UKPIA RESPONSE TO HYDROGEN TRANSPORT AND STORAGE INFRASTRUCTURE

General Considerations

1. **Do you agree with Government's analysis and vision for hydrogen network evolution through the different phases as described? Please explain your answer and provide any relevant evidence.**

UKPIA agrees with the Government's analysis and vision for hydrogen network evolution through the different phases. These seem a pragmatic approach to the development of the networks in line with the Net Zero strategy and emerging technologies.

The Low Carbon Hydrogen (LCH) Transport and Storage (T&S) Business Model needs to be available much sooner than outlined in the Consultation as it takes developers a long period of time (for example 4 years to develop large salt caverns and cross-country pipelines) to execute the project after the Final Investment Decision (FID).

BEIS is accelerating the LCH Production Business Models (BM) with an intention to reach FIDs by mid 2023, but some of these large projects won't pass through the FID unless they have a T&S system that can export their LCH to markets across the region. If the LCH T&S BM is not ready in Mid 2023, those projects will be put on hold and the UK Government's vision won't be realised.

Finally, the UK Government's decision on role of low carbon hydrogen in heating should be accelerated. Until the Government's decision on blending is taken (expected to be in 2023) and hydrogen for heat (expected to be in 2026), developers cannot predict the size and location of hydrogen networks required.

2. **Do you agree with these key design principles for the transport and storage business models? Please explain your answer and provide any relevant evidence.**

We agree with the key design principles for the transport and storage business models. However, some clarification is needed on the issue of double subsidisation; for example, should low carbon hydrogen be transported via the T&S Business Model and used for the manufacture of Hydrogenated Vegetable Oil (HVO), would that HVO qualify under the Renewable Transport Fuels Obligation (RTFO)?

Given that the LCH T&S BM development is significantly behind the LCH production BM, the early stage (first 1-3 rounds) of LCH production BM projects should have significant flexibility regarding the inclusion of T&S systems within their scope

Hydrogen Transport Infrastructure

3. **In your view, do you agree we have correctly identified and characterised the market barriers facing the development and operation of hydrogen pipelines and a hydrogen network? Are there any other market barriers we should be considering? Please explain your answer and provide any relevant evidence.**

We agree that the barriers facing the development and operation of hydrogen pipelines and a hydrogen network have been largely correctly identified.

We would add research into hydrogen use such as fuel cells for transport and industrial processes such as steel and glass making would be helpful in expanding the user base and uplift volumes, helping to future proof the investment decisions.

It is worth noting that the use of spare systems such as natural gas pipelines inherently risks a reduction in energy supply resilience and should be carefully considered to ensure that the correct risks and rewards are delivered. Further to this, reliance on using dualled systems leaves sections of the country isolated; for example, SW Wales whilst supplying 12% of gas needs does so through a single line from Milford Haven to Swansea.

4. **In your view, have we set out the main business modelled design options, or are there others that should be considered? Please explain your answer and provide any relevant evidence.**

We agree that the main business model design options have been set out. There is a need to balance the investment risks between government and industry in the development of the hydrogen networks, and this should be carefully considered in the final business model decision.

We would recommend due consideration needs to be taken with the design of the funding scheme that pays for systems funded through the business models; for example, those not benefiting from a specific T&S system may be unwilling to fund it through a national levy.

5. **In your view, do you agree that uncertain demand and supply and limited user base will be the predominant barriers in a growth phase of hydrogen network development? Please explain your answer and provide any relevant evidence.**

We agree that uncertain demand and supply and a limited user base will be the predominant barriers in the growth phase of a hydrogen network.

Support for low carbon hydrogen production under its separate business model is still developing, and user uptake for both industrial and transport users is still developing.

From a commercial perspective, the future hydrogen price remains an unknown and carries its own challenges. As recent times have shown, the natural gas can price disconnect sharply from other energy source costs, meaning that reliance on a natural gas floor in the HBM may not suit all demand centres that can switch. We are aware of others moving to LPG's or solid fuels as their balancing fuel in these times, undermining the UK Governments position that Natural Gas floor is the true system wider counterfactual. The reliance on a natural gas floor in the HBM needs to be readdressed so that it represents the true counterfactual of the

demand sides. Without this, demand centres with flexibility will be reluctant to swap to hydrogen and thereby slow the development and growth of the hydrogen market.

6. **In your view, which business model design options do you consider may be suited to address the barriers in a growth phase? Please explain your answer and provide any relevant evidence.**

There is significant merit for having a consistent approach in business models across the various decarbonisation technologies needed in the transition to net zero. This ensures a level playing field across emerging technologies and clarity for investors and operators alike.

The option of a phased approach with a Contracts for Difference (CfD) model during the initial phase and a Regulated Asset Base (RAB) once the market is developed may be useful for T&S developers and would appear to be their preferred business model option.

Due to the scale of the proposed hydrogen network, and the investment required, it makes sense to accept that local natural monopolies would form. These need to be carefully managed to allow the networks to develop in a cost-effective manner while protecting users of the system.

7. **In your view, are there any interim measures that we should be exploring to support the development of early hydrogen pipelines ahead of a hydrogen transport infrastructure business model being available? Please explain your answer and provide any relevant evidence.**

This needs to be carefully considered, as there is a risk that early development may lead to smaller pipelines initially, which do not have the capacity required to deliver the volumes as the transition progresses. Given the scale of the investment required, support needs to be in place at the start to allow the pipelines to be developed that meet the needs of the final volumes, rather than the initial ones. We would suggest that this is studied as part of the development of the T&S business models.

