

Energy UK Response to the BEIS Consultation on Business Models for Carbon Capture, Usage and Storage

23rd September 2019

About Energy UK

Energy UK is the trade association for the GB energy industry with a membership of over 100 suppliers, generators, and stakeholders with a business interest in the production and supply of electricity and gas for domestic and business consumers. Our membership covers over 90% of both UK power generation and the energy supply market for UK homes. We represent the diverse nature of the UK's energy industry – from established FTSE 100 companies right through to new, growing suppliers and generators, which now make up over half of our membership.

Our members turn renewable energy sources as well as nuclear, gas and coal into electricity for over 27 million homes and every business in Britain. Over 680,000 people in every corner of the country rely on the sector for their jobs, with many of our members providing long-term employment as well as quality apprenticeships and training for those starting their careers. The energy industry invests over £12.5bn annually, delivers around £84bn in economic activity through its supply chain and interaction with other sectors, and pays £6bn in tax to HMT.

Executive Summary

Energy UK welcomes the opportunity to respond to the Government's consultation on business models for Carbon Capture Usage and Storage (CCUS). There is widespread consensus across industry, experts and policymakers that CCUS will be crucial if the UK is to meet its climate change targets at the lowest cost, particularly in the context of the recently legislated target of net-zero emissions at 2050. Analysis from the Energy Technologies Institute (ETI) showed that failure to deploy CCUS in the UK could double the cost of meeting the old 80% emission reduction target¹, and the Committee on Climate Change (CCC) claim the technology is 'essential' to reach net-zero emissions². In light of this, it is positive that the Government is considering business models for CCUS and Energy UK supports deployment of the technology at the earliest reasonable opportunity.

The UK is fortunate to have a combination of suitable subsurface Geology and a wealth of skills and expertise built up through a world-leading oil and gas industry that positions the country as one of the most favourable locations globally for CCUS deployment. However, the technology has suffered from 15 years of policy uncertainty, including the cancellation of two government competitions at a late stage, which has damaged UK CCUS investor confidence. It is crucial that the Government sets out clear ambitions and policy support for the technology including specific targets in line with a net-zero pathway to attract domestic and overseas investment and capitalise on a uniquely favourable environment.

The existing government aims for CCUS were set out in the 2017 Clean Growth Strategy and were developed in the CCUS Action Plan published in November 2018. They commit:

- “that the UK should have the option to deploy CCUS at scale during the 2030s subject to the costs coming down sufficiently”;

¹ ETI (2015), Building the UK carbon capture and storage sector by 2030 – Scenarios and actions. Available [here](#).

² CCC (2018), An independent assessment of the UK's Clean Growth Strategy From ambition to action. Available [here](#).

- “to enable the development of the first CCUS facility in the UK, commissioning from the mid-2020s”;³
- To have at least one low-carbon cluster of heavy industry by 2030;
- To have the world’s first ‘net-zero’ cluster of heavy industry by 2040.⁴

Whilst Energy UK welcomes the commitment to CCUS deployment in the aims, particularly the ambition to develop the world’s first net-zero cluster of heavy industry by 2040, we encourage government to be more ambitious and clear with its targets. We agree with the BEIS Select Committee position that the CCUS deployment timetable should be accelerated to target the commissioning of first CCUS projects in at least three clusters by 2025⁵, to reduce the chance of a third major delay to the technology’s development and also reduce the cross-chain risk associated with capture failure. We further encourage government to commit to specific targets for carbon dioxide stored. Such targets will provide clarity and confidence for investors, as well as a baseline against which the pace of CCUS deployment can be measured.

We continue to believe that carbon pricing could play a very important role in supporting the market for CCUS. The consultation document sets out the many different technology approaches and routes for deploying CCUS. A clear benefit of a strong long-term carbon pricing framework which is applied consistently across all carbon emitting sectors is that it would support all carbon reduction options in a technology neutral way, allowing market forces to point the way to the most optimal forms of CCUS deployment and reducing the need for government or regulators to intervene in CCUS markets in other ways.

A strong carbon price will deliver the optimal outcome in operations with respect to abated vs unabated fossil fuel generation. We therefore agree that government should be considering how to support new-build / increasing capacity for CCUS, but clarification from Government on how CCUS fits with existing low carbon generation such as solar, wind and nuclear is needed.

Should you have any questions regarding this consultation response then please do not hesitate to get in touch via the details below.

I can confirm that this response may be published on the Department’s website.

