Department for
Business, Energy
& Industrial Strategy

Carbon Capture, Usage and Storage

An update on the business model for Industrial Carbon Capture

May 2021

Any enquiries regarding this publication should be sent to us at: CCUSBusinessModelsUpdate@beis.gov.uk

Contents

Disclaimer

This update sets out further details on the government's current proposals on the potential business model for industrial facilities with carbon capture usage and storage (CCUS). The proposals, as set out in the document, in whatever form they are expressed, are indicative only and do not constitute an offer by government and do not create a basis for any form of expectation or reliance.

The proposals are not final and are subject to further development by the government, and approval by Ministers, in consultation with relevant regulators and the devolved administrations, as well as the development and Parliamentary approval of any necessary legislation, and completion of necessary contractual documentation. We reserve the right to review and amend all provisions within the document, for any reason and in particular to ensure that proposals provide value for money (VfM) and are consistent with the current subsidy control regime.

This update takes into account engagement that has taken place during 2021 since publication of the CCUS Business Models update in the December 2020 document. This includes engagement with the CCUS Expert Groups, project developers, and various stakeholders.

BEIS will continue such engagement as it works to refine its proposals, including engagement with the devolved administrations, to ensure that the proposed policies take account of devolved responsibilities and policies across the UK.

Introduction

Background

Carbon capture, usage and storage (CCUS) is vital to decarbonising industries, such as the chemicals, refining, and cement sectors, and has the potential to create world-leading low carbon manufacturing clusters, while attracting investment in new facilities and sectors.

In December 2020, we set out our minded-to position on the design of an Industrial Carbon Capture (ICC) business model, which incorporates:

- an up to 15-year contract (the ICC Contract) that provides the emitter with a payment per tonne of captured CO_2, which is intended to cover operational expenses, Transport and Storage (T&S) fees and repayment of, and a rate of return on, capital investment in carbon capture equipment; and
- capital grant co-funding for a portion of the capital cost of capture projects, which will be available for initial projects only and is intended to mitigate against certain risks associated with these projects.

The capital grant co-funding will be funded via the Carbon Capture and Storage Infrastructure Fund (CIF). We will also set out details later this year on the provision of a revenue mechanism to fund our business model to stimulate private sector investment into industrial carbon capture projects.

In our 'generic' model (Figure 1), the ICC Contract will be allocated to an industrial emitter. This emitter will have an agreement with the T&S Company (T&SCo) to transfer its captured emissions to the T&SCo, who will transport and store the CO_2 for the emitter. This therefore results in the transfer of ownership of the emissions and liability for any subsequent emissions following custody transfer. The business model will provide support for the financial costs of utilising the T&S network[1].

Figure 1: Schematic to demonstrate revenue flows between various parties involved in the generic ICC business model.

[1] We expect this will either result in the emitter paying the T&S fees (funded via the business model), or T&S fees being directly paid to the T&SCo by the ICC Contract counterparty.

Alternatively, a company may offer 'Capture-as-a-Service' (CaaS) on behalf of the industrial emitter, in which case we would consider an alternative 'CaaS model'. Further details are provided later in the document.

The proposed ICC business model has been designed to incentivise the deployment of carbon capture technology for industrial users who often have no viable alternatives available to achieve deep decarbonisation.

We recognise that UK industry faces many challenges as it transitions to align with net zero. The Industrial Decarbonisation Strategy, published in March 2021, shows how the UK can have a thriving industrial sector aligned with the net zero target, without pushing emissions abroad, and how government will act to support these objectives[2]. In particular, it sets out the ambition to capture and store at least 3 megatonnes of carbon dioxide per year ($MtCO_2$/yr) from industrial sources by 2030, thereby contributing to the 10 $MtCO_2$/yr by 2030 ambition detailed in the Ten Point Plan for a Green Industrial Revolution[3]. The strategy shows that, without CCUS, emissions from current industrial processes cannot be reduced to levels consistent with net zero; therefore, it is critical to demonstrate this technology in the UK in the 2020s.

The UK Infrastructure Bank (UKIB) also has a potential role in supporting CCUS. As a component of the government's broader infrastructure strategy, UKIB can co-invest with the private sector to enable and accelerate the delivery of UK projects that are consistent with its mission to tackle climate change and support regional and local economic growth. Individual investment decisions will be made independently by UKIB in line with its objectives.

The government's commitment to net zero has been further enforced with the recent announcement that it has set in law the world's most ambitious climate change target, cutting emissions by 78% by 2035 compared to 1990 levels. In line with the recommendation from the independent Climate Change Committee (CCC), this sixth Carbon Budget limits the volume of greenhouse gases emitted over a 5-year period from 2033 to 2037, taking the UK more than three-quarters of the way to reaching net zero by 2050.

Purpose of this document

This document follows the December 2020 publication, 'Carbon Capture, Usage and Storage: an update on business models', which provided an update on the proposed commercial frameworks for T&S, power, and ICC business models[4].

It focuses on the following areas of the ICC business model: eligibility criteria, reference price trajectory, treatment of free allowances, recovery of and return on capital investment, and

[2] The Industrial Decarbonisation Strategy (March 2021) can be found out at: https://www.gov.uk/government/publications/industrial-decarbonisation-strategy
[3] The Ten Point Plan (November 2020) can be found at: https://www.gov.uk/government/publications/the-ten-point-plan-for-a-green-industrial-revolution
[4] The Carbon Capture, Usage and Storage: an update on business models (December 2020) can be found at: https://www.gov.uk/government/publications/carbon-capture-usage-and-storage-ccus-business-models

consideration of the applicability of the proposed business model to ‘capture-as-a-service’ delivery models.

This document is being published alongside the Cluster Sequencing for CCUS Deployment: Phase-1 Launch, the CCUS Supply Chain roadmap, updates on the CCUS business models for T&S and power, and an update to stakeholders on the CCS Infrastructure Fund.

We anticipate providing a further update on the ICC business model this summer and expect to include additional updates on the business model and the ICC Contract counterparty. The update will be accompanied by a draft of the proposed detailed Heads of Terms for the ICC Contract.

Eligibility Criteria

The CCUS Cluster Sequencing Process will be executed in two phases. In Phase-1, government will receive submissions of integrated cluster plans from cluster leads to identify clusters most suited onto Track-1, details of which are in the CCUS Cluster Sequencing Phase-1 Launch document. In Phase-2, government will receive applications from individual projects across capture applications (industry, power and hydrogen) to connect to one of the Track-1 clusters. The eligibility criteria set out below have been specifically developed for ICC projects entering Phase-2 of the CCUS Cluster Sequencing process.

Business model support for ICC will initially be targeted to those projects eligible to participate in Phase-2 but we will consider how eligibility, as well as allocation (e.g. via more competitive processes) and the business model itself, will evolve in the future. Government will continue to work with industry as our approach develops to support future CCUS deployment and industrial decarbonisation.

For Phase-2 of the industrial project selection, a project will be considered eligible if they meet the following criteria (more details are set out in the following sections):

- The project must be located in the UK.
- The project must meet the definition of an industrial facility.
- The project must have access to a carbon transport solution and storage site.
- The project must have commenced pre-FEED studies or be ready to commence pre-FEED no later than the end of December 2022.
- The project must be operational no later than the end of December 2027.
- The project must meet a range of technical eligibility criteria.

