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
ITM Power Trading Ltd

2. Project Name
Gigatest

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.
Zero Carbon Hydrogen Production Solutions

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

5. Stream 2 Demonstration Project Duration (months)
1 39

6. Stream 2 Estimated End Date
* 01/02/2025

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.
9798602.69

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

Gigatest will be an enabler for ITM Power to accelerate the commercial development of its 4th generation Proton Exchange Membrane (PEM) electrolyser stack and manufacturing site, the Gigafactory, at Bessemer Park in Sheffield. Through this project, ITM Power seeks to commercialise the lowest cost green hydrogen solution in the market, supporting rapid decarbonisation in hard-to-abate sectors and strengthening the UK's leadership in clean energy technologies.

As part of Gigatest, ITM Power will build its first 4th generation 5MW stack, following conceptual designs developed through previous BEIS funding competitions. Following construction, the stack will undergo rigorous testing under representative conditions to validate the performance under-real world conditions, and ensure the technology is ready for large scale commercialisation. ITM Power's 4th generation stack has multiple competitive advantages over current competitors, including ultra-low capital costs, a lower system footprint and significantly larger stack size. These advantages will greatly enhance the stack's ability to operate under flexible conditions coupled to renewable energy, and therefore produce green hydrogen at the lowest cost in the market. ITM Power is confident the 4th generation stack will be globally best in class, offer multiple advantages over other technology platforms and become the mainstream green hydrogen solution in the UK and global market. Furthermore, Gigatest will be critical for ITM Power to deploy and validate key manufacturing equipment at its Gigafactory at Bessemer Park, contributing to the rapid initiation of semi-automated mass production of electrolyser stacks. Advancements in manufacturing techniques and equipment will allow ITM Power to realise an immediate manufacturing capacity of 1GW/year by 2023 while maintaining the highest quality standards for the 4th generation stack. With current PEM manufacturing capacities of 30MW/year, ITM Power's Gigafactory will be is crucial in ramping up green hydrogen production in the UK and manifesting the country UK as a global export leader of electrolyser technologies.

Gigatest will be essential in contributing to the UK's 2030 hydrogen production target of 5GW by 2030, leading to annual emission savings of up-to 8.5 million tCO2 by 2033 and securing high-skilled manufacturing of jobs in the Humber region.

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

The 4th generation stack has been developed through the BEIS funded Gigastack project, cumulating in the testing of a short-stack (150kW). Gigastack project partners Orsted and Philipps66 are seeking reassurance of commercial readiness of the technology pre-FID for a 100MW deployment but the building and testing of a full 5MW unit, are a major up-front cost which under current financial conditions cannot be fully met by ITM alone. [This information has been redacted]

However, a successful gigatest project de-risks the UK losing the lead on electrolyser technologies and manufacturing capability, and de-risks large deployments in the UK – including the Orsted/Phillips collaboration. As Gigatest is essential for the UK's decarbonisation efforts, for the country to remain a technological leader in low carbon energy solutions, and to secure high-skilled engineering jobs in the UK, ITM Power believes requesting public sector funding and sharing project risks with HMG is justified. Other governments, including those of Germany and China are heavily investing in their hydrogen technology capabilities to build global technological leadership. Although ITM will benefit financial from this public sector investment, HMG will equally benefit through securing the UK's future role in an advancing technological field, essential to meet global climate targets.

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

Title	[This information has been redacted]
Full Name	
Position	
Email	
Mobile Number	
Organisation Name	ITM Power Trading Ltd
Organisation Website	www.itm-power.com

2. Email Email will be the primary method of correspondence following submission.

[This information has been redacted]

3. The registered address of the Lead Organisation

Address Line 1	2 Bessemer Park
Address Line 2	-
Address Line 3	-
Town/City	Sheffield
Postcode/ Zip Code	S9 1DZ

4. County (If Applicable)

South Yorkshire

5. UK Region (If Applicable)

Yorkshire and the Humber

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

Medium Enterprise <250 employees

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

[redacted] (but medium enterprise under Commission Recommendation of 6 May 2003 based on the turnover and balance sheet total criterion)

11. Lead Organisation Company Registration Number

06156553

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)

* 30/04/2021

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)

* 30/04/2021

16. Is the Lead Organisation able to recover VAT?

Yes

17. Lead Organisation Maturity

>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				

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

ITM Power is an AIM listed company and the UK's foremost manufacturer of electrolyser systems, based on polymer electrolyte membrane (PEM) technology. ITM has a first-class team comprising >200 engineers and scientists, based in Sheffield. The ITM facilities include prototype demonstration areas for applications of ITM's technology. ITM's Research & Development Facility comprises custom made laboratories and accommodates specialist equipment for ongoing optimisation, durability testing and optimisation of materials and electrolyser technology.

ITM is committed to the development of clean fuel systems for Fuel Cell Electric Vehicles (FCEVs), hydrogen energy storage, hydrogen gas injection and hydrogen systems for synthetic natural gas production.

ITM has experience in leading and collaborating in various BEIS, Innovate UK and European Union funded (including Horizon 2020 (FCH JU) and FP7) research and development and demonstration programs.

ITM Power has grown over the last 20 years from a basis in hydrophilic ionic polymers to that of an international hydrogen systems developer and provider. Three commercial generations of stack technology have been developed to date. All of these have been developed, tested and then manufactured for deployment at ITM's Sheffield headquarters.

This period of growth and expansion has included:
– Developing Europe's largest electrolyser plant in the Rhineland, the RefHyne project, a 10MW PEM electrolyser at the Shell Refinery in Cologne.
– Proving the ability to use a 20% blend of hydrogen by volume in the gas grid in homes in Keele. This will prove the ability for existing homes to utilise green fuels in their everyday domestic products without any compromise on utilisation.

Work is now focussed on scaling further, expanding to the Bessemer Park "Gigafactory" to meet the anticipated electrolyser market and imminent cost reduction programs to ensure competitive bidding on commercial sales.

ITM Power has a JV with Linde engineering, based in Germany ILE (ITM Linde Electrolysis) provides a platform for ITM to sell electrolyser systems, with Linde providing EPC services to large scale projects.

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

Yes

Parent Company Details

1. Parent Company Details

Organisation Name	ITM Power Plc
Address Line 1	2 Bessemer Park
Address Line 2	-
Address Line 3	-
Town/City	Sheffield
Postcode/ Zip Code	S9 1DZ

2. Country
United Kingdom

3. Number of employees (including directors)
6

4. Company Registration Number
05059407

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

6. Turnover Date (in most recent annual accounts)
* 30/04/2021

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

8. Balance Sheet Date (total assets net of depreciation)
* 30/04/2021

9. Organisation Maturity
>10 years

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)

Gigatest Project Overview

Gigatest will be an enabler for the UK's net-zero ambitions and global technological leadership in green hydrogen production. Green hydrogen is projected to be one of the two main zero carbon hydrogen sources. The International Energy Agency (IEA) forecast that global hydrogen demand could reach 17MT and 75MT/year by 2030 and 2040 respectively . According to IRENA, green hydrogen production costs could fall below £3/kg this decade. Further improvements are expected to yield a green hydrogen production cost well below 2.50£/kg , making green hydrogen competitive with blue hydrogen.

Achieving these green hydrogen cost reductions requires progress on two fronts – firstly, the installed cost of large scale electrolysers systems needs to fall and secondly, electrolysers need to be coupled with low carbon sources of energy at a very low cost of electricity. These two aspects are linked, as accessing low cost electricity tends to require operation at a low load factor (to access power when the grid has an excess), which in turn makes the cost of hydrogen production more sensitive to the capital cost of the electrolyser plant.