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Response to Questions

1. Have we identified the right parameters to guide the development of CCUS business models?

The parameters identified appear reasonable and logical in the first instance, however, it is worth noting that there will need to be clarification around the term ‘cost efficient’. In the current climate it is important that cost efficiencies consider climate and social-economic metrics as well as pure economics. The

³ BEIS (2017), The Clean Growth Strategy: Leading the way to a low carbon future. Available [here](#).

⁴ BEIS (2018), “World-first carbon ‘net-zero’ hub of heavy industry to help UK seize global economic opportunities of clean growth”. Available [here](#).

⁵ BEIS Committee (2019), Carbon capture usage and storage: third time lucky? Available [here](#).

parameters should also be flexible enough to allow for the evolution of the CCUS sector with room for alterations (for example to the cost sharing or risk allocation) when it becomes apparent that a metric is no longer deemed to be balanced.

There are other potential parameters that should be considered to acknowledge some of the wider benefits of CCUS and ensure the speed of deployment required to meet climate targets. There could be merit in focusing on initiatives that will deliver the greatest CO₂ reductions, particularly those that are able to help deliver the Government's decarbonisation targets. For example, there should be a parameter that ensures business models can cater for the rapid expansion of the CCUS industry that will be needed to reach climate targets. Another parameter should ensure that business models facilitate the growth of skilled jobs in the UK and that economic benefits of projects are felt by local areas.

We would welcome greater clarity on the intent of the overarching parameter which sets out that 'the models should have the potential to become subsidy free'. It is not clear whether this parameter could value a CCUS business model that can become subsidy free more than a CCUS business model that may deliver lower carbon emissions but with a subsidy.

An issue that has not been examined in the consultation document is one where different business models may be appropriate for a "first of a kind" project that demonstrates the capability of technologies and an "nth of a kind" project that deploys established technologies. There are very different risks associated with these categories and that has a significant influence on the appropriate business models.

2. Bearing in mind our emerging findings on CCUS business models, do you have any views at this stage on how the business models might be integrated?

The integration of business models will be crucial to the successful deployment of the technology and particularly pivotal in the early stages (we acknowledge that coordination challenges will reduce as more CCUS is rolled out). It is important that Government sets out the initial coordination requirements for developing the first full chain CCUS project within a cluster. The development of the first cluster will need to be highly coordinated to ensure that the many different aspects of the chain are ready when needed and interoperate efficiently.

There will need to be provisions within the business models that cater for cross chain risks and keep investors in each part of the CCUS value chain protected in the event that another part of the chain does not operate. This could be included in the contractual interface between the different parts of the CCUS chain.

Another important element of the CCUS supply chain to consider is the production of negative emissions which can be provided by CCUS enabled technologies such as Bioenergy with Carbon Capture and Storage (BECCS) and Direct Air Carbon Capture and Storage (DACCS), these technologies will interact with power sector and industrial business models. We would encourage government to develop a business model which supports the production of negative emissions as soon as possible, considering these interactions with the wider CCUS chain.

CCUS specific risks

3. Do you have proposals to mitigate CCUS-specific risks?

CCUS-specific risk 1 – mitigating CO₂-related cross-chain risks (CO₂ T&S assets not operating, or capture plant not operating).

Previous UK CCUS business models were based on the private sector developing full-chain projects for the first capture and transport and storage (T&S) elements of the CCUS chain in a cluster. The CCUS Cost Challenge Taskforce (CCTF) recommended that the CCUS chain was separated to allow

for natural investors to invest in each part of the chain, and whilst Energy UK supports this approach, we acknowledge that it introduces the issue of how the different elements of the chain operate together and exposes different elements to the risk of failure of another element.

Energy UK agrees with the CCUS Advisory Group's (CAG) recommendation that government should facilitate arrangements to hold capture assets economically neutral in the event that T&S assets are temporarily or completely unavailable. We acknowledge the fact that the need for this cross-chain protection will diminish as regional/national T&S networks develop, reducing single asset dependency.

In the event that a capture plant fails to deliver CO₂ to the Transport & Storage (T&S) system Energy UK believes that the capture plant should not receive revenue support, however, capture assets will still be obliged to pass on the T&S capacity reservation fee provided by the body that funds the capture asset.

CCUS-specific risk 2 – stranded asset risk

The description of the stranded asset risk is largely the same as CCUS-specific risk 1. As with risk 1, this is less of a technical risk and more of a policy risk which reduces as more projects/clusters come online. One important aspect of this risk is the timing of the completion of different elements of the chain. For example, the risk that a capture plant is operational prior to the completion of the local T&S system meaning a stranded asset with no off-taker. To mitigate this risk we suggest that completion dates are agreed in the coordination requirements and any delays to different parts of the chain result in the cross-chain protection laid out above.