Only eligible projects will progress to the evaluation and bilateral negotiation stages of Phase-2. Following this process, successful projects will enter into an agreement to receive an element of capital co-funding and award of an ICC Contract. Further detail on each of these eligibility criteria is set out below, and this information is also included in the Cluster Sequencing Phase-1 Launch document published alongside this business model update.

Any decision to award support would only be made subject to government satisfaction that subsidy control requirements have been met, government is comfortable with any balance sheet implications, all relevant statutory consents have been completed, and government is comfortable that the project represents value for money for the consumer and the taxpayer.

Located in the United Kingdom

This criterion has been proposed to reflect the UK government’s commitment to support decarbonisation across the UK in line with our 2050 net zero target.

Meets the definition of an industrial facility

For the purpose of this criterion, an 'industrial facility' is defined as a:

- facility; or
- part of a facility (including an industrial process or collection of industrial process(es)),

which manufactures products, treats materials and/or provides services for use in or as part of an industrial process or collection of industrial process(es) across one or more eligible sectors (being those sectors which are set out below).

Eligible sectors

In order to provide clarity for stakeholders, we are setting out which sectors we consider to be in and out of scope for the ICC business model for the first ICC Contract allocation round.

The industrial sectors we consider to be in scope include (but are not limited to):

- Midstream and downstream oil and gas (i.e. crude oil processing, natural gas processing, refining), iron and steel, cement, lime, and chemicals (including but not limited to fertilisers, pharmaceuticals, retrofitted CCUS-enabled hydrogen production and basic chemicals, such as ethylene and ethanol).
- Additionally, other sectors that are in scope are food and drink, non-metallic minerals, paper and pulp, nonferrous metals and other industry[5].
- Further details on retrofitted CCUS-enabled hydrogen production, Energy from Waste (EfW), and Combined Heat and Power (CHP) eligibility are set out below.

Sectors that are out of scope comprise:

- New build CCUS-enabled hydrogen production facilities.
- Upstream field operations for oil and gas.

The sectors outlined above that are in scope for the ICC business model fall within the Standard Industry Classification (SIC) codes 5 to 33 and 38. However, we do not propose limiting applications by SIC code and note that there may be cases where a project that is classified under one of these SIC codes is out of scope; this SIC code list is therefore provided for guidance only. Refer to Annex A for a summary table on eligible sectors and technologies.

CCUS-Enabled Hydrogen

Whilst retrofitting CCUS in existing "grey" hydrogen facilities is considered in scope for the ICC business model, new build CCUS-enabled hydrogen production facilities are out of scope. This is because hydrogen production in existing facilities has already proven to be commercially viable and the ICC business model will cover the extension to a capture component. Therefore,

[5] In this context, 'other industry' is defined as the subsectors of industry that are not listed here. Industry is typically defined as the various subsectors relating to manufacturing and refining, which fall under SIC codes 5 and 7 to 33 (excluding 24.46).

existing hydrogen facilities retrofitting CCUS will only be able to apply to the ICC business model for support and will be ineligible to apply for support under the business models in development for low carbon hydrogen. However, the business models for low carbon hydrogen will cover new build CCUS-enabled hydrogen production plants where commercial viability is less established.

Energy from Waste

Our current minded-to position, subject to further work, is to support the application of CCUS at EfW facilities, including waste incineration facilities with readiness and/or plans to implement energy recovery, via the ICC business model. This will include existing EfW facilities where the majority of energy output will be used by an eligible industrial facility and/or facilities where the energy output will be sold offsite to heat networks or the electricity grid.

It is intended that support will only be provided to the most energy efficient waste management facilities (i.e. only those facilities with energy recovery included) and to plants that are existing or already fully committed to being established, so that this support does not encourage perverse outcomes such as incentivising the construction of new EfW facilities ahead of more environmentally friendly waste management methods.

Therefore, this position is for initial CCUS projects and is subject to change, and the government will continue to develop its approach over the coming months. We will continue to consider the interactions with wider government priorities, including net zero, waste strategy, air quality, clean transport and value for money as we develop our approach.

Deployment of CCUS at EfW facilities is essential for meeting net zero and the deep decarbonisation of industry critical assets. The CCC have recommended that existing EfW facilities retrofitting CCUS need to do so in the 2020s, and that all new EfW plants should be built as 'CCUS ready', encouraging the application of CCUS to all EfW plants by 2050[6].

Some EfW facilities are located at industrial clusters, providing an opportunity to decarbonise assets with a long lifetime, support the potential diversity of emitters for T&S networks, whilst providing an opportunity for the energy produced from an EfW facility to be used or sold.

The primary purpose of an EfW facility is waste management; energy recovery is a secondary function and, if CCUS is deployed, part of the energy output would be used for CCUS operation, reducing the applicability of a support model that pays on electricity output. In addition, the nature of EfW processes means that electricity generation is not dispatchable, and therefore these facilities would not be eligible or suitable for support via a Dispatchable Power Agreement. Therefore, for the purposes of supporting CCUS deployment only, EfW is more suited to support based on the waste management processes it undertakes rather than on its energy output.

Municipal solid waste contains some biogenic content; this provides a potential opportunity for negative emissions. Further work needs to be done to determine how the potential use of an

[6] The CCC's Sixth Carbon Budget can be found at: https://www.theccc.org.uk/publication/sixth-carbon-budget/

ICC business model to support CCUS in EfW facilities would align with the work government is undertaking on negative emissions.

There will be further work this year (by the closure of the Phase-2 window) to detail our approach to eligibility, funding (including any capital co-funding), relation with other support mechanisms, and the applicability of the ICC Contract to EfW, including interactions between electricity revenues through EfW and the ICC business model. We will look to provide further detail on the applicability and requirements of a EfW facility seeking support in further updates this summer.

Combined Heat and Power

The decarbonisation of industrial CHP facilities is essential to helping to achieve net zero. We are aware that CHPs are often a critical part of an industrial facility's infrastructure, providing needed heat (in the form of steam) and electricity to run an industrial facility, therefore it is critical to support the decarbonisation of these assets.

The majority of industrial CHP plants are often located and embedded with industrial facilities and serve the primary purpose of providing a more efficient (by up to 30% more) source of heat and electricity to an industrial facility than traditional energy generation methods[7].

That is why our minded-to position is that the ICC business model will support, in some instances, the application of carbon capture at CHP facilities. Support will only be provided for cases where a majority of energy output (electricity and heat) is to be used primarily for eligible industrial processes. This means that the CHP facility must be (i) embedded or adjacent to and primarily used by eligible industrial process(es), or (ii) embedded whereby flue gases (or capture streams) are combined with those from eligible industrial processes and are to be routed to the same capture facility. This includes cases where the CHP facility is owned by a different entity.

We are minded to apply a similar definition of "majority of energy" output as applied under other government schemes, where 70% or more of the energy output must be used for eligible industrial process(es).

Additionally, support will only be provided to the most efficient CHP facilities, for example, those part of the CHP Quality Assurance (CHPQA) programme. There will be further work this year (by the closure of Phase-2 window) to detail our approach to funding and the applicability of the ICC Contract to CHP facilities, including interactions between electricity revenues and the ICC business model. We will look to provide further detail on the applicability and requirements of a CHP facility seeking support in further updates this year.

