The Teesside Collective:

Development of an Incentive Mechanism for an Industrial CCS Project

Report prepared by

SOCIETE GENERALE

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CONTENTS

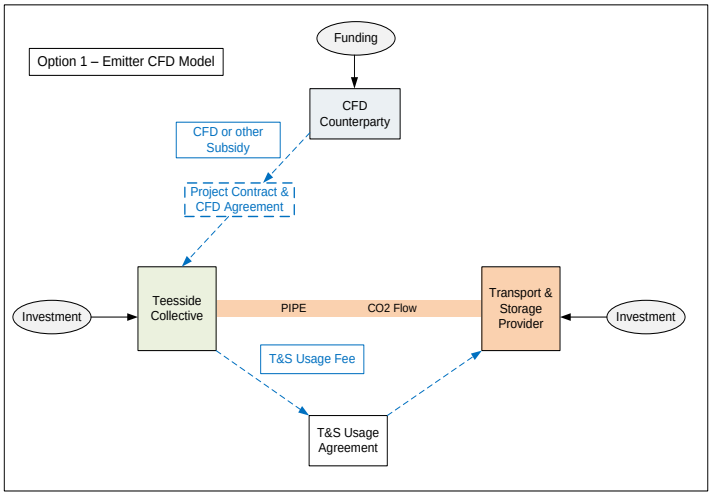
EXECUTIVE SUMMARY

Société Générale was engaged by the Teesside Collective to identify potential incentive mechanisms to support the implementation of Industrial Carbon Capture and Storage (ICCS) on Teesside, as part of a wider study into the potential of ICCS on Teesside undertaken by the Teesside Collective on behalf of the Department of Energy & Climate Change (DECC) and the Department for Business and Enterprise (BIS). Whilst focussed on the Teesside collective, it is anticipated that the findings of this study will also have wider application to industrial CCS in general.

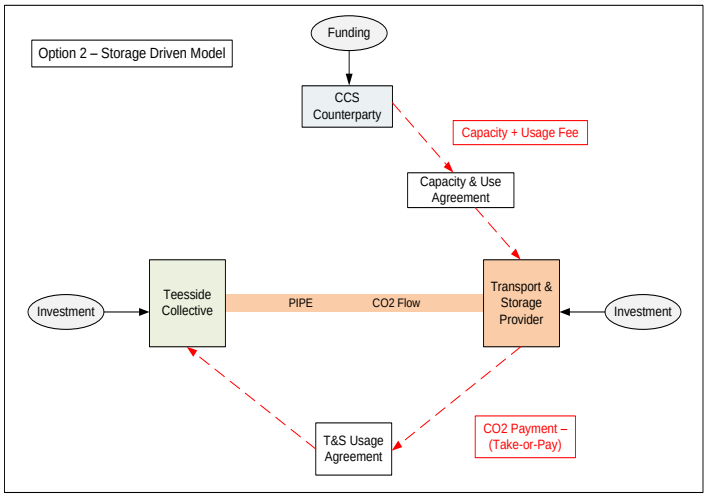
The initial phase of our work focussed on gaining an understanding of the companies in the Teesside Collective and the wider Teesside industrial area in order to assess the relative position of each in relation to ICCS. One key result from this phase of the work was the identification of a number of significant challenges specifically associated with ICCS, most notably the limited ability of many of the industries to bear or pass on to their customers any additional cost associated with CCS due to the highly competitive and commoditised nature of the industries in which they operate. In addition, whilst in many cases covered by the European Union Emissions Trading Scheme (EU-ETS) and technically liable to purchase CO_2 Certificates for CO_2 emissions, due to concerns around competitiveness and carbon leakage, many are exempt or receive specific assistance to alleviate the impact of the EU-ETS. This, combined with uncertainties around the future of the EU-ETS post 2020, provides little incentive for the industries to invest in CCS.

Against this background and following extensive research and evaluation of approximately 20 options, we arrived at a short list of four viable options and recommend that following two potential investment mechanisms are more fully investigated for further development, as they will facilitate the implementation of ICCS in the future.

Option 1 – Emitter Contract for Difference (CFD)
Based on a Strike Price against a reference price linked to the prevailing market price of the allowances (certificates) under the EU-ETS



Option 2 – Storage Driven Model
Two-part payment based on (i) availability of the transport & storage infrastructure; and (ii) a usage fee per tonne of CO_2 transported and stored.



Of the two other options considered, the Integrated Hub Model is particularly interesting as it could be used by the Teesside Collective to develop an ICCS project but then connect to a Transport & Storage (T&S) system developed and paid for by a power plant using the power CCS CFD. The obvious and most efficient way to do this would be to connect to one of the CCS Commercialisation projects currently in development (Peterhead or White Rose) to take advantage of the better economics offered by this option. This forms the basis of the analysis in the the parallel report prepared by Pale Blue Dot (PBD) on the business case for the Teesside Collective project ("Industrial CCS on Teesside – The Business Case").

1. INTRODUCTION

1.1 Philosophy

With limited direct or indirect precedent for ICCS, we sought to start with a "blank page" and look as widely as possible for mechanisms that could be applied to, or adapted for use in, the specific circumstance of the Teesside Collective project, but also in the wider industrial CCS arena. In doing so we also tried to focus on mechanisms that:

- Could operate within existing regulatory, legal and commercial frameworks (including State Aid requirements) to the greatest extent possible;
- Would have more general applicability to UK industry, and in the wider European Union context;
- Are as simple as possible to implement, bearing in mind the resources typically available within commercial industrial companies; and
- Have sufficient flexibility to accommodate the diverse industries in the Teesside Collective and the wider industries on Teesside, but also a number of potential transport and storage solutions, including the potential to tap into existing infrastructure (potentially the Peterhead or White Rose projects).

In defining options, we also sought to look first at a range of mechanisms to produce a long list (see Appendix 1) of alternatives, and only then measured these against commercial and practical considerations to identify the options, which we thought had merit for further analysis. Whilst policy and regulatory factors were not explicitly part of the scope of this report, we did keep this context in mind when shortlisting options.

1.2 Methodology

In the initial phase of the work, we focussed on an assessment of published research and other information on ICCS, engaged with various stakeholders, as well as reviewing the tariff/payment mechanisms in other energy and non-energy sector projects including LNG, power, refineries and the infrastructure arena, with PPP and PF2 precedents. Existing incentive mechanisms were also reviewed, including for example the CFD developed for the power sector, and the Renewable Heat Incentive Mechanism.

From this initial analysis a long list of options was compiled and reviewed for practicality and applicability prior to focussing on a more manageable subset of potential options for more detailed assessment. Part of this process included "market testing" of concepts with various stakeholder groups outside the Teesside Collective, including potential finance providers, the IEA, the CCSA and others, both formally and informally. The results of these discussions are covered in Section 3 of this report.

1.3 Underlying Assumptions

In preparing our options analysis it was necessary to make some assumptions in relation to the environment in which we are operating. For example we assume that:

- We are looking at a green field project without access to existing assets, whilst clearly there could be scope for linking into at least proposed storage capacity, or taking advantage of other existing infrastructure, possibly the Peterhead or White Rose projects;
- We are not policy constrained at this stage; we consider this to be reasonable in the context of the scope of this study;
- We are only considering the EU ETS implications at this stage and have not taken the UK specific Carbon Price Floor (CPF) into account given the lack of clarity of its long term trajectory. The effects of CPF can be easily incorporated into the mechanisms at a later stage;
- An acceptable underlying risk allocation can be achieved in order to facilitate the implementation of the options presented;
- The resources required to fund the incentive mechanism will be made available, although where from is considered to be a policy related matter; and

- The Teesside Collective is viewed as a single entity (the "Emitter") effectively acting as an aggregator despite, for example, the need for phasing, differences in capex and other factors that may influence the practical implementation of the incentive mechanism.

1.4 Challenges

Whilst it is recognised that CCS entails some significant technical and commercial challenges, the initial analysis for this project highlighted some additional challenges specific to ICCS that have a bearing on the design of an incentive mechanism:

- **Inability to Adsorb CCS Costs**: Unlike, for example, the UK power sector where "environmental costs" can be passed through to consumers due to the relatively closed nature of the market, many of the industries in the Teesside Collective operate in very competitive global commodity markets where this is not possible. In these industries, any additional costs imposed at the UK level only, and not more widely across the whole industry, can have a very significant impact on competitiveness;
- **Credit Risk**: As a result of the competitive environment in which they operate, many of the industries are perceived as having a relatively high credit risk. For this reason, their external corporate funding is usually limited to around 5 years on average. This is a relatively short credit time horizon in the context of the longer term commercial operating life typically expected for a capture plant (15-20 years), a transport and storage investment (up to 40 years) or the potential duration of an incentive mechanism (15-20 years);
- **Motivation**: In the current environment, it is not easy to identify a clear motivation for industrial companies to invest in CCS, given the above comments, the lack of a "green premium" on their products and the marginal impact of the EU-ETS for companies not captured by the scheme, exempted or otherwise receiving support to avoid the impact of the UK carbon floor price; and
- **Visibility**: The lack of visibility around Phase 4 of the EU-ETS and the lack of clarity around the longer-term trajectory of certificate prices further undermine the incentive to invest in long-term carbon reduction assets.

These, and a number of other factors, provide a particularly challenging background for the development of an incentive mechanism for ICCS but one that we believe can be managed.

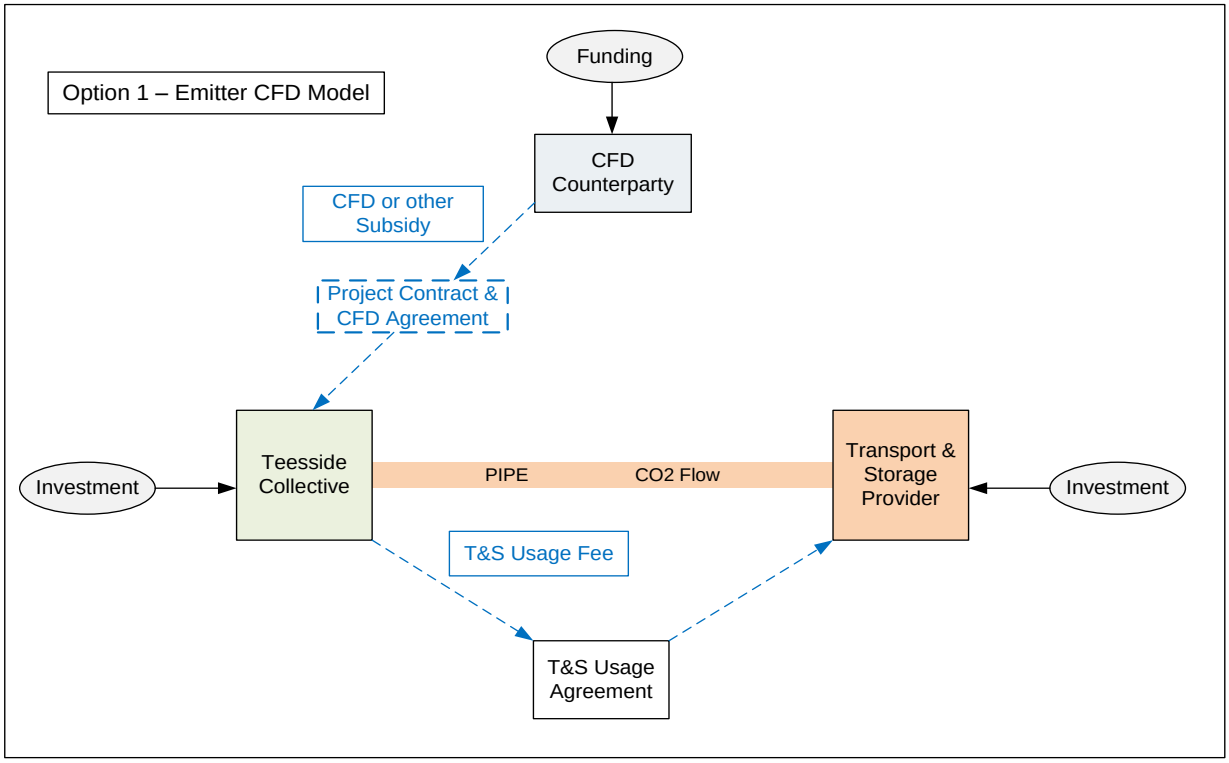
2. INCENTIVE MECHANISMS BEING CONSIDERED

As a result of our analysis, we shortlisted three possible options for an ICCS Incentive Mechanism, with a further option of integrating ICCS into a CCS hub together with a power plant. In the following sections we outline each option in some detail.

