The CarbonNet Project

Developing a business model for a CCS hub network

Australian Government

State Government Victoria

Disclaimer

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1. Introduction

CCS industry knowledge sharing

The Global Carbon Capture and Storage Institute has played an industry-leading role in knowledge sharing for the development of CCS globally. CarbonNet, together with many other CCS industry participants, recognises and appreciates the value of this knowledge sharing in aiding the development of a global CCS industry. Due largely to the efforts of the Institute and similar industry organisations, there is a growing body of knowledge sharing material available to the CCS industry. These reports and analysis help project participants and their stakeholders understand the benefits and progress of CCS, but also to address the challenges faced.

It is generally recognised globally that there are five significant challenges to overcome to enable CCS deployment:

- storage certainty
- technology integration
- regulatory requirements
- lack of a business model
- public perception.

This CarbonNet knowledge report focuses on one of those key challenges – developing a business model, and the associated commercial framework, for the development of a CCS hub network. This includes developing an understanding of the roles for the public and private sectors in a hub network.

A key message from the CCS industry is that no two CCS projects are the same – CCS project participants and governments globally have highlighted the importance of considering the unique market, political, social and environmental influences of each project. In developing a business model for CCS, this is particularly the case. In the current global policy context and without commercial drivers, such as enhanced oil recovery, CCS is not seen as commercially viable.

As such there is a role for governments to play in supporting CCS development, there are many commercial and financial structures that could be put in place to drive different outcomes and behaviours from the range of potential participants across a CCS value chain. The objectives of government and context within which a CCS development is being considered will influence the structure of the preferred business model.

Therefore, the focus of this knowledge sharing report is to outline the factors that influence future CCS hub developments and should be considered when structuring a business model so that developers may apply to other projects..

Structure of this knowledge share report

This report is structured as follows:

- **CCS hub project:** Provides a high level understanding of the CCS value chain and broadly defines a hub project in the context of multiple users and, potentially, multiple storage facilities (provided as context to inform the commercial framework).

- **The CarbonNet project:** Provides background on CarbonNet, including the objective for a hub network, along with a summary of the current status of each of the components of CarbonNet.

- **Framework for commercial model development:** This section provides an overview of a methodology developed to assist in defining a business model for a hub network project. The commercial framework assumes a role for government and provides a structured approach to determine the efficient allocation of roles and responsibilities (including risks) between the public and private sectors in developing and operating a CCS hub network. The report then provides definition around each element of the framework.

  - Project definition: CCS hub project – A strong understanding of the key components of a CCS hub project is important to provide context to commercial analysis. This section provides an overview of the key elements of a hub project, and the approach to defining the project for commercial structuring.

  - Project packaging: This section looks at the range of ways a CCS network can be commercially packaged for delivery (that is, segmented or integrated structures across the CCS value chain).

  - Delivery models: This section defines the range of options for the nature and extent of government's role in involving itself in delivery of a CCS project (or parts of a CCS project) – as facilitator, lead developer and co-investor or through providing other support for private sector developments.

  - Contracting and funding models: This section outlines the types of contracting approaches that can be adopted to support delivery of CCS infrastructure and network hub operation.

- **Appendices**: Definitions and contracting model outline

2. CCS and a hub network approach

Defining a CCS network

CCS involves the capture of carbon dioxide (CO_2) emissions and transporting CO_2 to a suitable storage site where the CO_2 is injected into underground geological formations for permanent storage. The application of CCS has occurred in petroleum industry for many years, but is increasingly being considered for industrial/power plants using fossil fuels.

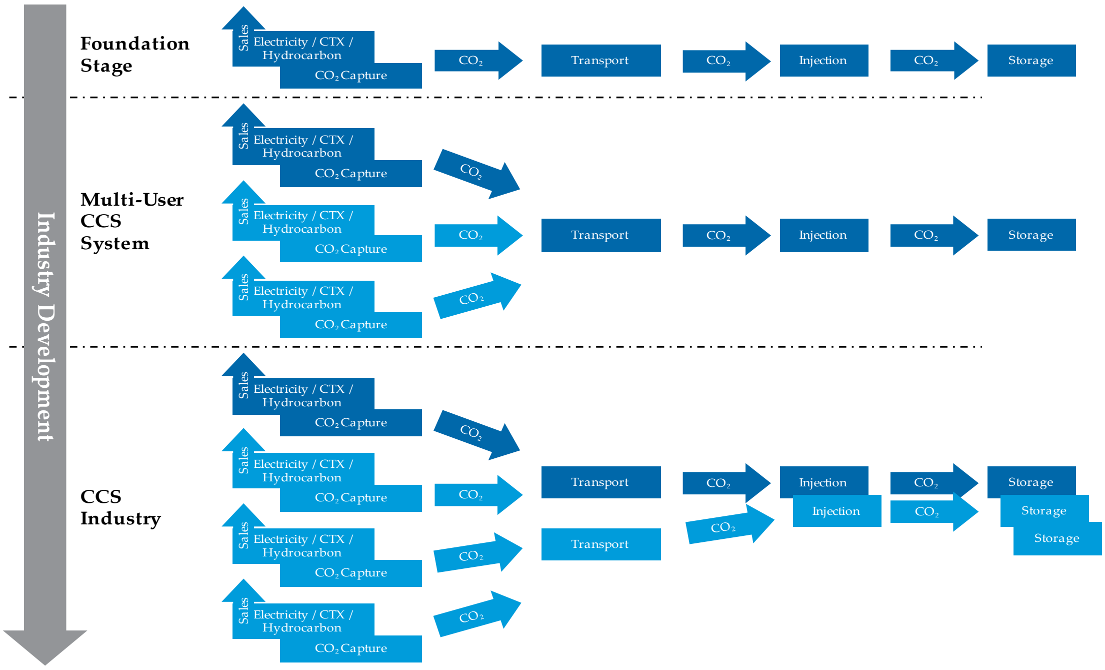
The elements of the CCS value chain can be considered as follows:

- Source: An industrial facility producing/releasing CO_2 as a by-product of the value adding process (in some instances can be considered distinct from the CCS value chain).
- Capture: Facilities/technologies adopted to capture the CO_2 from a by-product stream containing other elements from the source and these may be integrated with the source facilities or separated from it.
- Transport: A network of transportation facilities generally involving a pipeline network, including compression facilities, for the transport of CO_2, though may also include trucks, barges or other forms of transportation.
- Injection: The injection well(s) and associated infrastructure for the injection of CO_2 into geological formations.
- Storage: The geological formations which provide permanent containment of CO_2.

A CCS hub network involves each of the elements along the CCS value chain with multiple source/capture facilities (of the same or different types) providing CO_2 to a shared transport and storage network. As the network expands, this may also increase to multiple transport pipelines, injection facilities and storage formations (although the capacity to expand the number of storage formations will depend on the geological characteristics of the area). Areas where there is a high concentration of CO_2-emitting industries and sufficient capacity to store emissions may lend themselves to a CCS hub network approach.

Figure 1 illustrates how the single CCS value chain could grow and progress to a hub network and a developed CCS industry:

Figure 1: Illustration of the development of a CCS industry



A hub network provides economies of scale benefits (through shared infrastructure, industry knowledge sharing and the development of region-specific experience) and can create impetus for further development: in the case of CCS, potentially accelerating deployment of capture technologies as the first mover disadvantages are overcome.

Unique factors for a multi-user CCS network

While all elements of the CCS value chain for a single, end-to-end project are the same as those in a hub network, development of a multi-user network requires consideration of some matters not necessarily contemplated in a single, end-to-end development. If a foundation stage project is developed with an expectation of expansion, some network-specific considerations may also need to be addressed from the outset.

Matters for consideration in a hub network are technical and commercial/financial in nature and may include, for example:

Capacity considerations

- Initial capacity: A key challenge for any project, and in particular economic infrastructure such as a CCS network, is determining optimal size. Decisions are required as to the level of excess capacity needed to take advantage of economies of scale for future users and increasing demand while not over-investing in capacity that may be stranded or not provide sufficient payback.

- Expansion capacity: Approaches to fund and implement expansion capacity, such as incremental compression facilities or additional pipeline infrastructure, will be required for a CCS network.

- Storage capacity: CCS network projects are premised on future availability of cost-effective storage capacity. Providing confidence to future users of sufficient storage capacity to support those users' investment in CCS, will be critical in delivering growth on the network.

Technical considerations

- Interface management: A multi user system is likely to require systems and processes to manage the interfaces between different owners and operators of different elements of the value chain.

- Specifications: CO_2 specifications which facilitate access to the network by multiple potential source parties need to be established.

- Specifications and monitoring: Monitoring mechanisms must be set to ensure the CO_2 stream from each user meets the requirements of the system (including in terms of CO_2 specification, volumes, and pressures, and the like).

- Tie-ins and network expansion: Processes and procedures are required to manage the connection of new parties to the network.

Multi-user considerations

- Varying Profiles: CO_2 emitters participating in a CCS hub can vary significantly in terms of the broad range of markets they operate in and hence their market exposures. For example, power generation companies are being more sensitive to movements in electricity pricing while CTX (Coal to products) plants are more sensitive to the movement in prices for 'X' and its impact on operations).

  Companies may also have different respective technologies, risk and return requirements, investment cultures and underlying commercial and financial arrangements.

- CCS appetite: Different industries have varying exposures to carbon price risk and financial capacity to adopt CCS to address such risks.

- System access: Multi-user systems require a range of system balancing and coordination mechanisms to manage inflows and outflows from different users and the interfaces between different elements of the value chain.

- Flexibility: Given the diversity of participants' characteristics, the appetite for CCS may vary across participants and may change over time. The CCS network technically, and through the underlying business model, needs to facilitate new entrants (and enable parties to exit).

Commercial considerations

- CO_2 title and liability: The participation of multiple users, both current and prospective, will require clarity on who owns or is liable for the CO_2 streams.

- Pricing: While not apparently financially viable outside of Enhanced Oil Recovery (EOR) applications, there is an expectation that CCS will become viable (as alternative costs of CO_2 emissions/disposal increase and costs of CCS decrease). Therefore, the business model and financial charging arrangements need to consider not only current financial feasibility for participants, but also potential changes in participation incentives and develop adaptable commercial terms and charging arrangements to address these. The impact on first movers who may bear disproportionate risk to future users, and may require similarly disproportionate share in future upside will also need to be considered.

- Risk and fault allocation: As with any multi-user system, a regime that can effectively define and allocate responsibilities and liabilities is required.

- Regulators: Various regulators may be required to oversee different elements of the network hub and the impact on upstream/downstream markets, including approaches to ensure future users are able to access the network.

These types of considerations are defined further throughout this report and reflect the issues to be addressed in developing a commercial business model for a multi-user CCS hub network.

What a role should government play?

The current stage of CCS industry development means there are limited commercial incentives for a private sector to develop CCS projects independently. While some projects have been required to adopt CCS as a licence to operate or to meet regulatory conditions, generally CCS for non-EOR purposes is uncommercial and, without government support, has not been developed.

There are significant disadvantages for the first investor in CCS:

- Developing a CCS value chain: First of a kind technical, commercial, regulatory and project development risks will need to be addressed in the local environment.

- Locked in cost profile: First-mover investors lock in CCS costs at current levels while future investors will benefit from expected CCS cost reductions as the industry develops.

A CCS hub network may place further financial pressure on what are already uncommercial projects. The hub network typically requires increased up-front investment in excess capacity when compared with a single, vertically integrated CCS project. As the user network expands over time, there is an expectation that the economies of scale and other value drivers from shared infrastructure will provide a return on this incremental investment. However, a decision to invest up-front requires a view on the long-term demand for the network and capacity of future users.

CCS is expected to be a key tool in meeting global greenhouse gas emission targets. Therefore, governments globally have supported development of CCS projects. Support has been provided through a range of funding and other mechanisms. Alternative commercial structures and tools have been adapted to meet the specific requirements of the jurisdiction and the relevant policy objectives. These have included direct capital and operational funding, regulatory changes, royalty relief and taxation support along with market reforms, such as energy market reforms. Some government support programs have also contemplated objectives that support network expansion and shared infrastructure.

Another consideration, particularly in supporting a multi-user network over the long run, is that if the cost of emitting CO_2 increases, and CCS costs decrease due to learning and industry development, CCS is expected to become more commercially viable.

