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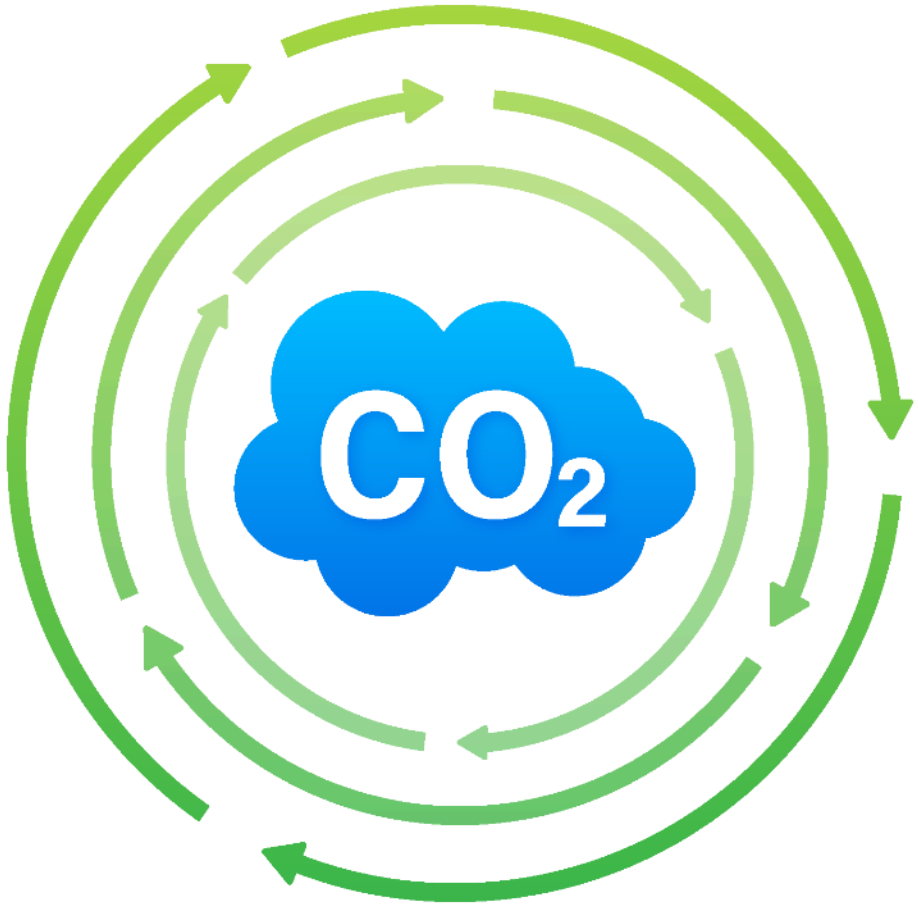


Carbon Capture Usage and Storage

Seeking a bankable business model

MAKING AN IMPACT THAT MATTERS since 1845

Monitor Deloitte - Point of view - November 2023

Introduction

- The International Energy Agency (IEA) and the Intergovernmental Panel on Climate Change (IPCC) recognizes Carbon Capture and Storage (CCS) as a **critical technology to achieve the Net Zero target by 2050**

- The IEA's Sustainable Development Scenario suggests **~15% of the world's emission reductions to be achieved using CCS**, which will require at least $1.5 trillion investment on an international scale

- **Private-sector investments are needed to achieve this level of funding**, including debt financing, capital markets and other sources of capital

- **This report provides an overview of emerging CCS business models, specifically focusing on their bankability** - financial viability and attractiveness for potential private-sector investors

- Although various CCS projects and models are emerging across the world, **this report focuses on recent developments across advanced CCS domains - Europe and the US**

- **While licensing and permitting processes for CO_2 transport and storage are very important elements** in the investment decision process, **the detailed analysis of those is left for a future study**

Agenda

01 Executive Summary

Executive summary

CCS overview

- **Carbon Capture and Storage (CCS) is considered as one of the pivotal solutions to decarbonize hard-to-abate industries as well as to achieve negative emissions** through its application in bioenergy production
- **Since the 1970s, some elements of CCS technologies have been used** in the oil & gas and chemical industries. **However, to achieve the required scale CCS should develop into a comprehensive commercial solution** for various emitters, underpinned by massive infrastructure
- **Full-scale CCS clusters are actively developing in Europe and the US**, with the first 1.5 Mtpa CO_2 storage project launching in Norway in 2024. Meanwhile, **European governments are actively introducing push and pull regulations to grow the storage capacity** by a factor of 100 by 2030

CCS *"investability"*

- While **the first CCS projects receive significant government subsidies, scaling up the next wave will require private investments**. With current risk assumptions, investment in a mid-size CO_2 transport and storage project can yield medium to high single-digit returns
- However, **to become 'bankable' specific CCS investment hurdles should be addressed**, first **it should be economically attractive for emitters**, but also **various cross-chain risks and risks of long-term storage leaks should be mitigated**
- **Our analysis indicates that only the UK has implemented an investable CCS business model** by taking an integrated cluster view on the infrastructure **and implementing the regulated asset base approach, which might limit expected returns**

CCS investment catalysts in Europe

- Although emitters in the UK, Netherlands and Denmark can receive local subsidies to cover a gap between CO_2 capture costs and the EU ETS price, similar **Contracts for Difference-like subsidies tailored to CCS should be introduced across Europe to support the emitter business case**
- **To make CCS investable, a guarantee-type of risk protection** (e.g. regulated asset-based models or EU ETS-baked fund) **should be established to support in case of low-probability high-impact events** (e.g., CO_2 leakage) until the insurance instruments for CCS are developed and affordable
- **Cross-border CO_2 transport and storage** (i.e., London Protocol) **should be enabled to allow emitters to access ideal storage locations**, as well as to promote competition among developers and **mitigate storage underutilisation risks through access to a wider pool of emitters**

02 CCS overview

Historically CCS was used by O&G industry for EOR & gas processing - we expect in the next decade a rapid scale up of CCS for hard-to-abate industries & BECCS to reach the climate targets

Focus of this study

Enhanced Oil Recovery (EOR)

Injection of CO_2 into oil reservoirs to extract hard-to-recover oil remaining in older fields

Decarbonizing own operations

Capturing CO_2 from own projects (e.g. gas processing) to ensure license to operate

Decarbonizing hard-to-abate industries

Storing of CO_2 from various industrial emitters (e.g., cement) to avoid CO_2 emissions

Bioenergy with CCS (BECCS)

Generating electricity from bio-waste (e.g., waste-to-energy plant) and storing CO_2, thereby achieving negative emissions

Direct Air Capture (DAC)

Removal of CO_2 from the air with a storage, thereby achieving negative emissions

Historical adaptation since 1970s → **To scale up in next 10 years** → **Low technical readiness**

