not being immediately profitable from the outset. Even when reasonable initial efforts are established to optimize both interfaces and protocols, a fully realized solution still requires ongoing refinements and adjustments as the project progresses. The incremental nature of this growth will come up against many potential obstacles as depicted in **Figure 1**.

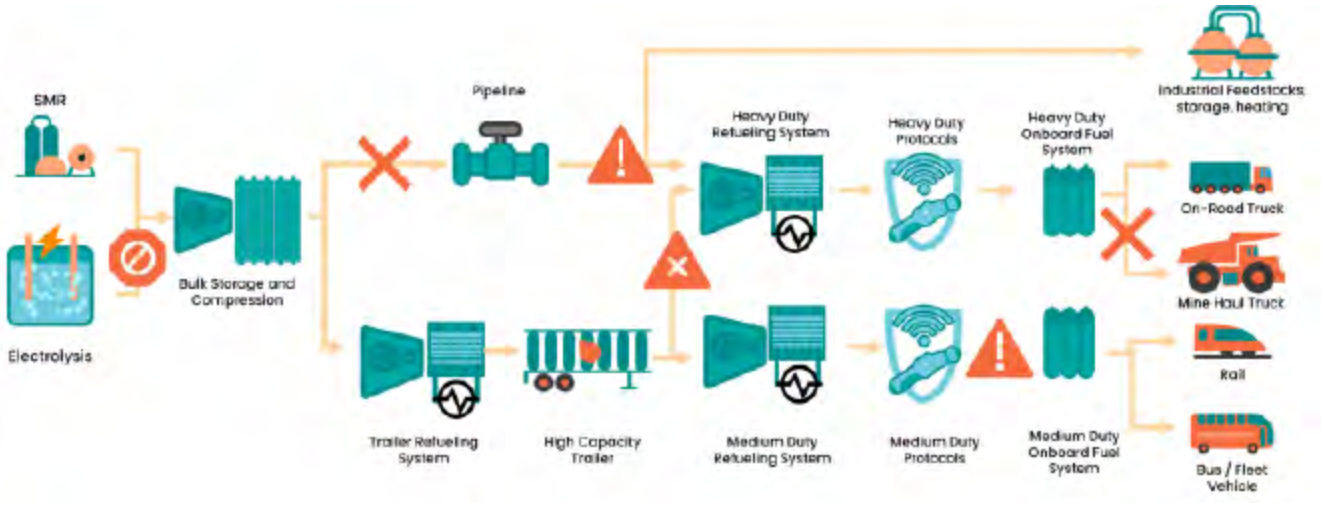


Figure 1. Lack of optimized supply chain interfaces leads to barriers in hydrogen infrastructure performance.

Lessons from Previous Projects

How do these challenges manifest as problems in hydrogen operations? Here are two real-world scenarios in light-duty vehicle (**LDV**) hydrogen refueling stations (**HRS**).

→ USE CASE 1: Underperforming storage tubes

In one HRS, alerts indicated that the hydrogen storage tubes were repeatedly reaching their purging cycle limit, far ahead of supplier projections. As each of these units cost hundreds of thousands of dollars to replace, finding the root cause of these mysterious discrepancies became a matter of some urgency. The operator combed through a year's worth of data, to identify similar shortcomings in the equipment's history. This search revealed that the purging cycle alerts were being tripped during maintenance sessions, not because of typical use patterns. Each time an attached pressure transmitter got disconnected by a technician during a depressurization event, the system counted this as a complete cycle, thus artificially shortening the tube's lifespan. The storage tube vendor did not account for the number of times panel maintenance would be required, thereby skewing the data. The operator needed a complete set of HRS time-stamped records to resolve this issue, which could be correlated with documented maintenance events.

→ USE CASE 2: Station unavailability

In another HRS, availability data was routinely reported to a governing body and subsequently presented on a website for consumer viewing. Consumers relied on seeing status updates online, but they often found when they arrived at the station that they were unable to refuel, due to trouble with the station's point of sale (**PoS**) system. The payment apparatus could be down for hours at a time. The operator had no remote access to the status of the PoS, and no way to synchronize payment events with HRS activity. The necessary solutions to these problems with the PoS were veiled by vendor secrecy. This resulted in mounting consumer frustration and business losses for the station.