Given that the LCH T&S BM development is significantly behind the LCH production BM, the early stage (first 1-3 rounds) of LCH production BM projects should have significant flexibility regarding the inclusion of T&S systems within their scope. Some of these large projects won't pass through the FID unless they have a T&S system that can export their LCH to markets across the region. If the LCH T&S BM is not ready in Mid 2023, those projects will be put on hold and the UK Government's vision won't be realised.

8. **In your view, is a RAB model, based on the natural gas RAB design, likely to be the most suitable business model during a steady state, or would another business model design be more appropriate? Please explain your answer and provide any relevant evidence.**

As we outline in our response to Q6, we agree that the RAB business model is likely to be the most suitable business model for the installation and operation of the hydrogen pipeline network.

There are security of supply risks that need to be given due consideration if this is the case. As the Rough Gas Storage case shows, an asset that can be considered strategic to the overall UK Energy Resilience system, was allowed to go out of service as the costs required were seen as too high, right up until the point that it was realised that the Rough Gas Storage system provided significant security of supply. The Government should use this as an opportunity to re-examine risk and cost trade-offs within critical systems that ultimately come under a RAB or similar return limited schemes.

9. **In your view, is there a need for compatibility between a business model for a growth phase and a business model for a steady state, and how should this be managed? Please explain your answer and provide any relevant evidence.**

We agree that there is a need for compatibility between a business model for a growth phase and a business model for a steady state. The option of a phased approach with a Contracts for Difference (CfD) model during the initial phase and a Regulated Asset Base (RAB) once the market is developed may be useful for T&S developers and would appear to be their preferred business model option.

10. **In your view, is there a need for compatibility between a business model for hydrogen and a business model for natural gas, and how should this be managed? Please explain your answer and provide any relevant evidence.**

We agree that there is a need for compatibility between the business model for hydrogen and a business model for natural gas. There may be synergies in using natural gas infrastructure for hydrogen through the energy transition and the flexibility for this needs to be considered.

As suggested in Q8, a RAB business model for hydrogen would be like that already used in natural gas and allow for the resource efficient use of pipelines in the energy transition. This should be managed by coordinating the regulators for both in an appropriate way.

11. **In your view, are there any other considerations we should take into account? Please explain your answer and provide any relevant evidence.**

UKPIA is not aware of any other considerations that should be considered at this time.

12. **In your view, what ownership arrangements do you think are likely to be suitable for hydrogen networks? Does this depend on the chosen business model and/or phase of network evolution? Please explain your answer and provide any relevant evidence.**

The investment costs required are likely to be substantial, and without substantial government support the investment risks for private companies are likely to be too great to allow Final Investment Decisions (FIDs) to be taken.

To provide the infrastructure required for the energy transition, we would suggest private ownership with government support through BMs, in line with what BEIS are considering. Projects demonstrating value for money while contributing to the Net Zero transition and UK

Energy Resilience should get the support. We understand that this is also aligned with the preferences of T&S developers.

13. **In your view, is an external funding mechanism needed in a growth phase of network evolution? If so, at what stage of market and network evolution might it no longer be required? Please explain your answer and provide any relevant evidence.**

This is something that needs to be carefully considered, particularly if it involves cross-subsidy from other energy consumers. The UK already has a significant cost base, including the impact of the UK ETS, and a further increase in costs risks investment in UK industry, including in the energy transition.

14. **In your view, if needed, what are your views on possible approaches to funding a potential external subsidy mechanism? Please explain your answer and provide any relevant evidence.**

As we outline in our response to Q13, approaches to funding through external means such as a cross-subsidy need to be carefully considered to ensure that UK energy intensive industries remain competitive in a global market. If costs rise relative to international investment, then UK companies may not be able to compete leading to carbon leakage and GHG emission reductions through deindustrialisation.

15. **In your view, how may other onshore hydrogen pipelines, including pipelines transporting hydrogen through a carrier, develop in the UK? Please explain your answer and provide any relevant evidence.**

These could develop as discrete business models in the future, or as an expansion in the existing hydrogen T&S Business model.

Given the substantial investment that is likely to be required in say ammonia manufacture at scale, there will need to be a clear business case for investment. This business case will need clearly defined uses and customers, and investment in the infrastructure required to serve them. Given that the technology is still emerging and developing it is unlikely that investment decisions on transporting hydrogen through a carrier will be made in the short-term.

16. **In your view, is a business model required for the development of other onshore pipelines for hydrogen and, if so, how might a business model for onshore pipelines transporting hydrogen as a gas be adapted for this? Please explain your answer and set out the specific market barriers that a business model would be required to address as well as providing any relevant evidence.**

Please see our response to Q15. Given the state of the technologies at present, it is premature to consider this issue in detail at this time. We would recommend that the hydrogen T&S Business Model be designed with flexibility in mind for other technologies as they develop.

17. **In your view, how may offshore hydrogen pipelines develop in the UK? Please explain your answer and provide any relevant evidence.**

UKPIA has limited experience with offshore pipelines. However, we would suggest that the RAB model for onshore pipelines could be expanded to include offshore under the same approach. This ensures that appropriate support exists for investment, and that the infrastructure for offshore production ties up effectively with the onshore network to effectively deliver supplies to users.