ITM Power's 4th generation "Gigastack" electrolyser technology will enable globally significant progress on both aspects. The system will cut electrolyser module costs by over [redacted] compared to the state of the art, while allowing highly flexible operation to cope with the intermittency of renewable electricity. [This information has been redacted] will make the Gigastack technology the globally leading electrolyser stack (of all cell chemistries) and a key component of the global shift to green hydrogen.

This new large format stack design, with novel material selection and approach has been designed for mass manufacture through successive BEIS funded hydrogen production programs. This Gigatest project will take the next step which is to manufacture and then thoroughly validate and test the stack at the full [redacted] scale which will be the building block for future large scale systems.

As part of Gigatest project, ITM Power has the following objectives:
1. Assemble and validate the semi-automated manufacturing equipment for large scale stack production capacity at ITM Power's Gigafactory
2. Deliver a functional state of the art test bay and develop quality control processes to support large scale electrolyser manufacturing
3. Manufacture and commission the first 5MW Gigastack stack, using the designs and manufacturing techniques developed in Gigastack Phase 1&2
4. [This information has been redacted] This innovative ultra-low cost stack, combined with significant upscaling in production volumes, will allow renewable hydrogen production to become a mainstream option for the UK's future hydrogen supply.

Latest developments by ITM Power ahead of Gigatest

ITM Power is a globally leading electrolyser developer and has installed PEM electrolyser systems worldwide. These have tended to be based on relatively small systems deployed on the MW scale to demonstrate the potential of hydrogen technology. As the requirement for renewable hydrogen in the energy system have become clearer, ITM have recognized a UK and global requirement to start building lower cost and much larger (100MW+) electrolyser facilities. As a result, ITM Power has focused its R&D efforts into developing its 4th generation stack technology, which solves four key issues: a) providing low cost hydrogen, b) operating efficiently in a flexible environment, c) with a large format low footprint design suitable for GW scale installations and c) capable of being manufacturing

on a large scale through a semi-automated process. In addition ITM have developed a 50:50 joint venture with Linde Engineering to allow ITM to focus on electrolyser manufacturing, with EPC services provided by Linde. ITM are therefore perfectly placed to bid into the 100MW+ scale projects of the future.

As part of the BEIS funded Gigastack Phase 2 project, ITM Power developed the detailed manufacturing design for their 4th generation high capacity electrolyser stack and built the first short-stack 150kW prototype. They have also generated new integrated balance of plant designs for a new 5MW electrolyser module which will be the basis for future stacks.. [This information has been redacted]

ITM Power has also taken the first steps in developing the largest global electrolyser manufacturing facility at Bessemer Park, Sheffield. [This information has been redacted] Preparation and construction of all factory areas were completed by October 2020, and ITM moved into the factory for production in January 2021.

[This information has been redacted]

Finally, under Gigastack Phase 2, a complete FEED study was carried out for a 100MW installation in Immingham, Humberside in partnership with Phillips 66 (hydrogen demand at their refinery) and Orsted (provision of power from offshore wind), where key challenges in green hydrogen production have been addressed, including water availability, access to renewable power and moving from containerized to industrial electrolyser designs to facilitate scaling up.

The Gigastack Phase 2 project also identified significant regulatory barriers that need to be overcome to make large scale green hydrogen projects commercially viable. Further regulatory developments are required on the current Offshore Transmission Owner (OFTO) framework, to mitigate high risks of cost disallowance and provide assurance to green hydrogen developers. Uncertainty around Network charges (relating to TNUoS and BSUoS) for grid connected electrolysers and lacking clarity on metering to unlock the full value of negative hours are still major hurdles to deploying large scale hydrogen projects. [This information has been redacted]

Although ITM Power has gained significant confidence in its 4th generation stack and manufacturing capabilities, Gigatest is essential to validate the KPIs of the 5MW full-size stack and ensure the stack can operate in real-world representative conditions, proving its abilities to energy system stakeholders, project developers and financiers in the UK and globally. Equally important will be validating the capacity and performance of the semi-automated manufacturing process to produce full 5MW sized stacks cost effectively and to a high product standard.

The main activities and the expected outcomes of this project are described below:

Activity 1 - Assembly and commissioning of manufacturing equipment to enable large scale manufacturing capacities - The assembly of key manufacturing equipment and subsequent commissioning will be essential to enabling ITM Power's large scale manufacturing capacities [This info] The process innovations below will be evaluated based on different KPIs, including: [This information has been redacted] An overview of the manufacturing equipment deployed through Gigatest is presented in Table 1.

Innovations include:
- Inspection & Quality: [This information has been redacted] This will increase the speed of inspection, the reliability of stacks and facilitate the introduction of [This information]
- Manual to Automated: [This information has been redacted]
[This information has been redacted]
o Implementing [This information has been redacted] will eliminate a key bottlenecks in [This information has] deposition.
o Increasing production speed of [This information has been redacted] will be

increased by a factor of [redacted].
- In-House Equipment: ITM Power has developed innovative in-house equipment which will be deployed through this project.
o Injection moulding, electrode position, edge finishing and stamping tools will be directly implemented.
o ITM Power has also developed novel processes which [This information has been redacted] [redacted]. Through this assembly time will by reduced by [redacted], while stack energy consumption will be improved through reducing [redacted]
- New Processes: ITM Power will also be the first to implement the innovative [redacted] in electrolyser manufacturing. [This information has been redacted] [redacted]

Outcomes:
[This information has been redacted] [redacted]

Activity 2 – Building the first 5MW stack design - ITM Power will build the first full sized 4th generation 5MW stack, using the design and specification work conducted during Gigastack.

Outcomes: Through this task ITM Power will physically validate the manufacturing designs/processes and the cost reductions available from the larger cell area stack design, reduced cost design and the potential for economies through volume manufacture, with the ultimate aim to prove an electrolyser stack manufacturing cost of below [redacted] This will be considerably lower than the current [redacted] industry standard for stack manufacture and significantly enhance the UK's position in the global electrolyser market.

Activity 3 – Full testing and validation of the 5MW stack - After the successful build of the first 5MW stack, the stack will be rigorously tested under real world representative conditions to assess [redacted] This task will overcome the uncertainty around performance in real world conditions, ensuring the system operate flexibly coupled to renewable energy sources, without compromising on hydrogen production costs or equipment lifetime. The overview of the [redacted] module evolution is presented in Figure 4.

Outcomes:
This will be first time the full [redacted] stack will undergo representative testing and the KPIs listed above will be validated and compared to ITM Power's targets. [This information has been redacted] [redacted] The task will bring the TRL of the Gigastack technology from 6 to 7 (with all pre-conditions met ready for a move to 8 in a first large [redacted] scale deployment).

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)

Gigatest will significantly lower the capital and operational costs of producing green hydrogen, with costs tending towards [redacted] by 2025 and well below [redacted] by 2030. This will be achieved through reductions in the capital and operational costs of the 4th generation ITM electrolyser stack, and improvements in flexibility which enable the use of low-cost electricity.

A comparison between the 4th generation stack and ITM targets, the current Megastack (state the art) and the FCH JU targets is found in Table 2.2. The various improvements are described below and supporting data from prior work is provided in the annex (see figure 2.1-2.8).

Reductions in capital costs
The reduction in capital costs is achieved through three distinct factors, increased stack size, lowered stack part count and footprint and moving to semi-automated manufacturing process.