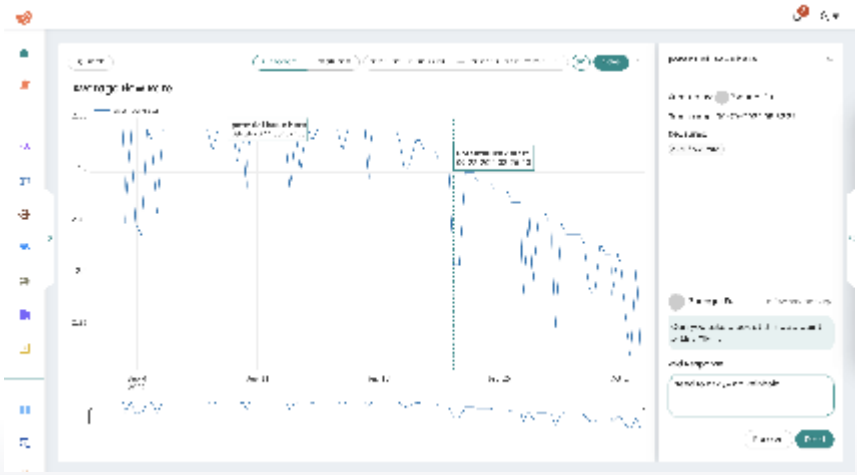
Issues like these have significant and long-lasting effects on station availability, OPEX, and overall operational performance. The problems are exacerbated when an asset manager doesn't have the proper tools for data collection and reportage, when downtime isn't fully documented, when data is lost between shift changes, when a dependency on subcontractors yields inconsistent results, when there is a lack of alert prioritization protocols, and when vendor privacy leads to inadequate event responses.

Solving Real Problems

So, what can we learn from the challenges in the previous examples? Using the elements of their APM, the engineers proposed corrective actions and began building solutions to remove inefficiencies from the system. This was a reactive solution to a problem rather than a **proactive** one, but it still solved the problem for their customer, and contributed to a knowledge base that might prevent similar snags in the future.

→ USE CASE 1: Mystery solved

In the first example, an Internet of Things (**IoT**) device was installed with the help of digital platform experts. The data gathered by this device saved a tremendous amount of time, as downloading HRS data from the programmable logic controller (**PLC**) had previously been very slow and labor-intensive. By relating the storage tubes' use cycles to actual maintenance events, necessary repair work could be differentiated from any low-pressure counts that might occur during normal operations. With a digital platform to collect the IoT device data, the operator could correlate all this information in one graph. The operator now had a complete data set of the tube's history to effectively negotiate with the vendor for a corrective action. This significantly reduced OPEX for current and future stations.



→ USE CASE 2: It takes two in tandem

Our second example found that the POS system did not connect properly with the HRS, and often failed to recognize valid credit card transactions. The internet connection to the PoS was inoperable from four to eight hours a day, preventing payment transactions, regardless of the station's availability. Furthermore, the two subsystems were operating on different clock sources. Changes were made to both systems to align the clock sources, and the PoS internet connection was upgraded, significantly enhancing performance. Once IoT devices were installed, the operations team could finally obtain complete data from both the HRS equipment and the payment provider. They cross-referenced their data with customer refueling events and customer complaints to establish a complete picture of the situation. Clear evidence of network interruptions could now be presented to the internet service provider. After these operational improvements were implemented, consumers and the station owner enjoyed the benefits of higher station availability.

These situations, while painful to experience, offered valuable insights. Taking issues and using them to examine the whole system, then codifying, communicating, and replicating the most optimal strategies throughout the business, allows us to take full advantage of what an asset performance management system can offer. By building upon these lessons and applying insights gathered through adverse experiences, LIFTE will be able to help the hydrogen industry make the leap from "firefighting" to "fireproofing."

Breaking Hydrogen Data Silos

Data from existing hydrogen projects is often collected in a limited, laborintensive, and "siloed" fashion. Before any useful analysis can begin, many time-consuming transfers, reformatting, and collation must occur. Analysts and engineers with hydrogen expertise are rare, making it difficult for projects to be designed appropriately from an end-to-end system perspective. This lack of expertise also hinders the ability to provide reliability and improvement analysis throughout the project's life cycle. The shared historical knowledge base will remain quite limited until operational data can be made available outside of proprietary company vaults. One of the most critical aims of any APM strategy is the controlled dissemination of pertinent information.

Figure 2 depicts the challenge that data silos cause in collecting project KPIs.