CCUS specific risk 3 – long term liability

Energy UK note that the probability of a leak from a long term CO₂ store is very low but is a risk that must be addressed due to the potential high impact. We identify an opportunity post-Brexit, whereby the long term liability risk could be mitigated by altering the post-injection 20 year monitoring periods outlined in the EU CCS Directive, however, we acknowledge that any reduction will have a small impact on the overall risk premium applied to a potential leak.

In the highly unlikely event that a leak does occur, we believe that the cost of the leak should be added to the T&S Regulated Asset Base (RAB) as an allowable cost (subject to the provisions of the incentives and penalties regime). The reason for choosing this solution is that the T&S operator is incentivised through the RAB to be entirely transparent with the regulator in its estimation of the leakage rate and the management of the leak remediation.

4. Are there any other CCUS-specific risks that need to be considered? If so, what are your proposals for mitigating them?

We identify four additional CCUS-specific risks relating to CCUS asset sizing, carbon pricing and policy:

1. There is a significant risk surrounding the sizing of CCUS assets. The emphasis in the initial stages should be to oversize the T&S system to allow for growth of the CCUS industry and CO₂ producers to tie-in to the system at a later date. However, oversizing introduces the risk of stranded assets if an oversized T&S system is under-utilised. If the T&S system is undersized, there is the risk that another pipeline may have to be constructed. Oversizing, if well-calculated, should lead to lower overall costs than needing to build additional pipelines in future and a grant could be considered to fund the extra capacity. Clear long-term targets for carbon dioxide stored, that satisfy a net-zero target, would go some way to reducing the sizing risk associated with the T&S system.
2. The potential future price of carbon has an impact on the commercial viability of CCUS as well as the cost of complying with regulatory framework (e.g. required budget to cover costs of a potential leakage are unknown and presents a risk which projects must take on-board).

3. Government policy or the withdrawal of support is a risk. There will need to be evidence of significant commitment to CCUS from across government in order to progress projects past the development stage. Without this firm agreement, the pipeline of CCUS projects in development is likely to be slow to progress.
4. We would also welcome clarification on how the long-term CO₂ storage liability and leakage risk would be mitigated in the event that the UK is no longer a member of the European Union and therefore unable to use EU ETS permits.

Carbon dioxide transport and storage (T&S)

5. Have we identified the most important challenges in considering the development of CO₂ networks?

We agree with the assessment that whilst the initial T&S construction costs are likely to be relatively high, once built, operating costs for well-utilised T&S infrastructure will be relatively low. We also see significant potential to reduce costs through the re-use of existing oil and gas assets and refer the reader to our response to the consultation on re-use of oil and gas assets for CCUS. We note that the scale of CCUS required to deliver net-zero reduces the risk of stranded T&S assets, for example, the development of all six of the sites identified in the consultation (figure 1) would provide annual capacity much lower than the lowest 2050 CCUS deployment scenario identified by the CCC.

We note that the T&S fee needs to be carefully designed so that it is seen as politically palatable. One lesson from the previous competition was that if costs are loaded onto the first projects, they may be challenging to support.

Energy UK supports the concept of splitting the business model as it should widen the ability of CO₂ emitters to access the T&S infrastructure, hence increasing the value of CCUS to the UK economy. The provision of T&S infrastructure should be viewed as a valuable asset/important sector in its own right and be supported accordingly.

6. Do you agree that a T&S fee is an important consideration for any CO₂ T&S network? In your view, what is the optimal approach to setting the T&S fee?

Energy UK believes that the T&S fee is critical in the consideration for any CO₂ T&S network and that it must be structured to ensure it is attractive to investors in both the T&S network and the capture facility. We believe the optimal approach to setting the T&S fee would be to have a fixed and a variable element to the payment. The fixed element would cover a to-be-determined proportion of the T&S costs with the variable element based on utilisation of the system.

We believe the T&S fee should come from the funder of the capture plant ((i.e. Low Carbon Contracts Company (LCCC) for power CCUS)) and T&S utilisers will be obliged to pass on this fee directly to the T&S owner. The fee should be only required to cover the utilisation of the T&S network and not the costs of an oversized network. Until additional CCUS users connect the shortfall in T&S revenue should be covered from alternative sources (e.g. government) to prevent an undue burden on power consumers. This highlights the importance of having multiple CCUS projects connected to the T&S system so we call again for government to increase its ambition to the commissioning of first CCUS projects in at least three clusters by 2025. As more CCUS projects emerge, the T&S fees charged should be spread equitably across all T&S utilisers with the variable element of the fee differentiating between extent of use.

