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Abstract

This interim report presents the third phase status of the Business Case Development work under the ELEGANCY project. It further develops the details within the overall methodology that is characterised by a number of steps to i) define the scope of the H_2-CCS chain subject to a particular ELEGANCY case study, ii) perform a focussed market background review and gap analysis, iii) identify business and investment risk and corresponding risk mitigation strategies, and iv) develop business models. Steps i) to iii) are completed. Step iv) is covered in this interim report, which comprises a methodology for H_2-CCS chain business model selection and the commercial structuring required to deliver a new H_2-CCS chain infrastructure. The methodology is generic and has been created for use beyond the ELEGANCY project case studies.

A recap is provided of the methodological approach introduced in reports D3.2.1 and D3.3.2 for the characterisation of the business context of a case study. This is followed by an overview of the business model development and selection framework. The principles of infrastructure investment structures including risk allocation, ownership, funding, and operational responsibility are introduced. The possible roles of the public and private sectors are discussed, including the limitations on what each can and cannot be expected to do. The ELEGANCY methodology distinguishes between system business models for removing investment barriers and operational business models for handling business risks and interactions between business segments within a H_2-CCS chain. The relationship with business case assessment is described in advance of being dealt with in detail in companion report D3.3.4. The report is completed with the details of the business model selection process, elements and tools.

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1 INTRODUCTION

This report will continue the previous work undertaken by Sustainable Decisions Limited ('**SDL**') in ELEGANCY Work Package 3 (WP3) and will focus on developing a framework to support the selection of suitable business models at both system level and business level for H_2-CCS chains by both private and public sector entities.

As indicated in the previous report D3.3.2, the major barrier to deployment of CCS is no longer technological, but political and commercial. In this context, and taking into account the multiple attempts at CCS in Europe over the past 15years, this methodology has been structured to facilitate engagement between public and private sector parties as early as possible for the joint definition of suitable business models and business cases which could be approved by their respective stakeholders (shareholders and the public).

There are numerous definitions of business models in the literature but in simple terms, business models describe how a business or organisational entity creates, delivers and captures value. A business model can also be defined in terms of 'how a business or other organisational form characterises its activities in order to achieve its goals of profit-making or other objectives'[1,2,3]. In another version, Alexander Osterwalder created the Business Model Canvas[4] where a business model is made of 9 elements: key resources, key activities, partners, costs, value proposition, customer relationships, customer channels, customers, and remuneration/revenue.

In the case of European first-of-a-kind (FOAK) or early stage H_2-CCS chain infrastructure such as investigated in the ELEGANCY case studies, we need to consider the business model to be a way to organise and structure all the relevant and material elements of investment, market development and asset operation that can deliver the combined objectives of the public and private sector sponsoring parties.

The choice of a business model will depend on a number of factors; the technological and organisational capabilities of the entities and their competitors, the stage of maturity of the relevant markets, the wider social, economic and institutional context including policies and incentives. There is a vast array of traditional forms of business models for infrastructure investment, each host country having their own cultural and historical preferences. In addition, these models are also ever-changing to adapt to the challenges of the external environment at any given time. Infrastructure investment is quite unique and

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[1] Bryson, J., Pike, A., Walsh, C., Foxon, T., Bouch, C., Dawson R., 2014, *Infrastructure Business Models (IBM) Working Paper*, iBUILD programme, Newcastle University, University of Leeds, University of Birmingham, https://research.ncl.ac.uk/media/sites/researchwebsites/ibuild/BP2%20-%20Infrastructure%20business%20model%20definition_DRAFT.pdf, accessed 29th March 2019

[2] Teece, D., J., 2010, *Business Models, Business Strategy and Innovation*, Long Range Planning 43, 172-194, Elsevier, http://www.businessmodelcommunity.com/fs/root/8jig8-businessmodelsbusinessstrategy.pdf, accessed 29th March 2019

[3] Zott C., Amit R., Massa M., 2011, *The Business Model: Recent Developments and Future Research*, J Management 37:4, 1019–1042, http://www.cse.tkk.fi/fi/opinnot/T-109.4300/2013/luennot-files/Zott%20et%20al.%20-%202011%20-%20The%20Business%20Model%20Recent%20Developments%20and%20Future%20Research.pdf, accessed 29th March 2019

[4] Osterwalder A., Pigneur Y., 2010, *Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers*, (Wiley Desktop Editions), Wiley, Hoboken, New Jersey

requires business models that can address its specific characteristics: requirement for major upfront capital investment, long term revenue streams, public involvement, natural monopolies, and complex value delivery (economic, social, environmental value in addition to financial returns).

Technical, policy and commercial innovation is essential in the case of first-of-a-kind project with the creation of new markets. Therefore, the framework developed in this report aims to offer the user the flexibility to define the most appropriate business models for his or her investment opportunity or case study. The framework includes a number of fundamental building blocks combined with the information gathered on business context and risk from the earlier stages of the ELEGANCY process. At the same time the business model selection is guided by existing traditional business models but without being constrained by them.

The first steps of the ELEGANCY business model selection and development methodology concentrated on the relevant business background assessment (legal and regulatory, macro-economic and fiscal, market and public policy), and on the identification and mitigation of major business risks and investment barriers. The chapters herein will focus on step 4 of the methodology, i.e. the selection of appropriate business models (at system and business level) to create an investable business proposition from both a public and private perspective. This report is a companion report to the ELEGANCY report D3.3.4, which details the business case development and assessment process for any given business model.

Finding a suitable business model requires a complex and tailor-made interaction between the public and private sector to define the right ownership, funding (capital and operating) structure and allocation of risks and responsibility. Specific guidance will be provided (along with an Excel based business model selection tool) with reference to the main drivers for business model selection, the risk allocation and transfer of responsibility between public and private sector, main types of public/private business structures available, key types of contractual relationships and agreements to support the user.

The report presents:

- the overall methodology (and supporting business model selection tool) to guide the selection of potential business models from the information collected and analysed from the business context assessment and risk assessment;
- guidance on the main types of financial structures classified by their types of ownership, financing and revenue streams;
- guidance on the main types of commercial agreements and terms; and
- the main operability parameters and risks that impact the commercial agreements.

This report is structured as follows.

Chapter 2 recaps the methodological approach introduced in reports D3.2.1 and D3.3.2 and extends the overview to the business model selection process presented in this report. It is complemented in Appendix A with a compilation of business risks and mitigation measures provided through consultation with CCS experts and practitioners.

Chapter 3 provides a detailed review of private/public business structures that can be considered for the selection of a H_2-CCS business model in different jurisdictions and case studies.

Chapter 4 summarises some of the principal operability conditions that can influence business risk handling in H_2-CCS service contracts, and which have an impact on business models. It is complemented in Appendix C with a greater level of detail of the terms handled in typical commercial contracts.

Chapter 5 presents the business model selection process in detail with guidance on each one of the process steps.

A complementary Excel spreadsheet tool for business model selection has been added to the ELEGANCY WP3 tool-kit.

2 METHODOLOGY

2.1 Summary

In this chapter, the report will present:

- A recap of the overall methodology and principles of risk allocation:
  - definition of the project/case study parameters including the metrics to assess the value delivered (report D.3.2.1)
  - focused assessment of the business context from a macro-economic, legal, market and policy perspective (report D3.2.1)
  - identification and mitigation of the main major business risks and investment barriers (report D3.3.2)
- Distinction between system-level business model and operating-level business model;
- Principles for classification of public/private business structures as reference for business model selection;
- Principles for guidance on commercial structures and key commercial terms; and
- Principles for business model selection and business case assessment

2.2 Business Model Development Methodology (Recap)

The flowchart in Figure 2-1 presents the overall methodology developed and applied by WP3 to select business models for H_2-CCS opportunities (see ELEGANCY reports D3.2.1 and D3.3.2). A business case can be defined and assessed once a business model is selected. The ELEGANCY business case assessment methodology (presented in report D3.3.4) is therefore applied to business models chosen through the process described herein. As business model preferences can change with changing business contexts as well as with the maturity of a project, the combined selection and assessment process is iterative, but follows the same steps and analysis at fit-for-purpose levels of detail.

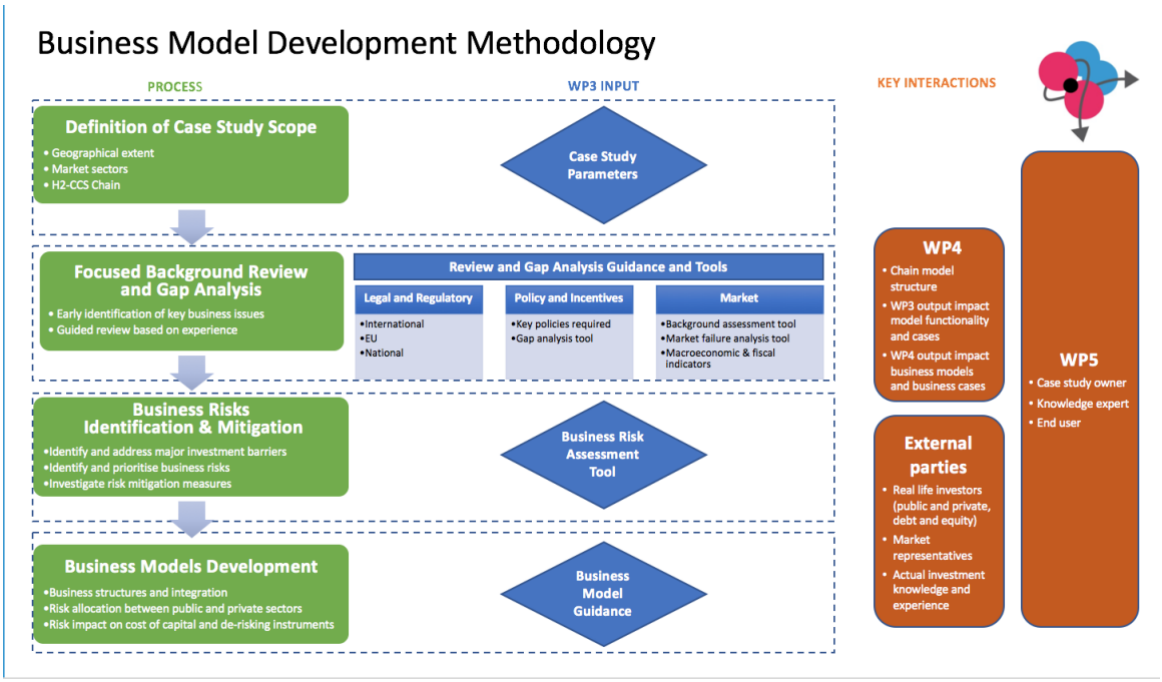

Figure 2-1 Business Model Development Methodology

The Business Model Development process is divided into four distinct steps:

Step 1: *Definition of the scope of the particular H_2-CCS chain for the relevant case study*

The process commences with an initial focus on the specific H_2-CCS chain technical sub-components, business segments, and associated market sectors of main interest, the geographical extent (including industrial hubs, production facilities, storage areas, end-users, cross-border interactions, etc.), and market potential.

First Climate and Sustainable Decisions have created a standardised framework for any case study lead organisation to use in this first step that matches the needs of the scope definition exercise described above. This framework comprises the technology elements and market sectors, a H_2-CCS chain business tree, and an extensive set of potentially relevant case study parameters (described in report D3.2.1). This framework and analysis are to be used side-by-side with the scenarios and quantitative estimates of market potentials undertaken in Work Package 5 *Task 5.1 Interfaces* and reported in D5.1.1.

Step 2: *Focussed market background review and gap analysis*

The purpose of this second step is to guide an overall assessment of the market background for any case study in preparation for the third step of understanding the investability and handling of major business risks. The major barriers and business risks that are faced by potential developers and financiers in the H_2-CCS business chain have been identified by stakeholders to be non-technical, and robust economic scrutiny is essential for any large-scale infrastructure investment. Technology components within the H_2-CCS infrastructure chain and end markets exist and have proven functionality. Hence, investing in, and delivering, low-carbon hydrogen using CCS at scale requires an understanding of the risks associated with government policy, market development, and regulatory frameworks. Full chain operability issues are another area of risk that is dealt with in Step 3 below.

A set of Excel spreadsheet tools (Report D3.2.1 and Report D3.3.2 Appendix A.1) has been designed and produced, based on the project development experience gained over a number of years in countries such as Netherlands, Norway and UK, to facilitate a simple high-level analysis of the major drivers for each of the H_2-CCS chain market sectors and business segments. The market background includes the legal and regulatory environment, the market fundamentals and applicable market failures, key macroeconomic drivers, the policy status and financial support mechanisms. An important aspect of this assessment method is the requirement to include thinking and review of the interactions between different market players reflected in the chain business segments.

Step 3: *Business and investment risk identification and mitigation*

Based on the information gathered during step 2, the third step is to identify and quantify the major business risks that impact the level of investment potential for each of the market sectors and business opportunities from both a public and a private sector perspective. A bespoke risk assessment spreadsheet tool has been designed (Report D3.3.2 Appendix A.2) that can be applied to any individual or bundled business opportunities along the H_2-CCS chain selected from the standardised business tree.

Section 2.4 of report D3.3.2 describes the risk assessment methodology in more detail. In summary, assessable risks are divided into:

1. Investment Barriers: these are circumstances or facts that raise the risk of detrimental investment outcomes to an unacceptable level for any type of investor. Generally, these barriers will affect multiple segments along the chain, or the whole chain, and require a 'system view' and multi-party (often in collaboration with government) approach to mitigation measures. These barriers need to be addressed in priority for any investment to be possible; and
2. Major Business Risks: these are risks that impact cost, revenue, liabilities, financing, schedule and therefore the risk/return equation for a final investment decision (FID). Individual businesses will generally be capable of mitigating these through familiar technical, commercial, insurance and other standard measures.

This step facilitates an early identification and prioritisation of risks to be addressed by a case study lead organisation and guide the subsequent communication and conversations with potential private investors and public/government organisations. Appendix A contains a summary and examples of principal investment barriers, business risks and mitigation measures for a H_2-CCS chain[5].

Step 4: *Business model development*

The fourth step in the method focuses on how to remove the investment barriers and mitigate business risks, and to select appropriate business models for any given case study. Chapters 4-7 of Report D3.3.2 deal with the principles and elements used in the methodology. This report D3.3.3 completes the methodology with a description of the business model selection process, its relationship with preparing and assessing a business case, and a business model selection tool. When applied to case studies, the outcome will be the development of a number of viable commercial structures and business models, investigation of the potential investor mix and the allocation of risks between those investors for each of the market opportunities, the de-risking mechanisms required from the financial and carbon markets and from the EU and national governments.

[5] The tables in Appendix A have been prepared in conjunction with the Zero Emissions Platform (ZEP) Temporary Working Group on 'Collaboration Across the CCS Chain' and discussed in detail by experts at the joint ELEGANCY WP3-ZEP workshop held in Brussels, 18th September 2018.

2.3 Risk Allocation

This section recaps the principles of risk categorisation and allocation defined in the previous report D3.3.2.

For the purpose of WP3, investment risks were grouped using the classification system of the Climate Policy Initiative[6] and based on the OECD risk sharing model[7]. The four categories of risks are presented in Figure *2-2*.

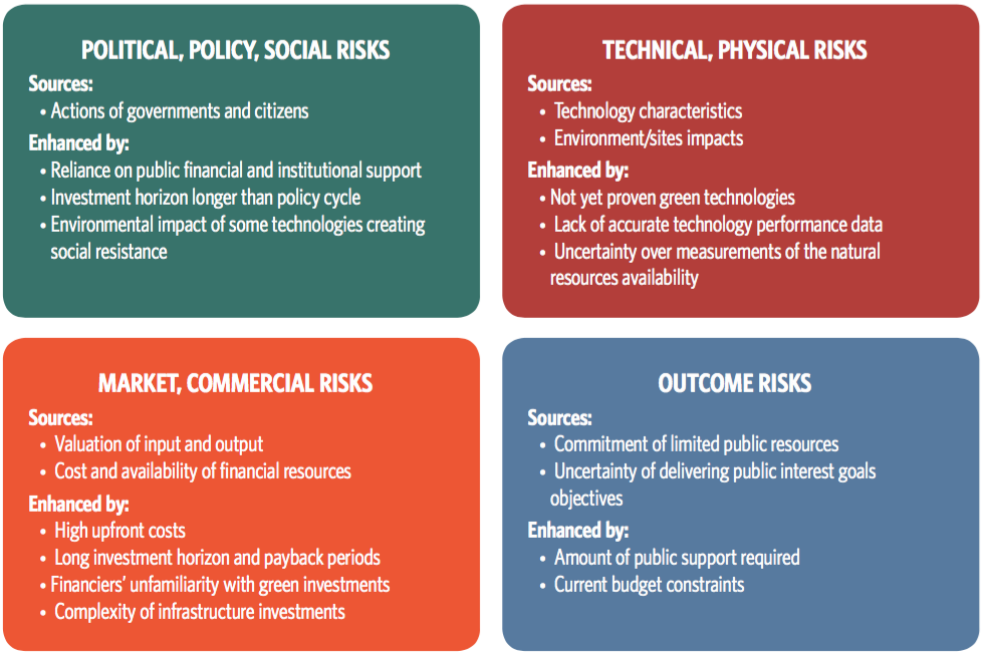

Figure 2-2 Risk Classification (after CPI[8])

In a first step, the risk assessment exercise, as described in step 3 of the methodology and using the classification above, allows the users to identify the investment barriers and major business risks that need to be addressed through some form of government intervention and through a coherent ensemble of risk allocation and mitigation measures that will form a core component of the final business model.