Sources: Deloitte analysis

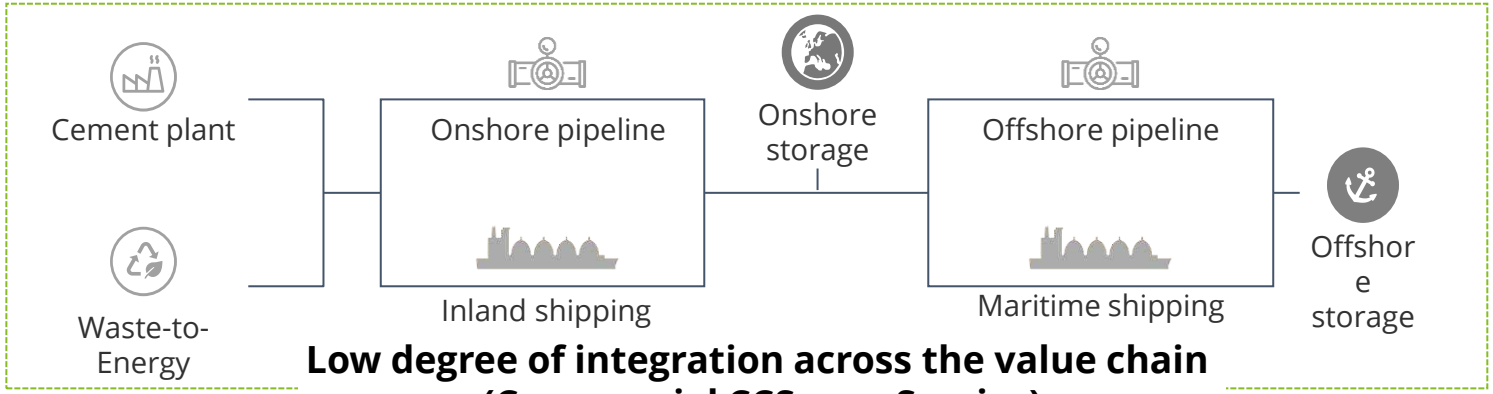
The rapid scale up will see a shift from the integrated model adopted by the O&G industry to the commercial CCS-as-Service, which is based upon a true merchant approach

CCS value chains and business models

ILLUSTRATIVE

High degree of integration across the value chain (CCS is integrated in own operations)

Focus of this study



Low degree of integration across the value chain (Commercial CCS-as-a-Service)

CCS Business Models

Integrated CCS

- Vertically integrated Oil & Gas company develops, owns and operates EOR / CO_2 storage
- **CO_2 is captured only from its own upstream and midstream operations**
- CO_2 transportation through its own onshore or offshore pipelines being a part of the integrated operations

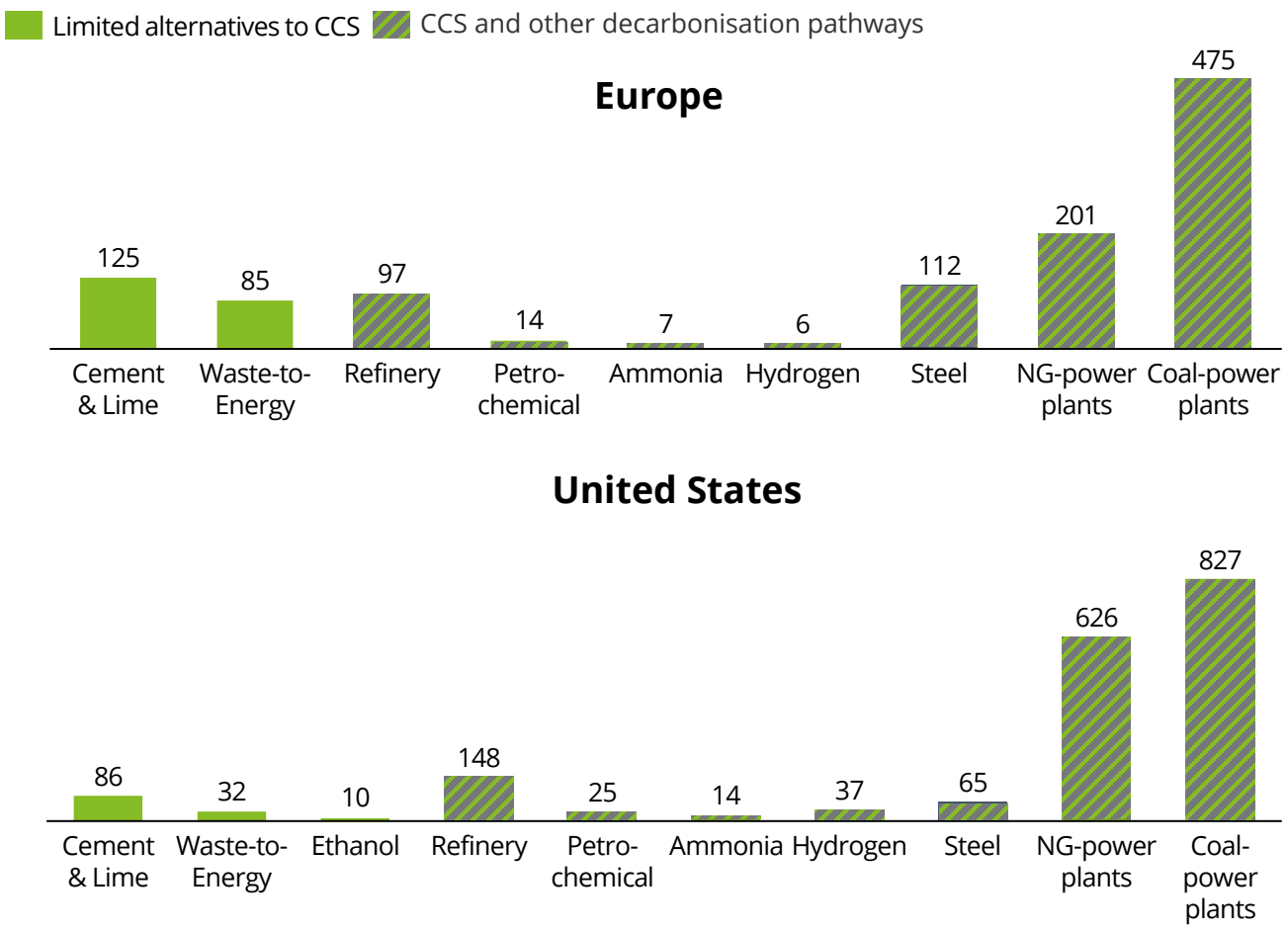
Commercial CCS-as-Service

- Development, ownership and operatorship of CO_2 storage could be allocated to multiple parties
- **CO_2 is captured from multiple independent emitters to be stored in multiple CO_2 storages**
- CO_2 transportation could be provided through various modes (e.g. shipping) by multiple independent parties

Sources: Deloitte analysis

In EU and US, CCS-as-Service market has a large potential demand of CO_2 to capture, depending on the availability and costs of alternative decarbonization options for emitters…

CCS potential in selected sectors (CO_2 Mtpa | 2021)



Sources: EEA ETS, EEA GHG, CREA, EPA GHGRP, EIA, Deloitte analysis

Comments

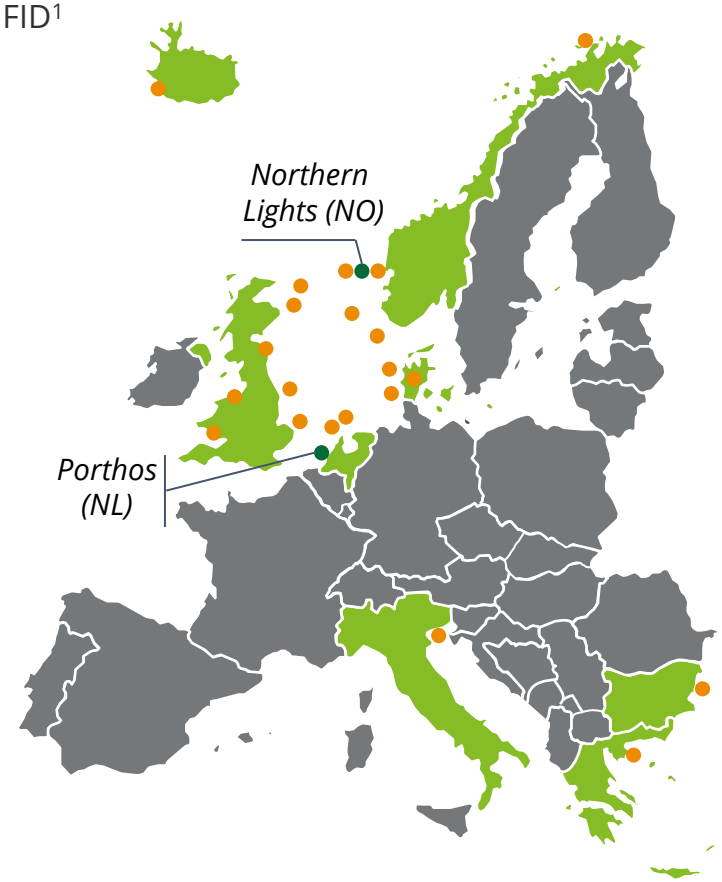
- Application of CCS depends on technical readiness, availability and cost of alternative decarbonisation solutions in specific sectors and regions:

