Low Carbon Hydrogen Supply 2 Competition Application Form Stream 2

Proposal Summary

1. Name of Applicant Organisation This should be the lead organisation/co-ordinator for the proposed project
H2GO Power

2. Project Name
SHyLO: Solid Hydrogen at Low pressures

3. To which technology theme(s) are you applying? Please refer to Section 2.3 of the Stream 2 Guidance Notes/ ITT for further information on themes. Select the most applicable theme(s) for your technology.
Hydrogen Storage and Transport Solutions

4. Stream 2 Estimated Start Date
* 01/11/2021

5. Stream 2 Demonstration Project Duration (months)
1 24

6. Stream 2 Estimated End Date
* 31/10/2023

7. Stream 2 Total Demonstration Project Costs (£) Please enter the total amount of BEIS funding for Stream 2 that you are applying for excluding VAT.
4347217.05

8. Please give a brief description of the project. (Maximum 400 words)

The UK government has identified the opportunity for the use of hydrogen as a NetZero energy source, replacing the use of natural gas as a fuel. The key challenges surrounding NetZero energy sources include the intermittency of its availability, which highlights energy storage is more important than ever. Low-pressure solid-state hydrogen storage provides an interesting alternative to other methods, such as compressed gas storage.

Green hydrogen can be produced during periods of high renewable electricity generation; therefore, it is unlikely that hydrogen can be produced at the same rate as is commercially required for hydrogen as fuel gas or other energy storage requirement. Therefore a storage method is required to store hydrogen for periods of low generation to provide a buffer.

Currently, compressed gas technologies are being deployed across the UK as a relatively easy method of storing gas for medium-to-long durations, utilising underground geological facilities and pressurised vessels. The ease of its input/output of gas makes it a reliable method of gas storage, however, this method comes with its own challenges. Pressurised vessels on operational sites pose safety challenges, efficiency limitations, high costs at scale associated with compression, and require large areas of land to store.

This project will design and build a modular hydrogen storage solution with the H2GO Power reactor which is proven and certified, storing 1kg of hydrogen. The H2GO product provides a solution where compressed gas is not feasible. The technology can achieve volumetric storage densities of up to 50-100gH2/L, higher than liquid and gaseous state hydrogen storage, thus needing less floor space for storage.Additionally, the technology stores hydrogen at ambient temperatures and pressures, making it a safer, lower-cost, and more efficient alternative to high-pressure storage solutions onsite for long-duration storage. This has significant cost savings (removing compression or cryogenic cooling costs), space savings and is safer; removing a lot of regulatory requirements, and hydrogen can be stored in periods of days to months providing the security of supply required.

This first construction of a modular prototype is critical for the technology evaluation at scale to establish a viable solution and a market offering in the future.The program of works will look to integrate 30 hydrogen storage reactors into a shipping container with the associated heat management and process safety controls to confirm the solution. This solution will then be integrated into the EMEC network of hydrogen assets to assess its performance and commercial viability.

9. Please explain why public sector funding is required to take this innovation forward. (Maximum 300 words)

H2GO Power has the technical expertise and experience with low-pressure hydrogen storage solutions and requires partners with use expertise and cases to support the design, integration, and scaleup of multiple units of the solution in a modular format, hence managing out the associated risks. Having discussed with the consortium, it became clear that the experience with the hydrogen economy, use cases and designing and building modular storage solutions would benefit and accelerate the program.

Without securing public funding, the pace of progress will certainly slow down. As this is a first of its kind and an unproven modular solution, the risks to outside investors from other financing methods are high. Our activities would be limited to carrying out further computational designs and smaller-scale testing, without the ability to reach the market at the right time and the bridge in development will remain essential prior to raising funds from venture capitals or corporates to realise the potential of the technology. Also, delays in progressing to the feasibility phase in a timeframe that enables us to maintain our innovative and competitive edge will reduce our chances for successful commercialisation. Securing public funding immediately, on the other hand, will enable us to take the partnership with the MTC, EMEC, ARC, Autodesk, and HSSMI to the next level, ensuring a commitment to scaling the technology to the volumes that enable commercialisation, and establish contract manufacturing collaborations, as well as bringing in necessary technical expertise to the team with the best value for money. Funding will also advance the H2GO business by adding a new dimension of innovation to our portfolio that can yield more patents, demonstrate power systems that facilitate a unique positioning to deliver long-duration emission-free energy storage that is competitive with other existing solutions.

Eligibility Criteria

1. Technology Categorisation The technology must be in scope of one of the themes described in Section 2.3 of the Low Carbon Hydrogen Supply 2 Stream 2 ITT.

	Yes	No
Is the technology in scope?	X	

2. Innovation and Technology Readiness This Competition is to support the development of innovative Low Carbon Hydrogen supply solutions. It is to support the development of technologies that are not yet commercial from Technology Readiness Levels (TRLs) 6 to 7 at the start of the projects. (Further information on TRLs can be found in Appendix 1 of the Low Carbon Hydrogen Supply 2 Stream 2 ITT).

	Yes	No
Will your technology / system be at TRL 6 – 7 at the start of the project?	X	

3. Technology Scope The focus of the Competition is to support the development and demonstration of innovative hydrogen supply solutions as detailed in Section 2.3 of the Low Carbon Hydrogen Supply 2 Stream 2 ITT. Exclusions: Funding will not be provided for projects where the technology development focuses on: Upstream energy production (power and fossil fuel extraction) End-use technologies (for example boilers, and other hydrogen appliances) Technologies where the core technology has previously been operated commercially (in UK or Internationally) Power generation from hydrogen (for example fuel cells or CCGT) Gas-grid systems (onshore) Novel CCUS technologies which aren’t intrinsically linked in the hydrogen production process

	Yes	No
Does your application exclude costing/budget for any of these technology exclusions (listed above)?	X	

4. Project Status BEIS is unable to fund retrospective work on projects.

	Yes	No
Can you confirm that your application does not seek funding for retrospective work on this project?	X	

5. Additionality Projects can only be funded where evidence can be provided that innovation would not be taken forwards (or would progress at a much slower rate) without public sector funding.

	Yes	No
Can you confirm that this project would not be taken forward (or would progress at a much slower rate) without public sector funding?	X	

6. Contract Size Demonstration (SBRI) contracts for up to £10m per project with a total of £30m across the Stream 2 competition are available, with a maximum of £5m for engineering design. Stream 2 Projects must be completed by 1 February 2025.

	Yes	No
Can you confirm the funding requested from BEIS for your project cost for Stream 2 will be equal to or below £10m with a maximum of £5m for engineering design and is 100% of eligible project costs?	X	

7. Eligible Project Costs SBRI is aimed at organisations working on research and development (R&D) of an innovative process, material, device, product, or service prior to commercialisation. Funding is available for R&D activities only, including related dissemination activity. Projects requesting funding for commercialisation activities are not eligible. The full list of eligible project costs is set out in Appendix 3 and outlined in Section 5 of the Low Carbon Hydrogen Supply 2 Stream 2 ITT. BEIS must fund 100% of eligible project costs, no match or in-kind funding is allowed.

	Yes	No
Can you confirm that requested funding is for eligible costs and BEIS will fund 100% of those costs?	X	

8. Project End Date Projects must be completed and approved by BEIS by 1 February 2025. Projects need to allow time for the BEIS monitoring officer to review the project; this process can take up to a month and should be included in your project plan.

	Yes	No
Can you confirm that the project will meet the specified project end dates?	X	

9. Risk Benefit Sharing The sharing of risks and benefits is an important aspect to the SBRI approach. Projects receive financial support and retain any intellectual property generated, with certain rights of use retained by BEIS. Project outputs are also expected to be shared widely and publicly and project teams are not permitted to include profit in the eligible project costs.

	Yes	No
Do you agree to this approach?	X	

10. Delivering Multiple Projects If project consortium member(s) are part of multiple successful applications, they must be able to deliver on them and they must not have applied for funding for the same piece of work more than once.

	Yes	No
a) If you or your consortium are part of multiple successful applications, would you be able to successfully deliver all projects if necessary?	X	
b) If you or your consortium are part of multiple successful applications, could you please confirm that you have not applied for funding for the same piece of work more than once?	X	

11. Multiple Applications If you intend to submit multiple applications, you must comply with the following limits of entry into the competition: Lead organisations may only enter one application into the Stream 2 competition as the project lead. A technology provider/OEM are limited to one application for a particular technology/solution requiring development.

	Yes	No
a) If you are the lead organisation, as the project lead can you confirm only one application has been submitted for stream 2?	X	
b) If you or your consortium are part of multiple applications, could you confirm that the main technology being developed is different in each application i.e., only one application per particular OEM's technology has been submitted?	X	

12. Prompt Payment For contracts of £5m or more, if you intend to use a supply chain for this contract, you must demonstrate you have effective systems in place to ensure a reliable supply chain. If the application value is over £5m, and you intend to use a supply chain, please complete the document in Appendix 4, Declaration 7 of the Low Carbon Hydrogen Supply 2 Stream 2 ITT.

	Yes	No
If your contract size is greater than £5m, can you demonstrate you have effective systems in place to ensure a reliable supply chain?	X	

Contact and Lead Organisation Details

1. Primary Contact Details

[This information has been redacted]

[redacted]

[This information has been redacted]

3. The registered address of the Lead Organisation

Address Line 1	Translation & Innovation Hub
Address Line 2	Imperial College White City Campus
Address Line 3	84 wood lane
Town/City	London
Postcode/ Zip Code	W12 0BZ

4. County (If Applicable)

London

5. UK Region (If Applicable)

London

6. Country

United Kingdom

7. Project Location: Is this registered address the location where the main activity of the proposed project will be carried out? You will be asked to provide project location details in the separate BEIS Project Cost Breakdown/ Finance Form.

Yes

8. Lead Organisation Type

Private Company

9. Lead Organisation Size

Small Enterprise <50 employees

10. Number of employees in Lead Organisation (including directors)

10

11. Lead Organisation Company Registration Number

09139481

12. Turnover Amount of Lead Organisation (in most recent annual accounts) Please include the currency of the amount in your response.

[redacted]

13. Turnover Date (in most recent annual accounts)

* 31/07/2020

14. Balance Sheet Total of Lead Organisation (total assets net of depreciation) Please include the currency of the amount in your response.

[redacted]

15. Balance Sheet Date (total assets net of depreciation)

* 31/07/2020

16. Is the Lead Organisation able to recover VAT?

Yes

17. Lead Organisation Maturity

6-10 years

18. How is the lead organisation currently funded? (Choose all that apply)

	No Funding	Founders (including bank loans)	Friends and Family	Public Sector Grants	Angel Investment	Venture Capital	Private Equity	Stock Market Flotation
		X	X	X	X			

19. Lead Organisation Status: a brief introductory description of the company. (Maximum 400 words)

H2Go Power is a UK-based and pioneering clean-tech SME founded in 2014. An award-winning spin-out company from the University of Cambridge, and further supported by Imperial College London. Our mission is to develop hydrogen-based solutions for renewable energy storage for zero-emission, safe and reliable power supply. Our patented technology portfolio is highly scalable, widely applicable across the hydrogen value chain, and can bring a profitable social and environmental impact to its users and society in general. H2GO is a woman-led company founded by CEO Enass Abo-Hamed, also a Fellow at the Royal Academy of Engineering.