We note that it will be challenging to set a single, firm T&S fee at point of financial investment decision (FID) to cover the entire project lifetime given some inherent cost uncertainty and so it may need to adjust overtime.

7. Of the models we have considered for CO₂ T&S, do you have a preference, and why?

Energy UK believe, in line with the CCTF and CAG, that thinking should move away from the full-chain model if the UK is to maximise the benefits of CCUS and develop regional infrastructure that is readily accessed by multiple emitters. We believe that the three models proposed by the CAG could all work for investors in T&S and emitters of CO₂.

The key question is the attraction for government of the different models. In particular are the models compatible with the scale of investment in T&S that is implied by the adoption of net zero? For example, would the use of a capital grant be attractive for the development of a single cluster but impractical for developing three clusters over next ten years?

8. Are there any models that we have not considered in this consultation which you think should be taken forward for CO₂ T&S, and why?

An additional model to consider (that was considered in the CAG) is a T&S plus Industry RAB model. Within this model, the T&S RAB has the powers to be able to develop industrial capture in order to bring additional volumes of CO₂ forward, this would aide in the development of the T&S system.

T&S models which include other transport methods such as shipping and to a lesser extent rail freight, should not be omitted from the T&S discussion. Lessons from the EU ETS and CCS Directive show that omitting potential future developments can have unforeseen implications for future projects. Benefits of other transport methods include;

- Operating on short-term contracts (relative to pipeline life)
- Becoming operational at relatively short notice
- Enabling flexibility for projects, including back-up storage opportunities,
- Leaving the future possibility of CO₂ supply from an international market open

Power CCUS**9. Have we identified the most important challenges in considering the development of CCUS power projects?**

Energy UK and its members have overseen the overhaul of the electricity system which has seen the decline in the use of coal from 42% of the total generation in 2012 to 5% in 2018. With the influx of renewable technologies and the decline of coal, fossil fuel generation must now increasingly act as mid-merit or peaking capacity. It is important to note the wider system benefits of dispatchable thermal generation in that it provides the electricity network with flexibility and reliability.

We agree with the CCC's recognition that by 2050, CCUS has a large potential role to play in multiple applications, including flexible low-carbon power generation. We commend BEIS for showing its intent by consulting on the subject, however, we are aware that cross-departmental agreement and support for power CCUS is vital if we are to achieve a net-zero target at 2050.

The presence of existing, proven and increasingly low-cost options for achieving a very low carbon electricity mix means that CCUS is likely to be most crucial to the industrial sector. We do, however, note that with the gradual electrification of transport and heat, demand for low carbon power is forecast by the CCC to double by 2050 vs today, creating scope for many technologies to play a role in meeting demand, including power CCUS.

From the perspective of maximising decarbonisation of the power sector, Energy UK believes that fossil power CCUS should be dispatched behind renewables, but ahead of unabated gas in the merit order. We do, however, note that this is subject to the findings of significant work that is needed to determine

if there are constraints around efficiency, start-up costs, ramp rates and other plant parameters. We agree with the statement in the consultation on the need to incentivise generators and technology providers to reduce costs and improve capture rates. We assume that both of these outcomes will materialise as experience is gained with deployment and operation. Ultimately we agree with the proposal in the consultation that a proposed business model should enable power CCUS to play the role required of it by the electricity system, noting that CCUS offers the potential for baseload, flexible and dispatchable low carbon generation source.

The consultation document touches on the different roles that BECCS power may play vs gas CCUS. We believe that BECCS, as a Greenhouse Gas Removal (GGR) technology, is key in reaching a net-zero emissions target at 2050, in line with the projections made by the CCC and National Grid in its Future Energy Scenarios. We call for government to develop an effective negative emissions incentive mechanism to encourage the deployment of BECCS and other GGRs. This mechanism should ensure that BECCS is incentivised to run in the most appropriate manner to maximise the negative emissions potential in the context of the wider merit order. If BECCS is identified as needing to operate at higher load factors, this should be recognised when selecting the most appropriate mechanism for deployment and we note that the design of the current CfD in the market would be suitable to deploy early BECCS projects either accompanied by a negative emissions mechanism or not.

We also believe that government needs to carefully consider how any support mechanism is likely to effect the merit order of dispatch and the consequent impacts on economic efficiency. The level of carbon price applying to fossil generation in future will also have a significant influence on the merit order of dispatch. An ambitious carbon price under any EU exit scenario combined with stringent environment standards provides the best way for merit order dispatch. This echoes the Government's commitment to carbon pricing, as set out in the Clean Growth Strategy, to help reduce emissions in the power sector.