The 4th generation electrolyser has a stack size of [This information has been redacted] compared to [redacted] in the previous generation. This leads to a substantial reduction in the number of stacks required per electrolyser system. The electrolyser deployed at the [This information has been redacted] In order to achieve the same capacity using the 4th generation stacks, this would only [This information has been redacted] [This information has been redacted]

A combination of the compact module designs and increasing stack capacity to 5MW will enable the system to produce significantly more hydrogen per unit footprint. This will ease the transport and installation of electrolysers to industrial sites and facilitate deployment. A reduction of [redacted] per MW is expected. Minimising the system footprint allows for space efficient integration in industrial environments at large scale thereby reducing land and civil costs.

Additionally, producing the 4th generation stack through a semi-automated manufacturing process reduces the capital costs significantly. Moving away from batch manufacturing to a high throughput factory process, minimizes loss of materials and reduces labor costs, further reducing the overall stack costs. During Gigastack Phase 2, [This information has been redacted]

Combining these three characteristics, ITM will reach manufactured stack costs of [redacted] This low stack cost allows ITM to deliver fully installed modules at [redacted] in 2023 and [redacted] by 2025. This will enable complete integrated green hydrogen project solutions (i.e. Including civils, compression, power connection etc) at costs below [redacted] in 2023 and below [redacted] in optimal locations by 2025.

Operational Costs
Further to the capital costs reductions achieved above, the 4th generation stack will also reduce the operational costs, driving down the costs of production of green hydrogen.

During Gigastack Phase 1, [This information has been redacted]

[This information has been redacted]

In addition to these steady state values, ITM Power has also established specifications for the performance of the system at a range of output levels, thereby characterising performance across the entire operating range in figure 2.8. This demonstrates the potential efficiency improvement from operating at part-load.

ITM Power has designed the system to produce hydrogen at a pressure of [This information has been r]. This is a major advantage compared to other systems on the market (e.g. most alkaline electrolysers work at atmospheric pressure). The higher pressure output simplifies the cost of the downstream systems as it voids the need for expensive, energy intensive and unreliable compressors.

In terms of reliability to meet demand, electrolysers themselves are highly robust. The systems have a proven field availability [This information has been r] and very few moving parts. This maximizes the hydrogen production during useful hours of renewable electricity, further driving down the levelized-costs of hydrogen.

Lower capital costs enable a larger system to operate at a lower load factor for the same overall capital cost contribution to the price of hydrogen. This combined with the ultra-high response rate of the electrolyser stack means the 4th generation stack is ideally designed to access low-cost electricity, which will require operation at times when a) there is a large amount of renewable energy generation and/or b) where the price of electricity is low.

Hydrogen Quality
PEM Electrolysis produces highest purity hydrogen commercially available at [This information has been redact] [This information has] The quality of this hydrogen is monitored routinely in accordance with an appropriate hydrogen risk assessment, in line with the ISO 19880-8 and EN 17124: 2017. The sampling methodology is based on the principles of [This information has been redacted]

[This information has been redacted]

Validation of Key Performance Indicators
As part of Gigatest, ITM Power will validate the key performance indicators to ensure reductions in capital and operational costs are achieved, leading to a TRL of 7 and overall lower hydrogen production costs.
The following stack KPIs will be validated in WP 6:
• Efficiency – [This information has been redacted]
• Installed Capital Cost – [This information has been redacted] [This information has] [This information has b] ensuring that ITM Power can meet capital cost targets which are essential to access low-cost renewable electricity. The experience from building these modules will also help validate the more aggressive 2025 targets (< [This information has] stack and [This information has be] for the installed module).
• Degradation – [This information has been redacted]
• [This information has been redacted]

Validating the KPIs of the manufacturing process is equal important to realise the performance targets set above and raising the MRL to 6.
The following manufacturing KPIs will be validated:
• [This information has been redacted]
• Factory throughput per component – optimizing factory throughput allows the facilities to be used cost-effectively, bringing down manufacturing costs and further improving cost-competitiveness of ITM Power's stack.
Market Acceptance of the 4th generation stack
ITM Power is confident that the 4th generation stack will gain widespread market acceptance and match sales targets. [This information has been redacted]

[This information has been redacted]

With further technological improvements in the 4th generation stack, leading to reduced module costs and the ability to access low cost electricity without compromising on the economics, the stack has multiple competitive advantages over other technologies [This information has been redacted]

Strategy following completion
Once the first 5MW stack is manufactured and tested, the intent is to begin manufacturing and deploying further 5MW stacks at customer sites in the UK and worldwide. The first Gigatest 5MW stack will continue to operate as a permanent testing unit at the Gigafactory to provide longevity testing and input into customer decision on ongoing plant operations, contributing to the learning base and providing insights on the long-term operational behavior in a large-scale integrated deployment project.

The manufacturing equipment and the process system will continue to be used by ITM Power to produce electrolyser stacks at a large capacity of >1GW/year post-2025. This will be critical for ITM Power to becoming a leading global electrolyser manufacturer, securing manufacturing jobs in the UK and positioning the UK as a global leader in clean energy technologies. The test bay and quality control processes developed will also be used by ITM Power to validate future electrolyser stack systems, ensuring manufacturing quality is of the highest standard to achieve global mass adoption.

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 objective of Gigatest, and also in the wider context Gigastack, is to deliver large-scale renewable hydrogen [This information has been redacted]. Advancements through Gigastack Phase 1 & 2 have paved the way for plausible business cases for renewable hydrogen through:
• CAPEX & OPEX reductions – increasing the stack size from 700kW to 5MW and progressing to a semi-automated manufacturing process reduces both the capital and operational costs
• Ability to operate flexibly – these capex and opex improvements allow the electrolyser to operate flexibly with a low load factory without driving up hydrogen production costs
• Access to low cost renewable electricity – Cost reductions combined with flexible operation allow the electrolyser to be selective with the power price range accepted, importing only low cost renewable electricity, which further reduces the LCOH

• Innovative sitting of electrolyser – reductions in stack footprint allows sitting close to the windfarms, reducing grid fees and additional infrastructure costs, while overall system efficiencies are improved.

To analyse the effect of these a simple levelised cost of hydrogen model has been built and key assumptions are provided in Table 1 (Annex 1), while the results are presented in Figure 7. In the analysis, the complete delivered project costs for electrolysers including ITM Power's electrolyser modules are used for the CAPEX [This information has been redacted] Electrolyser degradation is accounted for by increasing the variable OPEX by [This information has been redacted] The variable OPEX consists of the electricity price and the water costs. Stack replacement costs are taken into account in the Fixed OPEX cost contribution.

Counterfactual – today's electrolyser with simple power procurement

For Gigatest, a counterfactual has been defined as the current technology for ITM's electrolyser stacks (Megastack), which is currently a globally leading stack, together with the electricity price provided by BEIS. The assumptions for this counterfactual and the scenarios identified below are defined in Table 1.

This yields a levelized cost of hydrogen at [This information has been redacted] of [This information has], with the variable OPEX contributing [This information has], the fixed OPEX [This informat] and the capital costs [This information has been redacted]

Improvements in sourcing power

Through the work conducted in Phase 2 of Gigastack, various improvements in electricity procurement by siting close to an offshore wind farm substation have been identified, including:

• EII Exemption: an Energy Intensive Industries (EII) exemption reduces the cost of green levies by 85%.
• Minimising Wind Power Grid Fees: Smart operation to avoid high grid fee period and also intelligent connection to a wind farm sub-station to reduce/share certain costs.
• Arbitrage: Marginal reductions in commodity costs come about through avoiding consumption of power more expensive than [This information has been]
• Wind Fixed PPA Pricing & Arbitrage: Attractive terms can be reached with a wind farm to fix the cost of power when used from the wind farm - this reduces the average power price (which is based on a mix of grid and wind farm).