[7] https://www.gov.uk/government/statistics/combined-heat-and-power-chapter-7-digest-of-united-kingdom-energy-statistics-dukes

Access to a carbon transport solution and storage site

The Phase-2 process is open to applications located across the UK regardless of geographic location and proximity to a T&S network. However, projects are expected to demonstrate that they have a carbon transport solution and access to a carbon store. Although access to a UK store is not a requirement for eligibility, projects which intend to store CO_2 overseas may be required to demonstrate the need to utilise overseas storage capacity ahead of UK capacity.

To demonstrate access, a project should have a provisional agreement with its preferred carbon store and transportation provider and clear plans for how to integrate with this infrastructure.

Pre-FEED stage or ready to commence pre-FEED no later than the end of December 2022

To ensure that a project is at an appropriate stage of development to align with a 2027 operational date (at the latest) it must, at a minimum, be at Preliminary-Front End Engineering Design (pre-FEED) stage or ready to commence pre-FEED by no later than the end of December 2022. This should be set out in a project execution plan as part of the application.

Pre-FEED is the stage in which a project would have undergone feasibility studies with further definition around cost estimates and technology specification to prove project feasibility and provide a basis to enter into the FEED stage. A more detailed overview of how pre-FEED is defined for industrial carbon capture projects will be provided in further publications.

Note that we would expect projects with earlier operational dates, such as anchor projects, to be further ahead with their FEED studies and for this to be a considered as part of project evaluation.

The project execution plan must also demonstrate that the project is sufficiently advanced in obtaining planning approvals and other permit consents to align with its delivery timeline, along with information on when any challenge period for a relevant consent expires. We reserve the right to delay or prevent entry into a contract where a valid challenge has been brought within the relevant time period.

Operational no later than the end of December 2027

This deadline has been proposed to align with the government's commitment to deploy CCUS in the UK in the 2020s, with at least two clusters to be operational by the mid-2020s. Note that this is intended as a backstop date; having a credible earlier operational date will count favourably towards the project in the evaluation stage.

Technical eligibility considerations

In order to be eligible for an ICC Contract, the industrial facility will need to be:

- Classed as an eligible CCUS technology.
- Able to sufficiently demonstrate the ability to reach high process CO_2 capture rates of at least 85%.

Eligible CCUS technologies

In the December 2020 update, we noted that existing industrial facilities retrofitting carbon capture and new industrial facilities with carbon capture technology intrinsic to the process will be eligible for the ICC business model. We maintain this position, while recognising that new build CCUS-enabled hydrogen production facilities are an exception and are instead covered by the business models in development for low carbon hydrogen.

Both the full-scale application of CCUS and modular applications of CCUS are in scope and all carbon capture technologies (including pre- and post-combustion, oxyfuel and emerging technologies) are eligible.

In the December 2020 update, we set out the minded-to position that the ICC business model is intended to be applicable to carbon captured for the purpose of usage (CCU) when it results in the permanent abatement of CO_2 emissions. This is to ensure alignment with government's net zero ambitions. However, we recognise that this brings additional areas of complexity to the ICC Contract and, as such, are still considering this application of carbon capture and our position is subject to change as the policy in this area develops. There will be further work throughout the year to detail our approach to CCU.

Technologies that we do not currently consider to be in scope for the ICC business model include CCU resulting in temporary abatement due in part to the prioritisation of permanent abatement methods, Direct Air Carbon Capture and Storage (DACCS) and other GGR Greenhouse Gas Removal (GGR) technologies. A call for evidence on GGRs closed in February 2021. Government will set out further details on the evidence submitted in regard to investment frameworks for GGRs such as DACCS and Bioenergy with Carbon Capture and Storage (BECCS) in due course.

Refer to Annex A for a summary table on eligible sectors and technologies.

Process CO_2 capture rate

We define process CO_2 capture rates as the percentage of CO_2 emissions captured from the specific emissions stream that the capture technology is applied to. It does not refer to the percentage of captured emissions from the whole site, otherwise known as application rate. Please refer to Annex B for a detailed description and worked example of this definition of capture rate.

In the December 2020 update, we noted that we would expect a CO_2 capture rate of 90% to be achievable. However, further work this year (including through gathering stakeholder feedback) has highlighted that this may not be achievable for all industrial facilities across all sectors. This may be due to various reasons, including how the heterogeneity of industry may result in different expected capture rates in different sectors, varying levels of technological readiness and dilute CO_2 concentrations in the stream directed to the capture plant.

We have therefore revisited our expected CO_2 capture rate and now expect a minimum design capture rate (technology efficiency) of at least 85% for both new build and retrofit facilities, with consequences under the ICC Contract (including in relation to payment) if this threshold is not achieved.

While 85% represents the minimum CO_2 capture rate we would expect to see, higher capture rates will score more highly at the evaluation stage. This is to incentivise industry to optimise plant design to achieve higher capture rates and reduce residual emissions in line with net zero objectives. More stringent rules in respect of capture rates may be applied to future projects following learnings from initial applications of carbon capture and as technological improvements occur. We will continue to test the design of the business model to ensure that higher capture rates are incentivised, perverse incentives are not introduced and barriers to achieving energy efficiency are minimised.

We will provide further detail by the close of the Phase-2 window on what evidence emitters will need to provide to demonstrate that the capture rate they propose for the evaluation criteria (i.e. 85% and above) is achievable. Further technical details will also be provided.

Business Model Design

Reference Price Trajectory

In December 2020, we set out our minded-to position for the reference price for projects selected in initial allocation rounds: the reference price will follow a fixed trajectory, defined before the start of negotiations. The price could be analogous to the projected carbon market price for the contract lifetime, though not necessarily directly derived from it.

We have applied the following principles to guide our setting of the reference price trajectory:

- Providing predictability to investors in respect of support payments
- Reducing subsidy over time
- Providing a fair subsidy and avoiding negative market distortions
- Compatibility with carbon pricing policy
- Simplicity for investors and the government
- Providing value for money and cost certainty to the Exchequer
- Replicability across different contracts for initial ICC projects
- Transparency so that the way in which support payments are determined is clear to stakeholders.

This document provides more detail on how we plan to set the reference price for initial ICC Contracts.

Setting the reference price

Our minded-to position builds on that from December 2020. In addition to following a fixed trajectory, defined before the start of negotiations:

- The starting point of the reference price will be the average carbon market price under UK carbon pricing policy (UK Emissions Trading Scheme, UK ETS) defined over a sufficient period prior to contract negotiation.
- The reference price will follow a straight-line upward trajectory based on historical growth in carbon prices over the last several years.

This method of determining the reference price aligns with the principles set out above and can be considered analogous to a projected carbon market price though is not directly derived from it. We have avoided using published carbon price projections because those that are publicly available relate to EU Emissions Trading Scheme (EU ETS) carbon prices, which would not be suitable for UK projects. UK ETS projections are forthcoming, however are subject to scheme design changes that will be consulted on this year. In the absence of this and to give certainty to investors, we have opted for this simple approach for the reference price for projects selected in the initial allocation rounds.

For future allocation rounds, our intention is to transition towards a market-based reference price where setting a starting point and trajectory in advance would not be required.

Base and effective reference price

The method for determining the reference price trajectory described above will apply to the initial ICC Contracts. This is the 'base' reference price. The following section on the treatment of free allowances introduces an individual industrial's 'effective' reference price, which takes account of compensation for an industrial's forfeited free allowances.