The report explained the main principles of risk allocation. Risk allocation determines not only the attractiveness for equity, debt and government investors of a given project (acceptable rate of return, financeability, value-for-money), but also whether it will be able to remain viable through to the end of a long-term contract. These key principles are:

- Risks should be allocated to the parties best suited to manage them and at the lowest cost;

[6] Climate Policy Initiative (CPI), 2013, *Risk Gaps: A Map of Risk Mitigation Instruments for Clean Investments*, http://climatepolicyinitiative.org/wp-content/uploads/2013/01/Risk-Gaps-A-Map-of-Risk-Mitigation-Instruments-for-Clean-Investments.pdf , accessed 29th March 2019

[7] OECD, 2008, *Public-Private Partnerships: In Pursuit Of Risk Sharing And Value For Money*, http://www.oecd.org/gov/budgeting/public-privatepartnershipsinpursuitofrisksharingandvalueformoney.htm, accessed 29th March 2019

[8] CPI, 2013, op. cit.

- Risk allocation should consider not only who is the best party to manage the occurrence of the risk but also the outcome of the risk (and its ultimate cost);
- Risk allocation should be informed by market conditions.

In general, exogenous risks such as political, policy, social and outcome risks are difficult to manage for private parties who have limited control over their occurrence and their impact and better allocated to the public sector. Endogenous risks such as mature market and commercial risks and technical and physical risks are generally better borne by the private sector. However, this remains flexible and risks are often mitigated by a combination of measures from both public and private sectors.

In any given situation, there will be a number of viable commercial structures and business models, which will depend on the potential investor mix and the allocation of risks between those investors for each of the market or business segment opportunities in the H_2-CCS chain, the de-risking mechanisms required from the financial and carbon markets and from the EU and national governments.

A bespoke risk mitigation heat map tool was developed to guide the user and facilitate this risk allocation/mitigation exercise. The tool provides a visual representation of the main business risk categories that impact the investability/risk profile of the project and the preferred mitigation party for each of them along with the main mitigating instruments.

In addition, a supplementary template has been developed to focus on the main investment barriers for any given project and identify the actors who can intervene to remove such barriers. An illustration of this 'collaboration' template is provided in Figure *2-3* below:

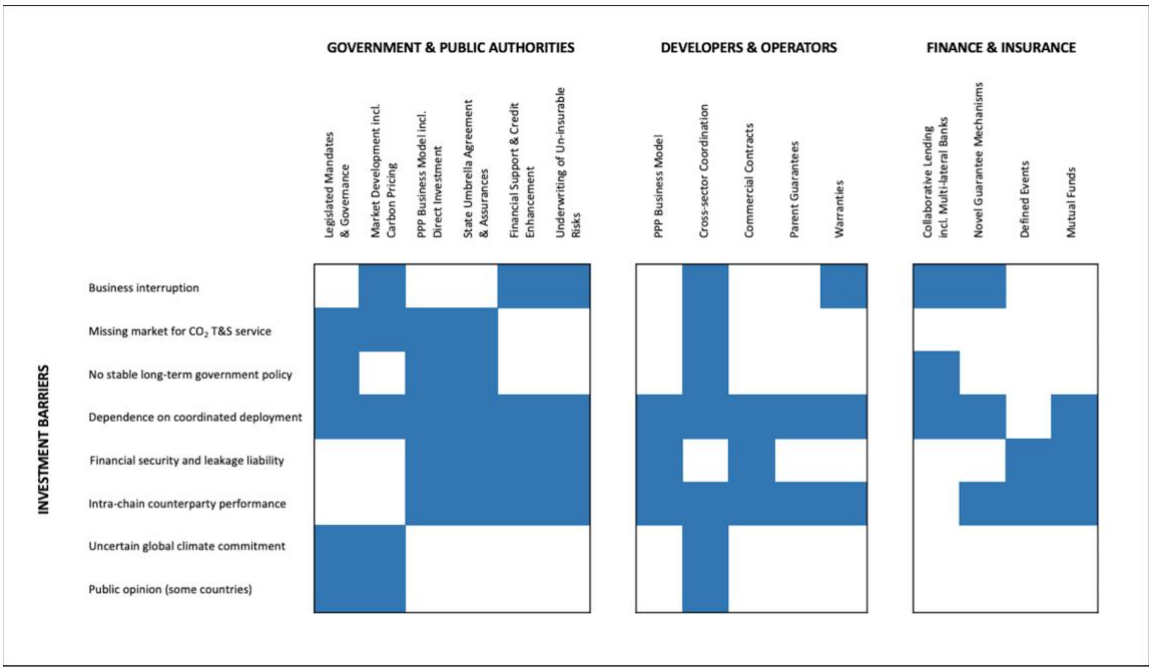

Figure 2-3 Investment Barrier Mitigation Collaboration Matrix

2.4 Defining Business Models

Substantial confusion and ambiguity have arisen around the term 'business model' in the CCS community and in the preferences of different CCS stakeholders for the deployment of CCS infrastructure. Some exponents use the term to mean revenue and revenue support structures. Some use it to mean the split of ownership between the public and private sector. Some focus on market creation and development models. Others combine all the necessary ownership structures and policy and fiscal/financial support mechanisms required to facilitate delivery of FOAK or early stage projects. Still others distinguish between sectors such as 'industrial CCS', 'electricity generation with CCS', or 'CO_2 transport and storage'.

Different perspectives between the public and private sectors have influenced CCS dialogue and policy development with respect to business models. The public sector (Government) is looking to cost effective and 'affordable' solutions for dealing with emissions targets and therefore necessarily focusses on macro-economic and fiscal impacts of intervening or investing in infrastructure development. Private sector organisations must ensure shareholder funds are deployed in ways that provide appropriate returns either in the short term or over a longer-term strategic horizon. Hence each looks to a business model that delivers the business case which justifies their involvement. Finding alignment between these has been difficult for FOAK and early stage CCS infrastructure projects.

In order to create some clarity within the ELEGANCY WP3 methodology we differentiate between system or macro-economic business models and business segment or micro-economic business models (Figure 2-4). System business models are the combined elements, structures and mechanisms that can overcome barriers to investment by both the public and private sectors for the development and utilisation (through market creation) of a full chain H_2-CCS infrastructure. Operational business models are the organisational forms and combined elements, structures and mechanisms that deliver the outputs and services for a particular business segment within the H_2-CCS chain while both mitigating the risks that the business activity faces and providing a return on funds deployed.

Section 4.5 of ELEGANCY report D3.3.2 discussed the principles of risk allocation and in particular introduced the CPI framework[9] of endogenous and exogenous risks as an approach to risk sharing in public-private partnerships (ref. Section 2.3 above). Building on report D3.3.2, we identify the system business model as the principal means for the mitigation of exogenous risks (including political, policy, social and outcome risks) that cannot in general be managed by the private sector alone. The operational business model is identified with mitigating endogenous business risks (market, commercial, technical and physical risks) that the private sector can manage. There is an interaction between the two when outcome, market and commercial risks must be shared between public and private sectors. How this is done, and with what preferences, is the interface between the two scales of business model. In other words, the system business model provides a macroeconomic solution that enables investment and activities to take place at the operational business segment level. What can't be resolved at the operational business

[9] CPI, 2013, op. cit.

level will need to be supported at the system level because the whole infrastructure chain is affected.

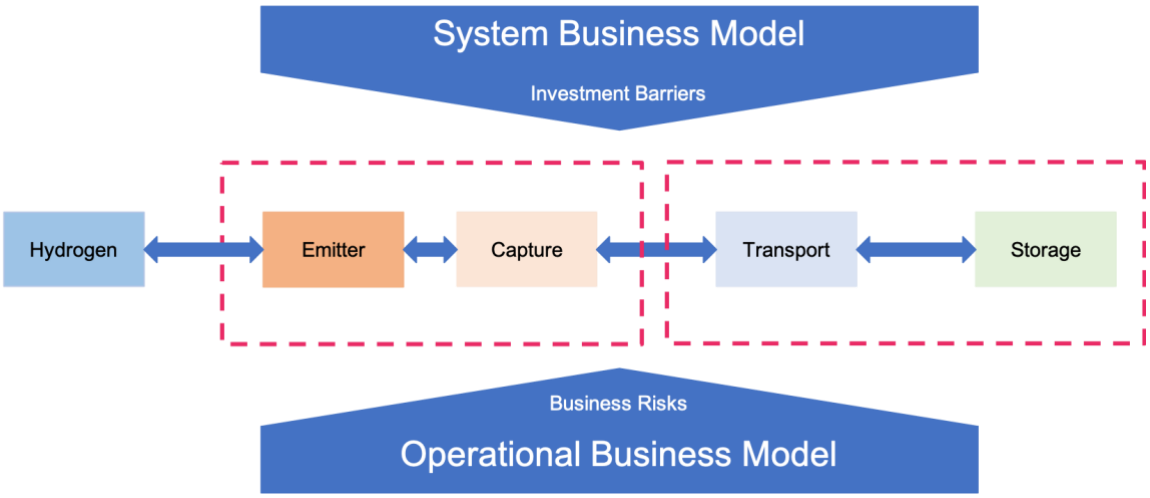

Figure 2-4 Business Model Characterisation

Each scale of business model in Figure 2-4 has an associated business case, the metrics for which are tailored to the drivers and outcomes required of the case study or project. In Section 2.8 we describe the interaction between selecting business models and assessing their associated business cases within the ELEGANCY methodology.

2.5 Drivers for Business Model Selection

The following steps have been codified in the selection process and included in the ELEGANCY Excel spreadsheet tool accompanying this report (see also Chapter 5):

- Background Review and Gap Analysis key issues. Comparison between public and private sector assessments – identify overlaps and differences
  - Principal market/macro-economic drivers
  - Investment barriers
  - Risk heat map
  - Policy Needs heat map
  - Intervention measures - Public vs private sector preferences
  - Mitigation measures - Public vs private sector preferences
  - Outstanding regulatory concerns;
- From the analysis identify major or material differences between the public and private sector views– these become priorities to address in the business model solutions;
- Understanding the above at system level and individual chain components/business sectors provides guidance on boundaries between 'conventional' business investment solutions/decisions (BAU) and those presented by the H_2-CCS chain in a case study;
- From the above analysis, a number of key business model drivers can be extracted and tested against what would be required to deliver the various dimensions of a business case. These are most relevant to prioritise actions for developing the risk sharing and allocation solution;

- The previous step is conducted at system level first and then at business segment level – this can be iterated to ensure consistency.

EU level legislation can impact preferences and feasibility of selection of business models so various checks need to be performed on the application of various legal requirements (see also ELEGANCY Report D3.1.1):

- Selection of private partner, issues of equality of treatment of candidates and transparency;
- Fixed term contracts, leases, support etc. so as not to limit competition beyond what is required to pay off investment with return;
- Implications of step in clauses in case of failing to deliver - limiting call for competition;
- Unregulated contractual changes;
- Possibility to add work without a call for competition;
- EU community law on public contracts and concessions; and
- Additional concepts/inputs taking account of jurisdictional preferences.

Some examples of the principal drivers for business model selection are summarised in the following two tables.

Table 2-1 Drivers for system business model selection

Category	Business Model Driver
Institutional	○ Energy policies (and policy gaps) and government commitment ○ Energy policy incentives (and gaps): funding (direct or indirect), ○ Infrastructure creation/development policies (and policy gaps) ○ Infrastructure investment incentives (and gaps): government guarantees and other forms of indirect support ○ Capacity of public sector to implement different types of PPP ○ Adequacy of country institutional framework for different types of PPP
Financing (private)	○ Country attractiveness for infrastructure/energy investment ○ Availability of bank financing ○ Cost of financing infrastructure ○ Types of infrastructure finance available: green bonds/infrastructure bonds/traditional bank financing
Financing (public)	○ National debt levels ○ Budgetary constraints ○ Fiscal rules and constraints ○ Accounting Rules and Considerations ○ Availability of public financing (bonds)

Category	Business Model Driver
Macroeconomic	○ Impact of national carbon pricing model on private sector business decisions ○ GDP per capita and growth ○ Inflation ○ Energy demand and forecast (for relevant sector: heating, electricity, industrial, etc.) ○ Population growth ○ Unemployment rate (average, geographical distribution) ○ Emissions (total, growth)
Legal	○ Adequacy of legal framework in country to implement different types of PPP ○ Cross border waste management – extent of legal constraints on H_2-CCS chain ○ State aid – extent of constraints on public sector incentivisation ○ Environmental liability – extent of legal constraints on private sector investment
Existing business models for infrastructure investment	○ Extent of public sector ownership of utilities for provision of key energy services ○ Existing balance between state owned provision and private ○ Extent of pre-determined preference from government for a specific business model for infrastructure service provision and delivery ○ PPPs in-country - level of experience (% use) ○ Use of RAB model in country - Level of experience ○ Availability of contractual framework for infrastructure investments
Societal	○ Extent of public perception of H_2 as low carbon energy source ○ Extent of public sentiment with regard to environmental and health issues and willingness to pay for related benefits ○ Extent of trust in oil and gas companies to deliver low carbon energy future

Table 2-2 Drivers for sectoral business model selection

Category	Business Model Driver
Market Development	○ Level of market maturity (high: established, medium: developing, low: new) ○ Extent of market regulation ○ Market competition structure and regulatory environment (high: merchant, medium: regulated, low: monopoly) ○ Market demand, and evolution (growth/decline) ○ Extent of market failures
Physical and Technical	○ Existing physical assets and opportunities for re-use ○ Geographical distribution of potential customers and assets (extent of clustering) ○ Technology maturity

Category	Business Model Driver
	○ Capacity of private sector to manage physical activities and manage unforeseen activities
Societal	○ Extent of positive/negative public perception of each of the relevant industries/sectors ○ Extent of trust in private sector to deliver services

2.6 Infrastructure Investment Structures: Role of the Public and Private Sectors

In the same way as risk categories were classified in report D3.3.2 in four main categories to facilitate the risk assessment exercise, guidance is provided in this section to classify infrastructure investment structures according to a number of key principles. This presentation and classification are designed as guidance for the user to select a suitable structure which addresses the business risks and investment barriers. A number of key traditional investment structures and their strengths and weaknesses are detailed in Chapter 3.

The main axis to classify those structures is the degree of transfer of responsibility and risks from the public sector to the private sector. On one end of the spectrum, the public sector retains all responsibility for the ownership, financing, and all the physical activities. On the other end, all these responsibilities are transferred to the private sector without any public sector intervention. In between, there are many types of arrangements where those responsibilities are split between the public and private sector.

The structures can be classified according to four main components of the transfer of responsibility (Figure 2-5).

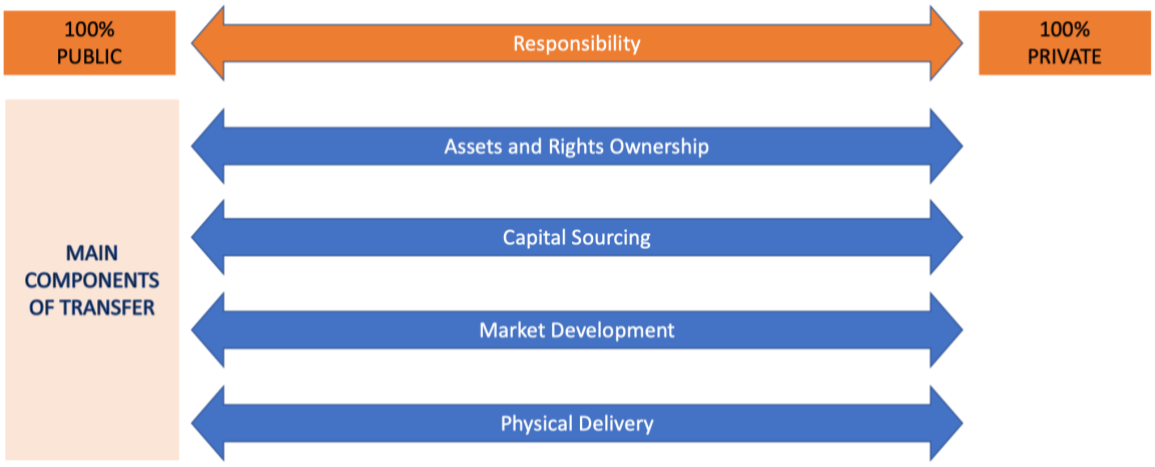

Figure 2-5 Main components for investment structures in the transfer of risk and responsibility from the public sector to the private sector

These components are defined as:

- *Assets and Rights Ownership*: 100% public, 100% private, Joint Ventures, mixed shareholding, split asset ownership and usage rights;
- *Capital Sourcing*: public sector, private sector (debt, equity), international funds, export credit agencies, and any combination;
- *Market Development*: market maturity, and who is responsible for market development where the market is immature or does not exist, dictates the capacity of the economic system to remunerate or create value for the participants. Remuneration ranges from direct and/or indirect support from fully government-based revenue to fully market-based revenue (no support). Mechanisms include service-based payments, performance-based (availability, capacity) payments, regulated returns on capital and operating costs, regulated tariffs, demand-based payments, market-based revenue with government support (such as contract for differences, feed in tariffs, renewable obligation certificates); and
- *Physical Delivery*: the extent of the activities transferred to the private sector (design, build, operate, maintain, or any specific services).

There is a vast range of variations based on multiple combinations of the components above to allocate the risks and responsibilities appropriately.

2.7 Commercial Agreements

For completeness the methodology includes summaries of operability issues and key commercial terms that may help with understanding how contract structures can address business level risks and use commercial arrangements:

- for the transfer of responsibility between the public and private sector;
- for the provision of the main industrial services through the H_2-CCS chain.