2.1 Option 1 – Emitter Contract for Difference (CFD) Model

2.1.1 Operation of the Emitter CFD Model

In this option, we propose to adapt the existing power sector CCS CFD developed through DECC's Commercialisation Programme for use in the industrial CCS sector. The Market Reference Price (MRP) based on the intermittent or base-load power price used for the power sector CFD is not appropriate for ICCS, so in this option we propose to use the EU-ETS certificate price as the MRP against which to strike the CFD. This proposal is represented in the following diagram:



The key features of this approach are:

1. The Emitter signs a CFD with the CFD Counterparty (potentially the existing Low Carbon Contracts Company) under which the Emitter receives a payment for each tonne of CO_2 captured and permanently stored.
2. The Payment is calculated with reference to the net certificate position[1] of the Emitter, the prevailing certificate price and the additional costs incurred to capture, transport and store the CO_2. This mechanism is intended to be similar to the power CFD except in this case the MRP would be based on the market price of CO_2 certificates, with the incentive mechanism providing a top up between this, and the price level required to provide a return on the above costs (the "Strike Price") i.e. for each tonne of CO_2 captured and stored, the Emitter would receive the Strike Price less the value of the EU-ETS certificates avoided by capturing the CO_2 at the MRP.

[1] The certificate position of industrial emitters is complicated by support provided to reduce the impact of the EU-ETS/UK Carbon Floor Price and will need to be considered carefully in the detailed design phase of the incentive mechanism to avoid over compensation

3. Payment flows could be either way: if the MRP is below the Strike Price the Emitter receives a difference payment, if the MRP exceeds the Strike Price, the Emitter pays the surplus to the CFD Counterparty.
4. The Strike Price is set at a level that, based on volume assumptions, enables the Emitter to fund and earn a return on their investment in the capture plant, and provide a "service fee" to the operator of the transport and storage (T&S) infrastructure, to provide them with a return on the investment in their infrastructure. How this fee is paid (to the pipeline and then onto the storage provider or direct to each component) is a commercial issue for further assessment at the design stage.

Whilst simple at this conceptual level, the detailed definition of this mechanism is complex, particularly given the differing treatment of industries under the EU-ETS and the lack of clarity on the longer-term evolution of the trading mechanism and certificate prices. In the following sections we outline some of the positive points and challenges with this approach, and seek to identify how some of the barriers to implementation may be overcome.

2.1.2 Evaluation

The Emitter CFD Model has a number of key benefits, including:

- **Defined Strike Price:** The Strike Price for the specific application will be fixed when the CFD is entered into and thus the ICCS chain will have some certainty on the level of incentive payment to be received by the project. However, one weakness of the proposal is that it is not a fixed price for the project as the market sets the underlying reference price against which the CFD is struck (see further discussion in the challenges section);
- **Value for Money:** As with the power CFD, assuming that the industries involved in the project are captured under the EU-ETS and pay for certificates, the mechanism proposed automatically reduces the incentive payment required if the value of CO_2 certificates increases. This is a key benefit for the government (public) as whilst the amount of subsidy is capped at the Strike Price, it could reduce if CO_2 prices increase hence the subsidy is not locked in for the long term;
- **Precedent:** By adapting the existing power sector CFD, we are seeking to take advantage of the significant development work already undertaken to date in respect of system design, documentation, European approvals, market education etc. This could significantly improve the efficiency of implementing ICCS;
- **Financeability:** The concept of the CFD is well known to financial institutions and has formed the basis of bankable financing structures previously. In addition, by the time the Teesside Collective project seeks financing, we expect a number of projects in off-shore wind, and potentially CCS, to have raised finance based on the power CFD, thus creating familiarity with the basic concept in the finance community, albeit the industrial CCS model may be different in some material respects (see non-cash benefit comment below);
- **Applicability:** The Emitter CFD Model is viewed as potentially a very flexible instrument that can be adapted to a variety of industries with a range of different EU-ETS Certificate positions. The model has the flexibility to be applied to a range of capture scenarios and for a capture project feeding into an established T&S infrastructure as well as a green-field full chain project, given that the strike price can be adjusted to cover a range of cost recovery scenarios; and
- **Direct Linkage:** The proposed scheme is defined in terms of tonnes of CO_2 through the whole chain from capture to storage and so avoids the complexity of power sector, where the CFD is tied to power output (MWh) whilst transport and storage are essentially CO_2 volume based.

Whilst the Emitter CFD Model has advantages, there are a number of material challenges to be addressed, including the following:

- **Volume Risk:** Depending on how the T&S Usage Agreement is structured, either the Emitter or the T&S Provider (or conceivably both) would have to take volume risk. This risk would be on absolute volume, but also on flow rate variation due to the underlying operating regime of the Emitter(s);

- **Evolution of the EU-ETS:** There is uncertainty around the next phase of the EU-ETS from 2020, so any mechanism based on the CO_2 certificate price and assuming a certain obligation of an industry to buy certificates, may need to be adapted if Phase 4 fundamentally differs from Phase 3 in terms of the obligations for industrial emitters. In the case where an industry is not currently obliged to buy certificates, there is an argument to say that they should receive a CFD based on "zero-volume" i.e. assuming no avoided cost of CO_2 with a subsequent adjustment should they later fall within the EU-ETS and/or have to buy certificates;
- **Non-cash benefit:** On the assumption that industries in the Teesside Collective are currently required to buy CO_2 certificates to cover some or all of their emissions, under the proposed mechanism, part of the benefit received by the project would be the avoided cost of these certificates. However, this is non-cash benefit and the proportion varies according to the market price of CO_2 certificates. Even though the Emitter is left in an equivalent economic position through the strike price mechanic, external financing of the capture plant would be complex as the non-cash operating cost benefit in the underlying business would be more difficult to assess for debt sizing, and would vary over time unless hedged for the long term (currently not available). One other option would be to monetise their free allocation (to the extent they have one) by selling these in the market in proportion to the volume of CO_2 captured. This area of the mechanism will require significant evaluation and definition;
- **Deliverability Risk**: In the case of a green-field project, there is an element of "chicken and egg" in that taking an investment decision on an industrial capture project, transport or storage requires a high level of confidence that all elements of the chain will be built and operating when required. This raises a potential timing issue, but also risk considerations as the T&S revenues are dependent on the operation of the capture plant to earn the CFD, whilst the capture plant cannot earn the CFD until the T&S is available. For this reason, it is likely that completion guarantees or other completion support may be required. Extensive due diligence and commercial work would be required to define the extent and nature of this support. However, the proposed mechanism would just as easily support a project connecting to an existing T&S network, which would help to resolve this issue in part;
- **Phasing:** A key strategic decision to be taken early in the development of any full chain ICCS project will be the capacity for which you design the T&S network. From a cost efficiency perspective, it is better to build the infrastructure for the maximum conceivable capacity required for the project when fully operational in order to gain economies of scale, but initially volumes may start small and build up over time as projects join the system, with possibly greater uncertainty around later projects. In this case, the initial unit cost (CFD Strike Price) would be high. Practically, the CFD mechanism can be adapted to deal with this by, for example, incorporating a "volume ratchet" mechanism to reduce the Strike Price as new emitters join the system and costs are spread over greater volumes, or by allocating all the cost to the pathfinder project and reducing the costs of follow on projects connecting at marginal cost. It is worth noting that these issues are currently being addressed as part of the CCS Commercialisation Competition which could provide a template for the Teesside Collective. Going further, connection to this infrastructure may help resolve phasing and other issues in a cost effective way;
- **Credit Risk:** Under this model, both the Emitter and the T&S Provider are dependent on the other's credit risk, and it is likely that neither would be considered sufficiently credit worthy to raise the long term financing required for this kind of investment;
- **Complexity:** compared to the usual business of many of the Emitters, the CFD and associated negotiations will appear hugely complex and they are unlikely to be staffed with sufficient resource to deal with this, particularly in the case of a first of a kind project. Whilst use of an aggregator and/or connecting to an existing T&S infrastructure may reduce this complexity and possibly execution risk, the commercial negotiations will still be challenging; and
- **Investment Incentive:** Leaving aside the complexity, with the right level of return, the CFD funds flowing to the Emitter could, in our view, provide an incentive to invest in capture technology. There is no precedent for industrial CCS to benchmark risk and return, but the PBD analysis assumes a post tax return of 13%. For the T&S Provider the investment case is less clear as the risk profile could be very different. They will need to take an investment view on the ultimate capacity available for capture and decide whether point-to-point or a cluster approach is preferable.

Clearly, in a new area like ICCS there will be material policy related issues to be addressed, and for this model to work, the following are among the key challenges that are immediately evident:

- **Funding:** Like the power sector, industry players such as the Teesside Collective and their T&S partner will have to fund the additional cost of building and operating the ICCS project. However, unlike in the power sector CFD scheme, there is no clear route to pass the cost of decarbonisation back to the end consumer through the supplier levy and Low Carbon Contracts Company. For ICCS, identifying a "market-based" funding mechanism is more of a challenge. The nature of the industries and markets in which they operate means that anything that equates to a UK only tax on them or their product would have a material impact on their competitiveness, and levying their customers is very challenging given the global nature of their businesses. Therefore, we believe that at this stage funding for ICCS will need to come from the government, absent a route to pass this back to the consumer;
- **State Aid:** The European State Aid authorities have cleared the concept of a CFD and recognise that there is market failure in CCS, but there will inevitably be sensitivity around subsidy to ICCS given the commoditised nature of many of the industries making up the Teesside Collective. In the case of the following options, State Aid clearance may also be required, depending on the final structures agreed;
- **Setting the Strike Price:** Given the complexity and nascent nature of ICCS and following previous precedent in first-of-a-kind projects, it is likely that the initial strike price will have to be set by bilateral negotiation rather than competitive auction;
- **Risk Appetite:** Funding and risk go hand-in-hand so a key decision is defining how much risk the public sector is willing to take in order to reduce the direct cost of ICCS. There is a point at which the private sector will not take more risk (irrespective of the return) so this is not a linear decision but as outlined in PBD Report, the impact of the decision on return and therefore cost per tonne of CO_2 captured is significant; and
- **Development:** There is a fundamental policy decision underpinning development of any ICCS initiative and that is, do we want and/or need it? Our understanding from the CCS Roadmap[2] published by the Department of Energy & Climate Change in August 2014, is that ICCS is seen as an important decarbonisation option for energy intensive industry and, therefore, solutions will be required to ensure that this contribution can be made without the risk of "carbon leakage" and/or undermining the industrial base of the country. The decision then becomes how to implement ICCS even if it may be challenging from a policy perspective.