- **Cement, Lime and Waste-to-Energy sectors will need to use CCS** due to a lack of alternative decarbonisation solutions
- **Refineries, petrochemicals** and **ammonia sectors may apply CCS as a part of a mix of solutions**, including low-carbon hydrogen and electrification
- **Blue hydrogen** production from fossil gas **with CCS has a significant potential in the US**
- The **steel sector may aim to use low-carbon hydrogen as a reducing agent**, and electrification, with consideration of CCS for addressing residual emissions
- The **power sector may consider CCS** to provide a stable base load in networks with a high share of renewables. **The solution is being considered in the UK and the US, but currently controversial in the EU**

...in EU policies are pushing to meet this potential demand, expanding CO_2 CCS capacity from current ~4 Mtpa, which has taken Final Investment Decisions, to operational ~100 Mtpa by 2030

Overview of developing CO_2 CCS projects in Europe (2023)

- Development of major CO_2 storages
- CO_2 storage taken FID[1]



Comments

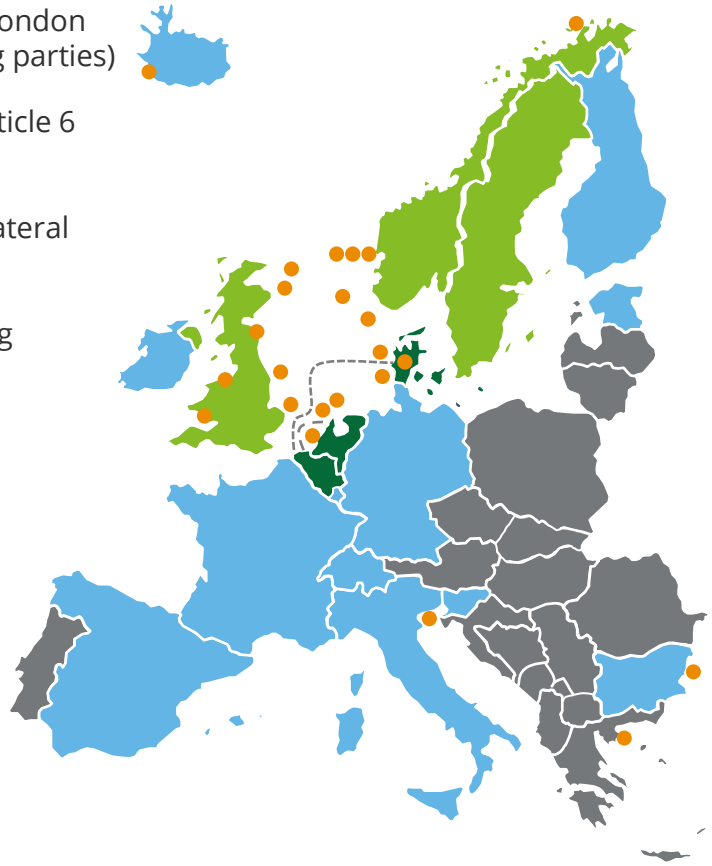
- **The EU Net Zero Industry Act** is contemplating **obligating oil & gas producers in the EU** to contribute to the CO_2-injection capacity (CO_2 storage) with the goal of achieving **at least 50 Mtpa of CO2 by 2030**
- Announced **CO_2 storage projects in the EU** total 35 Mtpa; however, the analysis of progress indicates a capacity **~20-25 Mtpa at the advanced development stage**
- **CO_2 storage projects** are being **actively developed in the North Sea**, but development in **the Mediterranean Sea is progressing slow**, although being crucial to unlock the solution for emitters in Italy, as well as in the south of France and Spain
- Outside the EU, **Norway** has a significant storage potential and supportive environment; **currently announced projects will count to ~20 Mtpa**
- UK has an ambition to capture and store **20-30 Mtpa of CO_2 by 2030** and has progressed with the selection of 2 clusters with total ~9 Mtpa CO2 storage capacity for further development

Notes: 1) Final Investment Decision - the point in the capital project planning process when the decision to make major financial commitments is taken and the construction begins
Sources: International Association of Oil & Gas Producers, Deloitte analysis

Besides, EU CCS projects can benefit from cross-border CO_2 imports to reduce commercial risks and achieve economies of scale, though adaptation of the legal agreements is required

CO_2 cross-border transportation in Europe (2023)

- Development of major CO_2 storages
- Countries adapted London Protocol (contracting parties)
- Countries ratified Article 6 amendment
- Countries signed bilateral agreements
- --- Allowed CO_2 shipping