2.7.1 Public Private partnership agreements

As explained in Section 0 above, there is a vast number of investment structures combining private and public sector involvement. The World Bank has developed a useful reference database of documents and tools which are available on its website. This includes contractual templates for a number of those public/private structures[10]:

- Service contracts
- Management/operation and service contracts
- Leasing
- Build Own (BO), Build Operate Transfer (BOT)

2.7.2 Standard Operating Agreements

A number of commercial agreements for the main business sectors of the H_2-CCS chain (sourced from similar energy sectors) have been reviewed and key commercial terms discussed in Chapter 4 in three categories (service and payment, operability and performance, and liabilities, warranties and indemnities) and summarised in greater detail

[10] World Bank Group, *Public Private Partnership Legal Resource Centre (PPPLRC)*, 2019, https://ppp.worldbank.org/public-private-partnership/standardized-agreements-bidding-documents-and-guidance-manuals , accessed 29th March 2019

in Appendix C. The transportation terms and conditions have been based on a common carrier, third party access model. Contract structures include:

- H_2 Production tolling agreement;
- H_2 or CO_2 Pipeline Transportation service;
- Long Term Hydrogen Sale and Purchase Agreement;
- CO_2 storage service; and
- H_2 inter-seasonal storage service.

2.8 Business Model Selection and Business Case Assessment

At the heart of the ELEGANCY methodology for business model selection and its associated business case assessment is an iterative development process analogous to the typical investment/development stage gate and decision-making progression for a major infrastructure project. The business model selection process is described in this report in detail in Chapter 5. Sections 2.2 and 2.5 above highlighted how this selection process takes account of all inputs derived from WP3 tools and assessments of the business, investment and risk context along with relevant drivers for a case study. A flow chart of the process is shown in

Figure 2-7. The business case development and assessment processes are the subject of report D3.3.4 '*Detailing the guidelines for the assessment and application of the business case templates in WP5*'.

2.8.1 The Relationship Between Business Models and Business Cases

Section 2.4 introduced the principle that to make a business case for an investment proposition, or strategic macroeconomic objective, there needs to be a business model that describes how the outcome will be achieved and what mechanisms will mitigate risks and support delivery actions. The business model selection process therefore has a link to the metrics that will define its corresponding business case.

The iterative process previously discussed, and used in the ELEGANCY methodology, is summarised in Figure 2-6 below. Decision gates refer to points at which decisions are made to undertake increasingly more detailed work and increasing expenditure on project and policy design and development. For the ELEGANCY case studies, there will only be one initial pass through the process in order to advance the proposals to a point where there is useful input to government and industry stakeholders as per the ERA-NET ACT objectives.

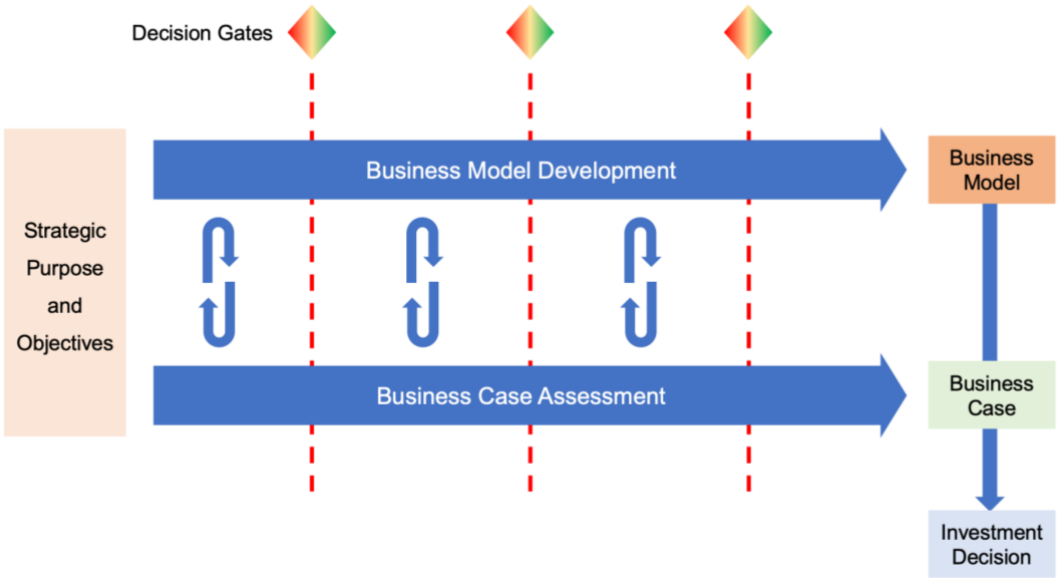

Figure 2-6 Iterative Development of Business Investment Decision

Business model development and selection is based upon the drivers that have been tailored to the strategic purpose and objectives of a case study or infrastructure project. The information on business context resulting from the detailed risk and policy assessments undertaken in previous steps of the method is used to determines stakeholder preferences for the investment and commercial models that form the basic structure of both the system business model (for removing investment barriers) and the operational business model for high priority business segments that interact with, or have an impact on, those barriers.

Once an allocation of risks and mitigation measures has been made between relevant stakeholder entities, a business case assessment can be undertaken. Depending on the outcomes of this assessment it may be necessary to review the business model and modify its structure and mechanisms. In some cases, it may also be necessary to revisit the business context analysis to alter or vary the associated stakeholder preferences. This can

lead to a different business model being selected. The business case is then again assessed. The process can repeat until stakeholders converge on an agreed outcome.

Figure 2-7 below represents the main steps of the iterative process between business model selection and business case assessment.

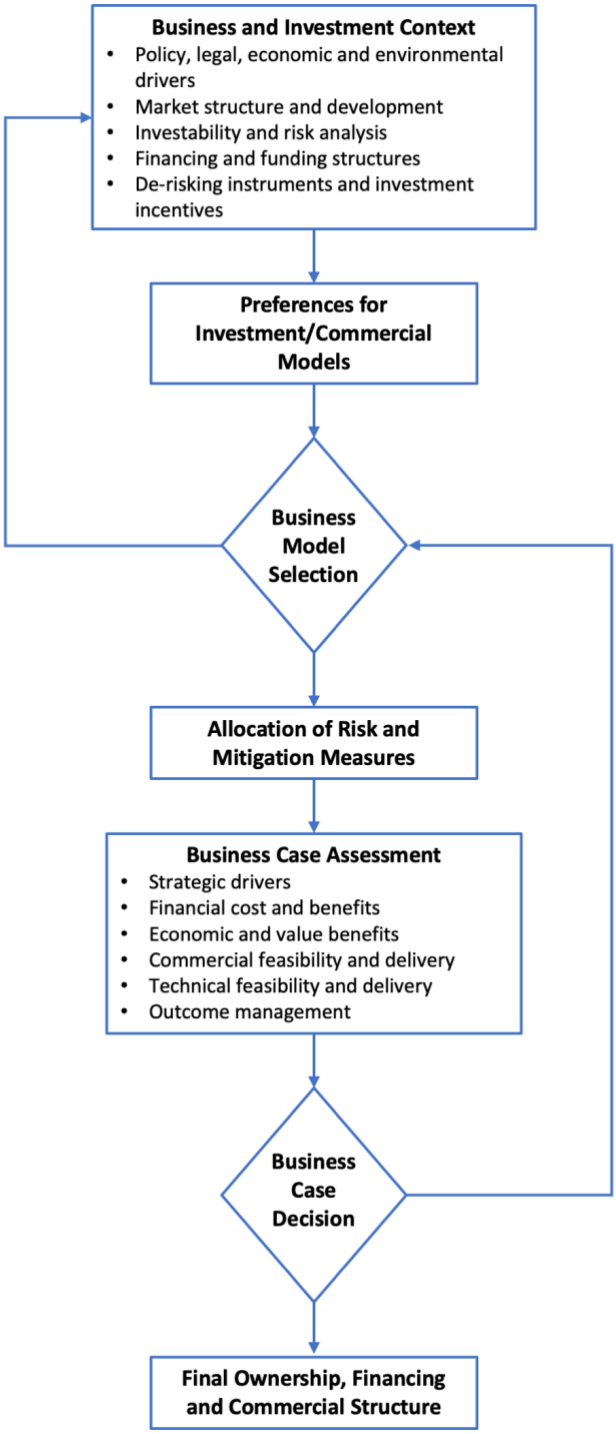

Figure 2-7 Business Case Development Process

2.8.2 Business Models with Bundling or Integration

In contrast to the mature natural gas markets in Europe, deployment of the first H_2-CCS infrastructure and operations may actually require some bundling in order to remove investment barriers, provide market-making certainty for operators, and generally reduce commercial risks, including counterparty risk.

Table 2-3 is an example of business bundling options, or business combinations, for the H_2-CCS chain. For each business segment in the H_2-CCS value chain shown vertically on the left of the table, an indication is given as to whether public and/or private sector participation is likely or even warranted for that segment (a cross represents unlikely participation and a tick represents likely participation). The right-hand columns of the table under the heading 'Possible Business Combinations' show bundling choices that could be selected by investors/operators. For example, the vertical shading in the first column outlined by the red rectangle indicates that the business of H_2 retailing is combined with the business of H_2 distribution. In this particular case further granularity in bundling options could be envisaged due to the possible different H_2 market segments and distribution infrastructure associated with them.

Table 2-3 H_2-CCS value chain example business bundling options.

	Public Sector Delivery	Private Sector Delivery	Joint Public-Private Delivery	Possible Business Combinations
H_2 Retail	✓	✓	✓	
H_2 Distribution	✓	✓	✓	
H_2 Storage	✗	✓	✓	
H_2 Transmission	✓	✓	✓	
H_2 Import/Export	✓	✓	✗	
H_2 Production	✗	✓	✗	
CO_2 Capture	✗	✓	✗	
CO_2 Gathering	✓	✗	✓	
CO_2 Transmission	✓	✗	✓	
CO_2 Storage	✓	✗	✓	

Viewing the value chain in this way facilitates an exploration of the options for acceptable risk allocation between parties and where policy and regulatory gaps or improvements may be required. This business option framework can also be used to understand interfaces between the H_2-CCS chain and other parts of the energy system that will influence delivery

and scale of the two networks. For example, various possible business combinations within the hydrogen network will interact with the transport sector; and various business combinations within the CCS network will interact with industrial utilisation of CO_2 and H_2 as feedstock. Furthermore, there may be business and risk mitigation benefits from cross-ownership of different segments of the chain in order to facilitate investment and operability. Such ownership structures have been used effectively in the international LNG industry.

In Section 2.5 we highlighted that European legislation can impact preferences and feasibility of application/selection of business models. Integrating business segments in the H_2-CCS chain is an important example of this. Whilst the FOAK infrastructure required to deploy H_2-CCS in the ELEGANCY case studies may benefit substantially from business segment bundling or cross-ownership, this would require business models that are in contravention of the EU Gas Market Directive 2009/73/EC: unbundling energy suppliers from network operators. The European Commission's description of the market legislation under this directive states[11]:

"*Unbundling is the separation of energy supply and generation from the operation of transmission networks. If a single company operates a transmission network and generates or sells energy at the same time, it may have an incentive to obstruct competitors' access to infrastructure. This prevents fair competition in the market and can lead to higher prices for consumers.*

Under the third package, unbundling must take place in one of three ways, depending on the preferences of individual EU countries:

- *Ownership Unbundling: all integrated energy companies sell off their gas and electricity networks. In this case, no supply or production company is allowed to hold a majority share or interfere in the work of a transmission system operator;*
- *Independent System Operator: energy supply companies may still formally own gas or electricity transmission networks but must leave the entire operation, maintenance, and investment in the grid to an independent company;*
- *Independent Transmission System Operator: energy supply companies may still own and operate gas or electricity networks but must do so through a subsidiary. All important decisions must be taken independent of the parent company.*"

Hence, what may appear to be optimal business models for a given case study ownership and operational requirements will need to be checked against legislation and regulations at both European and national level. Different modes of H_2 production and/or supply may lead to effective competition and obviate the need for unbundled structures. On the other hand, if regulations are not fit-for-purpose to deliver H_2-CCS chains in a cost-effective and optimal manner, then they may need carve-outs or changes for FOAK infrastructure until such time as sufficient hydrogen and/or CO_2 disposal market maturity materialises.

[11] European Commission, 2019, *Market Legislation*, https://ec.europa.eu/energy/en/topics/markets-and-consumers/market-legislation, accessed 29th March 2019

3 PRIVATE/PUBLIC BUSINESS STRUCTURES FOR THE SELECTION OF A BUSINESS MODEL

3.1 Overview

Following from the discussion in Section 0, this chapter will introduce and present the main types of existing business structures in the context of infrastructure investment in order to provide a useful reference point for the selection of business models in the projects/case studies. Such structures represent major building blocks of any business models both for the overall system and for the individual business sector and are critical in the allocation of responsibility and risk between the public and private sector, to secure the necessary investment and stakeholder approvals. They will be presented briefly with their key characteristics, advantages and disadvantages and categorised according to four main components: ownership, financing, market development (including revenue structure), and responsibility for operational activities. Examples (based on UK experience) will be provided to illustrate the use of these structures.

There is a large number of variations in the detail of these structures, and complex structuring can be used to fine tune them. In addition, these structures are also the subject of continuous innovation to adapt to the external investment environment, jurisdiction, and macro-economic conditions. However, this chapter only focuses on the main structures to facilitate the high-level business model definition and engagement between public and private sector entities rather than the numerous detailed variants discussed at later stages of project development.

The objective is to provide general guidance and a list of high-level options for the business structures to be used when applying the business model selection methodology. The chapter will also provide an overview of the process of debt financing along with characteristics/drivers to be aware of. This aspect of business model selection is important because private sector finance will always look at how the participants in a project are sharing the risks, and any loan decision making process must be harmonised with, and complementary to, the project sponsors' decision processes.

3.2 Private/Public Business Structures

The main classes of business structures[12,13,14,15,16,17,18,19,20] will be presented below with their key characteristics and advantages and disadvantages. These classes illustrate various levels of transfer of responsibility and risk between the public sector and private sector, and therefore offer a range of options for the allocation of risk between the parties.

3.2.1 100% Public Responsibility

At one end of the spectrum, the public sector retains all responsibility for financing, constructing, operating and maintaining assets, including the responsibility for assuming all associated risk. The government may carry out traditional public procurement activities for specific services such as the design and construction of assets, or specific operation and/or maintenance services. The public sector retains complete control over the delivery of the service and full operating responsibility at all times.

For most of the 20th century, the traditional approach for the delivery of infrastructure projects and services was the design-bid-build model which separated the process into three distinct phases. In this model, there is a separation of responsibilities between each of the phases: an independent adviser is appointed for the design phase, the public sector retains the responsibility for the bidding process (with the support of relevant specialist advisors) and a private contractor is awarded the construction of the project.

This traditional model had a number of inherent issues:

- operating inefficiencies and 'gold plating' of the assets constructed;
- a tendency to lack of, or low level of, innovation; and

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[12] Foxon, T.J., Bale, C. S. E., Busch, J., Bush, R., Hall, S., and Roelich, K., 2015, *Low carbon infrastructure investment: extending business models for sustainability*, https://infrastructure-complexity.springeropen.com/articles/10.1186/s40551-015-0009-4, accessed 29th March 2019

[13] Ernst & Young, 2015, *Infrastructure Investments: An attractive option to help deliver a prosperous and sustainable economy*, https://www.ey.com/Publication/vwLUAssets/EY-infrastructure-investments-for-insurers/$FILE/EY-infrastructure-investments-for-insurers.pdf, accessed 29th March 2019.

[14] OECD, 2012, *Alternative ways of financing infrastructure investment*, https://www.oecd-ilibrary.org/transport/alternative-ways-of-financing-infrastructure-investment_5k8zvv4vqj9s-en, accessed 29th March 2019

[15] European Commission, 2004, *Green Paper on Public Private Partnerships*, https://publications.europa.eu/en/publication-detail/-/publication/94a3f02f-ab6a-47ed-b6b2-7de60830625e/language-en, accessed 29th March 2019

[16] European Commission, 2004, *Resource Book on Public Private Partnership Case Studies*, http://ec.europa.eu/regional_policy/sources/docgener/guides/pppresourcebook.pdf , accessed 29th March 2019

[17] HM Treasury, *Investing in UK Infrastructure*, 2014, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/357135/infrastructure_pitchbook_28072014.pdf , accessed 29th March 2019

[18] European Commission, 2003, Guidelines for successful Public Private Partnerships, http://ec.europa.eu/regional_policy/sources/docgener/guides/ppp_en.pdf, accessed 29th March 2019

[19] Goldthorpe, W., Ahmad, S., Eldering, L., Sannes, O., Baker, A., Grosvenor, D., .Dean, T., 2016, *A need unsatisfied - Blueprint for enabling investment in CO_2 storage*. London, UK: Deloitte/The Crown Estate.

[20] Public-Private Infrastructure Advisory Facility (PPIAF), 2009, *Toolkit for public-private partnerships in roads and highways*, https://ppiaf.org/sites/ppiaf.org/files/documents/toolkits/highwaystoolkit/6/pdf-version/1-13.pdf , accessed 29th March 2019

- limitations in public funding as a result of affordability and financing constraints (e.g. EU fiscal rules, IMF restrictions, etc.).

3.2.2 100% Private Responsibility

At the other end of the spectrum, the private sector carries all the risks and responsibility for the infrastructure assets and there is no government involvement and support. This can work in the case of fully liberalised markets such as cable and mobile phone networks (Europe), wholesale gas supply (UK) and petrol retail (Europe). This model is designed to ensure high levels of competition with high efficiencies and innovation and no financial burden on the government.