2.1.3 Conclusions

The Emitter CFD Model is a relatively elegant solution to the funding of an ICCS project or cluster in that it is a volume based mechanism that is linked to the market price of the commodity (CO_2) and a subsidy level that automatically adjusts with the evolution of this price. Developing this mechanism is also likely to benefit directly from the work already being done on the power CFD, including commercial structuring and financing for the White Rose and Peterhead CCS projects, if they proceed to a successful conclusion. Using a CFD-based mechanism would also facilitate connection to the T&S infrastructure of one of these projects. However, there are a number of challenges specific to ICCS that may not be adequately addressed directly by the mechanism, particularly around credit risk and incentive to invest. With further work it is anticipated that some or all of the challenges could be resolved but the result may be a scheme where either government is effectively backstopping a range of risks or, alternatively, the level of complexity is such that neither Emitters nor potential T&S providers can be attracted to invest in the industry.

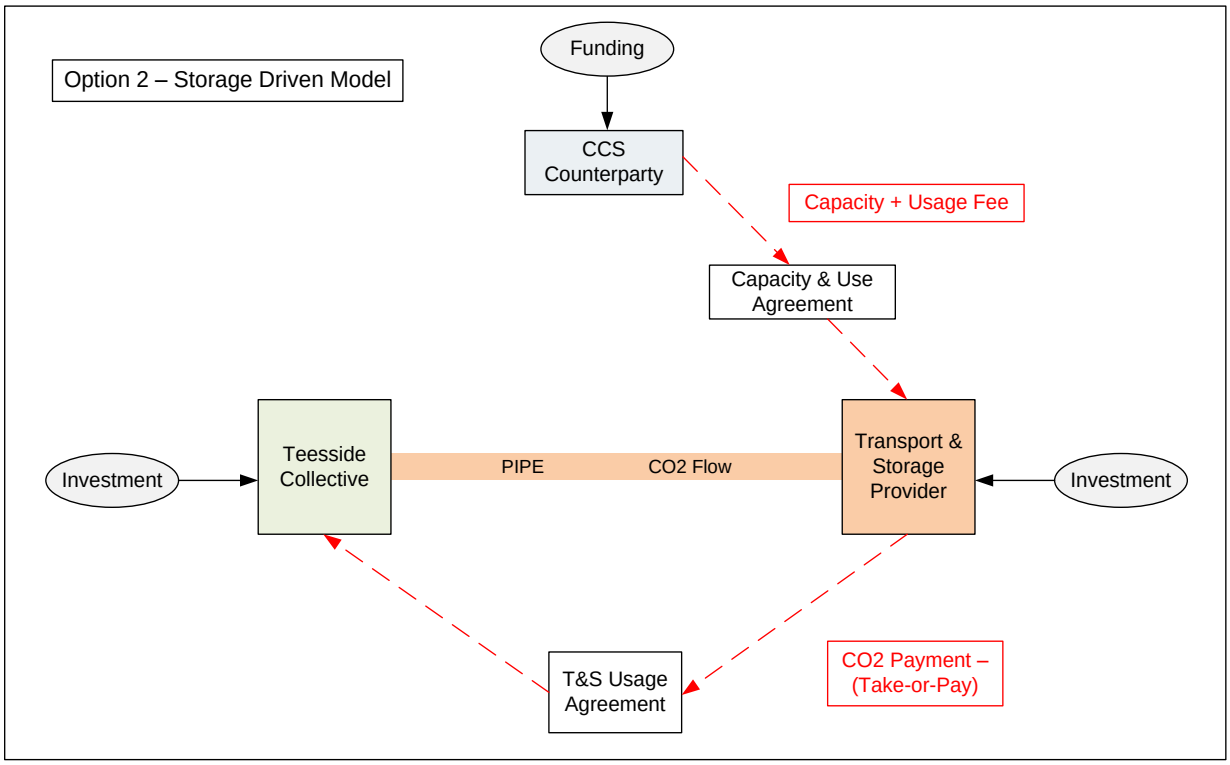
2.2 Option 2 – Storage Driven Model

2.2.1 Operation of the Storage Driven Model

In this option, we have sought to look at the problem from a different perspective. In our view, T&S, and storage in particular, are the most challenging areas into which to attract the investment required to stimulate the development of ICCS. In order to address this, we sought to develop a

[2] Next Steps in CCS: Policy Scoping Document – Developing an approach for the next phase of Carbon Capture & Storage projects in the UK. (DECC, August 2014)

solution that provided a degree of certainty around the return on investment for a T&S Provider as well as addressing some of the challenges of the Emitter CFD Model. The following diagram summarises an approach where funding is channelled through the T&S Provider in the form of a "Capacity Fee" and separate volume-based "Usage Fee".



The key features of this approach are:

1. The T&S Provider signs a Capacity & Use Agreement with the CCS Counterparty, under which he will receive a Capacity Payment for building and maintaining the T&S infrastructure available for use. The Capacity Payment is set at a level designed to reimburse the T&S Provider for the investment made in the infrastructure plus an agreed return on this investment over the life of the asset (or contract), and in return, the T&S Provider will be penalised for unscheduled unavailability of the infrastructure on terms to be agreed.
2. In addition, the T&S Provider will receive an additional volume-based payment from the CCS Counterparty for each tonne of CO_2 transported and permanently stored. For the sake of simplicity at this stage, it is assumed that the payment is designed to enable the T&S Provider to "buy" CO_2 from the Emitter at a price which covers the investment cost of the Emitter with the required return, and also compensates the T&S Provider (or separate transport and storage entities) for the costs (including risk premium) of transporting and storing the CO_2.
3. The contractual arrangement between the T&S Provider and the Emitter in this example is in the form of a "take-or-pay" obligation, meaning that the T&S Provider is required to take the agreed volume of CO_2 delivered at the fence or compensate the Emitter for an inability to do so. Other commercial arrangements could also be envisaged.

2.2.2 Evaluation

We believe that the Storage Driven Model has a number of distinct advantages, including:

- **Risk:** The Capacity Payment mechanism is designed to de-risk the T&S investment from both volume and Emitter credit risk by ensuring that the base cost of the investment in the infrastructure is recovered over the life of the contract with an agreed return, irrespective of whether or not CO_2 flows into the system. We believe that this approach also offers a more acceptable risk profile for the storage part of the project and in doing so opens up the universe

of investors and potentially, reduces the return required on this business. Finally, from an Emitter perspective, the T&S risk could also be considered lower under this model;

- **Emitter Certainty:** As this structure effectively de-links storage from CO_2 capture, the risk taken by the Emitter on the T&S infrastructure is significantly reduced to effectively an operating/availability risk. On this basis, a financial investment decision in a capture plant can be made in the knowledge that the T&S infrastructure will be built and is not co-dependent on the completion of capture plant either technically or financially;
- **Phasing:** Using this model allows for the "right-sized" T&S infrastructure to be developed from day one on a relatively low–risk basis for the investor and largely independent from the phasing of capture plants. It also facilitates connection of new Emitters on a marginal cost basis through adjustment of the Usage Fee, making the capture investment more straight forward;
- **Bankability:** The back-stopping of a Capacity Payment represents a significant improvement in risk terms over the Emitter CFD Model presented in Option 1 or the current approach envisaged for the power sector, and should make the financing of the T&S infrastructure more attractive for commercial banks. Equally, a contracted revenue stream from the "sale" of CO_2, backed by an equivalent payment from the CCS Counterparty, could also enhance the financeability of the Emitter's investment, given the underpinning of the T&S Provider's business by the Capacity Payment; and
- **Precedent:** There is extensive precedent for Availability and usage type contracts, most notably in the infrastructure (PPP/PF2) and power sectors where these contracts have formed the basis of financing greenfield power and developments for many years in the Middle East, Europe and the Americas. The investor and finance community are very familiar with these contractual structures and precedent risk allocation exists, although some modification will be required for ICCS.

Despite the highlighted advantages of this option there remain a number of commercial and practical challenges in implementation, including the following:

- **Deliverability Risk:** Whilst there is still deliverability risk in this model, we would argue that development of a T&S infrastructure on a capacity basis reduces this to a certain extent by enabling the potential disconnection of the different elements of the chain, e.g. early completion of the T&S infrastructure (supported by the capacity payment), to give headroom on the capture side. However, other additional forms of completion support may still be required if, as is desirable, early movers on the capture side are asked to develop projects in parallel with the T&S development;
- **Availability Risk:** The T&S Provider will lose a significant proportion of their revenue if they are unavailable as well as potentially incurring penalties to the Emitter under a take-or-pay type structure. For the Emitter, the risk of T&S unavailability in this (and other) models is that they are likely to be penalised for venting CO_2; probably at the EU-ETS certificate price. How these risks are managed will be a matter for commercial negotiation and insurance may play a role, but ultimately the government may be required to backstop availability, particularly where this relates to a "CCS Risk", although this is not inconsistent with the principles expressed in the Baseline Risk Allocation Matrix (BRAM) summarised in the previously referenced CCS Roadmap, and developed as part of the Commercialisation Competition for power related CCS;
- **Motivation:** There is a risk that the T&S Provider may not be sufficiently incentivised to actually go and seek CO_2, as clearly the technical and commercial risk increases significantly with the introduction of gas into the system. One key aspect of the detailed design must therefore include providing a compelling incentive to actively seek CO_2 volume – whether this is in the form of a higher return through the Usage Fee, a must take obligation or alternatively, the risk of losing the asset if volume targets are not met;
- **EU-ETS Interface**: Unlike the Emitter CFD Model, the storage led approach, to a certain extent, de-links the CO_2 capture at the Emitter from their EU-ETS position and thus needs to be structured in a way that nets off the certificate benefit from the payment flows to avoid over-compensating the Emitter as CO_2 prices move, and this adds another level of commercial complexity. It does not resolve the previously highlighted issues around the cash and non-cash benefit to the Emitter; and

- **Part Chain Project**: One potential disadvantage of this approach is its applicability to a part chain (emitter only) project connecting to existing T&S infrastructure developed on a basis where they are paid for taking CO_2 (the basis on which we understand at least one of the power CCS projects is proceeding). However, we do not see this as an insurmountable challenge as a payment mechanism allowing for payment from the T&S Provider for CO_2 funding could be incorporated, for example, through a CFD uplift or via a direct payment to the T&S provider. In terms of system design for the Teesside Collective however, if the likelihood is that it will connect into an existing T&S system (Peterhead or White Rose) based on a CFD structure, it may steer the incentive mechanism design more towards a CFD based approach.