Sources: OSPAR Commission, Deloitte analysis

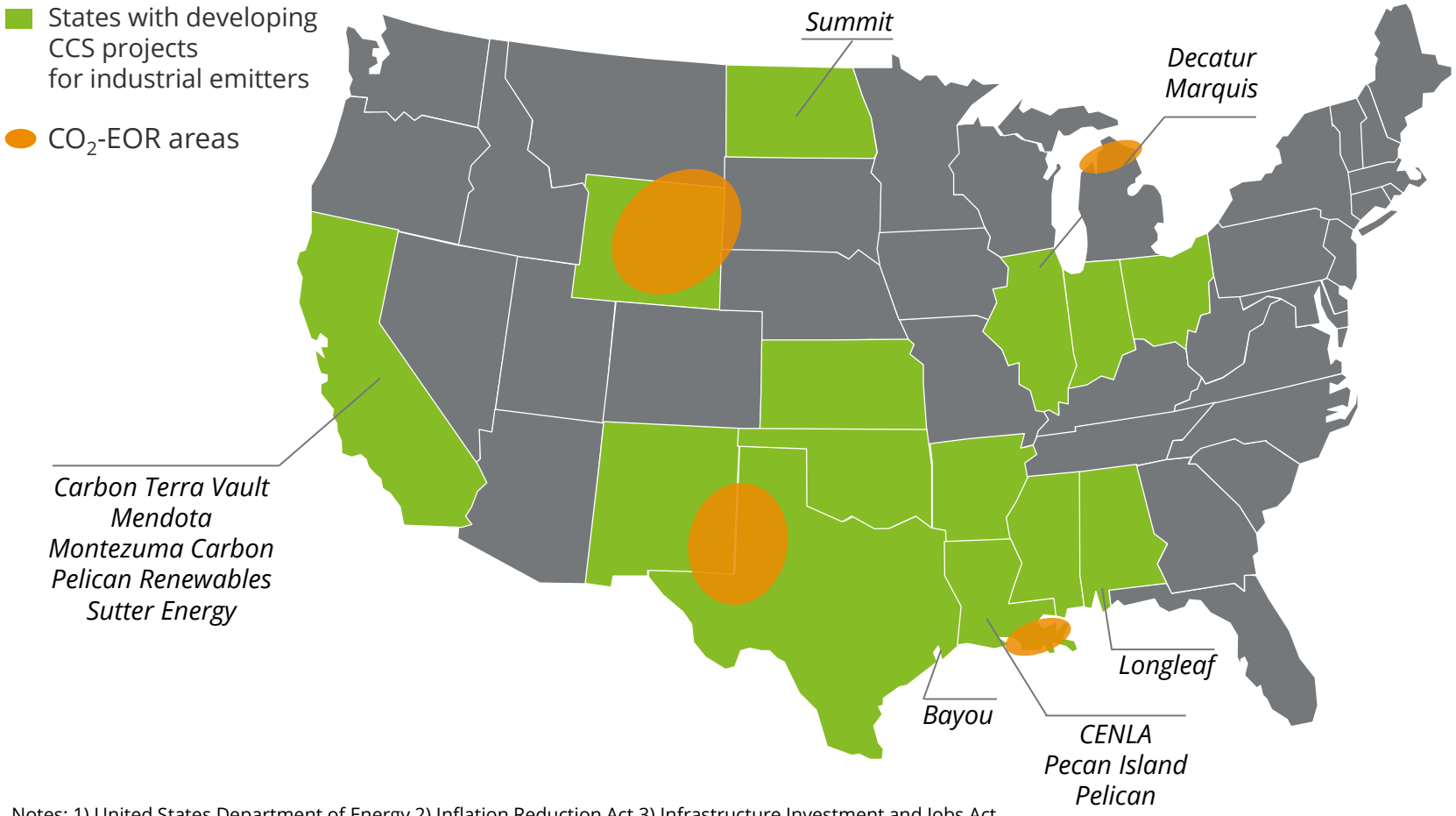
Comments

- **The objective of the London Protocol is to promote the effective control of all sources of marine pollution, including CO_2**
- Initially Article 6 of the London Protocol prohibits the cross-border transport of CO_2 with the purpose of permanent CO_2 storage
- In 2009, Norway proposed an Article 6 amendment allowing CO_2 export for CCS. However, it has not yet been entered into force
- **In 2019, an additional resolution was adopted allowing two or more countries to export CO_2** if certain conditions are met, including the requirement that **those countries have ratified the Article 6 amendment and entered into a bilateral agreement**
- **Currently only two bilateral agreements were signed between Belgium and Denmark, as well as Belgium and the Netherlands**, allowing cross border transportation of CO_2 with the purpose of permanent storage
- **Some other European countries are working closely together to establish bilateral agreements** and fully kick off a European internal market for cross-border CO_2 transportation

1996	2006	2009	2019	2022
Adoption of the London Protocol	Frist amendment (CO_2 streams incl. in waste definition)	Second amendment (Cross-border transport of CO_2 streams)	Provisional application is agreed by contracting parties	First bilateral agreement signed between Belgium and Denmark

In the US, although no firm target for CO_2 to capture, DOE[1] funding and subsidies under the IRA[2] and IIJA[3] are going in the same direction of EU in meeting the potential demand

Overview of developing CO_2 storage projects in the US (2023)



Notes: 1) United States Department of Energy 2) Inflation Reduction Act 3) Infrastructure Investment and Jobs Act
Sources: United States Environmental Protection Agency (EPA), Clean Air Task Force (CATF), Deloitte analysis

Comments

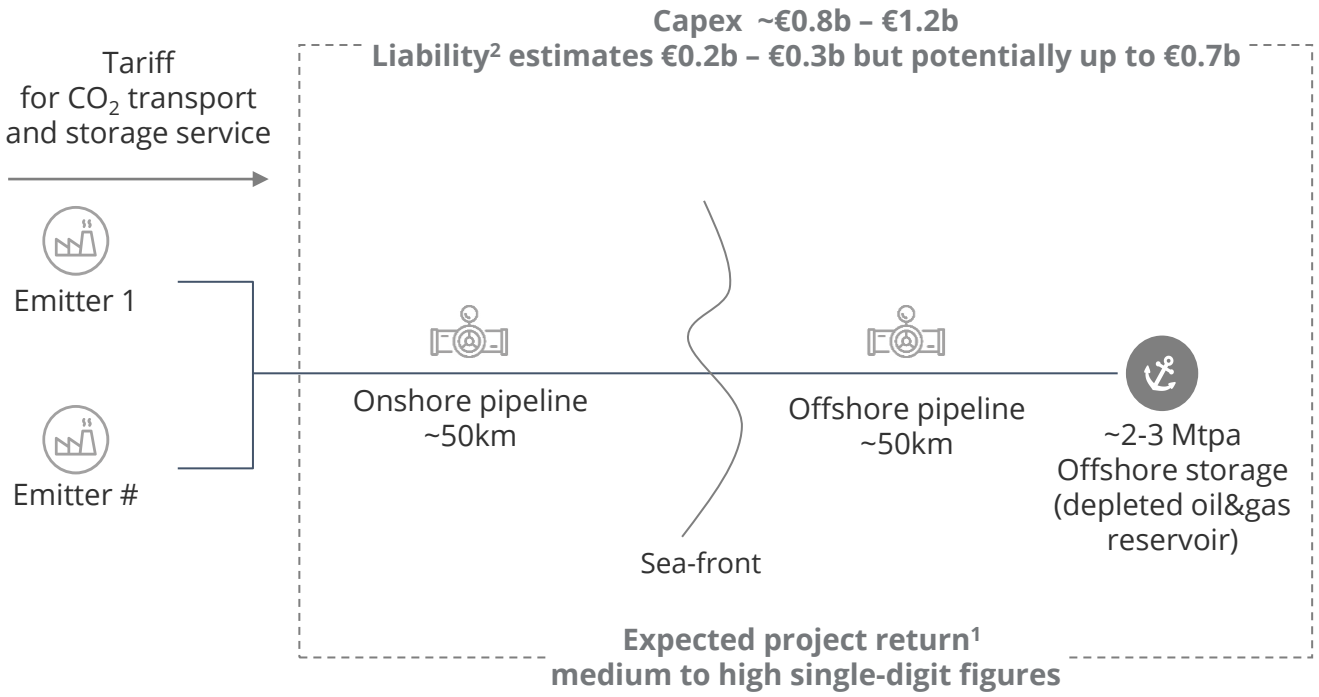
- Since the 1970s, the practice of injecting CO_2 into nearly depleted oil fields to extract additional oil has been applied in the US, which **represents the first case of underground CO_2 storage**
- Introduction of a specific tax credit per ton of CO_2 captured and stored in 2018 along with additional revenues from EOR initiated the **development of the first few industrial CCS projects at power plants**
- The further extension of the tax credit in 2022 **(IRA[2])** and other supporting legislations **sparked announcements of several CCS projects across the US**
- However, there is significant uncertainty in the project pipeline, making it difficult to differentiate between **projects that are progressing and those that are merely ambitions**

03 *"Investability"* of CCS projects

CCS is a multi-billion capital project, which based upon current risk assumptions, has a financial return in a range of a medium to high single-digit…