As such, a commercial model for development of a CCS network and provision of government support, needs to consider not only the current feasibility of projects, but must adapt to take advantage of changing financial motivations for CCS, opportunities for industry growth and the balance of risk and reward between initial and future network users.

Alternative models for government support CCS, in particular how these might apply to a hub network development, are considered in more detail in Sections 7 and 8. However, given the status of the CCS industry, government is likely to have some role to play in supporting a CCS hub network development. The development of a business model is based on this and considers the range of roles that government can take.

3. The CarbonNet project

CCS in Victoria

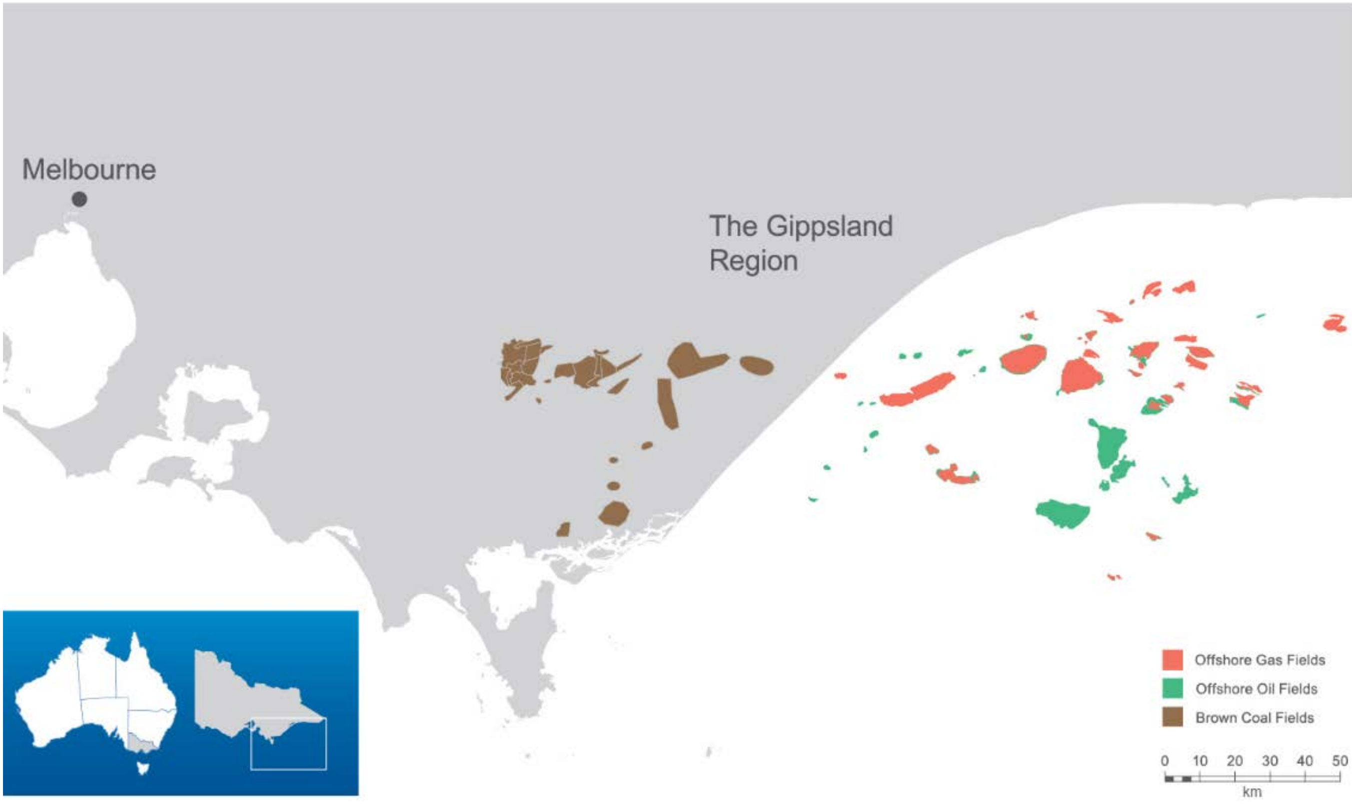
Victoria's Latrobe Valley, 150 kilometres south east of Melbourne, is the major economic centre for Gippsland. It contains the second largest deposit of brown coal (lignite) in the world. It is home to coal-fired power stations producing some 90 per cent of Victoria's electricity generation.

However, in the long term, for the state's coal resource to continue to be used and further developed, new approaches and technologies that can significantly reduce emissions are likely to be required.

The Latrobe Valley is adjacent to the Gippsland Basin, one of Australia's most prolific hydrocarbon producing areas. The basin, which has both onshore and offshore elements, has proven to be world-class and contains several significant oil and gas fields. Large scale petroleum explorations have been underway in the region for over 50 years. The geological characteristics, including porosity, permeability and seal rock characteristics of the Gippsland Basin make it an ideal prospect for the long term storage of CO_2.

The combination of abundant coal reserves adjacent to a proven world class hydrocarbon basin provides the ideal environment for development of a multi-user CCS hub network.

Figure 2: Gippsland Region Victoria



CarbonNet overview

CarbonNet is investigating the potential for establishing a world class, large-scale, multi-user CCS network. The vision for the network is to integrate multiple CO_2 capture projects in the State of Victoria's Gippsland region, transporting CO_2 via a common use pipeline and injecting it deep into offshore underground storage sites in Victoria's Gippsland Basin. CarbonNet aims to initially capture, transport and store one to five million tonnes of CO_2 per annum, with the potential to increase capacity significantly over time.

With its prime location, industry support and ability to facilitate commercial deployment, CarbonNet has the potential to deliver one of the world's first commercial scale CCS networks. The establishment of a successful CCS network would support the development of new industries in Victoria.

If proved viable, CarbonNet could play a significant role in national efforts to abate CO_2 emissions.

The State of Victoria – which manages CarbonNet via the Department of Economic Development, Jobs, Transport and Resources – is working with the Australian Government, industry and other organisations such as the Commonwealth Scientific and Industrial Research Organisation (CSIRO), the Cooperative Research Centre for Greenhouse Gas Technologies (CO2CRC) and Australian National Low Emissions Coal Research & Development (ANLEC R&D) and the Institute to fully investigate CCS potential in Victoria.

CarbonNet also actively engages with a broad range of community representatives and interest groups to provide Project information and inform the community on the potential of carbon capture and storage.

CarbonNet vision and objectives

CarbonNet's vision is to *'develop a commercially viable CCS industry that provides a safe, sustainable, competitive, long term solution for Victoria to deal with its future carbon emissions*' through the development of a CCS network hub in Victoria.

This requires that capture, transport and storage are progressed in a cohesive manner. Addressing the commercial gap for capture costs and providing confidence levels for adequate storage are critical elements in the CCS puzzle globally, and a key task for CarbonNet.

CarbonNet's feasibility phase seeks to:

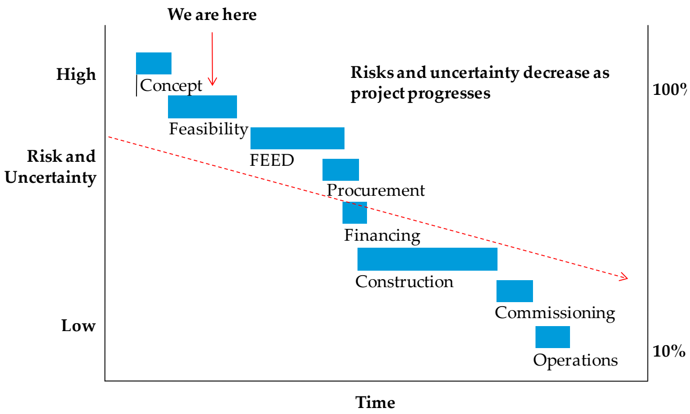
- identify and verify the storage resource to a high level of confidence and test the regulatory frameworks for CCS
- identify potential CO_2 sources, or potential foundation capture projects, that could provide the initial CO_2 volume for the network
- design the overall commercial structure and commercial definition for the network, including the role of government
- identify potential future CO_2 capture projects that could be part of the network and establish an active engagement process.

The results of the feasibility study will inform a decision by government on how it may choose to progress the project, in accordance with the stage gate approach being adopted by CarbonNet (refer following).

Stage gated approach

CarbonNet is adopting a stage gate approach, similar to the oil and gas sector, which has been adapted to meet the requirements for securing government funding decisions. The project is currently in the feasibility and commercial definition stage phase, as illustrated below:

Figure 3: Stage gate approach



CarbonNet's focus to date has primarily been on developing confidence in the storage assets. However, significant work has also progressed in evaluation of a transport pipeline and pipeline CO_2 specifications.

Potential suitable CO_2 capture plants and technology has also been investigated.

As confidence in storage increases, the focus of effort is shifting to the source and capture elements of the CCS value chain, including identifying potential foundation network participants, development of the foundation project commercial structure and a business model for future network users.

Defining the commercial structures and underlying principles to attract private sector investment is also important during this feasibility phase of the project. Various business models between government and private sector have been adopted on global CCS projects.

These will be considered and a model for CarbonNet will be developed through consultation with stakeholders.

CarbonNet feasibility phase

The CarbonNet feasibility phase focuses on the following issues.

- Storage: Identify and assess potential storage sites. The site selection process involves Australian and international experts, with the aim of determining the optimum location for the safe, long term storage of CO_2.
- Transport: Identify and assess a range of corridor options, capacity, specification and other considerations for a multi-user transport pipeline.
- Source and capture: Assess the range of source and capture options for CarbonNet, including understanding capture technology developments and the status of potential source projects as Foundation Project participants or future hub network users. The source and capture options assessment will be informed through an industry consultation process during the feasibility phase.
- CO_2 specification: Determine an envelope for CO_2 specification (given the potential range of CO_2 sources) that enables future users to efficiently connect to the network.
- Commercial model: Identify preferred solutions for delivery of the Project, including as appropriate, the procurement approach, funding and commercial structures and risk allocation profiles. The commercial model is to be informed by precedent projects and approaches, as well as feedback through an industry consultation process.

The feasibility phase of CarbonNet will result in a business case for Government to inform a decision on next steps for the project.

CarbonNet storage program

One of the key challenges identified for CCS projects globally is obtaining confidence in the ability to store CO_2 in selected geological formations. This issue was considered a key factor in the failure of some earlier CCS projects. As a result, CarbonNet has adopted a strategy and initial focus on the characterisation of prospective storage formation(s)/complex(es) in the Gippsland Basin to demonstrate their ability to store CO_2.

The strategy is expected to address requirements of various stakeholders and regulatory regimes and leverage learnings from CCS projects.

In 2009, the Australian Carbon Taskforce (the Taskforce) completed its review of the CO_2 storage potential of Australia's basins. The Taskforce delivered its report, *National Carbon Mapping and Infrastructure Plan – Australia, 2009*, to the Minister for Resources and Energy in September 2009 and reported that 'the Gippsland Basin has the greatest capacity of the eastern basins. It is also very close to the Latrobe Valley hub (150 km). From a purely technical point of view, it is the first choice for the development of a long-term storage basin in Victoria.' The Taskforce found the prospective storage capacity for the Gippsland Basin to be greater than 31 GT.

The CarbonNet storage program benefits from geological data acquired and made public by the oil and gas industry, which has operated in the region for decades.

CarbonNet has analysed high resolution details of the subsurface geological strata from 2D and 3D acoustic imaging data, together with rock core material and information from over 50 existing wells within the immediate project area. Over 1,500 wells support this data on a regional basis.