As with Option 1, the Storage Driven Model also raises policy considerations, many of which are similar to the CDF model. However, focussing on the differences, the following key considerations arise:

- **State Aid:** This is potentially more of an issue for the Storage Driven Model than the CFD-based Option 1 as no precedent structure has been cleared by EU State Aid Authorities as far as we are aware;
- **Setting the Capacity and Usage Fees:** Unlike the CFD in Option 1, while determining the level of Capacity and Usage Fees could be challenging, we believe that there could be more scope to introduce competitive tension into the process in Option 2. On the T&S assets, if the project is well structured, we believe that there may be the potential to at least run a competition to select a developer to build, own and operate the asset. In terms of the usage fee, this is more complex as it would be a combination of the payment to the Emitter to cover his costs and return, and the additional fee and return requirements of the T&S Provider. We believe that with the right incentive Emitters may be willing to bid, but initially the more likely alternative is a bilaterally negotiated price with Emitters on a case-by-case basis. The T&S Provider's component of this charge would be very difficult to bid competitively as there is unlikely to be an alternative T&S solution to create competitive tension, therefore fees are likely to be set on a negotiated (maybe cost plus) basis. The challenge overall is to ensure that the fee structures agreed are appropriate, represent value for money for the government/public sector and do not over compensate either the Emitter or T&S Provider;
- **Risk Appetite:** Again, funding and risk go hand-in-hand so in this case definition of "Availability" will be a key element of the commercial negotiation and is likely to include a significant element of risk allocation;
- **Implementation:** This option raises a key policy question around how the T&S infrastructure could be implemented. The options range between a fully regulated and largely de-risked asset to a more commercial structure where the private sector takes significant risk, with the use of "PF2"-type structures and risk allocation in between;
- **Shared Infrastructure:** This model to a certain extent conflicts with the basis on which the Commercialisation Competition projects are being developed (CFD – payment from emitter to T&S infrastructure). A policy assessment is required as to the desirability of developing a different model for ICCS and the resulting potential to connect into shared infrastructure; and
- **"White Elephant":** With the "build it and they will come" approach to the T&S infrastructure there is inevitably a risk that CO_2 volumes do not build up as expected leading to more expensive decarbonisation or ultimately abandonment of the assets. This White Elephant risk has to ultimately be borne by the public sector as the assets are likely to have no alternative use and the Capacity Payment would be due whether or not CO_2 entered the system.

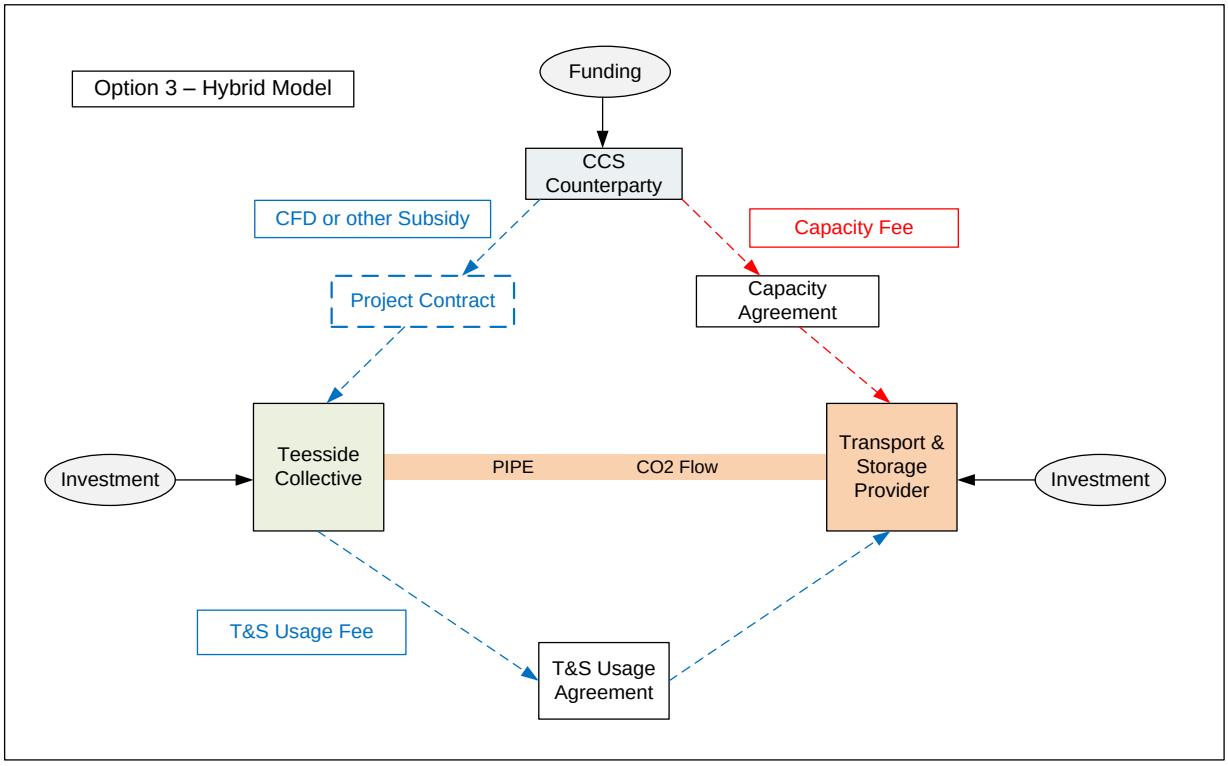
2.2.3 Conclusions

In our view, if structured well, the Storage Driven Model helps to resolve a number of the challenges implicit in the Emitter CFD Model, including counterparty risk, volume risk and motivation for investment in the T&S assets. In addition, the concept of availability-based infrastructure asset development has been widely used in various sectors for many years and is accepted by the finance market. However, there are still significant challenges to be overcome in adapting this precedent to the ICCS arena, including the substantial reliance on the government for underpinning of the capacity payment obligations, and the move away from the CFD model developing for power CCS.

2.3 Option 3 – Hybrid Incentive Model

2.3.1 Operation of the Hybrid Incentive Model

Given the advantages (and disadvantages) of each of the previous options, we considered whether a hybrid approach could provide a better overall incentive mechanism for ICCS. This approach is represented in the following diagram and is followed by a description of the key concepts.



This hybrid approach has two limbs; the Emitter incentive and a separate underpinning of the T&S business, and can be simplistically explained as follows:

Limb 1 – Emitter Incentive:

1. The Emitter signs a CFD with the CFD Counterparty (potentially the existing Low Carbon Contracts Company) under which the Emitter receives a payment for each tonne of CO_2 captured and stored;
2. As with the CFD Option, the payment is calculated with reference to the net certificate position of the Emitter (to ensure avoidance of double counting), the prevailing certificate price and the additional costs incurred to capture, transport and store CO_2. The Emitter also receives a capital component (also volume based) through the CFD to compensate for the investment in the capture plant; and
3. Unlike the CFD Option, the Strike Price in this case is set at a level that allows for the payment of a volume based T&S Usage Fee to the T&S Provider at a level which covers only the incremental cost incurred for transporting and storing the CO_2, but not the base capital invested in the T&S assets.

Limb 2 – Transport & Storage Provider:

1. Under this option, the revenue of the T&S Provider comes from two sources:
    a. A Capacity Fee from the CCS Counterparty (as per Option 2) for recovery of capital and fixed operating costs; and
    b. The Usage Fee from the Emitter(s) (as per Option 1) for recovery of variable operating costs.

2. The usage fee in this option is paid by the Emitter to the T&S Provider from the proceeds of the CFD rather than the reverse as described in Option 2.

2.3.2 Evaluation

This option is clearly more complex than either the CFD or Storage Driven Models previously discussed but it does bring a number of commercial advantages, including:

- **Risk:** The T&S Provider remains largely insulated from Emitter and volume risks through the payment of the Capacity Payment as before. The Emitter also maintains the benefit of committed T&S infrastructure, but the mechanism allows greater granularity of risk allocation through the separation of the different revenue streams;
- **EU-ETS Interface:** This separation, however, allows for the integration of the EU-ETS position of the Emitter into the mechanism to gain the direct benefit of netting off the certificate value against the incentive. However, as discussed in respect to Option 1, there remain challenges in recognising the non-cash (avoided cost) component of the benefit ascribed for fitting capture plant in terms of financing the investment;
- **Flexibility:** The combination of the two mechanisms has the added advantage of greater flexibility, including the potential use of the T&S infrastructure for both industrial and other sources of CO_2, and in doing so, enhancing the value of potential clustering;
- **Competition & Phasing:** With the separation of the T&S infrastructure cost from the capture costs, one could envisage competitive bidding for CFDs based on cost per tonne stored as the relative costs can be assessed on a more comparable basis, enabling an optimal phased "least cost" build out plan to be followed;
- **Part Chain:** This model addresses the concern with the Storage Driven Model around how capture would be funded in a part chain (capture only) scenario as in this case, the Emitter receives a CFD payment which it uses to pay for the T&S service. We do not see an issue in this scenario with over-compensation of the T&S provider (and associated State Aid concerns) as it is assumed that the T&S Provider would either have had to agree third party access arrangements to receive public funding for the oversized infrastructure to be used, or will enter into an agreement to expand existing infrastructure (similar to a grid connection in the UK power sector), with a commercial agreement on the basis of the recovery of the associated cost; and
- **Bankability:** The hybrid approach could also facilitate financing in a more efficient way by allowing targeted financing of various elements of the chain; matching assets to the specific areas of the financial markets that are most comfortable with that risk. For example Oil & Gas banks may be more comfortable financing pipelines and potentially storage, whilst utilities or natural resources teams could be more comfortable looking at the capture facilities.

Despite the positive features outlined above, a number of the challenges from previous options still carry through. For example, availability risk, the complexity of the contractual arrangements and ultimately, underutilisation. Similarly, many of the policy challenges remain to be faced under this Hybrid option, including the source of funding for the incentive mechanism.