18. **In your view, is a business model required for the development of offshore hydrogen pipelines and, if so, how might a business model for onshore pipelines transporting hydrogen as a gas be adapted for this? Please explain your answer and set out the specific market barriers that a business model would be required to address as well as providing any relevant evidence.**

Please see our response to Q17. We recommend that the same RAB model is used for both onshore and offshore pipelines, which has a significant number of advantages

19. **In your view, how may vehicular transport for hydrogen develop in the UK? Please do include any other vehicular transport we may have missed. Please explain your answer and provide any relevant evidence.**

There are significant technical challenges to the transport of hydrogen in vehicles. These are well articulated in the consultation response. This will be reflected in significantly higher costs for hydrogen compared to the liquid fuels currently used. The HSE risks associated with vehicular transport are also significant, given the nature of the material handled.

For this reason, there needs to be compelling reasons why vehicular transport is used compared to say localised hydrolysis technologies using renewable electricity. Quality for EVs may be an issue, but the higher costs associated with vehicular transport have the potential to encourage research and investment in improvements in electrolyser technology.

Due consideration should be given to the reward of hydrogen under the BEIS Business Models and those under the Renewable Transport Fuels Obligation (RTFO). The latter supports the production and use of LCH for transport as a development fuel. There should not be undue double-subsidy by the BEIS LCH Hydrogen business models. The use of LCH as a potential feedstock for Low Carbon Fuels should also properly be considered, although we do recognise that this is a highly complex area.

Finally, we would ask that the UK Government needs to define low carbon hydrogen and its use consistently across all policy areas, including use in transport (covered by the DfT) and support under the Low Carbon Hydrogen Standard (covered by BEIS).

20. **In your view, is a business model required for vehicular transport and, if so, how might a business model for onshore pipelines transporting hydrogen as a gas be adapted for this? Please explain your answer and set out the specific market barriers that a business model would be required to address as well as providing any relevant evidence.**

As with offshore pipelines, we support the flexibility under the hydrogen T&S Business Model to include transportation. However, the costs and challenges of this should not be underestimated and must be carefully considered.

Hydrogen Storage Infrastructure

21. **What do you consider to be the key technical barriers associated with the development of particular approaches to storing hydrogen which should be considered? Please explain your answer and provide any relevant evidence.**

The smaller size of hydrogen molecules compared to other energy carries including methane makes containment a particular challenge. Technologies that exist for hydrocarbon storage may not therefore be suitable for hydrogen, and careful consideration needs to be given to ensure that escape rates are reasonable and safe.

The temperatures required for liquid hydrogen are extremely low (about 17'C higher than the temperature of space), and difficult to achieve at the scale required. This leads to large energy requirements, which must be provided in a low carbon manner in order to realise the decarbonisation benefits required. We would take this opportunity to recognise that boil off levels for such a liquid hydrogen system for pump cool down can be very high, with losses generally lost to atmosphere, and that the energy demand for the insulating liquid nitrogen similarly needs to be considered.

Another challenge is the long time (4 years from FID) it takes to develop large scale storage facilities (aquifers and salt caverns). The Low Carbon Hydrogen (LCH) Transport and Storage (T&S) Business Model needs to be available much sooner than outlined in the Consultation as it takes developers a long period of time (for example 4 years to develop large salt caverns and cross-country pipelines) to execute the project after the Final Investment Decision (FID). BEIS is accelerating the LCH Production Business Models (BM) with an intention to reach FIDs by mid 2023, but some of these large projects won't pass through the FID unless they have a T&S system that can export their LCH to markets across the region. If the LCH T&S BM is not ready in Mid 2023, those projects will be put on hold and the UK Government's vision won't be realised.

There are significant HSE challenges associated with hydrogen, particularly a large explosive range relative to hydrocarbons and a low ignition threshold. Current HSE and Planning approval processes for hydrogen are also limited and need to be developed to prevent them becoming a barrier.

Finally, there are some overlaps between the use of depleted oil and gas fields for hydrogen storage and those for CCUS. These need to be carefully considered to ensure that the available resources are best used in the energy transition.

The overall efficiency of a renewable power to green H2 to storage then back to national grid for power generation to be extremely low (around 25%). This leads to a large capacity overbuild just to achieve a low efficiency route to energy supply.

22. **In your view, have we correctly identified and characterised the key market barriers facing larger-scale hydrogen storage infrastructure, and in particular its deployment by the late 2020s? Please explain your answer and provide any relevant evidence.**

We agree that the consultation has correctly identified most of the market barriers facing larger-scale hydrogen storage. However, it has not considered the associated technological and HSE risks (as outlined in our response to Q21) which are also significant market barriers. These should be identified and characterised in more detail.

Due consideration needs to be paid on how the T&S storage operator will generate revenue; for example, will they charge a fee per unit volume passed through their system, and how will these rates be set?

23. **Do you agree that volume and revenue risk stemming from demand uncertainty represents the main barrier to the deployment of storage infrastructure? Please explain your answer and provide any relevant evidence.**

UKPIA agrees that volume and revenue risk represent significant barriers in the deployment of storage infrastructure. However, they are not the main ones, and as we articulate in our responses to Q21 and Q22 the associated technological and HSE risks are also substantial and need to be considered.