However, the inherent nature of infrastructure investment with high front-end capital requirements, sunk costs, and long-term cost recovery with pricing subject to regulatory intervention can lead to a perception by potential investors that risks are high and can represent a significant obstacle to private investment. There are risks of stranded assets, significant cost overruns, inability to recover the costs from the users or the government because of insufficient demand or regulatory intervention, especially if those services have high externalities (social or environmental value for example). In addition, in those cases where the infrastructure has significant benefits beyond financial or quantifiable economic value (positive externalities) which are relevant for users and the wider society but not for the private investor, this may lead to suboptimal investment and suboptimal sizing of the infrastructure. Finally, the monopolistic nature and high barriers to entry can make it difficult for new entrants and therefore the risk exists that insufficient competition will lead to overcharging by the private sector operator.

In summary, the main potential issues with this model for large scale infrastructure investment are:

- Market failures: lack of or insufficient private sector investment to build or develop the infrastructure assets required for the public benefit;
- Valuation of externalities: lack of valuation of positive externalities for the public and wider society by the private sector leads to sub-optimal investment sizing of infrastructure for long term; and
- Market power: overcharging by the private sector due to lack of competition and a high barrier to entry.

3.2.3 Public Private Partnerships (PPP)

The nature of infrastructure investment with long term capital requirements, value delivered which is beyond traditional financial returns, and monopolistic nature therefore requires synergies and/or collaboration between the public and private sectors to overcome those challenges. The PPP model[21,22,23] was designed to overcome both the market failures in critical infrastructure investment from the private sector (market power, externalities) and the government failures (inefficiencies, gold plating, financing constraints). This

[21] World Bank PPPLRC, 2019, op. cit.
[22] OECD, 2008, op. cit.
[23] INTERNATIONAL MONETARY FUND (IMF), 2004, *Public-Private Partnerships*, Prepared by the Fiscal Affairs Department, https://www.imf.org/external/np/fad/2004/pifp/eng/031204.pdf, accessed 29th March 2019

model allows the transfer of risks to private investors who can access significant pools of capital funds and achieve better operating efficiencies whilst retaining the necessary control over pricing and infrastructure development. The ultimate purpose is added value.

Though commonly and widely used in practice, there is no firm and agreed definition of the term PPP in the literature. The following definition is from the International Transport Forum at the OECD[24]:

"*One can define a public-private partnership as an agreement between the government and one of more private partners… according to which the private partners deliver the service in such a manner that the service delivery objectives of the government are aligned with the profit objectives of the private partners and where the effectiveness of the alignment depends on a sufficient transfer of risk to the private partners*."

Under this PPP definition for conventional assets and services, a long-term agreement is put in place between the public and private sector whereby the private sector takes responsibility for owning and/or providing and/or financing infrastructure assets and/or services which were historically provided by the government.
The main potential benefits of PPPs[25] are:

- Acceleration of infrastructure provision;
- Faster implementation;
- Reduced whole life costs;
- Better risk allocation;
- Better incentives to perform;
- Improved quality of service;
- Potential to generate additional revenues; and
- Enhanced public management.

There are two main types of PPPs; purely contractual PPPs and institutionalised PPPs (joint legal entity), with a significant number of variations within these two main categories as illustrated in the sections below. Further examples are shown in Figure 3-1 and a number of additional tables and perspectives from literature are provided in Appendix B.

3.2.3.1 Traditional PPPs Structures

The following types of PPP structures are organised in simple categories with increasing levels of transfer of responsibility:

1. Management and Maintenance Outsourcing
   The key features of this type of PPP are:
   a. Scope is for Management and Maintenance service contracts.
   b. Limited transfer of responsibility for delivery of services only.
   c. Public sector retains responsibility for ownership and financing.

[24] Meaney, A., and Hope, P., 2012, *Alternative Ways of Financing Infrastructure Investment: Potential for 'Novel' Financing Models*, OECD/ITF, https://www.econstor.eu/obitstream/10419/68826/1/726714259.pdf, accessed 29th March 2019.
[25] European Commission, 2003, op. cit.

2. Operation and Maintenance Concessions
   The key features of this type of PPP are:
   a. Scope is for operation of maintenance of existing assets.
   b. Transfer of responsibility includes the physical delivery and the financing of capital improvements.
   c. The contractual arrangements can be in the form of: lease, affermage[26], franchise or concession.

3. Integrated Service Concessions
   In these PPPs, the scope of transfer of responsibility increases to integrate a broader scope of services in order to facilitate the delivery of greater efficiencies by the private sector. There are multiple variations and the key features are:
   a. Transfer of physical delivery
      i. The transfer is based on an integrated life cycle approach rather than a short-term competitive tender.
      ii. Scope can include Design, Build, Operate, and Maintain in multiple combinations.
   b. Transfer of responsibility for financing
      i. Traditionally financing was structured using non-recourse financing. The additional pressure from investors and financiers put focus on assurance of the quality of the transaction and on the cost effectiveness.
   c. Transfer of ownership - the main variations are:
      i. Public ownership.
      ii. Private Ownership with transfer back to the state.
      iii. Private ownership with/without minority shareholding.
   d. Market Development and Remuneration
   Many types of remuneration structures are used depending on the market maturity and the outcome that the public sector seeks to achieve – mainly:
      i. Output based remuneration (performance-based payments).
      ii. Demand based remuneration (tolls).
      iii. Additional government guarantees and indirect support such as underwriting are generally offered to facilitate the financing of the transaction.

4. Regulated Asset Base (RAB)
   a. Ownership: Private sector.
   b. Physical Delivery: Investors are responsible for the delivery of services from a defined Asset Base. This model was traditionally used for regulated

[26] World Bank PPPLRC (2019 op. cit.) defines the differences between leases and affermage contracts as follows: "*the operator does not receive a fixed fee for his services from the awarding authority but charges an operator fee to consumers, with*

- *in the case of a lease a portion of the receipts going to the awarding authority as owner of the assets as a lease fee and the remainder being retained by the operator,*
- *in the case of an affermage, the operator retaining the operator fee out of the receipts (prix du fermier) and paying an additional surcharge that is charged to customers of the awarding authority to go towards investments that the awarding authority makes/ has made in the infrastructure".*

utilities and can be applied to both new (to be constructed) assets and existing assets.

c. Market Development:
    i. The Regulated Asset Base model requires an independent economic regulator to be in place and which, under the instruction of the government regulates the private sector activities to ensure socially optimised objectives are achieved during the life of the infrastructure.
    ii. Investors are allowed to earn a return to cover their investment (capital and operating) in three main components: depreciation of the asset base calculated to defined regulatory rules (and which can be altered to reflect the specific risk profile); an investment return on capital invested to reflect an appropriate expectation from the investors based on cost of debt and equity; and operating expenditure for the operation and maintenance of the asset based on an agreed forecast. The structure and timing for earning such a return can be customised for different infrastructure categories and specific circumstances.
    iii. Regular price/remuneration review within a defined framework and boundaries – this allows for an acceptable adjustment with demand forecast and other market/asset uncertainties (asset condition for example).
    iv. Guarantee to investors in the form of statutory legislation which places a duty on the regulator, and investors have recourse to the courts to enforce it.

5. <u>Targeted Government Support</u>
    a. Private sector ownership, delivery and financing
    b. Market Development:
        i. Existing infrastructure in a mature competitive market.
        ii. The government support is designed to influence some specific outcomes that cannot be delivered by a free market - outcomes for which the value to society is not taken into consideration by the market participants – rather than build a new infrastructure. For example, facilitating the entry into market of new technologies (renewable energy deployment through CfDs, renewable obligations or feed in tariffs) or addressing security of supply concerns – ensuring sufficient generating reserve capacity to avoid unacceptable price spikes and black-outs through capacity payments.

Higher Risk Transfer

Business Model Structures	Characteristics	UK Examples
Free Market Private ownership, finance and delivery Market Risk – No Revenue Support	• Competitive markets • Full exposure to market/volume risk • Higher risk/return expected from investors	• Cable and mobile phone networks • Petrol stations
Public Concession (Design-Build-Finance-Operate) Public ownership / Private finance and delivery Demand based Revenue	• Procured by public sector • End user paid revenue stream with full exposure to final demand/utilisation	• M6 Toll
Free Market Enterprise Targeted Government Support Private ownership, finance and delivery Targeted revenue support – Price stabilisation (Cfd, FIT, ROCs), Capacity payments, Grants	• Competitive markets • Government-led market framework to influence desired market outcome	• Electricity Generation
Build Own Operate Private ownership, finance and delivery with performance based returns agreed contractually with government	• Individual assets rather than network • Non-recourse commercial debt financing, equity financing, multilateral bank financing • Integrated private sector delivery (construction and operation) for lower overall cost	
Public Concession (Design-Build-Finance-Operate) Public ownership, Private finance and delivery with performance based Revenue (Design-Build-Finance-Operate)	• Procured by public sector • Public sector revenue stream - limited market risks • Social infrastructure services deemed not appropriate for full privatisation	• Public Finance Initiative (Schools, hopsitals…)
Build Operate Transfer Public ownership and finance, private delivery with performance based returns agreed contractually with government	• Individual assets rather than network • Integrated private sector delivery (construction and operation) for lower overall cost • Financing from regional, national and international funds and commercial debt and government bonds	
Regulated Asset Base (Operating Assets) Private ownership, finance and delivery Price regulated revenue	• Monopoly infrastructure businesses • Independent regulation of returns on capital and operating costs providing stability for investors- under regulatory licence • Revenue paid by end users • Lower cost for public and • Potential risks in regulatory structure to adapt to needs of changing environment to incentivise necessary infrastructure upgrades	• Electricity, gas and water transmission and distribution networks
Regulated Asset Base (New Assets) Private ownership, finance and delivery Price regulated revenue and government support for construction	• Same as above • Regulatory licence awarded pre construction and additional government support for construction risks	• Thames Tideway Tunnel
Joint Venture Joint public/private ownership Price regulated revenue	• Resulting from part privatisation with government retaining shareholding and control (often golden shares) • Independent regulation of returns guaranteeing returns on capital and operating costs and providing stability for investors	• National Air Traffic Service
Government Owned Contractor Operated (GOCO) Public Ownership and finance, Private delivery Tender based, contractual agreements	• Government Owned Contractor Operated (GOCO) • Access operating efficiencies • Government retains full ownership for strategic assets / services	• National Nuclear Laboratory
Capital Procurement – Design & Build Public Ownership, finance and control Limited scope delivery	• Public Sector procurement • Financing from regional, national and international funds, multilateral bank financing, commercial debt and government bonds	• Crossrail

Lower Risk Transfer

Figure 3-1 - List of Main Business Structures

3.2.3.2 Institutionalised PPP - Joint Ownership

In an institutionalised PPP, the cooperation between the public and private sector is defined within a distinct and jointly held entity and the rights and obligations are legally covered in the company's statutes and the shareholder agreement. In these arrangements, the public sector usually retains control over the company either through majority shareholding or special rights and has a more active management role to oversee performance, adjust the service terms, gain knowledge and resolve conflicts. Such adjustments and conflicts are managed internally through the statutes of the company (organisation, governance) and the terms of the shareholder agreement (risk sharing, conflict resolution, potential call option for the public owner.

3.2.4 Market Development – New models to manage uncertainty in immature markets

As the popularity of PPP structures which allowed governments to transfer an increasing level off risk to the private sector grew rapidly around the world, a number of major inherent disadvantages became more and more apparent, especially when managing the uncertainty over exogenous events[27,28]:

- *Inherent inflexibility and incompleteness of contracts*: long term PPPs are inherently inflexible in order to create reasonable certainty for all the parties and to avoid opportunistic behaviour from both parties. This often represents a constraint when there is uncertainty over the future with regard to exogenous events, for example when demand/usage or prices change. The potential incompleteness of the contract (and need for renegotiation) can lead investors to require higher rates of return, resulting in increased costs of capital for such projects.
- *High transaction costs*: building flexibility into contracts requires assessment and identification of the potential future scenarios with integration of outcome-dependent terms and conditions in the risk sharing mechanisms. Negotiating and integrating such contingencies in the structure of the transactions leads to high transaction costs.
- *Private sector opportunism*: in cases where the public sector has transferred the risk to such an extent of becoming dependent on the private sector for the provision of the services, or where the contracts are not sufficiently complete, cases of opportunistic behaviour by the private sector have led to inflated demand forecasts and forced renegotiations;
- *Inappropriate risk transfer*: As the market for PPPs has expanded, the public sector has looked in many cases to transfer as much risk as possible to the private sector, including even those risks it was the best placed to manage. The effect of this is to raise the perceived risk to investors with a consequence of increasing the overall cost of capital and not achieving good value for the taxpayer.
- *Lack of Innovation:* Private sector innovation can be constrained by a rigid design and execution scope.

These disadvantages represent an obstacle for their use in the realisation of first-of-a-kind investments in large-scale infrastructure where there is significant uncertainty over the future demand prospects. Such investments have to compete with other technologies or options to replace infrastructure already in place. In addition, given the large-scale nature of these infrastructure investments (and therefore costs), even a small saving in the cost of capital can result in a large absolute overall saving for the public so new models are worth investigating. As a consequence, new models have emerged to replaced PPPs. The Regulated Asset Base (RAB) model, which has been used historically in the regulated utility sector (gas and electricity distribution networks) is one of the main ones being

[27] European Court of Auditors, 2018, *Public Private Partnerships in the EU: Widespread shortcomings and limited benefits*, https://www.eca.europa.eu/Lists/ECADocuments/SR18_09/SR_PPP_EN.pdf, accessed 29th March 2019

[28] World Bank, Group, PPPLRC, 2019, op. cit.

considered by governments who want to use PPP structures rather than government owned/controlled entities.

The main advantages of the RAB model are:

- *Transparency and credible guarantee*: the RAB model offers transparency over the calculation of the asset base and a guarantee to investors over their return as long as the physical delivery meets the expectations of the regulator. The statutory obligation placed on the duties of the regulator to manage the allowed revenues and to finance its own regulatory activities provides the credibility to the investors to remove a significant risk premium. This therefore ultimately creates significant cost savings for the tax payer. In the RAB model, the tax payer bears the equity risk as the latter is agreed and incorporated in the formula for the allowed revenues.
- *Lower cost of regulation*: from experience, the cost of regulation is significantly less than the transaction costs of PPPs.
- *Flexibility*: the RAB model allows for a review of the revenue and cost assumptions at regular intervals and provides flexibility to adjust for exogenous events, within a defined statutory framework.
- *Long term management*: the RAB model creates an incentive for the owner to maintain the asset in a good condition over the long term.

There are, however, also a number of issues/disadvantages that need addressing in the RAB model for the realisation of new large scale H_2-CCS infrastructure:[29]

- *The issue of funding and allocating costs to users*
  - The RAB model is based on the principle of providing a service to a body of consumers (market) who are willing to pay for that service. One of the main difficulties for CCUS infrastructure is that no market exists to contribute to the initial remuneration of the developer/owner of the asset base.
  - The fact that CCUS will be a shared infrastructure servicing multiple end-use consumer markets leads to the problem of how to socialise the costs through the different markets. The consequence is a need for a mechanism and policies to reconcile how to split consumer contributions (and benefits) in different proportions and at different times.
- *The issue of structuring an attractive remuneration for the investors*
  - The RAB model is traditionally low risk/low return (as the taxpayer bears the equity risk). However, oil and gas companies (who are the only ones with the capability to build and operate large scale CO_2 transport and storage projects) operate a business model with a high risk/high return profile. This creates a potential conflict in the attractiveness of such an investment proposition.
  - The development of storage takes significant time and cost. This needs to be accounted for early in the business case and model i.e. pre-FEED stage. Some of the storage related risks would need to be included in the remuneration model and supported by government before infrastructure is utilised or even built.

[29] Includes comments from the workshop '*A Framework for CCS Risk Sharing and Business Model Selection*' held on 14 March 2019 in Brussels jointly by ELEGANCY Work Package 3 (WP3) and the Zero Emissions Platform (ZEP).

- The remuneration structure needs to consider the construction risk and long-term commitment that the investors are taking.
- The difference between what the initial user(s) of the infrastructure can pay and the return on the investment expected by private sector investors - for an infrastructure built at a sufficient scale for further market growth – might be very large.

3.2.5 Capital Sourcing of PPP Structures

Investors have access to a number of capital sources for financing large-scale infrastructure projects in order to complement their equity. High level characteristics for accessing the main capital sources are illustrated in the paragraphs below.

3.2.5.1 Debt

There are number of debt instruments available from the market with a suitable tenor (medium to long term) for infrastructure projects. The most common ones are bank debt and bonds (corporate, market, public). Such debt financing follows a reasonably standard process of decision stage gates with a thorough assurance exercise to test the credibility and worthiness of the proposed investments. This process is illustrated below:

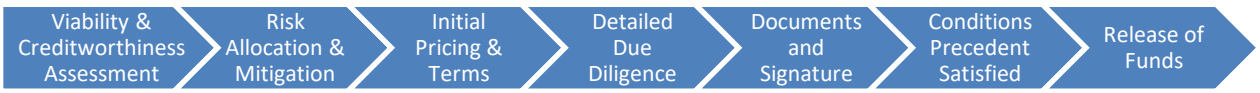

Figure 3-2 Debt financing process

The key characteristics and parameters are:

- Credit rating is defined for the investment based on the project financial viability and risk profile. Credit enhancement instruments are available.
- Investments need to match the lending criteria of the lending organisation: financial, ethical, sectoral.
- Financing capacity: Each individual lender has a limited financing capacity restricted by its capitalisation, international banking rules and internal restrictions. There is the potential for access to bank syndicates, and also specialised state-owned financial institutions as co-lenders to increase the financing capacity. Bond issuance capacity is dependent on the market conditions including investor interest and competing bond issuances.
- Loan pricing is set by the bank syndicate or bond arranger.
- Total loan costs include an extensive package of annual and upfront fees in addition to interest (arrangement, issuance, legal, advisory, auditors, credit enhancement, swaps, insurance and agents).
- Extensive documentation needs to be prepared including an information memorandum, loan or bond agreement, facility agreement including loan tranches and conditions.
- A security package is required including such elements as liquidated damages, performance bond, warranties, retainage accounts, insurance, and other risk mitigation instruments for lenders.

