Green Distilleries Application Form

Proposal Summary

1. Name of Bidder (This should be the lead organisation/co-ordinator for the proposed project)
Supercritical Solutions Ltd

2. Project Name
WhiskHy Phase 2

3. Project Lot Number?
2

4. Technology Type/Category
Fuel conversion (electrolyser)

5. Estimated Start Date
* 05/07/2021

6. Project Duration (months)
1 21

7. Estimated End Date
* 15/03/2023

8. Total Project Cost (£)
2994778

9. Total BEIS Funding applied for (£)
2994778

10. Project Summary (please provide one or two sentences)

Supercritical will advance its novel high pressure, ultra-efficient electrolysis technology and build the world's first demonstrator whilst delivering the world’s first hydrogen direct fired whisky with Beam Suntory

11. 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 and key deliverables and the expected project benefits. Maximum 300 words

Supercritical is developing the world’s first high pressure, ultra-efficient electrolyser for the production of hydrogen and oxygen from water, with zero emissions.

WhiskHy will see the technology advance from single cell scale to a multi-cell module to be demonstrated and tested. Distillery partner, Beam Suntory, will trial 100% hydrogen fuel delivery to a direct fired still at one of their distilleries and plan for deployment of Supercritical's technology to be piloted at their largest Scottish distillery where the green hydrogen will decarbonise the existing steam boiler.

WhiskHy can achieve the twin goals of re-introducing traditional production methods whilst also achieving the environmental sustainability goals. WhiskHy will demonstrate the lowest cost route to a zero carbon distillery reliant only on its local natural resources. The demonstration will be the first of its kind, paving the way for distilleries and other industries across the UK and the world.

Eligibility Criteria

12. Eligibility Criteria

	Yes	No
1. Project Led - ***Projects must be led by a UK based company the same company that led Phase 1. The demonstration study must also take place in the UK.*** **Is the project being led by the same company that led Phase 1, and that the demonstration study will take place in the UK?**	X	
2. Technology and Transferability - ***The technology must be directly transferable to the distillation sector, including from maltings through to maturation.*** **Is the technology transferable to the distillation sector (from malting to maturation)?**	X	
3. Innovation and technology readiness - ***This Competition is to support the development of innovative fuel switching or fuel-switch enabling technologies that are directly transferable to the distilleries sector (from malting to maturation). It is to support the development of technologies that are not yet commercial from Technology Readiness Levels (TRLs) 4 to 7 at the start of the projects.*** **Will your technology/ system be at TRL 4 – 7 at the start of the project?**	X	
4. Innovation and technology readiness - ***The focus of the Competition is to support the development of innovative fuel switching or fuel switch enabling technologies that are directly transferable to the distilleries sector (from malting to maturation).*** ***Exclusions: Funding will not be provided for projects where the technology development focuses on:*** ***- CCUS (Carbon Capture Utilisation and Storage)*** ***- Energy efficiency (apart from heat pumps which is in scope)*** ***- Switching of feedstocks, (except where feedstock provides chemical energy to drive the process)***	X	

Does your project exclude the technologies listed above?		
5. Project status - ***BEIS is unable to fund retrospective work on projects.*** **Can you confirm that your application does not seek funding for retrospective work on this project?**	X	
6. Additionality - ***Projects can only be funded where evidence can be provided that innovation would not be taken forwards (or would be taken forwards at a much slower rate) without public sector funding.*** **Can you confirm the funding requested from BEIS for your project cost for Phase 2 will be equal to or below £3m?**	X	
7. Contract size - ***Phase 2 – Demonstration phase (SBRI): Split into Lot 1 (up to £5.99m) and lot 2 (up to £3m) with a total of £8.99m. The maximum funding available per project is £3m. If we don't receive sufficient bids (in number or in quality) to use the funding from one Lot we will reallocate funding to the other Lot if the bids in that Lot score the 60% pass mark All projects will be ranked against the assessment process and criteria (section 7). Demonstration studies must be complete by 12pm (noon) BST 15th March 2023.*** **Can you confirm the funding requested from BEIS for your project cost for Phase 2 will be equal to or below £3m?**	X	
8. 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 2 and outlined in Section 5 of the Green Distilleries Phase 2 Application Notes.*** **Can you confirm that requested funding is for eligible costs only?**	X	
9. Project end date - ***Phase 2 Demonstration Studies must be completed and approved by BEIS (projects need to allow for time for the BEIS monitoring officer to review the demonstration study final report and amend accordingly) by 12pm noon GMT 15th March 2023.*** **Can you confirm that the project will meet the specified project end dates?**	X	
10. 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.*** **Do you agree to this approach?**	X	
11. Applicants and Project Team Make-up - ***The Phase 2 Demonstration project is expected to be delivered by a project team or consortium. A single project application must be submitted by the lead project member (the project co-ordinator).*** ***Members of the project team can be:*** ***• Private sector companies: both SMEs and large enterprises can apply as sole applicants or as part of a consortium with other private sector companies, or in a consortium with academic, research or public sector organisations.*** ***• Academic, research, public, third sector or community organisations must work as part of a project consortium with private sector organisations – they cannot be sole applicants to this competition.*** ***The project team co-ordinator can be a private sector company, academic, research, public, third sector or community organisation as long as they have the necessary skills and capacity to effectively lead the proposed demonstration project and have a route to market.*** **Can you confirm that your project team meets eligible organisation requirements?**	X	

12. Planning, Regulatory and Environmental Permissions - *Where planning, regulatory and environmental permits are required, the applicants must ensure that these permits will be in place to successfully complete the demonstration before the end of the Phase 2 Demonstration Study (12pm noon GMT 15th March 2023).* **Can you confirm that the necessary permits required to successfully deliver the Green Distilleries Phase 2 project will be in place to successfully complete the demonstration before the end of the Phase 2 Demonstration Study (12pm noon GMT 15th March 2023)?**	X	

13. Delivering multiple projects - If project consortium member(s) are part of multiple successful bids 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
13 (a) Eligibility question: If you or your consortium are part of multiple successful bids would you be able to successfully deliver all projects if necessary?	X	
13 (b) Eligibility question: If you or your consortium are part of multiple successful bids could you please confirm that you have not applied for funding for the same piece of work more than once?	X	

Contact and Organisation Details

1. Supercritical Solutions Ltd Contact Details

Title [redacted]

Name [redacted]

Position [redacted]

Email [redacted]

Mobile Number [redacted]

Organisation Website www.supercritical.solutions

2. Organisation Name

Supercritical Solutions Ltd

3. The registered address of the Lead Organisation

Address Line 1 10 Downlands

Address Line 2 Partridge Green

Address Line 3 -

Town/City Horsham

Postcode RH13 8QU

4. County
West Sussex

5. UK Region
South East

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? If the answer is No you will be asked to provide location details in the separate Project Cost Breakdown Form.
No

8. Organisation Type
Private Company

9. Organisation Size
Micro Enterprise <10 employees

10. Number of employees (including directors)
[redacted]
[redacted]
[redacted]

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

* 30/04/2021

16. Is the Organisation able to recover VAT?

Yes

17. Organisation Maturity

Startup - <1 year

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

[This has been redacted]

19. Organisation Status: a brief introductory description of the company to set the scene for the assessors Maximum 250 words

Supercritical offers a 10-25% step reduction in the cost of pressurised green hydrogen.

The technology has the potential to rapidly accelerate transition to green hydrogen as a fuel in whisky distilling and other hard to abate sectors.

SC's invention utilises supercritical water which has many advantageous properties reducing overpotentials and increasing efficiency. [This information has been redacted]

Lastly, it produces pressurised gases at >200 bar. This eliminates or reduces the need for gas compressors which are a system weak point, more costly, space consuming and inefficient compared to water pumps.

The Founding team:

[This information has been redacted], is uniquely placed with experience in supercritical water reactors and electrochemical systems at Promethean Particles and Ceres Power.

[This information has been redacted], has a PhD in electrolysis and has extensively scoped hydrogen technology in his Founder role at Deep Science Ventures.