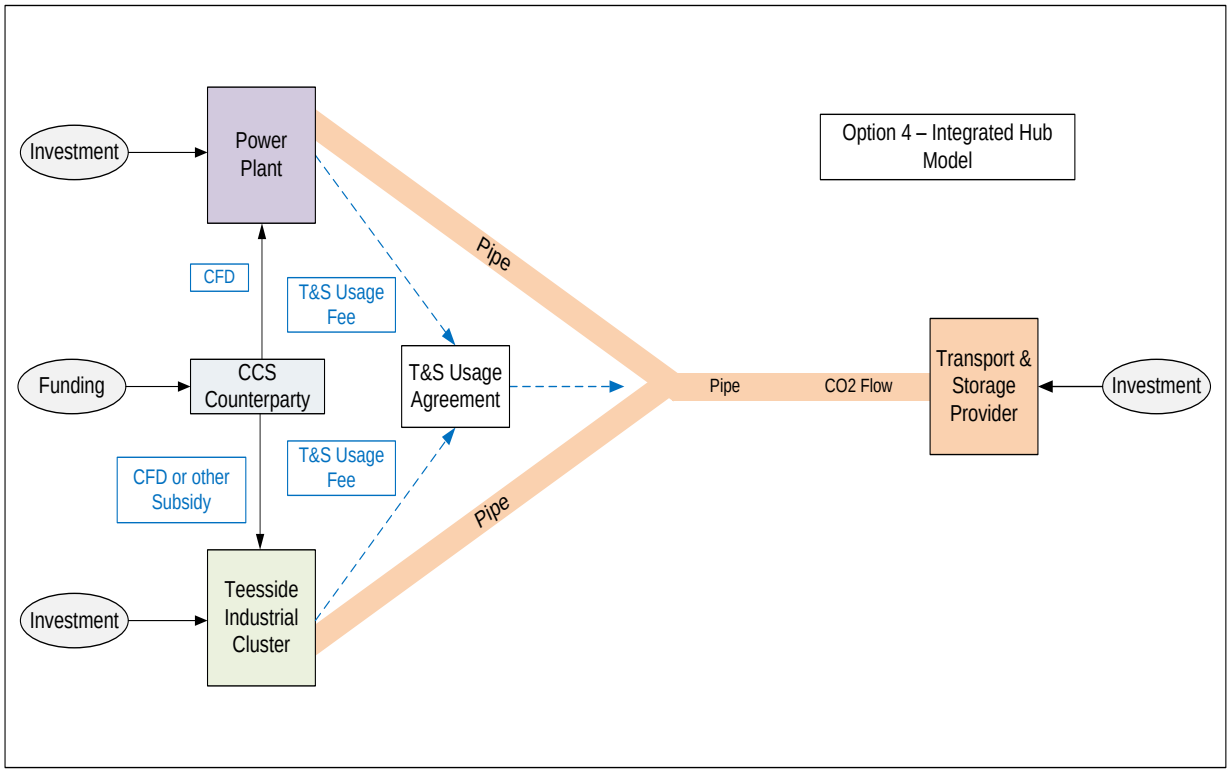
Specifically in relation to availability risk, as previously described, if the storage were unavailable for example, both the capacity fee for the storage and the CFD for the emitter would stop, leading to significant cashflow difficulties for both, irrespective of the damages payable in either direction. Discussions from the power sector CCS projects suggest that some of this risk may be insurable (subject to deductibles and caps) but that some of the likely causes of storage failure are neither insurable nor likely to be borne by the private sector. In this case, it is likely that public sector support will ultimately be required to backstop risk in this area, but one could reasonably expect the scope of this support to be clarified by the power CCS projects through the CCS Commercialisation Competition.

2.3.3 Conclusions

The combination of Option 1 and Option 2 into a hybrid solution does have some compelling benefits but there remain a number of significant commercial challenges and key policy related issues requiring resolution, which is not surprising given the fundamental nature of the challenges to be addressed and decisions to be made. Despite this, we believe that the Hybrid Model could be a pragmatic way to develop the ICCS and on this basis, worthy of further consideration.

2.4 Option 4 – Integrated Hub Model

Finally, in terms of shortlisted models, we looked again at the concept of an Integrated Hub in which the Teesside Collective combines with a power plant which forms the anchor for the development of the necessary T&S infrastructure. This was, in essence, one of the potential schemes submitted to the commercialisation competition although at that time it was not selected to go forward. The following schematic illustrates how such an option may be implemented.



The contractual arrangements will be familiar from previous options so are not repeated here but the key advantage of this approach is the presence of a base load CCS power project, providing access to the existing power sector CFD for low carbon generation, as an "anchor" client for the T&S Infrastructure. In turn, this would allow for ICCS projects to develop in parallel and connect to the infrastructure at potentially marginal cost and thereby reduce the risk for both the T&S provider and the Emitters in the context of delivery of infrastructure. The above methodology could be used for either creating a hub with a new power plant or for connection to an existing facility.

Whilst development of a completely new integrated hub may raise timing issues for ICCS due to the long lead time for greenfield CCS power plants, connection to an existing power anchored hub (White Rose or Peterhead for example) could accelerate the implementation of ICCS. Further volume from a greenfield power development and other industries could be added subsequently.

2.5 Other Considerations

In addition to the benefits and challenges described for each option above, there are a number of additional areas that are likely to impact the implementation of ICCS at a high level. Specifically, these include:

- **Phasing of the Implementation:** It is unlikely that a simultaneous multi-project execution could be delivered for an ICCS project so any incentive mechanism design must facilitate phasing of the investment and a build up of CO_2 volume over time. As described elsewhere in this report, this has implications for costs, strategy and the policy approach to the sector;

- **Risk Allocation:** As has become increasingly evident through the various CCS projects in the UK and internationally, the risk allocation is crucial to delivery of projects and the basis on which they are delivered. The large-scale CCS projects that have entered operation or are in construction have been, to a large extent, funded by the public sector directly or indirectly with significant backstopping of risk. To convert the options presented into workable solutions, it will be necessary to have a very clear understanding of risk allocation as this will influence not only the extent to which the commercial sector will play a role in ICCS, but also the choice and design of the final incentive mechanism;
- **CCS Risk:** One absolutely fundamental issue that will need to be addressed is the extent to which the commercial sector is expected or willing to take CCS related risks. This specific aspect of risk allocation will hopefully become clearer as the commercialisation competition projects develop in the coming months, but will be crucial in further developing the incentive mechanisms for ICCS;
- **Role of an Aggregator:** Given the somewhat fragmented nature of the industries that could participate in an ICCS cluster, there may be an important role for an aggregator to stand between the Emitter and the T&S Provider. All of the options described could accommodate this additional role;
- **The Scope for CO_2 Use:** As part of the preliminary review work for this project we looked also at the scope for CO_2 use as an alternative or addition to storage. There is some potential for use of CO_2 in chemical conversion processes and having volume available could encourage new pilot projects to be set up in Teesside. Whilst volumes are unlikely to be significant, provision for tapping of some volume of CO_2 should be incorporated into the design;
- **EOR:** Use of the CO_2 for enhanced oil recovery could transform the economics of ICCS, but initially volumes and reliability of supply make this impractical, although in our view, all of the proposed incentive mechanisms could be adapted to reflect the benefits of future extension into EOR;
- **Full Chain vs Capture Only:** Whilst our analysis primarily looked at the design of incentive mechanisms from the perspective of a full chain project, as indicated we have considered the implications of the incentive being used for capture only and feeding into an existing T&S infrastructure. This could be simpler scenario from a commercial structuring perspective but many of the highlighted risks around credit quality, predictability of volumes, interdependency etc will still remain to be resolved. However, all three of the proposed mechanisms could be adapted to either full-chain or capture-only applications in our view; and
- **Catastrophic failure:** Related to to the above, is the discussion around the extent to which government will act as "backstop" for some significant risks in projects including, economic failure due to CCS risk, CO_2 leakage etc.

3. FINANCING OF ICCS

As part of our evaluation of potential investment mechanisms for ICCS, we also considered how each mechanism might influence the potential for financing projects. This is a key consideration in our view, as the ability to raise finance for ICSS projects could be essential for deployment.

3.1 Market Testing of Concepts

Given the early stage of ICCS and lack of detailed risk allocation, the focus of the financing assessment was around the challenges of ICCS and the extent to which the proposed investment mechanisms helped in addressing these. Through a series of formal and informal meetings, both the project and potential investment mechanisms were introduced to a range of financial and other institutions that could conceivably have role in financing the project at some point, and other stakeholders who we felt could contribute to the analysis. Key initiatives in this regard included:

- **Initial Meetings:** In the initial phase of the work we held a number of informal meetings to discuss ICCS and the challenges around potential investment mechanism concepts to support the industry. Various stakeholders were canvassed, including financial institutions, multilaterals and other organisations that had given thought to the area (most notably IEA) and other interested parties. These meetings were crucial in setting boundaries, identifying the work done already in the area, understanding the challenges to be addressed and framing initial concepts for support mechanisms to try to address these.
- **Financial Institution Briefing:** A meeting was arranged between the Teesside Collective, SG and six senior project finance institutions from the City, including Green Investment Bank. These banks were selected for the role they have played in financing UK projects, including in new areas such as off-shore wind and other renewables. Importantly, they are all also involved in the bank funding exercise underway for the White Rose CCS project and therefore have an understanding of the key issues associated with CCS. Representatives attending were senior people within these organisations with many years of experience in structuring debt facilities for a wide range of projects in power, infrastructure and oil & gas industries.
- **Carbon Capture & Storage Association:** We were invited to present progress on the project and potential investment mechanisms to the Regulation & Policy Group of the CCSA. Given the wide range of experience of this group, we considered this to be a good opportunity to market test the validity of the proposals being developed.
- **Multilaterals and other non-bank agencies:** We have informally discussed potential investment mechanisms with a number of other UK and European institutions to solicit their views and to discuss other concepts that may be relevant to our work. We see organisations such as EIB, I-UK, GIB and others as being potentially key to the development of early projects.

3.2 Summary Financing Feedback

It is useful to summarise the feedback in two parts; the financing potential of ICCS and the specific feedback on the proposed investment mechanisms themselves.

3.2.1 Financing Potential for Industrial CCS

The feedback on financing ICCS has to be seen in the context of the very limited knowledge of the sector and almost no precedent to date. Key themes can be summarised as:

- **Credit Challenge:** A common theme of the discussion was the credit quality of the integrated project and the individual links in the chain – industrial emitters, the pipe and store. The key concern was the ability of the Emitters to fund the investment in the capture plant and related to this, the ability to justify an investment in the T&S infrastructure with the associated risk of the emitters being able to supply CO_2 on a reliable basis over the anticipated long-term investment horizon of the infrastructure. The consensus view was that the credit risk of the industries themselves, unless mitigated sufficiently, would be the most likely reason for ICCS projects not to proceed;

- **Rationale:** There were questions around the motivation of industrial emitters to invest in capture technology, which was seen as a concern from a financing perspective. Equally, there were initially questions around the rationale for Government to incentivise CCS from industry, although with further clarification of the volume of CO_2 potentially available to be captured on Teesside through the Teesside Collective, there was a greater understanding of the potential policy motivation;
- **Economics:** The perception of many is that ICCS with dedicated T&S infrastructure will be prohibitively expensive and thus not competitive with other forms of carbon reduction. Several institutions expressed interest in seeing cost comparisons with power sector CCS and offshore wind for example (even if the comparability is questionable). Part of the benefit of this work will be to provide some definition to the costs, if only at a high level, in order to demonstrate that ICCS could have a key role to play in decarbonisation. It is also evident from the work done, that the Teesside Collective project could conceivably use the same storage field as White Rose (5/42) or Peterhead (Goldeneye) for example. Additional users could join the Teesside Collective system when operating, further enhancing its economics which is a factor to be considered when designing the T&S elements of the project;
- **Risk Allocation:** The commercial banks focussed on risk allocation, doubting that without significant third party underpinning (from government, insurance or other parties), funding could flow into ICCS projects. It was anticipated that this may have to go beyond addressing CCS risk; to potentially deal with corporate credit, volume and other risks whilst recognising the difficulty this may raise with state aid and other areas of competition regulation;
- **Timing:** The timing of when a project may come to market was questioned, particularly given the perceived commercial complexity of ICCS. The common perception was that ICCS may have to follow, and potentially "piggy-back" off power related CCS and this was seen as a significant disadvantage, given the extended development period for a power project and related T&S infrastructure – potentially pushing an investment decision on ICCS at least five years into the future. We believe that with foresight, commitment and careful planning this timing challenge could be addressed by developing an ICCS project in parallel; and
- **Technology:** Without very much detailed knowledge, there were concerns around the technical challenges in capturing, transporting and storing the CO_2. This was recognised as an issue that could be addressed with a better understanding of the technology proposed – essentially more of a due diligence issue.