Expected financial project return[1] of mid-size CCS project

INDICATIVE



Comments

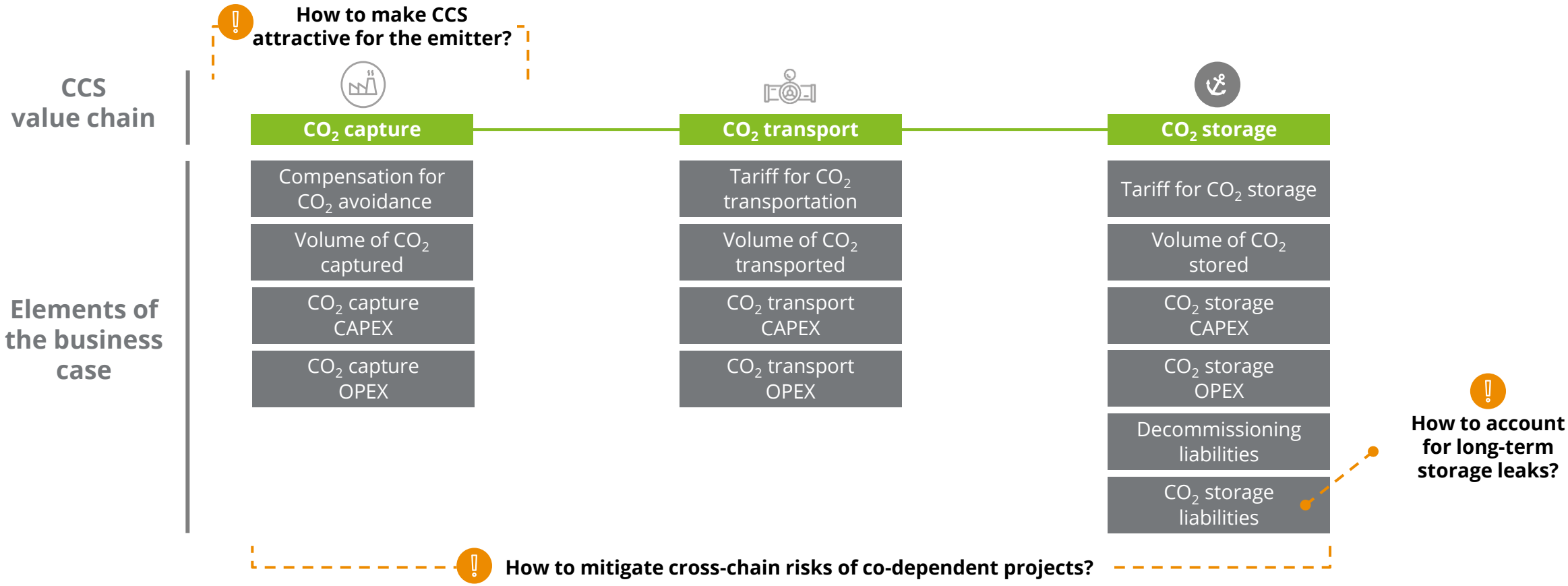
- Commercial CCS business models are emerging worldwide and there is still **significant uncertainty regarding some elements of the business case**, as well as expected returns
- Limited empirical data on CO_2 capture, transport and storage technical performance, with only a few operating projects leads to **uncertainty surrounding technical risks** and therefore decreases expected project returns
- Development of the first full CO_2 storage and transport projects is primarily funded from the balance sheet of major O&G companies with support of various government grants, allowing for **acceptance of higher risks and lower returns**

Notes: 1) Project Internal Rate of Return (IRR) 2) decommissioning liabilities and CO_2 leakage liabilities

...therefore, specific CCS risks must be mitigated to ensure CCS projects are 'bankable' and meeting financing criteria of the private investment sector

Overview of CCS business case and specific investment hurdles

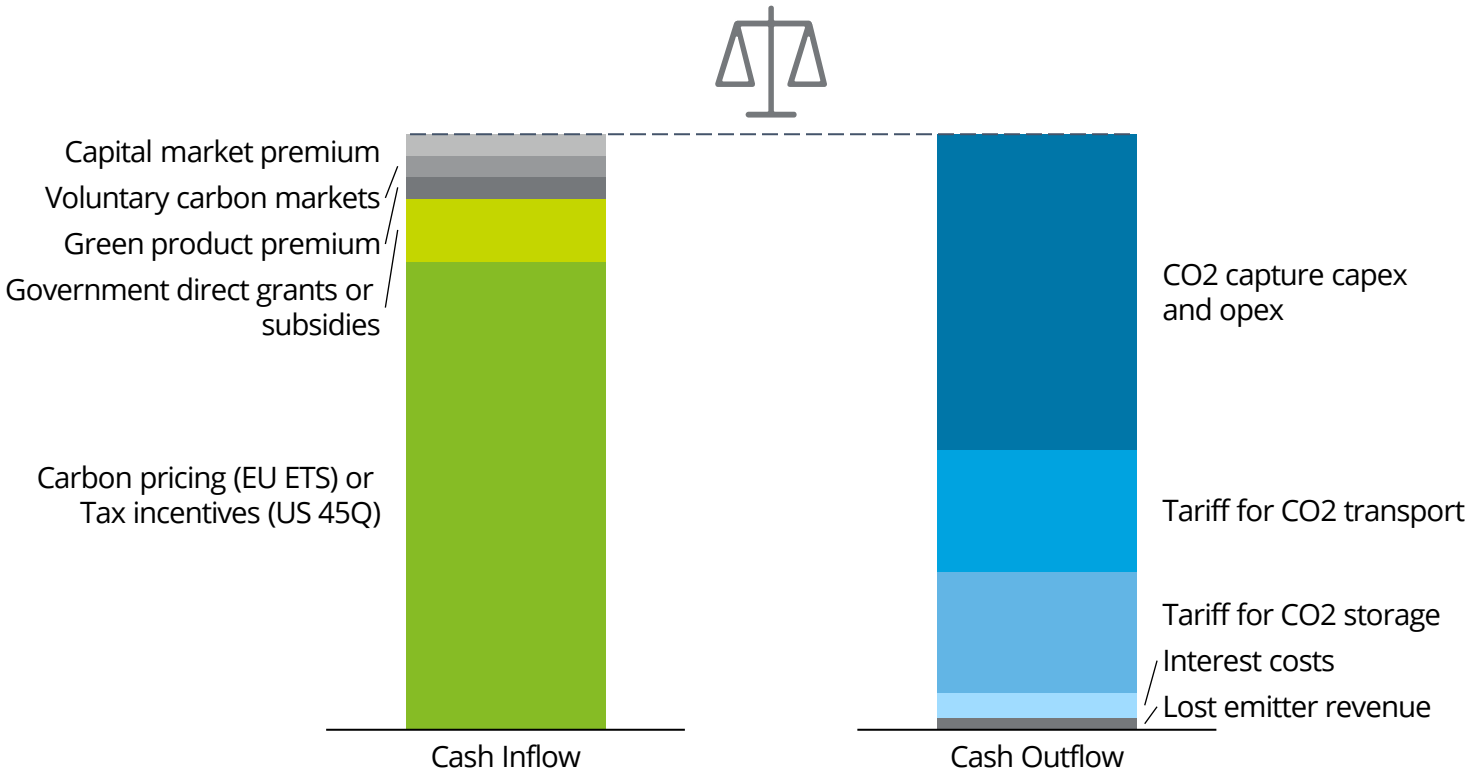
NOT EXHAUSTIVE



Sources: Deloitte analysis

Firstly, (i) CCS must become economically attractive for an emitter and various government and market instruments are being rolled out to cover CO_2 capture costs…