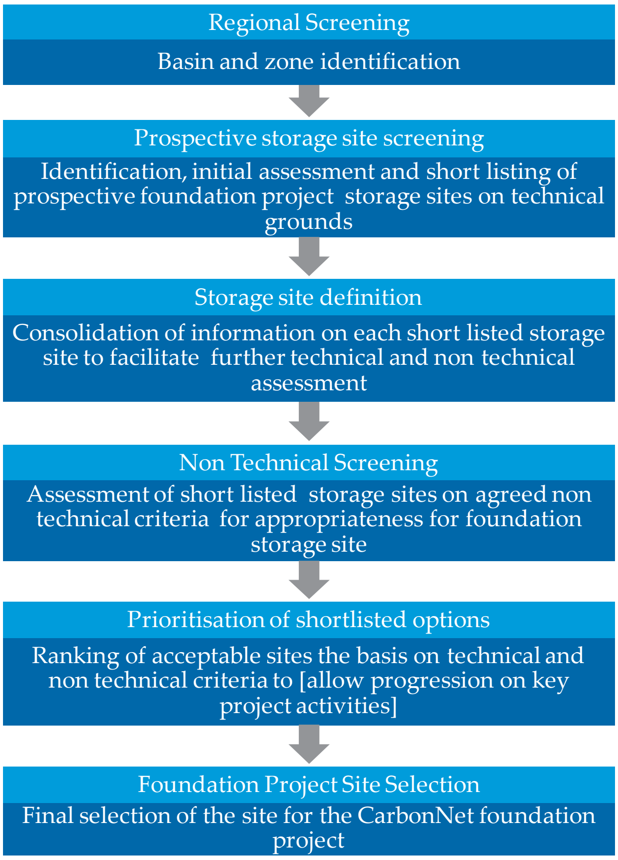
CarbonNet has developed three-dimensional models of the Gippsland Basin, allowing geologists and reservoir engineers to analyse potential storage sites and predict the behaviour of CO_2 throughout the storage process, including injection, migration and stabilisation.

- Evaluated and short-listed prospective storage sites in a process similar to that employed by the oil and gas industry, focusing on safe and secure storage.

CarbonNet is continuing to evaluate short-listed potential storage sites. This will determine viable locations for the safe, long-term storage of CO_2.

In short listing prospective storage sites, CarbonNet has developed a structured and robust process. This draws on recommended practices and criteria developed by Det Norske Veritas (DNV) and the US Department of Energy, including a process for the screening, selection and characterisation of CO_2 storage sites. The key steps in our process are set out in Figure 4.

Figure 4: Storage site selection process



CarbonNet transport program

CarbonNet has undertaken work to identify and assess a range of pipeline options from the Latrobe Valley to the offshore Gippsland Basin. These options have been informed by information gathered across government and screened using a multi criteria analysis.

Several viable corridors exist and some present synergies with existing infrastructure. CarbonNet will be seeking to establish a foundation network based around strategically placed collector hubs and, as such, is likely to comprise multiple linking elements to allow the industry to inform the most appropriate sequence of development. CarbonNet is seeking views on the development of the network through consultations with industry.

Feasibility designs for the transport network have been developed during CarbonNet's feasibility phase.

CarbonNet source and capture approach

CarbonNet has to date focused efforts on providing confidence in the storage capacity of the Gippsland Basin prior to securing a source and capture participant for the project.

As a CCS network hub project, CarbonNet is CO_2 source agnostic. This enables CarbonNet to focus, on developing a CCS network that can be made available to a variety of source participants from across a range of industries. However, confidence in a source market is required to support an investment decision in CCS.

Further, as the range of potential source industry participants operate in a variety of markets, their development can achieve different outcomes (including for government, the economy and the region). They also have different requirements and appetites for participating as a first mover in CCS, and the associated risk profiles. Understanding these profiles is crucial for CarbonNet in developing the foundation project and commercial model.

CarbonNet is consulting with industry to develop a better understanding of potential source projects and their appetite for CCS and CarbonNet.

4. Framework for commercial model development

Commercial framework: A structured methodology for government

The technical challenges associated with planning and developing a large scale CCS network are numerous (such as the scale-up and performance of capture technology and capacity of storage formations). Furthermore, there are significant commercial challenges for structuring a CCS project, particularly in defining the role of government. In this context, a structured methodology for defining alternative commercial approaches and for comparing these options is required. Given the range of potential participants in a CCS hub, a robust, transparent methodology is required.

The role of Government in facilitating CCS can occur in a range of ways that could create different incentives and achieve different outcomes or objectives. While providing a structured commercial framework adaptable to any CCS hub project development, the commercial framework as presented in this report has to some extent been developed from a government perspective. The framework needs to test how government can best facilitate industry investment.

Underpinning the commercial framework is an objective for development of a multi-user hub network. The commercial model must in the first instance facilitate investment in the foundation project while ensuring future expansion of CCS is not restricted. The unique attributes of a CCS hub network to be addressed in the commercial model include the following.

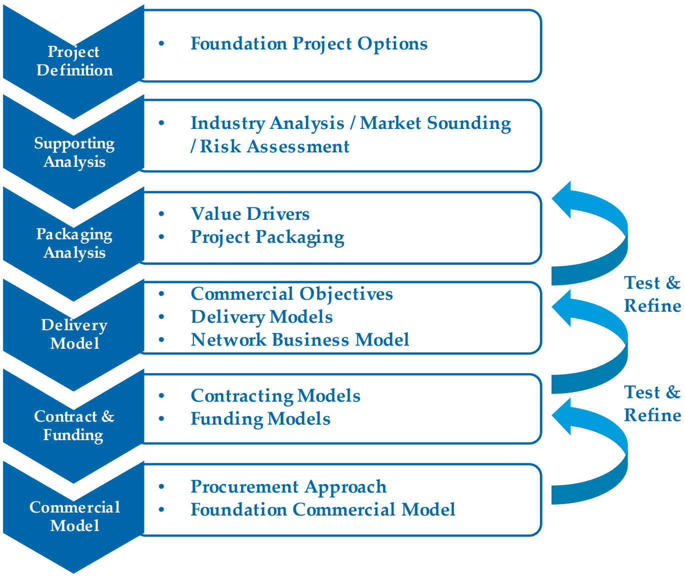
- Nature of the CCS value chain: The most efficient commercial packaging of components across the CCS chain for delivery and operation will depend on the different types of parties involved at each element of the value chain, the nature of the interfaces and the risk profile and risk appetite. This is further complicated by the maturity of technology development across the range of source projects that might participate.

- Role of government in supporting projects and industry development: The development of approaches that enable commercialisation, including approaches to bearing risks (unique and business as usual risks) and providing either support (for private delivery of projects/project elements) or contracting/co-investment models (for more public led delivery)

- Whole of life approach: The consideration of planning/approvals through construction, commissioning, operations and decommissioning in the commercial model including consideration of the incentives for foundation and subsequent parties to participate in the CCS network.

Figure 5 illustrates the commercial framework developed for defining the commercial model for a CCS hub project involving government support. It provides a structured approach to defining and comparing alternative commercial and financial arrangements involving government and the private sector in a way that addresses the unique attributes highlighted above.

Figure 5 – Commercial Framework



The following summarises each element of the framework, with further details in the following chapters.

Project definition and analysis

The Project Definition element of the commercial framework requires developing an understanding and definition of the Project, including the range of project options under consideration, across each element of the CCS value chain. This definition provides a basis for analysis of commercial structuring, risk allocation, funding requirements and identifying areas to realise value through the commercial arrangements. Project definition includes:

- for each project element, technical definition, scope, key assumptions, planning and approvals, development timelines and so on.

- for the CCS value chain, understanding technical interfaces across the value chain for the foundation project and tie-ins required for future network expansion.

The project definition, including the range of options, should be informed by the project objectives and technical/market studies drawing on industry precedent from technical and commercial perspectives. It should also consider the various potential users and provide a comprehensive understanding of the risk associated with the defined project and options.

The key elements of a CCS hub project definition are considered in Section 2.

Packaging – integrated or segmented delivery

The nature of the CCS value chain and uniqueness of each element along the CCS chain lends itself to considering whether, from a contractual/commercial perspective, project components should be delivered as an integrated single project or delivered separately. This is particularly important when considering development of the foundation project, where emphasis will naturally be on delivering a fully operational end to end chain that reduces integration risk, and structuring an approach that does not constrain the future growth of a hub network, where future users will seek to access only the transport and storage elements of the chain.

In this context, the packaging analysis element of the commercial framework considers alternative commercial structures for packaging the delivery and operation of elements across the CCS network, from the perspective of government support.. Packaging analysis needs to consider the following.

- Project packages: Identify alternative packaging approaches available. Broadly, packaging approaches range from a single, end to end, integrated approach to a segmented package where each CCS chain component is delivered separately. This will also consider the inclusion or otherwise of the source as part of the CCS project definition.

- Packaging value drivers: Identify attributes and value drivers of the project components along the CCS value chain. Understanding the value drivers will inform how value may be affected by alternative packaging approaches. Value drivers might include interface risk, economies of scale and market appetite, including considering the varying profiles adopted by the range of industry participants involved or potentially involved in CCS, and so on.

- Operational roles (including system operation and coordination): Specific to a multi-user hub, the impact of alternative commercial packaging approaches and structures on the system operation and coordination and the role of various participants in enabling and encouraging future users to access the system must be addressed. This may include provisions within the funding or contracting models together with the regulatory environment in place (or to be established).

- Assess preferred package: Analysis of alternative packaging options for the defined project must be assessed against the value drivers to determine the preferred project packaging approach.

The packaging analysis for a CCS hub project is considered in Section 7.

Delivery model

CCS projects without EOR are generally not commercially viable and the private sector may not be inclined to deliver CCS outside of asset development regulatory requirements without some government support. However, government can provide support in a number of ways. Support can range in simple terms from facilitating investment, sharing certain defined risks, providing direct funding, (such as grants and subsidies), through to government-led delivery/co-investor in infrastructure delivery. In considering alternative business models, some distinction between these different delivery approaches is required.

The delivery model phase of the commercial framework defines private sector-led development and public sector-led (or co-investment) approaches. A preference for alternative approaches will depend on government's commercial objectives, the nature of the market and project specific matters. The delivery model element of the framework needs to consider the following.

Commercial objectives: Identify commercial objectives for delivery of and level of involvement in the project, to provide a foundation for comparing options (including flexibility for the role of government to evolve).

- Delivery models: Define the public and private delivery model options and consider these against commercial objectives. The focus of the delivery model assessment in the first instance will be on the delivery of the foundation network.

- Network business model: Specific to the CCS hub network development, the delivery model assessment will then consider the impact on future network users of alternative delivery model options and how this might influence the selection of the preferred delivery model. This will be supported by an understanding of the regulatory framework that exists or can be put in place to support a multi-user network.

Delivery model definitions for a CCS hub project are considered in Section 7.

Funding and contract models

The contract and funding model phase of the commercial framework seeks to identify appropriate forms of funding support (for a private-led development) or government contracting approach (for a public-led/co-investment development). Analysis will be required to reflect the characteristics of the preferred project package(s), and may vary depending on the package. The contract and funding model analysis will consider the following.

- Funding models: Define funding models across project lifecycle (for example, grants, operational subsidy, royalty relief, tax support, and so on) and associated commercial principles and risk profile that may be adopted.

- Contracting models: Define contract models across full project lifecycle, for example, design & construction, alliancing, design, construction and management, service contracts, public–private partnerships and associated commercial principles and risk profile that may be adopted.

- Assessment: Assess contracting and/or funding models for project packages against commercial objectives.

Funding and contracting model definitions for a CCS hub project are considered in Section 8.

Commercial model

The commercial model will bring together the analysis under project packaging, delivery model and the associated funding or contracting models. It will do the following.

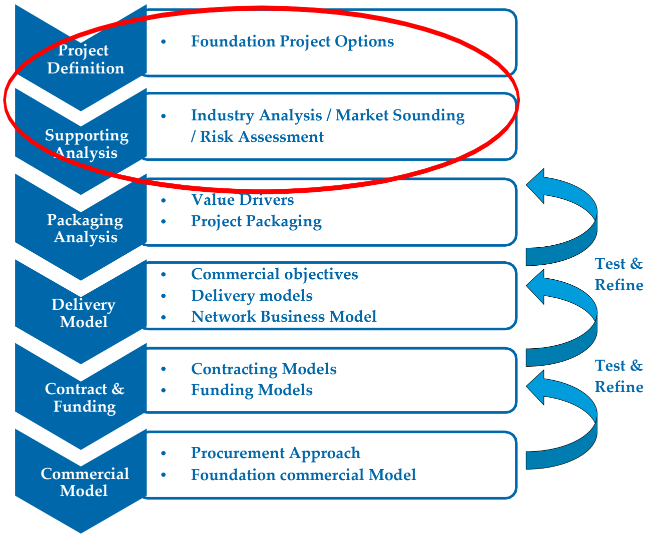
- Refine and Retest: Project packages and delivery model analysis will be re-tested based on the contract and funding analysis, and so on. Given the structured approach to the commercial framework, it is necessary to re-test the outcomes of each step given the subsequent analysis and determine whether the analysis would change.