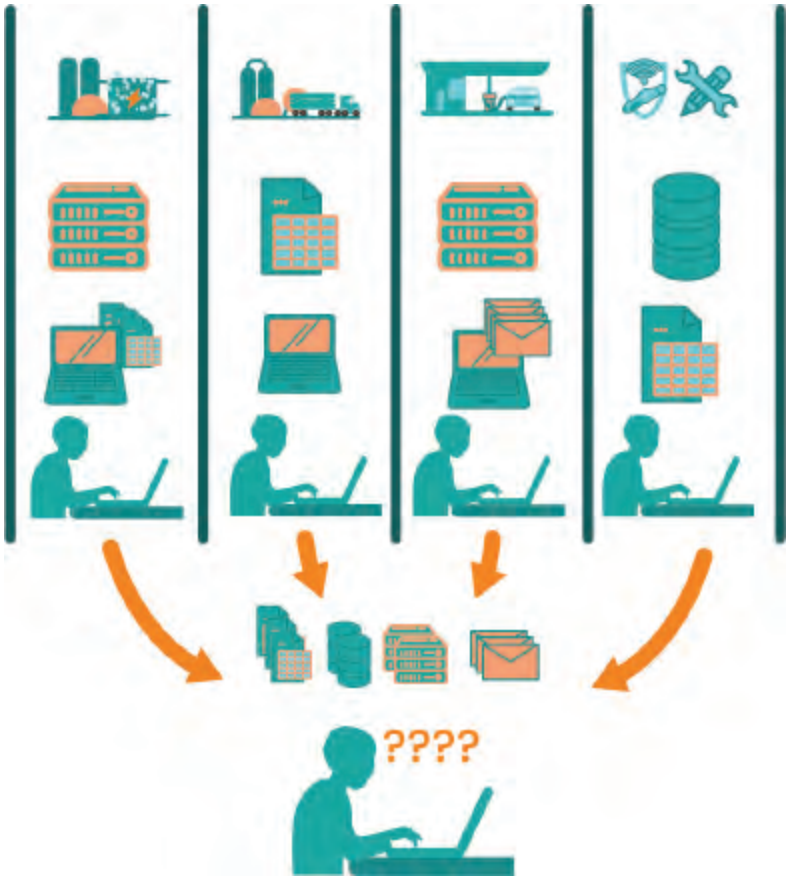


Figure 2. How data silos present barriers to effective APM

Performance, Cost, and Safety Implications

Monitoring equipment performance is essential to improving hydrogen infrastructure. Downtime for maintenance and unexpected failures can impact operations, thereby increasing costs. By incorporating accurate data collection, using expert analysis to identify systemic issues, and implementing predictive maintenance, an APM system allows for a holistic view of each hydrogen project and its specific needs. To maximize an asset's performance over time, a team needs to examine its operational history and gather relevant data in a quickly accessible form so that proactive or preventative measures can be taken as required. Standardization, consolidation, and transparency are paramount.

Cost in any commercial venture is a key factor in assessing bankability. For hydrogen projects, the cost is typically measured in terms of levelized cost, which factors in cost per installed kilowatt, cost per kilowatt-hour, cost per kilowatt-year, capital recovery, and fixed/variable operations and maintenance.

Hydrogen, like other fuels, presents safety challenges that must be recognized and reduced. With proper procedures and training, these hazards can be mitigated...but to help prevent accidents, many stringent and perhaps unfamiliar practices must be implemented and enforced. An APM should consider the need for security, supervision, and accessibility.

Asset performance management (**APM**) tools and methodologies improve the reliability and availability of physical assets by integrating data capture, visualization, and analytics. Deeper insight enhances performance, lowers costs, and promotes safety.

Asset Performance Management to the Rescue

An ideal APM system consists of three components: a tool for collecting operational data, a team of hydrogen experts that analyze this data to recommend corrective actions, and procedural strategies that are shared between all involved partners (vendors, suppliers, owners, technicians, and engineers).

An APM is more than just a toolset...it is a forward-thinking methodology, a schema of recognition and responsibility that encourages an attitude of collaboration throughout an entire team. It starts with careful and accurate data collection, continues through ongoing analysis by qualified experts, and eventually leads to suppliers and asset managers implementing recommended changes. Any improvements are tested, evaluated, and refined, and the process is repeated to move the project incrementally closer to its goals. An effective APM transforms the aforementioned "chicken and egg" problem into a program of ongoing enhancement.