Whilst this feedback may be perceived as somewhat negative, it is not dissimilar to that received when we began bank soundings for the White Rose and Abu Dhabi CCS projects. However, it is worth noting that as these projects, particularly White Rose, developed and became more "real" they have developed significant interest from a broad spectrum of finance providers. In part, this has been achieved through greater understanding of the specific projects, but also reflects the growing awareness of the importance of CCS as a tool in the carbon reduction arsenal. We anticipate that this work for the Teesside Collective will be the start of a similar process in respect of ICCS. We further believe that the challenges raised to date are not an insurmountable barrier to development and financing of ICCS in the future, with the right structures in place. However, it is our view that ICCS financing would be significantly more difficult should the current CCS Commercialisation Competition projects fail to proceed.

It is also worth reiterating that the financial institutions became significantly more interested in ICCS when they understood the scale of the CO_2 emissions available from the Teesside Collective and other industries that could join the scheme. We believe that the projections in the PBD Report prepared for this exercise will further demonstrate to the finance community the potential of ICCS as a competitive decarbonisation option but were unable to make this data available for them for the discussions held.

3.2.2 Incentive Mechanisms

The mechanisms presented for discussion were in essence the options presented in this report. As well as comments on the practicality of these options, we solicited views on other mechanisms or structures that may better facilitate the development of ICCS. In terms of the proposed models:

- The Storage Led (Option 2) or Hybrid (Option 3) Models appeared to be considered the most favoured models for a greenfield full chain project, primarily because they had the potential to

remove the previously highlighted credit and/or volume risk from the structure. This was a key positive as far a potential financing was concerned;

- There was no clear preference for either of these models, with both considered to address some (but not all) of the concerns of the financial institutions. One of the comments common to both options was that having a "de-risked" T&S Provider, through an availability and take or pay usage arrangement, could assist in financing both capture and T&S infrastructure. However, credit standing behind this risk was a significant financing consideration;
- The Emitter CFD Model, whilst familiar to those involved in the power sector, was less favoured as it failed to address the fundamental risk of the emitter credit. The key concern was that long term (10 years plus) financing of investment in either the Emitter or T&S infrastructure relies on the ability to earn the CFD subsidy over a similarly long period of time – an area of uncertainty for industrial emitters. It was noted however, that this model was perceived as being relatively bankable if the credit issues can be resolved, particularly given the development of potential precedent through the current competition projects;
- One common theme raised by a number of organisations, including commercial banks, was the potential use of a power plant as an "anchor tenant" for an industrial cluster, with the power project delivering the long-term reliable CO_2 load for the construction of the T&S infrastructure, leaving a more manageable capital burden to be recovered for the industrial emitters. This was, to a large extent, why the Integrated Hub Model was left in the options as it has some merit for further consideration but is not without challenges as discussed;
- In terms of alternatives, other than creating the T&S infrastructure as a "government owned" asset (attractive to the finance community) there was some discussion around the applicability of infrastructure-type models (PF2) and the application of grant and guarantee funding. Infrastructure type models, to a certain extent, are reflected in the availability based options presented and when developed in detail, precedent from PF2 is likely to be relevant. Whether the model includes a hand back of the assets to the public sector needs to be evaluated;
- Not surprisingly, grant funding or guarantees covering specific risks were seen as positive for developing and financing the project; and
- A further potential solution raised was to use the CO_2 rather than directing it to permanent storage – EOR being an option considered to have particular interest.

3.2.3 Infrastructure Ownership

It is worth exploring further the ownership of the T&S assets as touched on above. One thread of the discussion with the finance community was whether transport, and particularly storage, investment should be developed in the public or private sector given the very specific risk profile of the assets, apparent lack of interest in investing in, or financing, such assets on a standalone basis, and the strategic importance of the assets to the UK decarbonisation policy. The consensus was that in order for CCS to develop effectively in the UK, very significant government backstopping of the CO_2 storage risk would be required to encourage investment in an industrial or power capture plant. There comes a point at which, the level of public sector support effectively equates to government ownership of the asset even if it is nominally developed in the private sector, so the question becomes why not develop CO_2 storage as a public sector asset on the basis of strategic importance and then reduce the public stake in the asset at some point in the future when the industry is sufficiently proven. Such an approach may be the most economic basis on which to develop the industry but could also have a transformative impact on investment in capture by potentially removing storage risk through, for example, a take-or-pay contractual structure with the emitter. Clearly this would require a major policy decision but, this is an approach previously postulated by several stakeholders. There are various ways for the government to achieve this position if public ownership is not palatable, including creating of a regulated storage company with appropriate risk support or implementing storage on a public-private partnership basis; both of which are consistent with the Storage Driven Model.

3.3 Sources of Financing Liquidity

In terms of liquidity sources for the funding of ICCS, the following are likely to play a key role:

- **Traditional Debt Financing:** Depending on structure, debt funding could be available for both capture and T&S elements of the project. Debt tenor, pricing and other terms range significantly depending on risk and other factors. The key challenge will be the novel nature

of the industry but it was encouraging that during the meetings with financial institutions there was significant interest in the Teesside Collective project and potential financing. We anticipate that the White Rose project, if it proceeds, will help to provide workable risk allocations and familiarity with financing in the sector;

- **Multilateral Institutions:** Given the first-of-a-kind nature of the Teesside Collective project, we would anticipate that institutions such as Green Investment Bank and EIB could play a material role in underpinning debt finance structures either with direct lending and/or other risk mitigation products. EIB in particular is very familiar with CCS, having evaluated many of the leading European CCS projects and completed the selection assessment for the NER300 applicants;
- **Infrastructure UK (I-UK):** Although on a different scale, the I-UK intervention in the Hinckley nuclear project will be crucial in ensuring the financeability of that transaction and could conceivably play a similar role as a catalyst for financing of ICCS;
- **Export Credit Support:** Usually linked to the country of origin of capital equipment or investment in the project, this potential financing source may be less relevant in this case but should not be ignored;
- **Role of Grant Funding:** The CCS Competition projects in the power sector will benefit from significant grant funding to support their capital plan. From a financing perspective, grant funding could prove crucial as it can be used to address specific risks within the structure and/or reduce the capital requirement of the project, thus potentially improving gearing with the corresponding benefit for debt financing terms; and
- **NER400:** One other potential source of funding for the project is the NER400 scheme, which could conceivably offer grant or operating revenue support as the case for the NER300, which provides funding on a per tonne of CO_2 stored basis. Accessing this source of funding, assuming that ICCS qualifies for support, is complex for ICCS as it is not clear how the NER400 process will fit with the timing of the project or the need to phase development, however, it remains a potential source of funding for the Teesside Collective.

The Teesside Collective ICCS project is at an early stage of the development so it is too early to present a more detailed financing plan but one would expect the Teesside Collective to target most of the above sources as the project develops in order to optimise the financing options and terms provided.

However, it is probably worth focussing more on the role of grant funding in facilitating investment in first-of-a-kind projects, and the balance with the ongoing incentive payments. One significant advantage of grant funding for both the equity and debt participants in a project is that it can be viewed as low-cost equity in terms of the capital structure. By this we mean that to a financial institution lending to a project, any funding that ranks below them can be viewed as equity and thus beneficial for the gearing of a project and the risk profile of their loans. From an equity perspective, grant funding reduces the amount of shareholder equity they need to inject in a project to get to the gearing required to raise financing, thus reducing their equity at risk. Finally, grant funding is effectively zero cost funding and so reduces the life time cost of a project as no return is required on the grant (unlike debt or equity). In theory, this should be reflected ultimately in a reduced cost per tonne of CO_2 stored when compared to a project funded entirely with debt and shareholder equity. However, there is also an operating cost associated with CCS so even if the capital was 100% grant funded, it is likely that some form of incentive would still be required on an ongoing basis unless for example, EU-ETS certificate prices increased to a level where they covered this cost (the value-for-money argument in respect of the CFD based incentive mechanisms). Ultimately, this is again a policy related issue and significant work would be required to define the optimal proportion of capital grant and ongoing incentive support for any specific project.

3.4 Key Financing Challenges

Based on this study, in summary the key financing challenges fall into several categories as follows:

- **Technology:** Whilst we understand that the capture technology required for industrial capture is not completely new, its application will be novel for financial institutions. The same could be said for the pipeline, but storage is an area where financial institutions do not have experience and seem unlikely, at this point, to take risk;

- **Motivation:** This is a two-way issue in that banks will look at the motivation of the various counterparties involved in the project (typically, financial, regulatory, strategic etc), but will also need to be provided with the motivation to become involved themselves. For financial institutions, motivation centres on the potential size of the market, key relationship client involvement, clear political and regulatory support and strength of the underlying business case. Offshore wind provides a good example in this respect, with significant debt funding entering the market only when the above factors fell into place;
- **Risk Allocation:** Risk allocation is crucial to the availability of financing and with no relevant precedent template, we anticipate that negotiation of this area will be complex, time consuming and potentially beyond the reasonable resources expectations of the industrial emitter partners of the project. Having said this, the risk allocation being developed by the power CCS projects may provide a basis for ICCS and help alleviate some of the burden in this area by enabling ICCS projects to at least start from an agreed risk allocation around managing CCS risk and potentially share infrastructure on template terms;
- **Economics:** The incentive mechanism has to be flexible enough to provide for the return required (a function of risk) by each of the participants in the project. It will also have to be sufficiently robust to ensure that the project can survive the "down-side" scenarios defined by both equity and finance providers; whether through headroom on returns or by backstopping of some risks;
- **Competition:** There is a risk that industrial CCS will fall into the "too difficult" category as far as financial institutions are concerned; an issue when they have a choice of whether to deploy capital and may find more proven low carbon investments such as renewables more attractive. This can only be addressed by working with the finance community, in the broadest sense, as the power CCS projects in Europe and the US are seeking to do in order to understand what commercial and other conditions are required to be met in order to make their projects attractive to commercial finance providers.

The significance of these challenges, and others, cannot be underestimated even with an incentive mechanism that appears to be logical, sensible and workable from a theoretical perspective. With no precedent for commercial financing of ICCS or indeed CCS in any sector to date, the development of the project, incentive mechanism and financing need to progress hand-in-hand to ensure that an optimal solution can be found to enable the Teesside Collective project to be successfully realised. As previously mentioned, the project is likely to be able to benefit substantially from the work being undertaken by National Grid Carbon and the Capture Power consortia for White Rose, albeit with what is likely to be a more or less different incentive model. The progress on this project is considered encouraging for the potential financing of the Teesside Collective project and ICCS in general in the future.