- Financing agreements define strict boundaries and conditions for the drawdown of capital, its use, distribution of profits and for any unused capital (guaranteed investment/escrow account).
- Currency and interest rate hedging mechanisms are available to mitigate financing risk (for bank debt): swap agreement coupled to loan agreement

3.2.5.2 Public Sector lending

Investors can also access a number of national and international public sector lenders and guarantors with policy-based mandates such as the European Investment Bank (EIB), state owned specialised financial institutions (member state agencies and export/Import credit agencies), treasuries etc[30].

- These public lenders are generally public banks with significant capitalisation protected by a sovereign guarantee.
- They generally work with commercial lenders and have a similar risk appetite.
- Their focus is to fill the gaps that markets, commercial banks and other classical institutions do not want to serve and can therefore increase the capital capacity available for investors.
- They can deploy their capital over a longer period without the same pressure for short term returns and can address early stage risks that are difficult to assess and accept for commercial lenders when there is insufficient track record.
- Some of the main institutions in Europe are: KfW (Germany), Caisse des Dépôts and Oseo (France), ICO (Spain), European Fund for Energy and Climate Change Infrastructure ('Marguerite Fund'), Long Term Investors Club (LTIC).

[30] Lecacheur, X., 2010, *What model for a Green Investment Bank? Can we learn from European examples?*, Report for Climate Bonds Initiative and Abercorn Frontier Consulting, https://www.climatebonds.net/files/uploads/2010/07/EU_GIB_experiences.pdf, accessed 29th March 2019

4 CHAIN OPERABILITY, RISKS AND SERVICE CONTRACTS

4.1 Operability and Commercial Contracts

The key constraints on how different segments of the H_2-CCS can be made to function together from an individual business perspective (operational business model) within the market/full chain system business model relate to the technical and technology risks, limitations, operating conditions, and maintenance requirements that find their way into commercial contracts for service or product delivery at the interfaces between the different business segments. We call these various constraints the operability conditions for a business.

In the following sections we summarise some of the principal operability conditions that can influence business risk handling in H_2-CCS service contracts and have an impact on business models. Appendix C contains a more detailed summary of the typical commercial terms and conditions that can be found in such agreements. CO_2 transport by ship has not been included here, but analogous commercial terms and conditions found in contracts for other marine transport of gases such as LNG, LPG, and CO_2 itself will be applicable. Some of these are very similar to pipeline transport from the point of view of supply and offtake performance obligations as well as guarantees, liabilities and remedies.

4.2 Typical Conditions Precedent

In any commercial agreement 'conditions precedent' (CPs) define the conditions that must be satisfied in order for the contract, or parts of the contract, to come into force. A common example is that loan funds will not be released from a lender until a number of conditions are met by the borrower/developer. For very large and complex projects with multiple business segments and/or multiple participants CPs are often subject to some form of multi-party 'umbrella agreement', which might be in the form of a State agreement with a government or government organisation, an inter-governmental agreement or treaty (if international), or a commercial 'co-ordination' or 'implementation' agreement. The purpose of the umbrella agreement is to ensure a co-ordination and governance structure that enables mitigation of a variety of risks that ultimately are related to CPs.

Examples of conditions precedent include:

1. Statutory and regulatory approvals/permits;
2. Any linkages between parties in an umbrella agreement or implementation agreement - Entire chain investment can be jeopardised:
   - Commissioning/turn-down;
   - Window for start of services, deliveries, delays;
   - Allocation of specified risks;
3. Financing and other project structuring requirements; and
4. Actions if the CPs are not met – penalties, remedies, security package etc (for finance see report D3.3.2).

4.3 Hydrogen Production and Integrated Capture

4.3.1 Operability

The operations of a large-scale hydrogen production facility with integrated capture are typical of any large chemical plant. Specific operability issues that will impact the

commercial arrangements of hydrogen production and delivery into a transmission pipeline, and CO_2 delivery to transport and storage infrastructure include:

- Design for continuous production – multiple trains may be required to enable redundancy;
- Turn-down capability (to 30-40%);
- Availability of natural gas feedstock – location, quality specifications, cleaning required for input to reformers;
- Steam/water availability – high reliability required;
- Choice of technology – e.g. steam reforming (SMR) versus autothermal reforming (ATR);
- Choice of capture location in the process can dictate cost and efficiency – capture inefficiencies must be minimised;
- Flue gas stream composition (CO_2 concentration) dictates capture design and cost;
- Practical and low disruption maintenance schedules;
- Warm-up period from a cold start can last approximately 24 hours;
- CO_2 gas quality specifications[31] for delivery to a pipeline and storage site will require conditioning by the H_2 facility operator.

4.3.2 Key Performance Obligations of a Tolling Service

A likely business model for hydrogen production is a regulated asset provided as a tolling service to natural gas producers. See Appendix C.1 for some of the principal commercial terms handled in a tolling agreement. Further to the above, important reliability requirements, with penalties and remedies for non-performance, will include:

- Delivery of hydrogen to agreed level of availability;
- Hydrogen quality to agreed specification;
- Accounting of sales quantities with balancing and make-up;
- Emissions/carbon accounting;
- Maintenance scheduling without disruption.

4.4 Long Term Hydrogen Sale and Purchase Agreement (SPA)

Contracts for the sale and purchase of hydrogen are likely to have similar characteristics to familiar long-term natural gas agreements. Short term and spot sale agreements are not expected for FOAK projects, but if a mature market develops over time for large scale regional centralised production such as envisaged in the ELEGANCY case studies, it is not unreasonable to envisage similar commercial terms that currently exist for natural gas SPAs. Imports and international trade in hydrogen would also be expected to develop along the lines of the LNG industry.

The selling party, or parties, for a domestic supply of hydrogen will depend in large part on ownership of the hydrogen production facility. Examples of facility ownership could include:

a. Independent company;
b. Upstream gas producers;
c. Part-equity from upstream gas producers;

[31] CO_2 gas quality specification refers to the limits of non-CO_2 molecules allowed in the gas stream and includes compounds such as water, sulphur oxides (SOx), nitrogen oxides (NOx) and oxygen.

d. Cross-ownership between upstream gas producers and transmission pipeline owner.

Title to the hydrogen being sold will reflect these ownership structures. Back-to-back pricing and transfer pricing arrangements will also depend on ownership. Long-term hydrogen SPAs will mirror a number of other commercial arrangements in similar ways to natural gas or LNG sales from production, processing and transportation joint ventures. The business models chosen for FOAK H_2-CCS infrastructure will therefore need to ensure not only that remuneration can flow smoothly along the chain without commercial hindrance, but also that remedies for non-performance are commensurate with the immature nature of the markets and the counterparty risks that ensue. Appendix C.2 provides a more detailed summary of terms and conditions expected in a hydrogen SPA.

4.5 CO_2 Pipeline

4.5.1 Operability

Although the operations of gas product transmission pipelines are generally similar, there are idiosyncratic variations depending on the properties of the transported gas. In the case of CO_2, the principal parameters are operating pressure and temperature (which determine the phase of the gas and whether there is any compressibility in the linepack) and the gas composition (which determines phase behaviour, injectivity at the storage site, and safety with respect to pipeline steel and seal integrity). Key operability issues include:

- Operating conditions – gas or dense phase;
- Compression requirements;
- Metering and carbon accounting including fugitive emissions;
- Embrittlement and corrosion, prevention of seal failure;
- Rupture and safety management;
- CO_2 specification pass-through from storage operator;
- Linepack/compressibility and latency, management of delivery interface with storage operator;
- Coordination of pigging and maintenance with H_2 producer and CO_2 storage operator.

4.5.2 Key Performance Obligations

A large number of commercial terms and conditions are required for transportation contracts because the operator is sandwiched between a ‘shipper’ and the ‘offtaker’. Performance obligations can be both back-to-back and stand-alone, so the pipeline operator needs to lay off obligations, risks, and guarantees to the appropriate party. A good example for multiple users of a CO_2 pipeline is the need to ensure any blended CO_2 stream carried by the pipeline operator falls within quality specifications suitable for the storage operator (the offtaker).

In the case of CO_2 transportation to a storage site, any non-performance can have potentially large or expensive consequences such as penalty payments for CO_2 emissions allowances, hence operational business models that work to facilitate FOAK infrastructure are required including appropriate remuneration, liability and remedy solutions within the framework of an overall system business model.

For details of commercial terms and conditions see Appendix C.3

4.6 H_2 Pipeline

4.6.1 Operability

The transport of hydrogen by pipeline is a well-established technology and in Europe there are approximately 1500km of such pipelines. The primary operability issue for this technology in the ELEGANCY case studies will be the need for large scale infrastructure operating at different pressure tiers[32]: one for longer distance transmission (higher pressures of 40-80 bar); one for intermediate regional distribution to connect major centres of demand (pressures of 7-40 bar); and one for connecting into mains supply systems within the demand centres. Operability conditions impacting commercial arrangements will include:

- Embrittlement – integrity of internal epoxy coating;
- Operating pressure – more extensive metering;
- Fugitive emissions – ignition risk;
- H_2 specification pass-through from retailer and distribution network operator;
- Line pack management;
- Input/offtake balancing and management;
- Coordination between different network operators.

4.6.2 Key Performance Obligations

As with other pipeline systems (including CO_2), a large number of commercial terms and conditions are required for H_2 transportation contracts because the operator is sandwiched between either a 'shipper' and the 'offtaker', or other pipeline network operators. This intermediate role requires performance obligations that may be both back-to-back and stand-alone. Wherever possible, the pipeline/network operator needs to lay off obligations, risks, and guarantees to the appropriate party. In the case of a hydrogen system replacing the natural gas system, this will likely include interfacing obligations between the pipeline operator and operators of any inter-seasonal geological H_2 storage facilities.

For examples of commercial terms and conditions see Appendix C.3

4.7 CO_2 Storage

4.7.1 Operability

The operations of a geological storage site are influenced by everything upstream of the 'receipt point' for the CO_2 stream as well as from the subsurface conditions and uncertainties. For H_2-CCS chains there is the potential to have a consequential effect at the storage site even from something happening in the consumer market. While infrastructure will be designed and operated to manage latency, disruptive events, outages and maintenance down-time, storage site operators will have to mitigate the impact on operations and revenue of the full chain operability parameters through commercial arrangements. At the storage site and injection facility key operability parameters that must be managed include:

[32] See for example Northern Gas Networks, *H21 North of England Report*, 2018, https://northerngasnetworks.co.uk/h21-noe/H21-NoE-23Nov18-v1.0.pdf, accessed 29th March 2019.

- CO_2 stream specifications;
- Flow conditions – pressure, flow rate;
- Metering and carbon accounting including fugitive emissions;
- Injectivity – well management, pressure management, interface with pipeline operations;
- Site capacity and containment;
- Water production and subsurface pressure management;
- Stored CO_2 plume measurement, monitoring and verification.

4.7.2 Key Performance Obligations

Unlike pipeline operations, CO_2 storage operations will not be analogous to natural gas short-term or seasonal storage operations. Capacity 'booking', and utilisation may have some similarities, but the risk profile of the geological storer briefly described above is substantially different because of its obligations to ensure permanency and because of the consequences of failure to take delivery of a CO_2 stream from a pipeline on behalf of an emitter. The storage operator can become liable for very substantial, and potentially bankrupting, penalties due to non-performance. Hence the business models that can work for FOAK storage facilities and operations will be tightly linked to the system business model and the extent to which government can help to share in these liabilities and remedies.

Appendix C.4 provides details of a number of commercial terms and conditions for a CO_2 geological storage service.

4.8 Inter-seasonal H_2 Storage

4.8.1 Operability

The operations of an inter-seasonal geological storage site for hydrogen will be analogous to those for natural gas storage. Engineered salt caverns will be the most likely form of geological storage and examples of these types of facilities for hydrogen already exist in the UK and USA. The main operating conditions will depend on size and depth of the caverns, which in turn will determine operating pressures and compression requirements. The management of injection during low consumer demand months and withdrawal during high demand months, and the 'cycle-rate' of the caverns, are the principal operability parameters impacting commercial terms offered to users of the service.

As for natural gas storage operators, there is the potential to have a consequential effect at the storage site from either gas supply interruptions or from something happening in the consumer market. While infrastructure will be designed and operated to manage latency, disruptive events, outages and maintenance down-time, storage site operators will have to mitigate the impact on operations and revenue of the full H_2-CCS chain operability parameters through commercial arrangements and the ability to interrupt some end-use customers.

4.8.2 Key Performance Obligations

Many of the commercial terms and conditions for inter-seasonal hydrogen storage will be similar to those summarised in Appendix C.4.

5 BUSINESS MODEL SELECTION

5.1 Process

The Business Model Selection Process is illustrated in Figure 5-1 below. Additional guidance (including recommended activities and supporting tools and guidance) is provided for each of the process steps in the subsequent Sections 5.2 to 5.9 and a full list of the supporting tools is provided in Section 5.10.

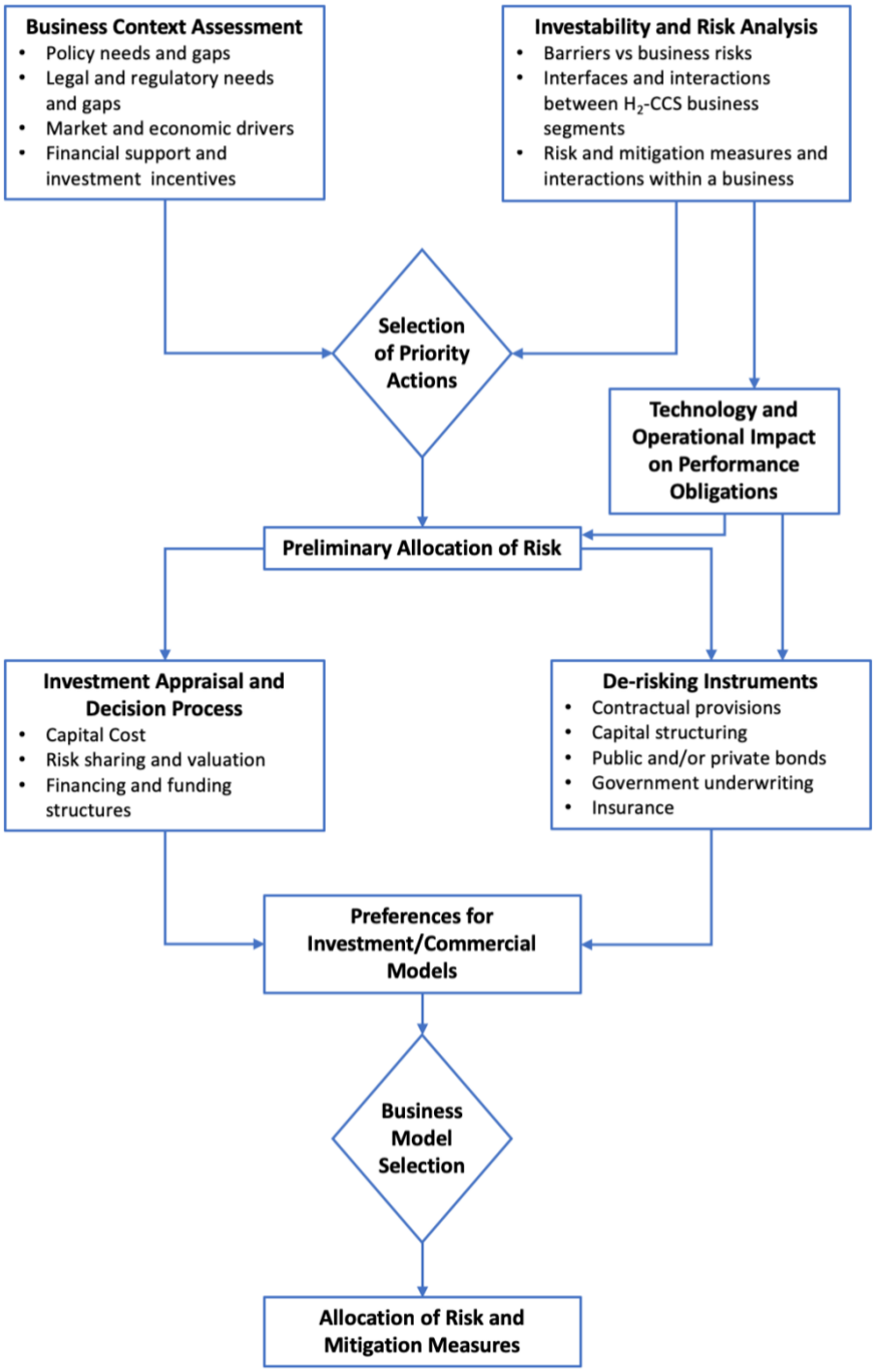

Figure 5-1 Business Model Selection Process

5.2 Project Definition

Objective: Define the main project scope, key parameters and early strategic rationale.

Recommended Activities	Supporting Tools and Guidance
▪ Project concept definition workshop with relevant stakeholders and relevant experts	▪ List of case study parameters (Report D3.2.1)
▪ Assess business case drivers, create early definition of strategic rationale and how success will be measured (metrics) from public and private sector perspective	▪ Business Case Drivers and Strategic Rationale sections of Business Case Definition and Assessment Excel Tool
▪ Joint or separate public/private sector exercise. Use case study parameter checklist to guide and focus the exercise. Need for early public sector input	▪ Report D3.2.1

5.3 Business Context Assessment

Objective: Identify key business factors that impact the investment risks, business model structure and business case development.