In our view, volume risk is unlikely to be the main limitation, but rather it will be revenue risk. In a typical liquid storage business model, the tank owner is paid based primarily on the user renting the tankage with a minimal additional revenue based on “throughput” that cover the extra costs of these associated activities. There are some locations that are just throughput basis pricing, these are established secondary distribution locations as opposed to the type of storage that is proposed for a hydrogen system.

24. **Do you agree that Government should develop a dedicated business model for hydrogen storage (subject to value for money and need) and that it should be designed to be technology-neutral? Please explain your answer and provide any relevant evidence.**

We agree that the government should develop a business model for hydrogen storage. However, it is unclear what the rationale is for this to exist separately to the transport business model, including potentially both onshore and offshore pipelines. These have similar uncertainties and investment risks and are seeking to achieve the same ends. We would argue that the storage and transport business models should be integrated. As we discuss in our response to Q19, the potential dual support for LCH under the BEIS LCH BMs and the RTFO (as a development fuel) needs to be carefully considered,

We agree that the business model support should be technology neutral, allowing investment in the best technologies that promote decarbonisation at the lowest net cost.

25. **Do you agree that business model support should focus on larger-scale storage, or is there a need to provide further support for small scale storage? Please explain your answer and provide any relevant evidence.**

In the first instance it would seem to be appropriate for the business model support to focus on larger-scale storage to establish the technology at scale and provide the highest initial decarbonisation benefits. However, as the technology develops through the transition then support for smaller scale storage could be reviewed to expand the use of hydrogen through the supply chain, if required.

26. **In your view, who are likely to be users of hydrogen storage infrastructure and which group, or groups, might be best placed to provide revenue to storage owners? Please explain your answer and provide any relevant evidence.**

In our view, this is likely to be larger scale industrial users who need a reliable source of hydrogen to operate in a resilient manner, particularly if using green hydrogen from potentially intermittent renewable sources. This could include for example refineries, steel manufacturers and glass works. These users may also use blue hydrogen; these plants move more slowly and will want a balance mechanism (similar to how the ICI hydrogen system used to work around Teesside).

It would also be needed by large scale CCUS enabled LCH producers who will benefit from higher efficiency by operating at constant max rate. Also the inability of this plants to reduce and increase capacity very quickly forces the need for large scale storage and transport to smooth any transition period. Storage is also required to enable the use of LCH power plants which will need to kick in promptly to absorb peaks in power demand, just like they do today using high carbon fuels.

27. **Do you agree with our initial view that a storage infrastructure business model should support providers of hydrogen storage infrastructure (as opposed to users of storage infrastructure)? Please explain your answer and provide any relevant evidence.**

We agree with the initial view that a storage infrastructure business model should support providers of hydrogen storage infrastructure. This approach ensures the correct incentives in infrastructure provision are made in a focused manner.

This will depend on who is investing in the hydrogen storage infrastructure, for example private investment. Investors will need revenue certainty to make their FIDs and provide the infrastructure required. However, some support may also be required for users to enable their transition as well.

28. **What are your views on possible approaches to funding a potential subsidy mechanism? Please explain your answer and provide any relevant evidence.**

As we indicate in our response to Q24, it is not clear what the rationale is for a separate storage business model to the transport business model. As we indicate in our response to

Q6, the RAB business model would be appropriate in progressing the larger scale developments.

29. **In your view, have we correctly identified the main parties whose needs any storage business model will need to account for, and have their needs been correctly outlined? If not, what additional needs should be accounted for? Please explain your answer and provide any relevant evidence.**

UKPIA agrees that the main parties under the business model have been identified and that their needs have been correctly outlined.

30. **In your view, have we set out the main business model design options, or are there others design options, or variants, that should be considered? Please explain your answer and provide any relevant evidence.**

We agree that the main business model design options have been considered. However, as we have previously outlined the rationale for two separate business models for transport and storage have not been explained, and we would urge that they are integrated.

31. **In your view, are any of the business model design options set out above more suited to supporting particular types of storage infrastructure than others? Please explain your answer and provide any relevant evidence.**

As we indicate in our response to Q25, the business model design should focus on large-scale investment in the first instance to maximise early decarbonation. As we indicate in our response to Q30, there should be integration between the transport and storage business models. To this end, the RAB model would appear to be the best approach to encourage the early adoption of large-scale hydrogen storage infrastructure.

The incentivisation of other, smaller scaler hydrogen storage options can be developed as the technology and user demand progresses.

32. **In your view, which business model design options would be most suitable to address the identified market barriers? Please explain your answer and provide any relevant evidence.**

The option of a phased approach with a Contracts for Difference (CfD) model during the initial phase and a RAB once the market is developed may be useful for T&S developers and would appear to be their preferred business model option.

33. **In your view, which organisations are best placed to carry out the roles of economic regulator/counterparty/administrator that would be required to implement the business models set out above? Are there any other roles that you consider may be required? Please explain your answer and provide any relevant evidence.**

Organisations who carry out this work in similar fields such as natural gas or renewable electricity could provide the basis for an economic regulator / counterparty / administrator

required to implement the business models. These have been successful in the development and management of their technologies and should be used as the basis for future hydrogen investment and regulation.