Compensating CO_2 capture costs for the emitter



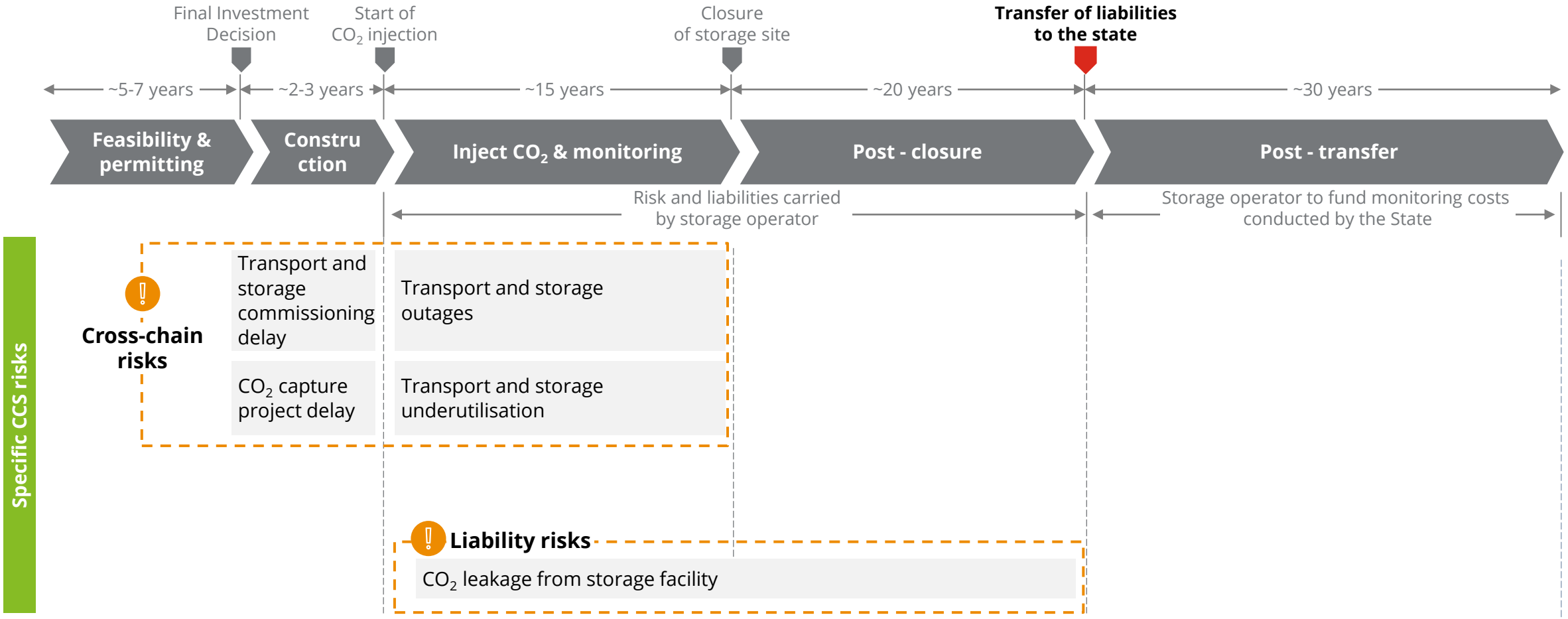
Comments

- **Carbon capture is a costly and complex technology**, which might account for up to ~50% of the total costs of CCS for an emitter
- Specific CCS solutions for some industrial facilities located close to a CO_2 storage **are becoming economically viable under the EU emission trading schemes…**
- …however, **in general, various government subsidies and grants are still needed** to support emitters' business cases
- Emitters can seek other sources of additional revenue to make CCS business case viable, including **voluntary carbon market and green product premiums…**
- **…but, scale up of voluntary carbon market is slow** and requires further compliance verification mechanisms
- Although additional cost of CCS as a price premium on a product is insignificant, **green premiums (e.g., 'green steel') cannot be factored in yet,** without further dedicated markets' development

Sources: Deloitte analysis

...and secondly, the (ii) cross-chain risks of co-dependent projects across the value chain and the (iii) risks of CO_2 leakage from the storage in the long-term will have both to be mitigated

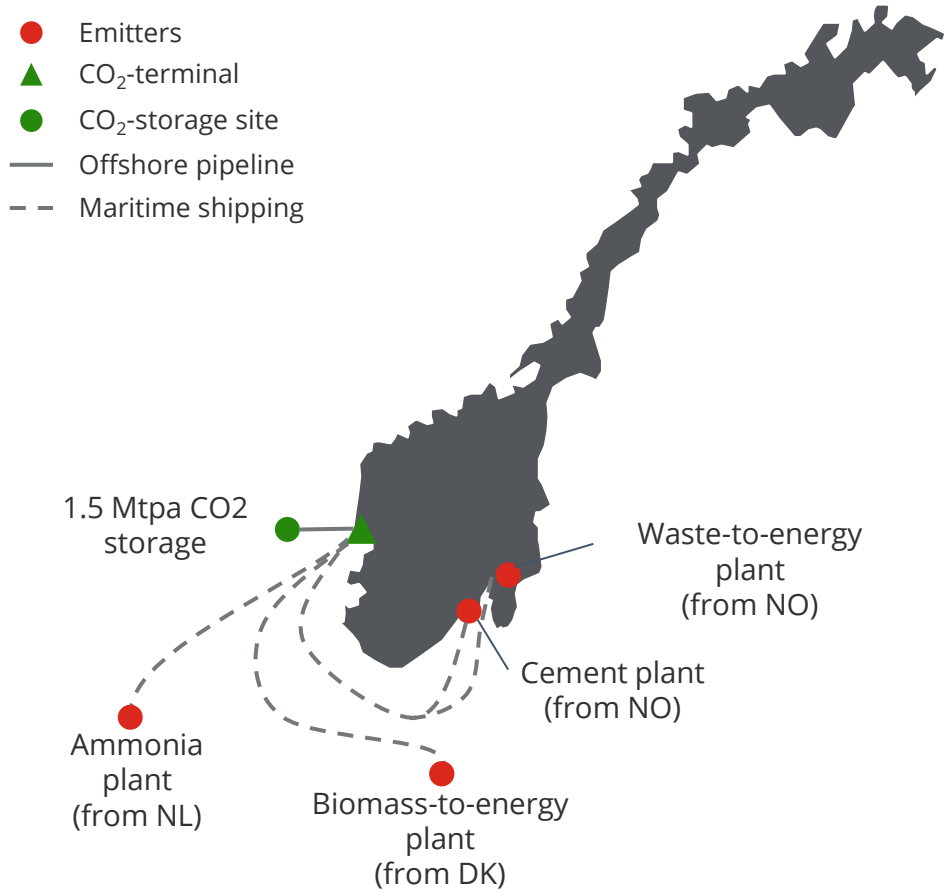
Specific CCS risks during the project life-cycle



Sources: EU CCS Directive; Deloitte analysis

As example, Northern Lights CCS project in Norway recently faced a cross-chain risk when one emitter temporarily halted its participation, potentially leading to network underutilization

Northern Lights CCS project in Norway



Comments

- **The Northern Lights** project in Norway is building **the world's first open-source CO_2 transport and storage Infrastructure**
- **Phase I** of Northern Lights received its Final Investment Decision in 2020 and **plans to transport and store 1.5Mtpa of CO_2 as of 2025** (initially late 2024)
- Northern Lights project and its first customers (cement and waste-to-energy plants) **received significant capex and opex subsidies from the Norwegian government**
- **In April 2023, one of two initial customers** (waste-to-energy plant) **decided to put the CO_2 capture project on hold** due to a large increase in costs estimates…
- …and Northern Lights is offsetting to fill in the uncontracted capacity by **actively securing new commercial customers** (ammonia plant in the Netherlands and biomass-to-energy plant in Denmark)**…**
- …However, it is likely that the CO_2 transport and storage infrastructure will be **underutilized during the initial period**
- Realization of such risks in a fully commercial project with only funding from private investors **might result in an unfeasible business case**

Sources: CCS Norway, Longship CCS website, Deloitte analysis

To cope with the CCS "*investability*", EU and US are proposing different frameworks, and we assess in the UK the more holistic and bankable one, though it has yet to be proven

	UK	European Economic Area			United States
		Netherlands	Denmark	Norway	
Scope of scheme	Dedicated to CCS projects	Broad range of technologies (renewables and other CO_2 reducing tech)	Dedicated to CCS projects	Not yet replicable approach implemented	Dedicated to CCS projects
Support receiver	Emitter Transport & Storage company	Emitter	Emitter		Emitter
Duration	10 + 5 years	15 years	15 years		12 years
Specific CCS risks protection	Government provides protection against major risks	Not available	Not available		Not available
Additional considerations	✓ Comprehensive regulatory and commercial framework ✓ Adjustable CfD-type subsidy X Regulated return limits the interest of private investors X Complex and lengthy process	✓ CfD-type subsidy for emitter ✓ Straightforward subsidy award criteria X No specific CCS subsidy domain X Lack of flexibility in subsidy adjustments	✓ Adjustable CfD-type subsidy for emitter ✓ CCS dedicated subsidy fund X Additional complexity of subsidy award criteria	✓ Government is perceived to support CCS and storing of imported CO_2 in Norway X Dedicated support for the flagship project, but not yet a clear business model for the next wave of projects	✓ Straightforward tax credit structure X Sectors with high capture costs remain unprofitable X Uncertainty after the tax credit realization period X Total tax credit budget might not be sufficient
Bankability	✓	X	X	X	X