The company currently has 10 employees and access to a fully equipped lab and offices to conduct all required development, based at the Imperial College Innovation Hub in White City, London. Our staff are highly specialised in both R&D and commercial aspects with a proven track record, which together with our IP portfolio can ensure a wide market uptake. We have received £5.2 M funding so far, from private investment and multiple funding bodies, including Innovate UK, BEIS, Royal Academy of Engineering and Climate KIC accelerator program. Furthermore, the company has received excellent feedback and interest in its technology from key industry players, such as Siemens, Schlumberger, BP, EVONIK, Lockheed Martin, Rolls Royce, Snam, Centrica, and Enel.

Our technology and team have received numerous awards, grants, and recognition worldwide, including:
i) The Financial Times recognised our CEO as one of the Top 100 Influential Women in Engineering in the UK and Europe
ii) World Economic Forum recognised our CEO as an extraordinary young scientist
iii) MIT Technology Review included our CEO in their "innovators under 35" list and awarded her as visionary of the year
iv) H2GO Power received the best energy start-up award at the Global Hello Tomorrow Summit and others

Our CEO is regularly invited as a keynote speaker at international forums and participates in high-impact roundtable discussions on clean energy, energy security, and women entrepreneurship in tech. Please watch her TEDx talk (https://www.ted.com/talks/enass_abo_hamed_changing_climate_change) and a video demonstrating the application of our technology in a hydrogen-powered drone on the BBC here: https://www.youtube.com/watch?v=q4Oh21r6FF8.

20. Does the lead organisation have a parent company? (If yes you will be asked to provide details)

No

Criterion 1: Innovative Low Carbon Hydrogen Supply Approach

Criterion 1: Innovative Low Carbon Hydrogen Supply Approach This criterion will be used to assess the novel approach to Hydrogen Supply in the proposed demonstration project. Applicants should have already determined in outline, that their Hydrogen supply solution is technically feasible and meets, or has the potential to meet, the relevant industrial regulatory requirements, including health and safety and air quality. In their responses under this criterion, applicants are expected to justify that their project is sufficiently proven in terms of technical and regulatory feasibility to warrant funding for their proposed pilot demonstration. In making these justifications, applicants should reference any outputs from their earlier work, identify where further development is needed to confirm feasibility and explain how the pilot demonstration will be designed and executed to provide these confirmations. Highest marks will be awarded to the innovative low carbon hydrogen supply solution that best describes the design and the work expected to be carried out through the project. In the text box below, the applicant should: Describe what is innovative about your solution. Clearly state the aim of the demonstration trials proposed by, for example, stating what levels of performance constitute a successful trial. Describing how and why the demonstration will accelerate the development of low carbon hydrogen. Provide the latest evidenced justification for the technical and regulatory feasibility of the proposed demonstration pilot. This should reference any relevant earlier work, including engineering designs, engineering calculations and the outputs of other feasibility research and recapitulate the innovative nature of the solution. Clearly set out where there is remaining uncertainty about technical and regulatory feasibility and explain how your demonstration pilot will address these uncertainties. (Weighting for Criterion 1 – 5%) (Maximum 2,000 words)

For over 6 years, H2GO Power has been developing a novel hydrogen storage solution utilising solid-state materials to enhance performance and safety characteristics, meeting the demands of commercial operation. H2GO have been honing the technical performance of the heat and hydrogen management systems, as well as developing an innovative Artificial Intelligence (AI) platform to optimise the operation of the full energy storage system and to advance the state-of-the-art. The business is now ready to develop a commercial-scale demonstrator. Figure 1.1 in the Criterion 1 Appendix document explains how H2GO's technology works.

The innovative aspects of H2GO's solution offer several advantages over the main competitors currently in the large-scale energy storage market, these being:
• Battery storage technology – is effective for short duration storage but has a relatively short lifecycle. However, hydrogen can be stored using H2GO's solid-state technology for extended periods of time and offers 3x the lifetime of battery solutions, at a ⅓ of the cost.
• Compressed gas and liquid hydrogen storage – pressurised solutions store hydrogen up to700 bar, whereas solid-state storage uniquely operates at near-ambient pressures (~1% of compressed gas). It also operates at near-ambient temperatures, eliminating the cooling required by cryogenic liquid storage. Solid-state hydrogen storage has a larger volumetric energy density range (50-100 gH2/L) than both compressed gas and liquid storage alternatives (30-40 gH2/L) resulting in higher storage efficiency. The low-pressure requirements of solid-state storage solution eliminates any potential fast vaporisation which can lead to catastrophic failures, improving the full system safety, increasing commercial accessibility.
• Pumped hydroelectric storage, storage of hydrogen in caverns – the H2GO solution offers advantages over large scale storage solutions currently employed. Pumped hydroelectric storage operates at very large scales but requires significant costly infrastructure development, and environment requirements only found in limited geographies. Storage of hydrogen in caverns is similarly limited.

The H2GO solution utilises a standard ISO shipping container, ensuring that it is modular, scalable, and easily deployable, making it suitable for almost any environment. The benefits of H2GO's solution vs the state-of-the-art is further explored in Criterion 2a.

Further innovation is embedded within the system through the incorporation of an innovative AI (HyAI) platform which uses algorithmic prediction of the generation/storage/demand environment to optimise the operation of the H2GO storage system. Figure 1.2 in Criterion 1 Appendix attachment shows how the HyAI system interacts with the wider hydrogen infrastructure, whilst Figure 1.3 illustrates how the HyAI platform works.

HyAI addresses the unique operational challenges that come with the production, storage, distribution and conversion of hydrogen as a commodity. Existing technologies in the market (e.g. Arenko's licensed software platform) focus on lithium-ion battery storage optimisation. However, the hardware characteristics and use cases for hydrogen differ significantly from batteries. Consequently, an asset management platform that specialises specifically in hydrogen is well placed to meet demand from the rapidly growing hydrogen industry. A key advantage and innovation of the HyAI platform is that it is highly modular and scalable, complimenting the scalable nature of the storage system itself. It can easily be configured for a wide variety of use cases, from the simple hydrogen value chain shown in Figure 1.2 in Criterion 1 Appendix document, to complex systems involving a variety of assets across multiple sites, all whilst maximising the systems performance.

H2GO will demonstrate and trial their technology at EMEC's Eday site in the Orkney Isles, integrating a 1MWh containerised solution with the existing hydrogen infrastructure, to demonstrate a large-scale power-to-gas system. The trials will measure and validate a series of performance characteristics which, if successful, will prove H2GO's technology and are listed below:
• Validate benefit to cost ratio against competitor technologies, i.e. levelised cost of hydrogen (in terms [redacted]
• Validate >100 cycles of operation with storage material capacity degradation of <0.01% per cycle
• Validate technical performance, measured by flow rates, achieving [redacted] per reactor sustained for >5h.
• System efficiency >70% (energy in vs energy out for full-cycle)), comparing energy required to heat reactors (H2 desorption), energy required to cool the reactors (H2 absorption) and base operation.
• Validate peak flow in <30mins for cold start.
• Transient response 10%-90% and 90%-0% of 15mins
• Purity of hydrogen output >99.95%

• Validate user testing of HyAI dashboard (used to help the site operators understand/visualise the HyAI model's real-time decisions)
• Integrating the SHyLO and HyAI system with assets at EMEC's Eday hydrogen production site
• Live field testing HyAI which involves using the cloud-based model to control the on-site hardware assets in real-time. Assessed across: reliability; decision safety; decision quality
• Gross PnL from system operation improved by >10% using HyAI against control baseline

Perceived safety concerns with large-scale production, storage, and use are major barriers limiting the development of the hydrogen economy, alongside challenges related to achieving certification. H2GO's system is inherently safer than other large-scale hydrogen storage solutions and the project will prove this, ensuring that legislative challenges are addressed throughout. The following safety features/advantages and project components will facilitate this development of low carbon hydrogen:

• H2GO's system does not utilise high-pressure storage, the main aspect of hydrogen storage that can lead to safety issues.
• Demonstrating H2GO's solution and disseminating the results will address the public's perception of large-scale hydrogen storage being dangerous. In this solution, if a vessel was to rupture, the hydrogen would leak out slowly rather than be released instantly, which is a major safety concern for compressed gas solutions.
• It can be rolled out across a diverse range of sites due to its lower operating pressure. Sites such as urban environments, inside buildings, oil and gas platforms. All are suitable locations for this technology, widening the opportunities for utilising low carbon hydrogen
• The solution requires less spacing between storage and other functions (production, use etc.), enabling deployment in space critical sites, key for accelerating the development of large-scale refuelling stations.
• Abbott Risk Consulting (ARC) will subject the integrated system, including HyAI, to rigorous system safety engineering to ensure that the relevant hazards/risk control measures are identified and implemented. This will be aligned to the relevant legislation and regulatory stakeholders to ensure that a commercially viable system can be rolled out.

The H2GO solution also results in a more commercially viable storage solution which facilitates the deployment of large-scale hydrogen systems:
• H2GO will demonstrate that the system can provide hydrogen at cost parity to its competitors, increasing the commercial accessibility of green hydrogen.
• By operating assets intelligently, the HyAI component, maximises the monetisation of hydrogen systems, thereby improving the commercial viability of large-scale green hydrogen projects and reducing the price of green hydrogen.
• Hydrogen production and storage hardware have unique positioning requirements (e.g. electrolyser start-up time), so better planning improves their operation. Moreover, these assets have longer operational horizons than other storage technologies such as lithium-ion batteries, meaning predicting further into the future is necessary for smart decision-making.

To date, H2GO have gone through multiple R&D cycles and scaling to get its hydrogen storage technology optimised in a full-scale modular unit.

In 2019 H2GO designed and manufactured a scale-up prototype storage reactor that could store 300g [redacted]

performance operational parameters optimised for hydrogen storage and release. This was also CE marked as a pressure vessel. In 2020, H2GO developed a 'Hydrogen Battery' (Figure 1.4 Criterion 1 Appendix attachment). The 10kWh reactor was integrated into a fully autonomous, small-scale power to power development unit, with a 2.3kW electrolyser and 1.2kW fuel cell. This was demonstrated on the BBC Royal Institution Christmas Lectures - 2020: Planet Earth - A User's Guide: 3. Up in the Air. Recently, H2GO scaled up the reactor technology further, achieving 1kg of hydrogen storage (33.3kWh) at 10 bar (shown in Figure 1.5), being designed according to pressure vessel standards and UKCA requirements, with medium production volumes in mind. Its integration into a commercial scale stacked unit will be the focus for this project.

Supporting the development of the storage solution, H2GO Power have been developing the HyAI platform through an Innovate UK project (October 2020 to June 2021), in collaboration with the European Marine Energy Centre (EMEC) and Imperial College London. The modelling approach underpinning the HyAI platform was developed by a cross-functional team of Tier 1 experts. Following initial development work, the team productionised the platform, which automated everything from data storage to real-time, on-demand decision-making. It has been designed to ensure security and scalability, both in terms of cost-effectiveness and performance. The platform was validated by integrating it with the 'hydrogen battery', which demonstrated the ability of the HyAI platform to integrate with and control the system in real-time, including considerations such as response latency and safety control. Two case studies were carried out using historical data from Whitelee and Kilgallioch wind farms to test and validate the HyAI platform operation. The results (shown in Figure 1.6 and Figure 1.7

in Criterion 1 Appendix attachment) indicate that HyAI improves the gross profit generated by storage assets by over 40%, relative to a baseline control. Moreover, simulations demonstrated that using HyAI de-risks future hydrogen production contracts that must be fulfilled cost-effectively.