34. **In your view, are there any early interim measures that we should be exploring to support the development of the first hydrogen storage projects, ahead of a hydrogen storage business model being available? Please explain your answer and provide any relevant evidence.**

UKPIA is not aware of any interim measures currently. However, any interim measures should encourage the long-term availability of large-scale storage infrastructure in the first instance. Encouragement of small-scale storage too quickly may lead to incorrect investment decisions being taken and significant regret capital spend.

Strategic Planning

35. **In your view, should the build out of hydrogen transport infrastructure evolve through either a) a solely a market-led approach, b) a form of strategic planning, or c) neither? Please explain your answer and provide any relevant evidence.**

UKPIA's view is that the build-out of hydrogen transport infrastructure should involve b), some form of strategic planning. This ensures that the resources are applied in a coordinated manner to achieve the best decarbonisation results.

HMG should play a small strategic planning role, but ultimately this is led by Value for Money based decisions (including considerations of overall UK Resilience) given that financial support is ultimately burdened by the taxpayer. There is no market led strategy as without the subsidy being centrally coordinated, there is no LCH T&S BM support.

36. **In your view, should the build out of hydrogen storage infrastructure evolve through either a) a solely a market-led approach, b) a form of strategic planning, or c) neither? Please explain your answer and provide any relevant evidence.**

UKPIA's view is that the build-out of hydrogen storage infrastructure should involve b), some form of strategic planning. This ensures that the resources are applied in a coordinated manner to achieve the best decarbonisation results. It also ensures consistency with the approach taken to the build-out of hydrogen transport infrastructure.

HMG should play a small strategic planning role, but ultimately this is led by Value for Money based decisions (including considerations of overall UK Resilience) given that financial support is ultimately burdened by the taxpayer. There is no market led strategy as without the subsidy being centrally coordinated, there is no LCH T&S BM support.

37. **In your view, if strategic planning was to be implemented for hydrogen transport infrastructure what form should it take? a) central network planner, b) coordinated approach, c) evolved approach, d) a blend of strategic planning and market-led approaches, or e) none of the above? Please explain your answer and what this approach might look like in a UK context.**

This is an extremely complex area, and it is difficult to say with certainty which approach would work best given the current uncertainty on exactly how hydrogen implementation will proceed. With this in mind, a flexible approach would be beneficial, with a blend of strategic planning and market-led approaches. This could include, for example a system where investment is supported by a mixture of user commitments and potentially additional government support where the strategic planner decides that this is appropriate. However, we accept that this approach can evolve in time, with an initial strategic planned approach to establish FOAK projects, which evolves into one that this more market led as the market becomes more established.

HMG should play a small strategic planning role, but ultimately this is led by Value for Money based decisions (including considerations of overall UK Resilience) given that financial support is ultimately burdened by the taxpayer. There is no market led strategy as without the subsidy being centrally coordinated, there is no LCH T&S BM support.

38. **In your view, if strategic planning was to be implemented for hydrogen storage infrastructure, what form should it take? a) central network planner, b) coordinated approach, c) evolved approach, d) a blend of strategic planning and market-led approaches, or e) none of the above? Please explain your answer and what this approach might look like in a UK context.**

Please see our response to Q37, and a consistent approach between transport and storage infrastructure would be beneficial.

This is an extremely complex area, and it is difficult to say with certainty which approach would work best given the current uncertainty on exactly how hydrogen implementation will proceed. With this in mind, a flexible approach would be beneficial, with a blend of strategic planning and market-led approaches. This could include, for example a system where investment is supported by a mixture of user commitments and potentially additional government support where the strategic planner decides that this is appropriate. However, we accept that this approach can evolve in time, with an initial strategic planned approach to establish FOAK projects, which evolves into one that this more market led as the market becomes more established.

HMG should play a small strategic planning role, but ultimately this is led by Value for Money based decisions (including considerations of overall UK Resilience) given that financial support is ultimately burdened by the taxpayer. There is no market led strategy as without the subsidy being centrally coordinated, there is no LCH T&S BM support.

39. Further to your answers to questions 35 – 38 above, in your view, is it important for there to be alignment between the ways in which hydrogen transport infrastructure and hydrogen storage infrastructure are built out and, if relevant, the form of strategic planning involved? Please explain your answer and provide any relevant evidence.

As we outline in our previous responses to this section, it is very important for there to be alignment between the ways in which hydrogen transport and hydrogen storage infrastructure are built out and the strategic planning involved.

There is considerable alignment between these two, with storage being unviable without transport infrastructure, and vice versa. This is particularly the case in the early years of hydrogen build-out, with potentially large-scale projects and investment in both (such as pipeline systems and caverns) being required to enable repaid deployment. Failure to coordinate both aspects could leave stranded assets such as pipelines being built with no available storage, or storage that is unused to an inability to supply hydrogen to it.

A coordinated approach allows the available investment and infrastructure to be best used to allow hydrogen deployment at the lowest cost, avoiding potential wasted effort.

40. Considering onshore and offshore hydrogen transport and storage infrastructure, do they have specific characteristics, or wider interactions with other infrastructure, which may mean the different infrastructure types favour a market-led approach or a form of strategic planning? Please explain your answer and provide any relevant evidence.

In our view, a single coordinated approach across the entire range of options for hydrogen transport and storage should be considered.

As we mention in our response to Q37 and Q38, a flexible approach would be beneficial involving a mix of user commitments and potentially additional government support where the strategic planner decides that this is appropriate. The role of the strategic planner should include both on, and offshore transport and storage infrastructure. This allows the investment and infrastructure to be best placed where it can decarbonise quickly and at the lowest possible cost. However, this approach can evolve into one that is more market led as the market becomes more established.