Figure 3 depicts the APM system elements. The toolset consists of an Industry 4.0 digital infrastructure that collects all asset data via Internet of Things (**IoT**) devices.

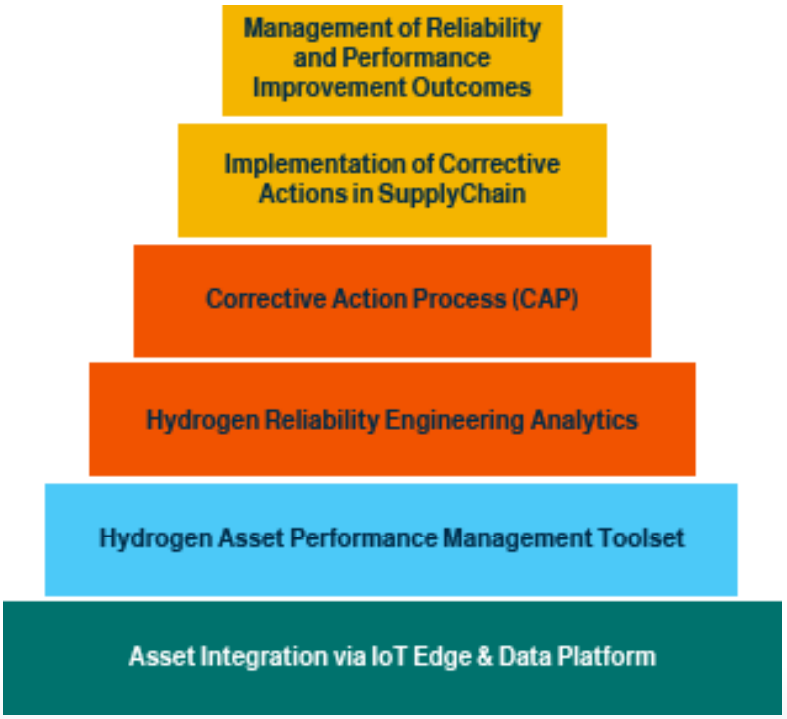


Figure 3. Optimal asset performance management system for hydrogen projects

Enabling an Asset Performance Management System

An effective asset performance management system is comprised of a digital platform, expert personnel, and a network of committed partners. The APM's collective effi ciency determines the rate and overall cost for every improvement.

A recent study published by Deloitte1. identifi ed several stages of maintenance maturity.

Any improvements will be costly and slow to establish if operations are supported only by manual data collection and reactive maintenance actions.

Operations that use **preventative maintenance** will slightly improve over the reactive mode, as maintenance events are regularly scheduled.

Condition-based maintenance provides more even more effi ciency, as maintenance is performed only under given condition sets.

After a period of operational data has been collected, **predictive maintenance** can be implemented, further enhancing equipment performance.

A more sophisticated approach uses advanced reliability data collection and analysis, combining scheduled maintenance processes with other operational measures to enact **prescriptive maintenance**.

Intelligent collaboration between suppliers, operational personnel, and safety experts, supported by large data sets and analytic tools, will afford the most rewarding use of an APM.

The efficiency of a continuous performance improvement cycle directly affects the rate of achieving project goals, as depicted in **Figure 4**. The optimal destination, from an operations perspective, is in the lower-left corner of this graph, where the cost and time of improvement are at a minimum.

