UK Carbon Capture and Storage Demonstration Competition

UKCCS - KT - S12.0 - FEED - 001

Lessons Learned Report

April 2011

ScottishPower CCS Consortium

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ScottishPower CCS Consortium

ScottishPower Generation Limited
Longannet Power Station
Kincardine on Forth
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Scotland

Consortium Lessons Learned

"A period of around 3-4 months should be set aside prior to project delivery, to create the delivery organisation structure, develop a governance model and resource the organisation."

Project Governance Workstream

"Technical design teams need to be given protected time at the outset of FEED in order to agree the Basis of Design."

Technical Workstream

"Consortium tools and processes must be selected, tested, approved and rolled out at the beginning of the project and used consistently. They should be selected by a cross-Consortium group – or ideally a centralised CMO made up of all Consortium Partners"

CMO Workstream

"Project developers should maintain close communications with Partners critical to the success of the project (like storage Partners). Time should be spent at the start of the project to identify influential stakeholders."

Project Governance Workstream

"Early engagement with CCS regulators is extremely important. Early CCS developers should expect to expend additional effort and resource on liaison with regulators and providing assistance with the modification or creation of regulation."

Consents/ Regulatory Workstream

"You need to truly understand interface points of the CCS chain and think through the impacts of changes/ messages on other parts of the chain."

Technical and Communications Workstream

"Project developers may still have knowledge gaps and uncertainties when seeking internal executive support. Regular engagement between the client's executive representatives and the Consortium's senior executives was helpful in this regard."

Commercial Workstream

"Consortium leaders must trust each other to deliver their industry-specific packages of work, while acknowledging their interdependence, and maintaining the oversight to intervene in support of another Consortium member if required"

Project Governance Workstream

"Project developers will need to find technical resources who can operate outside of their comfort zone on an open-ended project, often within uncertain design parameters."

Technical Workstream

"Procuring CCS demonstrations through a competitive process throttles one of the fundamental objectives of CCS demonstration because information is actively suppressed to maintain competitive advantage."

Commercial Workstream

"Clarity over timelines, processes and payment mechanisms should be provided to the Consortium in as much detail as possible. Once this commitment was provided, it helped Consortium Partners keep internal stakeholders onboard and maintain credibility."

Project Governance Workstream

"Project developers need to be skilled at maintaining and articulating the vision of CCS. Agreed core messages and positive public relations opportunities helped the Consortium achieve senior support."

Project Governance Workstream

"Progressing a demonstration project and a regulatory framework in parallel has created a lot of re-work. Ideally, an enabling set of regulations should be formulated prior to the issue of a demonstration tender, against which CCS developers could pitch designs and subsequent contract discussions."

Commercial / Consents / Regulatory Workstream

Content

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1.   Introduction

Carbon Capture and Storage (CCS) is an innovative and emerging technology. The ScottishPower CCS Consortium FEED study therefore had very few precedents to follow. The result has been a fruitful learning process for both the ScottishPower Consortium and the UK Department of Energy and Climate Change ("the client").

The FEED Close Out Report contains the tangible materials and outputs created during the FEED study; this 'lessons learned' document seeks to support these outputs by drawing out some of the reflective learning taken from the most experienced stakeholders across all functional areas of the FEED study.

When considering lessons learned, the ScottishPower Consortium set out to capture specific, discrete lessons that could better shape future CCS FEED studies in the UK and abroad. However, Consortium members also reported significant benefits by taking the time to reflect on how the Consortium could improve performance for the next stage of the UK CCS Project.

Lessons learned approach

In order to ensure that lessons learned were being gathered from across all functional areas, and in recognition that new challenges and solutions could be identified throughout FEED, data was collected at two points in time before being distilled into the cross-Consortium and workstream specific learnings provided in this report.

First lessons learned data collection

Initial interviews were held halfway through FEED when workstreams were expected to be embedded into ways of working. Each of the key Consortium workstreams were invited to participate in a guided discussion on FEED progress and challenges, which the knowledge transfer team then distilled down into specific and actionable lessons learned.

The key objective of the first workshop was to understand what areas of work had proven to be particularly challenging during the first six months of the project, so these could be reviewed in more detail during the second lessons learned session. The methodology used to guide the discussion is illustrated in Figure 1.

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Figure 1: Lessons Learned workshop 1 approach
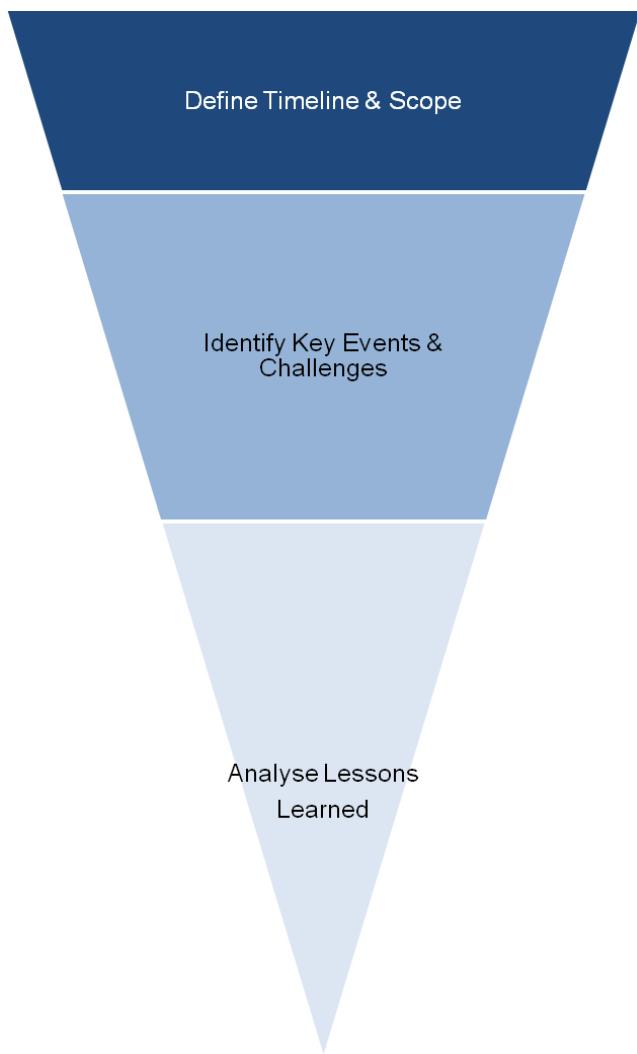
Define Timeframe and Scope
- Re-affirm that the purpose of the interview is to provide relevant and actionable feedback
- Define the in-scope timeframe

Identify Key Events and Challenges
- Identify the key events and challenges which occurred during the timeframe
- Assess the impact of these events and challenges on the workstream and project

Analyse Lessons Learned
- Understand how attendees modified their approach to adapt to the unforeseen challenge by:
  - Taking actions which were not previously taken
  - Terminating action which were previously underway
  - Reconsidering actions which would previously not have been questioned
- Understand what was involved in making the transition from a standard approach or technical discipline to their new method of working
- Understand whether the attendees would amend their approach if presented with a similar challenge in the future

Second lessons learned data collection

The second lessons learned data point was held ten months into FEED, by way of a 'project-wide lessons learned' meeting attended by all workstreams and Consortium Partners.

This session was split into two sections: a Consortium-wide discussion on the general themes emerging from the initial lessons learned session, followed by workstream specific breakout sessions where groups were asked to review and expand on the key workstream learnings which had emerged from the first set of interviews, and take a more in-depth look at some specific areas of challenges/learning so further detail and examples could be provided. This was facilitated by giving the workstreams three specific points of

discussion, followed by a task to develop material illustrating a particular example. Each workstream was asked to focus on the following areas of interest:

- What were the key issues faced by this workstream? Recap and expand on learnings from the first data collection session

- What worked well and what did not work so well? Why?

- Did the workstream have to change their approach to anything? Why?

- What was your experience of FEED practice – any differences from business as usual?

- What skills/ resources/ tools worked well?

- What additional skills/ resources/ tools would have helped?

All information gathered was then collated and the final lessons learned across the Consortium were distilled.

The key themes which emerged from across the Consortium workstreams are presented in section 2 of this report. Each theme is focused on a set of related challenges experienced during the Consortium formation and delivery of FEED, and subsequent lessons learned in overcoming these. Workstream examples are used to illustrate these. Section 3 drills down into workstream-specific learnings on what worked well and what would have been done differently in establishing and managing each workstream if they were to repeat FEED. This workstream content is supported by further detail in the report appendix. Also included in the appendices are two large supporting documents (National Grid Staff Training Presentation and the Consortium Communications Strategy) that the Consortium considered useful for future CCS project developers.

2. Cross-Consortium Key Themes

The interviews revealed strong agreement on the important lessons learned during FEED, with five key themes emerging consistently across workstreams:

- **Mobilisation:** Ensure an appropriate mobilisation period to establish Consortium relationships, processes and systems prior to the start of FEED

- **Early Engagement:** Facilitate early engagement with key decision makers, internal stakeholders, local communities, regulators and potential Partners

- **Communication and Collaboration**: Strong leadership, planning and cross-Consortium communication required to create and present an integrated Consortium

- **Competitive Procurement**: Recognise restrictions imposed by developing a demonstration project within the bounds of a competitive procurement process

- **Adapting to Uncertainty**: Working with uncertainty across regulation, scope, budget, political will and novel technology

This chapter explores each of these themes in more detail.

2.1 Mobilisation

The most common lesson from across the project workstreams was the need to ensure an appropriate mobilisation period at the outset of FEED.

A combination of uncertainty surrounding scope and timescales prior to the award of the FEED contract and a requirement to meet strict competition timelines caused a number of issues when establishing the Consortium FEED project structure. There was a need to rapidly accelerate workstream outputs to stay on track with the project programme. This resulted in the Consortium having to build and operate its delivery organisation concurrently. The project team did achieve this, but only through a concerted effort – one which resulted in significant delivery timescale challenges. It was felt that the eventual successful outcome was not a justification for the approach taken, "In terms of learning for the future, it is not about who we have achieved but how we had to achieve it".

As part of lessons learned, the project recommended the following activities should be completed during FEED mobilisation:

Build cross-Consortium relationships and alignment, ensuring common understanding of and confidence in the project

- Overwhelmingly the feedback was that an initial lead time was needed to improve communication and understanding between the Consortium Partners so they could gain confidence in each other. Partners are participating in the development of CCS in the UK for a range of reasons and it is important to understand their key drivers and objectives for participating in FEED, and why they have chosen to work together. It was felt that an improved understanding of each of the

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Consortium Partners' aims and objectives would have helped improve team working earlier in the project.

- Combining three large organisations from different industries requires time to establish common understanding in areas like nomenclature, risk management, reporting and cost recovery. Spending time to understand Partner positions and pressure points in these areas will help improve Consortium relations and reduce misunderstandings when working under pressure.

Agree and establish the FEED project structure, workstreams and governance across the Consortium

- A shared vision and Consortium operating model should be agreed jointly at the outset, establishing buy-in from each party.

- Sufficient time should be spent on organisational design, developing a governance model and resourcing the organisation. The Consortium Management Office felt that all the Partners having personnel situated together in a central office would have had a significant impact on the organisation of the delivery of the demonstration project, although in reality this would have been difficult to achieve.

- Consideration should be given to the interaction between the preferred Consortium model and what is perceived to be 'business as usual' within each Partner organisation. This would assist with internal stakeholder management - difficulties in adopting a structure which does not easily conform to existing organisation systems should not be underestimated.

- Future FEED projects - and from the ScottishPower Consortium's point of view, future stages of the CCS Demonstration - require more time to set up and stabilise the Consortium's functions, processes and tools. This period should also be used to establish interface points, test the practicalities of the contract and prepare Consortium communication materials such as Consortium logo, graphics and key messages prior to start of FEED delivery.

    Consortium tools and processes should be selected by a cross-Consortium group – or ideally a centralised Project Management Office made up of all Consortium Partners, to ensure they meet project requirements and all parties are happy to use them.

2.2 Early Engagement

There is a need for early engagement with stakeholders in the widest sense of the word – key decision makers, internal stakeholders, local communities, regulators and potential partners.

CCS demonstration projects are novel in concept and execution, and require organisations from different industry sectors, public and private, to align and collaborate when they are not familiar with each others' operations or with CCS. Given the tight competition timelines, early engagement was essential to quickly establish trust and confidence and develop the right working relationships to progress the demonstration.