41. In your view, are there any factors, other than those listed above, that should be considered if a strategic planning approach was to be adopted? Please explain your answer and provide any relevant evidence.

The list of factors provided is a reasonable start, including many key items that should be considered. In our view, the following additional factors should be considered

- The investment costs involved for the infrastructure
- The scale of the infrastructure (i.e., transport capacity or storage volumes)
- The expected operational lifespan of the infrastructure

- Appropriate high-level safety and planning considerations (i.e., is it being built in a safe manner, at an appropriate location)

42. If the UK were to create a central network planner role for hydrogen, would the FSO (if it is established by the Energy Bill) be best placed to take this role on? If not or if the FSO is not established, is another organisation more suited to the role or would a new body need to be created? If yes, in your view what temporary solution could be implemented prior to the FSO taking on the role? Please explain your answer.

UKPIA does not have a firm view on this currently. There are certain synergies in the FSO taking on the role of central network planner, as it would have overall responsibility for the significant energy vectors in the transition and can offer a coordinated approach. The option of a phased approach with a Contracts for Difference (CfD) model during the initial phase and a RAB (potentially under the FSO) once the market is developed may be useful for T&S developers and would appear to be their preferred business model option.

We agree that further consideration and engagement would be needed on this topic as government policy develops and that any organisation should be sufficiently resourced including available expertise in this area.

43. In your view, what role could the strategic planner have in the provision of business model support? How would this role change under different strategic planning approaches? Please explain your answer and provide any relevant evidence.

It is likely that a mixture of approaches will be needed. The strategic planner should be proactive in identifying the need for early hydrogen transport and storage infrastructure based on a value for money to the taxpayer; however, it may also be reactive in taking account of proposals from project developers.

It is likely that in the early years at least, projects offering the opportunity for suitable hydrogen transport and infrastructure will be scoped including business cases. In other words, the two approaches are not as widely separated as it would initially appear.

HMG should play a small strategic planning role, but ultimately this is led by Value for Money based decisions (including considerations of overall UK Resilience) given that financial support is ultimately burdened by the taxpayer. There is no market led strategy as without the subsidy being centrally coordinated, there is no LCH T&S BM support.

44. In your view, should government seek to identify "low or no-regrets" and/or systemically important projects to prioritise their development if possible? If so, how might such projects be identified and how might the best be prioritised? Please explain your answer and provide any relevant evidence.

We agree that the government should seek to identify "low or no-regret" and/or systematically important projects to prioritise their development if possible. We believe that these projects can be identified using the expanded set of criteria set out in the consultation and our response (please see Q41).

The government (BEIS) is best placed to identify these 'no regrets' options as nobody else knows every single project being developed within the LCH T&S area in the UK, ultimately each project must demonstrate its value for money proposition to BEIS to be worthy of their subsidy. In other words, BEIS are the only ones that have all the information in hand to make the call.

As we indicate in our response to Q43, projects which can offer these benefits should have already been developed, including business cases, and this approach should not prove difficult.

Regulatory Framework

45. **In your view, are the existing market framework and industry commercial arrangements for hydrogen optimal for supporting the development of hydrogen transportation and/or storage infrastructure? Please note we are seeking your views on the whole existing market framework and industry commercial arrangements, including any possible gaps, and not just matters relating to the Gas Act. Please explain your answer and provide any relevant evidence.**

In our view, no, the existing market framework is not optimal for supporting the development of hydrogen transportation and/or storage infrastructure.

46. **If you answered 'No' to the previous question, how do you think this should be addressed:**

a. **Through amendments to the existing market framework / industry commercial arrangements?**

b. **Through the replacement of aspects of the existing market framework/industry commercial arrangements (for example, with new arrangements that are specifically designed for hydrogen)?**

c. **Through a different approach?**

In our view, point b, would be appropriate to potentially provide greater regulatory certainty in some areas (for example with regards to revenue certainty). We agree that this is likely to involve the introduction of commercial arrangements codifying access and charging arrangements.

We also agree that a review should be held on the inclusion of hydrogen as a "gas" under the Gas Act 1986 to ensure that hydrogen can be transported and stored in a safe and appropriate manner.

47. **Further to the regulatory areas set out below, in your view, is the existing onshore non- economic regulatory framework optimal for supporting the development of a rapidly expanding UK hydrogen economy?**

UKPIA agrees that the existing onshore non-economic regulatory framework is broadly optimal for supporting the development of a rapidly expanding UK hydrogen economic.

It builds on the existing expertise already in place in this area, rather than reinventing systems and processes, to ensure the safe non-economic regulation of hydrogen in the UK.

However, we would recommend that this regulatory framework is sufficiently resourced with appropriate personnel and expertise so that the safe build-out of hydrogen infrastructure is not inhibited and can proceed at pace.

The regulatory framework needs to consider to how consider how both local and national objectives are met. This prevents local considerations becoming barriers to achieving the decarbonisation goal.

48. If you answered 'No' to the previous question, how do you think this might be addressed (regulation/standards/guidance, etc.)? Please explain your answer and provide any relevant evidence.

A clear challenge in any development is that local concerns can weigh heavily on the decision, often to the detriment of the overall goal. If we look at onshore wind farms; no one denies it is very cheap on a levelized cost basis, cheaper than offshore and solar.