There is an acknowledged gap that exists in meeting regulatory requirements and ensuring a robust safety system is embedded within the demonstrator. Specific examples include:
[This information has been redacted] [redacted]
• The system-level – ensuring that comprehensive hazard controls are in place to ensure safe operation is an aspect of the system that the project team needs to explore.

To address these aspects, H2GO are planning to hire technical experts to bring new skills to the company increasing the expertise of the business regarding safety and regulation. Furthermore, ARC will specifically address the regulatory uncertainties. They will support and advise from the design stage, to the commissioning of the demonstrator, to testing on site at EMEC, ensuring that necessary hazard controls are embedded in the final system design to achieve certification.

From a technical perspective, understanding the optimal management of heat within the system will be key. Heat management is required to store and release the hydrogen. To be a cost-effective and competitive energy storage solution, this needs to be as efficient as possible to reduce parasitic losses and increase performance and ROIs. To address this at the design stage, MTC will support with Multiphysics simulations to iterate different design decisions then optimise the chosen design, to reduce heat losses, pressure drops and assess heat recuperation options.

With regards to the HyAI platform, the main uncertainties and associated plans to address these are summarised below:
• Handling extended connection outages: options to be explored with the most suitable being trialed during demonstration
1. yielding back control to a manual operator
2. using a light-weight version of the model that can run on the edge device to optimize the operating schedule during outages
• Refining human/computer interaction with the HyAI model: a prototype UI enables operators to visualize and understand HyAI decisions. The next step is to enable operators to control the assets. This introduces questions of human/computer interaction safety that will be explored through user testing during the demonstration phase.
• Data privacy and access: a key regulatory consideration, as some data is publicly available and open-source, but other data sources are client-controlled and not always clear how available it will be. EMEC has agreed that this data will be available to H2GO for this project, and H2GO will explore strategies and methods to approach data acquisition from clients moving forward.

Successful demonstration of H2GO's system will catalyse and accelerate the deployment of low carbon hydrogen through increasing the commercial viability and safety of large-scale green hydrogen projects, whilst reducing the price of green hydrogen.

Please enter the core content of your response to this criterion in the text box. Applicants who wish to support their response with figures (e.g. illustrations/PFDs/graphs/charts/schematics) may attach these as part of the Referenced Figures single attachment (max. 20MB allowance provided) in the Further Information section of this application form. Applicants must clearly label the figures in the attachment and reference the figures in their response within the text box to ensure they are assessed. Any further text submitted within the Referenced Figures single attachment will not be assessed. Additionally, applicants may use evidence of relevant earlier work (limit to 20 pages), all assumptions / calculations / references to respond to this criterion which should be detailed in the attachment below and will be assessed. To complete this section you may upload evidence of relevant earlier work, all assumptions / calculations / references with your application. Max upload size per file – 20MB Max number of files – 1

- File: Criterion 1 Appendix.pdf - Download

Criterion 2: Performance and Cost Reduction of the Hydrogen

Supply Solution

Criterion 2a: Performance of the proposed solution The applicant should provide a detailed explanation of the performance of the proposed hydrogen supply solution and compare it to the current state of the art solution and the applicable counterfactual parameters (see Appendix 2 of the Low Carbon Hydrogen Supply 2 Stream 2 ITT), define the assumptions made and the basis for those assumptions. Describe the impact of different operating conditions, for example if the hydrogen supply solution is operating at a variable throughput. Details of the impact on the efficiency of the process should be presented including impact on OPEX costs, longevity and performance. In the text box below, applicants should: Provide details of the performance and flexibility of the proposed solution at the demonstration site and when rolled-out across multiple, suitable sites in future. Explain how the demonstrator will be used after this project has been completed or indicate the decommissioning strategy. Provide evidence of how and why this solution allows performance benefits when compared to the current state of the art and applicable counterfactual parameters. Provide an explanation of the technical barriers to deployment and description of the plan during the demonstration to overcome/scope-out/understand these barriers better. Provide an overview of any relevant performance validation that has previously been conducted. Applicants should detail the approach of the performance validation process that will be followed during the demonstration phase. Provide an explanation of why it is believed that the hydrogen supply solution will be acceptable to the market in terms of ease of installation and reliability (Weighting for Criterion 2a – 10%) (Maximum 2,000 words)

H2GO have developed a solid-state hydrogen storage solution which can store hydrogen more efficiently, at lower cost, and safer than compressed gas solutions. Furthermore, it is inherently scalable and can be modified for different application scales.

The proposed solution can supply hydrogen instantly and at ambient conditions. The unit may require pre-warming before use to get the reactors up to temperature, depending on the state of charge. The warm-up requirements depend on the supply of H2 required from the system, and the size of the storage relative to the size of the load. This is something the trial is aiming to address (shorten warm-up times and extend instant dispatchable hydrogen supply).

This is a modular system and very flexible (shown in Figure 2a.1 in Criterion 2a Appendix attachment). The baseline solid-state hydrogen storage reactor technology contains 1kg of hydrogen, at up to 10 bar. In this project, the solution will be demonstrated at 30kg which equates to 1MWh of energy storage and the full solution will be stored in a 20ft shipping container. As an example of its flexibility, if one reactor is faulty, the remaining will remain in operation unaffected and there is no need to shut down the whole storage site. The proposed storage units can form a distributed network of low-pressure storage solutions. This allows the possibility to build a gas distribution network with pipes to move hydrogen around the country safely and without the need for road transport. The system can be deployed anywhere, in the basement of city blocks, in rural communities, on oil platforms, as it is not geographically or space limited.

The low pressure of the storage solution allows for seasonal storage. When storing compressed gas for long periods of time, leaks are often found due to the high-pressure differential between the gas (300/700 bar) and ambient pressure (1 bar). With the H2GO solution, there is a much lower differential [redacted] facilitating seasonal storage.

The HyAI platform has been developed with modularity and scalability in mind. The model can easily be configured for a wide variety of use cases, including complex systems involving a variety of assets across multiple locations. The cloud architecture of our platform has been designed to easily scale, both in terms of integrating new data sources and handling the computation requirements of many asynchronous requests from multiple sites.

The proposed solution offers various benefits when comparing with other available solutions in the market. See Figure 2a.2 in Criterion 2a Appendix document for an overview of the benefits vs current competing technologies.

Safety; storing large quantities of hydrogen safely, represents one of the biggest hurdles faced by the industry. To achieve high storage hydrogen densities, H2 is stored under high pressure as compressed gas or under extremely low temperatures as liquid. If these conditions are disrupted, the risk of a severe accident is very high, limiting the opportunity to deploy them in domestic and commercial settings. H2GO's proposed solution works with low pressures to reduce the safety measures required and opens up deployment locations, in populated areas for example.

Storage costs: Current hydrogen storage systems require compressing/cooling of the hydrogen which significantly increases the total operational costs, especially at scale. H2GO's system eliminates these costs. The technology is up to twice as volumetrically dense as compressed hydrogen and therefore more space-efficient, which reduces land rent for customers.

Efficiencies and lifetime; Current hydrogen storage options are disadvantageous since they require compressors or cooling systems to store the hydrogen under high pressures/cryogenic conditions, which reduces considerably the overall the efficiency of the system as a high amount of energy is wasted during compression/cooling (40% to 80% losses of the stored hydrogen's energy). Figure 2a.3 in the Criterion 2a Appendix attachment illustrates the cost and efficiency benefits realised by H2GO's solution vs current competitors. Furthermore, in scenarios where energy is from renewable sources, wasting renewable energy can be more economical than storing it.
The main issue for Li-ion and acid-based batteries is the short storage duration (up to 4h). For longer duration storage, several batteries are required in parallel which multiplies the capital expenditure for the same service. The low-pressure hydrogen has a longer lifetime than competitive technologies (>10,000 cycles / ~30 years).

Carbon emissions and the environment: Significant emission savings when compared to diesel/natural gas alternatives that are the most widely used methods for storing energy. The proposed solution, utilising electrolysis of renewable energy emits zero emissions, and if offsetting diesel-powered generators, would save 1.27kg CO2e/kWh Regarding renewable energy storage, Li-ion batteries remain the most widely adopted solution. However, the technology is not sustainable, from both a financial and green perspective. On average, producing Li-ion batteries of 1 Wh storage capacity requires a cumulative energy demand of 328 Wh and causes greenhouse gas (GHG) emissions of 110 gCO2eq

Complex resource planning decisions: HyAI overcomes difficult and complex resource planning decisions that hydrogen value chains with many moving parts face (project structure, asset management, daily production/storage rate, output constraints, etc.). More effective hydrogen resource management means less capital and operational expenditure, as well as improved certainty in meeting contractual hydrogen production obligations. Hydrogen production and storage hardware have unique positioning requirements (e.g. electrolyser start-up time) and so better planning improves their operation. In essence, this will lead to HyAI driving down the cost of green and blue hydrogen and improving hydrogen affordability. Reliability of hydrogen supply will be essential as industries become more dependent on hydrogen-powered technologies with more commitments coming to light. The sophistication of the hydrogen trading market will grow in parallel with the HyAI platform.

In regards to potential technical barriers that the project may face, 3 have been identified: achieving the system efficiencies at the scale envisaged, hardware integration difficulties and data availability. Due to the scale involved it might be difficult to minimise energy losses and hence reduce the impact of the solution as an energy storage device; although due to the theoretical maximum efficiencies the system will still be more efficient than incumbent technologies such as compression and cryogenic hydrogen and the risks will be reduced as much as possible through the design stage using multi-physics modelling. Our project partner EMEC has budgeted time and resources to carry out hardware integration and live testing. Nonetheless, if complications arise, we have our own integration engineering that can provide support or bego onsite if necessary. This has also been budgeted for in this project. To minimize the risk of necessary data sources not being available, we have already discussed data requirements with EMEC. Based on these discussions, we have been assured that all data sources required for the project can be provided by these partners or sourced from a third party, such as a weather forecaster, as has been done during the initial development stage. Therefore, we consider the probability of overcoming all these technical risks to be likely.

H2GO has already demonstrated and validated the technology in previous projects:

• The Innovate UK granted project titled hZERPH developed a power-to-power demonstrator unit designed and demonstrated a 10kWh solid-state H2 storage system coupled with a 2.3kW electrolyser and 1.2kW fuel cell. The unit was AI enabled, hosted on the cloud and could be controlled remotely, which featured on the BBC XMAS lectures 2020.
• A 300g H2 storage reactor proof of concept was validated in the lab and as power-to-power unit (above).
• A minimum viable product (MVP) 1kg hydrogen storage reactor has been designed and tested proving the concept can be scaled. Operates at 10 bar and can sustain 33L/min H2 flow rate for 5-8h.