Applying these improvements to the Megastack technology is the basis of scenario 2, yielding a LCOH of [This information has]. The reductions identified through the Gigastack FEED study lead to an average electricity price for the electrolyser of [This information has] as result of reduction in non-commodity charges and using roughly 10% of the electricity from the grid and 90% from the windfarm (for an overall load factor of 96%). This reduces the electricity contribution to the LCOH from [This information has been redacted] This cost is still prohibitively high and as a result first deployments using this technology have relied heavily on subsidy.

Improvements due to the Gigastack technology

In Scenario 3, the same conditions are applied to the 4th generation Gigastack stack in 2023, further reducing the levelized cost of hydrogen to [This information has] as result of the reduction in the integrated system's installed cost, decreasing the LCOH capital cost contribution from [This information has been redacted]. Improvements in the stack efficiency to [This information has be] lead to a reduction in the electricity cost contribution. The Fixed OPEX associated costs are also reduced from [This information has], while stack replacement costs fall from [This information has] to [This information has] through the transition from the Megastack to Gigastack. This corresponds to a [This inform] reduction in the LCOH in comparison to the counterfactual.

The Gigastack technology will continue to mature to 2025 (Scenario 4), in particular stack efficiency improvements to [This information has been re] and manufacturing cost decreases which lead to total delivered project cost reductions to [This information has] This leads to a LCOH of [This information has] in 2025 (scenario 4), a [This inform] reduction in the LCOH compared to the counterfactual.

Whilst these numbers are higher than the cost of fossil derived hydrogen (in the range [This information has been redacted] including CCS), they are within the range of a number of policies to designed to support green hydrogen, including the UK's RTFO policy for hydrogen use in road fuels (which provides an effective subsidy (uplift) well over [This informat] for the use of green hydrogen) and the European implementation of

RED II, whose values range from [redacted] for use in refineries and the mobility sector. Gigastack technology therefore provides a route to making large deployments possible using these regulatory mechanisms in the mid to late 2020s.

Long-term Outlook for Costs of Hydrogen Solution

By 2030, changes in the electricity market lead to further cost reductions in hydrogen production costs. Overall, electricity wholesale market prices are expected to significantly increase by the end of the decade by an average of [redacted]. This increase is the consequence of more volatile electricity markets, the intermittence of renewable energy as their share of the electricity mix increase, and higher carbon prices. However, simultaneously it is expected that as a result of the volatility there will be considerable periods with ultra-low electricity prices when there is an imbalance between the amount of renewable energy and demand. This presents an opportunity for ultra-low cost electrolysers using the 4th generation stack technology which are well suited to operate selectively (at low load factors) during these off-peak times to capitalize on very low electricity prices. An electricity cost of [redacted] for 40% of the year was found to be reasonable during the FEED study conducted in Gigastack Phase 2 in accordance with Orsted. Day Ahead Electricity Market Prices for 2018 compared to projections for 2030 are presented in Figure 6. With this reduction, the electrolyser could operate at a [redacted] load factor, and still achieve an overall lower LCOH.

Such a configuration, as highlighted in Scenario 5, would correspond to a LCOH of [redacted]. This is achieved through further lowering the installed integrated system capex, reducing the fixed [redacted]. Stack replacement costs are also expected to fall to [redacted]. The LCOH includes a manageable increase in the capital cost contribution from to [redacted] (due to higher load factor), an increase in the fixed OPEX from [redacted] and large reduction in the variable opex from [redacted], owing to the low cost of electricity accessed by the electrolyser in 2030.

Overall by 2030, this would lead to a cost reduction of [redacted] compared to the counterfactual. Taking into account the expected price increases for natural gas and carbon credits, this would make green hydrogen production cost competitive with blue hydrogen by 2030. Additionally, the variable OPEX could be further reduced for all scenarios by direct connection to the wind farm, opting for more frequent stack replacements and therefore improving the efficiency. The attractiveness of this operational strategy increases over the coming decade, as the costs for stack replacements continue to fall.

Potential for industrial synergies & System Benefits

Exploiting industrial synergies has the potential to further improve the levelized cost of hydrogen beyond the costs identified in scenario 5. [redacted] Additionally, there are also non-industrial sites which have oxygen demands, such as fish farms, which could act as potential off-takers. Assuming a value of oxygen of [redacted] per kg of oxygen (£[redacted] of hydrogen), could yield a LCOH of [redacted] in 2030.

Overall the 4th generation also enables wider system benefits through the use of hydrogen to couple the electricity sector with other energy demands. This includes:
• Improving the business case for RES deployments by providing a securely priced demand for the output electricity (where the price security comes from the relative stability compared to prices in the other markets) – this can drive increased RES uptake
• Balancing of the electrical grid – electrolyser can be operated flexibly to help balance the grid over very short timescales. [redacted] This reduces the cost of balancing the grid in an increasingly intermittent supply and demand situations expected with a higher future penetration of renewables.
• Longer term storage –converting electricity into hydrogen creates an opportunity for storage over long time periods. By adjusting hydrogen production according to periods over and under supply of electricity, it becomes easier to manage the GW of large-scale imbalance between supply and demand expected on the renewable dominated grid in the future.

Contribution of Gigatest

Gigatest is an essential step to realizing the 2030 LCOH targets for green hydrogen. Constructing the

first 5MW stack will be enable the 2023 capital cost reductions to be made real and accelerate first of a kind deployments and the rapid up-take of electrolysers in various sectors. [This information has been redacted]

Accelerating short-term large scale hydrogen deployments will enable learnings and technical advancements in industrial settings and create demand for zero-carbon hydrogen solutions, which will allow ITM Power to further invest in its R&D activities and reduce hydrogen production costs. [This information has been redacted]

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: BEIS Hydrogen Supply Competition Stream 2 - Annex 2 Relevant Previous Work.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)

In the short-term Gigatest will enable ITM to move the electrolyser stack into commercial deployment, shifting the Bessemer Park production from manual production of Megastack (the 3rd generation technology) over to the new larger format Gigastack in a semi-automated process with a 1GW/year capacity.

[This information has been redacted]

Gigatest will also enable ITM Power's commercial plans to initiate other projects worldwide such as the Refhyne II project in Cologne. By 2024, the project partners plan to increase the electrolyser capacity at Shell's Cologne refinery from 10 to 100MW, producing over 10,000tH2/year and saving an additional 76,000 tonnes of CO2 per year. Deploying the 4th generation stack technology in Refhyne II and Gigastack would be a key milestone for ITM Power, showcasing the potential of its innovative

solution to a global audience. Figure 9 shows ITM Power's global sales leads which will be a key route to market.

With the expansion of the manufacturing capacity at the Gigafactory, ITM Power will also realise the opportunity to mature its supply chains. [This information has been redacted] The new manufacturing capacity by 2025 will require ITM to stress test its suppliers and build in confidence in the resilience of its supply chains. ITM Power has hired a specialist procurement manager to help create new supply chains to facilitate building the GEP. Maturing and building trust in these supply chains is not only critical to reach manufacturing targets and be able to fulfil orders on time, but also to ensure quality is not compromised.

Summary of business plan

With the UK government and the European commission setting targets to deploy hydrogen capacities of 5GW and 40GW by 2030 respectively, the imminent need for low cost hydrogen supply solutions is evident In fact, the International Energy Agency (IEA) forecasted that global hydrogen demand could reach 17MT/year and 75MT/year by 2030 and 2040 respectively, highlighting the exponential demand surge over the coming decades.