[This information has been redacted] draws on 8 years of applied knowledge in the hydrogen sector with Johnson Matthey and a degree in Chemical Engineering from Imperial College.

[This information has been redacted] drives strategy, having managed budgets of >£100M at TalkTalk and grown a startup from £0 to £22million in 3 years.

[This information has been redacted]

Incorporated 29 June 2020, yet to file annual accounts.

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

1. Description of novel technology, technical feasibility, replicability and performance of Green Distilleries solution

1a. Please give a high level description of the proposed Green Distilleries solution, including a description of the novel technology, its technical feasibility and its replicability. (5%) (applicants can use the upload link to provide supporting evidence and illustrations, any further text beyond the word limit will not be assessed) With reference to the Phase 1 Feasibility study, applicants are expected to: Describe the technology readiness level (TRL) at the start of the project, and at the end of the Phase 2 Project. Describe why the Green Distilleries solution is novel and how it will support the decarbonisation of the distilleries sector. Describe how the proposed Green Distilleries Solution can be replicated across the distilleries sector and the advantages of this solution over other state of the art technologies. Describe how the solution(s) work, including a description of your engineering design for the demonstration, and how it fits into distillery processes to enable decarbonisation of the sector. Provide evidence to demonstrate that the proposed approach is technically feasible, providing justifications for all technical data provided. This should reference earlier feasibility work, including engineering designs, engineering calculations and the outputs of other feasibility research Explain how the outputs of the feasibility work you have carried out to date have informed your engineering design. Explain how your demonstration project will accelerate the development of fuel switching/fuel switch enabling technologies Describe the potential challenges and barriers of the proposed solution and how they will be overcome/mitigated. (Maximum 2000 words)

Supercritical (SC) has integrated technological components to build the first proof-of-concept electrolyser capable of continuous electrolysis at supercritical conditions, in a single cell achieving TRL4. With multiple cells, the principles of operation are the same but the operation complexity increases. SC will further optimise the electrolyser at a cell level, design, model and build a larger multi-cell module for Phase2. This system will be the technology demonstrator, progressing to TRL5. By the end of Phase2, the module will be fully tested with a full system FEED and detailed design. By March 2023, all necessary inputs for the Ardmore site procurement, construction and test of SC's electrolyser system will be ready to allow TRL 6 trials.

SC's invention is a unique electrolyser design that is able to harness heat and pressure to overcome thermodynamic and mass transport limitations associated with demanding electrolytic reactions such as water electrolysis, enabling a step change cost reduction in the production of pressurised green hydrogen. The water electrolyser achieves these outcomes with a highly differentiated approach compared to existing electrolyser technologies, namely it;

[This information has been redacted]

The largest energy usage at distilleries is thermal heating during the distillation process. The ultra-efficient SC electrolyser will deliver a pathway to the lowest cost of production of H2. Working with Beam Suntory to develop the feasibility study in Phase1 demonstrated an absolute need for a low cost solution to deliver an economical 24/7 zero emission fuel. Phase2 will enable the advancement of the technology, guided by industrial demand, allowing the industry to shape the product. H2 delivery system to Ardmore's existing boiler can be achieved with a retrofit to the burners enabling co-injection

of between 0% and 100% hydrogen, reducing the LPG load. For the distillery, it marks the first step towards enabling a transition to 100% green H2, expected to be achievable and cost competitive with the existing LPG fuel source by 2029.

Presently, the predominant thermal sources of energy are Natural Gas (NG), Fuel Oil and Liquefied petroleum gas (LPG). 98% of Scottish distilleries use steam boiler heat systems for distillation. Like LPG at Ardmore, NG and Fuel Oil burners can be partially or fully replaced by green H2 making this system ideally replicable across the industry. SC believes that it will be possible to use the distillery wastewater as a feedstock for the electrolyser requiring no addition to the freshwater withdrawals and will test this in Phase2. SC supplies >200 bar hydrogen and stores it in high pressure storage tanks, which in turn feeds the boiler.

vs SMR with CCS - SC are zero emission, whereas CCS does not capture all CO2, and risks fugitive emissions of CH4. SMR with CCS must also consider distribution infrastructure. Whether by new/existing pipeline or road logistics this will add significant costs.

[This information has been redacted]

SC's electrolyser module, which works by splitting water into hydrogen and oxygen, will sit within a wider 'electrolyser system', consisting of pumps, heat exchangers, heaters and separators. The system will be fed by electricity and water. For the pilot, grid electricity will be used, but at commercial scale, the system will be paired with renewables to ensure green electrons are being sourced. The distillery wastewater direct from the pot ales and post aerobic digester treatment will be trialled as a direct feedstock to SC's electrolyser. This could remove the need for additional water treatment.

The electrolyser produces hydrogen and oxygen at >200 bar. Oxygen could be used to improve wastewater treatment on site or used to enhance fuel burning. The hydrogen has the potential to be a sole fuel source. Minimal footprint and cost can be achieved in the delivery of 24/7 supply. Storage is essential for continuous operation as renewable power is intermittent.

The stored hydrogen is then let down in pressure and fed to the distillery's boiler. We have had in-depth conversations with Dunphy Combustion who have conducted in-field trials of their burners in the field (HyNet project) and the technology is capable and available today. The main barrier to change is the cost and availability of hydrogen which SC addresses, by removing the green premium and providing zero emission hydrogen at the same (or lower) cost than fossil fuels.

[This information has been redacted]

The feasibility work has helped inform SC's engineering design in many ways. SC worked closely with CPI during the feasibility study to model and size a full hydrogen production pilot plant based on SC's experimental findings. Due to the early stage nature of the technology multiple unknowns and challenges were identified that need to be overcome to ensure successful commercialisation. The key items were materials of construction, process safety, reactor design, effluent specifications

[This information has been redacted]

Process safety and control strategy - There are inherent hazards in the technology that SC is developing: high pressure, high temperature, electricity, hydrogen and oxygen. SC is acutely aware of this and has built a team with experience in risk assessments and hazard identification. SC will expand the breadth and functions of its team and work with both [This information has been redacted] to identify risks and consequently eliminate or control them to an acceptable level.

Reactor design - SC's larger module design is in early stage design. During feasibility, SC worked with [This information has been redacted] progress the design based on performance, safety, reliability, cost, manufacturability and controllability (and others). [This information has been redacted] strengthen the design with expert viewpoints in mechanical design and process safety, and engage the MTC in critical component design.

Operating point - Critical to the economics of a full scale system is the chosen operating point of the reactor and the other processes in the system. A full range of operating conditions is still to be tested in SC's electrolyser. Therefore specifics such as the optimal single pass conversion for product purity and safety and the purge flowrate to control buildup of contaminants in the system require additional testing to be conducted in Phase2.

On the integration and the applicability of SC's system to a distillation site, SC worked closely with the 3rd largest distilling group in the world, Beam Suntory. It was identified that wastewater utilisation could well be a feasible source for the feedstock of the electrolyser resulting in the Phase2 planned trials. It was also identified that co-products of the hydrogen production process, oxygen and sodium hydroxide solution, could also be put to valuable use at their distilleries. These will also be trialled in Phase2.

The best use of renewables and the natural resources in a given site will be critical in delivering economically viable solutions and enabling net zero operations. SC worked with Xodus to build a better understanding of the availability of wind and solar near Ardmore but also Scotland-wide, developing a complex techno-economic model determining the optimal use of renewables and capacity deployment at full scale. In addition, their environmental impact assessment and site evaluation helped determine pilot location and define the infrastructure considerations for a full scale commercial deployment.

The demonstration project will accelerate fuel switching in the distillery sector and other sectors due to its favourable cost per kWh vs other fuels. SC's techno-economic model developed in Phase1 projects long term costs for hydrogen produced by SC's solution to less than LPG and fuel oil by 2030 and less than natural gas by 2040, both of which are expected to be accelerated with the anticipated UK governments policy measures which will support hydrogen deployment, such as a carbon tax, and we await the announcement of the UK Hydrogen Strategy expected imminently. Capital costs are inherently low based on material choice and manufacturing costs, and economies of scale can be achieved relatively quickly (within 5 years) due to the large number of industries that this technology can work with. When equivalent production volumes are reached with PEM electrolysers, it is anticipated that SC will maintain a 1-2p/kWh (10-20%) step change in cost benefit. It is this cost parity that will be the tipping point for change and SC addresses this cost whilst addressing multiple infrastructure challenges like distribution and storage of hydrogen.