Treatment of Free Allowances

In December 2020, we set out our minded-to position on free allowances: the agreement will see UK ETS free allowance certificates forfeited in line with capture volumes and monetised against the reference price, while residual emissions (and any remaining free allowance certificates which have not been forfeited) will remain subject to the UK ETS.

This document provides more detail on the methods by which forfeiting and monetising will be applied for initial, 'first-of-a-kind' projects. It is anticipated that a different position will be taken for future contracts as the business model evolves and the CCUS sector matures.

Rationale

Free allowances (FAs) provide industry with a means of mitigating the risk of carbon leakage to other geographies without similarly stringent carbon policies as a result of being exposed to a carbon price through the UK ETS.

Revenue from FAs that no longer need to be surrendered under the UK ETS form a potential revenue stream for industrials deploying CCUS that will need to be taken into account when determining what is an appropriate level of support. However, this revenue stream is not fixed as there is uncertainty over the price and volume of an industrial's FAs over the course of the ICC Contract:

- *Price risk* – uncertainty over the price that FAs can be monetised for (and cost savings of carbon abatement) on the carbon market over the contract period.
- *Volume risk* – uncertainty over the number of FAs the emitter will be allocated over the period, particularly as the government develops UK ETS policy.

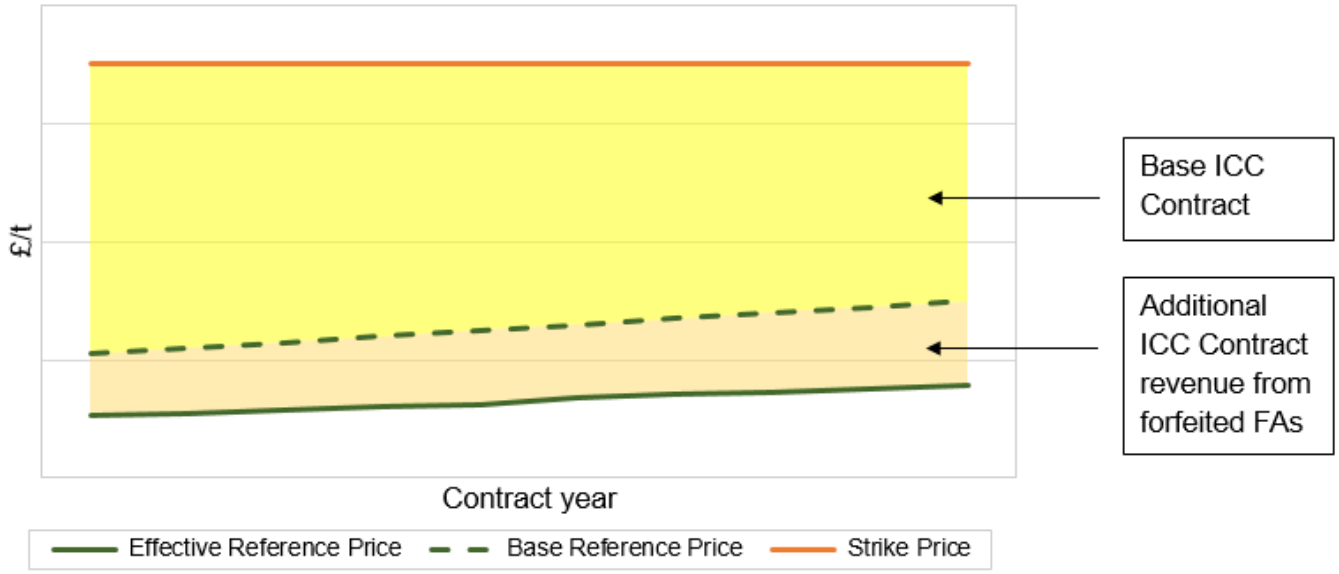
We anticipate that this uncertainty would be factored into industry's determination of the expected support levels needed in the ICC Contract to deploy industrial carbon capture, resulting in higher overall costs and worse value for money.

Our minded-to position is to provide greater revenue certainty to industry by requiring industrials party to an ICC Contract for initial projects to forfeit FAs for a known value of compensation and providing a degree of protection for this value.

Price assurance

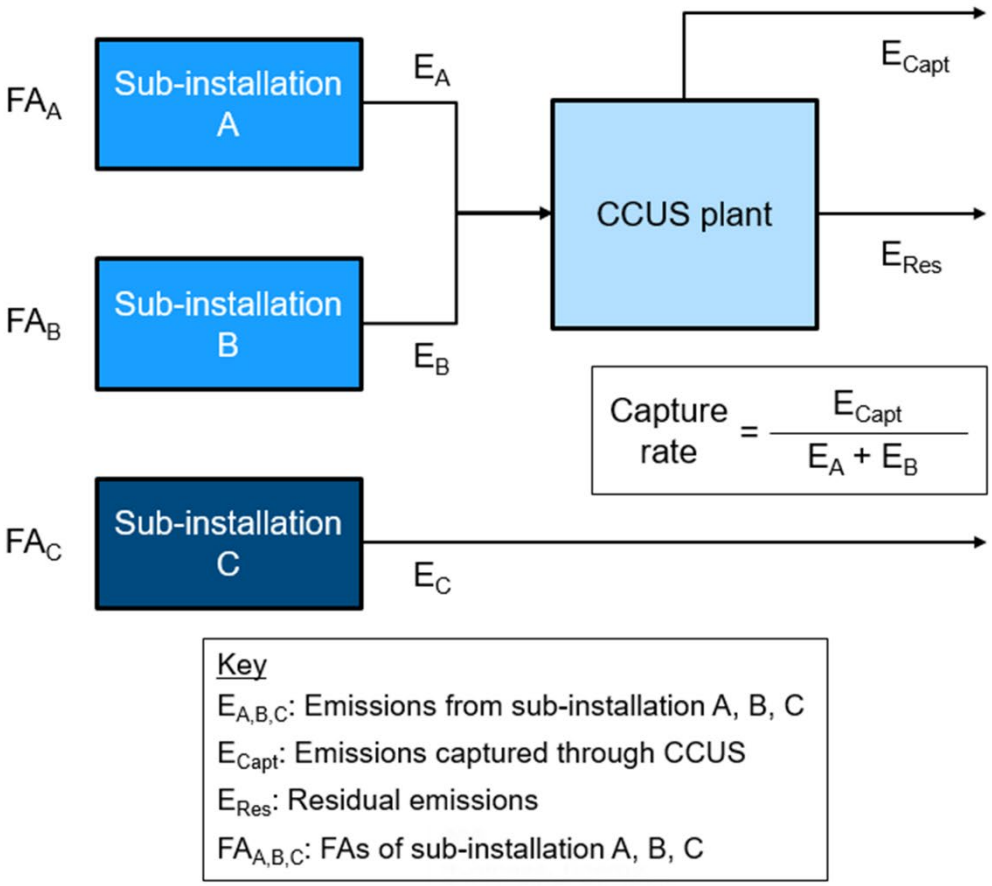
The business model seeks to reduce the risk of price volatility of FAs by providing the industrial emitters with predictability on the value of its FAs, with respect to captured emissions, for initial contracts. As a condition of the contract, industrials will forfeit a portion of their FAs to the government and in return for these FAs will be compensated at the value of the reference price for that year. Compensation for the value of these FAs will be made through the ICC Contract payment by lowering the 'base' reference price (as described in the section above) to an 'effective' reference price (Figure 2). This removes uncertainty for both emitters and government over the price at which FAs can be monetised.