In ITM Power's business plan, the company expects electrolyser sales to reach [This information has been redac per year by 2030 (see figure 15)in Annex (insert figure with sales vs. time, capturing [This information h of the market share by 2030. ITM Power potential sales pipelines consists of roughly [This information has been re in projects in Europe alone between 2023-2025 as seen in figure 9. The early target markets for sales will be:
• Additional refinery demands – building on the success of the Cologne refinery deployment, ITM Power currently has numerous enquiries from refinery projects across Europe. Here, the market is supported by the RED II changes to allow renewable hydrogen as a blend for refineries. The global opportunity for electrolysis here could amount to 7.5GW by 2030 [This information has been redacted]
• Other industrial demands – a wide range of other industries are recognising the importance of as a tool for decarbonisation and are planning green hydrogen projects ITM has numerous active 100MW+ projects in the steel, ammonia and e-fuels segments.
• Transport sector – Mobility is a growing market in Europe. The FCH JU projects the deployment of 3,750 hydrogen refuelling stations across Europe by 2030, which could require up to 7.44GW of installed electrolyser capacity. [This information has been redacted]
• Heat sector – blending hydrogen into the natural gas grid is also expected to mature on these timescales. In countries which have allowed high hydrogen blends (up to 20% by volume) and also legislated to incentivise blending, there is a significant market for early electrolyser sales. [This information has been rec

Technical & Commercial Risks

Although ITM Power is confident in its business plan, there exist residual technical and commercial risks which need to be managed. Key technical/commercial risks are listed below:

Commercial Risks
• Lack of hydrogen demand from off-takers – ITM Power proactively market to off-takers in the targeted sectors to develop new business models for hydrogen use and demonstrate strategies to reduce the cost of producing green hydrogen. ITM Power also work with policy makers to develop measures to support the competitiveness of green hydrogen.
[This information has been redacted]
[This information has been redacted]

Technical Risks

• Supply Chain disruptions – ITM Power conduct regular quality control of the materials/components procured, proactively communicate with partners and conduct regular auditing of the resilience of the supply chain to identify problems before they occur
• Unexpected disruptions in the manufacturing process – ITM Power conduct regular inspections and testing of the manufacturing systems and the electrolyser stacks produced to identify problems early

and deploy countermeasures.

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)

Following the successful completion of Gigatest in 2025 and the progressive scale up at Bessemer Park, ITM will continue to ramp up its manufacturing capabilities by constructing a second Gigafactory in the UK, which will be larger than the factory in Sheffield. ITM Power has already secured funding for this venture and will begin construction in 2022. By 2025, total capacity will have increased from 1GW per year to 2.5 GW/year. ITM Power's factory output could therefore easily support the UK government's 2030 target of deploying 5GW of hydrogen production capacity.

ITM Power has strong ambitions to not only become a global leader in electrolyser technologies, but to also play a key part in decarbonising the UK economy. Gigatest will be the first major step in reaching these objectives, as building the first 5MW demonstrator and validating the highly innovative semi-automated manufacturing process will build the required confidence in ITM's technology and the firm as a whole. Following Gigatest [This information has been redacted] and Cologne refineries, ITM Power expects a rapid increase in global sales, as the projects will showcase ITM Power's capabilities in a world leading project. At the same time green hydrogen will gain more traction through other major deployment projects around the world e.g. the GW-scale NortH2 and Aquaventus projects in Europe. ITM Power's second Gigafactory, coming online during 2024, will support ITM Power in managing these sales volumes. Global newly built hydrogen production projects are expected to amount to 60GW/year by 2035, of which [This information has been redacted]

Through the development of the 4th generation stack and the rapid building of manufacturing capacities ITM Power will contribute to the UK's net zero carbon targets in three ways:

♣ Electrolyser cost reductions and efficiency improvements – ITM Power's target capital cost for the 4th generation stack of [This information has] in 2025 will contribute significantly to lowering the levelized cost of green hydrogen, and therefore accelerating the roll-out of green hydrogen projects in the UK. Similarly, improvements in the stack efficiency to [This information has been] by 2025 and the smaller footprint make the PEM electrolyser the ideal technology platform for green hydrogen production, further improving the business case for green hydrogen.

♣ Flexible Operation – The low capital cost, combined with the short hot and cold idle ramp time, small footprint and modular nature of the 4th generation PEM stack paves the way to cost-effective flexible operation. This is critical as it allows green hydrogen producers to selectively choose electricity input at lower prices during off-peak periods, without compromising on capital investment costs. This will be a key enabler in reducing grid constraints and producing green hydrogen in the most economical way.

♣ Manufacturing scale – Through ITM Power's Gigafactory in Bessemer Park, Sheffield, and the second factory being built from 2022, ITM Power would develop manufacturing capabilities of 1GW/year by 2023 and 2.5GW/year by 2024. This will overcome the issue of currently low manufacturing capabilities of electrolyser producers, which is a major bottle neck for the deployment of large scale green hydrogen projects. Long lead times as a result of inefficient batch manufacturing are a major bottleneck for project developers, often leading to delays and incurring additional costs.

♣ Increased renewable deployments – One of the challenges facing the offshore wind industry is to secure a market for the power from the wind turbines. As wind deployment ramps up, the price of electricity becomes inversely correlated with wind speeds. This reduces the "capture price" available for wind operators and can make projects non-viable. Furthermore, grid connections are often the biggest constraint on future development. One solution to this is to divert this electricity to a higher value market. Hydrogen for transport, industry and potentially the gas grid can offer such a secure and reliable market. This in turn provides a secure and long-term price against which the wind development can proceed. In this way large scale electrolytic hydrogen helps justify increases in the UK's renewable energy deployment and a pathway to diversify the renewable electricity into other "hard to treat" sectors.

Direct Contribution to UK and Global Climate Targets

ITM Power's Gigafactory 1 and the 4th generation stack has significant decarbonisation potential as highlighted by Figure 10. Assuming the use of renewable power and the displacement of fossil sources of hydrogen, by 2033, the stacks produced by ITM Power's Gigafactory could be avoiding 8.5MtCO2/year by 2033 (assuming all remain in operation) and could cumulatively have avoided 46.6MtCO2 from 2023 to 2033. These numbers correspond to 2% and 11% of the total GHG emissions of the UK in 2020. Once the 2nd Gigafactory is operational, CO2 emission reduction potential from ITM Power's activities will further increase, leading to an annual reduction of almost 20MtCO2/year by 2033, and a cumulative reduction of 104MtCO2 between 2023 and 2033 as shown in Figure 11. Through both fully used Gigafactories ITM Power will therefore significantly contribute to the UK's climate targets.

Job Creation and Economic Benefits

ITM Power's activities through Gigatest and the wider Gigastack project will unlock significant economic benefits and lead to long-term job creation[This information has been redacted] [This information has be] Early year jobs are dominated by capital expenditure (>90%), which are associated with the construction and deployment of various technologies. New operational related jobs are added in time to run the various facilities and maintain equipment. These are likely to be more sustainable long-term employment opportunities. Operational related jobs are ~50% of all jobs in the central and high scenarios.

Considering the analysis above refers only to activities in Immingham and surrounds will have an immediate annual production capacity of 1GW of electrolyser once its first Gigafactory is operational, the overall economic benefits of the Gigafactory, the 4th generation stack technology and ITM Power's planned global expansion of sales, the realised figure can be assumed to be significantly higher than the values presented in Figure 12.

Competitive Advantage and Comparison with Alternative Technologies

Gigatest will be a major contributor in establishing ITM Power's competitive advantage in the global zero-carbon hydrogen market. Enabling mass production of electrolyser through the first Gigafactory, and the further extension of this manufacturing capacity through the second Gigafactory, will make ITM Power a world leader in PEM electrolyser manufacturing capacity. With over 20 years of experience in developing cutting edge electrolyser technologies, and being involved world leading demonstration projects such as Gigastack and Refhyne, Gigatest will allow ITM Power to realise its position as a world leader in the electrolyser market.