The biggest challenge to SC's solution and the commercialisation of the technology is funding through the early pre-revenue higher risk stages. Early TRL investments are perceived as a considerable risk by private investors but confidence would build with government financial assistance in progression to a higher TRL. From a manufacturing perspective, the challenges are seen in two distinct areas: Firstly, in establishing the optimum process and methodology to manufacture the internal components of the electrolyser in line with the design requirements. This is likely to involve a number of non-conventional machining processes as well as potentially additional fusion processes or alternatively additive manufacturing processes. The challenge will be to establish the optimum process to achieve the desired performance and durability. Secondly is to ensure that the chosen process is both affordable and efficient in terms of cost effectiveness and volume potential. Throughout the course of Phase2, this optimisation will be constantly reviewed with multi-functional design reviews as assess scaling progress and compatibility, ensuring that the technology can be manufactured at a scale, speed and cost appropriate to ensure there is an economic case.

1b. Please give a high-level description of the performance of the Green Distilleries solution. (15%) (applicants can use the upload link to provide supporting evidence and illustrations, any further text beyond the word limit will not be assessed) With reference to the Phase 1 Feasibility study, applicants are expected to: Identify and compare the performance of their solution with other state of the art technologies Describe the technical and commercial advantages of your solution over other state of the art technologies Describe the scalability of the solution and applicability/replicability across different distillery sites (is the technology transferable to other industrial sectors?) Describe costs of the solution, providing a detailed analysis on the lifetime costs of your solution costs (including CAPEX and OPEX) comparing these costs to other state of the art technologies. Describe how the solution will impact product quality, costs and output. Identify any uncertainties associated with these cost estimates and how the design and execution of your demonstration study will address these uncertainties Explain the impact the solution would have on a site in terms of health & safety, air quality, fuel delivery logistics and production disruption and how the applicant will ensure the necessary risk assessments and training will be carried out. (provide a qualitative and quantitative comparisons to these impacts relative to the current state of the art technologies) Explain where planning permission/environmental permits are required, the applicant must justify and provide reasoning as to how these permits will be in place to successfully complete the demonstration before the end of the Phase 2 Demonstration Study (12pm noon GMT 15th March 2023) (Maximum 2000 words)

For full answer refer to attachment 'Question 1b.pdf'

To provide supporting evidence and illustrations upload your file/s here. Please do not upload any further text in order to go beyond the word limit, it will not be assessed. Max upload size per file - 10MB Max number of files - 5

- File: Question 1b.pdf - Download

2. Long term development plan, carbon saving, dissemination and delivery of Social Value

2a. Please provide a description of your long-term development plan for your Green Distilleries solution. (10%) (applicants can use the upload link to provide supporting evidence and illustrations, any further text beyond the word limit will not be assessed) With reference to the Phase 1 Feasibility study and how the Phase 1 feasibility study has helped influence these plans, applicants are expected to: Describe the long-term development plan for the technology, further development, commercialisation, and exploitation beyond the Green Distilleries competition (15th March 2023), including a credible route to market. Describe long term plans for further development, commercialisation, exploitation post project and how this lines up with HMG’s legal target to achieve Net Zero and key government policies and roadmaps such as the 10 Point Plan, 6th Carbon Budget, Energy White Paper and the Industrial Decarbonisation Strategy Explain how the project/technology supports and enables goals set out in the 10 Point Plan, 6th Carbon Budget, Energy White Paper and the Industrial Decarbonisation Strategy. Highlight the key barriers and challenges to achieving commercialisation, timescales, and estimated long term development costs, and how these will be addressed. Describe the timescale and costs of your development plan Describe the market potential/replicability of the solution and how the solution could help achieve Net Zero (Maximum 2000 words)

The journey to deliver a commercial product will occur through the application of the tacit knowledge and know-how that comes through application, aka learning by doing, specifically in manageable steps building to a full-sized deployment.

SC is perfectly positioned as a disruptive technology to support the government's 78% reduction in UK territorial emissions between 1990 and 2035, meeting legally committed reductions and for the UK to

be a global leader in the technologies needed to decarbonise our economies and transition to net zero.

Further development:
Phase1 of the green distilleries project has taught us that a phased fuel switching from fossil fuels to hydrogen would be desired by the distillery to manage risk and is possible with a dual fuel delivery system, allowing larger electrolysers and storage to be installed as the risks are managed, costs reduced and phasing the transition to a zero carbon distillery over time but before the end of the decade. This enables SC the time it requires to both scale up and 'cost down' the solution. Through the Phase1 feasibility we were able to establish the distilleries desired commercial model of buying 'fuel' rather than owning and operating state of the art electrolyser equipment. We were also able to establish that for a material sized solution, contracting with a small, emerging start-up company would be a challenge for their risk profile and would need to see, either backing or a collaboration with an established brand in the energy industry, with the ideal being that they would contract directly with an experienced, funded, energy/gas operator.

Whilst the hygiene path is to continue to build a strong brand reputation, the timescales dictate that for a highly successful commercial product, a strategic partnership/s will need to be formed.

Commercialisation steps:
Whilst SC advances its technology, it is important that it continues to explore relationships wider than distilleries (~530K tCO2e). The largest challenge and most ideal fit is the UK Industrial sector representing an 84MtCO2e (19%) decarbonisation opportunity. The commercial development plan is to focus on industrial users that require heat (ideally with waste heat available) and will benefit from the pressurised gas delivery, either through integration of an existing process that requires pressurised delivery (negating gas compressors) or in energy storage in compressed hydrogen form. These industries are known as the foundation industries, producing 75% of all the material in the UK's economy and vital for the manufacturing and construction sectors. They are worth £52Bn annually but emit 50 million tonnes of CO2 per year, 10% of the total UK CO2. They use an equivalent of 12 million tonnes of oil (oil equivalent fossil fuel) each year (excluding electricity), equivalent to ~12k tonnes of hydrogen a day (KTN, 2021). The perfect end customer would be Ammonia, a process that is exothermic with waste heat of ~500oC available for system integration and requires 200bar hydrogen delivery. Ammonia is the largest user of the 70million tonnes of hydrogen produced today but predominantly uses fossil hydrogen, which as a production process emits 10.6kg of CO2e for every kg of hydrogen produced. Decarbonisation of these sectors is in line with the Industrial Decarbonisation Strategy. Ammonia for new markets are orders of magnitude greater than ammonia markets today. So the use of the technology to produce ammonia as a way to distribute hydrogen over long distances, as well as ammonia as a shipping fuel should be markets of interest.

The SC Industrial focus directly supports the government's goal of reducing emissions by 90% from today's levels, by 2050, as outlined in the Energy White Paper.

Secondary market sector is aligned with Point 4 of the government's 10 point plan; transport, specifically buses (3MtCO2e) and goods (21MtCO2e), who would both benefit from the ultra efficient production of green hydrogen and delivery of the gases at 230bar, requiring a less energy intensive compression step to go from 230bar to 300-700bar. UK road freight is estimated to be 6,697 tonnes of hydrogen per day opportunity (ONS, 2020). The main competition for decarbonisation in this sector is battery Electric Vehicles (EVs), with the trip distance and fuelling time being the differentiator between the two EV technologies. There are operations that need the range and refuelling time that could not be achieved with batteries.