4. COMPARISON OF INCENTIVE OPTIONS AND RECOMMENDATIONS

In order to simplify the comparison of the options, the table below seeks to condense the information provided previously into a simple summary of the material differences for information:

Option	Positives	Challenges	Commentary
1. Emitter CFD Model	○ Flexible mechanism ○ Linked to CO_2 price ○ Value of subsidy adjusts with EU-ETS certificate price ○ Volume-based across the whole chain ○ Precedent mechanisms ○ Application to full chain greenfield or capture projects connecting to existing infrastructure	○ Volume risk ○ Emitter credit risk ○ Potential project-on-project risk ○ Phasing challenge ○ Incentive to invest ○ Future of EU-ETS/UK Carbon Floor	Whilst there is precedent for CFD-based financing, this option exposes counterparties to the credit quality of the emitters and T&S Provider – neither may be strong enough to raise financing without significant credit enhancement. Further development does provide flexibility to switch to other options later, including the hybrid or hub models, and in the case of the hub, based on one of the existing competition projects as anchor, or a new power development
2. Storage Driven Model	○ De-risks storage infrastructure ○ Less interdependence (chain) risk for emitter ○ Phasing issues less significant for overall system design ○ Improved bankability – T&S credit risk reduced, emitter only needs to fund its own capex by connecting to T&S at marginal cost, emitter CCS income comes from more secure source ○ Potentially a lower return requirement in return for de-risking	○ Lack of a clear incentive on the T&S Provider to secure volumes of CO_2 ○ Availability risk – damages payable for unavailability could be material (technical assessment required) ○ Mechanism needs to be defined for setting various payments to avoid over-recovery ○ Policy challenge of defining a capacity based T&S industry and funding ○ State Aid issues – no analogous model yet cleared – power capacity payment not really relevant	We believe that this model addresses a number of the material structural points of an ICCS project but also raises some additional and not immaterial issues around the policy and public-private risk allocation and the potential of a stranded T&S asset. On the positive side, it could be envisaged that the structure may make T&S a more attractive investment and conceivably deliver lower return requirements in T&S and capture, but this needs significantly more work to confirm. To a certain extent this model conflicts with the current development ethos of the power CCS projects
3. Hybrid Model	○ Seeks to combine the positives of the CFD and Storage Driven Models, although not perfectly ○ More direct EU-ETS interaction ○ Flexibility on CO_2 sources and potential for competitive allocation of CFD contracts with greater T&S certainty ○ Emitter CFD only recovers direct investment and T&S fee – cleaner structure for financing ○ Easier for an aggregator to stand between capture & storage	○ Increased complexity – effectively two separate but interrelated incentive mechanisms required ○ Availability risk still remains ○ Policy challenges remain to be addressed ○ Methodology for agreement of transfer pricing and risk between emitter and T&S Provider remains to be addressed	The hybrid model has significant attraction for ICCS in that it addresses material risk issues in T&S infrastructure provision but also provides a direct revenue stream to the Emitter from which to fund the investment in the capture plant. The option also (as with the Storage Driven Model) de-links the emitter and T&S investment and implementation risks
4. Integrated Hub Model	○ Use of the existing CCS power CFD "template" with one of the competition projects of a greenfield power plant bearing the cost of the T&S infrastructure - ICCS could pay marginal cost for connection ○ Emitter then only needs to recover capture investment, funded through specific industrial CFD ○ Potential volume related benefits for the industry, particularly in relation to the cost per tonne of CO_2 stored ○ Would feed back into connection fees paid by incremental capacity (power or industrial) ○ Dilution of industrial credit risk for the T&S provider	○ Complexity – policy, commercial and practical challenges of trying to implement a combined power, industrial and T&S project in parallel ○ Execution time may also be a problem as development of "Phase 2" CCS projects has yet to start in earnest, but connection to the Peterhead or White Rose infrastructure (should these projects proceed) could be a faster and more economic basis for development	Whilst this approach has a number of benefits, not least the potential for volume-based cost reductions from the development of a hub, the complexity and associated timing issues around implementing such a model are significant. We also doubt significant development expenditure will be forthcoming prior to clarification around the risk allocation and commercial structuring for the Commercialisation projects, which could further delay implementation of industrial CCS

Our assessment of the options as summarised in the above table suggests that whilst all of the above options could provide the basis of a viable incentive mechanism for ICCS, either the Storage Driven Model or the Hybrid Model appear to offer solutions to significant problems that would be encountered in developing a stand alone greenfield ICCS project – i.e. de-risking the T&S assets and addressing Emitter credit and volume related issues. This approach also addresses perceived issues around the development of the capture plant and the interface between capture and T&S assets. An Emitter should be able to take an investment decision with confidence that the storage facility will be available and will be a relatively strong counterparty (subject to mitigating availability risk). From the other perspective, the T&S Provider will be to a large extent neutral to the credit risk of the Emitter and variability of CO_2 volumes, as they recover their base return from making the infrastructure available, irrespective of the volume of CO_2 received thus helping to resolve another major challenge for ICCS.

However, in the case of the Teesside Collective project, there is the potential to connect into the T&S infrastructure being developed by Peterhead or White Rose through the CCS Commercialisation Programme, and as outlined in the report of PBD, this could bring significant cost benefits as well as potentially reducing execution and operating risks. Given the amount of work still to be done and in the interest of not closing doors too early, our recommendation then is to focus on the following mechanisms for further development in the next phase of the work as they provide "bookends" for four options, including the Integrated Hub (based on connection to exiting infrastructure or a new power plant):

Option 1: **The Emitter CFD Model**
Could function as a stand alone model for new project development or be used in a Hub or Hybrid Model approach

Option 2: **The Storage Driven Model**
Stand alone model or a component of a Hybrid Model approach

In other words, further development of these two options would form the fundamental building blocks for any of the four options presented and so leaves options open whilst the very detailed analysis needed to fully assess and further design each model is undertaken.

5. CONCLUSION

Developing an incentive mechanism for ICCS has posed a number of unique challenges in terms of scope, complexity and the very specific risk profile presented. However, we believe that we have identified a number of viable alternative incentive mechanisms which, when further developed, could form a basis for implementing the Teesside Collective ICCS project. These mechanisms are also transferrable to other projects in the UK as well as outside the UK, particularly to a number of countries considering migrating their clean energy incentive mechanisms to the CFD, or variations of it.

Our recommendation is that a second, significantly more detailed of commercial, technical, financial and policy analysis should now be undertaken based on the Emitter CFD Model and Storage Driven Model, as "bookends" for the range of incentive mechanisms that could conceivably meet the needs of the Industrial CCS sector.

Whilst all the shortlisted options pose their own challenges, we believe that these challenges are not insurmountable and have a good chance of being resolved and/or mitigated with further work as the project develops. All three of the ICCS-only incentive mechanisms are considered to be capable of development into an investible mechanism. From a financing perspective, whilst we only have outlines of the potential incentive mechanisms at this stage, based on our own assessment and discussions with various stakeholders, we believe that both a CFD and Storage Driven model could form the basis of a workable incentive mechanism for successfully financing the Teesside Collective project.

To move this project forward, we believe that it will be essential to further develop the incentive mechanism alongside the Teesside Collective project to provide a commercial frame of reference, and that financing considerations are represented as the project and incentive mechanism are carried forward to ensure that capital is available when required.

Ultimately, in the case of the Teesside Collective Project specifically, there are clear timing and economic benefits in connecting to one of the existing Commercialisation projects should they proceed, and on this basis, the most appropriate investment mechanism may prove to be the CFD Model.

Appendix 1 – Summary of Potential Investment Mechanisms Evaluated (not exhaustive)

Mechanism	Description	Positive	Negative	Commentary
1. Carbon Pricing - EU ETS Certificate price	Many of the industries on Teesside are captured by the EU-Emissions Trading Scheme, which in theory requires them to buy certificates to cover CO_2 emissions. Capture of CO_2 means these certificates would not be needed for production so the avoided cost benefit could contribute to the paying back capital invested in capture plant	• Uses an existing system • Already based on a tonnes of CO_2 rather than output of product • State aid issues should not be an issue if not modified • Simple to implement	• EU ETS certificates are not "bankable" in their current form • Volatility in value does not provide stable revenue stream • Current low prices would not fully cover investment in CO_2 capture, transport and storage • Higher price could have a materially adverse impact on competitiveness of industries – lead to closure or relocation (protection already deemed necessary at relatively low EU-ETS CO_2 price) • Significant regulatory uncertainty around the future of EU ETS – significant reform planned	Need to fully assess the current and future certificate obligations of the Teesside Collective but variability of output, uncertainty around the post 2020 EU-ETS and bankability of the CO_2 certificates make this option difficult for developing long term ICCS projects. Would need European-wide application at least to avoid carbon substitution
2. Contract for Difference (CFD) against the EU-ETS certificate price	Adaptation of the current proposal for the power sector but with a strike price against the EU-ETS Certificate price as a base. Strike price payable to the emitter on a per tonne stored basis	• Uses existing reference • Applicable across sectors where ETS applies in UK and Europe • Directly linked to volume of CO_2 captured and stored across chain • If CO_2 certificate market price increases, subsidy is self-adjusting • Meets value for money test (government) • Targeted subsidy for incremental cost of CCS and thus easier from a State Aid clearance perspective • Flexibility to deal with the differential capture costs of different industries through bespoke strike prices, tailored to the circumstance	• How would it be funded – no obvious pass through to consumer unlike power? • UK Government / EU policy in relation to industrial emissions currently unclear/evolving – continuation of exemptions? • Credit and operating risk – potential volume volatility • Mix of direct cash (CFD) and indirect non-cash (avoided cost) benefit – how will this be reflected in financing? Non-cash component would increase with increasing carbon price • Potentially complex to document and administer	Interesting as a potential mechanism as based on existing power template and can be designed to adjust with cost of carbon to each industry. Mechanics may be complex to define and inherent credit risk on emitters – highly commoditised industries. Potentially provides the flexibility to deal with the variability of industries on Teesside