Figure 2: Graph showing compensation of forfeited FAs paid through ICC Contract revenue.



The industrial will forfeit a number of FAs in proportion to the volume of captured emissions. This proportion is the capture rate of process emissions fed through the capture plant. Figure 3 shows that only CO_2 emissions from sub-installations that are being fed into the CCUS plant (from A and B below) are used to calculate the CO_2 capture rate. Following on from this, only FAs associated with these sub-installations are eligible for forfeiture (FA_A and FA_B).

Figure 3: Schematic showing which emissions constitute the process CO_2 capture rate.



This capture rate is then applied to eligible FAs to calculate the number of FAs forfeited under the ICC Contract. In Figure 4, a fictitious scenario is used to demonstrate this calculation. Here, sub-installations A and B combined have FAs of 0.5 $MtCO_2/yr$ associated with them and the capture plant has a CO_2 capture rate of 90%. As a result, 0.45 $MtCO_2/yr$ of FAs are forfeited.

$$\text{FAs forfeited} = \text{Total free allowances} \times \text{process } CO_2 \text{ capture rate}$$

The industrial retains 0.05 $MtCO_2/yr$ of its original allocation of FAs associated with sub-installations A and B to use on residual emissions and/or to trade.

The emitter will be compensated for forfeited FAs at the prevailing base reference price for that year. The annual 'value' of these forfeited FAs, in £ per tonne CO_2 captured, is calculated as follows:

$$\text{Annual value of forfeited FAs } (£/t) = \text{FAs forfeited } (t/yr) \times \frac{\text{Base reference price } (£/t)}{CO_2 \text{ emissions captured } (t/yr)}$$

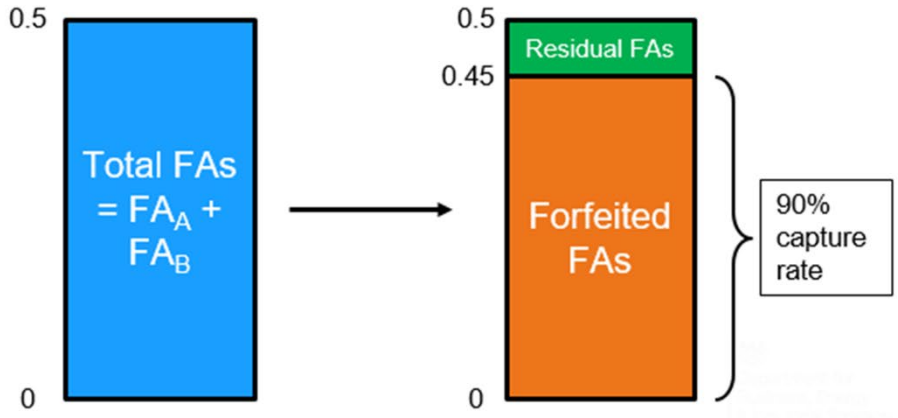
$$\text{Effective reference price} = \text{Base reference price} - \text{Annual value of forfeited FAs}$$

This value is awarded to the industrial by lowering the base reference price by this amount, to create an effective reference price. The value of forfeited FAs is thus paid to the emitter through the ICC Contract payment (the difference between the strike price and the effective

reference price) per tonne of CO_2 captured. Figure 2 shows the lower effective reference price resulting from forfeited FAs.

Further information will be provided in future ICC business model updates on how these processes will work, including how FAs will be forfeited, and how differences between expected and outturn capture volumes will be accounted for.

Figure 4: Schematic showing how to calculate forfeited FAs.



Volume assurance

The current method for mitigating the risk of carbon leakage is free allocation of UK ETS emissions allowances, which will be decreasing throughout the 2020s; however, the government has stated that it will be reviewing the evolution of the FA regime within the UK ETS, specifically in the context of the setting of a net zero consistent emissions cap. We acknowledge this means that future free allocations would not be known for the entirety of an ICC Contract and this creates uncertainty for investors. Therefore, for initial contracts only, we are proposing to provide a degree of protection so that these uncertainties do not feed through into higher costs for taxpayers via higher strike prices. This protection would be through setting out an annual minimum level of FAs for which the contract will provide compensation. This minimum level will take account of policy developments made by the review into UK ETS free allocations following the call for evidence[8] and upcoming consultation.

This will mean that, even if actual FA allocation falls below this level as a result of future UK ETS policy, the contract will still compensate for the value of FAs up to the minimum level, for these initial projects only. Regarding actual FAs, the industrial will continue to forfeit these in proportion to capture volumes (for which it will receive compensation, as described previously). We are considering different options for how this minimum level of FAs could be calculated, and the ICC Contract will set this out.

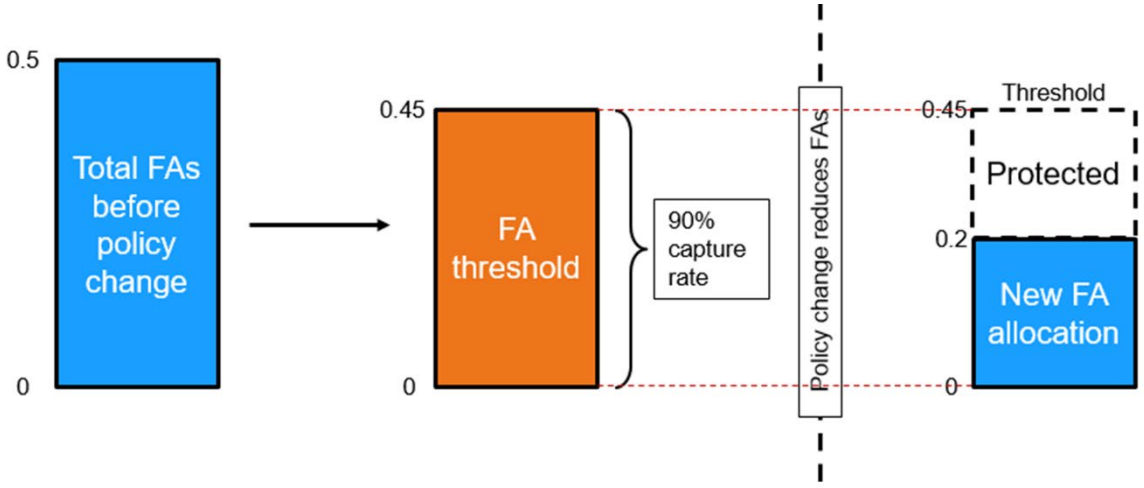
This protection would be provided with respect to captured emissions only, and so would present itself through a reduced effective reference price. The industrial would not receive any protection from UK ETS policies already in law or that have been announced by government

[8] The UK Emissions Trading Scheme free allocation review: call for evidence can be found at: https://www.gov.uk/government/consultations/uk-emissions-trading-scheme-free-allocation-review-call-for-evidence

prior to a fixed date (before the date of ICC Contract signature). This will be set out in the ICC Contract. FAs associated with residual emissions would remain subject to UK ETS policy and so no protection will be provided to FAs in respect of these.

For illustrative purposes, Figure 5 shows one possible method for administering this assurance, using a fictitious example where a change in UK ETS policy during the term of the ICC Contract would result in the industrial's FA allocation falling from 0.5 to 0.2 $MtCO_2$/yr. The industrial's total protected value of FAs (described below as the "FA threshold") could be calculated, for example, by applying the plant's 90% capture rate to its FA allocation prior to the policy change, resulting in 0.45 $MtCO_2$/yr.