Through 2023, Supercritical is planning on deploying multiple small scale pilot systems, starting with a signed agreement we have with Beam Suntory. After the initial pilot, the next stage would be a 10x larger electrolyser, enough to produce ~1.6million bottles (70 cl) of zero emission whisky a year, replacing the small-scale pilot, with any issues and challenges addressed. At this stage, with approximately 10% of the distillery's energy demand being met, it is anticipated that the system would offer more advanced renewable connectivity and complexity in control and operations, enabling deployment for a longer trial period. Success at this point would represent progression to TRL6/7 for SC. Experience SC would have attained managing this increased size pilot would enable SC to develop its first Megawatt sized electrolysers on commercial terms in 2025/26. It is envisioned that the Beam Suntory reference site for WhiskHy Phase1, would remain dual fuel (LPG and Hydrogen), phasing to 100% green hydrogen by 2028, removing fossil fuels completely by the end of the decade.

Beam Suntory's 2021 production, comprising Bourbon, Canadian, Scotch, Irish and Spanish is 165,084,225 litres of pure alcohol (lpa), of which their Scotch business is producing 12,946,522 lpa. With SC's technology being highly replicable across distillery sites, SC could deploy this solution to decarbonise all of Beam's Scottish assets. In addition, if Beam were to deploy this globally, it would represent an approximate 12x deployment potential for technology export.

Through our partner development programme of work, we plan to sign up further small scale pilot projects for 2023, within our primary and secondary market sectors. We have already secured a signed agreement with [This information] for the supply of a [This infor] electrolyser for them to test, on the understanding that we are able to achieve the advancement of the technology and hit key KPI metrics. Deployment in this sector will support the government's plans to end of sales of new petrol and diesel cars and vans by 2030, through increased refueling infrastructure, whilst directly supporting point5, delivering the fuel for zero emission FCEV buses and trains, supporting the government £120 million investment next year to begin the introduction of at least 4,000 more British built zero emission buses.

Additionally, SC intends to perform feasibility into our technology decarbonising Jet Zero and Green Ships, supporting point6 of the 10point plan. We have signed a MOU agreement to collaborate with [This information has been redacted], a disruptive carbon capture company to evaluate the feasibility for the production of synthetic hydrocarbon fuels for both shipping and aviation in addition to possible direct green H2 supply to the emerging FCEV aviation.

Through Phase1 feasibility we discovered that using low grade waste heat was not viable for the supercritical electrolyser, however we also quantified the amount of heat available for re-use in the output of the electrolyser. [This information has been redacted] We believe high growth scalability will come from simplicity of the business and focus on the identified markets. Once products have been developed for the primary and secondary markets, resources can be shifted to the ‘building heat’ and energy sectors.

Barriers and challenges:
The biggest challenge to the business and the commercialisation of the technology is funding through the early pre-revenue higher risk stages, where this early TRL stage is perceived as considerable risk by private investors but confidence would build with government financial assistance, were we able to progress to a higher TRL.

[This information has been redacted]

The biggest technical challenge beyond March 2023, is in the continued scaling of the technology to GigaWatt scale by 2030. Research and development to increase the cell power density will be an ongoing activity, improving performance and reducing costs. Larger electrolyser designs will require multi module arrays, all while reducing the cost per kW and maintaining durability. The commonality of the cell building block means SC will attain buying power, even in the early years of manufacturing. The optimisation of the entire solution will be required to prevent the ‘balance of plant’ from eroding the significant efficiency gains at reactor level.

Credibility Challenge:
By 2024 the business will be faced with the challenge of credibility, not in the technology or the management team but in the lack of track record demonstrating ability to deliver on multi million-pound contracts. Therefore, a key development activity will be to partner at an early stage with companies that already have this reputation and could form more meaningful partnerships to service large contracts together. SC has started building these possible relationships across gas operators, energy suppliers and the O&G industry. Our ideal is that one of the shortlist companies take an equity stake in SC in 2021/22, assisting with the development using their skills and experience to accelerate the product, through to and including the pilots in 2023.

[This information has been redacted]

[This information has been redacted]

2b. Please provide figures for the estimated carbon savings generated by your Green Distilleries solution and explain the wider benefits that your Green Distilleries solution will contribute to. (10%) (applicants can use the upload link to provide supporting evidence and illustrations, any further text beyond the word limit will not be assessed) With reference to the Phase 1 Feasibility study where applicable, applicants are expected to describe the commitment your organisation will make to ensure that opportunities under the contract deliver Social Value Policy Outcomes, via the following: Estimate the potential emissions savings from the solution and provide the basis behind the calculation for your site and if replicated across the distillery sector/other industrial sectors. Please provide further justification and reasoning behind calculations used to calculate carbon savings attached as an Annex as part of your application form. Describe how the emissions savings will contribute to the UK's Net Zero by 2050 target. Provide information about job creation and other benefits generated because of the Green Distilleries proposal, including those beyond the Green Distilleries competition. Describe how the project will benefit and impact the local environment and community beyond the Green Distilleries Competition Describe how the project supports the Government's plans of "Build back better" and "levelling up" of the economy (Maximum 2000 words)

For full answer please see 'Question 2b and AppendixQ2b.pdf'

To provide supporting evidence and illustrations upload your file/s here. Please do not upload any further text in order to go beyond the word limit, it will not be assessed. Max upload size per file - 10MB Max number of files - 5

- File: Question 2b and AppendixQ2b.pdf - Download

2c. Please provide a description of your dissemination plan for your Green Distilleries solution. (10%) (applicants can use the upload link to provide supporting evidence and illustrations, any further text beyond the word limit will not be assessed) Applicants are expected to: Identify the relevant stakeholders, including plant manufacturers and suppliers, end users, trade bodies and academia Provide a dissemination plan, including a timetable for any dissemination activities, describing how the learnings from the demonstration study will be shared with industry. The plan should include key stakeholders, lessons learnt, and any challenges faced during delivery. Describe how the outputs of the demonstration study will be disseminated beyond the end of the Green Distilleries Competition (15th March 2023) (Maximum 1000 words)

Over the course of Phase2, this first of a kind hydrogen solution will act as a means of demonstration and education for multiple stakeholders. Already, SC has produced a 3 page executive summary of the feasibility study to be released at the same time as the study to allow quick review of the key benefits and challenges of WhiskHy.

Please see AppendixQ2c for a dissemination plan and timetable of dissemination activities.

SC over the course of the feasibility has engaged multiple suppliers of products and services. Each of these suppliers, inclusive of plant manufacturers such as [This information has been r] will be sent SC's feasibility study. In a similar fashion, during and after Phase2, SC will report on progress and all suppliers will be invited to attend all-party webinars on progress updates, where the broader supply chain will be able to keep track of the application of their products and services. We will engage and maintain strong relationships with the UK supply chain through partnership and deep understanding of each other's technology, therefore we anticipate good engagement and participation. Progress, lessons learnt and challenges faced will be presented centrally, and time for discussion will be allowed. With such a diverse and broad set of stakeholders wide engagement will be achieved.

Over the course of this process, SC has had detailed conversations with a number of distilling companies, engaging 3 of the world's largest, in the process of finding a distillery partner for Phase1

and remaining engaged with all of them. SC have found a committed partner in Beam Suntory who is committed to decarbonise its entire operations by 2040 and by 50% by 2030. Throughout Phase2, SC will be working closely with the Ardmore team and project progress will be disseminated throughout the global business, including major operations in the US and Japan.

For trade bodies on a technical stage, as a world first for electrolysis, Supercritical will use hydrogen and renewable energy platforms such as the Renewable Energy Association, the UK Hydrogen and Fuel Cell association and the Energy and Utilities Alliance as well as sector specific media to disseminate technical information, benefits and lessons learnt from the pilot.

In the world of distilling, novel approaches to decarbonisation are being sought. Findings will be shared via webinars in collaboration with Beam Suntory to engage a wider audience in the UK and abroad. SC has been working with Beam Suntory to amplify the feasibility study in coordination with World Whisky Day. Towards the end of Phase2, findings will be presented to members of the Scottish Whisky Association.

Given the novelty of the proposal and associated infrastructure implications for the local communities to reach a net zero status, local councils have been engaged. Aberdeenshire is a vast council and is consequently split into 6 areas for management where decisions are made by local Councillors. Ardmore sits in the Marr area. The project has been introduced at both a county level and area level. This open communication will continue throughout the project to maximise dissemination through the council's extensive network. This is evidenced by Aberdeenshire Council's letters of support.