The technical advantages of the 4th generation electrolyser stack over alternatives have been

discussed in detail in section 2a. Putting these into commercial perspective, a lower footprint, faster response time, lower capital costs and higher operating pressures make ITM Power's stack ideal to capture the most value from renewable energy sources and provide off-takers with cheap and reliably hydrogen for applications in industry, transport and heat.

Compared to carbon capture technologies, the 4th generation stack solves three key issues: a) ensuring hydrogen is truly zero-carbon b) reducing dependencies on the natural gas price and c) reducing the UK's energy dependency. There still remains uncertainty around the emission reduction potential of CCS, with new studies such as the one conducted by Howarth and Jacobson suggesting fuel switching to CCS based hydrogen could even increase carbon dioxide emissions by up to 20% compared to natural gas. With natural gas prices expected to increase over the next decade, green hydrogen is becoming an attractive alternative with the levelized cost of energy from renewables set to decrease further over the same time period. Lastly, decoupling hydrogen production from natural gas will also improve the UK's energy dependency, as in 2018 59% of the UK's natural gas was imported via LNG shipments and pipelines. Furthermore, as e.g. the Hydrogen Council estimates, green hydrogen could be cost competitive with CCS based hydrogen by 2030, ITM Power's technology offers a significant value proposition that helps the UK de-risk its climate change mitigation strategy and become a world technology leader.

Market Potential

Longer term, it is expected that a wider range of markets for renewable electrolysis will become viable. In each case regulatory changes will be required to shift consumption from today's fossil dominant modes to the use of renewable hydrogen. As a result, the speed with which each segment becomes relevant to hydrogen is dependent on the speed with which regulations requiring a shift to net zero carbon are applied to each sector.

ITM Power is currently in consultation with various end-user to deploy the 4th generation stack on a large scale, including the 100MW Refhyne II project with Shell, a 30MW and 100MW project with mobility and refinery end use in Germany [This information has been redacted]

The ramp-up rates described in this bid document can more than deliver this requirement. Figure 13, taken from the CCC report on achieving net-zero energy system in the UK, shows the anticipated breakdown by demand in each sector. Note that whilst we note the relatively low projections for electrolytic hydrogen take-up, we would contend that the measures achieved through Gigatest and, subsequently, Gigastack will demonstrate that electrolytic hydrogen can be a) cheaper and b) more beneficial to renewable developers than the authors of the CCC report contend. The specific sectors from which we expect demand include:

• [This information has been redacted]

• New Industrial processes – using hydrogen for fuel switching, e.g. for direct reduction steel manufacture or for large scale industrial heating via new hydrogen burners.
• Refineries – the Rhineland refinery is an example where there are specific electrolyser advantages which drive uptake. This market will be strengthened by changes in the RED II which facilitate the carbon accounting of renewable hydrogen as a feedstock for refineries.
• Chemical Synthesis – particularly methanol and ammonia – here the driver is carbon reduction for industrial processes.
• Steel – longer term changes in steel production techniques will allow hydrogen to substitute for fuels used in steel production facilities.
• Gas Injection – injecting hydrogen to the gas grid will become viable once the HyDeploy I & II projects are completed and provide a large-scale market for hydrogen (albeit at very low value).

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)

Gigatest seeks to demonstrate technological advancements in electrolyser stack designs and effective upscaling of electrolyser manufacturing processes. The learnings from Gigatest will be critical to strengthen the trajectory for long-term renewable hydrogen supply in the UK and abroad. The primary aims of Gigatest's dissemination strategy will be to (a) share the technological advancements in terms of efficiency, cost and cycling performance of the new 4th generation stack design, (b) increase awareness and knowledge of the overall Gigastack project amongst UK decision makers and regulators, to highlight both the decarbonisation and economic potential, but also to emphasise the regulatory challenges which require policy changes to enable viable commercial deployment of renewables-based electrolysis, (c) prepare the market for future adoption of electrolysers by highlighting the ITM Power's manufacturing potential, (d) highlight to the supply chain for both electrolysers and wind turbines the potential for increased capacity and the need to scale accordingly due to the ramp-up in production and demand. The overarching aim of these aims is to build confidence from investors and developers in the performance of the Gigastack as a key component of 100MW+ electrolyser, which will underpin the global green hydrogen revolution.

Dissemination will be a core part of WP 7 of Gigatest and the project management team will ensure dissemination tasks will be carried out in a timely and coordinated manner.

Audiences, target messages and dissemination measures

The Gigatest campaign is based on a well-structured strategy that covers:
- WHO: Identification of the main target audiences/groups that should be reached.
- WHY: Identification of the reason for targeting a precise group.
- WHAT: Tailoring of the message towards these target audiences.
- HOW: Decision on the best communication channels and tools to reach the target audiences.
- WHEN: A detailed implementation plan.

This plan is shown in Table 2.

Planned dissemination activities

The dissemination activities planned as part of this project are found in Table 3 and the dissemination timeline in Figure 14. ITM Power is committed to sharing key lessons beyond the formal end of the project. Thus, the project will have a lasting legacy and continue to inform future developments in the sector beyond the project lifetime.

Strategy for knowledge management

ITM Power recognises the potential value of the data and knowledge arising from Gigatest's project activities and acknowledges the need to share some of the outputs publicly as part of the efforts to advance the zero-carbon hydrogen sector. It is further recognised that some of the information will be sensitive and that external communications muse be carefully coordinated to avoid publishing information out of context and to ensure consistent messaging from this and related projects. The strategy for knowledge management has been developed with the factors in ind.
Information and knowledge generated through this project falls into three main categories:
1) Quantitative data, e.g. the performance data for the semi-automated manufacturing process and the 4th generation electrolyser stack
2) Knowhow and best practice obtained in operating the manufacturing process and the 4th generation stack
3) The new designs and intellectual property associated with the 4th generation stack and the manufacturing facilities at the Gigafactory
The quantitative technical data (category 1) obtained through Gigatest will be dealt with on two levels:
1. Project internal summaries of key performance indicators – ITM Power will provide summaries of the way in which the 4th generation electrolyser stack performs against the agreed performance indicators for the project. Internal summaries on the performance of the manufacturing facilities in terms of relevant KPIs will also be provided. This data will be shared with BEIS but will not be circulated to the general public.
2. External data on the performance of the 4th generation stack and the manufacturing facilities – ITM Power will prepare reports that can be circulated widely. This will involve aggregated sets of key performance data (i.e. electrolyser stack and manufacturing system performance) for the project and will be made available via the communication materials and the website.

The knowhow on the project (category 2) is considered valuable for the sector as a whole but will not be sensitive and hence should be shared outside of the project once it has been collated and agreed. All of the new and pre-existing intellectual property related to the project will be retained (category 3). Where necessary, this will be made available to project development partners and the supply chain

under a project specific licence. The responsibilities for protecting the information via patents and other protections will also remain with the inventor.

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: Gigatest budget sheet 30.08.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)

The scope of the work packages is extensive and, therefore, requires a total funding budget of £9.8 million. This project will carry out three discrete tasks; building the first 5MW stack, full testing and validation of the 5MW stack and assembly and validation of the manufacturing equipment at the Gigafactory. Gigatest is an ambitious undertaking which justifies the funding requested through this competition. The budget breakdown is presented in Table 4.