The Consortium frequently cited early engagement with key stakeholder groups as one of the most beneficial lessons from FEED. Three stakeholder groups in particular presented challenges that could be met through early engagement:

- **Regulators and key decision makers:** given the undeveloped nature of the CCS regulatory environment, the consortium were keen to engage with CCS regulating authorities and statutory and non-statutory stakeholders to help them understand the practical challenges of CCS demonstration and build, collaborative relationships, to help create supportive future regulatory frameworks

- **Senior internal stakeholders:** difficulties in communicating the novel nature of the CCS demonstration project to decision makers resulted in challenges from senior management within the Consortium's parent organisations who were uncomfortable with aspects of the project which were outside their organisation's normal working practices. This was exacerbated by the extension of the FEED procurement process, which required the Consortium to make a substantial investment in a project of uncertain outcome.

- **The wider stakeholder community:** this group were often unfamiliar with CCS and impacts on the local community and the environment, and expressed concerns over this new technology which could have been obstructive to the progress of the project.

Early engagement with regulators and key decision makers brings significant benefits when working in an uncertain regulatory environment.

- Where regulators and key decision making groups were proactive and keen to engage with the Consortium, the results proved extremely positive - improved mutual understanding of the regulatory direction and smooth progression of consents. This increased confidence in the future regulatory framework has a direct impact on FEED design work, costs and solution development.

- Early engagement with regulatory authorities and key decision makers provided useful challenge during FEED, prompting project developers to look to the future and consider potential new regulatory requirements/ engagement activities, for example the Consortium had to consider the requirement for compulsory purchase orders and therefore drove development of new planning regulation to enable this.

> *In order to progress the Consortium storage Partner's environmental applications during FEED, modifications had to be made to existing offshore environmental legislation to take account of the incorporation of CCS in the Energy Act (2008). Following a great deal of engagement with regulators the modifications were agreed half way through FEED (The Energy Act 2008 (Consequential Modifications) (Offshore Environmental Protection) Order 2010. (SI 2010 No. 1513)) - easing the process for the Consortium Storage Partners to progress their environmental applications.*
>
> ***Consents workstream***

Ensure senior management have a clear understanding of the CCS demonstration, what is involved and how risks are being managed.

- It is important to ensure senior internal stakeholders engage with executive government representatives early on in the project to build confidence, demonstrate commitment and ensure

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personal buy-in at a senior level. This will drive early support, secure Consortium Partner alignment and the right level of executive insight for future government negotiation.

- During FEED there remained a high degree of uncertainty around timelines. External factors such as the 2010 Comprehensive Spending Review and successive budgets put the continued development of the CCS competition under question. Having supportive senior management who understood the complexities of the UKCCS Demonstration Competition helped secure the Consortium's continued involvement.

- Project developers should ensure that the expectations of senior internal decision makers are managed and that they are fully aware of aspects of a CCS demonstration project, such as financial requirements, risks, reputational exposure and timescales, which might be unconventional in the context of their core business.

Secure the support of the wider stakeholder community early on to build credibility and public acceptance.

- The Consortium benefited greatly from early engagement and relationship building in the local communities around Longannet Power Station, and with key opinion formers and credible third party advocates such as academic institutes and environmental NGOs. By building support and understanding of the project with these groups prior to any major consultation decisions, the Consortium improved its credibility and gained a better understanding of stakeholder concerns which could be addressed during FEED.

- Early scene-setting communications work on the concept of CCS allowed the Consortium to demonstrate thought-leadership, identify itself as a leader in this emerging technology, maintain the momentum of the competition and garner cross-party political support, greatly enhancing the Consortium's credibility during the later public engagement process. This exercise was useful both in order to increase buy-in to the overall CCS vision and to build key stakeholder relations early in the project life to support future tactical public engagement exercises.

2.3 Communication and Collaboration

Cross-Consortium communication and aligning of processes was challenging. Strong leadership and planning is required to create and present an integrated Consortium.

FEED brought together three large companies, from three separate industries, with three distinct business cultures and motives for working on CCS demonstration and tried to create a unified Consortium for a project with uncertain timescales and no clear revenue stream or value proposition. This created a number of difficulties in terms of cross-Consortium communication and collaboration:

- Creating and agreeing a Consortium identity and communication strategy was a vitally important process that should have been worked through before commencing FEED.

- Aligning systems, processes and programmes of activity and reporting across the Consortium was challenging. The short timeframes for FEED made investing in bespoke systems unrealistic, so Consortium Partners had to invest in novel solutions to adapt existing organisational systems to meet Consortium reporting requirements.

- The complexity of the project with its many interlinking dependencies made it very important to manage interface points, co-ordinate communication and engagement activities across the Consortium and to ensure that someone had responsibility for maintaining the integrity of the End-to-End design solution.

> *"At the outset of FEED each Consortium Partner maintained their separate corporate positions and approaches to communications. The result was an, at times, disjointed communications programme which in turn led to tensions between the communications leads from Partner organisations as they sought to protect their respective corporate reputations rather than take a collective approach in the development of the reputation of the Consortium. A clear structure, strong working relationships and a shared understanding of the responsibility or ownership of communications must be shared between Consortium Partners from the outset of any project work. If functioning properly the communications workstream should be able to create a collegiate public-facing entity in which Partners can adapt their communications approaches to operate on behalf of the Consortium as a whole."*
>
> ***Communications workstream***

Creating and agreeing on a Consortium identity takes time and effort and should be an early FEED activity.

- Although creating the Consortium identity and defining a joint approach to external communication and engagement was an extremely challenging process for the Consortium, the collaborative process of creating the communication strategy, messaging and supporting materials, helped forge the communication workstream, and embed the approved messaging and approach to external communication across other workstreams in the Consortium (useful extracts from the Communication Strategy are included in Appendix 5.6).

- The Consortium worked collaboratively to develop approved communication materials and messaging to allow all Consortium Partners to articulate the story of the full CCS chain, but found that detailed communication about specific parts of the chain was best left to individual Partners with the credibility and expertise in that area.

Consortium processes and procedures need to be tested with Partners' existing organisational systems, or bespoke systems invested in by the Consortium.

- From a collaboration point of view, it was found that although all of the Consortium Partners are large multi or international companies with a high degree of comfort using communications technologies and working across borders and time zones, these tools were not compatible across the Consortium and did not fit easily with the Consortium's reporting and programming systems. This resulted in pressure on resources.

  Communications methods and channels between the client, Consortium Partners and their respective sub-contractors should be optimised by leveraging technology. Achieving reliable communication methods are crucial to the success of one of these complex projects.

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Stakeholder communication and management is time and resource intensive

- The Consortium found that the requirement for Consortium leaders to manage a series of external partners in the storage venture resulted in additional difficulties, as unexpected business decisions made by partner organisations outside of the Consortium can have serious repercussions on the viability of the demonstration project. The lesson learned was that project developers should maintain very close communications and alignment at the highest level with partners who are critical to the success of the project. Time needs to be spent at the outset of the project identifying who these key stakeholders are.

- On a more practical level, the technical team highlighted that the work that is ongoing in academia is not always directly applicable to commercial scale CCS demonstrations as the research findings often fails to take the limitations and practicalities of live CCS demonstration into account. This recognition led to a recommendation for CCS project developers to foster closer links with academic bodies looking at CCS who have a lot of external influence but may not be aware of the issues being faced at the practical design level.

Establishing a true understanding of the interface points on the CCS chain and managing impacts of changes and decisions across multiple Partners is key.

- An initial organisation structure which had the technical teams of each Consortium Partner working in silos resulted in a lack of understanding of the End-to-End solution and an unsustainably high number of interface meetings to correct the situation. The Consortium lacked a technical integrator with the responsibility for delivering the bid, and the authority to make decisions which spanned both the technical and commercial areas of the project, resulting in protracted decision making processes that could not be sustained.

- The Consortium created a single design authority (the Consortium Design Authority - CDA) comprising three senior technical representatives from each of the Consortium Partners, to agree the direction of each of the individual Consortium Partner's technical teams and maintain the integrity of the full CCS chain. This small, but senior decision making group greatly improved communications within the technical workstream, and helped to speed up difficult decisions arising from interface issues in the CCS chain. Future developers should consider a similar group but with an additional commercial representation in the membership to ensure that those crucial interfaces are maintained.

- The consents team similarly learned that strong interfacing and alignment across Consortium Partners from the start of FEED would have helped. They recommend that common timelines are set between Partners at the outset, for example on periods for consultation so that Partners can collaborate on stakeholder engagement at all interface points. Potentially the Consortium should create a Consents Project Board that sets the approach and timelines for consents, ensuring one voice.

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2.4   Competitive Procurement

It has been highly constricting forming the basis of a demonstration project within the bounds of a competitive procurement.

A common message across all workstreams was the challenge of participating in a competitive procurement process for an emerging technology, being developed by a newly established delivery organisation.

Bidding for work and operating as a service provider was not a 'business as usual' activity for some Consortium Partners. Similarly the client was not used to operating in this capacity and was still evolving project criteria and scope during the final stages of contract negotiations. Further challenges arose from confidentiality obligations which at times restricted efficient dialogue and information exchange between the Consortium and client.

> *"The competitive process needs to take account of the fact that competitors may be at different stages of development and that "fair and equal treatment" of bidders should be broadly interpreted to allow the procuring authority some discretion over varying levels of interaction with bidders."*
>
> ***Project Governance workstream***

Future demonstrations would benefit from being treated more like research and development projects until a number of full-scale, commercial demonstrations are in operation. However, to support future CCS demonstrations that follow a similar competitive procurement process, the ScottishPower Consortium has highlighted several key learning points:

Both parties should clearly articulate project requirements upfront and minimise the complex and administrative nature of the contracting process.

- The client must provide a clear and detailed set of requirements at the start of the process, defining what it is looking to purchase.

- CCS project developers should expect to take the lead in terms of driving the timescales and scope requirements of future demonstration projects as they are developing the technical solution and have a better understanding of the issues – this is a difficult degree of flexibility to achieve under competitive procurement.

- Prior to the beginning of the FEED delivery programme, project developers should define and mobilise the mechanisms, processes and organisation to operate as a successful contractor and the client should understand and communicate the criteria for successful completion of the project prior to the beginning of the delivery phase.

- During the negotiation stage the Consortium found that identifying and agreeing key principles upfront, rather than attempting to decide upon the minutiae of the FEED contract agreements, was helpful in reducing legal input and the administrative burden. They identified 13 major areas for negotiation with papers created to explain each aspect of the issue, the Consortium commercial

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leads then met the client to discuss and agree a path through the big issues. This has proven to be a productive approach.

- It is important that the Consortium negotiating team should include representatives from across all workstreams, as well as commercial roles, in order to advise on feasibility and identify any potential delivery risks before the terms of the contract are agreed.

Ensure the contractual process and timescales can be flexed to incorporate new learnings as FEED progresses.

- Novel technology developments impacted other workstreams on the project, for example, delays in the licensing process due to dependencies on the output of development work being done by FEED technical workstreams. This led to an unrealistic compression of the time available to progress the licenses prior to the end of the project.

Restrictions on communication and sharing of information made collaboration difficult.

- The Consortium found that the competitive procurement process constrained the client / Consortium dialogue to the extent that it was very difficult to understand what the client's requirements were. These restrictions extended to communication between regulators, developers and the client, during FEED. If future CCS projects are being commissioned using a competitive procurement process, efforts must be focussed on developing clear lines of confidential communication with regulators, the client and key decision makers.

- The competition rules equally inhibited the Consortium from disseminating information externally, resulting in the knowledge transfer workstream having to build knowledge sharing networks without being able to share information, limiting the extent to which the Consortium could be seen as a partner for knowledge sharing. A greater degree of independence for knowledge sharing activities would allow a more effective dissemination of the valuable learnings from the demonstration.

2.5   Adapting to Uncertainty

Working with uncertainty is part of implementing new technology, but this is a high profile, large investment project that requires significant executive buy-in from three traditionally risk-averse industries. Regulatory, scope, budget and political uncertainties all proved challenging during FEED.

The novel nature of CCS resulted in both political uncertainty and uncertainty surrounding the process by which a contract would be awarded. The continuing doubt around the base parameters of the project, such as the commitment and budget of the client, payment mechanisms, timelines, processes and the basis of design, has been disruptive for the FEED delivery team.

As discussed in section 2.2, internal stakeholder management was a challenge, with the requirement for Consortium Partners to estimate budgets and schedules based on previous experience in their respective areas of competence, not making allowances for the additional complexity and rework involved in the necessary interfaces between Partners and the novelty of other elements unique to CCS.

In turn, the lack of a regulatory framework for CCS demonstration projects has resulted in an attempt to progress both the demonstration project and the regulatory framework which governs it in parallel, with the associated uncertainty leading to delays and a high degree of rework.