However, development approval timescales are typically more than 7 years, commonly subject to appeals in both directions and ultimately weigh local concerns more than global concerns; the visible amenity of the community is more important than getting electrical carbon emissions reduced.

Whilst DCO's seek to take these approval processes up to a single step, rather than multiple stages, they are generally only used on very large projects, leaving even smaller projects working through multiple approval steps any one of which can stop a project. Unfortunately, the taking of a DCO means a minister decides, which immediately makes any project going via this route overtly political.

The final step challenge is an innate precautionary principle, a bias to inaction rather than action. Given the governments aggressive plan for hydrogen economy development, a planning bias to inaction is a serious impediment.

49. In your view, is the existing regulatory framework for the non-pipeline transportation of hydrogen optimal for supporting the development of a rapidly expanding UK hydrogen economy?

As with our response to Q47, our view is that the existing regulatory framework for non-pipeline transportation of hydrogen is broadly optimal for the development of the UK hydrogen economy.

It builds on the existing expertise already in place in this area, rather than reinventing systems and processes, to ensure the safe non-economic regulation of hydrogen in the UK.

However, we would recommend that this regulatory framework is sufficiently resourced with appropriate personnel and expertise so that the safe build-out of hydrogen infrastructure is not inhibited and can proceed at pace.

50. If you answered 'No' to the previous question, how do you think this might be addressed (regulation/standards/guidance, etc.)? Please explain your answer and provide any relevant evidence.

A clear challenge in any development is that local concerns can weigh heavily on the decision, often to the detriment of the overall goal. If we look at onshore wind farms; no one denies it is very cheap on a levelized cost basis, cheaper than offshore and solar.

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The final step challenge is an innate precautionary principle, a bias to inaction rather than action. Given the governments aggressive plan for hydrogen economy development, a planning bias to inaction is a serious impediment.

51. In your view, are the current NSIP and TCPA regimes optimal for supporting the development of a rapidly expanding UK hydrogen economy?

There should be a consistency of approach between the planning rules applying to hydrogen and those to other projects of strategic importance.

The UK government should continue to review the NSIP and TCPA regimes to ensure that they remain fit for purpose given the significant energy challenges facing the UK, including the energy transition.

This includes ensuring that sufficient resources and expertise are in place to review applications in an appropriate and timely manner.

52. If you answered 'Yes' to the previous question, please explain which elements you think are conducive to the development of the hydrogen economy. If 'No', please explain how you think they might be improved (e.g., a dedicated hydrogen NPS). Please explain your answer and provide any relevant evidence.

The use of a staged approach is helpful to prioritise and progress the projects of most significant national importance in the first instance.

53. In your view, is the existing environmental regulatory framework optimal for the future hydrogen economy?

As with our response to Q47 and Q49, our view is that the existing environmental regulatory framework for non-pipeline transportation of hydrogen is broadly optimal for the development of the UK hydrogen economy.

It builds on the existing expertise already in place in this area, rather than reinventing systems and processes, to ensure the safe non-economic regulation of hydrogen in the UK.

However, we would recommend that this regulatory environmental framework is sufficiently resourced with appropriate personnel and expertise so that the safe build-out of hydrogen infrastructure is not inhibited and can proceed at pace.

A clear challenge in any development is that local concerns can weigh heavily on the decision, often to the detriment of the overall goal. If we look at onshore wind farms; no one denies it is very cheap on a levelized cost basis, cheaper than offshore and solar.

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The final step challenge is an innate precautionary principle, a bias to inaction rather than action. Given the governments aggressive plan for hydrogen economy development, a planning bias to inaction is a serious impediment.

54. If you answered 'No' to the previous question, how do you think this might be addressed? Please explain your answer and provide any relevant evidence.

As we have outlined in the onshore planning questions, barriers are commonly raised in the environmental space; commonly local amenity is seen trumping national or global need. The overuse of precautionary principle leads to project delay or cancellation on relatively minor grounds.

55. Further to the regulatory assessment set out above, in your view, is the existing offshore non-economic regulatory framework optimal for supporting the development of a rapidly expanding UK hydrogen economy?

UKPIA has limited expertise in the offshore regulatory framework and is not able to comment on this question.

56. If you answered 'No' to the previous question, how do you think this might be addressed (regulation/standards/guidance, etc.)? Please explain your answer and provide any relevant evidence.

N/A

Hydrogen Blending

57. To what extent might lead times for hydrogen transport and storage infrastructure limit the scale of hydrogen production capacity in the early years of the hydrogen economy? If applicable, can this be quantified for your project (e.g., in terms of production volumes, load factors, etc.)?

Lead times for hydrogen transport and storage infrastructure will be a critical path item on the deployment of hydrogen production capacity in the early years of the hydrogen economy.

Without appropriate demand for low carbon hydrogen, it is highly unlikely that the FIDs for the production plants will be made due to the lack of associated business cases. The same is also true for the FIDs for hydrogen transport and storage infrastructure due to a lack of suitably supply and users. Once the FIDs have been taken then the lead times for equipment become the critical path for infrastructure delivery.

There will be a need to align the timelines for Transport and Storage infrastructure deliver to those of major production facilities to ensure that production has an associated demand that can be met. Otherwise, there is a risk of production plants being started with no customers, or transport and storage infrastructure demand standing idle due to a lack of production infrastructure.