At a grassroots level, SC will explore the option to conduct a learning session at local schools or colleges. Demonstration and education of innovative science and engineering in practice as well as valuable lessons around decarbonisation will aim to encourage young people into STEM subjects and to explore opportunities to enhance the UK's pool of technical capabilities. SC will work with the local council to understand which schools might benefit most from this to offer the opportunity to those less exposed to technology in action.

Lastly, at a national and international level, findings will be shared with BEIS directly and disseminated to the leading national institutes for energy and clean technology such as the High Value Manufacturing Catapult network, of which 2 of 7 centres are part of the Phase2 plans. Other organisations such as InnovateUK, OGTC and the Offshore Renewable Energy and Energy Systems Catapults which have also shown their support, with some supporting financially, will be informed and suitable webinar/seminar opportunities will be sought.

SC is a team of innovators who have benefited heavily from the sharing of knowledge. In return, SC aims to be a leading voice in dissemination of findings that are not proprietary or commercially sensitive. Scientific publications will be issued with patent publishing. Through sharing of knowledge, SC will inspire others and to expand on what SC has achieved. SC will report on the progress of the project with a dedicated web page and share updates quarterly via blog posts which will be shared on platforms such as LinkedIn and Twitter and H2view for maximum engagement.

Beyond 15th March 2023, SC will issue a summary blog post and follow this up with social media updates teasers to certain key findings highlighted with appropriate imagery and video footage. The goal will be to build excitement to SC's Completion Webinar and Q&A, an event that will be hosted by SC, presenting achievements, lessons learned and future intentions in the space and targeting a wide representative from the sector. Beyond this, SC will issue a formal report of findings in line with BEIS expectations.

To provide supporting evidence and illustrations upload your file/s here. Please do not upload any further text in order to go beyond the word limit, it will not be assessed. Max upload size per file - 10MB Max number of files - 5

- File: Appendix Q2c.pdf - Download

3. Project Financing

To accompany your application you must upload the Green Distilleries Project Cost Breakdown Form here. Max upload size per file - 5MB Max number of files - 1

- File: Question 3a Finance Form - GD155PII.xlsx - Download

3a) With reference to the Phase 1 Feasibility study and how the Phase 1 Feasibility study has helped firm up these costs, applicants are expected to: Fully fill in the Green Distilleries Phase 2 project finance form. Clearly demonstrate that the project can deliver a workable solution (including the use of modelling or demonstration). Provide clear reasonings to the overheads and eligible costs Provide reasonings and justifications behind cost estimates, including any contingency and assurance planning for costs (please attach any evidence in terms of letters of support, contracts, existing agreements along with your Phase 2 application). Provide a detailed description of major cost items greater than £10,000. Justify costs and provide certainty of availability and assurance of costs provided for materials, equipment and products that are required for the Green Distilleries Phase 2 Project. BEIS normally calculates overheads as a fixed percentage of all direct labour costs at 20%, but in exceptional circumstances the overhead rate could be higher, applicants will have to justify overheads above this percentage, this must be fully detailed in the application. (Maximum 1000 words)

[This information has been redacted]

[This information has been redacted]

To provide supporting evidence and illustrations upload your file/s here. Please do not upload any further text in order to go beyond the word limit, it will not be assessed. Max upload size per file - 10MB Max number of files - 5

- File: Appendix Q3a.pdf - Download

3b) Value for money to HM Government - Please describe how your Green Distilleries solution represents good value for money for HM Government. (15%) (applicants can use the upload link to provide supporting evidence and illustrations, any further text beyond the word limit will not be assessed) Applicants are expected to: Provide evidence for the additionality achieved with this funding. Demonstrate a fair balance of risk and benefits for BEIS, including no element of profit in the project costs. Describe why the proposal

represents good value for money for HM Government, where costs are realistic and justified and are likely to secure the expected project aims and deliverables, including the selection and costing of suppliers and subcontractors. 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. (please refer to Risk-Benefits sharing Section 4 (10) of this application guidance form). As part of the assessment process for Phase 2, project teams will be asked to clearly state, where cost savings are being provided compared to exclusive development contracts. These cost savings form part of the eligibility conditions for the Competition, i.e. projects that do not offer justified cost savings will not be eligible for Phase 2 funding. (Maximum 1000 words)

[This information has been redacted]

SC will hire 4 new employees in this project and anticipate directly employing up to 165 skilled staff within the next 10 years, with indirect jobs being an order of magnitude higher. This supports the UK government's new Green Jobs Taskforce to support the creation of 2 million skilled jobs to build back greener (Nov20).

SC will sell MegaWatt electrolysers in early 2025, after investment into its first UK Megafactory in 2024, in 2030 the factory will be upgraded to Gigafactory. The location is likely to be in a region of the UK that would benefit from growth manufacturing jobs and investment, including South Wales, North West England, North East England and North East Scotland.

[This information has been redacted]

In order to become commercially viable, SC must scale the system and improve system costs. Given the inherent uncertainties present in the application of a novel technology, this early TRL stage is perceived as high risk by private investors but confidence would build if with government financial assistance we were able to progress to a higher TRL. Such funding supports the development of local supply chains, and sends a message of confidence to potential future investors (further reducing potential cost of finance, thereby providing further support). Long-term, the development of green hydrogen for use in distilleries has the potential to create high-quality jobs (often in remote, rural areas), significantly contribute to HM Government's own decarbonisation targets, and has global export potential.

Partners:
Engaging with the MTC, one of the High Value Manufacturing Catapults, SC is leveraging the benefits of HM Government's previous investment in UK manufacturing. Moreover, through having the MTC as a partner, the consortium are able to take advantage of the unique facilities and expertise of the manufacturing catapult, all sited within the Coventry facility. This will deliver best value as well as potentially open doors to the technology being expedited through the extensive MTC and wider HVMC network of member companies into the future.

[This information has been redacted]

commitment from the Distillery is extremely encouraging and shows their commitment to trying to progress the decarbonisation of their distillery and offering greater value for money for HM Government.

Subcontractors:
Subcontractors have been prospected and critically compared to ensure the best value, seeking competitive rates from leading institutions, maximising the chances for success. Staff are UK-based, representing significant VAT/PAYE/NI taxpayer payments.

[This information has been redacted]

[This information has been redacted]

Distilleries and wider market:
As demonstrated by WP7, hydrogen direct firing has the potential not just to decarbonise whisky but to enhance its quality with the potential to grow exports which were worth £3.8bn in 2020. Using distillery wastewater as a feedstock, supports Beam Suntory's public ambition of reducing water use by 50% by 2030 and fuel switching to hydrogen supports Beam Suntory's ambition to Reduce greenhouse gas emissions (GHG) by 50 percent across direct operations by 2030.

To supplement the ~530K tCO2e opportunity and quality benefits that could be obtained in the distillery industry, the core electrolyser technology would stand to benefit multiple other industries in the UK and globally. SC's technology offers the best efficiency and economics when tailored to the application. Investing in this technology now offers an accelerated option for the remaining UK Industrial sector 84MtCO2e (19% of UK total) decarbonisation opportunity, expanding into our secondary focus area of heavy transport; buses (3MtCO2e) and goods (21MtCO2e).

There are a number of companies (NEL, Siemens, McPhy, Elogen, ITM power) making significant progress in scaling electrolyser technology and only one of them is based in the UK. We are in danger of being an importer of a key part of the hydrogen value chain and missing out on the economic benefits and jobs that would come from developing UK technology. We can see these companies eyeing the UK market, NEL just installed their first UK electrolyser in London. To be a global leader in hydrogen the UK needs UK developed and owned IP, with competition in supply to create a rational, high growth, market. The investment in this project will progress SC from TRL4 to TRL5, a significant step in energy technology development and introduce a challenger to the UK electrolyser market.

