



Development Opportunities

Hydrogen Supply Chain & Operations



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Introduction

As part of the “Hydrogen-powered generator deployment” demonstration, the consortium team documented and discussed a number of operational and supply-chain learnings, which led to the creation of this report, with the aim to accelerate hydrogen adoption in the construction industry.

The consortium mapped the learnings to high-level industry goals and opportunity categories before analysing and prioritising the requirements to produce a set of opportunity recommendations for each.

The high-level industry goals are:

✂ **Standardise operations** - The industry relies on standardisation to ensure efficiency and to mitigate risks in often very complex projects. More specifically, the lack of standardisation means site teams cannot be certain that they have access to the skills and the knowledge to deal with the day-to-day operational requirements of hydrogen generators, let alone any unexpected situations that may arise.

🔗 **Create robust supply chain** - The industry invests heavily to ensure a secure supply chain to reduce any chance of disruption. Site teams not being able to do their work as a result of supply chain disruption has a direct impact on the project margin. Therefore, redundancy is a key consideration in any construction projects, and backup options must be available if any part of the supply chain fails.

💰 **Reduce adoption costs** - While the industry has the ambition to decarbonise, the high cost of hydrogen compared with diesel is discouraging companies from adopting, even though hydrogen is the only true emission-free fuel. Diesel, being a commodity, is often easily absorbed in the cost of project, but when the cost parity is too large, companies will have to seek money from alternative budget pools, such as innovation funds, which can be time-consuming, and hard to secure.

💡 **Promote knowledge** - All new technologies come with unknowns, which can often cause concerns amongst stakeholders. It is important to make hydrogen information easy to share and to digest amongst the industry, across all levels, allowing stakeholders to make informed decisions.

And the opportunity categories are:

- Project planning
- Health and safety
- Training
- Supply Chain
- Hardware

Key learnings

In order of priority, based on end-customer impact

Key Learning	Category	Industry goal
Lack of industry-recognised hydrogen generator operation certification	Health and safety	Standardise operations
Lack of hydrogen knowledge amongst the customer site team leading to resistance or uncertainties	Training	Promote knowledge
Lack of past energy data to enable confident hydrogen fuel forecasting	Project planning	Reduce adoption costs
Hydrogen generator critical spare parts not available	Supply Chain	Create robust supply chain
Customer site team not able to carry out basic hydrogen operations	Training	Standardise operations
Complex hydrogen generator refuelling process	Hardware	Standardise operations
Hydrogen generator error feedback not easy to understand	Hardware	Standardise operations

1) Lack of industry-recognised hydrogen generator operation certification

The Construction Leadership Council (CLS) has promoted the Construction Skills Certification Scheme (CSCS) as the de-facto certification scheme within the UK construction industry to provide proof that individuals working on construction sites have the appropriate training and qualifications for their jobs. CSCS, or any other recognised accredited scheme in the industry, does not currently have a program for hydrogen generator/asset operation, or hydrogen handling on construction site. This means construction companies are not able to easily verify supplier/contractor qualification, leading to challenges during the onboarding process, which is what the consortium team encountered at the beginning of the demonstration project when GRAHAM onboarded Hydrologiq as a supplier. Furthermore, the lack of an accredited certification scheme means there is no guarantee that the certified individual has in fact received the required level of training.

Opportunities

- Relevant industry bodies can work with key “practitioners”, as well as other stakeholders, in the industry to design a suitable certification scheme for hydrogen handling and hydrogen generator/asset operation.
- Companies such as Hydrologiq has developed their operational process based on a number of relevant regulations/guidelines as well as real-life experience commissioning and operating hydrogen generators. This can form the basis of industry-wide training programs for certification.

2) Lack of hydrogen knowledge amongst the customer site team leading to resistance or uncertainties

Hydrogen, being a compressed and flammable gas, does come with its set of safety requirements. However, if adequate health and safety measures are put in place, the risk is low, and impact on site operations can be minimal. Areas of knowledge to focus on include:

- Hydrogen benefits
- Basic hydrogen safety
- Generator compound setup
- Overview of generator operations

As an example, during the demonstration project, the consortium decided to run a “lunch and learn” session with site team. It was very well received, significantly helping alleviate many of their concerns.

Opportunities

- Hydrologiq, or similar companies, can create contents allowing customers to share key information with their site teams, at various points of the project. Online media can be made available.
- Hydrologiq, or similar companies, can include presentations on hydrogen information to the customer’s general site team as part of the planning process. Furthermore, they can provide online/in-person foundation-level hydrogen training for specific roles.