We expect that the early years of hydrogen system development are going to focus on isolated plants with a somewhat known but variable offtaker. This creates a very small system that needs very fast response to imbalance. Where practical, having a secondary balance system, such as takeaway hydrogen infrastructure or hydrogen blending to fuel gas will smooth out any plant operation. Secondly operating rate is critical to lowering the levelised cost of low carbon hydrogen production. Hydrogen takeaway capacity will thereby lower the costs of any early-stage units by allowing them to operate at near full rate continually, or certainly not constrained by their potentially limited takeaway consumer.

58. Do you see a potential for blending in helping to address this challenge by providing a route to market as a reserve offtaker? For how long do you expect this role for blending may be required? Please explain your answer and provide any relevant evidence.

Following our answer to Q58, we see the potential for blending to address potential imbalances in supply and demand for new production projects as a reserve off-taker.

It is impossible to quantify the length of time that this will take at the present time, due to the uncertainties over the development of the hydrogen economy.

The role of blending should be regularly reviewed to ensure that it remains an appropriate measure. If the transition of the domestic gas boiler network takes longer than expected, then the use of blending may also be beneficial in decarbonising domestic heating GHG emissions over the medium term.

On the short-term blending can provide a reasonable recourse to maintaining capacity and act as a reasonable reserve offtaker. A reserve offtaker will always be required until/unless there is a 100% hydrogen national grid. Any individual offtakers short term or long-term survival is not assured, so preventing stranded assets should be a key driver for allowing blending operations.

Finally, an agreement for grid blending as a reserve off-taker will allow larger hydrogen production plants to be constructed, directionally reducing the cost to produce hydrogen. The additional benefit of hydrogen blending into the grid would be to lower the carbon emissions from burning natural gas.

59. **Do you think that new transport infrastructure for 100% hydrogen may be required solely for the purposes of blending? If applicable, what scale of 100% hydrogen transport infrastructure would your project require to reach the GB gas networks (at distribution or transmission level)?**

It is very difficult to answer this question due to the current uncertainty over the ability of the current natural gas network to safely accommodate the higher levels. We welcome the research work being carried out in this field.

We believe that some 100% hydrogen transport infrastructure will be required to safely deliver higher purity hydrogen to users that require it. For example, dedicated hydrogen pipelines may be required for extremely high purity hydrogen users such as hydrogen fuel cell filling stations.

60. **Do you think that a reserve offtaker (e.g., blending) could help stimulate growth in hydrogen demand, by providing potential offtakers with more confidence to switch to hydrogen? If so, for how long might this be beneficial? What alternative measures could be enacted to help stimulate growth in hydrogen demand? Please explain your answer and provide any relevant evidence.**

We agree with the consultation view that a reserve off-taker such as blending may help stimulate hydrogen production capacity. This in turn may help stimulate demand with consumers being more confident of the security of supply.

In terms of beneficial duration, the answer is really until the off takers are no longer signing take or pay agreements for extended duration but are on gas contracts like their current natural gas contracts. That is to say, the duration is required until there is a well-established hydrogen distribution network whereby an offtake can pull from the network rather than via financing a specific asset to be built.

61. **Do you agree with our assessment of the range of options to address demand volatility? In addition to these measures, do you think a reserve offtaker (e.g. blending) could have value in managing producer volume risk caused by volatile demand? Please explain your answer and provide any relevant evidence.**

We agree with the assessment of the range of options to address demand volatility. As we discuss in our previous responses, the reserve offtaker such as blending can only increase the range of possible options available to producers, mitigating some of the producer volume risk caused by volatile demand.

The options rely significantly on turn up and turn down of units and insufficiently on the use of storage or line fill. The idea that blue hydrogen plants can start up and shutdown modules relatively quickly, securely and without operational/mechanical risk is not well founded (it is

a well-established industry fact that steady state operation is far lower risk than the start up or shut down operations).

62. If you believe a reserve offtaker would be beneficial for the hydrogen economy, are there any alternative reserve offtakers that could fulfil this role instead of, or in combination with, blending? Please explain your answer and preferred reserve offtaker(s) with supporting evidence.

We are not aware of any other options for alternative reserve off-takers that could fulfil the role in addition to blending, at the scale required to be material in the early years of the hydrogen economy.

63. In addition to those mentioned in this chapter, do you see any benefits and/or risks associated with blending? Please explain your answer and provide any relevant evidence.

The volumetric calorific value of hydrogen is lower than that of natural gas. Therefore, blending may reduce the overall volumetric calorific content of the gas in the current natural gas network.

This has the net effect of increasing the volume of overall gas being burnt by consumers, including those in the domestic market. This needs to be carefully considered to ensure that domestic utility bills remain affordable, including for the most vulnerable in society.

Blending can be a serious enabler to getting hydrogen working. Setting a home of reserve for early-stage project is a serious derisking of those projects which are already carrying more technical and financial risk that would be envisioned of later projects.

Finally, we would like to take this opportunity to highlight that cross-border flows of natural gas may be impeded should the UK and EU adopt different levels of hydrogen to be permitted in their respective gas grids. Where a difference exists, government should work to align on the higher of the levels of hydrogen allowed, for example if one country allows 10% and another 20%, then both should work to move the 10% to 20% rather than arbitrarily limit the 20% to 10% to achieve the maximum possible harmonised decarbonisation.