It is important that a definition of low-carbon electricity is agreed upon. This will be important in the design of any future power plant with CCUS. We also note that fuel price indexation is a further essential element for CCUS in power.

10. Of the models we have considered for power CCUS, do you have a preference, and why?

Energy UK agree with the view of the CAG that, of the options proposed to date, some form of dispatchable CfD model will be most suitable for fossil power CCUS and we believe that the 'Option 3 – Flexible CfD with Capacity Payment' model proposed by Cornwall Insight in their report for BEIS is the most suitable existing model. We recognise that this model is adaptable and can begin by incentivising baseload generation by moving the index price down and evolve to incentivise flexible generation as and when the system is ready. This adaptability reduces the risk of investor confusion over different funding models for different plant behaviour.

We note that it is important that the appropriate model drives innovation and cost reduction within the CCUS sector and that there needs to be a clear cost reduction pathway to promote cost reductions for the UK consumer. There is some concern within the Energy UK membership that alternative business models to those involving a CfD have not been fully considered and we urge government to ensure that all potential models have been examined prior to settling on a final model.

11. In your view, should any potential funding model(s) be applicable across all power CCUS technologies (including but not necessarily limited to CCGT with post-combustion capture, BECCS, and pre-combustion capture or hydrogen turbines)?

We believe that there is a clear case to support the development of early CCUS projects and develop an associated regulatory framework within which CCUS can operate. Business models may differ between 'first mover' CCUS projects and later projects as greater incentives may need to be in place to bring forward those first few projects.

It is important to note that there are multiple technologies that have the potential to contribute to power CCUS, each with individual requirements and preferences and thus if one model is not flexible enough to accommodate all of these then multiple models may be needed.

BECCS is a unique technology that has the potential to offer major benefit to the wider economy by offsetting difficult to reach emissions with its negative emission potential. Energy UK, in line with the CCC, believe that BECCS will be a key part of a net-zero generation mix and we call for government to introduce an incentive mechanism for negative emissions.

This mechanism should ensure that BECCS is incentivised to run in the most appropriate manner to maximise the negative emissions potential in the context of the wider merit order. If BECCS is identified as needing to operate at higher load factors, this should be factored into the design of a power sector CCUS, which may be required for initial BECCS projects. We note that the current design of the CfD is suitable for supporting BECCS generation either combined with a separate mechanism to reward negative emissions or not.

12. Are there any models that we have not considered in this consultation which you think should be taken forward for power CCUS, and why?

We note that the Capacity Market mechanism has the potential to work for gas CCUS deployment in future under the scenario of a strong carbon price. We are not aware of any analysis of this model to date and would encourage Government to consider it before settling on a final model. Beyond this, Energy UK does not propose any further models to be considered.

Industry CCUS

13. Have we considered the most important challenges in considering the development of CCUS for industry?

Energy UK supports the principles set out in the consultation, particularly the need for the industry CCUS mechanism to incentivise efficiency gains and cost reductions, and to be adaptable to the changing markets and sector specific differences in relation to capture costs and ability to pay.

The key advantage of deployment of CCUS in many of these industrial process contexts, whether in post or pre-process form, is that we believe it represents one of the few currently available technological routes for decarbonisation. It is this sector of deployment which most clearly justifies acceleration in the development of the CCUS business model.

We believe that the suggested risk of stranded assets will be mitigated by clustering and that this risk will reduce overtime as the CCUS industry grows.

In addition to the challenges mentioned in the consultation document, we would emphasise:

- **Offshoring of emissions:** The risk of further offshoring of emissions needs to be considered in more detail. Between 1997 and 2016, the UK's production of emissions fell by 35%, but the emissions embodied in the goods and services we consume in this country only fell by 9%, as manufacturing declined dramatically. To give one example, the closure of Redcar steelworks in late 2015 led to 2,000 job losses, but caused nearly half the fall in industrial emissions in 2016. This is not a sustainable position for the UK, is not compatible with the Clean Growth Strategy, and may actually increase emissions globally as industry in many countries is far more dependent on coal. Therefore, it is crucial not to add extra costs onto industry, where global competition is strong and margins are thin, as it will simply provide an incentive to relocate.
- **Subsidy-free:** Energy UK agrees that for a business model to be enduring it must move towards a subsidy free world. We would, however, note that government needs to define what being subsidy-free would look like and emphasise that it will take time for sufficient low-carbon product demand

and a high carbon price to be in place. There is potential for procurement policy / standards to support investment in the medium to longer term.

We also believe that there is a need to consider operational incentives at the culmination of a funding mechanism. The chosen business model(s) should be designed to continue to incentivise operation over a reasonable period beyond the end of the initial subsidy contract. For example, at the end of a contract, there should be an opportunity to consider whether it is cost effective to provide additional support. There is potential for this to be at a lower cost if capex has already been recovered.