Methods for adapting to uncertainty have evolved within the Consortium and some examples are provided below.

The uncertain nature of the competitive procurement process and structure of the demonstration needs to be minimised through early decisions and clear communication by both parties.

- Clarity over procurement base parameters such as timelines, scope, processes and payment mechanisms for a demonstration contract should be fixed as early as possible in the demonstration project to minimise disruption to the project team and to help improve morale. Once this commitment was provided to the Consortium, it proved to be a significant help to the Consortium Partners in keeping their internal executive stakeholders onboard and maintaining credibility.

- By articulating, quantifying and regularly communicating on the progress of mitigation measures for controllable risks, the Consortium's leadership was able to demonstrate progress in risk reduction to internal executive stakeholders, and maintain corporate support for continued participation in the procurement.

Dealing with regulatory uncertainty required additional resource and effort.

- As regulators were uncertain of the information they needed at the start of FEED, the technical workstream had to commit significant amounts of time and resources relatively late in the course of the project to satisfy regulators of the safety of the design.

- An enabling set of regulations should be formulated prior to the issue of a demonstration tender, against which CCS developers could pitch designs and any subsequent contract discussions.

- The developing legal and regulatory framework for the storage of CO_2 has resulted in uncertainty about the amount of work required to understand, quantify and mitigate the risks associated with storage. Until this framework has been more fully developed, CCS developers should expect to expend considerable time and effort on this issue.

- Assuming other CCS demonstration projects will take place within a relatively uncertain regulatory framework, extra time and resource should be factored into FEED projects to engage with a variety of regulatory bodies and key decision makers and help the development of new regulation.

  The time required to suitably inform regulators was exacerbated by the high turnover of the regulatory personnel assigned to this area, which led to challenges in engaging, educating and gaining useful input from regulators in the timescales demanded for in FEED. It is recommended that regulators should maintain a dedicated team who can go through a learning process and develop their thinking alongside the project developers.

The lack of a business case for CCS at this early stage is challenging and requires a great deal of internal stakeholder management to build support.

- CCS is a complex concept that is not a natural fit with Consortium Partners' normal businesses; therefore project developers need to be skilled at maintaining and articulating the vision of CCS to achieve senior stakeholder support. Agreed core messages and positive public relations opportunities helped the Consortium achieve this support during the FEED study.

- Clear and unequivocal client commitment to the procurement is essential to secure and maintain senior management support for the project in each Consortium Partner organisation. The Consortium found that the initial doubts over the client's commitment to the continuation of the demonstration project led to doubts over their credibility as a buyer which could have resulted in Consortium Partners withdrawing from the procurement. The client should be meticulous in ensuring that they deliver on their commitments and should refrain from sending signals of delay or changes in policy direction in order to maintain confidence in their commitment to a demonstration project.

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3. Workstream-Specific Findings

This chapter focuses on lessons learned that are applicable to each of the workstreams on the project. Further information and lessons learned material for each workstream is available in the report appendices.

3.1 Project Governance

The Project Governance workstream is the senior decision-making authority on the project. It is responsible for the overall management of the Consortium, including strategy formulation, budget and resource allocation and has overall accountability for meeting project milestones as well as delivering on contractual obligations. This workstream also ensures alignment across the different Partners and presents the Consortium position in contractual negotiations.

Key lessons learned from this workstream:

- **A lead entity is required with overall responsibility for negotiation and delivery.**

  The Consortium leaders found the governance structure, which positioned ScottishPower as the lead organisation and National Grid and Shell as the principal sub-contractors, useful in providing speed, accountability and clarity to the client.

- **The Consortium must start by creating its own vision and mission to drive leadership alignment.**

  The Consortium Partners should take time upfront to understand each others' interests and clearly define their responsibilities. Establishing why Partners are in the programme and why the Consortium have chosen to work together will help improve team motivation and morale early in the project.

- **Organisational design, communication and resourcing for FEED was challenging, it required longer mobilisation time and a better understanding of Partner motivations and pressures.**

  The novel and complex nature of CCS projects means there is no pre-existing standard for how they are organised and that they are highly resource-intensive, requiring a solid core of people who understand the history of the project and Consortium relations.

- **Design the Consortium Operating Model jointly at the outset, establish common understanding and buy-in from each party.**

  The structure of the UK CCS Demonstration Competition changed significantly between the Outline Solution and FEED phases. This required the organisational design to be adapted. Consortia should ensure they frequently review whether the rules of the game have changed and whether their organisations are still structured appropriately to deliver to those rules.

- **From experience delivering FEED, the project governance workstream strongly advocate a clear division of work between Consortium Partners, playing to each Partner's expertise and experience.**

Consortium leaders must trust each other to deliver their industry-specific packages of work, while acknowledging their inter-dependence and maintaining the oversight to intervene in support of another Consortium member if required. This separate approach to packages of work does require tightly managed interfacing, with cross-Consortium senior management support and oversight of areas of joint work like communication. Appointing an experienced FEED Integration Manager with a clear and accepted mandate to enforce delivery requirements and maintain the integrity of the End-to-End CCS solution by managing the impacts of any design or commercial changes is essential.

- **Establish a central Consortium Management Office with representation from each Consortium Partner.**

  This central CMO should be empowered to agree common processes, plans and tools, and have performance metrics linked to Consortium goals not individual company goals.

- **Include a dedicated communications arm within the CMO team to develop core messaging, communications materials and facilitate fast information distribution throughout the consortium. as internal and external events either dictate or require.**

  Ensuring fast and comprehensive internal communication across the Consortium workstreams and Partner organisations was an ongoing challenge throughout FEED. Establishing focal points for information dissemination would help ease this process, as would establishing integration roles between key workstreams such as technical, commercial and consents to keep workstreams informed of developments.

Further supporting content on each of these areas, with specific examples, is provided in Appendix 5.1

3.2 Commercial

The remit for this workstream was to develop the Consortium's contractual positions, commercial approach and corporate structure for the future project bid, which will be submitted during the next stage of the CCS competition. A number of these activities, including structural development and financial modelling, have been undertaken as deliverables for FEED. In addition, the workstream co-ordinates the internal governance processes of the individual Consortium Partners, which have to be satisfied before a bid or binding commitment can be made.

This workstream was at the forefront of the rapidly changing scope, budget and timeframes of the UKCCS Demonstration Competition, highlighting a number of contracting challenges which could be better managed on future projects if recognised at an early stage.

Key lessons learned for commercial activities during FEED were:

- **Understand what the client wants to buy and ensure there is a shared understanding of scope and priorities.**

  Understand at the outset if the client simply wishes to purchase a product, co-invest, or views this as an R&D focused programme. The contract should define a fixed scope with the flexibility to include new learnings during FEED. It is also important to understand who the key decision

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makers are regarding project priorities. Large, publicly funded, projects will likely have multiple interested stakeholders beyond the client's procurement team.

- **Appreciate difficulties inherent in forming a Consortium of organisations from different industries with different objectives for FEED.**

  Project developers should expect to engage in a negotiation process by which they identify common interests and barriers to engagement and then examine where those barriers can be flexed when formulating a Consortium.

- **Focusing on critical "Show Stoppers" from the outset in client discussions helps drive negotiations forward.**

  Potential show stoppers identified by the Consortium included chain integration, regulatory risk, project specification, IP issues, the impact of FEED contracting delays, and constraints due to the competitive nature of the UKCCS Demonstration Competition procurement process.

- **Get the balance right between knowledge transfer and IP.**

  Ensure both the Consortium Partners and the client have clear requirements and a mutual understanding of each others' position on the sharing of sensitive information at the start of negotiations, and approach the question of information transfer with a flexible mindset. The Consortium found delivering all useful knowledge up front challenging – having a contractual mechanism to both suggest and protect knowledge as it develops helped build trust between the Consortium and the client and ensure useful knowledge was shared from the FEED project.

- **Close integration with the Technical workstream is required during the FEED stage of these novel processes.**

  It is essential that the commercial team (and the client) has sufficient understanding of the CCS technical process being developed during FEED in order to negotiate the right type of commercial contract to fit the requirements for both FEED and the project contract.

Further supporting content on each of these areas, with specific examples, is provided in Appendix 5.2.

3.3   Consortium Management Organisation

The CMO has several primary responsibilities, including timely submission of a monthly report to the client and dissemination of feedback, development and implementation of the CMO handbook and associated processes (risk and issues, change control) and procedures, and ensuring project management activities across the Consortium are adequately supported. It is also focused on "The Way Forward" – engaging the Consortium to help identify process improvement, common tools etc.

Key lessons learned have been reflected in section 2 and are therefore only summarised below:

- **Cross-Consortium collaboration and senior management buy-in is essential.**

- **A mobilisation period is required to define the organisational structure and embed systems, procedures and roles prior to starting delivery of FEED, to ensure a common understanding and buy-in to the new ways of working.**

- **A single, co-located CMO function, comprised of representatives from all Consortium organisations would solve a large number of communications, management and cross-functional working issues.**

- **Collective Consortium buy-in to the management and content of the risk register.**

- **Individual programmes for each section of the CCS chain are the best way of managing the project, but this requires a comprehensive and cross-Consortium created milestone interface programme.**

- **Project management and control systems have to work with existing organisational systems; for FEED a full managed control system is not essential.**

- **It is recommended that formal requirements gathering, gap analysis and vendor selection for Consortium-wide systems must be undertaken before the start of delivery work. The Consortium found that a simple document control system has the basic capabilities for FEED delivery, with email used for project communication.**

Further supporting content on each of these areas, with specific examples, is provided in Appendix 5.3.

3.4   Technical

During FEED, the Technical Workstream's responsibility is to develop an overall CCS Chain technical design which is feasible, fully costed and which can be taken forward as the preferred solution for the main project, ensuring that interface and chain issues between the Consortium Partners during FEED are identified and resolved.

The lessons learned during FEED which affect technical design are captured within section 4 of the FEED Close Out Report. This section of the report is focused on lessons related to managing the technical workstream in a way which will get the most out of a cross-Consortium FEED study.

Key lessons learned were:

- **Technical work packages should first focus on agreeing integration points and the End-to-End solution, then be managed through the integration points, with Partners responsible for chain specific areas.**

  Delays in the creation of the FEED Basis of Design document and an early focus on chain specific elements of design work caused issues when trying to integrate the full End-to-End solution.

  To ensure that a Consortium-wide approach was taken to any design or operating decisions, a small Consortium Design Authority was created as discussed in section 2.3.

- **Technical input/expertise will be required on nearly all elements of the FEED project outing additional strain on the technical workstream.**

  The technical design elements of the CCS solution are the crux of the work carried out during FEED. This puts additional pressure on technical resources, as other workstreams are heavily reliant on technical resources to provide input to or validate their areas of work.

- **Re-use existing assets and infrastructure where possible, but be aware that this can place material and design constrictions on a CCS solution.**

  The re-use of existing infrastructure (power station, natural gas (methane) pipeline, offshore pipeline, gas reservoir) is likely to be key to demonstrating that CCS is a viable abatement technology. There are many benefits in terms of capital cost reduction and reducing construction disruption but it does restrict design solutions (see appendix 5.4).

- **Understand importance of human experience and knowledge.**

  Future developers will need to resource technical people who can operate outside their comfort zone on an open-ended project often with uncertain design parameters. The novel nature of the project means it is not easy to replace technical resources and retention of knowledge is vital.

- **Early CCS project developers can gain from the experience of other CCS projects – staff sharing was an extremely beneficial knowledge sharing activity.**

  The technical workstream benefited from learnings from Aker's Mongstad project regarding improvements to capture process, construction techniques for the Carbon Capture Plant absorber tower and modular building techniques. Similar staff transferring of learning is anticipated within Shell's multiple CCS demonstrations.

Further supporting content on each of these areas, with specific examples, is provided in Appendix 5.4.

3.5   Consents, Licensing and Regulation

Consents, licensing and regulation spans a number of areas of work largely co-ordinated by the consents workstream. One area of focus for this FEED workstream is the progressing of all consents, licences and permits required to construct and operate the full chain of CCS. This involves preparation of all applications (including the environmental assessments), as well as significant engagement and consultation with key stakeholders including consenting and regulatory authorities, other statutory and non-statutory stakeholders and local communities. The second aspect of its work is to develop a full understanding of the political and regulatory environment for CCS to support the CCS FEED and bid activities, where possible, co-ordinating engagement activities and Consortium Partner positions on key policy areas to ensure the development of a regulatory landscape supportive of deployment of CCS at commercial scale, with cognisance of the current demonstration stage of the technology.