3) Lack of past energy data to enable confident hydrogen fuel forecasting

Detailed site energy consumption data is often not easy to get hold of for construction sites, due to a lack of technology or process. This is changing especially when projects are increasingly having to meet energy reduction/sustainability targets. However, the higher cost and the lack of wide availability of hydrogen mean much more detailed, long-term data is needed still to enable the kind of accurate forecasting required to avoid under or over-ordering of hydrogen. For this demonstration, Hydrologiq were able to install their Remote Monitoring System on the diesel generators before the hydrogen generator was deployed, which gave the consortium valuable data to help estimate hydrogen usage throughout the project. Had the consortium had more data, we would have had been able to give even more accurate estimation to further reduce the quantity of excess hydrogen ordered.

Opportunities

- Construction companies should incorporate energy monitoring into their long-term green energy transition plan.
- Construction companies can start modelling their hydrogen needs based on data relating to seasonality and site changes to get a full understand of the cost of transitioning. Hydrologiq's own data has shown that for some construction sites, winter energy consumption can double the amount of summer energy consumption, mostly due to heating requirements.

4) Hydrogen generator critical spare parts not available

New hardware assets often have specific spare part requirements that are not commonly available in the market, and hydrogen generators are no different. During the demonstration, the hydrogen generator had to be turned off for a period due to low coolant level, and the site had to be powered by diesel generators while Hydrologiq was waiting for the coolant to arrive from the manufacturer.

Opportunities

- Hydrologiq, or rental companies, should work with manufacturers to understand spare part requirements and to ensure there is an inventory that can be easily accessed.
- Hydrologiq, or similar companies, can work with rental companies to create a fully digital, shareable record of the generator's service history, to allow for more visibility and data insights.
- Hydrologiq, or similar companies, can develop predictive maintenance, based on IoT data, to understand part failure scenarios as well as general asset health, to pre-empt downtime.

5) Customer site team not able to carry out basic hydrogen operations

Hydrologiq provided enough safety training and instructions to enable GRAHAM's site team members to turn the hydrogen generator off for the weekend, and on again after the weekend. However, GRAHAM's team had zero interaction with the rest of the hydrogen setup, which would have been required if they had had to troubleshoot any issues. While some hydrogen operations do need to be carried out by specially trained engineers with deep understanding of hydrogen, the more basic operations such as isolating hydrogen supply can potentially be supported by customer's own site teams with a level of basic operator training. This will give customers more operational flexibility, and a higher level of control.

Opportunities

- Hydrologiq, or similar companies, can provide operational-level hydrogen training for specific roles in the site team, or even to other contractors. Assessment exercises should be used to ensure individuals are qualified for the roles.
- Hydrologiq, or similar companies, can provide essential engineering and safety equipment for specifically trained roles in the site team, e.g. ATEX-rated personal protective clothing and personal hydrogen detectors.

6) Complex hydrogen generator refuelling process

Refuelling hydrogen generators using Manifolded Cylinder Pallets (MCPs) is currently a manual and complex process, especially if the generator must remain in operation during time of refuelling. It typically involves carrying out a sequence of isolation, depressurisation, connection and leak-checking tasks multiple times. The specialist knowledge and skills required to do this safely and correctly means it can constrain Hydrologiq's ability to scale its technical operation, and also reduce refuelling flexibility for customer's site teams. While future hydrogen storage solutions will likely supersede the use of MCPs, it is important that the supply chain can leverage such practical experience to inform product development.

Opportunities

- Hydrologiq, or similar companies, to work with supply chain, including storage solution providers, to design a hydrogen generator refuelling solution that would allow "plug-and-play" connection for safer and quicker operations.

7) Hydrogen generator error feedback not easy to understand

New hardware assets often come with new behaviours that are different from technologies they are replacing, and hydrogen generators are no different. During this demonstration, when the generator experienced a technical issue, the error message was not easy to understand. A clearer message would have made diagnosis easier and quicker.

Opportunities

- Manufacturers should improve remote diagnosis capability, to either remove the responsibility from operators entirely, or at least help better guide operators during diagnosis with real-time input from the remote technical support team.
- Hydrologiq, or similar companies, can work with supply chain to feed back their own or customers' operational experience to manufacturers to help them improve immediate user experience and to design future user interface standards.

Final remarks

While this report has focused a great deal on what the supply chain can do to reduce barrier to adoption, the overarching economic factor of cost will ultimately determine the pace of hydrogen adoption. Construction companies would like to see the cost of using hydrogen to be under 2x the cost of using diesel. While, through programs like the Hydrogen Allocation Rounds (HARs), the UK government has been driving the growth of hydrogen production, it has been widely recognised in the industry that financial subsidies for end-use would also be critical for the adoption of hydrogen to take off. This is the only way the entire end-to-end UK hydrogen supply chain can develop fast enough to help meet UK's Net Zero ambition.