Figure 5: Schematic showing how the FA threshold and 'protected' amount are determined.



From the new FA allocation, a proportion equal to the capture rate is forfeited:

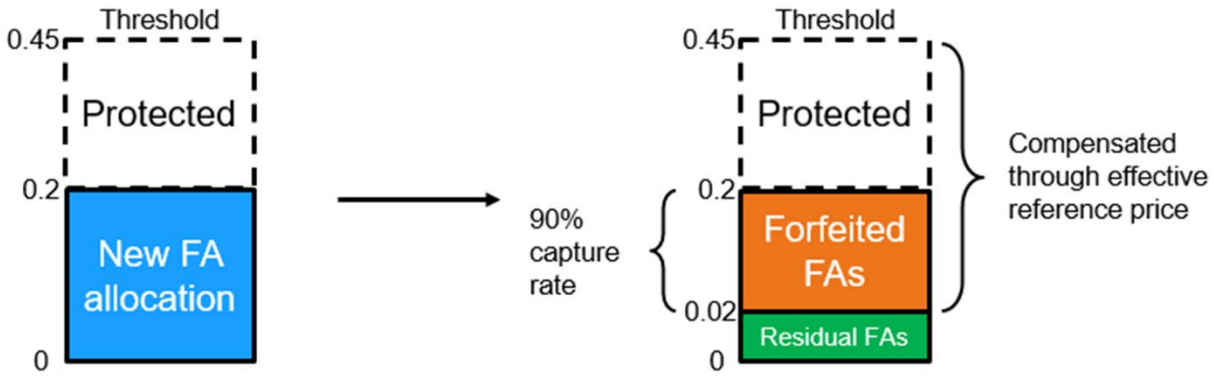
$$\text{FAs forfeited} = \text{New FA allocation} \times \text{Process capture rate}$$

This and the protected number of FAs are added together and valued at the base reference price:

$$\text{Value of protected \& forfeited FAs} = (\text{Protected number} + \text{FAs forfeited}) \times \frac{\text{Base reference price}}{CO_2 \text{ emissions captured}}$$

As described above, this value is awarded to the industrial by lowering the base reference price by this amount to create an effective reference price. In the fictitious example (shown in Figure 6), the emitter is compensated for 0.25 $MtCO_2$/yr (protected amount) and 0.18 $MtCO_2$/yr (forfeited FAs), leaving 0.02 $MtCO_2$/yr for residual emissions.

Figure 6: Schematic showing compensation of the protected number and forfeited FAs.



It should be noted that the 'protected' number of FAs is a theoretical figure and the industrial does not receive additional FAs for this; it receives the equivalent value of them at the base reference price.

Our minded-to position is for volume protection for these initial projects to last for the full duration of the contract before the proposed reopener/extension at 10 years. We want to give certainty now for first-of-a-kind projects to support competitive bids, which overall should help deliver best value for money for the taxpayer. We think this represents the best balance of providing revenue certainty for emitters, ensuring stranded asset risk is not exacerbated, and controlling costs for government. This position is for initial projects only, in light of the risks associated with deploying new technology at scale for these first-of-a-kind projects.

The risk of carbon leakage is likely to change before support for ICC is allocated and/or over the course of the ICC Contract as the policy landscape develops. The purpose of FAs in the UK ETS is to mitigate carbon leakage risk. If the risk of carbon leakage reduces, then it must be considered whether the level of protection over free allocation volume is still appropriate. Over the coming months as we develop the business model, we will continue to assess the risk of carbon leakage and be responsive to policy developments made by the review into UK ETS free allocations following the call for evidence and upcoming consultation.

Capital Repayment

Capex payment rate

In December 2020, we proposed capex repayments being made based on metered output of CO_2 entering the T&S network. It remains our intention that capex repayments will be linked to capture performance and contract requirements, and will not be made based on the availability of the capture equipment. Further details on contract requirements will be made in due course.

The proposed formula for the capex payment rate is set out below. The capex payment rate (CP) will be bespoke for each capture plant as it is based on the capacity of the specific capture equipment and the level of capex repayments.

Calculation of capex payment rate

$$CP = \frac{ACP + RC}{EC}$$

Term	Definition	Description
CP	Capex Payment rate (£ per tonne)	Pounds per tonne of CO_2 captured
ACP	Annual Capex Payment amount (£)	The total capex repayment amount divided by the number of years in which capex is due to be repaid (both set out in the ICC Contract)
RC	Return Component (£)	More information on how this will be determined will be given in a further update
EC	Expected annual CO_2 Capture amount (tonnes)	Will be set out in the ICC Contract and based on technical specifications of capture plant