Key lessons learned were:

- **Although consent applications will be made separately for different elements of the CCS chain, a great deal of co-ordination and collaboration is required across the Consortium to align approaches and messages.**

  Multiple consents are required along the CCS chain to enable demonstration. Joint consent applications are not practical, but consortia should endeavour to co-ordinate their applications.

  Additional effort should be expended early on in FEED to align the Consortium consenting processes to raise awareness of the different timescales and priorities for Partners during FEED and agree where common approaches and formatting is required.

Wherever possible, separate consent applications should be set in the context of the overall CCS project - the ScottishPower Consortium used common application formats, agreed project descriptions, diagrams and colour coding, to help create a consistent approach to consent applications.

- **Ensure cross-Consortium alignment of engagement activities, timescales and messages.**

Although Consortium consents teams progress individual consents applications, they share many of the same regulators and key decision making groups. Therefore a joint approach to stakeholder engagement from the outset, including aligning timing for consultation periods ahead of time, is beneficial for both the stakeholders and the Consortium consents teams.

- **Early engagement and collaboration with regulators/ key decision makers is very beneficial.**

The CCS consenting/regulatory framework is in its infancy, and so regulators and key decision making bodies tend to have a low level of understanding of the technology. Early engagement and collaboration with these groups improves understanding and helps create a more informed, practical regulatory framework.

- **Close collaboration with the communications workstream is necessary to present a consistent message to stakeholders and regulators.**

It is extremely valuable to have an understanding of each Consortium Partner's specific messaging and areas of sensitivity, but also to jointly create and consistently use shared messaging, graphics and project descriptions for individual consent applications and stakeholder engagement activities.

- **Maintain a cautious approach to uncertainties in the regulatory environment.**

It is very challenging to run competitive procurement projects for novel processes and technologies in parallel with developing the regulatory systems for those technologies to operate.

As CCS is a relatively new undertaking, and the demonstrative nature of the project meant a high degree of public interest in the project's outcomes the Consortium demonstrated their consistently took a cautious approach to compliance with safety and environmental regulations.

- **Flexibility on FEED competition deadlines should be considered for consents applications.**

The FEED competition rules did not take account of the timescales required to collect the necessary input data for consents, which was often dependent on the work of the technical workstream happening in parallel. It is recommended a more flexible and realistic timeframe for achieving consents is adopted for any future project developers, where companies can push out deadlines if the necessary data is not yet available.

Further supporting content on each of these areas, with specific examples, is provided in Appendix 5.5.

3.6 Communications

The remit of this workstream is to support the communications aspects of FEED and bid processes for the UKCCS Demonstration Competition. This includes managing both statutory and non-statutory stakeholder relations, media management, strategic communications planning, events management and providing input and oversight on the public affairs strategy. The workstream also has responsibility for generating all written, printed and graphic materials in support of the bid, and ensuring consistency and clarity of messaging across the Consortium Partners' communications programmes.

Key lessons learned were:

- **Ensure early engagement and collaboration across the Consortium Partners.**

  The cross-disciplinary and cross-Consortium nature of communications within a CCS Consortium requires the communication workstream to formulate a joined-up approach very early in the project's life. The team will greatly benefit from spending time with each Consortium Partner's wider work team to understand thoroughly the complete story of CCS and meet the experts that they will be using as advocates.

- **The communications workstream should consist of a small group of senior people with a mandate to react quickly and with access to senior executives.**

  The Consortium communications team found that a small number of relatively senior resources from each Consortium Partner formed an appropriate organisation structure to perform the tasks set during FEED. These resources should be able to react independently and with authority to unplanned events and dynamic situations. As with most communications functions in large organisations, the communications functions should have senior management level access whenever appropriate.

- **Approve Consortium core messaging and joint communication resources upfront.**

  It is worthwhile creating joint Consortium communication resources at the start of FEED, ideally during a mobilisation period, as debating and agreeing on these materials and messages upfront will help to forge strong relationships and understanding across the Consortium communications team.

  Agreed Consortium core messages should be harmonised across the Consortium Partners; suggested key messages include:

  - *The primary and secondary rationales for CCS*
  - *The nature of the project*
  - *The need for and reasons behind the project*
  - *The progress of the project in the context of the UKCCS Demonstration Competition*
  - *The breakdown of responsibilities between Consortium members*

- **Maintain a strong understanding of each part of the CCS chain's "story".**

  The cross-industry value-chain of CCS results in a complex communications story in which no single organisation can maintain an expert level of knowledge. High level understanding and key

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Consortium messages should be maintained across the team, whilst detailed enquiries should be referred to the communications resource specialising in that element of the value-chain.

- **Build a strong communication plan that defines the general approach to external communication for the Consortium.**

Project developers should structure their communications plan with the expectation that effort will have to be expended on improving public perception of CCS and the demonstration project and on maintaining sponsor interest in and support for a CCS demonstration project. In addition a significant amount of internal communications activities should be expected which may inform or otherwise impact focus on external communications.

CCS as a concept should not be over sold by project developers, maintaining an awareness of external perspectives of the relevance of project milestones can be a useful tool to achieve this.

It is also advised that in the early stages of demonstration, projects maintain a relatively low public profile while a lot of the research and design work is still ongoing, and focus on political engagement instead. The developmental nature of the CCS demonstration FEED has resulted in a very limited amount of reliable information being publicly available, leading to concern that putting information into the public domain for the sake of stories and headlines could be counter-productive and provoke poorly-informed comment which the project team would not be able to correct.

- **Third party advocates are an excellent communication resource and should be cultivated whenever possible.**

It is important to focus some communication effort on educating and promoting third party advocacy. The Consortium found the following groups of stakeholders to be valuable third party advocates: politicians at local, regional, national and European levels, key opinion formers from media and other influencers/advocates such as Trade Unions, ENGOs and local advocates and decision makers such as community council representatives and local member organisations.

- **Communication at public meetings should be tailored to address the concerns and interests of that specific audience.**

At public meetings, a balance should be struck between increasing public understanding of and support for the concept of CCS, and making sure that the emphasis remains on the element of the CCS chain that is going to impact the attendees of the meeting. Project developers should avoid the risk of 'over-heating' local engagement by placing too much emphasis on the innovative nature of the project.

Consortium experience was that the message about the need for CCS to mitigate climate change was not particularly influential on local stakeholders, they were more interested in the local economic opportunities and the technical advantages that CCS might bring at both a local and national level.

Further supporting content including detailed extracts from the ScottishPower Consortium communications plan are provided in Appendix 5.6.

4.   The Value of Lessons Learned

The process of reflecting, capturing and acting on lessons learned has brought tangible benefits to the delivery of the FEED programme and will be built into the next phase of the CCS demonstration. During FEED, the process was split into two distinct phases:

1. The identification of lessons learned key themes was carried out six months into the FEED programme, aided by facilitated discussions in individual workstream meetings.

2. The detailed review of key themes and further expansion on workstream learnings with specific examples took place towards the end of FEED by way of a full cross-Consortium workshop.

This phased approach worked effectively during FEED, bringing a range of benefits:

- **Improved FEED delivery:** The identification of lessons learned gave the opportunity for each workstream to reflect on their ways of working and openly discuss options for improvement. This process identified a number of improvements that were implemented during the remaining six months of FEED and made a tangible improvement to the FEED delivery effectiveness. A good example was the technical lessons learned discussion that led to the restructuring of the technical workstream to focus management activity on the integration points and maintaining the integrity of the End-to-End CCS solution.

- **Improved workstream integration:** The independently facilitated workstream lessons learned discussions provided opportunity for each Consortium Partner to constructively put forward their frustrations and concerns with the current working practices. This allowed open discussion and the opportunity to address the issues with full involvement by all organisations, with improved collaboration within each workstream.

- **Cross-consortium update:** The nature of the CCS demonstration FEED programme led to a Consortium of three organisations; geographically split with minimal opportunity to come together as a full delivery team to share the overall FEED status. The lessons learned workshop provided an ideal opportunity for the FEED management team to give an update on the programme progress and promote one common message across the Consortium and Sub-contractor organisations.

A final lesson learned to take forward into the next phase of CCS demonstration is the segregation of externally shared lessons learned and internal lessons learned. Based on FEED experience, it is proposed that activities to capture externally shared lessons learned should be conducted on a twice-annual basis to ensure sufficient time for reflection and improvement.

Internal Consortium review periods should be conducted more frequently (perhaps on a quarterly basis) in order to ensure alignment and address any underlying performance issues. This is particularly relevant with a geographically dispersed team.

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5. Appendix: Supporting Materials

5.1 Project Governance Supporting Material

Further detail on learnings provided by the project governance workstream:

Establish an organisational governance which reflects the complex and commercial nature of a Consortium CCS demonstration project.

The Consortium leaders found the governance structure, which positioned ScottishPower as the lead organisation and National Grid and Shell as the principal sub-contractors in order to provide speed, accountability and clarity to the client, useful for the purposes of the FEED project. A model by which a lead organisation contracts with the FEED project's client and then subcontracts with other companies to bring in expertise could work for other CCS developers.

At the Consortium lessons learned session in December, the project governance workstream were asked to describe the governance structure established to manage FEED and suggest areas of learning and improvement for future FEED studies:

Organisational Level	Current Objectives	Areas of improvement for future FEED Programmes
Level 1: **Consortium Board (CB)**	Meets on a quarterly basis and is composed of the Shell, National Grid and Scottish Power leads and their managers, as well as special invites depending on content. This senior board is made up of people who have appropriate level of decision making authority so resolution can be reached in that meeting and not have to be escalated further. • Report progress on FEED and Bid • Key decisions require joint sign-offs which must be unanimous.	• Ensure the Board faces off to senior government stakeholders early on in the process to demonstrate commitment and ensure personal buy-in. • CB objectives should focus on key decision making and escalated issues rather than simple one-way status updates. • This will drive early buy-in, fast Consortium party alignment and right level of executive insight for future government interaction.
Level 2: **Consortium Management Committee (CMC)**	Meets monthly and is composed of the Shell, National Grid and Scottish Power leads plus the technical, commercial, knowledge transfer and communications workstream leads. • Report FEED delivery status per Partner • Identify and deal with cross-Consortium risks and issues • Agree DECC monthly report content and prepare the next stage of Bid negotiating principles	• The CMC membership and objectives are appropriate as the forum allows for strong visibility of touch-points across the Consortium. • FEED has relied on goodwill and corporate commitment to deliver the end result; this will not work for project delivery. A collective body (the 'Lead Entity') should be established, with a cross-Consortium mandate to oversee progress and the authority to take the appropriate corrective actions (if necessary).

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- Ensure the overall governance is defined upfront with formal documents jointly drafted, approved and communicated at the outset – namely terms of reference for each level, roles and responsibilities and key outcomes anticipated. For example, decisions today take too long to reach consensus – need to define the right code of conduct and protocols to improve turnaround time.

- Both internal and external stakeholder messaging is a significant component of keeping FEED on track. Too much time has been spent by each of the Consortium Partners individually creating communication for project teams, often misaligned between Partners. Timely coordinated feedback post key decision meetings (for example with DECC) in the shape of a core brief from a central source could save time and improve overall alignment, leading to higher credibility and confidence across the Consortium Partners.

Level 3: **Consortium Management Office (CMO)**	This is a team subcontracted to ScottishPower responsible for the progress reporting standards, Project Management Office tools and methodologies and preparation of the Consortium-wide DECC reports.	• The CMO, reporting through to ScottishPower, is not recognised in the manner that is required to really drive CMO delivery success. The construct is key but it has to be viewed as independent and objective by all Consortium Partners, and given the mandate to manage. Options for improving this in the future include a team with members from each Consortium Partner organisation, measured through performance metrics tied to Consortium success not individual parent company success; or hiring in an independent CMO capability that is accountable to the overarching Consortium legal entity. • Today the CMO is very task focused, driven by client deliverables and reporting rather than the real objective of delivery of CCS proof of concept. A dedicated communications resource is

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required to ensure expectations are better managed and proactively create appropriate updates to keep everyone in the Consortium up to date on decision making direction and ensure a single source of truth.

• There is a lack of interface resources between the CMO and the Consortium Partner organisations. The administrative burden of this type of Government funded project was underestimated.

Given the experience of the Consortium during FEED, the organisational governance design in Figure 2 is suggested as a strong starting point for future CCS FEED projects.