Support has been received across the supply chain ranging from building demand for steel through new market creation to decarbonisation of some of the strongest industrial regions in the UK. Support from Aberdeenshire Council, the Hydrogen Accelerator, OGTC (energy), NECCUS (petrochemical), RICE (industry), and the BSSA (stainless steel) have been received [AppendixQ3b]. This project aligns with the Government's Industrial Strategy to "make clean technologies more competitive than high carbon alternatives" and to "take the lead in supplying to the global markets".

To provide supporting evidence and illustrations upload your file/s here. Please do not upload any further text in order to go beyond the word limit, it will not be assessed. Max upload size per file - 10MB Max number of files - 5

- File: Appendix Q3b.pdf - Download

4. Project delivery and teams

4a. Project team and Organisation – Please provide a description of your project team and organisation for the Green Distilleries Phase 2 Demonstration Study. (10%) (Please attach any CVs to the application prior to submission) (applicants can use the upload link to provide supporting evidence and illustrations, any further text beyond the word limit will not be assessed) Applicants are expected to: Identify the skills and competencies necessary for each task. Provide an organogram mapping skills, competencies, roles, and responsibilities (including percentage of overall time that key members will be dedicating to the project). Outline the key roles for each partner and the proposed governance arrangements between the partners to ensure effective project delivery. 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. Guarantee access to any necessary specialist facilities, operational knowledge and skills, or other resources required to execute the project. 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 previous projects, including the date, location, client and project size. Provide brief CVs of lead individuals within the project team in an Appendix to the Application (CVs should be no longer than 2 pages each). Have a strong delivery team with proven experience of successfully delivering comparable projects. (Maximum 2000 words)

SC has carefully curated a core project team, with core component manufacturer and end user committed as partners. This team is supported by an optimal subcontracting project team which draws on the UK's leading experts in their field.

Considering each primary task for successful delivery of the project as a major Work Package (WP#), SC defines WP1-8.

A detailed Gantt Chart is found in AppendixQ4b.

WP1: Test Environment. Skills and competencies required: Best practice in lab and pilot safety and risk management

SC's [This information has been redacted] has unique experience in building supercritical reactors and electrochemical systems. SC will work with the safety partner to the project, [This information has been redacted] from the [This information has been redacted] [This information has been redacted] to support scoping the needs of the test environment. As the technology develops and trials get larger, specialised premises to augment the design and control will be required. SC continues from Phase1 with the UK's leading early stage process technology group, the [This information has been redacted] has an in-depth understanding of SC's technology and will support in identifying the right needs.

[This information has been redacted]

[This information has been redacted]

WP6: System - Process engineering, mechanical engineering, instrumentation and control, relevant experience

[This information has been redacted]

WP7: Distillery. Skills and competencies required: Distillation process and equipment expertise, hydrogen burner expertise

BS's project operations team of [This information has been redacted] Distillation & Maturation Operations; [This information has been redacted] and [This information has been redacted] have over 100 years' direct experience within our BSUK / Ardmore distillery operations,

[This information has been redacted]

BS's technical environmental lead is [This information has been redacted] – Environmental and Sustainability Engineer, who is leading the BSUK 2030 and 2040 decarbonisation strategy and brings strong project management and technical skills from previous roles prior to joining BS.

Supporting BS and the wider project are [This information has been redacted] will deliver a 100% hydrogen burner as required.

WP8: Project Management

SC will hire a full time Project Manager (PM) for the duration of this project. The PM will be responsible for project management, project finances, project reporting and communicating with the project monitoring officer.

[This information has been redacted]

Supercritical is the lead partner for WhiskHy, who's key role is principle technology developer within the project. BS's key role as WhiskHy's distillery partner is delivering valuable insight into the whisky production process and market requirements. The Manufacturing Technology Centre, a member of the High Value Manufacturing Catapult is WhiskHy's manufacturing partner bringing a huge breadth of manufacturing expertise and resources to the manufacturing processes of SC's core component, the electrodes.

BS are committed to a decarbonisation journey for their global premium spirits business as communicated in their recently announced, 'Proof Positive' sustainability vision, which commits it's Scottish Malt Whisky distilleries, of which Ardmore is the largest, to achieving a 50% reduction in Greenhouse Gas emissions by 2030 and to achieving net-zero carbon emissions by 2040.

[This information has been redacted]

The three project partners, SC, Beam Suntory and MTC will complete and sign a Consortium Agreement to ensure effective project delivery.

[This information has been redacted]

The MTC is a pioneer in laser processing (specifically machining, drilling and cutting) and a lead centre for laser processing within the UK High-Value Manufacturing Catapult and has best-in-class facilities and expertise to deliver the project.

[This information has been redacted]

In addition, the MTC has the ability to provide expert insight in to potential supportive manufacturing techniques or alternatives such as additive manufacturing, design and build and integration, electronics, high integrity fabrication, advanced tooling and fixturing, non-conventional machining, robotics and autonomous systems, design and simulation and manufacturing informatics.

[This information has been redacted]

BS offers SC a unique opportunity for a full week's operation on a commercial scale whisky still. Offering both engineering time and feedstock to run the controlled trial, BS commits to partake in the first large scale whisky distillation fueled by hydrogen. Their analytical labs will be offered to test water quality of the wastewater to be used in SC's electrolyser tests and used to track the quality of their hydrogen whisky. Their unparalleled process and site knowledge will be provided in the direct firing full scale trial and the planning of the steam boiler pilot trial.

Please refer to AppendixQ4a to view an extensive list of relevant previous projects from project partners and subcontractors as well as brief CVs for the core team demonstrating proven experience of successfully delivering comparable projects.

To provide supporting evidence and illustrations upload your file/s here. Please do not upload any further text in order to go beyond the word limit, it will not be assessed. Max upload size per file - 10MB Max number of files - 10

- File: Appendix Q4a.pdf - Download

4b. Project Plan - Please provide a project plan for your Green Distilleries Phase 2

Demonstration Study, including any work packages and milestones. (10%) (applicants can use the upload link to provide supporting evidence and illustrations, any further text beyond the word limit will not be assessed) Applicants are expected to: Complete Table 4a (project work packages), outlining in detail the key work packages for Phase 2. Complete Table 4b (project milestone and deliverables), outlining the project milestone and associated deliverables for Phase 2. Download the excel spreadsheets through the link below. Once you have completed the forms please save it locally. The tables can then be uploaded using 'choose file' option after the question box. Table 4a - Project Work Packages Table 4b - Project Milestones and Deliverables Present a well thought-out, robust, credible, project plans. Provide a detailed plan to include any contingency planning for risks, costs, time and resources. Provide a separate high-level Gantt chart or outline project plan listing the key tasks and timescales. Provide stage gate review points in the project life that captures key project milestones/risks. (Maximum 2000 words)

WP1: Test Environment

[This information has been redacted]

There are no 'deliverables' with WP1, however there are 5 milestones to track progress:

1)Risk assessment document for module testing (includes V1-3 modules)
2)Lab Specification document
3)Signoff of module test stand by SC (CTO)
4)Updated Risk Assessment for larger V3 module
5)Confirmation of lab for module testing

WP2: Materials of Construction Review

Putting safety above all else, SC [This information has] have determined that existing widely available literature is not extensive enough to accurately downselect an optimal starting point for the material of construction of the pilot module.
The key deliverable for WP2 is the SC electrolyser specification document, which will be updated with new sections as the project progresses.
Additionally WP2 has milestones that track progress through the project:

1)Metallurgy Report
2)V1 Module assembly (ready for testing)
3)Passivation update to the SC electrolyser document

WP3: Cell Module and Design

Principally an electrolyser module brings multiple cells together within a single structure, linearly increasing the amount of hydrogen produced for every additional cell added to the module. Structuring this for optimal performance and durability whilst delivering on long term cost targets and SC's high safety standards is the challenge.

Due to the novelty of SC's innovation, optimised componentry is not available off-the-shelf. SC has completed preliminary designs of a module that leans on non-optimised off-the-shelf components and certain components that need to be processed to deliver the necessary design intent. Throughout Phase2, SC will iterate with its subcontractors on these components and module twice more, resulting in SC's largest working module to be tested in test cycle 4. SC's internal testing at cell level paired with an existing multi-physics computational model, developed through a strong working relationship with the [This information has been redacted] educates the design for SC's module.