Labour costs are the dominant cost driver, accounting for [redacted] of the total project cost, while overhead cost contributes [redacted] of the total costs. These are representative of the time and staff required to test and build the 4th generation stack design and the manufacturing equipment required. The labour force employed throughout the 7 WPs will consist of carefully selected and highly-skilled personnel. Due to the highly technical nature of this projects, ITM Power requires multiple high-skilled employees, including Design Managers, various Engineers (Process, Mechanical, Stack, etc.) and research scientists to be successful with Gigatest. The salary costs for these positions are in-line with the average rates for these positions in the UK, and are justified due to the demanding nature of the positions. A high-skilled workforce is critical to achieve the targets set out for Gigatest, and the workforce presented in the budget sheet, is representative of the positions ITM Power seeks to create beyond Gigatest.

Moreover, ITM Power will spend [redacted] of the funds on material costs. Of these material costs, Stack and skid components contribute [redacted] owing to the high material costs required to build the first 5MW stack.

The [redacted] of the funds spent on subcontractors will allow ITM Power to bring in the required specific expertise from carefully selected firms to support the testing of external components and processes. [This information has been redacted] [redacted]

ITM Power will spend [redacted] of the funds on capital equipment, including items such as a clicker press, screen printer and a foil plater. These items will be crucial to commercialise the manufacturing process, and ensure high-quality electrolyser stacks can be produced. Due to the long equipment lifetime and ITM Power's intention of using the equipment post-2025, the residual value of the capital equipment deflates the capital equipment contribution to the total costs to [redacted]

[redacted] of the total funds requested, which are classed as other costs, refer to costs associated with the tests conducted on the first 5MW electrolyser stack. The testing will cost [redacted] and will investigate the degradation rate, cycling behaviour and validate the 5MW stack as set out in section 2a. Given the importance of this task, this cost is essential to ensure testing provides the appropriate level of validation and is therefore justified.

None of the costs in the project include any profit and all are based on carrying out the project work at cost. All the costs listed above are eligible and in accordance with Appendix 3 of the guidance notes. The BEIS funding will be essential to enabling the work set out in the Gigatest project and the Gigastack project as a whole. The funding will accelerate the transition from concept development and low volume production into large-scale deployment of manufacturing capabilities and the development of the first 100MW+ electrolyser plant with improved performance and low investment costs in the UK.

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)

ITM Power has already invested [redacted] in 2020 and [redacted] in 2019 of shareholder funds in the R&D associated with the 4th generation stack technology and Gigastack. The funding of £9.8 million requested from HMG will accelerate the deployment time for the new generation of electrolyser stacks for early customers in hard-to-abate sectors across refinery applications and heavy duty transport. The results obtained through the FEED study in Gigastack Phase 2 highlighted the potential of deploying the 4th generation stack to decarbonise the adjacent Phillips 66 refinery in the Humber region.

The Gigastack project is still commercially premature and the absence of final regulatory system creates a challenging business case. Without intervention ITM Power would continue to offer the existing Megastack product to build up sufficient reserves to allow the final commercialisation of Gigastack. This will take time. The funding requested from HMG will directly accelerate the commercialisation of Gigastack and hence accelerate the realisation of the value proposition of affordable electrolyser at large scale, which without government intervention, could only take place in the late 2020s (as ITM would have to rely on the more costly existing MW-scale stack technology).

The project will overcome the initial hurdle of manufacturing the initial low-cost, high efficiency electrolyser stack and deploying the manufacturing process required to produce the electrolyser stacks at a sufficiently high volume to create wide ranging market uptake. Governmental support will also have strong spill-over effects that will be benefit the Yorkshire and Humber region and the wider UK economy. [This information has been redacted] With an anticipated production volume of 1 GW/year by 2023 and 2.5 GW by 202 including the second Gigafactory, ITM Power would become a global leader in both quality of electrolysers and manufacturing capacity. Through Gigatest and the Gigastack project, ITM Power can support the UK's ambition to remain a global leader in clean energy technologies, showcasing capabilities to a global audience and attracting further investments to the UK.
The activities carried out through Gigatest will also contribute to de-risking the financing of future bulk hydrogen production projects, by demonstrating ITM Power's capabilities and the technology readiness to future financiers. Through this, future financing from the private sector will become more accessible and allow companies and other developers to commit to new and larger scale projects as a result of Gigatest. As highlighted in section 3b, the cumulative savings from the Gigafactory in Bessemer Park within the first 10 years of operation could amount to roughly 47MtCO2 (11.3% of the GHG emissions of the UK in 2020). Gigatest is essential to enable learning by doing, build confidence in ITM Power and its technology, and will be a key enabler for the second Gigafactory and wider hydrogen activity in the UK. Therefore, the HM government would unlock significant decarbonisation potential through its £9.8 million investment in ITM Power.

Furthermore, through its investment in Gigatest, HM government would also benefit from significant future savings. ITM Power's 4th generation stack technology, with capital costs significantly lower than competitor technologies, would enable future green hydrogen projects to be roll-outed at significantly lower total deployment costs. Putting this into perspective with regards to the recently announced £240 million hydrogen production fund, this would lower HM government's subsidy amounts per megawatt (£/MW subsidy) significantly, allowing a more efficient use of future funds and improved outcomes for society.

ITM Power could generate cumulative sales revenues of up-to [redacted] by the end of the decade as shown in Figure 15. This would lead to taxes of up-to [redacted] during the same period, which is roughly [redacted] times larger than the requested sum of £9.8 million. Consequently, in addition to reducing future subsidies required to be provided by HM government, this investment in ITM Power would yield additional significant returns for the government. The funding requested from HM Government is an opportunity to maintain ITM Power's global electrolyser leadership and supply the UK and the rest of the world with zero-carbon hydrogen solutions 'Made in the UK'. Not only will this strengthen the UK's position in the global Clean Tech market, bring economic benefits and jobs as highlighted in section 3b, but it will also lead to UK wide synergies with other clean technology developers and establish the UK as a world leader in climate neutral technologies.

However, although the outcomes targeted through Gigatest have wide-ranging beneficial effects on multiple levels, the activities set out in the 7 WPs cannot take place without public funding. ITM Power is committed to providing the lowest cost hydrogen solutions to a variety of sectors, but due to the investment risks in this nascent sector, the project risks need to be shared with public sector. ITM Power bring to the project their extensive intellectual property and development experience that they will exploit to manage the development of both their next generation of stack technology and the manufacturing facility. Furthermore, ITM Power has already made considerable investments in the new

manufacturing facility that will facilitate the planned ramp-up in production (and will continue to make these investments during the project). Whilst investments are clearly a part of their core mission, they are taking significant risks in doing so since the market for electrolytic hydrogen is still immature. Furthermore, the funding requested through Gigatest will create certainty for ITM Power in regards to the government's commitments to supporting zero-carbon technologies and the feasibility of building the second Gigafactory in the UK.

Overall, Gigatest provides the UK government with an opportunity to:
• Ensure that large-scale hydrogen deployments in the UK will not become exclusively reliant on a single CCS production pathway. This will de-risk the UK's clean energy strategy as it mitigates reliance on the success of CCS technology advancements.
• Guarantee that the UK's future hydrogen economy is based on a diverse portfolio of hydrogen production methods, increasing the security of the future energy systems, and reducing the reliance of energy imports such as natural gas.
• Position the UK as a global leader and exporter of clean hydrogen solutions, establishing the UK as a global hydrogen production hub.
• Support the transition to cleaner fuels in hard-to-abate sectors such as industry and transport through the wider Gigastack project, overcoming the challenge of integrating intermittent generation technologies, such as offshore wind, effectively into the wider UK energy system.
• Mitigate potential job losses in the UK in the wake of the upcoming energy transition, ensuring high-skilled manufacturing and R&D jobs can be maintained in the UK as traditional oil and gas jobs in the UK subside.