Figure 2: Proposed organisational governance design for a CCS FEED demonstration project. - It is important that Terms of Reference and Job Descriptions be defined for all parts of this structure.
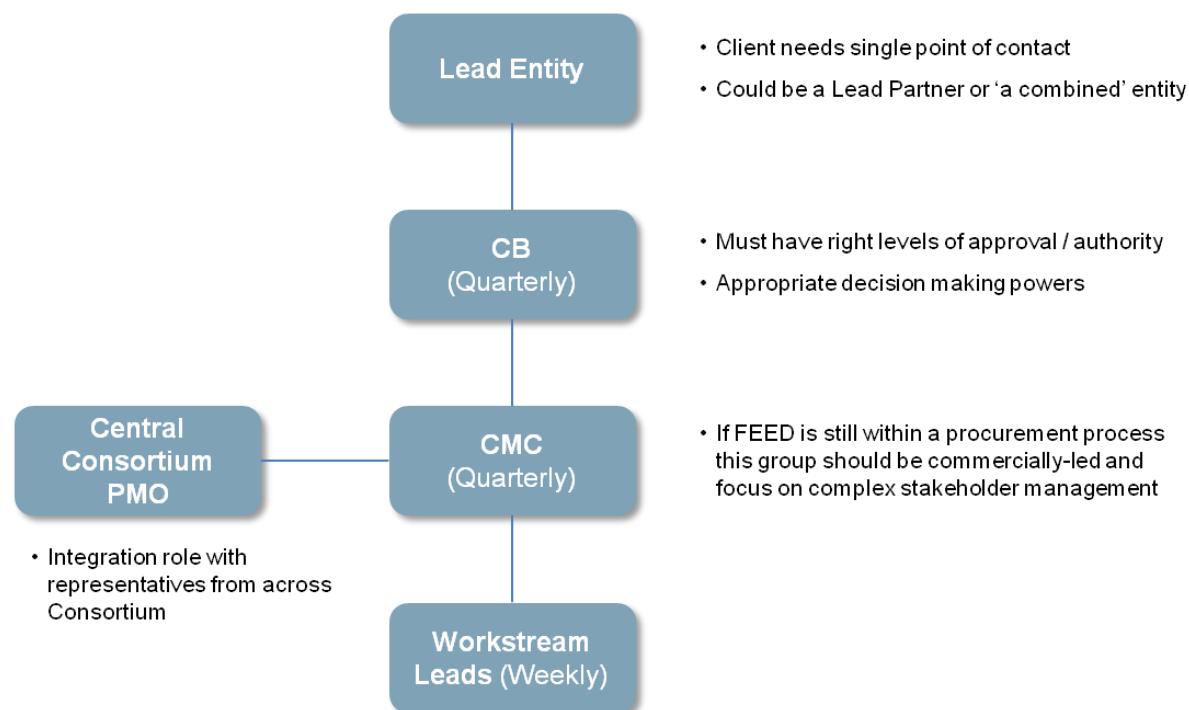
The Project Governance workstream provided the following additional learnings:

Ensure senior management is given a clear view of financial commitments and timetables required at the outset of the project.

Consortium leaders found that difficulties in communicating the novel nature of the CCS demonstration project to decision makers resulted in challenges from senior management within their parent organisations who were uncomfortable with the aspects of the project which were outside their organisation's normal working practices. This was exacerbated by the extension of the procurement process to include FEED, which required that the Consortium make a substantial investment in a project of uncertain outcome.

Project developers should ensure that the expectations of senior internal decision makers are managed and that they are made fully aware of aspects of a CCS demonstration project, such as financial requirements, risks, reputational exposure and timescales, which might be unconventional in the context of their core business.

Recognise the specialist skills and resources required for CCS.

The limited pool of appropriately skilled key resources across the Consortium has resulted in their simultaneous deployment on multiple FEED workstreams, in addition to related activities (such as contract negotiations), leading to a sub-optimal situation where individuals were sometimes working 12-14 hour days and weekends. Consortium leaders also found the uncertainty and complexity of the CCS demonstration project to be a challenge when trying to maintain the motivation of their staff. Both of these factors led to high staff turnover and loss of critical resources and skills.

- CCS projects, being complex and resource-intensive, require a solid core of people who understand the history of the project and cross-consortium relations. An appropriately sized and skilled team should be budgeted for from early on in the project to successfully and smoothly deliver the demonstration. One example was the level of demand placed on key technical subject matter experts, as there was found to be a great need for technical knowledge across the commercial and consents workstreams to reach appropriate decisions. This could be partially resolved by creating technical interface roles that sit in on technical meetings and decision making and interface as required with other workstreams.

- Decision makers should put the right project leaders in place with the stamina and patience to be self-motivated and appreciate the importance of encouraging and motivating staff to reduce churn.

- There should also be an effective mechanism for bringing new staff up the learning curve quickly to increase productivity. Consistent internal communications, well-documented organisation charts and a formal induction programme can help this effort.

Focus on delivering the End-to-End CCS scope.

Consortium leaders found initial challenges in programming and prioritising workloads. There was a tendency to take a 'business as usual' approach, focusing effort on the elements of the scope of work which each individual company could control rather than focusing on early identification of key interfaces, End-to-End issues or work packages. Lack of familiarity with the methods and professional cultures of

Consortium Partners also resulted in concerns over the ability of other consortium members to deliver their areas of responsibility and led to tensions between consortium leaders.

- Consortium leaders must trust each other to deliver their industry-specific packages of work, while acknowledging their interdependence and maintaining the oversight to intervene in support of another Consortium member if required.

- The priority areas to focus on early in a CCS FEED project are the integration points along the chain and those areas which span the entire CCS chain. These areas are most likely to be the areas which throw up contentious issues, they are also the key areas of interest and value in terms of CCS learning as they move companies out of their business as usual mode.

- Establishing a small cross-consortium group of senior representatives mandated to make decisions on the design of the End-to-End CCS chain, would help improve the efficiency of the FEED project as a whole.

5.2 Commercial Supporting Material

Further detail on learnings provided by the commercial workstream:

At the December lessons learned workshop the commercial workstream were asked to identify areas of challenge and potential delay during FEED and provide learning for future projects:

Developing an early understanding of your client	• *Public sector* - Typically Power Generation companies and Oil companies have relatively little experience in working with the public sector and need to recognise the differences between that and working with the private sector.
	• *Procurement process* – The client's experience with such processes should be analysed to ascertain the correct approach in whether the Consortium is dealing with a "knowledgeable" client. For example, in the ScottishPower Consortium FEED the client (DECC) purchases relatively little in comparison to other Government departments; this, coupled with the added complexity of CCS being a new technology, leads to difficulties for both the client and future demonstration organisations to develop a suitable contract.
	• *Nature of contract* – Understand at the outset if the client simply wishes to purchase a product, co-invest, or views this as a research and development focused programme. The contract should define a fixed scope with the flexibility to include new learnings during the FEED process.
IP Issues	• There is a clear dichotomy between knowledge transfer and IP issues and the balance between the two should be carefully considered.
	• Future demonstrations should develop a clear understanding at the outset of the client's objectives in relation to IP. In particular, what type of information the client requires, why it requires this information and what it intends to do with it. It should be clarified whether the client seeks to simply procure a new product or is co-investing in an R&D project.
	• Equally, each of the Consortium Partners need to inform the client of their various IP considerations, particularly what they class as commercially sensitive information and why. A distinction between the treatment of foreground IP (being produced as a result of the work funded by the client) and background IP (being produced beyond the work

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	being funded by the client) was found to be an effective way of handling the protection of IP.
	• As the client for early CCS demonstrations is always likely to be a government, project developers should also give early consideration to the potential application of the Freedom of Information Act 2000.
Constraints arose as a result of the nature of the competition.	• Throughout the majority of FEED, the client was unable to take part in site visits due to procurement constraints and an obligation to apply fair and equal treatment to all bidders. This meant the Consortium was constrained in its ability to fully illustrate its FEED development due to *inter alia*, the client's inability to undertake site visits.
Impact of FEED contract delays	• Ensure early contingency plans are developed to allow for the delay in signing the FEED contract. Contingency plans need to consider the impact on both the CCS workstreams and supply chain members.
Invoice process	• A complex cost-reimbursable procedure consumed a great deal of administrative support and resources (both for the client and Consortium). A simplified process should be considered, for example monthly invoices based on work done.
Consistent messaging	• Ensure all Consortium members are delivering a consistent and aligned message to the client, minimising unnecessary confusion.

The Commercial workstream provided the following additional learnings:

Impact of novel nature of CCS on contractual process.

Taking a Consortium approach to delivering a CCS FEED project meant bringing together a number of organisations from different industries with distinct corporate agendas, mandates and procurement strategies. The commercial team highlighted that:

- Project developers should expect to engage in a negotiation process by which they identify common interests and barriers to engagement and then examine where those barriers can be flexed when formulating a Consortium. This process is likely to result in the least unacceptable compromise for each organisation, but may result in significant operational challenges for each Partner in order to maintain internal compliance, particularly with regard to reporting regimes. It is recommended that project contract requirements are tested against the practicalities of FEED processes and individual organisations systems prior to project start, and project developers consider the cost impact of operating in a manner which is misaligned with their normal business processes.

- The client's familiarity with PFI contracts resulted in a reluctance to consider other options, leading to the selection of a contract template that was inappropriate for the FEED of a demonstration project. The contract for a CCS demonstration project should be created to facilitate the execution of the FEED rather than being defined by legal preconceptions of the most appropriate structure for a contract between public and private organisations.

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Ensure sufficient technical interfacing during negotiations.

It is essential that the Commercial team (and the client) has sufficient understanding of the CCS technical process being developed during FEED in order to negotiate the right type of commercial contract to fit the requirements for both FEED and the main project contract. It is also essential that the technical team is consistently aware of commercially agreed positions and works within these boundaries. Some examples of how the Consortium sought to better integrate the workstreams are:

- Set up a series of workshops prior to FEED contract negotiations in order to align and integrate technical and commercial teams. This will ensure the commercial team is building sufficient technical knowledge of the CCS design, constraints and the proposed 'Cost-Time-Resource' (CTR's) for an effective FEED contract agreement.

- Support the client in building a sufficient technical understanding of the CTR's prior to FEED contract negotiations.

- Ensure there is a common understanding of 'FEED' (what will be delivered, at what level of detail, risk share) internally with senior stakeholders, across the Consortium and with the client so that there is a clear understanding of what is being contracted.

- Ensure there is a consistent, simple message delivered to the client from both the technical and commercial workstreams through the frequent use of Integration meetings, avoiding the anxiety from inconsistent messages. The Integration meetings would also provide the opportunity for detailed technical updates to other workstreams at the point of achieving key milestones.

5.3   CMO Supporting Material

Further detail on learnings provided by the CMO workstream:

Ensure sufficient time and cross-Consortium agreement when establishing the CMO.

The CMO experienced a number of challenges due to the lack of time available to mobilise for FEED before starting project delivery. In particular, it made it difficult to put in place standardised and integrated systems and processes across the Consortium. There was also an underestimation of effort required to support the centralised CMO and insufficient interfaces with the individual Consortium Partners' project office functions.

This resulted in some recommendations for what they would have done differently. These include a greater standardisation of processes and information systems tools; senior management support for adhering to CMO processes; including representatives from each of the Consortium Partner organisations within the central CMO team; having the CMO assume responsibility for coordinating project office activities across the Partner organisations, and clearly defining the separation between the administration of the Consortium and the management and delivery of the programme from the outset. As CCS FEED is not business as usual for any Consortium Partner, additional resource was required to meet the administrative burden caused by the additional complexity and rework involved in the necessary interfaces between Partners and the reporting requirements with the client.

Given the acknowledged difficulties experienced by the CMO as a result of poor mobilisation, at the December lessons learned workshop, CMO representatives from across the Consortium were asked to

consider the key resources they would seek to have in place during a FEED mobilisation period, and the processes and procedures they would recommend establishing.

Example 1: Key resources and processes required for mobilisation of the CMO:

Key CMO Resources	Processes and Procedures
• Project management • Trainers to embed systems and processes across the Consortium • Quality Assurance / Document Controller - to validate content going to the client • Financial Specialist / Team • Planner • Risk Manager • Project Engineer - who can have an integrated role involved in QA, risk, technical and commercial etc A crucial point of learning was that all these resources need to have representation from across the Consortium Partners.	• Reporting timelines and standard meeting schedules, with monthly reporting mechanisms between Partners and the client • Define Financial Process / Controls / Reporting with the technical and commercial teams and advice on quality assurance, risk and programme • Project Execution Plan (PEP) • Standard set of procedures that can be tailored to suit the project (PMA) • A planning tool that is stored on a secure server and can be accessed and used by all Partner companies to avoid issues with software versions • client satisfaction review periods • Risk management process for the Consortium, and approved presenting format for the client • Deliverables / Milestones monitoring and reporting process

Managing project programmes across a consortium is challenging.