- Commercial model: Confirm the preferred commercial model (including packaging, delivery, contract and funding, and to the extent possible, the preferred risk profile).

- Procurement approach: Consider the approach to engaging with the market – and procuring the preferred project participant(s) for funding and/or contracting.

5. Project definition: CCS hub project

Introduction



As highlighted in Section 4 - Framework for commercial model development, the nature of the CCS value chain and each element along the chain, lends itself to consideration of alternative models for delivery – as a fully integrated CCS project or as segmented, multiple CCS projects.

The motivations, or requirements, to participate in commercial scale CCS will vary across industries and source projects.

CCS hub project definition

The elements of the CCS value chain can be considered as follows.

- Source: An industrial facility producing CO_2 as a by-product of the value-adding process, in some instances, can be considered distinct from the CCS value chain.
- Capture: Facilities/technologies adopted to capture the CO_2 from a by-product stream containing other elements from the source may be integrated with the source facilities or separated from them.
- Transport: This is a network of transportation facilities generally involving a pipeline network, including compression facilities, for the transport of CO_2, but may also include trucks, barges or other forms of transportation.
- Injection: These are the injection well(s) and associated infrastructure for the injection of CO_2 into geological formations.
- Storage: These are the geological formations which provide permanent containment of CO_2.

Other roles or activities that may be required to support that operation of a CCS hub network include the following.

- MMV: This is the measuring, monitoring and verification of the CO_2 stored in the geological formation.
- System operation and coordination: These are the coordination and operation of the CCS system across ownership boundaries to ensure safe and efficient operation of the system.
- Regulator: A number of different regulators may be required at different stages in the value chain.

As outlined in Section 2 a CCS hub network requires each of these CCS elements but with multiple source/capture facilities (of the same or different types) providing CO_2 to the network. As new source/capture facilities are added and the network expands, multiple transport pipelines, injection facilities and storage formations may also be required.

Set out below is a description of each element of the value chain and activities required to support development and operation of a CCS hub network. These are generic in nature and it is important in applying the commercial framework to ensure a comprehensive project definition specific to the project characteristics of each individual project.

Value chain elements

Source

In the context of a CCS development, a source can be considered as an activity or process that produces CO_2 as a waste or by-product from the conversion of a naturally occurring fossil fuel into a more marketable commodity. The role of the source in a CCS hub is to provide that CO_2 waste product to the hub network to be captured, transported and stored.

A range of industries could participate in or provide a CO_2 source to a CCS network.

- Natural emitters: Fossil fuel extraction releases naturally occurring CO_2 typically at a natural gas processing plant.
- Industrial emitters: Industrial projects or processes produce CO_2 as a waste or by-product:
    - Industrial Emitters: CO_2 emitters produce CO_2 as a result of a fossil fuel combustion or conversion process (typically in manufacturing processes such as cement, steel manufacturing and ammonia manufacturing from natural gas and oil refining).
    - CTX: Coal-to-products emitters produce CO_2 as part of the processes of converting coal to a higher value or easier to export commodity, such as dried coal, Synthetic Natural Gas (SNG)/ LNG, synthetic diesel, urea, other chemical feed stocks and alternative liquid fuels and so on.
- Power generators: Power generators using fossil fuel feed stocks produce CO_2 as part of the processes.
    - Post-combustion: Post-combustion capture of CO_2 is typically from fossil fuel thermal power generation.
    - Pre-combustion: Pre-combustion capture of CO_2 is from fossil fuel thermal power generation.

These source industries reflect a broad range of parties that use a range of technologies, have different investment profiles, horizons and risk appetites, financial positions and understanding of subsurface risks and processes. If they were to adopt CCS, they would also need different types of capture technologies that are at varying levels of development (particularly at commercial scale) with broad-ranging cost and financial impacts

The source industries' different ways of operating have varying impacts on, and could need different commercial arrangements to accommodate, their participation in a CCS network. Defining a hub project for commercial model development requires a clear understanding of the motivations for various (potential) participants in the development of the CCS network, in the short, medium and long term. This is particularly important where CCS is being led by a non-source proponent/sponsor, who may have very different objectives to a source party.

. In defining the source for commercial model development, the following characteristics should be considered for each potential source participant.

- Security of the source market: Understanding the market for the source's output/products. This considers long term viability of source operations, demand for their commodity, financial exposures and associated impact on expected duration of supply of CO_2, relative CO_2 intensity and market competitiveness/ability to bear CCS costs. This understanding will assist in defining contracting/funding approaches.
- Nature of source process: The stage in lifecycle development of the technology used by the source project may impact on the reliability of supply.
- Nature of development: Source projects for participation in a new CCS development could be either green or brown field developments. These types of projects present different risks, including confidence in project progression and certainty of future operations, together with the timing for development and how the development pathway may interact with the broader CCS development pathway.
- Source operations impact on CO_2 supply profile: Source operations can vary in terms of their emissions streams which can impact the load profile of CO_2 supply. This will be a particular consideration when operation is batched or intermittent, reflecting source operations that respond to short term market signals. Accommodating intermittent supply in the CCS network may require excess capacity reservations in the pipeline and injection infrastructure.
- CO_2 supply volume: The volume of CO_2 to be supplied to the CCS network.

- Level of support required: The level of support (financial and otherwise) required for different industries to adopt CCS varies. Furthermore, in a greenfield source development, it is important to consider whether the source project is independently viable without support or requires support to supplement its viability.

- Investment profiles and risk appetite: Source industries have different investment profiles and risk appetites which may drive incentives to participate in different elements of the CCS value chain. Some source participants are more informed on CCS technologies and understanding of storage capabilities and geological conditions, which may increase their ability to participate along the length of the value chain. Other source parties are more risk averse and less informed regarding sub-surface risks, which may limit them to selling a CO_2 stream into the network.

The project definition element of the commercial framework will require these matters to be clearly articulated and defined for the specific source options, to inform the commercial structure analysis.

Capture

Capture is the process required to separate the CO_2 in an emissions or waste stream from the source and remove impurities to meet transport and storage specifications.

The process of CO_2 capture is not new - there is some 40 years of history of capturing CO_2 for EOR and storage in Europe and the USA. CO_2 has also been produced or captured for use in the food and beverage industry and to make fertiliser for some time. However, the application of commercial scale capture technology to industrial or power generation processes is still in the demonstration phase.

The variety of technologies used in the production of CO_2 from industrial sources impact the nature of the capture process. There are three basic types of processes to capture CO_2:

- Pre-combustion: This process converts hydrocarbon into a gaseous mixture of hydrogen and CO_2. The hydrogen is separated for clean combustion and the CO_2 stream can be compressed for transport.

- Post-combustion: This process separates CO_2 from exhaust gases of an industrial process and captures the CO_2 using a liquid solvent, usually amine. The CO_2 is absorbed by the solvent and then released when it is heated to form a high purity CO_2 stream.

- Oxy-fuel: This is a post-combustion capture technology that uses pure oxygen rather than air for combustion of fuel. This produces exhaust gas that is mainly water vapour and CO_2 that can be separated to produce a high purity CO_2 stream.

In defining the capture element of the project for commercial model development the following should be considered.

- Technology development: The type of technology to be adopted, the status of that technology development and the associated risks in its application to the proposed project. The potential impacts on the local environment or nature of source emissions profile on the performance of the technology should also be considered.

- Nature of development: Integrated greenfield source and capture developments will present different challenges to brownfield integration of CCS into existing processes. This includes the ability to allocate what might be considered as business as usual and CCS specific risks. Understanding the nature of the development and these interfaces with source is required, including for example the impact on source operations if for example, the capture facility is out of operation or experiencing operational difficulties.

- CO_2 supply volumes and supply profiles: The volume of CO_2 to be captured and/or emitted, including the profile of the CO_2 stream, requires definition. The proportion of CO_2 produced by the source that is to be captured may also be important.

- Specifications: The ability of the technology to meet the network CO_2 specifications. This will also be considered in defining the network CO_2 specifications and as such, may require an iterative process to definition, where the capture technologies can be adapted to meet a range of CO_2 specifications, albeit at different cost and risk profiles.

- Cost of process: The relative capital and operational cost of the process and the potential to improve the operating costs over time or with different processing volumes should be defined. Where the technology sits on the cost curve (whether there is scope for the technology to move down the cost curve as it further develops) may also be important in considering potential future users.

- Monitoring: The ease, cost and reliability of monitoring the captured CO_2 for compliance with pipeline and storage specifications. The ease and cost of monitoring the waste streams for compliance with environmental and other regulatory obligations.

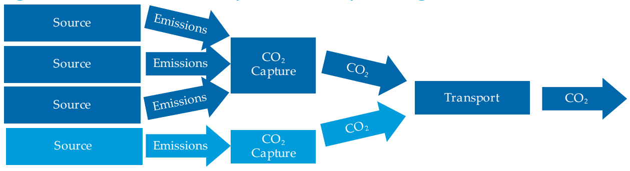
In addition to specific capture projects for a defined source, the CCS hub approach may present options for the physical arrangement and potential sharing of capture facilities.

- Shared capture facilities: Involves transporting emissions streams from industrial processes or power plants which are either unprocessed or have only had minor processing from multiple source facilities to a common shared capture facility. This may reduce the processing at the source, providing some economies of scale efficiencies. The extent of processing required at the shared capture facility will depend on the nature of the source and emissions stream.

- Capture facility for each source: This option assumes capture facilities are constructed for each source site, with those facilities responsible for processing CO_2 to meet the network specifications.

Shared capture facilities within a hub network can be illustrated as follows:

Figure 6 – Alternative capture facility arrangements



In addition to the capture definition considerations listed above, definition of shared capture facilities may also include the following.

- Homogeneity of CO_2 supply from sources: How similar are the sources emission streams and whether they require the same sort of capture processing.

- Location: The proximity of sources, where source facilities are relatively close together and can be located close to a shared capture facility location. The feasibility of transporting emissions streams will depend largely on their relative locations.

- Capacity and timing: Similarly to all shared infrastructure, the timing for source facilities joining the shared capture network will need to be considered when determining the level of over investment upfront to accommodate future users.

Transport

Once captured, the CO_2 needs to be safely and reliably transported from the source to the storage site. CO_2 transportation has been undertaken in various forms over a number of years and is a relatively well understood technical process.

Considerations in defining the transport element of the project include the following.

- Transport methods: Transport of CO_2 from commercial scale projects is generally by pipeline but other options may be considered based on geography (shipping or barges) or tie-ins of small facilities (trucking). The ability of the transport methods to deliver CO_2 at sufficient pressure levels (above that required for injection) is also important.

- Transport route: Optimised route for the trunk pipeline to connect the sources to the proposed storage site must be determined. The geography and populations centres along the proposed transportation route should also be considered. Other considerations include proximity to existing pipeline easements and number of river, road, rail and power line crossings affected.

- CO_2 specifications: Specification of CO_2 stream acceptable for the pipeline and injection facilities to support the foundation source, but also to provide an envelope that enables future users to meet CO_2 specifications must be determined.

- Pipeline specifications: These must be determined for the design, construction and operation of the pipeline for the given CO_2 specification (assuming a transport pipeline).

- Initial capacity: As with all shared infrastructure, the timing for source facilities joining the shared capture network will need to be considered when determining the level of over investment upfront to accommodate future users.

- Expansion options and requirements: Pipelines can be expanded by a transition from gaseous to liquid transportation states or via the addition of compression stations along the pipeline route. The relationship between pipeline diameter and expansion potential needs to be optimised.

- Metering: The volume of CO_2 at the inlet and outlet of the transportation network must be metered.

- Interface with injection: On/offshore injection facilities may have different interface considerations with the transportation pipelines, including the need to consider offshore pipelines as part of the transportation network.

- Safety: Transport network design must take into consideration the required safety standards.

Injection

Once CO_2 is captured and transported to the site for storage, it needs to be injected into the geological formation. CO_2 is injected in a geological formation in a supercritical state.

Storage injection comprises capital equipment, such as wells, equipment and structures for injecting CO_2 and associated operations (day-to-day injection of CO_2 using capital equipment).