Sources: National CCS regulations, expert interviews, Deloitte analysis

UK has developed a regulatory and commercial framework that offers financial and risk mitigation support to emitters and CO_2 transport & storage providers

UK government

Potential Capital Grant (CIF)
CCS subsidy scheme

Potential Capital Grant (CIF)
Regulated revenue

Financials

Emitter (CO_2 capture)

- Capital Grant and Capex repayments
- Subsidy for Opex (Contract for Differences mechanism)
- Subsidy for Transport & Storage tariff as a pass-through

Transport and Storage Tariff →

CO_2 transport & storage (T&S) provider

- Regulated revenue model where T&S company (single owner and operator of both onshore and offshore infrastructure) is allowed to charge emitters a certain Transport & Storage tariff

Risk Protection

Key risks	Government protection
Construction risk	✓
T&S commissioning delay	✓
Commercial risk	✗
Operating risk	✓
T&S outages and T&S capacity constraints	✓
User Stranded Asset	✓
Decommissioning risk	✗

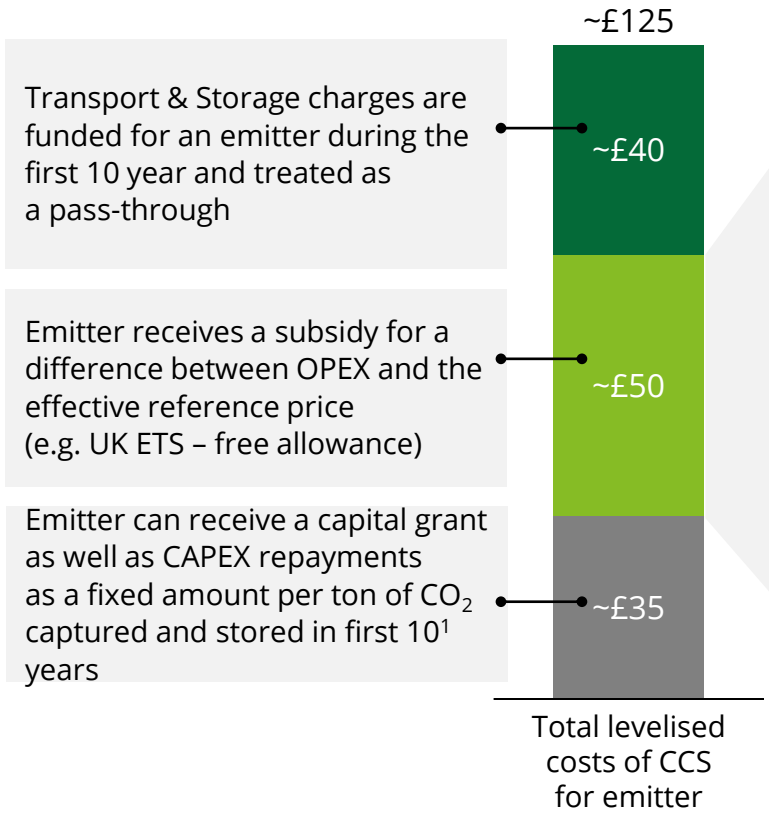
Key risks	Government protection
Construction risk	✗
Stranded asset risk (demand risk faced by T&S)	✓
Underutilization risk	✓
Leakage of CO_2	✓
Outages risk	✗
Decommissioning risk	✓

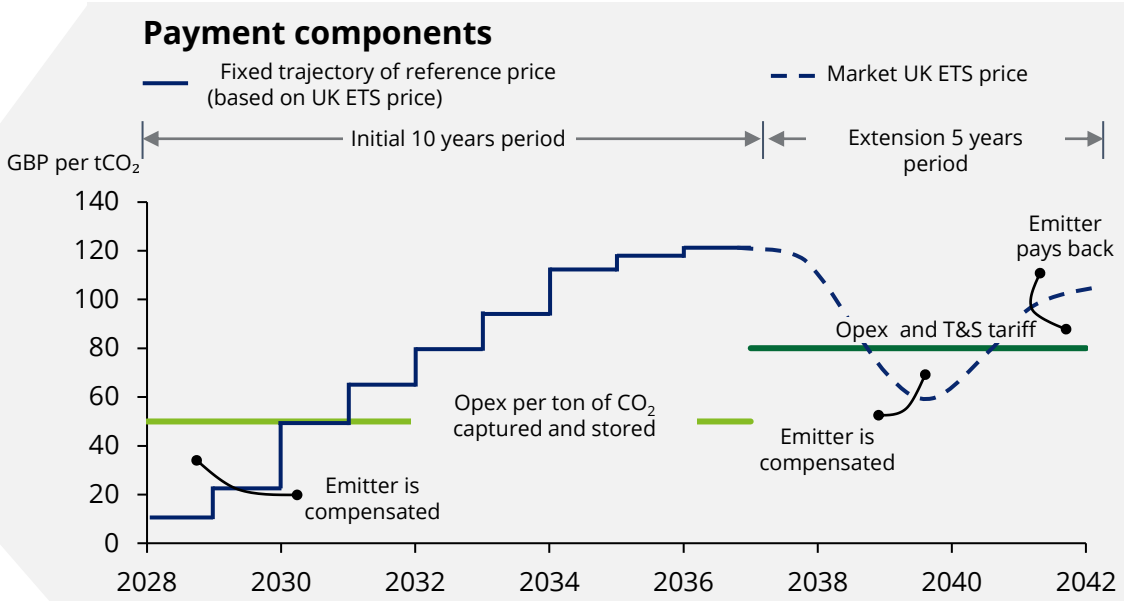
Sources: UK government ICC and T&S business models, Deloitte analysis

Financial support for emitters can be extended up to 15 years and includes potential capital grant, various repayments and Contract-for-Differences like subsidies

Overview of the financial support for an industrial emitter

ILLUSTRATIVE





- In the first 10 years, Emitter is compensated if Opex per ton of CO_2 stored is below the reference price
- Emitter can get an extension for another 5 years if certain performance and market conditions are met
- In the additional 5 years, the reference price is the UK ETS price, and the emitter must reimburse if UK ETS exceeds Opex + T&S tariff

Notes: 1) CAPEX shortfall period - If the capex has not been paid fully in the first 5 years due to lower CO_2 capture, it will continue to apply for up to a further 5 years
Sources: UK government ICC business model, Deloitte analysis

The government provides comprehensive protection for emitters and T&S providers against major risks, which makes the CCS proposition investable…

	Risk	Description	Protection from the government
CO_2 emitter	Construction risk	Construction risk refers to the group of risks associated with construction phase, including cost overruns, delays, contractual issues, etc.	✓
	T&S commissioning delay	The risk of delay in the commission phase of T&S project. A delay in this stage can impact the overall project timeline and may result in postponed operational commencement	✓
	Commercial risk	Commercial risk refers to the risk associated with obtaining the finance, managing cashflows and continuing commercial industrial operations	✗
	Operating risk	Operating risk refers to the risk of the facility either overperforming or underperforming in capturing and storing CO_2 compared to the initially agreed-upon terms	✓
	T&S outages and T&S capacity constraints	T&S outages refer to the risk when T&S systems are temporarily unavailable or not in operation. T&S capacity constraints refer to the risk of capacity limitations of T&S infrastructure	✓
	User stranded asset	The term 'User Stranded Asset' refers to the risk that if the T&S network is discontinued, and no alternative T&S option is feasible, then the capture project is considered stranded	✓
	Decommissioning risk	Decommissioning risk refers to the challenges associated with the safe and effective closure, dismantling, and remediation of CCS facilities at the end of their operational life	✗
Transport & Storage provider	Construction risk	Construction risk refers to the group of risks associated with construction phase, including cost overruns, delays, contractual issues, etc.	✗
	Stranded asset risk (demand risk faced by T&S)	In this case stranded asset risk refers to the demand risk faced by T&S, e.g., where users are late in connecting to the network	✓
	Underutilization risk	Underutilization risk refers to the potential risk that T&S system may not be fully utilized or may operate below its optimal capacity	✓
	Leakage of CO_2	CO_2 leakage refers to the potential risk for CO_2 to leak from its intended storage location	✓
	Outages risk	T&S outages risk refers to the risk of T&S assets not operating and being unable to transport and store the captured CO_2 from relevant projects	✗
	Decommissioning risk	Decommissioning risk refers to the challenges associated with the safe and effective closure, dismantling, and remediation of CCS facilities at the end of their operational life	✓