For the HyAI:

• IUK grant titled ‘HyAI’ developed prototype version of HyAI in collaboration with EMEC and academics from Imperial College London. This preliminary project has demonstrated significant progress in terms of modelling, simulation, data engineering, cloud deployment, and early-stage hardware integration.
• To validate the performance of the HyAI platform H2GO have performed extensive simulations based on over three years of historical real-world data from a wind farm in Scotland. These simulations modelled a complex, realistic ‘power-to-x’ hydrogen system, consisting of an electrolyser, compressor, hydrogen storage and battery storage, all of which is powered by green, variable generation from the wind turbines and is subject to constraints on both electricity and hydrogen exports. The model was benchmarked against a reactive control system, which is a rule-based alternative to AI, as well as a theoretical upper bound based on optimal control with perfect information. In our simulations, HyAI increased the gross profit attributable to the ‘power-to-x’ hydrogen system by over 40% relative to the reactive control system (see Figure 2a.4 in Criterion 2a Appendix document). Moreover, the model’s performance was within 9% of the theoretical upper bound, which further evidences its efficacy.

Along with the success of previous projects, H2GO believes the low-pressure hydrogen solution will be widely accepted in the market for various reasons.

1. This is a more reliable system (lower pressures/benign operating temperatures, less demanding conditions), and will offer a longer lifetime compared to other existing technologies (>10,000 cycles / 30 years).
2. Does not require any unusual integration requirements to that of existing technologies (power, communications, piping, groundworks, etc)
3. It is possible to have multiple reactors in parallel, which means that if one of them fails the system will continue working. This will lead to lower downtime in case of failure or maintenance operations.
4. The software requires data and communication with assets. Accordingly, the platform has been designed to be compatible with MQTT, a standard telemetry framework that is ideal for connecting remote devices with minimal network bandwidth, easily scalable and secure with support for message encryption and client authentication.
5. Lower leak rates caused by lower pressure differentials between the system and ambient pressure (10 bar vs 1 bar) allows for seasonal storage of hydrogen
6. The system in most cases can provide instantaneous hydrogen but is dependent on the state of charge and hydrogen demand. The mitigation against this is for the integration with HyAI which can forecast demand and supply and the ability to pre/warm if required.

To reinforce this point, two letters of support have been attached to this application, one from the [This information has been redacted] parties understand the need to develop safe, green, large volume hydrogen storage solutions in the transition to Net Zero, especially in the heat and gas industry, and are therefore keen to support the project. National Grid has also offered their subject matter experts to support via inclusion in project steering and technical meetings. National Grid has offered to share relevant storage use case data and information from parallel hydrogen projects. It foresees the project data and time in kind shared to SHyLO to be in the region of £10k over the year. On completion of the project objectives, National Grid has extended the opportunity to demonstrate the technology on its offline development facility for hydrogen.

The decision regarding how the system is handled post demonstration will be informed by the results, successes, and insights generated by the demonstration trials, with a specific project task allocated to determining the post-project strategy for the system. After the project's completion, it is unlikely that the unit will be fully decommissioned. Three options will be considered depending on the results of the trial:

1. Leave the unit on-site to continue gathering data and use it as a test site to continue the improvement of the technology.
2. Move it to another site to assess different use cases.
3. Investigate unit performance by conducting non-destructive testing to validate parameters such as storage capacity degradation (lifecycle analysis).

The unit will also be showcased for future investment raising from the private sector and the acquisition of customers.

For HyAI:
• The cloud process for updating the models, optimizing decisions and communicating with the hardware and dashboard can be easily deactivated if desired.
• The platform can be configured and deployed for other sites as we engage with additional commercial partners.

The learnings obtained from the integration process during this grant will help streamline this process

Please enter the core content of your response to this criterion in the text box. Applicants who wish to support their response with figures (e.g. illustrations/PFDs/graphs/charts/schematics) may attach these as part of the Referenced Figures single attachment (max. 20MB allowance provided) in the Further Information section of this application form. Applicants must clearly label the figures in the attachment and reference the figures in their response within the text box to ensure they are assessed. Any further text submitted within the Referenced Figures single attachment will not be assessed. Additionally, applicants may use evidence of relevant earlier work (limit to 20 pages), all assumptions / calculations / references to respond to this criterion which should be detailed in the attachment below and will be assessed. To complete this section you may upload evidence of relevant earlier work, all assumptions / calculations / references with your application. Max upload size per file – 20MB Max number of files – 1

- File: Criterion 2a Appendix v1.2.pdf - Download

Criterion 2b: Lifetime costs of the proposed solution With reference to relevant prior work, describe the likely lifetime costs of the Hydrogen Supply solution compared with the applicable counterfactual parameters (see Appendix 2 of the Low Carbon Hydrogen Supply 2 Stream 2 ITT) including round-trip efficiency, providing the assumptions made. Costs should be broken down, where possible/relevant, into CAPEX (and financing at IRR 10% where applicable), OPEX (broken down into fuel, maintenance, labour, consumables), carbon cost, for main plant equipment. We also expect a current and estimated future (2035) levelized cost where relevant. Describe how demonstration will firm up these costs. Where applicable, include in this analysis the capture rates, the system benefit costs, the impact on the purity of hydrogen, accessibility to hydrogen and round-trip efficiency. How do these compare against state of the art? Highlight the main uncertainties associated with these cost estimates and explain how the design and execution of your demonstration pilot will address these uncertainties. Applicants should note the following: The applicable technical parameters should match those stated in the counterfactual including the relevant pressures, purities and flow rates. These boundary conditions should be used to develop costs of a counterfactual. If a different set of boundary conditions is more representative for your hydrogen supply technology, this can also be included, in addition, to help support your application, but would require justification. Compare and justify all costs and cost reduction of the proposed system to the current state-of-the-art hydrogen supply solution or closest comparable existing solution. To calculate (and enable us to compare) lifetime costs, bidders should use BEIS's estimates for cost of carbon, electricity and natural gas prices in 2035 (assume these costs and prices do not change). These are provided in in Appendix 2 of the Low Carbon Hydrogen Supply 2 Stream 2 ITT. If a different cost assumption basis is more representative for your hydrogen supply technology, this can also be included, in addition, to help support your application. All units of measurement provided for the analysis should match those stated in the counterfactual. (Weighting for Criterion 2b – 10%) (Maximum 2,000 words)

The below points compare the H2GO solid-state hydrogen storage solution with the counterfactual provided in the guidance notes and provide explanation of any requirements to achieve said counterfactual parameters.

[redacted]

MWth.

[redacted]

counterfactual 67.2%. However, taking into account heat recuperation, the round-trip efficiency of the solution is more than 92%.
• CCS Parameters: The H2GO hydrogen storage system has zero direct emissions, therefore, CCS

parameters are irrelevant. The H2GO power solution is agnostic to hydrogen sources, however the preferred solution will only be produced by renewable sources such as wind, solar and tidal, and therefore have no carbon content.

• Operating Lifetime: The operating lifetime of the H2GO unit is at least 27 years, compared with the counterfactual 20. The storage material can undergo at least 10,000 cycles which equates to 1 cycle a day for 27 years.

[redacted]

[redacted] [redacted]

[redacted] [redacted]

[redacted] [redacted]

[redacted]

[redacted] [redacted]

[redacted] [redacted] [redacted]

[redacted]

[redacted]

[redacted] [redacted] [redacted]

[redacted]

[redacted]

[redacted]

[redacted] [redacted]

[redacted]

[redacted] [redacted]

[redacted] [redacted] [redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

This adds up to a total embedded CO2 for H2GO of 1,009kgCO2/kgH2 and a pressurised cylinder

equivalent of 214.5kgCO2/kgH2, and therefore a total carbon price for the H2GO solution of
[redacted] [redacted]

[redacted]
[redacted]
[redacted]
[redacted] [redacted]
[redacted]
[redacted]

[redacted]
[redacted]
[redacted]
[redacted] [redacted]

[redacted] [redacted]
[redacted] [redacted] [redacted]
https://www2.deloitte.com/content/dam/Deloitte/uk/Documents/energy-resources/deloitte-uk-energy-resources-investing-in-hydrogen.pdf, attached to this question also. The benefits compared to the state of the art extend past cost, and offers faster release and capture rate of hydrogen which has traditionally been a drawback in the past with material storage, longer operation lifetime (27 years) (typically double compressed cylinders), a volumetric density that is exceptionally high (50-100 gH2/L) than both compressed gas and liquid storage alternatives (30-40 gH2/L) (i.e. doubling the amount of H2 stored per unit volume when compared with 700bar compressed gas, the more H2 stored per unit volume, this is an enabler for storing more low carbon energy at reduced CO2 footprint), and high purity of hydrogen >99.95%, and less chance of any leakage due to the low pressures. Another major benefit of the solution is the improved accessibility of hydrogen that the system offers. Due to the scalable and space-efficient nature of the design (i.e. containerised solution), the storage system can be deployed swiftly anywhere. It can be deployed in urban areas whereas alternative solutions such as compressed gas need exclusion zones. The round-trip efficiency will be over 92% when utilising heat recuperation which is higher than both compressed gas and liquefaction alternatives (60% and x20% respectively (https://www.hydrogen.energy.gov/pdfs/9013_energy_requirements_for_hydrogen_gas_compression.pdf , https://www.sciencedirect.com/topics/engineering/cryogenic-hydrogen).)

Please enter the core content of your response to this criterion in the text box. Applicants who wish to support their response with figures (e.g. illustrations/PFDs/graphs/charts/schematics) may attach these as part of the Referenced Figures single attachment (max. 20MB allowance provided) in the Further Information section of this application form. Applicants must clearly label the figures in the attachment and reference the figures in their response within the text box to ensure they are assessed. Any further text submitted within the Referenced Figures single attachment will not be assessed. Additionally, applicants may use evidence of relevant earlier work (limit to 20 pages), all assumptions / calculations / references to respond to this criterion which should be detailed in the attachment below and will be assessed. To complete this section you may upload evidence of relevant earlier work, all assumptions / calculations / references with your application. Max upload size per file – 20MB Max number of files – 1

- File: deloitte-uk-energy-resources-investing-in-hydrogen.pdf - Download

Criterion 3: Social Value

Criterion 3a: Short term development plan. In the text box below, the applicant should provide a summary of the short-term development plan that comprehensively appraise the outstanding technical challenges of the solution and its commercial benefits and risks relative to the applicable counterfactual parameters. In the response, please cover the following: Present the plan for further development, commercialisation and exploitation of the hydrogen supply solution. What are the main technical and commercial challenges and risks to getting the solution to market; and how will you overcome them? A summary of the business plan must be presented that highlights the route to market and estimated time to secure market share. Applicants who wish to support their response with figures (e.g. illustrations/PFDs/graphs/charts/schematics) may attach these as part of the Referenced Figures single attachment (max. 20MB allowance provided) in the Further Information section of this application form. Applicants must clearly label the figures in the attachment and reference the figures in their response within the text box to ensure they are assessed. Any further text submitted within the Referenced Figures single attachment will not be assessed. (Weighting for Criterion 3a – 5%) (Maximum 1,000 words)

The key areas of further development required for the hydrogen solid-state storage solution are regulatory and safety requirements and ensuring design for manufacture is addressed. During the SHyLO project, research and groundwork will be completed to ensure that a thorough understanding of the regulatory and safety requirements for the system is gained.H2GO plan to then implement these learnings into a redesign of the solution that can subsequently be built and commercially trialled and validated.H2GO plan to further develop and optimise the manufacturing and build process using the findings and insights generated following the completion of the project. This is likely to be in the form of a solution redesign, similar to that of the safety redesign, but with a focus on design improvements to enable higher volume manufacture. H2GO, Autodesk, MTC, and HSSMI will also carry out further development work on the assembly and build process, aiming to improve these in terms of cost and speed.H2GO will invest in specialised tooling that enable higher volume production and optimises the overall cost of manufacture and build.