The Consortium faced a number of challenges when managing the FEED Programme. These are the key areas of learning:

- A point of contact needs to be established from the start for each programme.

- Separately managed programmes for each organisation work best for a project of this size.

- However this relies on programmes being managed through common interface milestones.

- The dependencies and interfaces between the programmes need to be clear and understood by all Consortium programme leads.

- Planning programme leads and technical/commercial leads need to be closely aligned, this could be achieved by having a planning representative present at some technical / commercial workstream meetings.

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- There is a need for clear communication between Consortium Partner programmes to understand consequences of changing interface timelines. All individual programmes should be linked to the interface milestones.

- As with many workstreams in the Consortium, internal communication was key. It is vital to have the right people at the right meetings – competent enough to understand the detail, make decisions, and disseminate the information to their own workstreams.

- Monthly tracking of interface milestones need to be time-phased appropriately for feeding into the monthly reporting cycle.

Ensure a requirements analysis phase so the right systems and processes are selected

Failure to clearly define requirements for a project management tool resulted in the Consortium choosing an internally preferred tool without checking it was fit for purpose. The management system was not popular due to technical and configuration issues, late implementation (the Consortium had already started FEED using other tools), and the administrative burden of using the additional functionality of the system when all Partners also had to comply with internal company systems. This meant the system was used purely as an information repository not as a full management system.

During the December workshop, the CMO workstream were asked to consider the key functionality required from a document control system for future FEED projects:

Example 2: Recommended outline specification for a document control system

Required	Not Required
- Easy access from different Partner companies. - Search function and upload document function that works well. - Comprehensive and user-friendly navigation - Good user interfaces. - Effective document repository / storage. - Straight forward indexing of documents. - Simple system of storage, with email notifications when items are uploaded.	- Not to be used as method of communication (via integrated email). The Consortium Partners can use their own company systems for that. - System with enhanced potential for other uses - if they are not going to be utilised. - Full notification system, as it is time consuming to do this through notifications and then go to search on the control system.

Establish a robust cross-Consortium risk management approach and tools

- Sufficient dedicated risk management resources, a Consortium agreed approach to risk, an integrated tool and a detailed 5x5 risk matrix is required to manage risks and should be in place from the start of FEED.

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- It is important to know and be clear about the purpose of the risk register from the start - if it is to assist design decisions or to track the development of the risk picture over the duration of the project. Ideally it should do both, and needs to be moulded to suit this as it is being created.

- Each Consortium Partner has their own risk register and risk methodology in addition to the Consortium one, and a co-ordinated approach is needed to remove duplicate risks and enable the Consortium to quantify and properly manage risk.

- There should be close alignment between risk and other workstreams, for example the commercial workstream, to ensure that risks are effectively costed into the pricing.

Consistent and efficient financial reporting across all Partners

Not all Consortium Partners report programme finances to the competition authority in the same manner, increasing the challenge in generating a holistic financial picture of the programme. Difficulties were exacerbated by the format of reporting on cost, which proved very labour intensive for some Partners using their existing internal system. It is therefore recommended that all financial reporting should be through a central CMO and should use a common format and methodology that works with Consortium Partners' existing systems. Careful management of commercially sensitive data is also necessary as there are difficulties with this data being shared amongst Consortium Partners.

5.4   Technical Supporting Material

Further detail on learnings provided by the Technical workstream:

Protected time should be afforded the technical workstream at the outset of FEED to structure and agree the Basis of Design across the Consortium.

- Commercial and organisational design distractions around the period in which the FEED contract was awarded diverted attention from the goal of agreeing the Basis of Design prior to the start of FEED. This resulted in a few months of design work progressing without a final, approved basis of design. Technical design teams need to be given protected time at the outset of FEED in order to agree this document. Having an approved Basis of Design from the outset of the project provides a crucial benchmark for assessing impacts of design changes suggested during FEED.

- The differing industrial and corporate backgrounds of members of the technical team resulted in initial difficulties in agreeing which elements of plant should lead operations, with each Partner expecting other parties to change operating procedures to comply with their requirements. This led to challenges in developing consensus on an End-to-End CCS operating philosophy from which to develop the design. There was also a natural tendency for each Partner to request design changes that could save them money without fully considering the resulting cost implications for other parties.

- The economic and design considerations of the whole CCS chain must be considered when determining a CCS operating philosophy. To ensure that a Consortium approach was taken to any design or operating decisions the Consortium created a small Design Authority to support the Consortium change control system which ensured that all change requests had to quantify each

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Partner's costs. The Consortium Design Authority was made up of one senior technical representative from each Partner organisation mandated to make design decisions which affected the entire CCS chain.

Design work should be managed in terms of the End-to-End solution interfaces – not three separate design programmes.

- Initially the Consortium technical teams were working in silos on their own areas of design, but managing a cross-Consortium CCS FEED must start from the integration points. It is important these tasks are prioritised sufficiently early in FEED.

- The End-to-End integration works should start as early in the project as practical as the outcome of the End-to-End development can have an impact on each section of the design. For example, the End-to-End Commissioning, Start Up, Decommissioning and Demobilisation Philosophy document identified a number of seasonality issues across the chain that impacted the overall project programme and timescales for delivering the demonstration (the End-to-End Commissioning Philosophy document can be found in Appendix D.1.5 of the FEED Close Out Report).

- Change control needs to be carefully managed to maintain the integrity of the End-to-End solution and manage the impact of changes across the CCS chain (examples of this process from FEED are available in section 4 of the Feed Close-Out Report). Change control should happen at a quicker pace than was generally achieved during the ScottishPower Consortium FEED project, it requires a small group of senior technical representatives with a mandate to assess impact and make Consortium decisions.

- Allowance in the FEED project costing and programming of time and resource to "wrap up" the results from the individual capture, transport and storage FEED studies, feedback into the overall CCS chain system design and perform a subsequent final iteration of the individual FEED study work would also be advantageous.

Resource the technical workstream with appreciation of added complexity and novelty of CCS.

- Although the project can draw upon the appropriate combination of technical disciplines, the novel nature of CCS demonstration inevitably turned up unexpected challenges. With few previous examples to base resource plans on, the number and variety of resources required for completing technical design work during FEED exceeded initial expectations. Challenges can be found in almost every element of the FEED process and future developers should not expect to base project resourcing strictly on "business as usual" generation, transportation or oil/gas projects.

- The novel nature of a CCS demonstration project means there are few analogues to validate discussions against, resulting in challenges in resourcing technical personnel who can work in novel technology areas where codes can be unclear, are not specific or not available and where engineering data may not exist. Future developers will need to resource people who can operate outside their comfort zone on an open-ended project often with uncertain design parameters. Given this it is not easy to replace technical resources, relevant both for FEED and for retention of knowledge for subsequent project stages.

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- The technical workstream found that there was a lack of project specific educational material for new team members to move up the learning curve. The creation of common Consortium documents like the Project Definition Document and the Basis of Design has helped with this. National Grid developed an educational presentation for all staff highlighting the differences for designers between working with CO_2 and natural gas; this presentation is included at the end of this appendix section.

- The competitive nature of the CCS demonstration project has resulted in complex formal reporting mechanisms for FEED and restricted communication/collaboration with the client. The technical workstream were particularly hampered by this challenge, as the client was not easily involved in design decisions, discussion had to be held through slow formal procedures, adding to the technical workstream administrative burden. Reporting and communications mechanisms should be streamlined as much as possible to reduce the administrative burden on technical resources.

- It would be useful to have a separate and additional R&D budget for occasions where new issues come to light that were not initially anticipated (for example CO_2 toxicity or new legislation). This will allow the developer to contact specialists to investigate problems without detracting from the existing FEED programme.

Re-use existing infrastructure where possible, but be prepared for this to place material and design constrictions on a CCS solution.

Re-using infrastructure on any part of the CCS chain can mean more upfront investigative work than simply building a bespoke solution. Project developers who are re-using existing infrastructure should be prepared to review material selection and the compatibility of their existing infrastructure with the behaviour and properties of CO_2 and its impact on facilities design and how to mitigate its impact on health, safety and the environment. They should also be aware that it can impose unexpectedly severe restraints on the design parameters of the complete chain. More information on this topic can be found in the "Key FEED Decisions" section (Section 5) of the Feed Close-Out Report.

Some specific examples of infrastructure re-use for each stage of the CCS chain are provided below. Since re-use of existing infrastructure is likely to be key to demonstrating that a proposed CCS project is viable, the present learning is considered likely to be directly applicable to the development of future CCS projects.

Example 1: Lessons learned on re-use of infrastructure across the CCS chain

CCS chain component: Scottish Power: Generation / Capture

Re-using Asset: Longannet Power Station

Learning	• Using existing facilities has been a challenge as there were existing constraints at the site such as cooling water availability. This had to be matched with what is required by the Carbon Capture Plant (CCP) and the Steam and Power Supply (SPS) by working with both the power station engineers and the contractor to agree a way forward. This activity has been complicated by the fact that the FEED design has developed and service requirements have been less well understood at the commencement of FEED than would be expected for

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a conventional project.

- There has been less power plant integration proposed than for new build CCS projects. The Consortium approach is better suited for retrofit of CCS, but needs to take account of the existing constraints. The main issue was identified as being the steam supply for the CCP.

- New-build projects will have more flexibility in terms of the available design options (e.g. pre/post combustion CCS technology) but this will only be the case once the CCP technology is commercially available with matching boiler and turbine designs developed for an integrated power plant / CCS solution.

- The footprint of the CCP has almost doubled over the course of the project. Future developers should not underestimate the footprint requirements of the process plant. In particular this involves the following:

  o The increase in size has been associated with a better understanding of the equipment design, operations and maintenance requirements. It is also associated with the fact that this is a demonstration project and the plant has not been optimised for size but rather for flexibility in terms of access and being able to change out equipment if required as the technology develops or if the equipment does not operate as planned.

  o Whilst it would have been possible to reduce the footprint, the associated costs would increase due to the increased complexity of delivering to a smaller area. Standard layout information for conventional power plant power islands have been developed and optimised over a number of years. While this could also be achieved over time for CCS projects, it is unrealistic to expect 'First of a Kind' layouts to be fully optimised.

  o Across the various feasibilities on other CCS projects, it is apparent that there is a common misunderstanding about the general footprint requirement for carbon capture technology. This is possibly due to consideration of CCP requirements only and not all the associated auxiliary services which are also required, for example cooling, demineralised, potable and fire fighting water.

CCS chain component: National Grid: Onshore Transportation

Re-using Asset: Feeder 10 pipeline

Learning	
	- It has been possible to greatly reduce the cost and environmental impacts by re-using existing pipeline assets. This has also significantly reduced the implementation schedule and enabled the Consortium to consider CO_2 storage at an earlier time.
	- For the development of the new pipeline section, it was decided to take a cautious approach until the transportation issues associated with the properties of CO_2 are better understood. Whilst the initial design approach was to follow a business as usual model, the specific properties of CO_2 mean that normal pipeline design principles and materials normally associated with natural gas are not always directly transferable (e.g. lower temperature resistant steels are required and new materials). This is due to the Joule-Thompson effect which is not an issue in natural gas pipelines. National Grid therefore used the safety in design

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criteria applied for methane pipelines.

- The problems associated with the lower pipeline operating pressure will be common to other CCS projects as this is due to the physical properties of CO_2. The properties of CO_2 will vary dependent on location and climate conditions and these need to be well understood for each particular application. Maintaining CO_2 in a gaseous phase over the 300 km pipeline has proven to be more difficult than initially anticipated. Designers who were experts on dealing with natural gas had to be educated on the properties of CO_2, especially with regards to safety. For example, CO_2 will collect at the lowest point, therefore designers need to understand the impacts of this behaviour on their chosen locations for vents, block valves etc.

- National Grid identified a need to develop a consistent knowledge base of CCS for all their people working on the UKCCS Demonstration Competition. A presentation and supporting training package was developed as a starting point for all participants (internal and external, commercial and technical) to provide an understanding of the fundamentals of CCS. The presentation is provided at the end of this appendix section.

**CCS chain component:** Shell: Offshore Transportation and Storage

Re-using Asset: Goldeneye offshore pipeline and gas reservoir

Learning	
	- Shell found that injecting CO_2 in vapour phase would result in slugging. By injecting CO_2 in dense phase instead, the Joule-Thompson effect has resulted in identification of problems with the temperature profile across the well.
	- By using existing pipeline and wells, there have been constraints (running ductile fracture, small operating window). This was not anticipated initially but has become apparent as dense phase CO_2 is better understood. Future projects need to work within these restraints; a better understanding of these issues will help inform the design process and avoid the rework / design iterations and developing learning undertaken on the present project.