Recommended Activities	Supporting Tools and Guidance
▪ Internal public sector/private sector review and assessment of macro-economic context, government policy and incentives, market status, and legal context in relation to the project and identify gaps and failures	▪ Policy and Financial Support Analysis Excel tool (Report D3.3.2) Policy Needs Heat Map Excel tool (Report D3.3.3)
▪ Invite all relevant stakeholders to participate and share outcome of their context assessment - whether in a joint workshop where all participants contribute or through individual exercises which are subsequently compared, consolidated and discussed	▪ Market Failures Excel tool (Report D3.2.1)
▪ Select relevant expert(s) and use ELEGANCY tools to guide and focus their review – level of details dependent on level of definition of project	▪ Market Background Assessment Excel tool (Report D3.2.1)

5.4 Investability and Risk Analysis

Objective: Define investment barriers and major investment risks from public and private sector perspectives at both system and individual business sector level, identify their nature (exogenous, endogenous) and those where risk mitigation measures do not exist/are insufficient.

Recommended Activities	Supporting Tools and Guidance
▪ Separate public and private sector internal workshops using supporting tools (or similar risk assessment/mitigation template)	▪ Outcome of Business Context Assessment
▪ Identify the main business risks that impact investment, rank their impact on project investability, review existing/potential risk mitigation measures	▪ Catalogue of de-risking instruments (Report D3.3.2)
▪ Highlight investment barriers, i.e. key factors that make business risks excessive for private investors to bear, and where risk mitigation measures are missing requiring further public sector intervention	▪ Risk Assessment Excel tool (Report D3.3.2)

5.5 Priority Actions

Objective: Identify the investment barriers and risks that need to be addressed in priority through collaboration with the other market actors (public sector, debt providers, insurance providers).

Recommended Activities	Supporting Tools and Guidance
▪ Joint session between public and private sector to share outcome of risk assessment and agree priority areas, discuss their resolution and seek feedback from government on preferences for business models/risk allocation and potential intervention	▪ Risk Mitigation Heat Map Excel tool (Report D3.3.3)
▪ Discuss and agree the main contributing factors to high risk levels and causes of investment barriers (policy gaps, market failures, external environment)	

5.6 Preliminary Risk Allocation

Objective: Create one or more allocations of risk for the major investment risks and barriers and identify potential business models.

Recommended Activities	Supporting Tools and Guidance
▪ Use supporting instruments in workshops/discussions with government to carry out an initial risk allocation and sharing of responsibility between public and private sectors	▪ Risk Assessment Excel tool (Report D3.3.2)
▪ Consider the four main components of a business model: Ownership, Capital Sourcing, Market Development, Physical Delivery	▪ Business Model Selection Excel tool (Report D3.3.3)
▪ Develop a number of business model options for further assessment – this can be completed separately and/or in a joint public/private session	▪ Risk Mitigation Collaboration Matrix (Report D3.3.3)
▪ Allow innovation in thinking	

5.7 Investment Appraisal and Decision Process

Objective: Undertake a preliminary test of the investment appraisal process using the business case assessment methodology.

Recommended Activities	Supporting Tools and Guidance
▪ Test the compatibility of public and private sector parties' (including financiers) decision processes for the selected risk allocation and business models using the business case development framework	▪ Business Case Definition & Assessment Excel tool (Report D3.3.4)
▪ Carry out a gap analysis of public and private sector preferences for financing and funding structures and commercial delivery mechanisms	
▪ Joint session/workshop between public and private sector parties to ensure financial and commercial preferences are consistent with minimising costs and maximising benefits in alignment with the metrics in the project definition	

5.8 De-risking Instruments

Objective: Agree and/or develop specific de-risking instruments to remove investment barriers and major business risks.

Recommended Process	Supporting Tools and Guidance
▪ Meetings/workshop with market actors (public sector, insurance, financiers, equity investors) to discuss risks, liabilities and define suitable mitigation mechanisms which address the investment barriers and major business risks	▪ Risk Assessment Excel tool (Report D3.3.2) ▪ Risk Mitigation Heat Map Excel tool (Report D3.3.3) ▪ Risk Mitigation Collaboration Matrix (Report D3.3.3)

5.9 Preferences for Investment/ Commercial Models

Objective: Define preferred business model and commercial structure.

Recommended Activities	Supporting Tools and Guidance
▪ Share outcome of business model and investment appraisal process with potential investors (private and public) for feedback	▪ Business Model Selection Excel tool (Report D3.3.3)
▪ Make decision on suitable business model for undertaking a business case assessment	▪ Business Model Selection Excel tool (Report D3.3.3 ▪ Business Case Definition & Assessment Excel tool (Report D3.3.4)

5.10 Complementary Supporting Tools

All the supporting tools developed by Work Package 3 are listed in the table below:

Supporting Tools	Source
1. Market Background Assessment 2. Market Failures	Report D3.2.1
1. Risk Assessment and Matrix 2. Policy and Financial Support Analysis	Report D3.3.2
1. Risk Mitigation Heat Map 2. Policy Needs Heat Map 3. Business Model Selection Tool	Report D3.3.3

A APPENDIX – H_2-CCS RISKS AND MITIGATION MEASURES

A.1 Priority H_2-CCS Chain Market Failures and Investment Barriers

H_2-CCS Market Failures and Investment Barriers	Possible Mitigation Measures
Emitter business interruption: hurdle to investment in capture facilities and changes to products and market segments	▪ European, national and regional collaboration to provide strategic and financial support mechanisms to business sector ▪ European and national financial support mechanisms for business income, labour costs and training
Missing markets for H_2 and CO_2 transport and storage services	▪ Government underwriting the provision of affordable service to CO_2 emitters ▪ Creating end use markets that can socialise and regulate the additional cost of clean energy and products e.g. Hydrogen for heat or transport ▪ CO_2 emitter obligation plus mechanism for import/export competitiveness adjustment ▪ Appropriate short and long-term price for CO_2 as environmental pollutant via e.g. carbon market, carbon tax
Dependence of investment case on stable government policy and coordinated delivery of infrastructure/utilisation	▪ Parliament commitment to first infrastructure in statute with binding mandate and budget given to an appropriate public authority ▪ Implementation agreements split between H_2 producers/emitters and the CCS chain with government providing State mandates and assurances to enable financing
Uninsurable long-term leakage liabilities defined in EU Directive and national regulations with large front-loaded Financial Security	▪ State owned transport and storage operator with no private sector involvement other than technology supplier with guarantees and warranties ▪ State owned transport and storage company accepting liabilities with private sector operator as contractor to state having capped guarantees and warranties ▪ Joint public-private transport and storage company with private partner liability capping and government underwriting of liabilities above agreed level ▪ Private sector transport and storage company based on agreed risk sharing principles (e.g. defined events, defined volume and carbon price collar) with liability capping and government underwriting beyond cap
Guaranteed intra-chain counterparty performance is required between CO_2 producer/capturer and CO_2 capturer/gatherer/transporter and storer	▪ Utilise a binding umbrella agreement that guarantees intra-chain counterparty performance with government providing state step-in, guarantor of last resort, assurances and underwriting as required
Uncertain global commitment to pace and evolution of low carbon or circular economy matching climate targets	▪ Strengthened EU and Member State policies to credibly deliver mid-century emissions targets at low cost and maximum macro-economic benefit
Poor or inconsistent public acceptance of utilisation of CCS technologies and chain for decarbonisation	▪ Long term proactive education, communication and engagement plan and actions ▪ Promotion and development of socio-economic and environmental benefits

A.2 H_2 Producer/CO_2 Emitter Capture Business Risks and Mitigation Measures

CO_2 Emitter/Capture Business Risk	Possible Mitigation Measures
Market Risks: 1. Market demand declines from, or doesn't meet, projection in H_2 production investment case 2. Initial customers delayed in start-up and use of hydrogen 3. Industrial customers become insolvent / close business 4. Lack of guaranteed priority dispatch for power generation (CCGT) plants with CCS 5. Overreliance on the market to deliver large scale CCS & excessive requirement on quantifiable benefits to prove business case	▪ Creating end use markets that can socialise and regulate the additional cost of clean energy and products e.g. Hydrogen for heat or transport ▪ State owned regulated entities receive support for demonstrated projects ▪ Government underwriting the provision of affordable service to CO_2 emitters ▪ CO_2 emitter obligation plus mechanism for import/export competitiveness adjustment ▪ Future amendment in state aid, appropriate policy to support equivalent to low carbon power generation
Macroeconomic Risks: 1. Risk of future carbon price being too low 2. International climate change efforts fail to address disparity between carbon content of goods and services produced in different regions and jurisdictions resulting in disequilibrium in global markets and disincentives for industry decarbonising	▪ Introduction of an EU carbon floor price ▪ Support measures for industry introduced (including import border adjustment, export price compensation) in accordance with a designed timeline consistent with meeting emissions targets
Financial Risks: 1. CAPEX and OPEX uncertainties (in particular auxiliaries and utilities) 2. Risk of unavailability of CCS makes investment into H_2 and other emitting activities 'dirty' and therefore non-ethical for banks	▪ Learning by doing, comprehensive business risk analysis, audits. ▪ Appropriate level of EU grant for initial demonstrator CCS projects ▪ CCS infrastructure umbrella agreement between state/public authority and private sector providing loan guarantees/debt repayment, revenue compensation at agreed threshold, regulatory review ▪ CO_2 T&S company is fully/partially owned by government entity and provides financial guarantees ▪ Parliament commitment to first H_2 conversion with CCS in statute with mandate and budget given to a public authority (or similar)

CO_2 Emitter/Capture Business Risk	Possible Mitigation Measures
Legal & Regulatory Risks: 1. Permitting issues and excessive delay 2. Change of laws/statutes/regulations governing end use markets having a detrimental impact on H_2 production business and other segment businesses 3. Operation of EU ETS and allowance allocations for H_2 producer exposes penalty risk if CO_2 emissions can't be captured, transported and stored	▪ Ensure government pushes for recognition of this issue and introduces adequate policies and regulations to accelerate permitting and limit delays ▪ Establish an oversight council of regulators and others to advise government on the impact of market and cross-market regulation on H_2 production and segment businesses ▪ Compensation mechanisms (contractual or government underwritten)
Political Risks: 1. Risk of policy changes which could have an adverse effect on CCS project viability 2. H_2 Production facility oversized but successive governments delay in dealing with decarbonising trade exposed industries with a slow uptake for hydrogen from industrial customers	▪ Enshrining CCS in EU directives to avoid the risk of local political decisions derailing projects ▪ Long term political and financial commitment to first clean infrastructure project in statute and multi-party consensus on energy policy ▪ Umbrella agreement between state/public authority and private sector providing loan guarantees/debt repayment, revenue compensation at agreed threshold, and regulatory review
Technology Risks: 1. Lack of knowledge regarding first of a kind plants and projects around the world 2. Uncertainty regarding which technology will be feasible at the project go-live date 3. Plant cannot produce hydrogen at correct quality specification for end users resulting in re-engineering and modifications 4. Full chain technical/technology integration and performance don't meet design criteria requiring re-design, remediation, or re-engineering	▪ In depth reviews of lessons learnt, detailed and comprehensive risk analysis, audits. ▪ Partnering with similar organizations in other states to accelerate knowledge sharing ▪ Contractual gas quality specification with performance guarantees and contractual liabilities from EPCM ▪ Technical collaboration between EPCMs and technology suppliers across the chain to stress-test integrated designs ▪ Umbrella agreement including government compensation above agreed threshold

CO_2 Emitter/Capture Business Risk	Possible Mitigation Measures
Operational Risks: 1. Delays in construction and commissioning 2. Uncertainty with the consistency of the stream of CO_2 to be captured in terms of volume, purity, rate and cost. 3. Unknown performance of scaled up technology operating in real world conditions 4. Short term operational outage: e.g. mechanical damage, maintenance overruns	▪ Learning by doing, comprehensive project monitoring and risk analysis ▪ In depth reviews of lessons learnt, detailed and comprehensive risk analysis, audits ▪ Third party assessment with proper integration of knowledge transfer and experience and need of detailed and comprehensive list of criteria for legal acceptability of CO2 from a given emitter with quality control. CO2 storage complex evolution addressed by monitoring and modelling. ▪ Ensure sufficient hydrogen storage capability, plant design with equipment redundancy ▪ Insurance cover
Social & Societal Risks: 1. Negative public opinion 2. Public perception that investment in CCS is less money for renewables technologies 3. Insufficient education and skills training programmes to provide workforce needed across the H_2-CCS chain leading to slower city conversion and underutilisation of hydrogen production service	▪ Communication of risks and finding a way to convey a realistic picture to the public. Risk estimate dependence on acceptability cf. on-shore vs off-shore risks ▪ Promote the critical role of CCS as an integral part of balancing future power transmissions system and an enabler of high renewable energy penetration ▪ Long term proactive education, communication and engagement plan and actions ▪ Promotion and development of socio-economic and environmental benefits ▪ Ensure training and skills development is integral to clean growth and industrial strategies at the sector level

A.3 CO_2 Transport Business Risks and Mitigation Measures

CO_2 Transport Business Risk	Possible Mitigation Measures
Market Risks: 1. Lack of certainty as to the risk/liability sharing for infrastructure (i.e. pipelines) that could be re-used for CO_2 transport 2. Lack of guarantee of income (tariff price) for transport of CO_2 3. Absence of business models that provide guaranteed revenue streams for all parts of the chain (banks will require visibility of revenue streams) - especially for non-electricity CCUS projects. Currently cheaper to emit CO_2 to atmosphere 4. Missing guidelines for industrial risk-sharing 5. Overreliance on the market to deliver large scale CCS & excessive requirement on quantifiable benefits to prove business case	▪ Government retains the risk/liability for the duration of the project, whilst current or new asset owner operates it. ▪ Strong support (i.e. financing guarantee/capital grants/liability underwriting) from the governments would contribute greatly in reducing the cost of capital. The Innovation Fund is a good route through which some business risks can be addressed. ▪ 'Railway type' approach where independent operators (either private or public) use their certified equipment on a common infrastructure. This would need to be supported by government policies. Alternatively, finding analogies in other sectors to allow both risk estimate/capping and adequate communication to stakeholders, collecting learned lessons and methodologies. Lessons and best practice from the nuclear and aviation sectors. Insurance caps (there are many industries or activities with this). Develop solutions where possible with insurance companies, European Investment Bank (EIB), International Maritime Organisation (IMO) and OECD ▪ Introduction of an EU carbon floor price ▪ State owned regulated entities receive support for demonstrated projects ▪ Government underwriting the provision of affordable service to CO_2 emitters ▪ Creating end use markets that can socialise and regulate the additional cost of clean energy and products e.g. Hydrogen for heat or transport ▪ CO_2 emitter obligation plus mechanism for import/export competitiveness adjustment ▪ Government needs to collaborate developing an initial revenue model for the first few projects. Revenue needs to be acceptable to financing community.
Macroeconomic Risks: 1. Risk of future carbon price being too low 2. Growth in new industry/service sectors pulls jobs and skills development away from CCS generally and T&S particularly 3. International climate change efforts fail to address disparity between carbon content of goods and services produced in different regions and jurisdictions resulting in disequilibrium in global markets and disincentives for industry decarbonising	▪ Introduction of an EU carbon floor price ▪ Co-ordinated sector strategies that are consistent with requirements for delivering emissions targets and ensure skills training and education programmes are pro-actively implemented in advance of shortages occurring. ▪ Support measures for industry introduced (including import border adjustment, export price compensation) in accordance with a designed timeline consistent with meeting emissions targets

CO_2 Transport Business Risk	Possible Mitigation Measures
Financial Risks: 1. CAPEX and OPEX uncertainties 2. Lack of operating full chain power and industrial demonstration project to give investors' confidence in outcome of CCS schemes 3. High associated off-shore CAPEX costs to prepare a natural resource which will have a high public value	▪ Learning by doing, comprehensive business risk analysis, audits ▪ Prioritise a full chain power and industrial demonstration project to prove concept to stakeholders. Also, Potential EU interim support scheme for mitigation of demonstration of pilot projects ▪ Future amendment in state aid, appropriate policy to support equivalent to low carbon power generation. Also, appropriate level of EU grant for initial demonstrator CCS projects ▪ Government to work with oil and gas regulatory authorities to put mechanisms in place to preserve strategic assets from decommissioning
Legal & Regulatory Risks: 1. Poor understanding on the (re)certification process of existing pipelines in order for them to be used for CO_2 transport (given that there is a change in use envisaged) 2. Mandatory third-party access to infrastructure leading to operational and commercial problems such as controlling CO_2 quality specs and inability to meet performance guarantees 3. Inconsistent laws and regulations between end use markets and those governing CCS permitting and operations affect construction and/or service delivery 4. Change of laws/statutes/regulations governing end use markets having a detrimental impact on segment businesses 5. Change of laws/statutes/regulations governing CCS having a detrimental impact on segment businesses 6. Statutory remedies including compensation and penalties for defined and limited events (incl. death) result in expensive insurance for an operator 7. Pipeline consents, permits, leases or licences are not easily obtained (delayed, conditional or not granted due to technical and/or safety uncertainty) 8. Risks associated with cross-border transport of CO_2	▪ Encourage government to address the re-use issue and ensure that re-certification process is not overcomplicated ▪ Ensure government pushes for recognition of the re-use issue and introduces adequate policies and regulations to accelerate permitting and limit delays ▪ Establish a regulatory regime that governs CO_2 quality specifications rather than leaving it to contractual arrangements ▪ Establish an oversight council including regulators and others to ensure consistency and compatibility of regulations ▪ Establish an oversight council including regulators and others to advise government on the impact of end use market regulation on segment businesses ▪ Establish an oversight council including regulators and others to advise government on the impact of CCS regulation on segment businesses ▪ Proactively work with the insurance industry, regulators and public authorities to characterise the linkages between remedies and insurance products and develop least cost or most efficient solutions for T&S infrastructure operators ▪ Proactively and collaboratively engage early with relevant stakeholders including regulators, local authorities, environment agencies etc. ▪ Proactively and collaboratively engage early with relevant regulators ▪ Bi-lateral treaties for cross-border transport. Potentially involve the IMO and OECD, who are also interested in the issue of unidentifiable risk. Commercial lessons from the recent EIB approval of the trans-Adriatic pipeline. Examine EBRD decision-making on the investment in the pipeline project in Southern Europe/Turkey