The considerations in the definition of injection include the following.

- CO_2 supply rate: The rate at which CO_2 will be supplied to the injection facilities must be determined.

- CO_2 state: The nature of the transportation network, size of the transportation infrastructure and CO_2 volume rate may impact the state (gaseous or dense phase) in which the CO_2 is delivered to the injection facilities. If the supply is gaseous, then compression may be required to ensure CO_2 is in a supercritical state for injection.

- Number and location of injection wells: The rate of injection may affect the number of wells required and where these wells should be located.

- Wells: The choice of horizontal/directional drilling or vertical drilling and nature of offshore injection facilities required (on or offshore, platforms or subsea completions and associated support facilities).

Storage

Storage refers to the secure long term storage of CO_2 in deep geological formations. The storage capability and capacity is primarily determined by the physical formation and as such, the geological storage risk will vary from site to site.

CO_2 can be stored in the following types of formations:

- saline formations
- structural traps
- oil or gas reservoirs which are currently produced for enhanced oil (or gas) recovery
- depleted oil and gas reservoirs
- deep unmineable coal seams.

In developing a CCS network hub, it is crucial that there is a storage reservoir for the network to access and ability to expand capacity beyond the foundation network requirements. The following would need to be considered in providing confidence in the capacity and capability of the storage site(s) for the network.

- Formation: The confidence required in the storage formation to hold CO_2 over the long term must be considered

- Capacity: The minimum capacity in the storage formation and its ability to meet the foundation network needs and provide capacity for the expansion as future sources join the network within the one formation or as part of a portfolio of future formations must be considered.

- Injectivity: The capability of the proposed storage site to handle the injection rate of the proposed foundation source and capacity for future sources to join the network through single or multiple injection wells must be considered.

- CO_2 composition: Composition of the CO_2 supply that the formation and associated regulatory environment can support must be considered.

- Access: Ability to access the proposed storage formation for evaluation, appraisal, injection, and storage of CO_2 at both research and commercial scales must be considered, as must the number of regulatory jurisdictions or permits required to access the site. Competing uses of the surface or subsurface must also be considered.

- Proximity to CO_2 source: The distance between the sources and proposed storage formation as well as the geography of the optimised route must be considered.

- Other uses of the subsurface: Where other resources (hydrocarbons, coal, potable water, geothermal energy or other) exist in proximity to the proposed storage site, the interaction between the resources and the storage site will need to be defined.

- Nature of licence or ownership rights: Existing licensing/ownership rights in the area may require negotiations with licence holders to access the site.

Other roles/activities

System operation, coordination and demand management

The reliable, efficient and safe transportation of CO_2 requires monitoring and management of the CO_2 entering and moving through the system to ensure the CO_2 in the transportation and injection facilities is kept within the required pressure range and the CO_2 specification is adhered to.

As in an integrated end to end operation the coordination of the system can be managed on a collective or individual asset owner basis. However, the need to manage and coordinate multiple CO_2 streams, and potentially storage sites and pipelines in the future, adds to the complexity of system operation and interface management. System operation and coordination does not necessarily fall to the asset owner and can be undertaken by one of a number of parties participating in the CCS chain or an independent party.

The nature and scope of the system co-ordination, and responsibility for that role, can vary. Defining the requirements for system coordination and operation will depend on the physical infrastructure along the CCS chain. How this is then structured will also depend on the commercial model established for the network and associated risk allocation profiles.

The scope of activities to be defined for system operation and coordination will need to include the following.

- Network infrastructure: Inbuilt technical mechanisms (safety valves, monitoring systems and so on) and the reliability of the supply must be considered.

- Nature of source/capture: Types of parties participating, reliability of supply, impact of upstream operations on the CO2 stream and so on must be considered.

- Emergency coordination: Coordination and operation of the system under defined emergency conditions must be considered.

- Day to day operations: Responsibility for day to day operation of systems flow, approach to balancing and nominations (as appropriate) and so on must be considered.

- Supply planning/demand management and forecasting: Demand forecasting, coordination and management – approaches to which may vary on a short, medium and long term basis – must be considered.

Monitoring, measuring and verifying

The long term secure storage of CO_2 in geological formations requires ongoing monitoring, measuring and verifying (MMV) to ensure the CO_2 is behaving as expected in the geological formation. The definition of this element of the CCS chain includes the following.

- MMV scope: This includes defining the nature of the MMV activities, including periodic and/or continuous activities, and approach to capturing, analysing and reporting results.

- MMV assets: Nature of the fixed or other assets required to support the MMV process must be considered.

- Approach to MMV: Depending on the nature of the storage formation and regional geography, MMV may be conducted via down-hole or surface techniques. The definition of these roles may lend themselves to alternative commercial models. For example, down hole approaches may lend themselves to integration with injection activities, whereas surface techniques may be coordinated and carried out by other parties.

- Duration of MMV requirements: The length of time MMV activities must be undertaken post completion of injecting CO_2 into the storage formation may be dictated by regulation. The impact of this additional duration of activities will need to be addressed in the commercial model.

- Regulatory requirements: Expected regulatory requirements for the conduct of MMV must be considered.

Regulators

The broad nature of a project like a CCS hub means it is likely to have a number of regulators and legislation involved. Regulators are likely to perform the following high level roles, which should be defined as part of the project definition to inform the commercial structures. These roles are as follows.

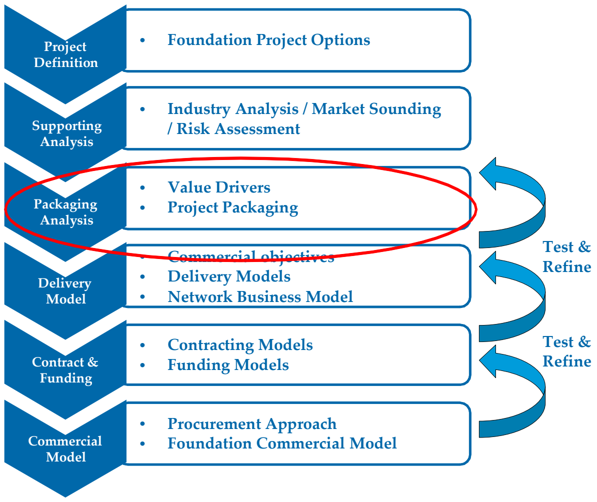
- Ensuring the occupational health and safety issues of the hub are considered, both for employees and the public

- Ensuring the environmental and cultural heritage impact of the hub is managed effectively

- Ensuring the efficient and appropriate access to infrastructure that may lend itself to shared use – government's support and underlying objective for a multi-user hub network will require an appropriate regime for enabling shared access; access may or may not require economic regulation.

6. Packaging

Packaging options



As highlighted in Section 4, the nature of the CCS value chain and each element along the chain lends itself to consideration of alternative delivery models, that is, as fully integrated CCS projects or as segmented, multiple CCS projects.

The motivations, or requirements, to participate in commercial scale CCS will vary across industries and source projects.

The ability of the commercial model to facilitate participation from different parties, including source and other parties, will depend on the nature of the target source industry(s) participating in the project and the objectives of government.

Commercial packaging options are available for CCS value chains. This is reflected in the range of structures adopted on global CCS projects where there is an element of government support.

- Source-led projects: These are projects with a requirement to include CCS as part of the regulatory obligations or licence to operate for the development of the source project. This has been the case for a number of resource developments such as Gorgon and Mongstad (CCM).

- Source-led projects in response to CCS funding support:
  These are projects which are led by the source, but adopt CCS as part of a broader funding support and reform for the source project. For example, the UK governments CCS competition which aims to fund new electricity generation projects that include end-to-end CCS operations, with the private sector required to define the parties and relationship within the CCS chain.

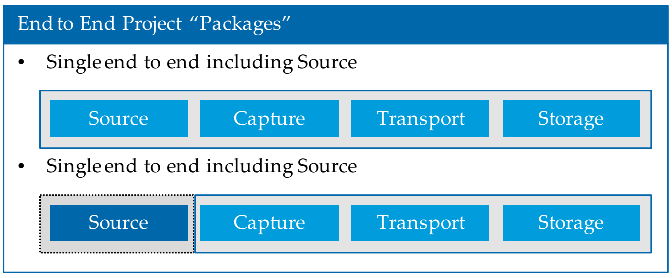
- CCS-led projects: Projects where the desire for CCS (testing or demonstration) drives the development of the project and complete separation of the CCS from the source has been adopted. In these cases, the source simply provides a waste stream to other parties for capture, transportation and storage. For example, the source power plant for the ROAD project in Rotterdam has complete separation between the power plant and the CCS operations. The power plant has been built regardless of the CCS project, but will in the future provide a CO_2 stream to the capture plant, which pays commercial rates for the power supply.

A range of packaging options are available for the CCS hub network, as considered from the perspective of providing government support for delivery and operation of a CCS network. The analysis relates to commercial structures and not necessarily the technical build of the network. - There remains an overarching objective to ensure the technical operation of the full network and technical/design interfaces along the chain are addressed, regardless of the commercial structure.

Commercial packaging options can be generally considered as:

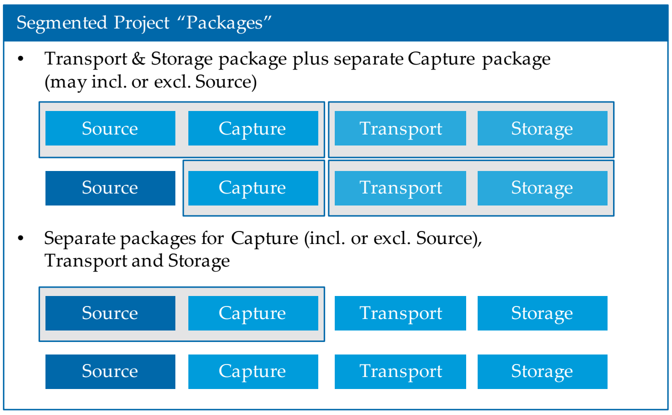
- Fully integrated CCS structures: Government engages with a single private sector entity responsible for delivery of the capture, transport and storage elements along the CCS chain, which may include or separately deal with the source project.

Figure 7: Fully Integrated CCS structures



- Segmented CCS structures: Government engages separately with multiple entities across the CCS value chain. This may include separate engagements for capture, transport and storage or sub-options such as combining transport and storage. Similar to integrated structures, source proponents may be integrated with or separate to capture.

Figure 8: Segmented CCS structures



The above structures reflect the packaging from a government perspective for defining their relationship with the private sector. Ways the private sector parties co-ordinate themselves can be different to the above structures. For example, they may elect to create a Special Purpose Vehicle (SPV) for engaging with government and have a range of sub-contracting entities under the SPV. The commercial model will need to consider the potential underlying structures and entities that can participate in each or all elements of the CCS chain.

Operational considerations

The packaging approach will need to consider the most appropriate model from a design, delivery and operational perspective. Some of the more operational specific considerations that can overlay the commercial structure include the role of an operator and/or system coordinator, which may include:

- Independent operator: Independent organisation to operate and coordinate the system on behalf of all parties in the system. This could be similar to the role that Australian Energy Market Operator performs for the Victorian gas market.
- Associated party operator: An entity involved in the supply chain in another capacity also operates the system on behalf of other network owners/ participants.
- Owner/operator: Each owner operates their assets within defined communication and coordination processes for each interface. Depending on the number of participants an independent or associated party may need to take on a coordination role.

Packaging value drivers

In determining the optimal project packages, each option will be assessed against a defined suite of packaging value drivers to determine if there is a preferred approach that delivers most value. Reflecting the commercial framework, the packaging analysis will be retested following the delivery model analysis to determine whether the results change depending on the preferred delivery model.