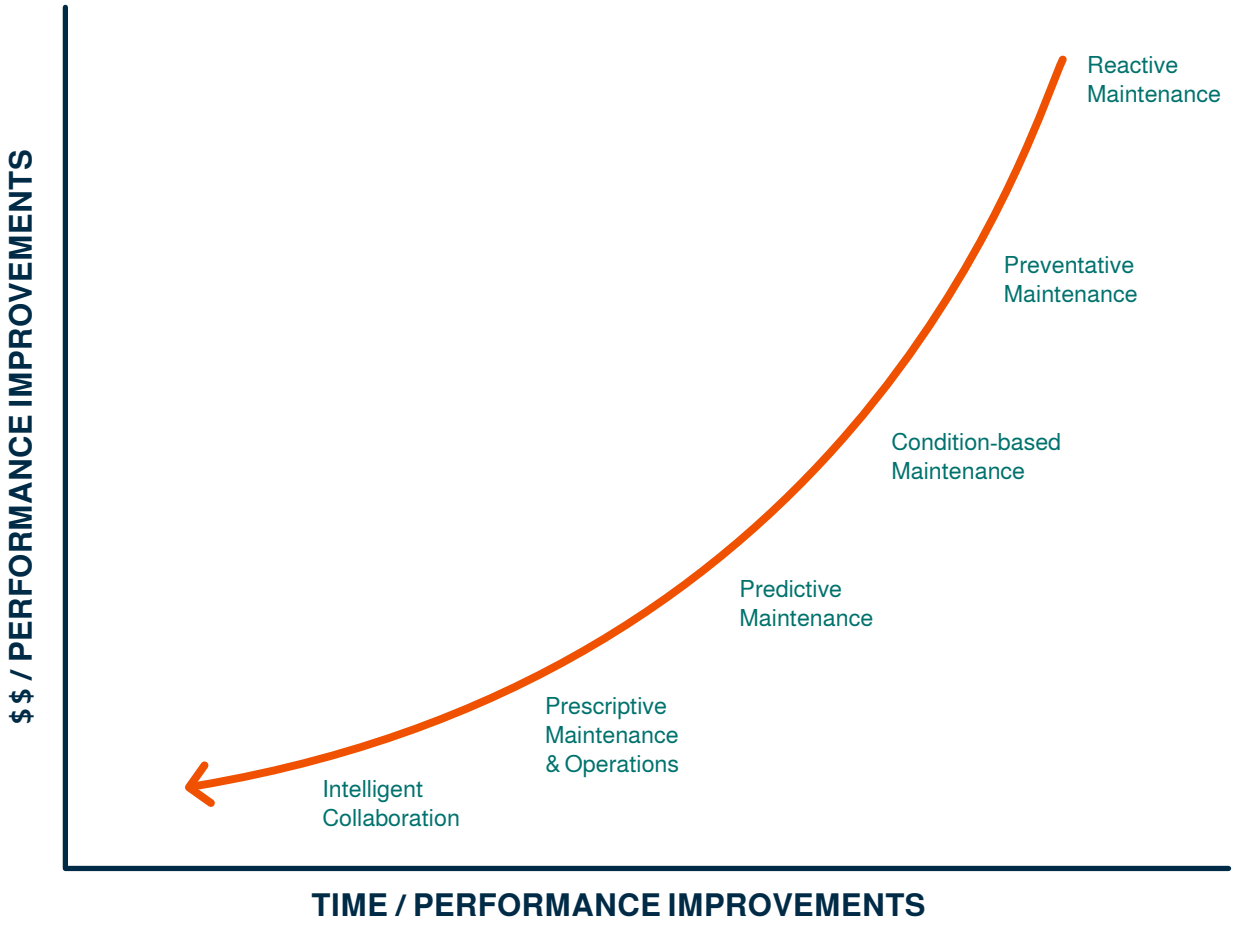


Figure 4. How efficient is your performance improvement process?

How LIFTE APM Can Help

With its extensive hydrogen expertise, LIFTE recognizes that asset performance management is essential to achieving overall project goals. LIFTE offers an APM tool that provides the capabilities of data capture, integration, visualization, and analytics. With the support of dedicated experts, this technology improves the reliability and availability of physical assets and allows for better assessment of KPIs.

LIFTE APM is a scalable and secure cloud-based platform that receives and stores all operational data. Users can easily observe, monitor, visualize, and analyze equipment data, respond to alerts, track updates, and enter additional information about related events.

When enough material has been collected and correlated, it is ready for analysis by reliability engineers and commercial specialists. These experts can focus their time and energy on establishing corrective actions and making concrete operational recommendations, rather than burning unnecessary hours on data collection and collation. Performance improvements can then be rapidly implemented, and the outcomes measured.

The third (and most essential) segment of the APM system is a network of committed and informed partners who are willing to implement corrective actions and other improvements. While the reliability and commercial analysts can provide educated recommendations, a system must be in place to ensure that the vendors and technicians correctly follow such directives. LIFTE establishes binding agreements with manufacturers so that our findings will yield actual results.

As depicted in **Figure 5**, LIFTE's APM tool is a single source for all project data. This APM was built by LIFTE hydrogen experts, expressly for hydrogen projects, and it ensures privacy for all projects and their users. It enables the collection of all asset data via Internet of Things (**IoT**) gateways. It includes webbased entry of various operational activities and specific modules to enable real-time monitoring, graphic visualization, and reliability analysis.