A key part of the SHyLO project, which will be furthered following its completion, is the development of a manufacturing scale-up strategy.This will define the requirements to enable high-volume manufacture and roll-out of their solution which is a critical step to commercialise their solution. This will include, for example, definition of key supply chain partnerships, volume/ramp-up planning to meet expected demand, and associated timelines. It is expected that this solution will be available in the market within [redacted] years of commercialisation.

One of the key challenges to overcome in order to achieve commercialisation is around regulatory [redacted] or if suitable standards are yet to exist for the solution, will likely cause delays in H2GO's commercialisation plan as the solution could not be certified for use.To overcome this, ARC have been included in the consortium to specifically address the regulatory uncertainties.ARC will review UK legislation to ensure current relevant legislation is known and review relevant HSE guidance and information to identify relevant standards and guidance. This will set an initial baseline of regulatory requirements that need to be met and will provide early identification of gaps that need to be addressed in the project.

There are risks achieving the system efficiencies at the scale envisaged as it might be difficult to minimise energy losses at larger-scale.Although due to the theoretical maximum efficiencies the system will still be more efficient than incumbent technologies such as compression and cryogenic hydrogen and the risks will be reduced as much as possible through the design stage using multi-physics modelling.

To build upon successful technology demonstrations and subsequent product design and build improvements, H2GO Power has devised a stepwise commercialisation plan to penetrate and accelerate the route to the UK, EU and global markets.

The key target markets for the product in the first [redacted] years of commercialisation are:
• Commercial: customers requiring energy for powering, heating, and cooling of buildings. Industrial activities include agricultural, mining, oil and gas, manufacturing, data centres and construction applications.
• Electricity grids and gas grids: In the electricity grids, hydrogen can be produced in times of curtailment and utilised in times of high demand. In gas grids, hydrogen can be injected to form natural gas blends up to [redacted] or run with [redacted] for zero-emission heating.
• Curtailment: wind energy that would otherwise be wasted will be turned into hydrogen and sold as a commodity for transportation.

Grid operators who are piloting systems for scaling around the UK are H2GO's priority for selling hydrogen storage systems[redacted]). The second addressable market for the gas storage technology is for power-to-power applications i.e. energy storage in the Commercial and Industrial(C&I) sector([redacted] for pre-orders). A large portion of C&I customers use diesel generators for energy storage applications, and given the pressure to decarbonise, the value proposition offered by H2GO's solution will be appealing to enable the transition to green energy. H2GO are currently involved in ongoing discussions on potential partnerships for using the technology including a notable opportunity to use H2GO's storage systems to decarbonise steel (pre-orders expected at Q4 [redacted]). H2GO will partner initially with grid operators[redacted]), energy OEMs[redacted] and energy infrastructure companies([redacted]), which will serve as distributors by integrating the systems into their energy solutions for businesses. H2GO have already secured the interest of several players with a wide network including the National Grid that will assist us in securing further projects across the distribution network(see support letter).Collaboration [redacted]

ambitions to expand its utilisation. Given the uniqueness of the commercial offering and superior technical positioning the company has, H2GO Power can take up to [redacted] market share of the hydrogen storage market in Europe in the next [redacted] years.

Criterion 3b: Long term development plan. In the text box below, the applicant should provide a summary of the longer term development plan that highlights the route to market and estimated time to secure market share including highlighting the key challenges to achieving commercialisation at scale (assuming there is a demand for bulk low carbon hydrogen), timescales, build rate, and estimated development costs, UK job creation and development of a supply chain to develop a future hydrogen economy. In the response, please cover the following: Discuss the timescales and development costs and any potential supply chain constraints to support a future hydrogen economy particularly focusing on the UK 2030 hydrogen ambition and 590 TWh by 2050 (based on National Grid's Future Energy Scenarios). This should include potential cost savings through learning by doing, UK job creation, the development of a supply chain to meet future demand, air quality impacts (NOx, amines, particulates etc.) and carbon (CO2eq) savings across the economy (direct or indirect). Where possible, please separate emissions into

Scopes 1 and 2 (direct and indirect), UK and international, and for theme 1 (Low Carbon Hydrogen Production) please include upstream emissions from natural gas (please see details in Appendix 2 of the Low Carbon Hydrogen Supply 2 Stream 2 ITT). The applicant should also detail the potential wider environmental impact (local and global) from the roll out of the proposed hydrogen supply solution and limitations in the supply of rare materials, and how they could be mitigated. With reference to the response against Criteria 5 (Project Delivery) how will these be mitigated? Route to market and market potential of the proposed solution discussing the alternatives and the competitive advantage, highlighting future innovations and learning rates and how the hydrogen supply solution could reduce the costs of achieving net zero. Explain how the demonstration will accelerate the development of low carbon hydrogen economy in the UK. Applicants who wish to support their response with figures (e.g. illustrations/PFDs/graphs/charts/schematics) may attach these as part of the Referenced Figures single attachment (max. 20MB allowance provided) in the Further Information section of this application form. Applicants must clearly label the figures in the attachment and reference the figures in their response within the text box to ensure they are assessed. Any further text submitted within the Referenced Figures single attachment will not be assessed. (Weighting for Criterion 3b – 10%) (Maximum 2,000 words)

The H2GO business model and route to market is the sale of hardware & software directly to customers (B2B) focusing on heating (i.e. [redacted], to hydrogen gas grid distribution points (i.e. National grid, see letter of support) and renewable energy generators (i.e. [redacted] Others include gas storage at refuelling stations as the benefit with the H2GO technology is large scale storage of hydrogen but at much lower and safer pressures which takes up less space.

This project focuses on the integration of the modular H2GO storage reactor and combines them into larger stacks and units for large scale storage, all made smart and autonomous with proprietary software. This project will demonstrate the principles and balance-of-plant required to create a safe and efficient system for large scale commercialisation. Once these principles have been demonstrated at scale they will be used by H2GO to create commercial large scale storage containers, themselves, or the instructions will be provided to end use customers or integrator companies to integrate the technology themselves. The latter will specifically help the scaling and roll out of the technology to a wider market base and allow for a more organic company and product volume to scale up.

H2GO estimates that market share from successful product roll out is projected to reach [redacted] of the hydrogen storage market by [redacted]. The [redacted] figure equates to [redacted] and equates to [redacted] H2GO reactors sold (individual, not container stacks).

The majority of the costs associated with the development of the technology to [redacted] targets is associated with labour, capital and materials costs.

[redacted]

technical staff, a commercial team and supporting business functions such as finance, legal and HR. The technical additions will be a mixture of hardware and software roles, examples include, mechanical, control and electrical engineers for the development and optimisation of systems performance, software developers to manage the AI platform development and deploying it to multiple sites, manufacturing and quality control roles to manage the supply chain and manufacture of reactors and large scale systems. [redacted]

It is important to note [redacted] Lab capabilities are designed to allow for large scale development, incl. higher flow rates and supply of H2 and stacking of lager systems for finalising commercial designs.

Capital expenditure will be attributed to scaling operations. Also there will be capital cost associated with scaling the designs and moving to higher volume manufacture. The current modular full scale reactor as designed is suitable for medium volumes but for mass volumes there will be slight design modifications to suit the economy of scaling. Investment will also be made in equipment for assembly lines and for tooling/jigs and storage material processing (which requires O2 and H2O depleted

[redacted]

The supply chain has been assessed and is very robust for the H2GO reactor technology. While specialist skills are required, e.g. pressure vessel equipment, speciality measuring and monitoring equipment, current supply chains are abundant as the skills cross many sectors and are not specific to hydrogen. The UK is very well placed to meet these needs and the current supply chain is in majority sourced here. Work will need to be invested into the supply of storage materials and to develop a wider network of suppliers as this is not possible to source from the UK, so that reliance on any one supplier can be reduced and reduces risks of any supply chain issues. Based on [redacted] projections H2GO will require [redacted] tonnes of hydrogen storage material.

The environmental impact of the H2GO solution is minimal. Local impacts are limited as the units are 'plug and play', and predominantly manufactured off site to be transported to site and integrated into existing infrastructure. Work required is not intrusive and covers aspects such as building foundations and ensuring there is access to utilities such as gas connections and electricity supplies.

At the point of use emissions are zero when using renewable energy as the electricity supply. A [redacted] H2GO unit that displaces an equivalent diesel genset would save [redacted] of CO2 yearly (assuming green hydrogen), the equivalent weight to 32 routemaster London buses. As air pollution kills an estimated 7 million people worldwide every year as a result of increased mortality from stroke, heart disease, lung cancer and acute respiratory infections, the roll out of the H2GO solution is a significant benefit. As the technology scales and elctrolysers and hydrogen with carbon capture increases (as per UK government goals for meeting net zero) this offset will further increase and has the potential to be massive. On a Europe wide scale, hydrogen is predicted to provide up to 6% (665 TWh) and 24% (2,250 TWh) of total energy demand by 2030 and 2050, respectively (ref: https://www.fch.europa.eu/sites/default/files/Hydrogen%20Roadmap%20Europe_Report.pdf). This would put Europe on a path to reducing 560 Mt of CO2 emissions by 2050, as much as half of the required abatements needed to achieve the 2 degC scenario.

Global environmental impacts associated with the H2GO solution are attributed to the requirements of raw materials, some of which are rare earth. However the elements required are not threatened by future supply issues and help diversify the requirements from incumbent technologies, e.g. Li-ion. However, it is important to note that the H2GO solution is agnostic to the specific storage material and the proprietary technology is the system that is designed around the material to improve its performance (hydrogen flow rates). Although unlikely, should concerns arise around materials in the supply chain in the future it is possible to use different constituents and optimise the design and system to achieve required results from alternatives.

The current energy storage market is dominated by diesel generators, compressed gas and liquid hydrogen storage, battery technology and pumped hydroelectric storage. Hydroelectric is heavily location dependant and has significant capital costs, battery technology is dominated by Li-ion which has a significant rare earth demand for elements such as lithium and cobalt and the environmental and geopolitical impacts of this is well known; on average, producing Li-ion batteries of 1 Wh storage capacity requires a cumulative energy demand of 328 Wh and causes greenhouse gas (GHG) emissions of 110 gCO2eq. Li-ion certainly has its place in the market however it has significant downsides for longer duration energy storage and global resource requirements.

Investigating the costs of alternative technologies:
• Li-ion :Li-ion batteries have limitations for long-duration storage, a growing market in the UK and EU in light of aggressive renewables integration and changing weather patterns. The increased number of cycles of our technology and therefore lifetime bringing levelised cost of storage to [redacted] of Li-ion batteries is an additional advantage, as illustrated in supporting Figure 3b.1 attached to this question.
• Hydrogen technologies: Alternatively when investigating the costs of the H2GO solution against compressed and cryogenic hydrogen it can be seen that a significant cost saving is achieved through the efficiency gains the solution offers. The answer in Criterion 2b breaks down these costs (both financial and carbon) with regards to the efficiencies of other hydrogen storage technologies and Figure 3b.2 in the supporting information attached to this question illustrates this.