The following value drivers have been developed as part of the commercial framework to support a high level comparison of alternative packaging approaches for the defined project. The identification of value drivers, and their relative importance to the packaging debate, will be project specific:

Potential packaging value drivers
Interface • The extent to which the package is best able to manage interfaces (within and across project components and for expected risk allocation profiles)
Complexity (Technology Risk) • The extent to which the package presents a comparatively increasing level of design, construction or operational complexity (including extent of technology development risk) • Skill set and expertise required to complete the works/operations
Project participants and expertise • The nature of the market and government expertise required, and the extent to which the package might attracts or influence particular market players' appetite to participate
Innovation Opportunities • The extent to which there is opportunity to access innovation from a design, construction or whole of project perspective (including ongoing operations and maintenance) by combining or separating project elements
Scope Certainty • The level of scope certainty expected (i.e. does the package adequately capture scope and service requirements) and the impact on risk profiles and commercial structures for different project elements
Economies of Scale • The extent to which the package can provide opportunities to deliver value through economies of scale
Time • The extent to which the package can facilitate on-time and coordinated delivery of each project component (including extent to which the package can deal with pre-construction requirements and approvals processes such as environmental and planning)

The value drivers will be applied in identifying the preferred project packages in two phases:

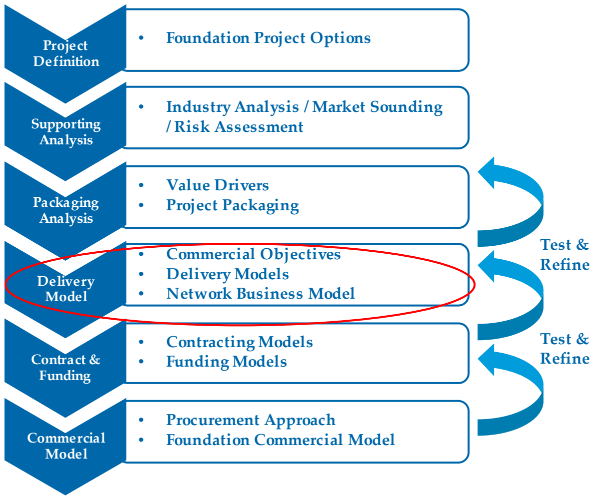
- Individual project components: A detailed assessment is undertaken to identify the relative value drivers and attributes of each component (source, capture, transport and storage), independent of other components within the Project

- Overall project: An assessment of the value drivers in relation to the overall project and alternative packaging options will be undertaken to inform the project packaging analysis.

Following an assessment of the value drivers against the detailed definition of the project and each element, a project package (or set of packages) can be identified.

7. Delivery models

Delivery Models - nature of Government's role



CCS is still in the early phases of development and there remains a role for government support, where the development of CCS is a clear government objective.

Defining the nature and structure of that support and the role of government is crucial in defining the commercial model for a CCS hub network.

As highlighted in Section 4, government can support CCS in a number of ways and involve itself to varying degrees in a CCS project, from providing direct funding (such as grants and subsidies) of private-led development through to government-led delivery/co-investment in the network. In considering alternative models, distinction between different government delivery approaches is required. The preference for alternative approaches will depend on government's commercial objectives, the nature of the market and project-specific matters.

In considering the range of support mechanisms available, it is useful to provide some context for the role of government and a distinction between a publicly led delivery model and privately led models. While not necessarily a simple and clear distinction, for the purposes of the commercial framework analysis differentiation between public and private-led delivery is considered as:

Distinguishing features	Public led delivery	Private led delivery
Definition/ Scope	Defined by government (may include opportunities for scope change, excess capacity, innovation and so on, from private sector)	Defined by private sector (may be influenced by public sector criteria for allocating funding, selecting projects and so on)
Performance Standards	Defined by government, milestones payments, performance regimes and so on	Determined by private sector (but may be influenced by public sector criteria and so on)
Risk Profile	Contracted risk allocation Performance regimes/abatement mechanisms incorporated	Generally private sector risks – influences level of funding support needed Funding support subject to milestones or performance
End of Term Arrangements	Per contract – either retained by the state or can transfer to private	Private sector retains ownership throughout
Delivery Model	Contracting/procurement models (refer following)	Funding support models (grants, subsidies and so on) (refer following)

Commercial objectives

As highlighted throughout this report, there are a range of commercial approaches available for delivery and operation of a CCS network involving government. The nature of commercial structures, and the nature of a multi-user, government supported, economic infrastructure project such as a CCS network, is such that there is not necessarily a right or wrong commercial model for the project. The preferred structure will depend on the underlying objectives of the participants and what they are seeking to achieve.

As such, in comparing alternative structures, clear articulation of the commercial objectives is required as part of the commercial framework. Commercial objectives will be project and sponsor specific, but may consider things such as:

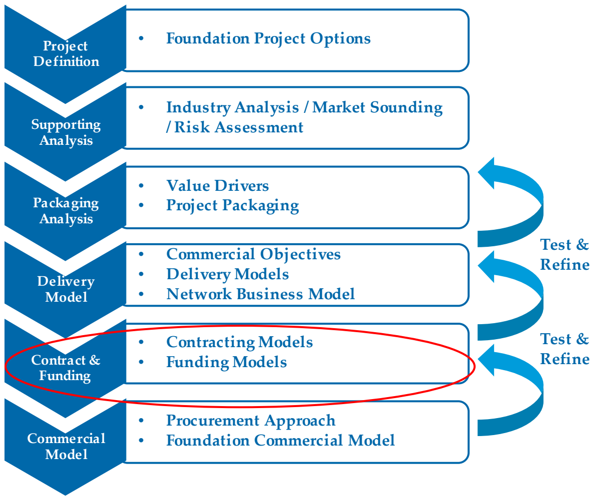
- Level of control and influence sought
- Any requirement for flexibility, both in specification and over time
- Value for money, including opportunities for innovation, risk allocation, competitive tensions, etc.

Evaluation of delivery models

Once the alternative delivery models and characteristics have been identified, an evaluation of these as against the commercial objectives is required. The qualitative aspects of each delivery model are assessed to consider the relative differences between the delivery models against these objectives. This should also be considered relative to the characteristics of each defined project package, to determine the preferred emphasis on private or public sector delivery model for each package.

8. Funding and contracting models

Introduction



This phase of the analysis will define both the funding (for private-led delivery) and contracting (including co-investment) models (for public-led delivery) across the full project lifecycle together with the associated commercial principles and risk profile that may be adopted under each model.

Funding models

Funding models refer to direct funding support provided by government to generally supplement construction and/or operational costs of a project and assist the financial viability of a private sector investment. These are typically adopted under a private delivery model.

Government funding programs can focus on a specific stage of the asset's lifecycle or across a range of phases. They may also be provided through single or multiple funding programs/packages. A project may receive funding from a range of programs over its life. For the purposes of a CCS project, funding models can be considered as:

- Front End Engineering and Design (FEED) funding: Grant or other support for completion of FEED. This may be attached to a right to receive future funding subject to FEED outcomes or funding may be specifically limited to FEED only.
- Construction phase funding: Capital grants, (low interest) loans, risk support and the like may be provided as a means to supplement financial feasibility for private development.
- Operating phase - Revenue support: Financial support to supplement or protect against uncertainty in revenues (e.g. CFD, RECs and the like).
- Operating phase - Cost support: Financial support to supplement operating costs (subsidies), Carbon price linked mechanisms (cost input).
- Other support: For example, tax concessions, carbon credits and the like.

FEED funding

Funding may be provided to assist a private sector party in undertaking the FEED and is typically provided for unproven or uncertain technology applications where government is seeking to support industry development. This has been adopted by the UK government through its CCS commercialisation program.

However, the funding may be structured to provide a right to further construction phase funding, where the results of FEED are such that the next phase of the project is progressed.

Construction phase funding – Capital grants

Grant funding is typically a large capital payment made to private participants for undertaking a project. It is used by government as a tool to facilitate industry development and test new technologies, or to supplement financial feasibility of a privately financed project that may provide some broader public benefit.

Grant funding has varied on CCS projects in both terms of the relative scale of grant funding provided and in relation to the conditions associated with the grant. Some governments have in fact required grants be repaid if a project does not successfully achieve commissioning (by a defined period).

Other programs have not had a link to operational performance as a condition of grant funding.

The following summarises the general features of the grant based models.

Feature	Comment
Value/proportion of funding	Grant funding can be set at any level and is typically defined as a fixed value (although in some cases this may be determined by reference to a proportion of the total funding requirement). The level of grant funding, and hence the level of exposure of the private sector, can change the incentives of the private sector in delivering a project and ensuring commissioning is achieved. A predominantly grant-funded project may reduce private sector incentives, where their funds are not at risk. Setting the right balance depends on technology readiness, the overall financial viability of a project and so on.
Timing	Timing of payments impacts private sector motivations and incentives; upfront payments can reduce incentives private sector to investment if a project is not progressing as planned. It may also reduce incentives to manage project delivery effectively, if their money is not at risk. Payment of a grant progressively, or in conjunction with private funding, may increase the incentives to ensure a project's overall success. Grant payments are often linked to project milestones.
Funding conditions and risk profile	Typically, grant funding is a fixed amount and structured to be paid subject to certain conditions being achieved. In some cases, grant funding may be refundable if successful completion or some other conditions are not met (where the grant is paid in advance of those conditions)
Flexibility for government to exit	While performance conditions may be attached to the payment of grants, there is not typically there is not a right to recall or receive a return on the grant. However, some grant programs have been structured in this way. Grants do not usually attach to ongoing operational performance, freeing governments from any long term involvement.
Tax effectiveness	Grants can be structured tax effectively for the private sector.

Construction phase funding – other

As the construction phase funding approaches, grant funding is the predominant tool adopted by governments. However, there are a number of other options that could be considered for the construction phase to supplement financial feasibility of a privately delivered project.

- Low interest loans: Concessional lending rates maybe procured from multilateral development banks such as the European Investment Bank (EIB) and Asian Development Bank or through Export Credit Agencies (ECA).

- Public equity injections: Equity or concessional equity may be provided by government to help bridge the initial funding gap.

- Tax credits: Favourable tax treatment may be provided to construction period expenditure such as utilised on the Kemper County project.

- Loan guarantees: Guarantees may be provided on loans through a variety of mechanisms to enhance the credit quality of projects.

Operating phase - revenue support

There are a number of revenue support models available to government for economic/user pays type infrastructure. The extent and nature of support is very project specific and largely depends on the objectives of government in providing such support and the level of involvement government wishes to have. In CCS projects, operational support is increasingly being provided by governments, particularly in electricity generation where the parasitic load[1] can be a significant ongoing impost.

Operating phase regimes providing some form of revenue support include the:

- Contract for Difference (CFD) regime under the UK government's energy market reform which has been adopted to support fully integrated generation with CCS projects

- Agreements to price electricity output for electricity generation projects with CCS at a premium price level, such as those seen in the US, e.g. Summit Power's Texas Clean Energy project.

- Renewable Energy Certificate (REC) type regimes adopted for renewable energy projects in Australia.

- Payment by government to purchase, or for the storage of, CO_2, providing similar outcomes to say a long term off-take agreement as seen in North America for EOR projects.

- Revenue guarantees/cap and collar – as used on road projects.

While the following seeks to distinguish between operating cost and revenue support mechanisms, these tools are not necessarily mutually exclusive. The level of support required under operating period mechanisms depends on overall financial feasibility of a project, which is obviously linked to both revenue and cost streams. However, the choice between, and structuring of, operating period funding mechanisms can create different incentives for the private sector and varying exposures for government.

Revenue support/guarantees

Under this model the government would provide minimum patronage or revenue guarantees for a defined period. The government support would be a contingent guarantee, with the expectation that it would only be triggered in the event of an adverse outcome.

The guarantee would cover debt service, but not necessarily equity. Ideally, the guarantee would fall away once certain revenue thresholds have been met. Depending on the accuracy of the forecasts to which the guarantee relates, the guarantee could fall away as early as three to four years after the new infrastructure has been opened.

A minimum patronage or revenue guarantee is provided, under which concessionaires are compensated when patronage or revenue falls below an annual threshold. The minimum patronage or revenue threshold could be set below (e.g. 10% – 30%) the expected base forecasts in order to reduce government exposure, while providing sufficient coverage to protect debt capital.

[1] Parasitic load refers to the generation capacity used to power the capture plant, and thereby reducing the capacity of the power plant electricity sold to the grid.

Patronage and revenue guarantees retain the private sector's financial incentive in the project, provided the minimum guaranteed revenue stream does not provide for a full return on equity.

In return, the concessionaire enters into a revenue sharing agreement in which it shares a percentage of revenue with the government once a threshold is exceeded. The government's share of the upside can be utilised to fund other infrastructure projects.