We also note some further challenges to consider below:

- There is a lack of recognition for the negative emission potential for industry, for example biomass use in the cement manufacturing process.
- There could be a difference in quality of flue gas from different industrial emitters going into a single network, the processing and cost of homogenising the flue gas to a transport standard needs to be considered.
- Any model chosen needs to provide a mechanism which balances the cost between industry, government and the risk of carbon leakage. Furthermore, a business model must not exclude sectors based on geography (i.e. dispersed sources of CO₂ such as those from the cement industry).

14. Of the models we have considered for industry CCUS, do you have a preference, and why?

Energy UK is supportive of a hybrid grant plus CO₂ CfD model, as recommended by the CAG, with the grant covering capital costs and the CfD operational costs. We believe that it is important to have a grant for capital costs to avoid a major initial hurdle to deploying CO₂ capture technology, especially for early projects. Existing schemes such as the £170 million industrial cluster decarbonisation challenge within the Industrial Strategy Challenge Fund (ISCF), and the £315 million Industrial Energy Transformation Fund (IETF) are possible avenues for providing initial capital grants, although they are not sufficient on their own.

CfDs are well-understood by investors from their use in low-carbon electricity procurement, and with the right implementation to the context of industrial CO₂ capture, should be able to attract investment. We believe that a successful mechanism for funding operational costs will ease the process of funding initial capital investment.

There are several important design considerations:

- **CO₂ price:** We agree that the CO₂ strike price will vary between and within industrial sectors. In order to manage this, an approach that delivers the lowest hanging fruit first would be helpful. This could be done through a competitive auction for the first few million tonnes, ensuring that the lowest-cost industrial capture is developed first and providing some certainty on CO₂ volumes for developers of the first T&S infrastructure. Subsequent auction rounds would encompass sectors that cost more to decarbonise, and hence a rising CO₂ strike price would have to be accepted.
- **Technology-neutral:** CCUS is not the only technology available to decarbonise industry, and so a CfD could be based on CO₂ *abated*, rather than CO₂ *captured*. This adds complexity, especially in establishing the baseline for emissions, although the EU ETS mechanism could be adapted. Including other technologies would also encourage, for example, fuel switching to hydrogen or bioenergy, low-carbon electrification, and energy efficiency, with the most cost-effective solutions winning out. It is worth noting, however, that in order for complete decarbonisation of industry, it currently seems that CCUS will be essential.
- **Regional auctions:** As we stated in our answers to earlier questions, a government strategic plan on the desired levels of CO₂ capture in each region, with a willingness to contract for the desired amounts, would provide certainty to T&S developers. For industry based in clusters, regional CfD auctions could be held for a specific level of capture, which would provide certainty for T&S developers, and hence certainty for capture plant developers.

- **Non-cluster industry:** Significant industrial emissions are produced by facilities not based in clusters. CCUS will inevitably cost more, as the transport of CO₂ to storage facilities will be more difficult and expensive. This factor will need to be considered in CfD auctions. Equally, it may be most sensible to focus on CO₂ utilisation for non-clustered industry, although there is a risk that the majority of utilisation facilities may themselves be in clusters.

Finally, on the question of whether to have a CfD for CO₂ capture only, or for technology-neutral CO₂ abatement, there are pros and cons of both approaches:

- For a CfD on wider abatement, it would be possible to hold an auction for, say, 3 million tonnes, and only, say, 1 million tonnes are awarded for CCUS. This would mean uncertainty for T&S developers.
- For a CfD on CO₂ capture only, there would be greater certainty for T&S developers, but other ways to decarbonise industry cost-effectively could be missed.

15. Are there any other models that we have not considered in this consultation which you think should be taken forward for industry CCUS, and why?

No, although we would emphasise the merits of holding regional auctions for industrial CO₂ capture, in the main industrial clusters. This would ensure that CCUS infrastructure is being built in multiple clusters which will deliver overall cost benefits.

16. In your view, are there any models which best work across all industrial sectors where CCUS could have a role to play?

Energy UK believes that the hybrid grant plus CO₂ CfD model would provide the most flexibility and thus work best across all industrial sectors. CfD auctions, including at a regional level, would help to ensure the lowest-cost sectors go first, and then higher-cost sectors can develop CO₂ capture plant in subsequent auction rounds, although a rising CO₂ strike price would have to be accepted.