3. SSI Anchor Project	An investment by SSI in power capacity could conceivably attract a power CFD which could be used to fund not only the power project but also the transport & storage infrastructure for a wider industrial cluster	• Would use an existing CFD mechanism with access to existing funding allocated by Government (LCF) • Strictly speaking, it would be consistent to pass this cost through to the power consumer, unlike ICCS costs • Could enable industrial companies to connect to the T&S infrastructure at marginal cost with associated cost benefit	• SSI credit risk long term • Incentive would be on a per MWh rather than tonne of CO_2 basis • Would still require an additional incentive mechanism to meet industrial capture cost • Concentration risk of CFD held through SSI – failure or relocation of SSI would bring down the T&S system as well • Complex for SSI as they will also be an industrial emitter from process gas	Despite the benefit of using an existing CFD mechanism, the credit and logistical challenges may be insurmountable. Superficially similar to the Abu Dhabi CCS project with ESI but that project is based on a CO_2 process flow, has EOR and is not externally funded
4. Storage Incentive	Rather than channelling funding through the emitter for CO_2 captured, this reverses the funds flow by paying a "storage fee" to the operator of the T&S network. Base (facility) fee would cover the T&S infrastructure and then an incremental fee to reflect the cost of CO_2 sourced by setting the fee at a level that allows the service provider to "buy" CO_2 to cover the investment costs	• Provides a basis for funding the initial infrastructure, potentially independently from the CO_2 sources – acts as a "pull" rather than push • Potential to offer marginal cost access to the infrastructure to improve affordability of CCS for industries • Relatively simple to implement • Reduces cost /tonne of CO_2 stored as volumes increase • Beneficial in terms of risk management – to a certain extent disconnects T&S and emitters and helps to manage	• Initially expensive infrastructure with no guarantee of CO_2 volumes – the facility fee would probably have to be availability based and independent of the CO_2 volume to gain investment • Decision on what capacity of system to invest in – requires long term projection of CO_2 volumes, phasing and timing • Potentially complex pricing structure and third party access issues around the use of the infrastructure • Identification of a T&S operator who sees this as a viable business opportunity • Potential State Aid challenge depending on structure	In our experience, storage is proving to be a difficult area in which to attract investors (and financing) but a "regulated" type return may solicit more interest There is no precedent for this structure currently although it is analogous to the US EOR model where the oil field operator (or an aggregator) buys CO_2 from process plants for use in EOR. Absent EOR (at least initially) the T&S operator or conceivably an aggregator becomes the single buyer but would need to be funded by Government in some form A regulated or quasi regulated storage operator funded on an availability basis could significantly improve the credit risk of this component of the chain
5. NER400	Whilst we do not yet have detailed visibility around the structure and process for	• Funding is likely to be linked directly to the amount of CO_2 captured and stored, so facilitates a volume-based	• Could be considered to be a "one-off" mechanism with limited repeatability for later projects	Likely to be a supplement to, rather than a primary source of investment support. Timing and the allocation

	NER400, it is possible that funding could be available on a per tonne sequestered basis. Assuming that ICCS is qualified to bid, this could provide a supplemental revenue stream to fund capture, transport and storage of CO_2	payment flow through the chain • Precedent could emerge from power related CCS (White Rose) who has won NER300 funding • Committed funding generating a revenue stream as long as the project performs	• Timing issue around when the project will develop relative to the auction process • Qualification of industrial CCS for NER funding? • Uncertain how much funding will be available and associated conditionality	process will make basing an investment decision on NER money a difficult proposition
6. Direct Subsidy/Grant Funding	Direct funding of ICCS through grant, operating subsidy or a mixture of both could provide a relatively straight forward mechanism to kick start the development of ICCS.	• Would provide the ability to target the optimal project structure based on lowest cost/high value targets • Relatively simple to implement • Effectively represents a low risk development – cost plus • Grant funding has significant benefit in reducing capex funding requirement – improving equity risk profile	• Could conflict with State Aid obligations – would need to be able to demonstrate that funding was applied only to CCS costs and not to subsidising the underlying business • Would require a conscious policy decision to develop specific industrial CCS hub(s) • Risk allocation could be challenging • Challenge to establish a basis of incentive level	Relatively simple approach but may be challenging to implement. Selection of projects, targeted funding etc may raise State Aid concerns. Setting an optimal grant level maybe challenging – balance between value for money for the public and level of grant required to attract investment
7. Feed-in Tariff (FiT)	Adaptation of the small-scale renewables approach in which industry would be paid a fixed amount per tonne of CO_2 avoided	• Existing template that could be adapted • Direct link to avoided cost volume of CO_2 • Creates a defined (guaranteed) revenue stream against which the investment required could earn a return and raise finance • Stimulated significant investment in European renewables and proven bankability • Price adjustable according to nature of project and evolution of the industry	• Source of the funding for the FiT • De-linked from the actual cost of CO_2 as defined by the EU-ETS and related to this, the cost is fixed and locked in irrespective of the evolution of the cost of carbon to the industry • How would cost of T&S infrastructure be recovered in this option – separate incentive or factored into the FiT? • Risk profile of the underlying industrial project may be significantly different from a FiT supporting renewable project	Potentially good mechanism for supporting ICCS but limited flexibility. Requirement to define how the FiT is set – competitive auction, bilateral, banding etc. Successful application of FiT would need to be based on long term recovery of cost – raises the issues of industrial host credit risk
8. Product / Border Taxes	Application of tax or other incentives to provide value for "green" industrial products	• Could provide a link between the volume of product produced and CO_2 captured & stored	• Tax-based incentives (tax breaks, taxation of imports etc) could be controversial and difficult to	Likely to be too complicated but US do have a tax-based renewable incentive system which could provide

		• Encourages investment in low carbon hubs to benefit from infrastructure	implement across different industries • Significant Trade and State Aid issues	some insight. Would potentially conflict with state aid, free trade and other international agreements
9. ICCS Certificate Scheme	Creating of a certificate scheme specifically for ICCS where the emitter receives a certificate for each tonne of CO_2 captured, supported by an obligation for certificates to be acquired elsewhere in the economy	• Certificated schemes already well established as a template for development of an ICCS specific scheme • Creates a direct link between emissions and cost and thus provides a clear incentive to invest in decarbonisation if applied across the industry • Creates a value for decarbonised products	• It is not easy to see who would have the obligation to buy certificates – consumers of the products produced? • Complicated to administer for a diverse sector & in effect duplicating the already existing EU-ETS • Difficult to implement in highly competitive global industries – could lead to closure/relocation of producers to avoid the "tax" • Bankability of the resulting certificates – creating of value to finance investment in CCS	Practical issues around implementation in competitive industries if not widely adopted and lack of an obvious buyer of the certificates make this a difficult option. Difficult to see who, other than government, would bear the cost of the scheme as there is no obvious target group for an obligation to buy CO_2 certificate. Could create government owned/supported T&S entity as a single buyer (see above Storage Incentive)
10. Mandated Target Scheme	Mandated CO_2 reduction targets for specific industries in order to create the incentive to invest in capture technology; similar to SO_X & NO_X targets or emissions standards in the power sector	• Clear signal to decarbonise across selected sectors • Conceivably in line with decarbonisation policy • Could be based on the existing EU-ETS by penalising emitters fully for their CO_2 emissions • Market driven system with limited need to intervene – similar to the approach taken with power plant – e.g. FGD	• Significant competitive impact – may drive industries out of the UK if the same rules are not applied across Europe / globally in some industries • Limited ability to pass significant additional costs on to customers • Unlikely to be widely acceptable politically or economically as a result • Difficult to define what level of penalty will stimulate investment in the infrastructure required • Some industries already receiving assistance to mitigate the impact of the UK Carbon floor price – indication of an inability to adsorb local costs in a global competitive market	Whilst relatively straightforward to implement and would provide a clear incentive, most carbon intensive industry is unlikely to be able to sufficiently price in the increased cost into their product to cover the investment required. Would almost certainly lead to transfer of industry to more "favourable" jurisdictions
11. Tax Credits	Used in the US as an incentive	• Precedent schemes operating in other	• Would require government policy	Methodology that has worked well in

	mechanism for wind, solar and to a certain extent CCS development. Could be applied to ICCS by providing a credit (£/tonne) linked to the volume of CO2 captured and stored	jurisdictions • Could provide flexibility for the emitter or a third party "tax investor" to monetise the value to fund the necessary investment	decision - directionally different from all decarbonisation to date • Ability to monetise the value of the tax credit sufficiently easily to ensure it acts as a viable investment incentive • Commercial and policy risk associated with execution	North America to stimulate investment in the renewable sector - usually monetised by a "tax investor" investing in the project SPV to gain access to the benefit. For ICCS, the capture investment may be an integral part for the host facility and so difficult to split out for a third party investor. Could work if the industrial plant was a significant tax payer
12. Integrated Power Hub	Implementation of an integrated power and industrial CCS hub, using the CCS power plant and associated CFD to fund the infrastructure with industrial emitters connecting at marginal cost. This could be achieved through connection to the Peterhead or White Rose projects, or through construction of a new power plant	• Existing precedent will be established if competition projects implemented and could be used as a template • Combined power & industrial volumes could significantly improve the cost per tonne of CO_2 stored • Power plant may be a better long term anchor for the hub vs ICCS only – improved investment /financing prospect • Potential to connect to T&S infrastructure of a CCS Commercialisation Competition project?	• The need to take a significant investment decision in a greenfield or power plant CCS retrofit which may not be straight forward as a route for ICCS • Complex implementation to integrate various facets of the project • Relatively high upfront capex • If connecting to an existing T&S infrastructure – issue on timing, certainty of project proceeding and third part access issues among other things	Complex and relatively expensive, but inclusion of power could help to alleviate some of the volume, credit and other risks associated with a CCS only project
13. CO_2 Diversion for Use	There are a number of potential uses for captured CO_2, including EOR, feedstock for other processes etc so some consideration was given to the scope for this as part of the mechanism for compensating the cost of capture for ICCS	• Reduction in the dependence on storage • Potential to create a revenue stream in place of a cost for the emitter – supporting the economic case for investment. Reducing public subsidy • Potentially simpler structuring – contractual arrangement for a product with value	• Potential variability of supply could be an issue for an industrial or EOR user • Volume challenge – industry users (e.g. aggregates) may represent a relatively small volume hence there may still be a need for storage. Equally, EOR is likely to require large dependable volumes that may not initially be available	Longer term, use of CO_2 may be a practical option but it seems difficult to incorporate this as part of the establishment of the Teesside Collective project. EOR would require significant additional investment and it seems unlikely that the Teesside volume would be sufficiently high or reliable enough initially to stimulate EOR investment. Additional complexity

Appendix 2 - Glossary

BIS	Department for Business, Innovation & Skills
BRAM	Baseline Risk Allocation Matrix (UK CCS Commercialisation Competition)
Capacity Fee	A fee payable for making a facility available irrespective of usage rate
CCSA	Carbon Capture & Storage Association
CFD	Contract for Difference
Cluster	See Hub below
CO_2	Carbon Dioxide
DECC	Department of Energy & Climate Change
EIB	European Investment Bank
Emitter	Facility emitting CO2 as a result of the manufacturing process
EU-ETS	European Union Emissions Trading Scheme
FiT	Feed in Tariff: fixed fee paid per unit of output
GIB	Green Investment Bank
Greenfield Project	Project constructed on a previously undeveloped site
Hub	Aggregation of CO2 emitters to take advantage of increase volume
ICCS	Industrial Carbon Capture & Storage
IEA	International Energy Agency
I-UK	Infrastructure UK
LCCC	Low Carbon Contracts Company: counterparty for power sector CFDs
LCF	Levy Control Framework
MRP	Market Reference Price
MWh	Megawatt Hour: unit of electrical output
NER300& 400	New Entrant Reserve: EU funding based on the sale of reserved EU-ETS certificates
PBD	Pale Blue Dot
PPP/PF2	Public-private financing structure used in the UK infrastructure sector
Strike Price	Fixed Price agreed in a CFD agreement
Take-or-Pay	Contract with an obligation to take a product or compensate the other party
T&S	Transport & Storage: CO_2 transport pipeline and storage facility
White Elephant	Project which fails and has no alternative use and is thus stranded
White Rose	UK CCS project shortlisted in the UK CCS Commercialisation Competition