The following summarises some of the features of the more revenue based models:

Feature	Comment
Extent of subsidy	Where to set the level of any guarantee is fundamental - some models set the level to protect debt only, ensuring equity, who also benefit from upside, bearing some exposure. Other models may be structured independent of the underlying financing requirement, and provide a level of guarantee that finance will then be structured around. Understanding the underlying uncertainty that is being addressed, and the drivers and risk profiles of both the state and private sector is required in structuring guarantees.
Nature of subsidy	Guarantees may be structured on a price variant (for example, the carbon price) or on a total revenue basis (reflecting a volume and price risk profile). Guarantees might also provide government with an upside regime, where guarantees are set within cap and collar. These models transfer other risks of the project, including construction and operational performance, to the private sector.
Timing	By its nature, revenue support is likely to be required during the operating phase of the project after construction completion. The duration of the support can be flexible.
Flexibility for government exit	Guarantees may be structured to provide some flexibility to exit, however it will be important that the flexibility is structured around measurable performance metrics or defined period of time. For example, the guarantee may fall away once a certain level of revenue is achieved. However, absolute rights to withdraw support may not meet the private sector/project proponent requirements for committing to the investment.

Operating phase – Cost support

Government subsidies provide ongoing financial assistance to the private sector, often to support the financial viability of a project. Subsidy funding as a proportion of total capital cost is typically sized to bridge the gap between funding achievable by the market and the cost of delivery.

The following summarises some of the features of operating cost subsidy models:

Feature	Comment
Extent of subsidy	Subsidy levels are also key to the effectiveness of these models. Where there is more certainty of forecast cashflows (cost and revenue) a subsidy may be set to support a required level of return, while maintaining tensions on the private sector to manage those cashflows. However, where there is uncertainty in cashflows a pre-set subsidy may not be sufficient. Variable subsidies may be required, which move with actual cashflows, and potentially reducing the incentives to manage those cashflows.
Timing	By its nature operating cost support will be provided during the operating phase of the project after construction completion. The duration of the support can be flexible.
Nature of subsidy	Subsidy regimes may also be structured around variable factors or as fixed level subsidies. It may also be appropriate to withdraw subsidies at certain levels of performance, etc. These models should provide effective transfer of other risks of the project, including construction and operational performance, while providing financial viability support.
Flexibility for government exit	Subsidies may be structured to provide some flexibility to exit. However, similar to guarantees, it will be important that flexibility is structured around measurable performance metrics or a defined period of time. An absolute right to exit is unlikely to provide the private sector with sufficient certainty to support investment.

Operating phase – other

- **Other mechanisms**: A range of other mechanisms can also be adopted such as tax credits, often used in the US where tax credits for depreciation/losses can be utilised in other projects, and royalty rebates or reductions, such as in Alberta, Canada where increased oil production from EOR activities is at reduced royalties.

- **R&D program**: Specific funding targeted to research projects and demonstration plants.

Contracting models

There are several alternative contracting models where government takes more of an active lead in the development and delivery of infrastructure. These contracting models are also applicable to the private sector in dealing with other private sector entities, but have slightly different characteristics when applied by government for a project such as CCS.

Broadly, the contracting models can be considered across the project lifecycle as:

- Design and construction phase contracts, accompanied by relevant service agreements during operations.

- Whole of life contracts, which combine the design, construction and operations requirements.

A summary of the key contracting models within the above categories and their characteristics is set out in Appendix B.

Depending on the packaging approach adopted, a CCS hub network (or particular project package) involving a government-led delivery could adopt a range of or combination of contracting models.

The commercial principles under each of the contracting models can be adapted to reflect specific requirements of particular project packages and their application may vary depending on the nature of the package.

9. Delivery model evaluation

Evaluation criteria

In order to support comparison of the delivery models, and associated funding and contracting models, a multi-criteria evaluation is required. The following criteria reflect the range of factors that could inform such an evaluation and determine the extent to which the delivery model assists in maximising value for money outcomes for a hub network project.

Criteria	Comments
1. Innovation • The extent to which the delivery model is able to achieve innovation in design, construction and whole of life benefits	• Ability of the delivery model to harness innovation in design and construction • Ability of delivery model to incentivise better long term design and operational outcomes
2. Risk management • The extent to which the delivery model efficiently and effectively manages and mitigates material risks	• Extent to which the delivery model manages or mitigates material risks associated with design, construction and commissioning • Extent to which the delivery model manages or mitigates material risks associated with ongoing maintenance, safety management and operations of the infrastructure
3. Time to deliver • The extent to which the delivery model is able to ensure timeframes for delivery are met	• Extent to which the delivery model can ensure the timeframes for delivery of the packages are achieved
4. Whole of life • The extent to which the delivery model provides for whole of life approaches	• The ability of the delivery model to deliver to required specifications and take account of future Whole of Life considerations, e.g. quality of materials
5. Flexibility (scope changes) • The extent to which the delivery model can accommodate scope changes (during construction and in operation)	• The extent to which the delivery model can cost effectively accommodate unexpected changes to scope or original specification during delivery, subject to the ability to define scope requirements up front • The extent to which the delivery model can accommodate scope changes during operations • The extent to which the scope can be defined in output terms, if required, i.e. PPP delivery model
6. Market interest/appetite • The extent to which market appetite, and hence value offered by the market, is affected by the delivery model	• The extent to which market appetite is increased as a result of the delivery model • The extent to which competition can be increased and consequently the ability to influence competitive pricing, resource commitments, innovation etc., as a result of the delivery model • The extent to which the delivery model is able to assist in

Criteria	Comments
	optimising market interest in the packages and therefore competition or contestability among parties with appropriate skills and capacity • Market players' perceptions regarding the process and likely outcomes
7. Interface and management • The extent to which each delivery model assists the state in managing interfaces	• The extent to which the delivery model can facilitate access to undertake and/or complete the packages and how each component of the CCS chain must work together • The extent to which the delivery model can facilitate approvals that may be required
8. Stakeholder management • The extent to which each delivery model assists the state in managing stakeholders through the delivery of the packages	• The extent to which the delivery model can facilitate stakeholder management, including: • Community stakeholders • Local councils • Unions • Environmental and heritage stakeholders
9. Budget and Value for Money (VfM) • The extent to which the delivery model provides a cost effective outcome and delivers VfM, taking into account price and other value criteria	• The extent to which the delivery model can provide certainty that the Project budget will be achieved for the anticipated scope • The extent to which there is efficient pricing for the required Project outcomes

Funding and contracting model evaluation

Following confirmation/selection of the preferred delivery model, with the emphasis on the role of government, an assessment of the funding and contracting models available is required. This assessment will also draw on the evaluation criteria established to determine the preferred delivery model.

Whole of project review

As a final step, the evaluation approach requires review of the proposed project packages and delivery models on a whole of project basis. This review assesses how the packages and delivery models relate to each other and the impact when multiple packages are delivered either sequentially or concurrently. This qualitative assessment will seek to consider whether the right balance between VfM and deliverability has been struck.

The whole of project review and validation will allow government to test whether the combined packaging and delivery model approach supports achieving the project objectives by providing a sound understanding of the project packages and delivery models, including relationships between combinations and on a whole of project basis.

Appendices

Appendix A – Definitions

ALDP	Advanced Lignite Demonstration Program
ANLEC R&D	Australian National Low Emissions Coal Research & Development
BCIA	Brown Coal Innovation Australia
CarbonNet or the project	The CarbonNet project is investigating the potential for large-scale CCS in Victoria's Gippsland region; capturing CO_2 from electricity generation, industrial processes and coal-based industries in the Latrobe Valley, and injecting it deep underground offshore in the Gippsland Basin for safe, long term storage
CCS	Carbon Capture and Storage.
CCS hub network	A CCS hub network involves each of the elements along the CCS value chain with multiple source/capture facilities (of the same or different types) providing CO_2 to a shared transport and storage network
CCV	Clean Coal Victoria
CFD	Contract for Difference
CO_2	Carbon dioxide
CO_2CRC	Cooperative Research Centre for Greenhouse Gas Technologies
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CTX	Coal to products (being a range of synthetic Hydrocarbon products)
DNV	Det Norske Veritas
DSDBI	Department of State Development, Business and Innovation
EOR	Enhanced Oil Recovery
FEED	The process referred to as Front End Engineering and Design, being a detailed study on a selected option post completion of the Feasibility Study
Foundation project	The initial phase of CarbonNet that will capture, transport and store a minimum of 1 million tonnes (Mt) of CO_2 per annum.
Institute	Global Carbon Capture and Storage Institute
Industrial emitter	Industrial emitter creating manmade CO_2, that is, cement, steel production and so on
KSR	Knowledge Share Report
MMV	Monitoring, measuring and verifying
Natural emitter	Processing plant emitter releasing naturally occurring CO_2

REC	Renewable Energy Certificate
SPV	Special Purpose Vehicle
SNG	Synthetic Natural Gas
Source project	A project or business which produces a CO_2 stream resulting from the conversion of a naturally occurring fossil fuel into a more marketable commodity which may include, but is not limited to power generation projects, CTX projects or other industrial processes
Taskforce	Australian Carbon Taskforce
VfM	Value for Money

Appendix B – Contract models

Design and construction (D&C)

- Design and Construction requires the functional performance requirements and typically concept design to be prepared by the state, typically in a project brief. The state then seeks tenders for completion of the detailed design, consistent with the project brief and the contractor provides a fixed price in accordance with a negotiated risk allocation contract model to design and construct the specified works.

- Depending on the extent of definition provided by the state, the contractor has the opportunity to develop a design and construction approach to meet the project brief requirements, providing the opportunity to identify innovation.

Element	Description
State retained risks	• Responsibility for the scope (as outlined in their project brief) and that it incorporates requirements of all appropriate stakeholders • Risk of scope changes, which the state may require the contractor to implement during design or delivery and for which the state will need to pay • Risk of site conditions, particularly unidentified or other concealed conditions discovered during construction (this will be dependent on the level of information available which can affect the level of risk retention or transfer) • Cultural and heritage risks • Whole of life (WoL), asset ownership risks, as the asset reverts to the state on final completion
Risks allocated to the contractor	• Design and construction risks that the design and constructed infrastructure meet the project brief • Completion of design and construction within the contracted timeframes (subject to state retained risks which may allow extensions of time) • The cost of the design and construction works
Payment mechanism	• The D&C contractor is paid on the basis of progress (generally on a cost of work completed although cost to complete basis can be applied) or on achieving milestones. • D&C contracts are normally priced as lump-sum contracts, and aim to lock in an agreed price. However, where there are changes to specifications or there is uncertainty in the specifications, this can result in disputes and claims and actual costs are nearly always higher than tendered costs. • Whole of life, maintenance and lifecycle type costs are retained by the state, who may enter into separate contractual arrangements for these works.
Interface	• Typically, an occupations and access regime is prepared by the Department in conjunction with the operator, for inclusion in the tender documentation. This regime is to identify the acceptable types and timing of occupations (and the cost to be reimbursed to the operator). • Contractors are to bid based on this agreed occupations regime or identify where changes could add value to the given option. • Once locked in, any amendments to the agreed regime during construction (e.g. additional, accelerated, adjusted occupations or access) may be approved at the operator's discretion (and the Department). • Operator approvals are also required for commissioning of completed works, and may

Element	Description
	influence scope changes during construction or on commissioning.
General suitability	• These models are predominantly used for projects where there is a high degree of certainty about project specifications i.e. functional, performance and technical requirements and reduced likelihood of scope changes after entering the contract. • The model is best suited to projects where the state's specifications can be clearly articulated before tender and are unlikely to change and where the state is best placed to manage non-construction project risks. Some level of innovation is usually introduced in these sorts of projects making them attractive for bidders. • However, major state-funded procurements for complex capital projects under D&C models have historically tended to experience a high level of cost and time overruns during the construction period. Due to the complexity of the work (meaning upfront specification by the state is more difficult) overruns have often been driven by disputes, contractor claims and changes to the scope or design as the project develops.

Design, Construct, Maintain (DCM)

- The DCM model is similar to the D&C model, with the inclusion of a period of maintenance of the infrastructure constructed by the contractor as part of the services contracted at the outset.

- The DCM contractor retains responsibility for maintenance, although typically these models do not extend beyond the first major lifecycle phase (five to seven years, depending on the project). The DCM model can provide incentives for the contractor to make construction decisions (such as quality of materials) on a longer term basis as they can be at risk for failing to achieve standards during the maintenance period.