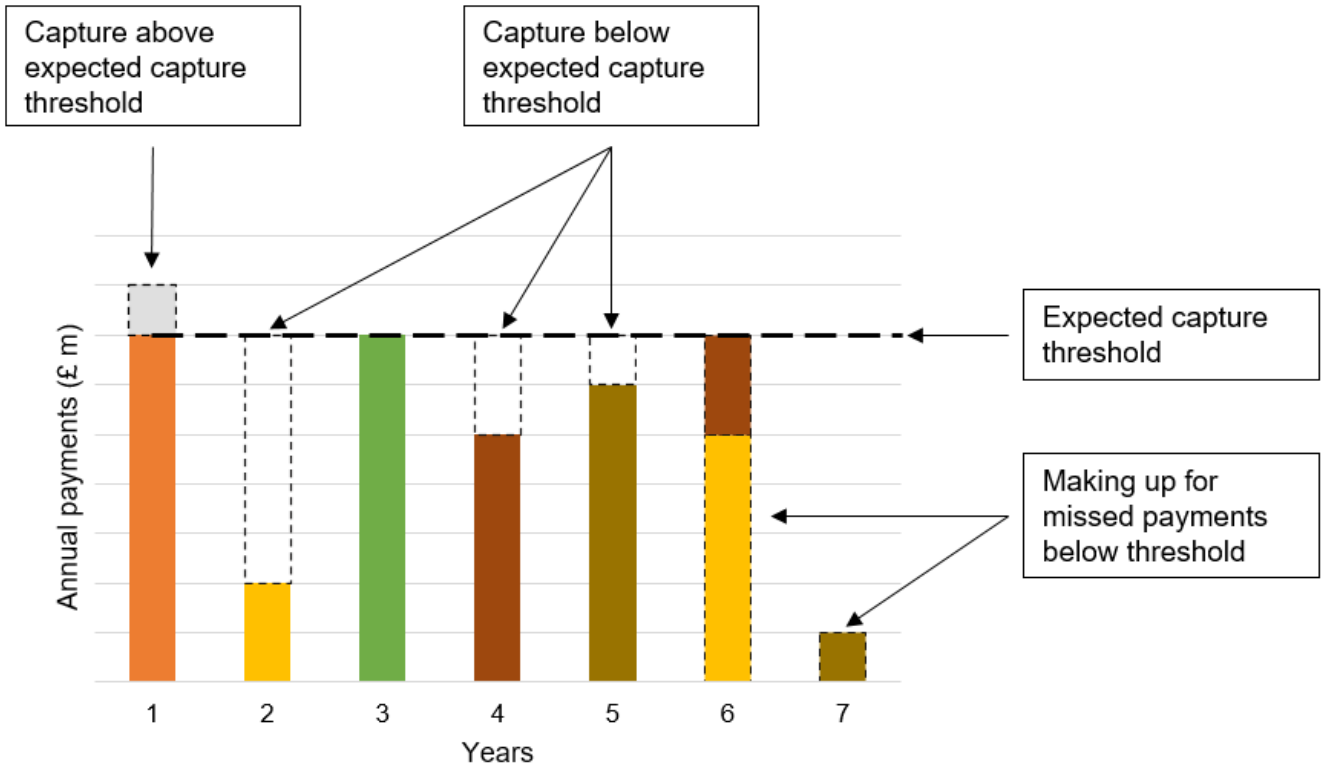
Capex repayment terms

Capex repayments and the return component will be based on a target five-year repayment period. In order to recover the total capex payments in this time the emitter would need to achieve the tonnes of CO_2 captured based on the expected capture rate (expected capture threshold) in each of the five years. We are aware that some emitters would typically target a repayment period shorter than five years, but we believe this offers the right blend of attractiveness to industry and acceptability to the government. The expected annual CO_2 capture amount will be based on the technical specifications of the capture plant and will be defined in the ICC Contract. If in any given year an emitter captures more carbon than the agreed expected annual capture amount, it will not receive additional capex payments for doing so. This position is for capex payments under the ICC Contract only; we will provide details for the opex component in the planned summer business model update.

If, in any year during the first five years of the ICC Contract, the expected CO_2 capture amount is not achieved and therefore the emitter does not receive the anticipated capex payments under the ICC Contract, the emitter will have an opportunity to make up these missed payments between the sixth and tenth years of the contract (Figure 7). This may occur due to issues related to the industrial facility or capture plant itself, leading to lower capture rates or prolonged shutdown. However, there are also risks that in the CCUS chain (e.g. T&S outages) that are outside the control of the industrial; for these circumstances we are considering if the same approach should be taken and will set out our methodology in a later update. The return

component will not be recalculated if capex payments extend beyond the fifth year; the capex repayment and return component amount will essentially be committed against a volume of capture at the beginning of the contract, which will be paid to the emitter in a period of between five and ten years.

Figure 7: Example of capital repayment over the ICC Contract, showing capture above the expected capture amount in year 1, and capture below the expected capture amount in years 2, 4 and 5 being made up in year 6 and 7.



Capture as a Service

In some situations, a company may arrange to capture the emissions of another, as a service. This mechanism of providing Capture-as-a-Service (CaaS) could provide a number of possible advantages for the CCUS programme:

- Allows decarbonisation of smaller industrial sites who might not want to and/or be able to install CCUS on their own sites;
    - This could apply to sites that are both smaller in terms of absolute emissions or overall revenues, and where geographic constraints limit the addition of new facilities.
    - This approach would allow economies at scale where emissions from multiple industrial sites are routed to a common capture plant, potentially improving value for money for the taxpayer.
- In some cases, CaaS may represent a route to supporting the deployment of CCUS to off-cluster sites or groups of industrial sites away from clusters, where shipping or T&S connection is unviable for single sites.

For these reasons, BEIS is keen to encourage this option as an approach to support the deployment of ICC in the UK and is developing a business model to incentivise it that is based on, and integrated with, the central ICC business model offer.

Principles

To develop a CaaS model while maintaining consistency and fairness with the generic central ICC offering, a set of principles has been established to inform the approach. The CaaS model should:

- maximise consistency with the 'generic' ICC model, where possible;
- provide an appropriate sharing of risks between parties;
- allow protections against cross-default between the emitter and CaaS Company (CaaSCo);
- be acceptable from a government balance-sheet perspective.

Approach

The consideration of these principles has led to the development of the following proposed approach for supporting and incentivising the CaaS model for ICC:

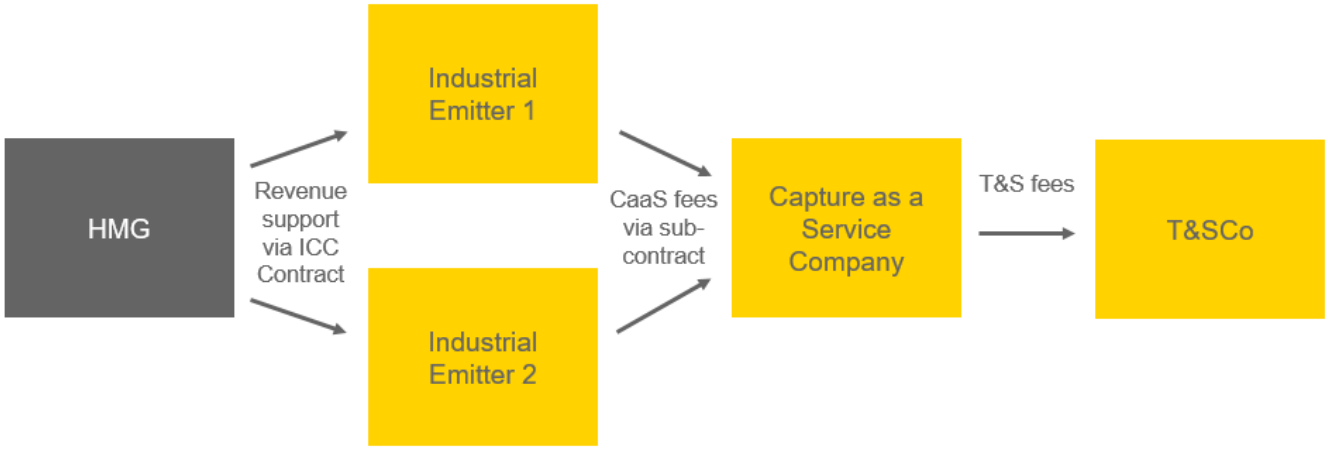
- ICC Contracts will be agreed with emitters, as in the generic model. We are still considering the approach to grants to co-fund capex (for initial projects) under the CaaS model. During negotiations the CaaSCo may act as the agent of the emitters to simplify interactions and ensure consistency;
- Emitters will then arrange subcontracts with the CaaSCo to fulfil the capture obligations, along with relevant information sharing, liabilities and T&S arrangements;
- The ICC Contract that is currently being developed will be adapted to accommodate this option, to create a consistent overall ICC agreement that is fair to all eligible approaches;
- BEIS will publish a subcontract checklist that will detail BEIS' requirements in relation to certain provisions of the CaaS subcontract. In particular, this checklist will set out BEIS' minimum requirements in relation to contract (and, if appropriate, grant) provisions that BEIS expects will be passed down to CaaSCo under the CaaS subcontract.

Further details on the logistics of the ICC offer in a CaaS model will be published in subsequent updates. This deviation from the generic central ICC model presents a number of policy and commercial considerations to be worked through, including:

- Uncertain long-term user base and expansion-scope will require consideration on approach associated with oversizing and relevant financing;
- Additional policy may need developing or adapting to accommodate for the differences in funding and risk distribution that this model poses to the 'generic' ICC model.

This approach outlined is only applicable to early ICC Contracts and the CaaS model is likely to change and evolve as the system and market matures. In the longer term, we will test whether different options are possible to allow for innovation and streamline the commercial architecture.

Figure 8: Schematic to demonstrate revenue flows between various parties involved in the ICC business model where the 'Capture as a Service' model is applied.