[This information has been redacted]

n[This information has been redacted] To manufacture this component, SC has partnered with the MTC to determine the optimal manufacturing method for delivering the design intent of the electrodes. Through a series of sprint manufacturing trials and round table design reviews, the MTC brings a pedigree of manufacturing excellence into the module design. The MTC will undertake manufacturing process technology selection as a series of rigorous steps undertaken to identify and trial the most appropriate technology or process for the specific application of making discrete elements of the overall electrolyser. This will allow the consortium to de-risk and accelerate the progression towards process optimisation. The work plan has been designed in discrete blocks to allow rapid sprints and learning, which can be pivoted to alternative processes and technology trials should one prove more preferable or one show no promise.

Due to the criticality of this component, SC has engaged MTC as a partner and MTC are committed to working with SC to deliver a technical and commercially viable solution. Continued advancement of SC's multi-physics computational model [This information has b] is required as an ever-more accurate model will reduce the number of physical trials required and ultimately reduce time and cost of development. The base model developed [This information h] will be used preliminary module design refinement [This information has been] product development experts, optimise the module [This information has be] mechanical design team will work closely with SC to challenge and refine the bringing together of all of the components and deliver detailed engineering drawings to facilitate accurate pricing and manufacture of the module.

In parallel with V1 and V2 Module testing, SC will be continuing core research on electrolyte, electrocatalysts and operating conditions. SC and the [This information has been redacted] devised a 12 month work plan to deep dive into existing literature and to test the leading candidates for performance and durability. At each design review, SC will use the most recent guidance on optimal materials to determine the best course of action for the next stage. At the end of this 12 month period, SC will settle on an agreed optimal electrolyte, catalyst and condition for normal operation.

Deliverable for WP3:
1)Update to the SC electrolyser specification document with the gen3 cell design
2)V3 Module designs
3)Update to the SC electrolyser specification document with gen4 cell designs
4)Update to the SC electrolyser specification document with Pilot spec
Additionally WP3 has milestones that track progress through the project:
1)V2 module designs
2)CFD model updated with V2 module design
3)Gen3 electrochemical CFD model
4)V2 module assembled, ready for testing
5)V3 Module assembled, ready for testing
6)Draft Patent
7)Electrolyte paper

WP4: Test
SC will lead cell development and testing at its facilities in London. [This info] will support larger module testing with SC directing the test plan and [This information has b] will conduct specific and targeted small scale testing of a wide range of electrolytes and catalysts aimed at mapping the options and identifying optimal choices. Given the early nature of SC's business, SC does not have the test premises or analytical capabilities [This information has been redacted] is a world leading electrochemistry establishment with state of the art analytical equipment and a research team second to none [This information] a perfect test bed for early stage process technology development, with unique facilities like explosion bays to mitigate risk as well as an expert team of process engineers who have worked on similar projects before.

Deliverable for WP4:
1)Test Cycle 2 - report
2)Test Cycle 3 - report
3)Test Cycle 4 (demonstrator) - report
Additionally WP4 has milestones that track progress through the project:
1)UoSA Conductivity report
2)UoSA Materials report
3)UoSA Durability report

WP5: Safety Review
With [This information has be] guidance and experience in HAZIDs and HAZOPs for industrial hydrogen pilots the consortium will work through a structured verification and validation process for the module and system in development. A full Safety Requirement Specification will be drafted to allow a smooth safety assessment for pilot deployment, working with Beam Suntory colleagues.

The key deliverable for WP5 is the final safety report with all safety risk and mitigation measures.

Additionally WP5 has milestones that track progress through the project:
1)HAZID/Hazard Quantification
2)Requirement Risk Assessment
3)Requirement specification - FMEA
4)System Design - Functional Safety Concept
5)System Design - Specification Requirement Specification
6)System Design - Module FMEA
7)System Design - HAZOP
8)Sub-system design - Safety constraints e.g. DSEAR/ATEX

WP6: System

Following on from a successful collaboration in Phase1, [redacted] will support SC's module development, attending design reviews and ensuring that system and scale up considerations are maintained. Within the scope of Phase2 [redacted] will be able to complete a full concept study and pre-FEED, building on their early stage concept study from Phase1. The additional operational data at a module level will facilitate accurate system sizing and enable [redacted] conduct the detailed engineering stage, meaning that with additional funding, only the procurement and construction of the pilot will be required to facilitate the in-field pilot.

The key deliverable for WP6 is the full subsystem design documents and code for control systems for the full pilot system.
The milestones to track progress in WP6 is the FEED design document for the pilot build.

WP7: Distillery
[This information has been redacted] Constantly on a quest to improve the quality of their product, a valuable export, [redacted] recognises a unique opportunity to finesse the character of their spirit whilst negating emissions [This information has been redacted] The quality of the spirit will be tested and compared to their huge database of existing and past spirits. [redacted] This will be tested regularly as it matures both analytically and traditionally by their resident master of malt, and will result after a number of years as 57,700 fully matured bottles of whisky. [This information has been redacted]

For the trial, hydrogen will be supplied by [redacted] has a standard industrial gas supply business model whereby it rents capitalised assets to supply large volumes of industrial gas on a regular basis from its network of manufacturing facilities. The system is automated to a degree where, once installation of permanent assets has taken place, a central remote operations centre and delivery planning centre schedule and optimise deliveries based on geography, logistic asset availability, telemetry data and surrounding customer base. [This information has been redacted]

[This information has been redacted] in place to support long term, large volume gas supply agreements and, in rare cases, support from an operational and safety standpoint for trials and turnarounds. In order to fulfil WP7 requirements, for a 4 day period, there is extensive disruption to normal modes of operation and extensive preparatory and fabrication work. [This information has been redacted] Four tractor units with trailers will need to make the onward journey to North West Aberdeen and return to Motherwell without the trailer unit and when the first trailer runs out it will initiate another trailer unit being driven to the distillery and being changed out for the empty trailer. This will have to happen a further 3-4 times.

To manage safety, a trained professional needs to be on site supervision at all times. The presence of a Customer Engineering Services (CES) engineer on site will also ensure that the trials go as planned in the stipulated time period, any further disruption [This information has been redacted] fulfil these trials will carry further surcharging.

It is estimated that 6-7 CES engineering days to prepare the flow skid in terms of safety inspection, written scheme of examination generation, replacement of PRVs, leak checking and vent stack preparation as specified by the British Compressed Gas Association regulations.

Deliverable for WP7:
1)Report on wastewater quality at the identified three stage at the distillery
2)Feasibility of O2 use case at distillery
3)Feasibility of electrolyser purge water use case at the distillery
4)H2 direct fired Spirit produced
5)Spirit Analysis report
Additionally WP7 has milestones that track progress through the project:
1)Purge requirementents added to the SC specification document
2)Direct Firing detailed plan
3)Direct burning still ready for H2 distilling
4)Spirit in warehouse casks
5)Spirit Maturity report

WP8: Project Management
SC will hire a full time Project Manager (PM) for the duration of this project. The PM will oversee the entire project, reporting to the CEO of SC. The PM will manage all stakeholders and report into the monitoring officer for BEIS as per the required reporting schedule.