It is clear to see the benefits and differentiators the H2GO solution has over current market incumbents, and although the H2GO solution has the potential to play a significant contribution to the UK (and worldwide) hydrogen economy for the above reasons, there are challenges that have been encountered to achieve commercialisation. When approaching investors to raise large enough rounds that allows fast scaling, it is challenging to convince them that our risks are mitigated despite the acknowledgment of the technical strength with a large scale demonstrator. Similarly, partnerships with large corporates or customers who won't take scaling risks before seeing an operational demonstrator at scale before committing to pre-orders. H2GO is at a stage that can leverage its strength but getting to market fast is key and it remains a challenge to demonstrate the technology in order to commercialise it with interested parties and raise private investment.

In summary, H2GO Power was born in the UK at Cambridge University (similar to inception paths of ITM Power and Ceres Power which were born in research labs) and scaled to gain global reputation for its unique technical capabilities and innovative engineering approach coupled with predictive algorithms for intelligent storage. The anticipated growth of this company in the UK will facilitate creating a ripple effect for sharing innovation across the H2 value chain that is being built in the UK and accelerating learning rates as it scales with partners from academia and industry impacting multiple sectors racing to decarbonise and reduce the cost of their operations that will benefit from knowledge transfer. Successful award of this grant will be an essential stepping stone to realise all the advantages this technology can bring which has an essential piece to play in the UK's hydrogen strategy.

Criterion 3c: Knowledge dissemination strategy. In the text box below, the applicant should explain the current plans for taking the knowledge and experiences arising from the demonstration pilot and ensuring that these are effectively communicated and shared within the relevant stakeholders. Applicants who wish to support their response with figures (e.g. illustrations/PFDs/graphs/charts/schematics) may attach these as part of the Referenced Figures single attachment (max. 20MB allowance provided) in the Further Information section of this application form. Applicants must clearly label the figures in the attachment and reference the figures in their response within the text box to ensure they are assessed. Any further text submitted within the Referenced Figures single attachment will not be assessed. (Weighting for Criterion 3c – 5%) (Maximum 1,000 words)

The SHyLO project work plan has a dedicated Work Package (WP9) focussed on ensuring successful dissemination and exploitation of the project outputs and results. The SHyLO consortium strongly support the need to maximise the impact of the project results and findings through effective and consistent dissemination activities. All project partners are committed to a dissemination baseline which includes: stakeholder identification, using tools and channels to reach target audience, and disseminating key information about the project results and findings as widely as possible to the relevant markets. Sharing the results of this project with the wider industry is a critical activity to improve the public perception of large-scale hydrogen storage and use.

SHyLO communication and dissemination activities will:
• Raise awareness and create wide visibility for the project's ambitions, technology evolution and outputs
• Identify strategic stakeholders and key partners from the hydrogen supply chain and wider industry to speed up the commercialisation and industrialisation of the solid-state hydrogen storage technology
• Ensure effective communication and information dissemination with strategic stakeholders
• Support the exchange of experiences and best practice by carrying out networking activities at suitable events, conferences, and webinars, and through coordination with the other projects funded within similar calls (e.g. Long Term Energy Supply, Low Carbon Hydrogen Supply Stream 1 and 2).
• Analyse customer requirements and profiles to build on and further define the existing range of potential users.
• Define regulations, standards and certifications, existent or non-existent for large scale hydrogen storage and use applications.
• Share the findings, challenges, and road blocks with other similar projects to enable a concerted effort to build the UK's hydrogen economy.

The dissemination strategy will follow the three steps explained below. H2GO, the leader of the dissemination and exploitation WP, will guide this process and all the consortium will contribute on the execution and update of the dissemination strategy according to the project evolution.

Step 1: Define Target Audience
It is important to define the specific target audience for communication and dissemination messages. End-users of the technology (e.g. customers requiring energy for powering and heating buildings, electricity and gas grids, and renewable energy businesses experiencing energy curtailment) are the major beneficiaries and exploiters of H2GO's technology and it is key that the project outputs reach them. However, wider industry, policy stakeholders and the general public, are also key audiences that the consortium will aim to target.
The dissemination target audience comprises:
• Academia / Research institutes working with:
Hydrogen technology, energy storage systems, hydrogen infrastructure, safety aspects of hydrogen, certification and regulatory issues.
• Policy stakeholders:
Governmental bodies, legislative stakeholders, local authorities looking to implement hydrogen infrastructure, other governmental organisations dealing with energy storage and gas/electricity grid

development
• Industry:
Hydrogen technology (electrolysers, fuel cells), infrastructure developers, renewable energy generators, technical suppliers, end of life and second life market.

Step 2: Target Message
Appropriate messages will be developed to communicate the benefits, successes and challenges of the H2GO solid-state storage solution and the SHyLO project. The consortium will define messages which are tailored to the interested stakeholders. Messages will be different depending on the consortium member posting as well as the target audience. Dissemination of the SHyLO project will inform the broader public about the project aims and objectives and will promote current or planned project activities. Besides targeting specific industry stakeholders and end users, the dissemination strategy aims to improve the general public opinion of hydrogen technology. This will be achieved by emphasising the improved safety, efficiency, competitiveness, and improvement of public and private infrastructure that this solution can bring and the promotion of local job creation, skills development and growth of the hydrogen economy that the commercialisation of this solution can facilitate. Possible messages to be disseminated about the project and H2GO's solution are:
• H2GO's hydrogen storage solution reduced the overall cost of hydrogen storage by…….
• The SHyLO project has increased the confidence of large-scale hydrogen production, storage, and use through demonstrating……
• Compared with compressed hydrogen gas solutions, H2GO's solution can store hydrogen more efficiently, leading to…….
• The industrialisation and commercialisation of the H2GO storage solution will lead to UK job and skills generation…….

Step 3: Select Dissemination Tools and Channels
The tools and channels will be used to inform the target audiences about the project progress, H2GO's solution, its benefits as well as on the implementation potential and it will be important to include a mix of dissemination tools. This can vary among networking events (site visits, conferences and fairs), webinars, digital and printed media (leaflets, videos, etc.), and social networks (e.g. LinkedIn, Twitter, company websites). Due to the timeframe of the project (2 years), it is likely that conferences and events could be attended by members of the consortium. Possible events to attend to disseminate the project outputs and objectives are:
• ICREREC 2021
• ICLCTSGD 2021
• ICEESIS 2021
• WHEC2022
• CERAWeek 2021
• Hannover Messe
• Cleantech group
• World Future Energy Summit
• All-Energy 2022

The first year of the project will focus on raising awareness of the aims, and objectives of the project and the challenges that it is aiming to address. This will be achieved through press work, newsletters, blogs etc, posted on social media networks and at events where possible. Year two of the project will focus on sharing more sound results of the project as well as achievements and challenges faced and overcome. There will also be a focus on engaging with key stakeholders through participation in webinars, workshops, and through posts on social media platforms, in order to enable exploitation of the project's success and to further the solution to commercialisation. H2GO and EMEC will host a demonstration event at the end of the project to allow interested parties and key stakeholders to see the large scale demonstrator in operation and understand its value and benefits.

Criterion 4: Project financing

To complete this section please upload a completed BEIS Project Cost Breakdown/ Finance Form for Stream 2 here. Max upload size per file - 5MB Max number of files - 1

- File: SHyLO-project-cost-breakdown-form v2.xlsx - Download

In the text box below, the applicant should: Provide justification of costs and ensure all costs are eligible. Applicants who wish to support their response with figures (e.g.

illustrations/PFDs/graphs/charts/schematics) may attach these as part of the Referenced Figures single attachment (max. 20MB allowance provided) in the Further Information section of this application form. Applicants must clearly label the figures in the attachment and reference the figures in their response within the text box to ensure they are assessed. Any further text submitted within the Referenced Figures single attachment will not be assessed. (Weighting for Criterion 4a – 10%) (Maximum 1,000 words)

H2GO

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted] [redacted] [redacted] [redacted]

[redacted] [redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted] [redacted]

[redacted]

[redacted]

[redacted]

[redacted]

• Will combine trips with project quarterly meetings where possible

Other
Modelling software and space allocation (costed using agreed Innovate UK rates per sq m)

EMEC
[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]
Covers the man hours required to support H2GOin optimising their hydrogen reactor design for

performance and commercial cost targets. All labour rates are at cost.

[redacted] [redacted]

[redacted]

[redacted]

[redacted]

Autodesk expect to attend 1 years' worth of project meetings (based on their contribution to the full length of project), equating to 4 UK based trips for 1 person.

Criterion 4b: Value for money to HM Government In the text box below, the applicant should describe why the proposal represents good value for money for HM Government. The answer should explain the following: How the availability of public funding makes a material difference to the actuality and pace of moving the solution towards commercialisation, and Qualify and quantify the savings that are being passed on to HM Government to reflect the asymmetric balance of risks and benefits accruing to the project consortium and HM Government. Applicants who wish to support their response with figures (e.g. illustrations/PFDs/graphs/charts/schematics) may attach these as part of the Referenced Figures single attachment (max. 20MB allowance provided) in the Further Information section of this application form. Applicants must clearly label the figures in the attachment and reference the figures in their response within the text box to ensure they are assessed. Any further text submitted within the Referenced Figures single attachment will not be assessed. (Weighting for Criterion 4b – 15%) (Maximum 1,500 words)

Without securing public funding, the pace of progress will certainly slow down. As this is a first of its kind and an unproven modular solution, the risks to outside investors from other financing methods are high and funding cannot be secured through that channel. We have been receiving compelling interest and feedback about the technology and its commercial potential from VCs and industrial partners, however, repeating feedback has been coming up highlighting their position to invest/partner/purchase systems after a full-scale demonstration has been executed. Without securing the funding in the immediate-short term, H2GO's activities would be limited to carrying out further computational designs and smaller scale demonstrations that are not suitable for full-scale evaluation/certification and commercialisation. This will have a severe impact on H2GO's ability to reach market at the desired and effective time, at a point in time where competition in the field (in Germany, France, and the US) is becoming significant. It is worth noting that our competitors' growth has been supported by their governments and EC funding mostly before they can attract private growth capital. Therefore, our bridge in development will remain essential prior to raising sufficient funding rounds from venture capitals or corporates to realise the potential of the technology at scale and establish a manufacturing strategy and supply chain that positions the company competitively for a shorter time to market and successful commercialisation. Also delays in progressing to the demonstration phase in a timeframe that enables us to maintain our innovative and competitive edge will reduce our chances for getting to market at the right time and grow ahead of our competition. Securing public funding immediately, on the other hand, will enable us to take the partnership with the MTC to the next level, ensuring a commitment to scaling the technology to the volumes that enable commercialisation, and establish contract manufacturing collaborations, as well as bringing in necessary technical expertise to the team with best value-for-money. Funding will also advance H2GO business by adding a new dimension of innovation to our portfolio that can yield more patents, demonstrate power systems that facilitate a unique positioning to deliver long-duration emission free energy storage that is competitive with other existing solutions.

Public funding provides the opportunity to be part of a collaborative program where H2GO can access skills and expertise outside their own business.
• Whilst H2GO have developed the technology, it does not have the facilities or expertise to manufacture a commercial scale demonstrator. Working with MTC allows H2GO to work with experts with track records at upscaling technologies and can understand and address the challenges associated with upscaling their technology.