At the December workshop the technical team were asked to mark up their key lessons learned at each section of the CCS Chain diagram. The output is provided in Figure 3.

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Figure 3: The ScottishPower Consortium End-to-End CCS chain
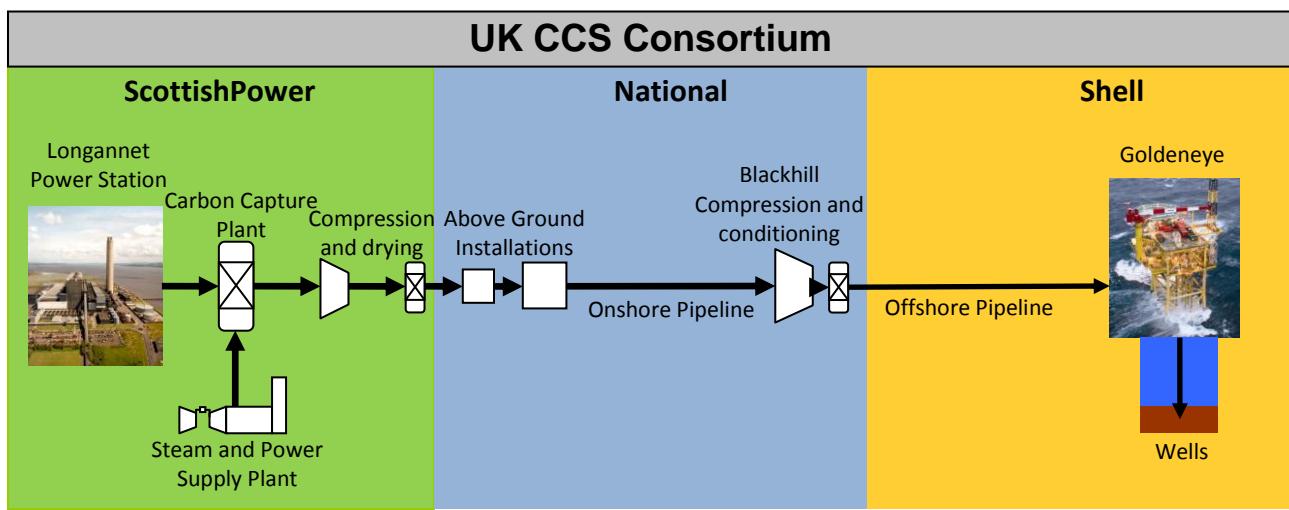
End-to-End Lessons Learned

Development and review of the End-to-End CCS chain design requires information transfer between all key parties and potentially significant design iterations to develop a completed FEED

Comprehensive Impact Assessment is required before implementing CCS chain design changes

Achieving CCS chain flexibility is complex. An understanding of base load operation is first required

Re-using existing infrastructure can achieve a cost saving to the project but potentially introduces significant design constraints on the CO_2 specification and process conditions

ScottishPower Lessons Learned	National Grid Lessons Learned	Shell Lessons Learned
CCP operation should first be understood under base load conditions before seeking to demonstrate flexibility.	Siting of Longannet AGI involved cross sector review of layout and consideration of the 'domino' effect impacts of equipment failure.	Cycling of wells is not preferred to avoid damaging the wells and the field structure.
CCP power and steam supply from the existing power plant may be not be the preferred solution for a retrofit demonstration project.	Defined MAOP for the onshore pipeline under FEED was based upon the desire to avoid CO_2 phase changes within the pipeline.	Potential difficulty in designing to avoid for running ductile fracture.
The Mobile Test Unit results have shown that the CCP output is cleaner than anticipated and therefore an Effluent Treatment Plant is not required.	Low water content of CO_2 is required to minimise potential for corrosion.	First start-up of CCS requires controlled conditions and a significant period of steady CO_2 flow. Regular stops/starts at the beginning of the operational period is undesirable/

Training material – CCS Foundation Presentation

National Grid identified a need to develop a consistent knowledge base of CCS for all their people working on the UKCCS Demonstration Competition. The following presentation was developed as a starting point for all participants (internal and external, commercial and technical) to provide an understanding of the fundamentals of CCS. The presentation and supporting training package continues to develop and is now targeted at three levels with distinct requirements; Foundation, Technical and Expert. The training package will develop as our knowledge and understanding grows to support the ongoing progression of work.

This document is available as a separate appendix to the FEED Close Out Report:

UKCCS - KT - S12.0 - FEED - 002 National Grid Training Material

5.5 Consents, Licensing and Regulation Supporting Material

Further detail on learnings provided by the consents, licensing and regulation workstream:

Ensure early mobilisation of a Consortium consents workstream for FEED.

A dedicated Consortium consents workstream should be established early on in the FEED process. Delays in establishing this workstream until part-way through the delivery of the demonstration project resulted in an initially segregated approach to engagement and consent work within the Consortium, including a hiatus around aspects such as branding, messaging and public identity. A mobilisation period required to appropriately resource the workstream, to establish requirements and work with communications to create the necessary materials for public engagement.

Strong collaboration and interfacing across the Consortium is required.

The individual disciplinary and industrial backgrounds of each Consortium Partner resulted in a tendency for them to approach the consenting process from the perspective of their element of the chain rather than as a single, integrated project. Aligning consent application timelines across the Consortium proved difficult due to a combination of different consenting process across different industries, a lack of co-ordination at the front end of the FEED project and conflicting competition deadlines. Although a CCS project requires multiple, distinct consents along the CCS chain, Consortium wide co-ordination is still needed to ensure that decisions are taken with an appreciation of their impact on the consenting process of others and that the route to all consents are streamlined.

- Additional effort should be expended early on in the FEED project to align the Consortium consenting processes to raise awareness of the different timescales and priorities for Partners during FEED and agree where common approaches and formatting is required.

- The Consortium received strong feedback from all Key Decision Makers that wherever possible consents should be approached from a Consortium point of view, or to present their requests for consents in the context of the overall project and not merely as individual components. To meet this expectation, constituent organisations within consortia may have to approach the consenting process in an unconventional manner.

- It was not practical for Consortium Partners to make joint applications as there are multiple consents required specifically for each section of the CCS chain and areas like offshore consents

involve entirely separate decision making bodies. However, to ensure that all applications had a consistent approach and message, a high-level project descriptor covering the complete CCS chain was included as a precursor to all normal application documentation, setting the context of the entire project. On advice from key decision making bodies, the Consortium also attempted to colour code documents which related to different sections of the CCS chain (see Figures 3 and 4).

- As a result of a request from Scottish Natural Heritage, the Consortium managed to pull together a consolidated Habitats Regulation Assessment – an assessment that all three Partners would have had to produce for their individual environmental consents. All three Partners agreed an approach and produced a joint Habitats Regulation Assessment. This resulted in a more efficient process, where the output was one joint report with headline issues across all areas.

- As the project progressed, the consents workstream found holding interface meetings between Consortium Partners to be a useful method of understanding how their different consenting processes aligned. This allowed the Consortium to maintain alignment in cases where there were multiple consents from different Partners occurring in the same geographic area or with the same stakeholder group.

- Collaboration on government consultations also proved useful. Where Consortium Partners shared government contacts and information including responses, and supported each other in responding. For one consultation the possibility was discussed of submitting one Consortium response rather than separate ones.

Employ a joint approach to stakeholder engagement.

As CCS is a novel abatement process, there is a high level of uncertainty and lack of knowledge across each of the Key Decision Making bodies involved in achieving consents and the regulators responsible for regulating this emerging industry. They prefer a consistent view of the End-to-End project when making decisions for CCS.

- A joint approach to stakeholder engagement right from the start, including aligning timing for consultation periods ahead of time, would have been beneficial.

- On the whole, CCS consents were possible to handle in a regular "business as usual" manner for each of the Consortium Partners. However, the storage Partners required some additional support and input from their subsurface experts, and across the complete CCS chain, extra effort had to be put in to try and take a joined up approach to consent work.

- The Consortium Partners held regular public or Key Decision Maker meetings with stakeholders, where representatives from all statutory consultees and consenting bodies were invited to briefing sessions about the project generally, then provided with focussed information on specific areas of the chain with the opportunity for open questions. Holding these meetings together proved helpful in driving out the issues which were common to a group of stakeholders, enabling consenting agencies to better understand each other's positions and defining the boundaries between the responsibilities of different agencies. In such cases the Consortium Partners frequently brought issues to the consultations together, for example joint public consultations were held for the CCP. Where Partner's responsibilities interfaced, joint attendance at meetings was crucial.

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- The Consortium held two Capture/Transportation joint meetings and one transportation/ storage focussed meeting during FEED, although it is important to note that these were in addition to a host of one-to-one meetings with stakeholders.

Early engagement and developing strong relationships with the regulators was beneficial.

- Taking a proactive approach and driving early engagement with the regulatory authorities has proved beneficial, as has promoting CCS more widely and getting endorsement from key stakeholders. For example, Scottish Government support has helped the Consortium in their dealings with the client. The Scottish Government saw a unique opportunity and the Consortium has benefited from a reciprocal proactive relationship.

- Shell's good relationship with the Offshore Regulator ensured smooth progress of those consents.

- Project developers should also look to the future and identify potential new requirements.

Figure 4: Example of project diagram and colour-coding detailing key consents that each Partner was responsible for.

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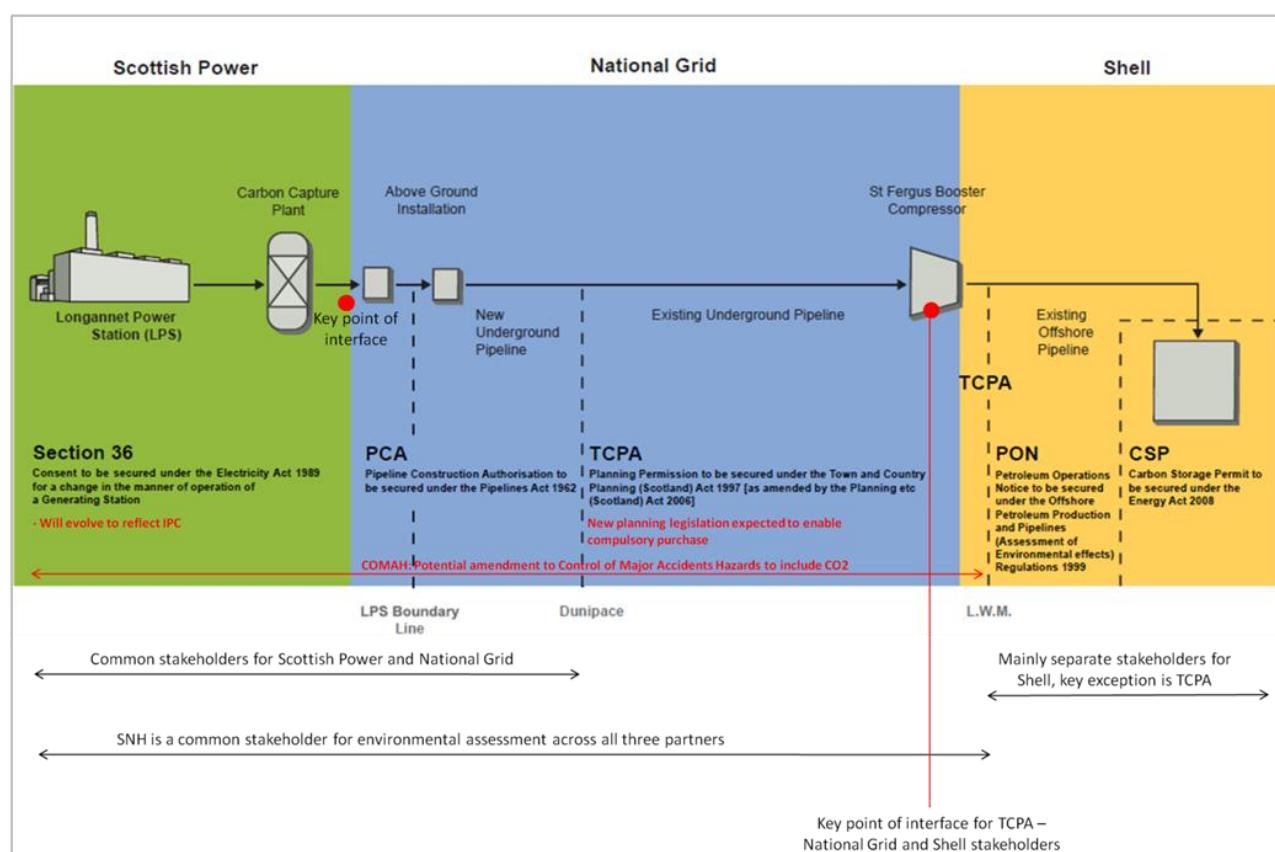
Key interface points between Consortium members where joint approach and stakeholder engagement is effective (Key Decision Makers Meeting/ Public meetings) are highlighted on the diagram above by red dots.