There are no ‘deliverables’ from the WP8 work package but there are milestones to track progress:

1)BEIS monthly progress report
2)Milestone progress report
3)Quarterly Invoice
4)Monthly accounts

To complete question on Project Plans you must upload Table 4a (project work packages) and Table 4b (project milestone and deliverables) here. And to provide supporting evidence and illustrations upload your file/s here. Please do not upload any further text in order to go beyond the word limit, it will not be assessed. Max upload size per file - 10MB Max number of files - 5

- File: Q4a Work Packages.xlsx - Download
- File: Q4b Milestones.xlsx - Download
- File: Appendix Q4b - Gantt Project Plan.pdf - Download

4c. Project Risks – Please complete a risk register (table 4c) and provide a description of the risks and risk mitigations for your Green Distilleries Phase 2 Demonstration Study. (5%) (applicants can use the upload link to provide supporting evidence and illustrations, any further text beyond the word limit will not be assessed) Applicants are expected to: Complete Table 4c (risks and risk management) outlining key project risk register for the Phase 2 Demonstration Studies, identifying key risks and providing suitable mitigation strategies. This should also include contingency planning. Download the excel spreadsheet through the link below. Once you have completed the form please save it locally. The table can then be uploaded using 'choose file' option after the question box. Table 4c - Risks and Risk Management - Phase 2 Show a realistic and robust approach to risk management. Justify and provide reasoning to the risks and mitigation actions identified (Max 1500 Words)

Risks have been categorised by ‘probability’ and ‘impact’, the rating determined by multiplying the above factors. These are detailed extensively in Appendix-Q4c. Through the project, risk screening will be used to monitor risks and progress on mitigating actions, adhering to ISO-31000 principles, reviewed at monthly meetings, led by the Project Manager to ensure active risk monitoring, contemporaneous mitigation measures, root cause analysis as necessary and proactive mitigation.

The highest rated risk in the project is ‘cash flow’. SC is experienced in managing large budgets (£100’s millions) and will continue diligent cash flow management and open up an equity funding round in mid 2021, which will significantly address this risk. However SC welcomes conversations with BEIS should it be successful in its application in how funding could be structured in a way to minimise cash flow risk.

As with all high energy systems, there is an inherent risk to people and property and safety is SC’s number one priority. The project plan has been developed with this priority at front of mind at all times. SC has factored in risk assessments and in depth reviews to ensure that safety is re-evaluated through the programme and as the electrolyser size increases. The project plan engages with [redacted] on design safety cases during each iteration. Engaging [redacted] from [redacted] enables electrolyser expert guidance. Safety focus on: pressure, temperature, flammability. Assess all normal and abnormal operating cases and make safe in design and control.

SC’s lab in Opencell Bio, West London, has been built for ‘single cell’ and small scale catalyst/electrolyte testing only and is not currently suitable for larger ‘multi-cell module’ testing due to the increased energy density and greater hydrogen and oxygen production. SC will assess the steps and equipment required to upgrade the existing facilities however for planning purposes, we have assumed that this will not be possible and that we will require new ‘multi-cell module’ facilities with appropriate test equipment. SC believe that this is likely to require dedicated facilities with explosion considerations and mitigations (blast proof) and extraction of gases. SC have planned for an environment that is suitable for the final demonstrator electrolyser (based on V3 Module and Gen4 cells, with Test Stand 4 system). Through Phase1 of the green distilleries project, SC were able to quantify the size of the reactor and system an[redacted] was able to provide a quote for [redacted] which meets the safety requirements, including trained lab technicians to complete the test plan created by SC. SC will evaluate alternative locations with [redacted] within WP1.1 and WP1.7, with the option of locating a new SC lab outside of West London, suitable for single-cell and multi-cell testing.

As a deliverable in Phase1 of the Green Distilleries proje[redacted]esigned a full mass balanced system for the electrolyser and ran a procurement exercise to cost the required components. However as some of the performance data was not available at the multi-cell level at the time, worst case scenario assumptions were used. This approach resulted in a significantly over sized system and therefore elevated cost.
For the module testing SC will require the appropriate sized system components for the testing and demonstration of the multi-cell modules. [This information has been redacted] however SC believes it will be less. The programme of work will establish module operating conditions through WP4.1 and WP4.2[redacted] as part of WP6.1 will update the system mass balance as new data points are established.

To complete question on Project Plans you must upload Table 4c (Risks and Risk Management) here. And to provide supporting evidence and illustrations upload your file/s here. Please do not upload any further text in order to go beyond the word limit, it will not be assessed. Max upload size per file - 10MB Max number of files - 5

- File: Question 4c - Risk Register - Worksheet in Green_Distilleries_Online_Application_Form (1).xlsx - Download

Collaborative Application

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

Yes

Partner 1 Contact and Organisation Details

Contact Details

Title	[redacted]
Name	[This has been redacted]
Position	[This has been redacted]
Email	[This has been redacted]
Mobile Number	[This has been redacted]
Organisation Website	https://www.beamsuntory.com/en

Organisation Name

Beam Suntory UK Ltd

The registered address of the Partner Organisation

Address Line 1	2 Longwalk Road
Address Line 2	Stockley Park
Address Line 3	-
Town/City	Uxbridge
Postcode	UB11 1BA

County

Greater London

UK Region
London

Country
United Kingdom

Organisation Type
Private Company

What is the size of the organisation?
Large Enterprise

Number of employees (including directors)
[This has

Business Registration Number
5591988

Turnover Amount (in most recent annual accounts)
[This has been redacted]

[This has been redacted]

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

Is the Organisation able to recover VAT?
Yes

Organisation Maturity
6-10 years

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

[This has been redacted]

[This has been

[This has been redacted]

Turnover Date (in most recent annual accounts)

* 31/12/2020

Balance Sheet Total (total assets net of depreciation)

[This has been redacted]

[This has been redacted]

[This has been redacted]

[This has been redacted]

[This has been redacted]

[This has been redacted]

Organisation Website www.the-mtc.org

Organisation Name

Manufacturing Technology Centre (MTC)

The registered address of the Partner Organisation

Address Line 1 Pilot Way

Address Line 2 Ansty Park

Address Line 3 -

Town/City Coventry

Postcode CV7 9JU

County

Warwickshire

UK Region

West Midlands

Country

United Kingdom

Organisation Type

Research Organisation

What is the size of the organisation?

Large Enterprise

Number of employees (including directors)

[This has

[This has been redacted]

[This has been redacted]

Balance Sheet Date (total assets net of depreciation)

* 31/03/2020

Is the Organisation able to recover VAT?

Yes

Organisation Maturity
>10 years

How is the organisation currently funded? (Choose all that apply)
[This has been redacted]

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

Additional Partner

Do you need to add an additional partner?
No

Programme Performance Indicators and Benefits

How would you describe the nature of your innovation project?
Product Development

State how many FTE jobs could be retained in your organisation as a result of participation in this project? (enter a number)
7

State how many FTE jobs could be created in your organisation as a result of participation in this project? (enter a number)
3

What is the number of Partner Organisations supported to deliver the project? (enter a number)
3

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				

The Green Distilleries Competition will aim to realise the following benefits. Please select which benefits your innovation could potentially contribute to.

	Yes	No
Further understanding of technical feasibility of fuel switching/ enabling technologies	X	
Successfully demonstrate fuel switching/enabling technologies	X	
Develop industry and market awareness of fuel switching/enabling technologies	X	
Build an evidence base to improve BEIS knowledge for industrial decarbonisation	X	

Further Information

Upload further information documents here. Max upload size per file - 10MB Max number of files - 5

- File: FINAL - GD155-BEIS-WhiskHy-Supercritical-Feasibility Report.pdf - Download
- File: Replacement of Declaration 2 (MTC signed).pdf - Download

Declaration Forms

Please download the following Green Distilleries Declarations Document to be signed offline and re-uploaded through the link below. If convenient you can use e-signature to sign the documents. Green Distilleries Phase 2 Declarations Max upload size per file - 5MB Max number of files - 1

- File: Green_Distilleries_Phase_2_Declarations SC.docx - Download

Terms and Conditions

Please read the competition's Terms and Conditions (linked below) and select the YES button below to declare you have read them: Green Distilleries Phase 2 Terms and Conditions

	Yes
I have read the Terms and Conditions	X

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
Green Distilleries Project Cost Breakdown Form	X	
Partner Information Form *If more than three Partners*	X	
Project Plan	X	
Risk Register	X	
Attached supporting documentation *Clearly referenced*	X	

Signatory Page

Enter details below

Name of Organisation	Supercritical Solutions Ltd
Signature *Please insert name*	[This has been redacted]
Position in Organisation	[This has been redacted]
Date (DD/MM/YYYY)	05/05/2021