Alternatively, a potentially attractive approach would begin with a business model that facilitates some bespoke financing to allow early projects to be progressed while consulting on and developing more enduring arrangements. The experience gained from the early projects will have great value in enabling lessons to be learned and the models to be refined to support the development of subsequent projects and clusters. This would also allow some of the outstanding issues around allocation of CCUS project risks to be further explored and solutions identified.

17. What actions should government and industry take to help establish demand for low-carbon industrial products?

Energy UK believes that there are two key actions that Government and industry could take on to help establish demand for low-carbon industrial products.

1. **Procurement:** Public procurement for infrastructure projects could include a certain percentage of low-carbon materials. This is likely to be easier for some projects than others, and so could be implemented on a project-by-project basis. We see this as an easy win to establish demand for low-carbon industrial projects.
2. **Low-carbon industrial product quality mark:** A new low-carbon industrial product certification and quality mark should be developed as recommended by the CCTF. It should be backed by Government and supported by industry, and ideally agreed internationally, although a UK brand would be a starting point. It would take time to get right, as the carbon footprint of input raw materials from other countries would also need to be considered, and other sustainability measures (e.g. land use) should also be incorporated.

Ultimately, we are aware that many industries in industrial clusters operate and export in an international market and that for many international markets, the demand for green products is currently very low. It is key that the UK is seen as a leading international voice on green products and this will/must be driven by government action. We see COP26 in Glasgow as an opportunity to communicate the importance of international alignment on low-carbon industrial products.

CCUS for hydrogen production

18. Do you agree that a future business model should focus on hydrogen production costs? If not, what are the benefits of considering other parts of the hydrogen value chain in the next phase of our work?

We believe that it is most straightforward to include hydrogen production costs only at this stage as other elements of the value chain should be funded through other means:

- The transport of hydrogen in pipelines should be funded by network charges,
- The use of hydrogen in transport should be funded by the Renewable Transport Fuel Obligation (RTFO) – although this should be expanded to cover all forms of low-carbon hydrogen production.
- If hydrogen is used for fuel switching in industry, it could be covered by an industrial emissions abatement CfD, as stated in our answer to Question 14.
- We believe that hydrogen in domestic heating is a key element to decarbonising homes, and consideration of how best hydrogen conversions and hydrogen fuel should be paid for is critical to avoid placing too heavy a burden on households. Network charges could be a key mechanism for paying for hydrogen use in domestic households (we also note that hydrogen network charges are not fully addressed in this consultation and should only be out of scope if there is clear ownership of these issues elsewhere in government).

We do acknowledge that it will be important to consider incentivising uptake in end use sectors as well in order to develop a hydrogen economy and this could be done through an end use subsidy/incentive/obligation.

Similar to our earlier comments, we also think it is important to develop hydrogen production in multiple industrial clusters at the same time, not just in one winning cluster for competition and risk reasons. In terms of location of these clusters, the International Energy Agency's recent review of the future of hydrogen concluded that ports with concentrations of refining and chemicals production would be ideal locations to scale up the use of low-carbon hydrogen, since hydrogen produced from fossil fuels without CCUS is already being used in these areas. And there are several such industrial port areas in the UK.

Finally, hydrogen storage is also an important element, which is vital for hydrogen production to play a flexible role in the wider energy system. Hydrogen storage should therefore be in scope when considering hydrogen production business models.

19. Do you have views on whether the model should seek to support both CCUS-enabled hydrogen production and renewable production methods? If so, how might this work?

At this early stage it is not clear what the most optimal route for hydrogen production will be in terms of economics and effect on the wider system, however, it is clear that, to begin with, there will be both CCUS-enabled hydrogen production and renewable production methods. As such, Energy UK believes there should be a level playing field for all low-carbon hydrogen production technologies and that it is important to consider the interactions with other decarbonisation mechanisms. If hydrogen is produced via electrolysis, then the CfD for renewable power generation also needs to be considered. If hydrogen is used for fuel switching in industry, then if set at the right level, an industrial CfD based on wider CO₂ abatement could include hydrogen production from both methane reformation and electrolysis.

A CfD for power generation, if set at the right level, could include hydrogen production, if the hydrogen was only used for power generation. For CCUS methods of hydrogen production, the choice would be either to run a gas-fired CCUS plant, or to run an advanced methane reformer with CCUS, and then

use a hydrogen turbine to produce power. Business model design should be agnostic about which route is chosen, and encourage the most flexible and cost-effective to win out.

20. Have we identified the most important challenges in considering the development of a business model for hydrogen production?

We agree that the higher cost of hydrogen relative to high-carbon fuels and the need to ensure that low-carbon hydrogen production facilities are investible are the most significant issues. Given that hydrogen costs more than natural gas, there is a genuine risk that hydrogen production is built, with no demand following.