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: BEIS Hydrogen Supply Competition Stream 2 - Gigatest Work Packages.pdf - Download
- File: Gigatest Gantt Chart 30.08.xlsx - 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)

ITM Power is an AIM listed company and the UK's foremost manufacturer of electrolyser systems, based on polymer electrolyte membrane (PEM) technology. ITM has a first-class team comprising >200 engineers and scientists, based in Sheffield. The ITM facilities include prototype demonstration areas for applications of ITM's technology. ITM's Research & Development Facility comprises custom made laboratories and accommodates specialist equipment for ongoing optimisation, durability testing and optimisation of materials and electrolyser technology.

ITM Power is confident it has the capacity to carry out the tasks set out in the work packages in attached in the Attachment.
ITM Power's core R&D development focus will be on Gigatest, as the project enables the validation of the 4th stack generation, this is particularly timely with the expected Zero Carbon Hydrogen Fund expected to generate significant opportunity for large electrolyser deployment(s). ITM have been working closely with Phillips 66 and Orsted [This information has been redacted]
The Core project team will be ringfenced for the Gigatest project, a method deployed for the 10MW Refhyne Shell project, this ensures the targets set out in Gigatest can be achieved at the highest standard in a timely manner. The Project manager will report to the steering committee on a monthly basis, which includes two executive directors. Progress will also be reported to the full board, at each board meeting.
ITM Power has recently recruited over 80 engineers, key HSE staff and technical purchasers in order to develop the electrolyser supply chain and is still expanding in order to meet the production and development demand.
The 7 work packages with descriptions of key tasks and costs, together with the associated milestones and deliverables can be found in the Attachment.
Availability of Site and Ability to accommodate Gigatest activities

ITM Power is based in Sheffield, UK and has the world's largest electrolyser facility which the company moved into in Jan 2021. The facility has space allocated for stack manufacturing, product assembly and product testing shown in Figure 16. A dedicated Gigatset centre will be developed as part of the Gigatest project with access to space, water, power and safety facilities to enable Gigatest to be developed and tested according to the project timescales. Proof of facility development is found in Figure 17.

[This information has been redacted]

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: BEIS Hydrogen Supply Competition Stream 2 - ITM Power Organogram.pdf - Download
- File: BEIS Hydrogen Supply Competition Stream 2 - CV Package.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 project will be overseen by a Steering Committee, which will be the ultimate decision maker on the project. This Committee will convene at least every three months (with more regular meeting planned as required) and will be led by [This information has been redacted], who will also act as executive sponsors. The Steering Committee will be further [This information has been redacted] .

The work carried out on the individual work packages (set out in section 5a) will be managed by the work package leaders who will report to the executive sponsors on issues affecting the progress on the project as a whole. The executive sponsors will be responsible for facilitating discussions (and associated escalation procedures) if issues arise within or between work packages.

ITM Power

ITM Power is an AIM listed company and the UK's foremost manufacturer of electrolyser systems, based on polymer electrolyte membrane (PEM) technology. ITM has a first-class team comprising >200 engineers and scientists, based in Sheffield. The ITM facilities include prototype demonstration areas for applications of ITM's technology. ITM's Research & Development Facility comprises custom made laboratories and accommodates specialist equipment for ongoing optimisation, durability testing and optimisation of materials and electrolyser technology.

ITM is committed to the development of clean fuel systems for Fuel Cell Electric Vehicles (FCEVs), hydrogen energy storage, hydrogen gas injection and hydrogen systems for synthetic natural gas production.

ITM has experience in leading and collaborating in various BEIS, Innovate UK and European Union funded (including Horizon 2020 (FCH JU) and FP7) research and development and demonstration programs.

ITM Power has grown over the last 20 years from a basis in hydrophilic ionic polymers to that of an international hydrogen systems developer and provider. Three commercial generations of stack technology have been developed to date. All of these have been developed, tested and then manufactured for deployment at ITM's Sheffield headquarters.

This period of growth and expansion has included:

– Developing Europe's largest electrolyser plant in the Rhineland, the RefHyne project, a 10MW PEM electrolyser at the Shell Refinery in Cologne.

– Proving the ability to use a 20% blend of hydrogen by volume in the gas grid in homes in Keele. This will prove the ability for existing homes to utilise green fuels in their everyday domestic products without any compromise on utilisation.

Work is now focussed on scaling further, expanding to the Bessemer Park "Gigafactory" to meet the anticipated electrolyser market and implementing cost reduction programs to ensure competitive bidding on commercial sales.

ITM Power has a JV with Linde engineering, based in Germany ILE (ITM Linde Electrolysis) provides a platform for ITM to sell electrolyser systems, with Linde providing EPC services to large scale projects. ITM are experienced in technical developments and complex project management. The core Gigatest team have worked together on the Gigastack (BEIS Funded) projects. The team have been built as a multidisciplinary team to encompass not only technology development, but also strong project management, compliance, production and HSE functions. In addition, a supply chain development officer and business case analysis function has been added to ensure that technological developments are produced at a scale which is suitable for commercial scale exploitation.

The core Gigastack team will report in to a Project Steering Committee consisting:

[This information has been redacted]

[This information has been redacted],

[This information has been redacted]

The project Steering Committee will meet monthly, and report progress to the full ITM Board as regular board meetings.

The Gigastack project will be managed on a day to day basis by [This information has been redacted]

[This information has been redacted]

[This information has been redacted]

[This information has been redacted]

Additional short CVs and an ITM Power organogram are given provided in the respective attachments.

Criterion 5c: Risk Assessment The applicant should provide a detailed risk register to outline the key project risks and risk mitigation techniques for the project (in the interests of thoroughness, we encourage you to think about risks and structure your risk assessment according to whether the risks are, or relate to: technical, legislative/regulatory, environmental, policy, economic, commercial, financial or project management). The risk register should include: Description of risk; cause of risk; risk owner; overall risk rating (probability x impact), mitigation action, and residual risk after mitigation action. Description of any contingency planning. Applicants should attach a risk assessment table to this criterion, which will be assessed. (Weighting for Criterion 5c – 5%) To complete this section please upload a completed Risk Register for Stream 2 here. Max upload size per file - 10MB Max number of files - 1

- File: Gigatest Risk Register 30.08.xlsx - Download

Collaborative Application

Is this a collaborative application? If yes you will be asked to provide contact and organisation details for each partner.

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

Process Development

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

50

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

78

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

0

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.

[This information has been redacted]

[This information has been redacted]

[This information has been redacted]

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)

Gigatest will be an enabler for the UK's net-zero ambitions and global technological leadership in green hydrogen production. As part of Gigatest project, ITM Power will build the first fully modular 5MW electrolyser unit based on its 4th generation Gigastack technology. Testing will take place under representative real-word conditions to validate the stack design and ensure it can perform efficiently in challenging flexible renewable-load coupled cycles.

Combining the low-cost stack design, with semi-automated manufacturing techniques and improvements by incorporating balance of plant elements into the overall efficient design will allow electrolyser stack manufacturing costs to reduce significantly whilst retaining high class performance. This innovative ultra-low cost stack, combined with significant upscaling in production volumes, will allow renewable hydrogen production to become a mainstream option for the UK's future hydrogen supply.

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: BEIS Hydrogen Supply Competition Stream 2 - Annex 1 Referenced Figures.pdf - 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: Declaration 1.pdf - Download
- File: Declaration 2.pdf - Download
- File: Delcaration 3.pdf - Download
- File: Declaration 4.pdf - Download
- File: Declaration 5.pdf - Download
- File: Declaration 6.pdf - Download
- File: Declaration 7 31.08.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	ITM Power Trading Ltd
Signature ***Please insert name***	[This information has been redacted]
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