Next Steps

A further ICC business model update is planned for this summer, aligned to the Phase-2 process under cluster sequencing. It is expected to include further details on: contract length and the 10 year extension/reopener; the early operational cost reopener; an update on risks including construction risk allocation and cross-chain risks; T&S fees, efficient capture of carbon, payment mechanisms; applicability of the model to CCU relating to permanent abatement; eligibility of EfW and CHP, and further specifics on process capture rates. We also plan to provide an update on the ICC Contract counterparty. The update will be accompanied by a draft detailed Heads of Terms for the ICC Contract, including adaptations for CaaS models.

Following the update in summer, we anticipate further updates later in the year, to align with the cluster sequencing timeline and support delivery of our commitment to deploy CCUS in at least two industrial clusters in the mid-2020s and four by 2030 at the latest. This will include publication of a draft ICC Contract and then final ICC Contract before negotiations with ICC project developers commence.

Glossary

Term	Description
ACP	Annual Capex Payment amount (£)
BECCS	Bioenergy with Carbon Capture and Storage
CaaS	Capture as a Service
CaaSCo	Capture as a Service Company
Capex	Capital Expenditure
CCC	Climate Change Committee
CCS	Carbon Capture and Storage
CCU	Carbon Capture and Usage
CCUS	Carbon Capture, Usage and Storage
CHP	Combined Heat and Power
CHPQA	Combined Heat and Power Quality Assurance
CIF	CCS Infrastructure Fund
CP	Capex Payment rate (£ per tonne)
DACCS	Direct Air Carbon Capture and Storage
EC	Expected annual CO_2 capture amount (tonnes)
EfW	Energy from Waste
EIIs	Energy Intensive Industries

Term	Description
FAs	Free Allowances
FEED	Front End Engineering Design
FID	Final Investment Decision
GGR	Greenhouse Gas Removal
HMG	Her Majesty's Government
ICC	Industrial Carbon Capture
$MtCO_2/yr$	Megatonnes of carbon dioxide per year
Pre-FEED	Preliminary-Front End Engineering Design
RC	Return Component (£)
SIC	Standard Industry Classification
T&S	Transport and Storage
T&SCo	A company licensed to provide transport and storage services
UK ETS	UK Emissions Trading Scheme
UKIB	UK Infrastructure Bank

Annex A

Eligible Sectors and Technologies

This table sets out which sectors and technologies are considered in and out of scope under the ICC business model. Please see the main text for further details.

Sectors		**Technologies**	
In scope	**Out of Scope**	**In scope**	**Out of Scope**
Midstream Oil and Gas (i.e. crude oil and natural gas processing) Downstream Oil and Gas (i.e. refining) Iron and Steel Cement Lime Chemicals Food and Drink Non-metallic Minerals Paper and Pulp Nonferrous Metals EfW*, ** CHP** Other Industry	New build CCUS-enabled hydrogen production facilities Upstream Oil and Gas	Both full-scale and modular applications of CCUS All carbon capture technologies (including pre- and post-combustion, oxyfuel and emerging technologies) Existing industrial facilities retrofitting CCUS New industrial facilities with CCUS CCU resulting in permanent abatement*	CCU resulting in temporary abatement DACCS GGR technologies

** Subject to further work and future updates*

*** Subject to certain conditions (detailed above)*

Annex B

Process Capture Rate: Worked Example

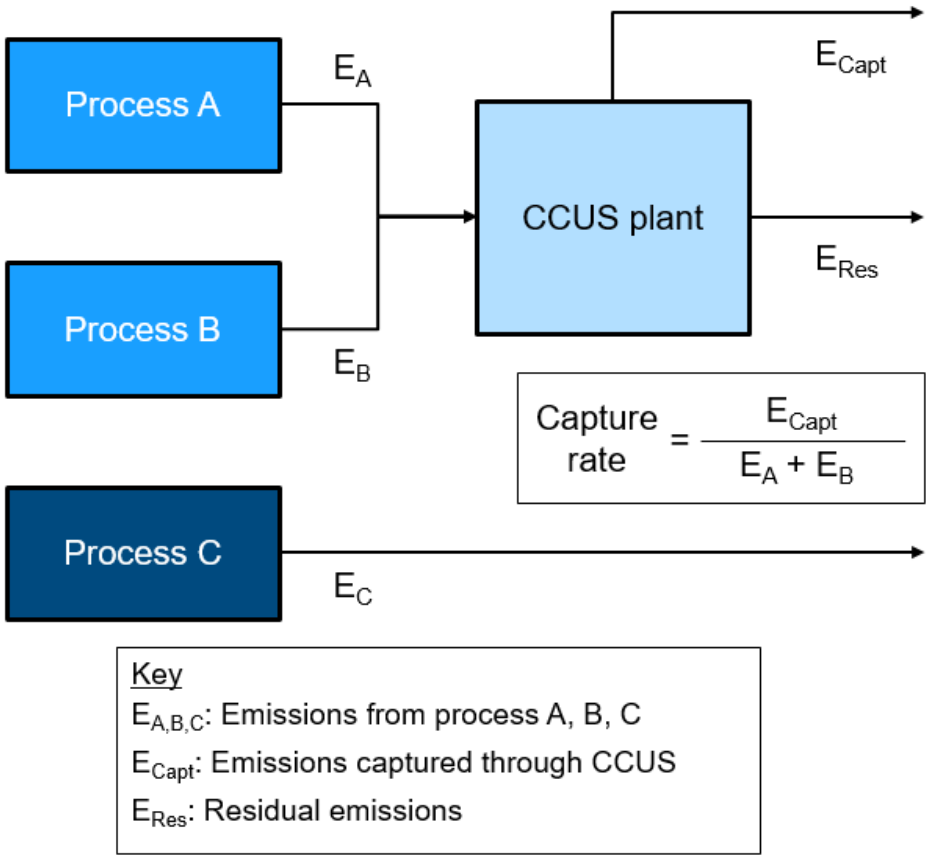
For illustrative purposes, please see below for a worked example on how process capture rate is calculated. This is not representative of the emissions from a real industrial facility.

A notional industrial facility which utilises post combustion capture can be divided into three separate industrial processes (Figure 9).

The facility emits a total of 1 megatonne of CO_2 per year ($MtCO_2$/yr): 0.7$MtCO_2$/yr from process A, 0.2$MtCO_2$/yr from process B and 0.1 $MtCO_2$/yr from process C. Carbon capture is applied to process streams A and B, but not C, and we define the application rate in this example as 90% (i.e. 90% of the CO_2 emissions from the site are routed to the capture plant).

If the facility has a process capture rate of 85%, this refers to 85% of the total emissions from process streams A and B (the sum of E_A and E_B) i.e. 85% of 0.9 $MtCO_2$/yr (0.765 $MtCO_2$/yr). It does not refer to the capture rate of the total CO_2 emissions captured from the facility as a whole (i.e. not 85% of 1$MtCO_2$/yr, equivalent to 0.85 $MtCO_2$/yr).

Figure 9: Schematic demonstrating the basis of calculating process capture rate of an industrial facility.



This publication is available from: www.gov.uk/government/publications/carbon-capture-usage-and-storage-ccus-business-models

If you need a version of this document in a more accessible format, please email enquiries@beis.gov.uk. Please tell us what format you need. It will help us if you say what assistive technology you use.