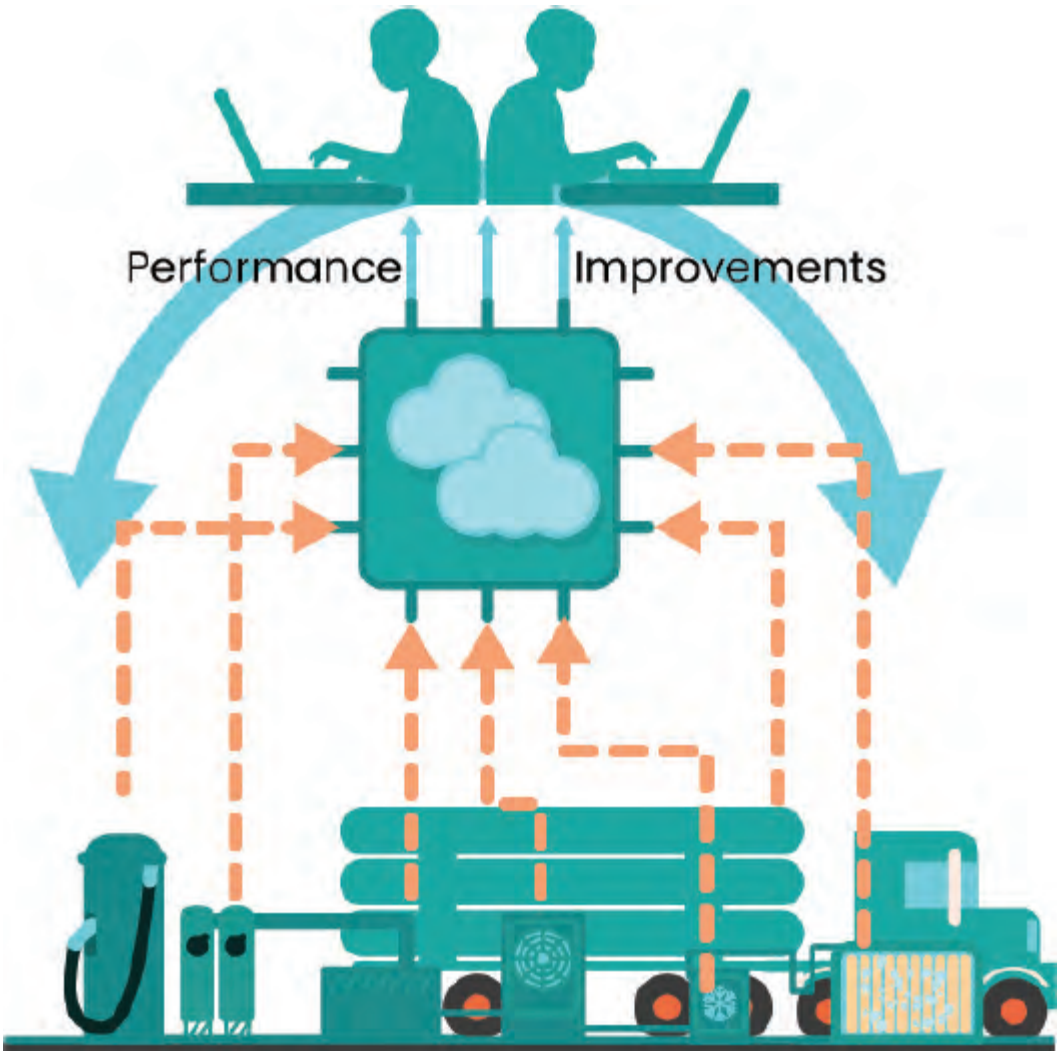


Figure 5. LIFTE H2's APM enables secure and private efficient performance improvements to hydrogen projects.

Call to Action

According to a Deloitte study[2], "oil and gas leaders rated the big data derived from programs such as APM as the most likely to provide the greatest business value." However, adopting asset performance management as a proactive tool for improving hydrogen projects has been surprisingly slow in the industry.

APM can accelerate the pace of hydrogen project profitability by enabling effi cient continuous performance improvements, as shown in Figure 6. Hydrogen asset owners, asset managers, developers, and even technology providers are encouraged to investigate how APM has the potential to transform the industry completely. LIFTE is in the ideal position to provide an optimal set of hydrogen-specifi c asset performance management tools and services.