However, we are not convinced by the third challenge, about ensuring that hydrogen is only deployed where it can make most contribution towards our decarbonisation goals. Determining this precisely in advance risks overcomplicating any support mechanism for hydrogen, and also risks unintended consequences. As we explain above, moving to auctions for power and industrial CCUS CfDs, and potentially opening up the industrial CfD to other decarbonisation technologies, allows for the market to determine the most cost-effective solutions. The same principle should also be applied to hydrogen production and use.

It would be possible, however, to consider competitive mechanisms for hydrogen production in different sectors, which would see differential pricing developed through market mechanisms. For example, expanding the RTFO to cover all forms of low-carbon hydrogen would provide a mechanism for establishing a hydrogen price in transport, and a CfD for hydrogen production, with the natural gas price as the reference price, would establish prices for hydrogen in industry and in the gas grid.

21. What reflections do you have on the approaches we have identified to address the main challenges in designing the model?

Energy UK agree that the priority for early projects is to minimise risks to investors through reliable revenue streams and that hydrogen should be deployed in multiple sectors, although as stated in our answer to Question 20, we would caution on determining precisely which sectors. We also agree that the avoided carbon price should be accounted for.

22. Do you have views on which business models we should evaluate in the next phase of our work?

Given the wide variety of possible uses for hydrogen, we believe the most straightforward approach may be to establish a hybrid grant/CfD for hydrogen production, with grants to cover capital outlays and the CfD covering operational costs. The reference price would be the natural gas price, plus a CO₂ price for those sectors that currently pay CO₂ prices on natural gas consumption. Such a structure would have similar advantages to those described in our answers to earlier questions on power and industrial CCUS.

For transport usage, the RTFO should also be expanded to include all forms of low-carbon hydrogen production, and UK hydrogen production only could be supported, to avoid the issue identified by the CAG that renewable transport fuels delivered to date have been largely imported.

This would, however, essentially mean that there would be up to five mechanisms to fund the production of low-carbon hydrogen:

- RTFO, if it was expanded to all forms of low-carbon hydrogen;
- Power CCUS CfD, if hydrogen production was allowed within the CfD and hydrogen was solely used for power generation;
- Industrial CfD, if wider CO₂ abatement was included, therefore covering fuel switching;
- Hydrogen production CfD.
- A market mechanism for low-carbon gas in heat (i.e. an obligation based approach with tradeable certificates)

It would be important to avoid double-subsidies, and this could be achieved, for example, by only allowing one of these mechanisms to be used per project.

For transport of hydrogen, an extension to the existing RAB-based network charging regime is most appropriate, ensuring a low cost of capital and using an existing well-understood and successful mechanism.

Energy UK believe that the development of business models for hydrogen CCUS is at an earlier stage than those for other sectors and further work is needed through a group similar to the CAG. Ultimately, government needs to look at business models which can underpin the development of a hydrogen market and these models need to be sufficient in scope to enable the large scale H₂ investment required.

Delivery capability

23. What capabilities are needed for the delivery of CCUS in the UK?

Energy UK does not believe there is a pressing need for a delivery body, especially for the first CCUS projects as the establishment of these type of regulators can take many years to implement. Rather, early projects should be overseen individually, and when the industry is deployed at scale, a regulator can be introduced. We would, however, note the following:

- Generally speaking, CCUS has been developed without a delivery body in those countries where using CO₂ for enhanced oil recovery has been employed.
- The Oil and Gas Authority is a successful example of a new regulator that has helped to spur increased activity on the UK Continental Shelf.
- Policy certainty is critical, and so an overall strategic aim for CCUS developed by government, with implementation de-coupled from politics, would help to provide more continuity. Any delivery body would need to be properly independent.

In terms of the capabilities required for the delivery of CCUS, we agree with the list provided in the consultation document, although we would add the following:

1. Implementing the legislation and other mechanisms needed to put the chosen business models into practice;
2. Setting out a strategic plan for the levels of CCUS desired in different regions;
3. Agreeing the amount of CCUS (i.e. how many millions of tonnes of CO₂) to auction in each round, including at regional levels;
4. For the first CCUS projects, including capture and T&S, before auctions are put into place, agreeing negotiated prices and other terms and conditions;
5. Agreeing levels of capital grant and required match funding for T&S, capture and hydrogen production projects, and agreeing capacity payment levels for flexible power CCUS projects;
6. Ensuring that the planning and regulatory permit requirements are obtained in a timely manner, without delays in planning decisions.

These six capabilities are critical to ensuring that projects are delivered in a timely way in practice.