CO_2 Transport Business Risk	Possible Mitigation Measures
Political Risks: 1. Risk of policy changes which could have an adverse effect on CCS project viability 2. Lack of long-term and stable investment policies with clear ROI and profitability	▪ Enshrining CCS in EU directives to avoid the risk of local political decisions derailing projects ▪ Parliament commitment to first infrastructure in statute with binding mandate and budget given to an appropriate public authority ▪ Stable framework of incentives allowing for private sector decision and public infrastructure decision
Technology Risks: 1. Pipelines cannot cater for the CO_2 transport requirements, e.g. not being able to handle the physical and chemical properties of blended CO_2 streams. Results in re-engineering or loss of customers 2. Full chain technical/technology integration and performance don't meet design criteria requiring re-design, remediation, or re-engineering 3. Legacy issues around re-use of existing infrastructure, and potential effect on commercial structures. 4. Lack of specialist off-shore knowledge 5. Lack of demonstration/full-scale projects in Europe/UK means risk allocation not yet fully understood.	▪ Government compensation for transport operator above agreed threshold ▪ Insurance cover wherever possible ▪ Umbrella agreement including government compensation for transport operator above agreed threshold ▪ Technical collaboration between EPCMs and technology suppliers across the chain to stress-test integrated designs ▪ Understand infrastructure lifetimes and select accordingly ▪ Conclude JV with offshore specialists ▪ Clear policy & support mechanism from government for initial projects to get things started and learning by doing
Operational Risks: 1. Negative performance impact on transport and operations of upstream emitter or CO_2 capture operations 2. Delays in construction and commissioning 3. Varying CO_2 purities and trace elements from multiple sources (IGCC, post capture, oxygen blown combustion) for transport long-term integrity (corrosion issues in particular) 4. Short term unavailability of CO_2 transport operations would lead to emitter operational risks 5. Project scale-up delay due to London protocol amendment not being ratified in time	▪ Use of proven technology and designs ▪ Supplier guarantees and warranties ▪ Insurance cover ▪ Emitter or capture operator compensation to transport operator ▪ Learning by doing, comprehensive project monitoring and risk analysis. ▪ Third party assessment with proper integration of knowledge transfer and experience, and need of detailed and comprehensive list of criteria for legal acceptability of CO_2 from a given emitter with quality control ▪ Plant design with equipment redundancy ▪ Contractual liability caps for customers ▪ Contractual guarantees with EPC and O&M companies ▪ Contractual guarantees with CO_2 transport companies ▪ Industry and government to promote international cooperation ▪ Government compensation for transport operator above agreed threshold

CO_2 Transport Business Risk	Possible Mitigation Measures
Social & Societal Risks: 1. Negative public opinion 2. Public perception that investment in CCS is less money for renewables technologies 3. Poor or inconsistent public acceptance of utilisation of CCS technologies and chain for decarbonisation 4. NIMBY reaction to individual components of H2-CCS chain preventing or delaying FID 5. Insufficient education and skills training programmes to provide workforce needed across the H2-CCS chain leading to slower city conversion and underutilisation of hydrogen production service	▪ Communication of risks and finding a way to convey a realistic picture to the public. Risk estimate dependence on acceptability cf. on-shore vs off-shore risks ▪ Promote the critical role of CCS as an integral part of balancing future power transmissions system and an enabler of high renewable energy penetration ▪ Long term proactive education, communication and engagement plan and actions ▪ Promotion and development of socio-economic and environmental benefits ▪ Proactive engagement and education programmes ahead of FEED studies and detailed design ▪ Ensure training and skills development is integral to clean growth and industrial strategies at the sector level

A.4 CO_2 Storage Business Risks and Mitigation Measures

CO_2 Storage Business Risk	Possible Mitigation Measures
Market Risks: 1. Market demand declines from, or doesn't meet, projection in investment case 2. Initial or cornerstone customers delayed in start-up and use of transport and storage service 3. Negative effects of dynamics of end use hydrogen markets, electricity markets or industrial product markets	▪ Take-or-pay contract with base-load emitters with sufficient capacity reserved and secured market demand to cover a threshold return on investment. Appropriate pass-through if third party capture provider. ▪ Choose counterparties with secure market demand or business model for a required minimum period ▪ Terms of take-or-pay contracts include public sector underwriting for transport and storage compensation mechanism or revenue support ▪ Public sector market-maker that carries coordination responsibility and is guarantor of last resort ▪ Market regulations extended to include mechanisms to dampen impact on transport and storage operators such as contracts for difference, revenue compensation, capacity payments
Macroeconomic Risks: 1. Carbon price on ETS stays too low for too long to incentivise decarbonisation investments in industry (incl hydrogen production) 2. Growth in new industry/service sectors pulls jobs and skills development away from CCS generally and T&S particularly 3. International climate change efforts fail to address disparity between carbon content of goods and services produced in different regions and jurisdictions resulting in disequilibrium in global markets and disincentives for industry decarbonising	▪ Carbon price floor and/or a new carbon tax increased in line with a credible price trajectory to meet national emissions targets and value the CO_2 externality for the economy, with compensatory mechanisms for the disparity between domestic and global markets. ▪ Co-ordinated sector strategies that are consistent with requirements for delivering emissions targets and ensure skills training and education programmes are pro-actively implemented in advance of shortages occurring. ▪ Support measures for industry introduced (including import border adjustment, export price compensation) in accordance with a designed timeline consistent with meeting emissions targets
Financial Risks: 1. Uninsurable components of the transport and storage infrastructure and operations require alternative and novel underwriting and guarantee mechanisms for lenders otherwise finance is unavailable 2. New technology/supplier guarantees and warranties will be required by lenders otherwise finance will be unavailable or high cost 3. Lenders seek onerous termination provisions or step-in rights making finance essentially unavailable	▪ Public sector underwriting where no insurance available, underwriting beyond limits on carbon pricing (guarantees for capped carbon penalties for geological storage), no-fault compensation mechanisms, guarantor of last resort ▪ Contract with technology suppliers who can provide substantive warranties and guarantees within a partnership structure under the terms and conditions of a suitable umbrella agreement ▪ Mandate a other public authority to perform step-in functions as part of regulatory oversight including permit/licence suspension or termination. Include cost capping and underwriting minimum repayment thresholds as required in the umbrella agreement ▪ Utilise umbrella agreement to establish required statutory provisions and regulations for private sector finance to be available

CO_2 Storage Business Risk	Possible Mitigation Measures
4. Lenders conditions incompatible with regulatory regime making finance essentially unavailable 5. Lack of confidence from banks in end user market and viability of long-term agreements with emitters 6. High associated off-shore CAPEX costs to prepare a natural resource which will have a high public value	▪ Include government/public authority guarantees in an umbrella agreement ▪ Government to work with oil and gas regulatory authorities to put mechanisms in place to preserve strategic assets from decommissioning
Legal & Regulatory Risks: 1. Mandatory third-party access to infrastructure leading to operational and commercial problems such as controlling CO_2 quality specs and inability to meet performance guarantees 2. Inconsistent laws and regulations between end use markets and those governing CCS permitting and operations affect construction and/or service delivery 3. Change of laws/statutes/regulations governing end use markets having a detrimental impact on segment businesses 4. Change of laws/statutes/regulations governing CCS having a detrimental impact on segment businesses 5. Statutory remedies including compensation and penalties for defined and limited events (incl. death) result in expensive insurance for an operator 6. Pipeline consents, permits, leases or licences are not easily obtained (delayed, conditional or not granted due to technical and/or safety uncertainty) 7. Storage permits, leases or licences are not easily obtained (delayed, not granted or require onerous conditions for example in monitoring and decommissioning plans) 8. Prosecuting or defending civil law cases is difficult and expensive due to novelty of storage related activities and no precedents other than analogues in other sectors	▪ Establish a regulatory regime that governs CO_2 quality specifications rather than leaving it to contractual arrangements ▪ Establish an oversight council including regulators and others to ensure consistency and compatibility of regulations ▪ Establish an oversight council including regulators and others to advise government on the impact of end use market regulation on segment businesses ▪ Establish an oversight council including regulators and others to advise government on the impact of CCS regulation on segment businesses ▪ Proactively work with the insurance industry, regulators and public authorities to characterise the linkages between remedies and insurance products and develop least cost or most efficient solutions for T&S infrastructure operators ▪ Proactively and collaboratively engage early with relevant stakeholders including regulators, local authorities, environment agencies etc. ▪ Proactively and collaboratively engage early with relevant regulators ▪ Proactively develop legal ‘toolkits’ focussed on civil law with experts, regulators and international bodies such as IEA & GCCSI

CO_2 Storage Business Risk	Possible Mitigation Measures
Political Risks: 1. Change in political priorities, policy or supporting mandates related to CCS or the end use markets (e.g. hydrogen market sectors, industrial CO_2 utilisation) 2. Successive governments delay dealing with decarbonising trade exposed industries resulting in slow uptake of storage services beyond initial emitters	▪ Long term political and financial commitment to first clean infrastructure project in statute and cross-party consensus on energy policy ▪ Minimise upfront investment and seek joint government funding for engineering studies ▪ CCS infrastructure umbrella agreement between state/public authority and private sector providing loan guarantees, long tenor debt repayment, revenue compensation at agreed threshold
Technology Risks: 1. Pipelines cannot cater for the CO_2 transport requirements, e.g. not being able to handle the physical and chemical properties of blended CO_2 streams. Results in re-engineering or loss of customers 2. Full chain technical/technology integration and performance don't meet design criteria requiring re-design, remediation, or re-engineering 3. Storage site cannot cater for required dynamics of CO_2 stream (includes surface facilities, wells and geological formation) requiring selection of another site 4. Existing MMV technologies are not able to provide necessary data for regulatory compliance purposes	▪ Government compensation for storage operator above agreed threshold ▪ Insurance cover wherever possible ▪ Umbrella agreement including government compensation for storage operator above agreed threshold ▪ Technical collaboration between EPCMs and technology suppliers across the chain to stress-test integrated designs ▪ Umbrella agreement including government compensation for storage operator appraisal and characterisation programme, FEED or detailed design above agreed threshold ▪ Characterise a back-up storage site pre-FID ▪ Regulator/Competent Authority implements flexible or less onerous compliance and site transfer rules
Operational Risks: 1. Negative performance impact on transport and storage operations of upstream emitter or CO_2 capture operations 2. Short term geological storage outage: e.g. well closures, injectivity problems, facilities problems, maintenance overruns 3. Underperformance of geological storage site (incl. capacity, lifetime injectivity, migration) 4. Unpredicted behaviour of CO_2 plume during post-closure phase causing delays to hand-over to Competent Authority or requiring remediation	▪ Use of proven technology and designs ▪ Supplier guarantees and warranties ▪ Insurance cover ▪ Emitter or capture operator compensation to storage operator ▪ Government compensation for storage operator above agreed threshold ▪ Extended pre-FID appraisal and characterisation period including injection testing, pressure monitoring and 4D seismic surveying ▪ Engineered redundancy in wells and storage formations ▪ Pre-appraised and characterised back-up storage sites prior to FID ▪ Public sector underwriting where no insurance available, underwriting beyond limits on carbon pricing (guarantees for capped carbon penalties for geological storage), no-fault compensation mechanisms, guarantor of

CO_2 Storage Business Risk	Possible Mitigation Measures
	last resort for financiers ▪ Pro-actively increased MMV programme to reduce unexpected outcomes ▪ Reduce storage site utilisation factor to minimise plume migration distances and reservoir pressures
Social & Societal Risks: 1. Public attitudes become negative after FID or construction causing underutilisation of the storage facilities and service **2.** Insufficient education and skills training programmes to provide workforce needed across the H_2-CCS chain leading to underdevelopment of T&S infrastructure service	▪ CCS infrastructure umbrella agreement between state/public authority and private sector providing revenue compensation at agreed threshold ▪ Ongoing education and engagement programmes to ensure public support ▪ Ensure training and skills development is integral to clean growth and industrial strategies at the sector level

B APPENDIX – EXAMPLES OF PUBLIC-PRIVATE PARTNERSHIP STRUCTURES

Final Ownership	Acronym	Private Sector Activities
Private Sector	BOO	Build own operate
	BOOR	Build own operate remove
	BOM	Build own maintain
	BDO	Build develop operate
	BBO	Buy build operate
	LOO	Lease own operate
Public Sector	BOT	Build operate transfer
	BOOT	Build own operate transfer
	BROT	Build rent own transfer
	BLOT	Build lease own transfer
	BTO	Build transfer operate
	LROT	Lease renovate operate transfer
	LDO	Lease develop operate
	Lease	Leasing
	O&M	Operate and maintain service contract
	Management (GOCO)	Management contract (Government Owned Contractor Operated)
Public and/or Private	JV	Joint Venture
	DBFO	Design build finance operate
	DBO	Design build operate
	DCMF	Design construct manage finance
	DBF	Design build finance

RESPONSIBILITY MATRIX FOR CONVENTIONAL PROCUREMENT AND PPP OPTIONS

			Public-Private Partnership				
Category	**Works and Service Contracts (conventional procurement)**		**Management and Maintenance Contracts**		**Operation and Maintenance Concessions**	**Build Operate Transfer Concessions**	**Privatization**
Type	Design, Bid, Build	Design and Build	Management Contracts	Performance-Based Contracts	Lease or Franchise or Affermage *Brownfield*	BOT/DBFO/ BOO *Greenfield*	
Design	Private by fee contract	Private by fee contract				Private by concession contract	Private
Build	Private by fee contract						
Operation and Maintenance	Public	Public	Private by fee contract	Private by BBC contract	Private by concession contract		
Finance	Public	Public	Public	Public			
Own	Public	Public	Public	Public	Public	Public after contract (BOT/DBFO) or Private (BOO)	
Private sector revenue options					Tolls (concession model)		
					Availability payments (PFI model)		
					Government guarantees and support Other support (eg insurance)		

Source: EGIS

Figure B-1 Project Procurement and Ownership Options[33]

[33] Public Private Infrastructure Advisory Facility (PPIAF), Supported by World Bank Group, 2009, *Toolkit for Public-Private Partnerships in Roads & Highways, Module 1: Overview and Diagnosis*, Figure source EGIS Group, https://ppiaf.org/sites/ppiaf.org/files/documents/toolkits/highwaystoolkit/6/pdf-version/1-13.pdf, accessed 29th Marcg 2019.

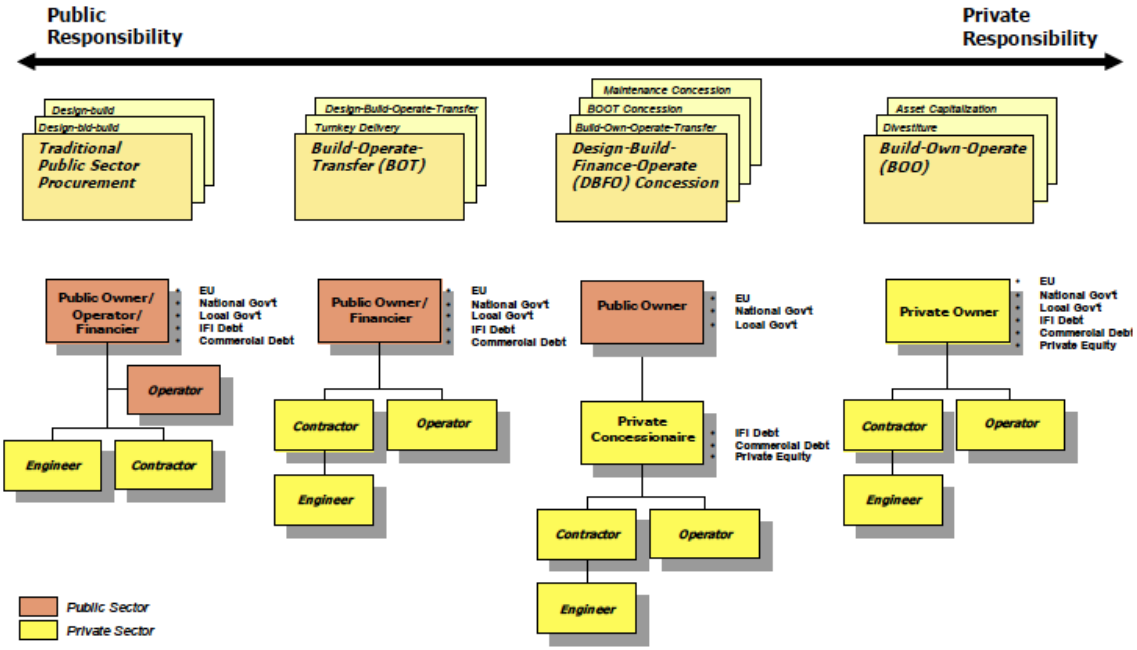

Figure B-2 Project Procurement and Ownership Options[34]

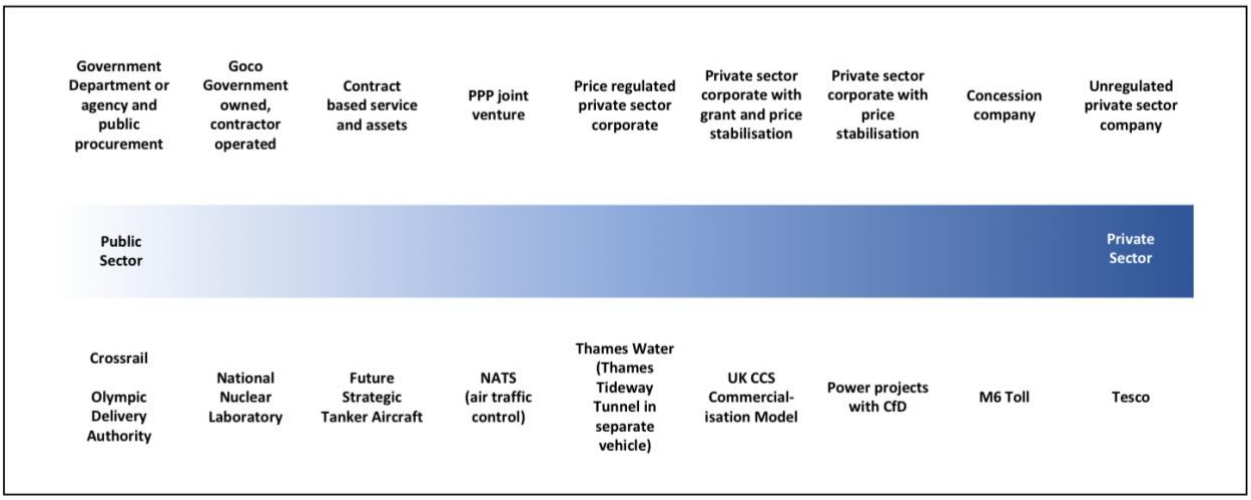

Figure B-3 Example Ownership and Financing Structures for Capital Projects in the UK[35]

[34] European Commission, 2003, op. cit.
[35] Goldthorpe et. al., 2016, op. cit.