Element	Description
State retained risks	• State retained risks are similar to the D&C approach. The state accepts risks of scope definition and scope changes, site conditions, cultural and heritage risks. • The state retains ownership of the infrastructure and associated ownership risks. • Typically, the DCM maintenance component is input specified and relies on all parties at contractual award agreeing the maintenance work to be undertaken. Depending on the nature of the asset, the maintenance period is generally shorter than the asset life, and rather reflects lifecycle maintenance for parts of the asset (such as mechanical and electrical). The state thus retains asset performance risk beyond these components.
Risks allocated to the Contractor	• Allocation of risks during the design and construction phase is similar to a D&C approach (design and construction meet the project brief, completion on time and within costs, subject to the state retained risks). • There is some enhanced degree of risk transfer to the contractor in terms of maintenance for the period of the maintenance contract.
Payment mechanism	• Under DCM model, as for D&C, the contractor is paid on the basis of progress (generally on a cost of work completed, rather than a cost to complete basis) or achieving milestones towards completing the design and construction works. • Again, as for D&C, DCM contracts are normally priced as lump-sum contracts, and aim to lock in an agreed price. • Maintenance costs are paid periodically by the state. Incentive arrangements and competitive tensions during the original bid phase can drive the DCM contractor to provide some reduced maintenance costs, although this will depend on the relative value of the

Element	Description
	maintenance works and the D&C component and the structure of the Contractor e.g. single entity, Joint Venture and so on.
Interface	• Similar to D&C in most respects with an enhanced level of operator interface required as the contractor would need access approvals to undertake maintenance work and ensure such maintenance work meets the operators safety and quality standards.
General suitability	• Similar to D&C, the DCM models are predominantly used for projects where there is a high degree of certainty about project specifications i.e. functional, performance, technical and, in this case, maintenance requirements. • More suitable where there is a reduced likelihood of scope changes after entering the contract. • Since the DCM contractor retains responsibility for some lifecycle maintenance, these models suit projects where there is opportunity to introduce design and construction innovation on a whole of life type basis or there is a need to create longer term alignment of interests between the contractor and the owner.

Early Contractor Involvement (ECI)

- A number of approaches to the ECI model are available. Under current forms of ECI the preferred contractor (ECI contractor) is selected under open competition for a whole of project contract, typically based on qualitative criteria but models are developing where elements of cost completion are introduced.

- The ECI contractor operates under a relationship based arrangement during the detailed definition and development phase. During this phase, the model is resource intensive, especially at senior levels. Significant commitment from senior people with the authority to make decisions and who possess the requisite experience should be required to ensure this model is effective in these early development phases.

- Following the completion of development phase and once there is clear understanding of project risks (the timing of which this may vary depending on the particular ECI arrangement or project characteristics) there are a number of options for the next phase.

  - Typically, ECI agreements are staged wherein a D&C contract is entered with the ECI contractor following the detailed definition phase. The timing of, and the rights and obligations to enter, the D&C arrangement can vary to suit particular project circumstances.

  - The State retains an option not to enter the D&C contract where price or contractual terms are unsatisfactory. In this case, the project must be re-tendered in an open market, where the ECI contractor may or may not be allowed to bid.

Element	Description
State retained risks	• During the development and definition phase, the risks are retained exclusively by the State. • When the ECI converts to a D&C, the risk allocation profile is per the D&C contract. The State retains risk that the project specifications adequately describe the project requirements, the risk of scope changes, risk of access being provided in accordance with scheduled access and environmental and planning risk.
Risks allocated to the Contractor	• D&C types of risks accepted by ECI contractor following agreement on D&C.

Element	Description
Payment mechanism	• During the design development phase, the ECI contractor is reimbursed by agreed rates on a time basis. • Based on the preliminary design and draft construction contract, the Contractor prepares a fixed price to undertake construction. The price is prepared on an open book basis utilising the standard rates and margins originally bid by the contractor. The State will engage an external auditor to verify the price prepared prior to fixing this in the D&C contract. Payments are then made similar to the D&C arrangement (on completion of milestones, for progress or on a cost to complete basis). • The ECI can be accompanied by a Target Pricing concept where the ECI contractor is entitled to a share of design and construction savings in the D&C contract as compared with price targets fixed at different stages of the project. • The ECI process should provide more predictability as to the effectiveness of the underlying D&C risk allocation. This reflects the ECI's involvement during development, better understanding of the State's requirements and project risks and more clearly defined allocation of responsibilities and risks. As such, ECI should reduce opportunity for successful claims and variations compared with D&C only if the risk allocation of the underlying D&C is different.
Interface	• The ECI contractor will have the opportunity to develop an occupations regime in collaboration with the operator. Once confirmed in the D&C contract, any further requirements (e.g. additional occupations or amended timing of access) will need to be approved at the operator's discretion (with the Department, through PTD). • Operator approvals will also be required for completed works as part of commissioning for operations.
General suitability	• The ECI model has been used when cost, risks and scope cannot be sufficiently defined upfront and where there are opportunities to access contractor innovation in design and development. • The ECI model is resource intensive during the development phases, especially at senior levels. Senior resources from the State and the ECI contractor can be tied up for much longer than under more traditional contract forms. In the subsequent phase, the resourcing requirements are likely to mirror D&C contracts.

Alliance

- An alliance relationship is formed between key project participants, who include the state and non-owner participants (for example, designer, constructor, other key stakeholders and so on). The relationship is formed through qualitative assessment of participants i.e. value based rather than cost based criteria. The relationship must be collaborative for the alliance to be effective.

- With an alliance arrangement, senior resources with the requisite experience are required to actively participate as part of the alliance leadership team (ALT) and the alliance management team (AMT) during development and delivery.

- The ALT is expected to consist of senior representatives from each of the alliance participants. The team provides leadership, governance and oversight to the alliance. The day-to-day leadership and management of the project package(s) is the responsibility of the AMT which will be headed by an alliance manager who is accountable for ensuring that the alliance meets or exceeds the agreed alliance objectives.

- Options are available to develop the Target Outturn Cost (TOC) in a competitive environment. However, most alliances have tended to use a single party to develop the TOC. In the absence of a competitive environment, this relies on the owner implementing approaches that create appropriate cost, quality and scope tensions and that the right level of expertise to critically validate the TOC, including risk quantification.

Element	Description
Risk allocation	• Alliances are predicated on a no blame and collective assumption of all project risk basis. • The state shares the majority, if not all, of the risks during the design and construction phase with the alliance participants. The extent of the alliance participants' financial exposure to adverse risk outcomes depends on the pain/gain share arrangements but is generally limited to their margin (corporate overhead and profit). The state remains fully exposed to the underlying project delivery costs, including the resultant costs of the occurrence of all project risks.
Payment mechanism	• Under an alliance model, the non-owner parties are typically guaranteed reimbursement of their direct project costs and payment of corporate overheads in an open-book arrangement. • Targets for cost, schedule and other key result areas are developed jointly during the pre-construction phase. If actual delivery (actual outturn cost (AOC)) is better than the agreed targets and performance in all non-cost key result areas, all participants share reward ('gain-share'). Conversely, if delivery does not meet agreed targets, the pre-agreed 'pain-share' formula applies (where the margins of non owner participants will be at risk). • Construction and other costs are paid over the course of the construction period on the basis of reimbursement of cost incurred (monthly).
Interface	• For the purposes of the delivery model assessment, it is assumed that the operator will be part of the alliance (which may include MTM and/or V/Line). • Experience on the recent VicRoads alliances demonstrates that the operator working together in the Alliance with designers, contractors and the department enables the occupations and access regime to be developed in unison, on a best for project (and best for network) basis. • Where the operator is not party to the alliance, the value of the collaborative arrangement and approach to dealing with access and occupation regimes in particular may be lost • Operator approvals required for commissioning will be a smoother process having had the operator as part of the alliance.
General suitability	• These models lend themselves to complex, high risk projects where it is difficult to effectively transfer risk and there is uncertainty around scope definition, design complexity, delivery complexity, and complex interfaces which will influence design and construction outcomes. • The model provides early collaboration of the designer and contractor in the project, providing opportunities to access construction expertise in the development of the design, definition and construction programming. • Success depends heavily upon the attitudes and abilities of the alliance participants (and their individual representatives) to manage the project on a best for project basis.

Public–private partnership (PPP)

- A PPP model may take many forms and provide a range of underlying risk allocations. Generally, a private sector proponent (or consortium) is responsible for the design, construction, operation, maintenance and finance of the infrastructure necessary over an extended period (typically 25–30 years).

- Unlike the traditional and relationship-based models, the PPP model is a long-term, whole of life approach to infrastructure delivery. Risk allocation is determined up front for the period of the contract, including maintaining the infrastructure and providing the services to a pre agreed condition for the duration of the concession.

- The level of detail and specification required of the state is substantial in these approaches. However, as specifications are expressed in output terms, and with a long term whole of life focus in these models, this provides substantial opportunity for innovation. Private sector parties are able to identify different ways to achieve the same outputs, including through the selection of different parties as members of the consortium. The selection of specialist consortium members is crucial for driving innovation in a PPP. Usually consortium members have strong international credentials; thus, they are able to select the best for the particular circumstances and issues.

- Contractual incentives to deliver on time are higher than in other models as the private sector consortium does not start to receive payment from the state until construction completion (payments by the consortium to their underlying D&C contractor(s) are funded by debt and equity finance). This adds a further level of review and rigour by financiers to ensure that what is being offered is able to be at least delivered on time, if not before.

- The whole of life, operational approach for the PPP models and the competitive tension on this basis, provide increased incentives for contractors to identify additional value to the state, bringing expertise to the consortia over and above the traditional design and construction expertise.

- Arranging a PPP agreement requires significant effort, specialist advice, management expertise and support for the delivery agency.

Element	Description
State retained risks	• Risks which would be retained by the state are common to the D&C delivery models including scope/specification risks, site availability and site conditions, land acquisition risks, cultural and heritage, environmental and some planning approvals risks. • As the project concession is for an extended period, the state also bears change in law (excluding some change in law, for example, tax law which is borne by the PPP consortium) and scope change over the concession period (as it would under all models, where it retains the asset ownership risks).
Risks allocated to the Contractor	• The majority of design, construction and maintenance risks on a whole of life basis are able to be transferred to the private sector consortium, which has full ownership risk over the assets. • The private sector consortium has full exposure (of all its capital invested) to the consequences of design and maintenance judgements and trade-offs over the life of the project. • The private sector consortium's financial exposure to these risks is greatest of any of the procurement options being considered as the full service payment from the state would be (1) priced upfront at financial close and (2) at risk for performance over the entire operating period. • The State will only bear the risk that is specifically attributed to it. This means that all

Element	Description
	unspecified risks are borne by the private sector consortium. This considerably lessens the state's exposure to issues/risks not thought of during the formalisation of contracts as it significantly lessens the scope of the possible disputes over issues.
Payment mechanism	• Under a PPP, payments for the project by the state are made by way of service payments once the project delivers the services at the required standard (post-commissioning). The consortium pays its design and construction sub- contractors during construction through private financing, which is then subsequently repaid by the consortium from the state's service payments. • The payment mechanism provides the basis for payment over the term of the concession. The structure of the service payment under a PPP is central to the allocation of risks between the parties and driving performance for the duration of the period. The payment mechanism links with the KPI and service specifications regime and provides for abatements to payments for poor performance during the concession. • PPP model will only be viable if it is an availability type commercial arrangement i.e. a user pay model with the consortium assuming patronage risk is not tenable for this Project.
Interface	• This is similar to D&C during construction. However, as the consortium is committing to a 25–35 year concession, engagement and sign-off from the operator during the tender phase, design development and construction are expected to be more intensive than in the D&C. • During operations, the operator interface will monitor performance of the consortium. The PPP can be structured to define the nature of operator access, which can be full and unrestricted.
General suitability	• The PPP model is suitable where – there is a clear measurable service output against which performance can be measured – there are opportunities for significant effective risk transfer to the private sector (including design, construction and whole of life risks) – there is opportunity for private sector innovation in any or all aspects of the project (design, construction, finance, maintenance and operation) to add value – benefits can be realised through a whole of life approach to design and costing, as there is a strong connection between the specific design, construction materials and the level and type of maintenance costs.