• Working with EMEC allows H2GO a site to test the demonstrator which is reflective of their target market once commercialised. Furthermore, they will provide unique insights into the safety and technical requirements of setting up a large-scale hydrogen storage demonstrator that do not currently exist within H2GO's business.
• Working with HSSMI in the project will allow H2GO to leverage significant and crucial expertise in developing high-volume manufacturing strategies that will facilitate H2GO to reach commercialisation following the success of the project.
• ARC provides critical expertise in risk assessment and ensuring regulatory requirements are met within the hydrogen space. ARC will provide unique insight into safety requirements throughout the design, build, and demonstrating phases of the project, and will ensure that the demonstrator meets the required regulation to achieve certification. This is crucial for H2GO to get their solution to market.
• Working with Autodesk, who have a unique market stamp of approval for designs of complicated systems for the likes of NASA, Toyota, and many OEMs, will facilitate important design modifications to the H2GO technology to enable the quick scaling of the reactor design so that post-project the system will be suitable for higher volumes at the required cost and performance targets. This will give our systems more credibility and allow us to realise initial commercial orders faster and enable H2GO to get to market as soon as possible.

Being part of a publicly funded project allows for H2GO to leverage the above skills and expertise and ensures the solid-state hydrogen storage solution is successfully demonstrated at commercial scale. This funding call is a catalyst to bring these partners together in a consortium motivated to contribute to scaling and growing a technology like H2GO's to commercial maturity. Working collaboratively with these partners allows H2GO to tackle and overcome the credibility questions as a small business, the challenges and uncertainties of scaling the solution which would otherwise take a significantly longer time to address, and at a much larger cost to the business that we already know is difficult to fund privately prior to demonstration. Without the opportunity to work in this consortium, the timeline to achieving commercialisation of the solution would be significantly extended and the decarbonisation and economical impacts it can contribute to the national strategy will also be delayed.

This project represents good value for money in that it will result in multiple economic, societal and environmental benefits:
Economic:

[redacted]

[redacted] [redacted]

[redacted]

Societal

at H2GO by 2026

created at H2GO

Environmental

Other:

[redacted]

make it a testing environment for novel technologies. This project makes excellent use of that investment through free of charge access to electrolysers, flow cell batteries, and power generators (tidal turbines and a wind turbine), hydrogen storage, communications infrastructure, and other systems.
• The application of machine learning / AI to industrial control systems is a new and specific challenge

to the current approaches for safety and software assurance. This will be an example that can be fed into the significant export market for professional engineering services that ARC is part of within the UK.

Criterion 5: Project delivery

To complete this section please upload a completed Gantt chart (or Outline Project plan) and Key Work Packages with your application. Key Work Package document not to exceed 6 pages. Max upload size per file - 10MB Max number of files - 2

- File: SHyLO Gantt Chart.xlsx - Download
- File: SHyLO Work Packages Document.docx - Download

In the text box below, applicants are expected to: Explain how the project team, if involved in multiple Hydrogen Supply 2 applications will ensure they have sufficient capacity to deliver multiple projects. Applicants who wish to support their response with figures (e.g. illustrations/PFDs/graphs/charts/schematics) may attach these as part of the Referenced Figures single attachment (max. 20MB allowance provided) in the Further Information section of this application form. Applicants must clearly label the figures in the attachment and reference the figures in their response within the text box to ensure they are assessed. Any further text submitted within the Referenced Figures single attachment will not be assessed. (Weighting for Criterion 5a – 15%) (Maximum 500 words)

No project partner is involved in multiple Hydrogen Supply 2 applications

To complete this section on Project Team please upload a completed CV package and Organogram here. Max upload size per file - 20MB Max number of files - 2

- File: SHyLO CV Package.pdf - Download
- File: SHyLO Organogram.pdf - Download

In the text box below: The applicant should present their proposed governance arrangements between the partners to ensure effective project delivery The applicant should list any external parties responsible for delivering goods or services worth more than 10% of the total project value and explain how they will ensure that these parts of the project do not give rise to delays in the delivery of the project. The applicant should provide details of the relevant skills, qualifications and experience of main project team members, including descriptions and evidence of previous relevant work carried out. Include brief details of relevant team member previous projects, including the date, location, client and project size. Applicants who wish to support their response with figures (e.g. illustrations/PFDs/graphs/charts/schematics) may attach these as part of the Referenced Figures single attachment (max. 20MB allowance provided) in the Further Information section of this application form. Applicants must clearly label the figures in the attachment and reference the figures in their response within the text box to ensure they are assessed. Any further text submitted within the Referenced Figures single attachment will not be assessed. (Weighting for Criterion 5b – 10%) (Maximum 3,000 words)

The SHyLO project is made up of a consortium of 6 partners: H2GO Power (the lead), MTC, EMEC, HSSMI, ARC, and Autodesk. SHyLO is an ambitious project including various types of interrelated activities. Thus, it requires an efficient management and organisational structure that can handle the project's complexity and assure smooth coordination, implementation and achievement of the project's goals.

HSSMI will operate as the project manager (PM) of SHyLO, bringing significant expertise and experience in managing large, publicly funded programs. They are responsible for ensuring the successful delivery of the full project to time and budget, managing risks, managing IP, and ensuring efficient collaboration and communication is maintained between the project partners. The project manager will be the main contact point for BEIS - all updates, questions, and issues to be reported to the Monitoring Officer will be communicated by the PM. The PM will coordinate quarterly review meetings to showcase to the MO, the progress and successes over the previous quarter, plus any risks or issues that have arisen in that time.

Large project decisions and vital issues in the project will be dealt with by the General Assembly (GA). The GA is composed of one representative of each partner organisation. Each representative is responsible for the proper utilization of the partner's resources allocated to the project and for the execution of the objectives assigned to his/her organisation. Issues to be dealt with by the GA include, but are not limited to:
• Changes in the overall project plan incl. re-allocation of tasks and budget, technical objectives and PM.
• Assessment of the technical progress and the results achieved
• Actions to implement regarding a defaulting party

To ensure the technical work of the project is managed effectively and in order to track project progress, the PM will manage and be in regular communication with all Work Package (WP) leads. WP leads are the partners responsible for the co-ordination of their respective WP, including the co-ordination of the workflow between their WP and other interlinked WPs. The WP lead will ensure the respective tasks, deliverables and milestones are met in a timely manner. The WP lead will have overview of all activities being undertaken within the WP and will work and communicate with all partners and sub-teams who are supporting the delivery of said WP.

To ensure consistent and successful project progress, regular meetings of varying levels will occur throughout the project.
• A consortium meeting will be held every two weeks between all WP leads, the PM, and any other relevant persons. The purpose of the progress meetings is to monitor total project progress and to discuss project updates, including:
• reviewing the development and progress of tasks and deliverables vs the project Gantt chart
• discussing risks (both new and existing)
• identifying delays to the project timeline and developing mitigation strategies
• setting actions for partners and ensuring required information/data is shared across partners
• WP meetings will be held to discuss specific activities within the project. These will be run by the WP leads who will be responsible for reporting WP progress and planning technical activities. They will also include relevant members across the project consortium. It is anticipated that some WPs will be combined into one WP meeting due to their interlinking natures. For example, it would be sensible to have combined WP meetings to discuss Design and Build (WP3, WP4) due to the dependencies between the ongoing activities in each WP. If the project team find it necessary, these meetings can be split into separate work package meetings. WP leads will schedule their meetings as necessary according to the development of the work in their respective WP. In principle, WP meetings will occur on a weekly basis.

It is anticipated that all project partners will conduct internal meetings to plan and delegate the technical work required in order to deliver and support the partner's relevant WPs. The progress that the partners make will then be reported and discussed in weekly technical meetings as well as consortium meetings if appropriate
• Ad Hoc meetings of the General Assembly will be arranged if a significant component, risk, or challenge of the project requires attention.
• Quarterly review meetings will be held between the consortium members, the Monitoring Officer assigned to the project, and anyone else from BEIS that is required. These meetings are to disseminate to the MO the progress and successes of the project over the previous quarter, plus any risks or issues that have arisen in that time.
There are no external parties being subcontracted at more than 10% of the total project cost.

Key Project Team

H2GO
[This information has been redacted] [redacted]

[This information has been redacted]

[This information has been redacted] [redacted]

[redacted]

[redacted]

[This information has been redacted] [redacted]

[redacted]

[redacted]

[redacted]

Relevant Past EMEC Projects
Name: HyFlyer 2 (2020)
Client: Innovate UK
Project Scope: To demonstrate a 600kW hydrogen fuel cell drivetrain developed by Zero Avia in a 19-seater aircraft.
EMEC's Role: EMEC supported the HyFlyer project and now its successor HyFlyer 2 by taking the lead on all hydrogen related infrastructure outside. EMEC is responsible for generating hydrogen airside using a small scale electrolyser, and developing a mobile hydrogen refuelling system capable of dispensing 100kg of hydrogen in less than an hour.
Project budget: £12.3M

Name: BIG HIT (2019)
Client: Horizon 2020 (FCH-JU programme)
Project Scope: Develop a hydrogen economy in Orkney by installing two electrolysers, fuel cells and hydrogen refuelling stations.
EMEC's role: Operation of a pierside fuel cell, operation of hydrogen transport trailers, operating one electrolyser, and provide hydrogen to assets in Orkney.

Project budget: €5M

MTC
[This information has been redacted] [redacted]

[redacted]

[This information has been redacted] [redacted]

[redacted]

[This information has been redacted] [redacted]

[redacted]

Relevant Past Projects
Name: ReFLEX H&S Strategy Development (2019)

Client: EMEC
Role: Development of a high level H&S strategy document for the ReFLEX project. The project consortium is a group of peers with no one single organisation having responsibility for H&S across the consortium. The H&S strategy document is intended as an initial framework to coordinate the H&S activities of the partners and to be built upon to provide an SMS for the Special Purpose Vehicle (SPV) which will take on the operation of the ReFLEX project.
Project budget: £29m

Name: HyFlyer I (2019)
Client: EMEC
Role: Provision of system safety engineering capability to the project consortium comprising ZeroAvia, EMEC and Fuel Cell Systems Ltd. for the R&D programme to design, build and test a hydrogen powered light aircraft including the necessary ground support systems. This project demonstrated the first flight of a hydrogen powered commercial-grade aircraft in the world.
Project budget

HSSMI
[This information has been redacted] [redacted]

[redacted]

[redacted]

[redacted]

[This information has been redacted] [redacted]

[This information has been redacted] [redacted]

[This information has been redacted] [redacted]

Organisation Website www.consultarc.com

Organisation Name
Abbott Risk Consulting Ltd.

The registered address of the Partner Organisation

Address Line 1 11 Albyn Place

Address Line 2 -

Address Line 3 -

Town/City Edinburgh

Postcode/Zip Code EH2 4NG

UK Region (if applicable)

Scotland

Country

United Kingdom

Organisation Type

Private Company

What is the size of the organisation?

Medium Enterprise <250 employees

Number of employees (including directors)

100

Company Registration Number

234532

Turnover Amount (in most recent annual accounts) Please include the currency of the amount in your response.

[redacted]

Turnover Date (in most recent annual accounts)

* 31/12/2019

Balance Sheet Total (total assets net of depreciation) Please include the currency of the amount in your response.