C APPENDIX – H_2-CCS CHAIN PRINCIPAL SERVICE CONTRACTS AND COMMERCIAL TERMS

C.1 H_2 Production Tolling Service

C.1.1 Service and Payment

- Capacity entitlements – H_2 production and short-term storage
- Processing (tolling) fee – fixed and variable components
- Variable costs including OPEX, fuel use, retainage, storage/bunkering/boil-off
- Revenue stream to cover financing
- Return on capital employed
- Gas transfer pricing if common ownership
- Taxes (corporate, VAT etc), royalties

C.1.2 Operability and Performance

- Warranties and title
- Scheduling and automatic data processing
- Balancing of gas receipts and H_2 deliveries – volume accounting with lending and borrowing
- Performance guarantees
- Quality specifications, comingling
- Maintenance schedules

C.1.3 Liability, Remedies and Indemnities

- No liability for consequential loss except in case of wilful misconduct or gross negligence, both to be defined
- Maximum aggregate liability per contract year
- Restriction on relief or remedy – e.g. money only
- Dispute resolution provision, remedies not for deterring breach, context of decisions to recognise rights and obligations defined under the agreement designed to apportion risk
- Indemnities for injury or death, damage or destruction from operations and facilities, breach of warranties etc
- Procedure for handling indemnification arising from specified events
- Indemnities against claims, proceedings etc arising from defined events/actions

C.2 Long Term Hydrogen Sale and Purchase Agreement

C.2.1 Service and Payment

1. General
   - Start date, commissioning period, and window for first deliveries – remedies for non-performance
2. Seller's right to sell additional gas on any day in excess of the nominated daily quantity (NDQ)
3. Seller's obligation
   - Deliver to delivery point at daily delivery rate (DDR)
   - Load factor
   - Obligation is lesser of daily contract quantity (DCQ) and NDQ
   - Yearly supply quantity, total contract quantity (covered by certified reserves), shortfall quantity
   - Gas quality as specified – buyer's remedy (e.g. penalty, reduced price, rejection)
4. Buyer's obligation
   - Take or pay – DCQ, maximum daily quantity (MDQ), annual contract quantity (ACQ), deficits, makeup, etc
   - Quantity nominations, price as agreed and indexed
   - Nominations, scheduling, allocation as per agreed procedure – penalties for non-performance
   - Offtake at uniform hourly rates
5. Security
   - Revolving letter of credit (LoC) to cover XX (12) months at DCQ
   - Gas price plus taxes etc
   - Exchange rates if necessary
   - Increase in face value of LoC if circumstances change or outstanding/contingent liabilities accrue beyond certain level
   - Seller's recourse against the LoC will not limit other rights and remedies for payment defaults
   - Seller can draw down LoC completely and hold as security if Buyer fails to replace LoC
   - Buyer liabilities such as unpaid taxes can be asserted by Seller and covered by cash payment into special account maintained by Seller until dispute resolved by court or other mechanism
6. Payment
   - Interest on failure to pay
   - Disputed amounts and time limits for payment
   - Provisional payments upon dispute and overpayment refunds from Seller
   - Currency if necessary

C.2.2 Operability and Performance

1. Transfer of title and risk
   - Delivery point

- Ownership of title during transportation

2. Measurement
   - Compliance with agreed standards
   - Meter verification
3. Planned maintenance
   - Reasonable endeavours to synchronise planned maintenance
4. Force Majeure
   - Usual wording includes 'reasonable and prudent operator', 'exercise of reasonable skill and care', 'not within the affected party's reasonable control' etc
   - Usually includes fire, accident, loss or breakage of facilities
   - Usually includes acts, actions or inaction of a regulator or relevant authority
   - Includes limitations and exclusions such as equipment failure from normal wear and tear, lack of funds, market conditions
   - Mitigation responsibility, burden of proof
   - Suspension while remedied, no performance obligation during force majeure (FM) period
   - Termination if FM longer than XX months
   - No relief to buyer to indemnify or pay due under the sale and purchase agreement (SPA)
5. Suspension and termination
   - Seller suspension of deliveries against Buyer default, relief from performance
   - Seller termination against material breaches, time limits for remediation, rectification etc
   - Buyer termination in event of Seller's material breach, time limits etc
   - Buyer termination in event of Seller's non-performance in delivery over a specified time (e.g. 12 months), notification time limits

C.2.3 Liability, Remedies and Indemnities

1. Liability, remedies and indemnities
   - No liability for consequential loss except in case of wilful misconduct or gross negligence, both to be defined
   - Maximum aggregate liability of Seller per contract year
   - Restriction on relief or remedy – e.g. money only
   - Dispute resolution provision, remedies not for deterring breach, context of decisions to recognise rights and obligations defined under the agreement designed to apportion risk
   - Buyer indemnifies Seller for injury or death, damage or destruction from Buyer's operations and facilities, breach of warranties etc
   - Seller indemnifies Buyer for injury or death, damage or destruction from Seller's operations and facilities, breach of warranties etc
   - Procedure for handling indemnification arising from events
   - Each indemnifies the other against claims, proceedings etc arising from its defined events/actions
2. Representations and warranties
   - Title to gas

- Ownership of assets etc.
- Incorporation and authority

C.3 H_2 or CO_2 Pipeline Transportation Service

C.3.1 Service and Payment

1. Types of service
   - Firm injection service – minimum duration of service
   - As-available injection service
   - As-available withdrawal service (H_2)
   - Other negotiated service provided to shipper
2. Service Provider obligation
   - Provision of transport service as agreed, maximum hourly quantity (MHQ), maximum daily quantity (MDQ)
   - Deliver at Delivery point and receipt at Receipt Point according to confirmed daily and hourly receipt nominations
   - Ensure relevant capacity and priority, management of scheduling
   - Calculation and allocation of daily imbalances for each service
   - Acquire and maintain sufficient line pack for efficient operation
3. Shipper's obligation to deliver and receive
   - All contracts required for delivery and receipt (e.g. through gathering or distribution networks) including multi-shipper agreements
   - Supply at Receipt Point according to confirmed hourly nominations
   - Receive at Delivery Point (H_2) according to confirmed hourly nominations
   - Quantity nominations, price as agreed and indexed
   - Comply with Service Provider requests for advance estimates
   - Gas quality as specified – service provider's remedies (e.g. penalty, rejection)
4. Service Provider's right to manage nominations
   - Capacity and operability management
   - Aggregation of multiple shippers' nominations within scheduling rules
5. Shipper's right to intra-day variation
   - Subject to Service Provider decisions acting in good faith
6. Overrun gas
   - Hourly and daily overrun
   - No obligation on Service Provider to deliver overrun gas
   - Overrun gas is interruptible
   - Additional charge for overrun
7. Tariffs
   - Capacity booking charge
   - Utilisation charge
   - Volume tolerance specification
   - Authorised overrun charge
   - Unauthorised overrun charge
   - Odourisation charges
   - Out-of-specification gas charges
   - Other e.g. priority, receipt and delivery flexibility
8. Creditworthiness and security
   - Confirmation of Shipper's creditworthiness – audited accounts, credit ratings
   - Refusal of supply in event of insolvency

- Service Provider credit limits
- Adequate assurance in the event Shipper experiences a material adverse event
- Shipper or Guarantor security if requested by Service Provider, e.g. cash to cover net financial obligations, irrevocable guarantee, irrevocable letter of credit
- Service Provider right to suspend service

9. Payment
   - Interest on failure to pay
   - Disputed amounts and time limits for payment
   - Service Provider right to suspend service
   - Provisional payments upon dispute and overpayment refunds from Service Provider
   - Currency if necessary
10. Shipper trading rights (Hydrogen)
    - Deal with third parties
    - Trading contracted capacity (bare transfer)
    - Contract conditions and Shipper's obligations prevail with bare transfer
    - Assign capacity with Service Providers consent

C.3.2 Operability and Performance

1. Transfer of title and risk
   - Receipt and Delivery points
   - Shipper warranty of title free of liens, encumbrances and claims at Receipt Point
   - Shipper warranty of control and possession after delivery at Delivery Point
   - Service provider has no title to gas at Shipper's Receipt Point
   - Service Provider has right to comingle gas
2. Measurement
   - Compliance with agreed standards
   - Meter verification
   - Shipper pays, and Service Provider installs, owns and maintains equipment
   - Shipper has right to check equipment and its calibration – invoices can be adjusted accordingly if tolerances are exceeded
3. Out of specification gas at receipt and delivery points
   - Requirement to give notices
   - Shipper or service provider rejection or acceptance dictates whether charges or consequential liabilities apply
4. Planned maintenance
   - Public notices from Service Provider
   - Advanced notice of changers to Shipper
   - Obligation to minimise disruption and curtailment
5. Force Majeure
   - Usual wording includes 'reasonable and prudent operator', 'exercise of reasonable skill and care', 'not within the affected party's reasonable control' etc
   - Usually includes fire, accident, loss or breakage of facilities
   - Usually includes acts, actions or inaction of a regulator or relevant authority

- Includes limitations and exclusions such as equipment failure from normal wear and tear, lack of funds, market conditions
- Mitigation responsibility, burden of proof
- Suspension while remedied, no performance obligation during FM period
- Shipper not relieved of service charges
- Extension of term, increase deliveries to recoup MDQ, makeup gas
- Termination if FM longer than XX months, or receipt and delivery point variations etc

6. Curtailment
   - FM, damage, maintenance, capacity, priority
   - Service charges apply only to quantities shipped
   - Priority service for make-up gas resulting from curtailment up to a cap (e.g. +15% of MHQ)
7. Representations and warranties
   - Title to gas
   - Ownership of assets etc.
   - Service Provider right to suspend on breach of representations or warranties
   - Shipper payments continue during suspension
8. Termination
   - Defaults
   - Rectification
   - Shipper and Service Provider rights defined

C.3.3 Liability, Remedies and Indemnities

- No liability for consequential loss except in case of wilful misconduct or gross negligence, both to be defined
- Restriction on relief or remedy – e.g. money only
- Dispute resolution provision, remedies not for deterring breach, context of decisions to recognise rights and obligations defined under the agreement designed to apportion risk
- Procedure for handling indemnification arising from events
- Each indemnifies the other against claims, proceedings etc arising from its defined events/actions

C.4 CO_2 Storage Service

C.4.1 Service and Payment

1. Types of service
   - Firm injection capacity – minimum duration of service
   - Interruptible injection capacity
   - As-available injection service
   - Other negotiated service provided to customer
2. Storage Provider obligation
   - Provision of injection service as agreed, MHQ, MDQ, ACQ, total contract quantity (TCQ)
   - Ensure relevant capacity and priority, management of scheduling
   - Management of daily imbalances for each service at receipt point (interface with transporter and agreed title transfer point)
   - Acceptance of blended CO_2
   - Maintain sufficient injectivity for efficient operation
   - Permanent stored CO_2 accounting – maintain stored CO_2 register
   - Customer right to audit
3. Customer's obligation to deliver
   - All contracts and procedures required for delivery to receipt point (e.g. through gathering and transportation networks) including multi-shipper agreements
   - Supply at receipt point according to confirmed hourly nominations
   - Quantity nominations per request procedure, price as agreed and indexed
   - Comply with Storage Provider requests for advance estimates
   - Gas quality as specified – back-to-back obligations with transporter to ensure blending is within quality specification – Storage Provider's remedies (e.g. penalty, rejection)
4. Storage Provider's right to manage nominations
   - Capacity and operability management
   - Management of receipt point accounting – title transfer
   - Aggregation of multiple customers' nominations within scheduling rules interfaced with transporter and title transfer management
5. Customer's right to intra-day variation
   - Subject to Storage Provider decisions acting in good faith
6. Overrun gas
   - Hourly and daily overrun
   - Obligations on Storage Provider to inject overrun CO_2 and on customer to reduce delivery to balance overrun in agreed timeframe
   - Additional charge for overrun
7. Tariffs
   - Capacity booking charge
   - Utilisation charge
   - Financial security/Financial mechanism charge
   - Volume/mass tolerance specification
   - Authorised overrun charge
   - Unauthorised overrun charge

- Out-of-specification gas charges
- Other e.g. priority, receipt and delivery flexibility

8. Creditworthiness and security
   - Confirmation of Customer's creditworthiness – audited accounts, credit ratings
   - Refusal of supply in event of insolvency
   - Storage Provider credit limits
   - Adequate assurance in the event Customer experiences a material adverse event
   - Customer or Guarantor security if requested by Storage Provider, e.g. cash to cover net financial obligations, irrevocable guarantee, irrevocable letter of credit
   - Storage Provider right to suspend service
9. Payment
   - Interest on failure to pay
   - Disputed amounts and time limits for payment
   - Storage Provider right to suspend service
   - Provisional payments upon dispute and overpayment refunds from Storage Provider
   - Currency if necessary

C.4.2 Operability and Performance

1. Treatment of title and risk
   - Receipt point
   - Title treatment between Customer, transporter and Storage Provider
   - Customer warranty of control and possession to transporter and treatment of title pass-through - free of liens, encumbrances and claims at Receipt Point
   - Storage provider has no title to CO_2 during transportation
   - Delivery of comingled CO_2 to Storage Provider
2. Customer trading rights
   - Deal with third parties
   - Trading contracted capacity (bare transfer)
   - Contract conditions and Customer's obligations prevail with bare transfer
   - Assign capacity with Storage Providers consent
3. Measurement
   - Compliance with agreed standards
   - Meter verification
   - Customer payment contribution and Storage Provider installs, owns and maintains equipment
   - Customer has right to check equipment and its calibration – invoices can be adjusted accordingly if tolerances are exceeded
   - Back-to back customer contracts and procedures required for delivery to receipt point (e.g. through gathering and transportation networks)
4. Out of specification CO_2 at receipt point
   - Requirement to give notices
   - Back-to back arrangements, terms and conditions with transporter – allocation of fault to customer or transporter

- Storage Provider rejection or acceptance dictates what charges or consequential liabilities apply

5. Planned maintenance
   - Public notices from Storage Provider
   - Advanced notice of changes to Customer and transporter
   - Obligation to minimise disruption and curtailment
   - Back-to-back procedures with transporter

C.4.3 Liability, Remedies and Indemnities

1. Force Majeure
   - Include 'reasonable and prudent operator', 'exercise of reasonable skill and care', 'not within the affected party's reasonable control', meeting of regulatory requirements etc
   - Include fire, accident, loss or breakage of facilities
   - Include acts, actions or inaction of a regulator or relevant authority
   - Includes limitations and exclusions such as equipment failure from normal wear and tear, lack of funds, market conditions
   - Mitigation responsibility, burden of proof
   - Suspension while remedied, no performance obligation during FM period
   - Customer not relieved of service charges
   - Extension of term or increase injection receipts to recoup MDQ, makeup quantities
   - Termination if FM longer than XX months
2. Curtailment
   - FM, damage, maintenance, capacity, priority
   - Service charges apply only to quantities received and injected
   - Priority service for make-up gas resulting from curtailment up to a cap (e.g. +15% of MHQ depending on injectivity and prudent reservoir management)
3. Liability, remedies and indemnities
   - No liability for consequential loss except in case of wilful misconduct or gross negligence, both to be defined
   - Remedy for inability of storage site to meet total contract quantity
   - Customer compensation for defined circumstances such as loss of sales, capture and transport costs, EU carbon allowance penalty
   - Restriction on relief or remedy – e.g. money only, EU allowances
   - Dispute resolution provision, remedies not for deterring breach, context of decisions to recognise rights and obligations defined under the agreement designed to apportion risk
   - Procedure for handling indemnification arising from events
   - Each indemnifies the other against claims, proceedings etc arising from its defined events/actions
4. Representations and warranties
   - Title to CO_2
   - Ownership of assets etc.
   - Storage Provider right to suspend on breach of representations or warranties

- Customer payments continue during suspension

5. Termination
   - Defaults
   - Rectification
   - Non-performance of storage site to meet total contract quantity
   - Customer and Storage Provider rights defined