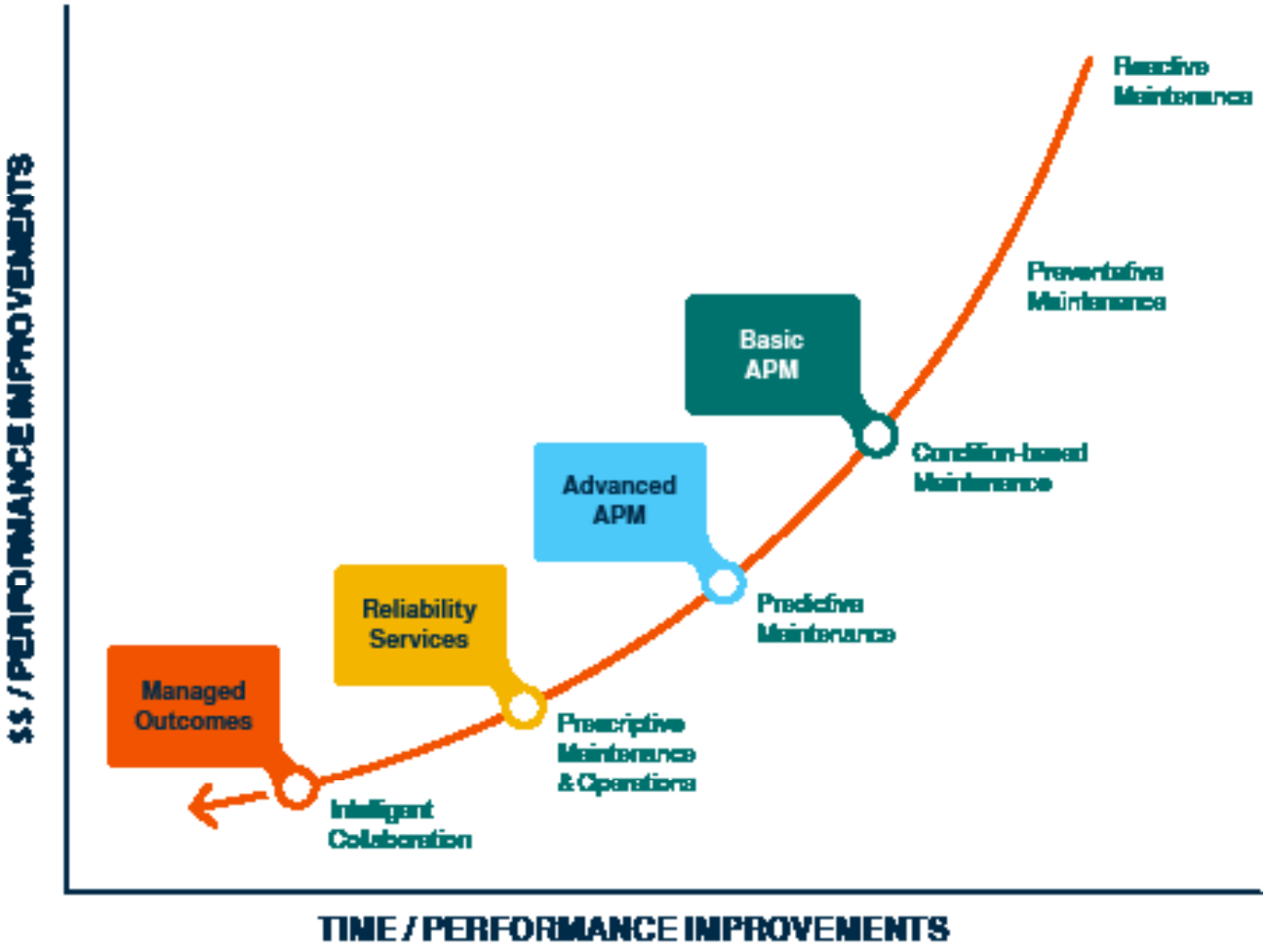


Figure 6. Asset performance management can enable effective continuous performance improvements for hydrogen projects

[2] Daecher, A., Dunn, P., Dipanker, D., & Sniderman, B. (2019, February 26). Asset performance management Driving value beyond predictive maintenance. Deloitte Insights

LIFTE is prepared to guide every aspect of hydrogen infrastructure development, and to secure the industry's future.

Contact LIFTE H2 today to learn more.

LIFTEH2.com

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