[redacted]

Balance Sheet Date (total assets net of depreciation)
* 31/12/2019

Is the Organisation able to recover VAT?
Yes

Organisation Maturity
>10 years

Does the organisation have a parent company? (If yes you will be asked to provide details)
No

Additional Partner

Do you need to add an additional partner?
Yes

Partner 2 Contact and Organisation Details

Contact Details

[This information has been redacted]

Title	[redacted]
Name	[redacted]
Position	[redacted]
Email	[redacted]
Mobile Number	[redacted]
Organisation Website	WWW.AUTODESK.COM

Organisation Name
AUTODESK LTD

The registered address of the Partner Organisation

Address Line 1	SMALL HEATH BUSINESS PARK
Address Line 2	TALBOT WAY
Address Line 3	-
Town/City	BIRMINGHAM
Postcode/Zip Code	B10 0HJ

County (if applicable)

West Midlands

UK Region (if applicable)

West Midlands

Country

United Kingdom

Organisation Type

Private Company

What is the size of the organisation?

Large Enterprise

Number of employees (including directors)

600

Company Registration Number

01839239

Turnover Amount (in most recent annual accounts) Please include the currency of the amount in your response.

[redacted]

Turnover Date (in most recent annual accounts)

* 31/01/2020

Balance Sheet Total (total assets net of depreciation) Please include the currency of the amount in your response.

[redacted]

Balance Sheet Date (total assets net of depreciation)

* 31/01/2020

Is the Organisation able to recover VAT?

Yes

Organisation Maturity

>10 years

How is the organisation currently funded? (Choose all that apply)

	No Funding	Founders (including bank loans)	Friends and Family	Public Sector Grants	Angel Investment	Venture Capital	Private Equity	Stock Market Flotation
								X

Does the organisation have a parent company? (If yes you will be asked to provide details)

Yes

Parent Company Details (for Partner Organisation)

Parent Company Details

Organisation Name	AUTODESK INC
Address Line 1	111 MCINNIS PARKWAY
Address Line 2	-
Address Line 3	-
Town/City	SAN RAFAEL
Postcode/ Zip Code	CA 94903

Country

United States

Number of employees (including directors)
~11,500

Company Registration Number
SEC CIK #0000769397

Turnover Amount (in most recent annual accounts) Please include the currency of the amount in your response.
[redacted]

Turnover Date (in most recent annual accounts)
* 31/01/2021

Balance Sheet Total (total assets net of depreciation) Please include the currency of the amount in your response.
[redacted]

Balance Sheet Date (total assets net of depreciation)
* 31/01/2021

Organisation Maturity
>10 years

Additional Partner

Do you need to add an additional partner?
Yes

Partner 3 Contact and Organisation Details

Contact Details

[This information has been redacted]

Title	[redacted]
Name	
Position	
Email	
Mobile Number	
Organisation Website	www.emec.org.uk

Organisation Name

European Marine Energy Centre

The registered address of the Partner Organisation

Address Line 1	The Charles Clouston Building
Address Line 2	OIC
Address Line 3	Back Road
Town/City	Stromness
Postcode/ Zip Code	KW16 3AW

County (If Applicable)

Orkney

Country

United Kingdom

Organisation Type

Research Organisation

What is the size of the organisation?

Medium Enterprise <250 employees

Number of employees (including directors)

61

Company Registration Number

SC249331

Turnover Amount (in most recent annual accounts) Please include the currency of the amount in your response.
[redacted]

Turnover Date (in most recent annual accounts)
* 30/06/2020

Balance Sheet Total (total assets net of depreciation) Please include the currency of the amount in your response.
[redacted]

Balance Sheet Date (total assets net of depreciation)
* 30/06/2020

Is the Organisation able to recover VAT?
Yes

Organisation Maturity
>10 years

How is the organisation currently funded? (Choose all that apply)

	No Funding	Founders (including bank loans)	Friends and Family	Public Sector Grants	Angel Investment	Venture Capital	Private Equity	Stock Market Flotation
				X				

Does the organisation have a parent company? (If yes you will be asked to provide details)
No

Additional Partner

Do you need to add additional partners?
Yes

Additional Partner

Do you need to add additional partners?
No

Additional Information

The answer to the following question will only be taken into account once the application has been fully assessed to ensure projects are not double funded. Have you applied, or are you planning to apply, for any other government funding for this project?
No

Programme Performance Indicators and Benefits

How would you describe the nature of your innovation project?
Product Development
Hardware Development
Service Development
Software Development
Process Development

State how many FTE jobs could be retained in your organisation as a result of participation in this project? (enter a number)
11

State how many FTE jobs could be created in your organisation as a result of participation in this project? (enter a number)
100

What is the number of Partner Organisations supported to deliver the project? (enter a number)
18

Will the project be conducting consumer trials?
No

Technology Readiness Level at Project Start

	1	2	3	4	5	6	7	8	9
						X			

Expected Technology Readiness Level at Project Close

	1	2	3	4	5	6	7	8	9
								X	

What do you think are the current market barriers to the commercial exploitation of your innovation? Please select all that apply.
Availability of finance
Capital intensive demonstration phases
Further technical, scientific or engineering challenges
Lack of industry standards
Sector culture and behaviour in favour of proven technologies

The Low Carbon Hydrogen Supply 2 Competition will aim to realise the following benefits. Please select which benefits your innovation could potentially contribute to. This is not a scored section.

	Yes	No
Supply Chain Development **Help support the growth of 'clean growth' supply chain companies in key technology and engineering sectors.**	X	
Export Opportunities **Support development of domestic and export markets.** **Multiple countries are developing hydrogen strategies, which have low carbon hydrogen production targets of multiple GWs. A recent update to the Energy Innovation Needs Assessment (EINA) estimates that by 2050 an active UK hydrogen economy could generate a GVA of £11.7bn and support 100,000 jobs from both domestic and export markets. Without support for innovation projects the hydrogen economy is unlikely to achieve this market share.**	X	
Policy Insights **Provide insight into costs, performance and what is required to remove technology and market barriers to deploying hydrogen supply solutions.**	X	
Spillover Benefits **Result in knowledge spillovers, where discoveries made from advancing your innovation could enable developments in other sectors. The projects could also provide wider benefits supporting the development of a hydrogen economy.**	X	
Green Jobs **Increase number of jobs working on 'building back better' in the UK.**	X	
Carbon Savings **Increase carbon savings through improved efficiencies, greater capture rates or through enabling greater applicability for hydrogen to decarbonise the energy system.**	X	
Reduced Costs **Increase and de-risk the range of products on the market which could enable greater competition.**	X	

Public Description of the Project

The public description of the project should be a brief non-confidential description of the project that BEIS may use in online or printed publications. Please describe the project objectives, key deliverables and the expected project benefits. (Maximum 400 words)

The UK government has identified the opportunity for the use of hydrogen as a NetZero energy source. The key challenges surrounding NetZero energy sources include the intermittency of its availability, which highlights energy storage is more important than ever. Low-pressure solid-state hydrogen storage provides an interesting alternative to other methods, such as compressed gas storage.

Green hydrogen can be produced during periods of high renewable electricity generation; therefore, it is unlikely that hydrogen can be produced at the same rate as is commercially required for hydrogen as fuel gas or other energy storage requirement. Therefore a storage method is required to store hydrogen for periods of low generation to provide a buffer.

Currently, compressed gas technologies are being deployed across the UK as a relatively easy method of storing gas for medium-to-long durations, utilising underground geological facilities and pressurised vessels. The ease of its input/output of gas makes it a reliable method of gas storage, however, this method comes with its own challenges. Pressurised vessels on operational sites pose safety challenges, efficiency limitations, high costs at scale associated with compression, and require large areas of land to store.

This project will design and build a modular hydrogen storage solution with the H2GO Power reactor which is proven and certified storing 1kg of hydrogen. The H2GO product provides a solution where compressed gas is not feasible. The technology can achieve volumetric storage densities of up to 50-100gH2/L, higher than liquid and gaseous state hydrogen storage, thus needing less floor space for storage.Additionally, the technology stores hydrogen at ambient temperatures and pressures, making it a safer, lower-cost, and more efficient alternative to high-pressure storage solutions onsite for long-duration storage. This has significant cost savings (removing compression or cryogenic cooling costs), space savings and is safer; removing a lot of regulatory requirements, and hydrogen can be stored in periods of days to months providing the security of supply required.

This first construction of a modular prototype is critical for the technology evaluation at scale to establish a viable solution and a market offering in the future.The program of works will look to integrate 30 hydrogen storage reactors into a shipping container with the associated heat management and process safety controls to confirm the solution. This solution will then be integration into the EMEC network of hydrogen assets to assess its performance and commercial viability.

Further Information

Referenced Figures (will be assessed) The applicant’s response must be entered in the text box(es) where provided in the Assessment Criteria section. Applicants who wish to support their responses with figures (e.g. illustrations/PFDs/graphs/charts/schematics) may attach these here as part of the Referenced Figures single attachment (max. 20MB allowance provided). Applicants must clearly label the figures in the attachment and reference the figures in their response within the text box to ensure they are assessed. Any further text submitted within this attachment will not be assessed. To complete this section, you may upload referenced figures here Max upload size per file – 20MB Max number of files – 1

- File: Criterion 3b Appendix.pdf - Download

Supporting Information Additional letters of support or other supporting information can also be submitted here before you submit your online application form, where they add background/ supporting information (this could include but not limited to relevant papers, assumptions/ calculations to back up the assertions made in the application) to the application. However, the assessment will be based on the information directly written in the online application; you should not assume that any additional information will be cross-referenced or reviewed as part of the selection process. Applicants may upload up to 4 such attachments (max. 20MB per attachment). Upload further information documents here. Max upload size per file - 20MB Max number of files - 4

- File: [This information has been redacted]
- File: H2GO Power SHyLo LoS.pdf - Download
- File: BEIS_Additional_Project_Partner_Contact_and_Organisation_Details.xlsx - Download

Declaration Forms

To complete your application, you must download, complete and sign where relevant and upload the following documents using the 'choose file' option below. Statement of non-collusion Form of Tender Conflict of Interest form Standard Selection Questionnaire Code of Practice GDPR Assurance Questionnaire Prompt Payment If convenient you can use e-signature to sign the documents. Max upload size per file - 5MB Max number of files - 7

- File: SHyLO Declaration 1 Signed.pdf - Download
- File: SHyLO Declaration 2 Signed.pdf - Download
- File: SHyLO Declaration 3 Signed.pdf - Download
- File: SHyLO Declaration 4 Signed.pdf - Download
- File: SHyLO Declaration 5 Signed.pdf - Download
- File: SHyLO Declaration 6 Signed.pdf - Download
- File: Declaration_7__Prompt_Payment.pdf - Download

Application Form Checklist

As well as the completion of this Application Form please check that, if required, you have provided the following information.

	Yes	No
Organogram	X	
CV package	X	
Stream 2 Gantt Chart or Outline Project Plan	X	
Stream 2 Key Work Packages	X	
Stream 2 Risk Register	X	
Project Cost Breakdown / Finance Form	X	
Declarations	X	
Attached supporting documentation ***Clearly Referenced***	X	

Signatory Page

Enter details below

Name of Organisation	H2GO Power
Signature ***Please insert name***	[This information has been reda
Position in Organisation	[This information has been redacted]
Date (DD/MM/YYYY)	31/08/2021

Do you give BEIS permission to contact you/your organisation in relation to your application and to provide updates on its progress. We may also share with you further details on the Low Carbon Hydrogen Supply 2 competition when available? Consent is required for the application to be submitted.

Yes