Consents likely to change in the future are highlighted in red.

Arrows used to indicate consents across the chain with common stakeholders.

Close collaboration with the communications workstream is necessary to align messaging.

Dividing the responsibility for obtaining consents amongst the Consortium Partners resulted in challenges in maintaining consistent messaging between the individual consent applications and stakeholder engagement activities. The team working on achieving consents and licences for the project must work very closely with the communications team. It is extremely valuable for Consortium members to understand each Partner's key messages and sensitivities, and to create and maintain consistent overarching Consortium messaging across the individual consent applications and stakeholder engagement activities.

Expect delays when dealing with an uncertain regulatory environment.

The novel nature of CCS has resulted in delays to the licensing process due to dependencies on the output of development work being done by FEED technical workstreams, leading to a compression of the time available to progress the licensing process prior to the end of the project. In addition, rigid lines of responsibility within regulatory organisations have resulted in the responsibility for the transposition and implementation of EU regulations on the licensing of CO_2 storage sites moving from the policy units which helped to formulate the regulation, to regulatory units with limited exposure to CCS and which have other responsibilities to discharge, leading to further delays to the licensing process.

- It is extremely challenging to run competitive procurement projects for novel processes and technologies in parallel with developing the regulatory systems for those technologies to operate.

- CCS developers should expect to expend additional effort informing regulators on subjects such as the unique aspects of characterising a storage site, defining a monitoring plan and conducting risk assessments, as well as the CCS-specific issues regarding liabilities, liability transfer and financial security, before anticipating that regulators will be content to issue consents.

- A significant concern of the regulatory and consents workstream is that the impact of CCS-specific additions on the licenses of existing infrastructure has not yet been defined. It is very important to work with regulators, to bring them onboard and share information to make sure that any additions to licensing criteria are practical to implement.

- Where regulations were ill-defined or there was some dubiety around the required level of consent for a CCS demonstration, the Consortium tended to adopt a cautionary approach. As CCS is a relatively novel process and the demonstrative nature of the project meant a high degree of public interest in the project's outcomes, the Consortium felt it was important to err on the side of caution when it came to compliance with safety and environmental regulations. For example the Consortium assumed that Section 36 was the right application process for the Carbon Capture Plant, due to the emissions abatement element of the project. However, the Consortium could

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equally have applied through the Town and Country Planning Act which would have been a less detailed application. To a limited extent, such a cautionary approach should help future proof the project against future tightening of regulations

Flexibility on FEED timelines should be considered to complete consents applications.

This is a FEED study for a demonstration project, with many unknowns due to the novel nature of the technology, and knowledge being amassed only as the project develops. The competition rules did not take account of the timescales required to collect the necessary input data for the consents, given in many cases these were waiting on learning from the technology workstream before they could proceed. For example, the chemistry knowledge from the Carbon Capture Mobile Test Unit (MTU) is progressing at the same time as the Consortium's Environmental Statements, and the HSE are waiting for the evidence body regarding CO_2 to build up before they take a position on whether it should be classed as a hazardous substance, impacting the consents process for change of use of the transportation pipeline.

- In the case of the Environmental Impact Assessment (EIA), the Consortium was only able to meet competition deadlines because it happened to have recent baseline data available, and was forced to make assumptions and re-work sections later once technical results were available. This is an inefficient approach to consents applications

- A demonstration project will need to be flexible and adapt to the changing knowledge base being built as the demonstration starts. This is not always a comfortable place for consortia or regulators. In the future it is anticipated project developers will find CCS consents and planning more business as usual.

- It is recommended a more flexible and realistic timeframe for achieving consents is adopted for any future project developers, where companies can push out deadlines if necessary data is not yet available.

Further detail on progress of the Consortium consents is contained within section 9 of the Feed Close-Out Report.

5.6   Communications Supporting Material

Supporting material for the communications workstream:

The Consortium Communications Plan

This document details the proposed stakeholder engagement activities associated with the Consortium CCS project. It is intended for use by those involved in stakeholder engagement for the project. It is based on an audit of academic work on perception management in relation to CCS and similar high-profile or controversial projects, established stakeholder engagement best practice, stakeholder identification and analysis, and an understanding of known key challenges and opportunities.

It sets out who we need to talk to, what we will say and how we will say it. There are some useful operational guides covering the use of logos, which Partners speak on which issues and a comprehensive messaging guide which sets out our agreed messages and responses to questions.

This document is available as a separate appendix to the FEED Close Out Report:

UKCCS - KT - S12.0 - FEED - 003 ScottishPower Consortium Communications Strategy

The Consortium Communications Timeline

The timelines below summarise the Consortium's communication activities throughout 2009 – 2010 and the planned approach to communication and messaging in 2011. The timelines are meant to demonstrate the evolution of the Consortium's approach to communication, both in response to external events and key phases of the UK CCS demonstration.

Communications Timeline: 2009

Timeline	Q1	Q2	Q3	Q4
UK CCS Competition Milestone		Invitation To Negotiate (ITN) issued	Invitation To submit an Outline Solution (ISOS) issued	RWE exit UK Competition
Consortium Milestone		Consortium Storage Partner exits	Consortium formed with NG & Shell	Outline Solution Submitted
External Events	CO_2 storage in Scotland Study released - planned engagement & messaging	Mobile Test Unit (MTU) launch at Longannet Power Station	EEPR	EEPR Announcement
Communication Activities/ Events		Intensive schools / community and political engagement & media activity around the MTU launch	Engagement at Political Party conferences	
		Ongoing participation in high-level CCS events/ conferences/ seminars		
Key Themes Communicated		Core messages centred on Consortium **credibility, opportunity** that CCS provides the UK, **urgency** of demonstrating CCS and Consortium **commitment** to delivering CCS.		
		Emphasise benefits of retrofit solution in tackling climate change also quality of the Consortium and the full chain solution that the ScottishPower Consortium offers		

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Communications Timeline: 2010

Timeline	Q1	Q2	Q3	Q4
UK CCS Competition Milestone	FEED announcement – 2 organisations qualified for next stage of UK CCS Competition			EON leaves competition, ScottishPower Consortium announced as sole demonstration project for UK CCS Competition
Consortium Milestone			Consortium Storage Site announcement	
External Events		General Election, Coalition Government elected	Comprehensive Spending Review Announcement	Call for EU NER
Communication Activities/ Events	Joint DECC-Consortium press coverage for FEED	Prepare Consortium communications strategy & working agreement	Consolidate links with new Government Ministers & relations with ENGOs	
		Prepare communications materials – brochure, posters etc.	Messages and positions prepared to respond to the Comprehensive Spending Review	
	Ongoing participation in high-level CCS events/ conferences/ seminars			
Key Themes Communicated		*Media strategy:* Maintain low profile, cherry pick high-level opportunities to profile the project		
	Stakeholder strategy: Public affairs engagement sought to establish the ScottishPower Consortium as leading the UK Demonstration Local engagement activities took a "no fuss" approach, Increased involvement with CCS Trade Associations			
			Core messages adapted to focus on economic advantages of CCS	

Communications Timeline: 2011

Timeline	Q1	Q2	Q3	Q4
UK CCS Competition Milestone	FEED close	To be defined		
Consortium Milestone	NER application submitted to Member	NER application submitted to European		

	State	Investment Bank		
	FEED Submission	ISDS Submission		
External Events	Budget			Government Spending Review
Communication Activities/ Events	Development of overarching PR strategy to support project delivery			
	Increased engagement with local & regional stakeholders adjacent to Longannet and along the CCS pipeline corridor			
	Ongoing participation in high-level CCS events/ conferences/ seminars			
Key Themes Communicated	Accommodate changing UK CCS landscape into core messages.			
	Establish ScottishPower Consortium Demonstration as a stand-alone early demonstration project – differentiated from the rest of the "chatter" on CCS			

The Consortium Communications Materials

At the December Lessons Learned Workshop the Communications workstream were asked to describe the key communication materials they created during FEED and consider any lessons learned in the creation or use of those materials.

Materials	Explanation	Lessons Learned
Brand logo	A consistent and recognisable identity for the project.	Should be completed before any public engagement commences.
Communications strategy	A plan for identifying which stakeholders to engage with, when to engage, what to say and through which channels.	A collective plan should acknowledge and where practical, reflect the range of ambitions / business objectives / cultures and communications approaches taken by the Consortium members. It should be updated regularly.
Messaging	Agreed clear and consistent lines to take and Q&As across the project Partners and sub-contractors.	The collective set of messages should, where practical, reflect the range of ambitions / business objectives / cultures and communications approaches taken by the Consortium members. They should be updated regularly and be constantly reviewed to take account of external events.
Brochure	A straightforward overview of the key aspects of the project, for distribution to a wide-range of stakeholders.	Should be completed before any public engagement commences.
Banner stands	Key messages and information on the project, for use at events, meetings and consultations etc.	The content and design should be consistent with agreed Consortium messages and style.
Website	A forum to provide information on the project to interested stakeholders and	The Consortium Partners made the decision that a Consortium website was not required during FEED. Each Partner has an

	for these stakeholders to communicate with the project participants via feedback/queries tool.	organisational website with CCS content, and it was collectively decided that this was sufficient for FEED communication requirements.

The Communications team regularly review the communication tools in use, as we start to engage in the detailed consenting process a website will likely be produced that will be consistent with Consortium messages and style. |
| **Graphics** | Visual representation of the project for a wide-range of purposes and stakeholders. | A single set of graphics which explain the process to a range of stakeholders and which are consistent with agreed Consortium messages and style should be available as early as possible in the process.

Always ensure graphics are to scale to avoid raising public concerns over size of pipes or depth of storage areas etc. |

The Consortium Approach to Third Party Advocates

At the December Lessons Learned Workshop the Communications workstream were asked to describe their approach to selecting and briefing potential third party advocates, and consider any lessons learned for future CCS developers looking to engage similar third party advocacy groups.

Third Party Advocates	Consortium Approach	Lessons Learned
Politicians at local, regional, national and European level	Regular and frequent engagement was undertaken with politicians at a local, regional, national and European level. The three organisations involved in the Consortium already had established relations with a broad range of politicians and this was key to the engagement process. Engagement ranged from specific briefings, visits to Longannet and general updates. The majority of political engagement was undertaken by individual companies and not the Consortium as a whole.	Early, consistent and regular engagement is key with this group, ensuring key individuals are kept up to date with the project was of great value. Using pre-existing contacts and long-standing relationships by individual members was also beneficial to the whole Consortium. Individual Consortium members were asked to keep Partners informed of any engagement where practical.
Key opinion formers from media and other influencers/advocates such as Trade Unions	Established relationships were the focus of engaging with the media. The extent of proactive engagement was very rapid reactive response carried out during the project process as was deemed appropriate.	Early, consistent and regular engagement ensuring key individuals are kept up to date with the project was of great value.
Environmental NGOs	Time was spent at the outset of the project, meeting and discussing CCS with Scottish ENGOs with whom we had existing relationships. This helped us understand the general environmental position on the technology, garner advice on messaging and communicating about our CCS solution, and inform these important opinion formers about our project very early in its	Early (and then consistently maintained) engagement with the ENGO community was hugely beneficial for the Consortium as it resulted in trusted and balanced advocacy of the ScottishPower Consortium CCS Solution.

Although many members of the ENGO community are not entirely supportive of CCS, there is a general openness to demonstration, |

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	development. This process established strong working relationships with local ENGOs who went on to independently advocate for our scheme within their own organisations and memberships as well as to media questions and Politician's.	and a willingness to present a fair and balanced case for CCS as long as the community is kept informed and engaged with demonstration progress.
Industry Trade Associations	All members of the Consortium are members of the CCSA trade association. They also sit on the communications working group and seek to influence The CCSA's communications strategy.	The Consortium found value in introducing the practicalities of actual CCS project delivery into the discussion forums of Industry Trade Associations to inform and influence industry-wide discussions. The CCSA were an important advocate for CCS, when the Consortium were not able to discuss their work on the UK demonstration competition, they provided an industry-wide perspective on CCS and were adept at rebutting negative reporting.
Local advocates and decisions makers such as community council representatives and local member organisations	Leverage pre-existing links by individual Consortium members and maintain an ongoing open dialogue. Focus messaging on economic benefits to local communities.	Understand that climate change is the context but not the driver for CCS at a local and regional level.

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