Sources: UK government ICC and T&S business models, Deloitte analysis

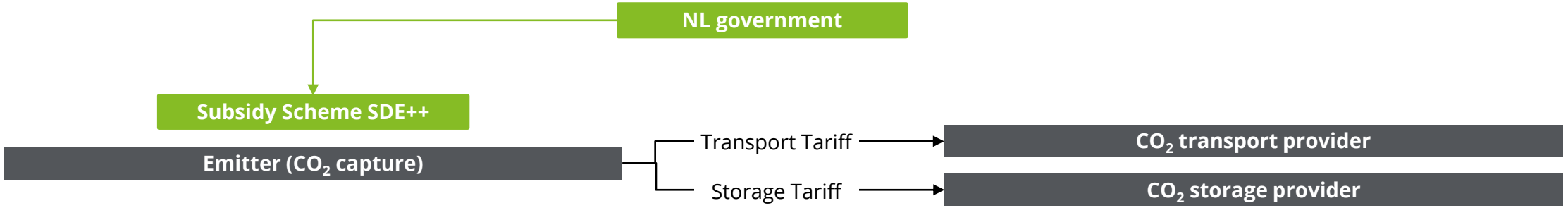
…However, T&S provider operates under a regulated revenue scheme, which while being transparent, it may deter private investors due to expected limited returns

Allowed revenue

Return on Capital	• **Return on Capital = Regulated asset value (RAV) * WACC** • **RAV** = **development spend** (Devex) + **construction spend and asset expansion** (Capex) + **rolled up cost of capital** (i.e., WACC during the construction period) – **depreciation and disposals** • **WACC** - will consider – **Expected costs of financing** – **Risks borne by T&S** (e.g., construction risk, development risk, technology risk, operational risk, etc.) – **Initial WACC will be determined in dialogue with the T&S**
Depreciation	• Depreciation – revenue collected from users to cover asset depreciation over the operational period and profiled to reduce payments in the early operational period to support the initial stages of the project
Opex	• Opex will be the allowed spend for efficient operational costs, which will have been agreed in the initial settlement • Opex allowance could also include user bad debt, expected hedging costs, expected private sector insurance premium etc.
Decommis-sioning cost	• Decommissioning – allowance to cover decommissioning costs of the T&S network at the end of assets life
Tax	• Allowed revenue will include an allowance for expected tax costs
Adjustments	• Adjustments – adjustment for pass-through costs and any required true-ups and incentives (can be positive and negative), including availability incentive, leakage incentive, connections incentive, construction delay

Sources: UK government T&S business models, Deloitte analysis

The Netherlands is yet to establish a comprehensive commercial CCS framework, with which emitters can receive subsidy, while no dedicated support for transport and storage providers



Financials

- Emitters can apply for Dutch SDE++ subsidy, but will compete for funding with other decarbonization projects[1]
- Emitter can seek additional financial support from EU subsidy schemes (e.g., EU Innovation Fund)

- Free market approach, unbundled CO_2 transport and storage providers can set tariffs based on its expected returns
- CO_2 transport and storage providers can seek additional financial support from EU subsidy schemes (e.g., Connecting Europe Fund via Project of Common Interest status)

Risk Protection

- No specific mechanisms to protect emitters against major risks

- No specific mechanisms to protect transport and storage providers against major risks
- Indirect government support is evident through the active involvement of state-owned companies in the development of CCS transport and storage infrastructure

Notes: 1) since 2023 domain fences for certain technologies are implemented (e.g., heating and 'molecules'), but not for CCUS
Sources: SDE++ scheme, Deloitte analysis

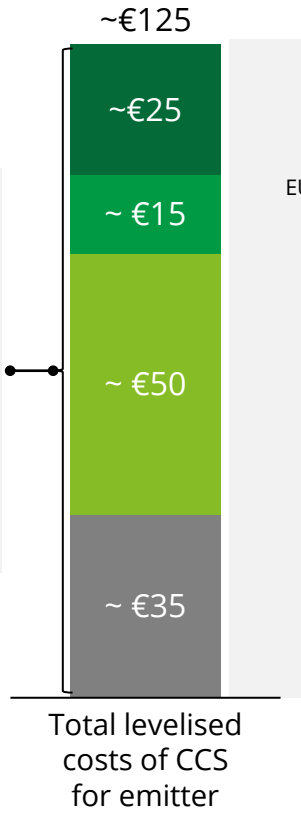
Emitters can apply for Contract for Differences-like subsidies and receive a 15-year support covering the cost of CCS above the EU ETS price

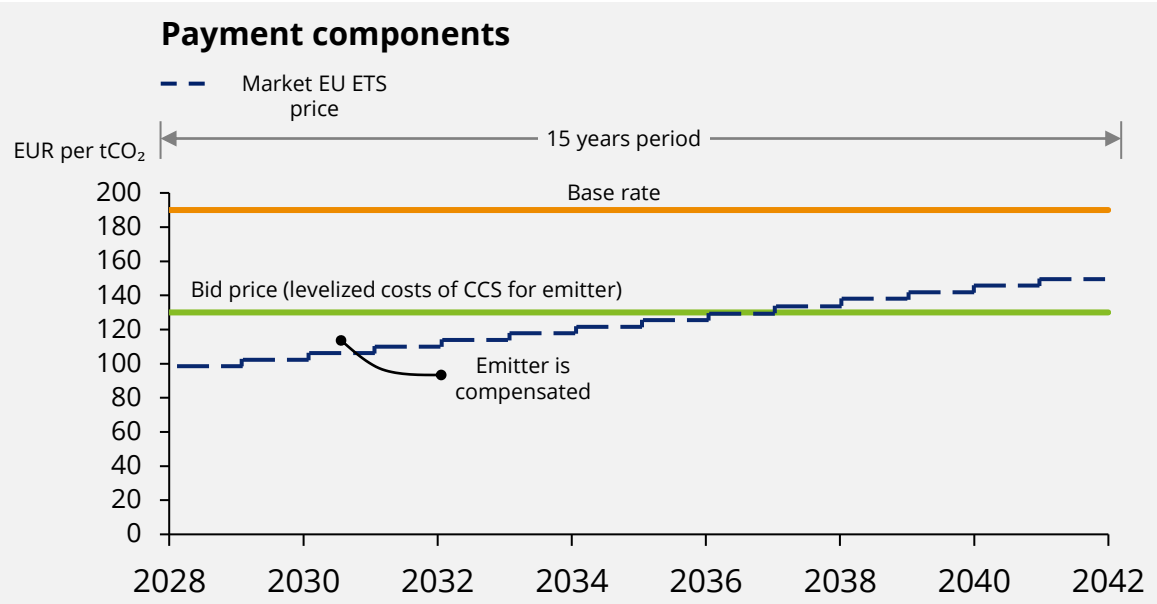
Overview of financial support for an industrial emitter

ILLUSTRATIVE

- Storage tariff
- Transport tariff
- Opex per ton of CO_2 captured
- Capex per ton of CO_2 captured

Emitter receives a subsidy for a difference between EU ETS and total levelized costs of CCS (in contrast with split compensations in the UK)

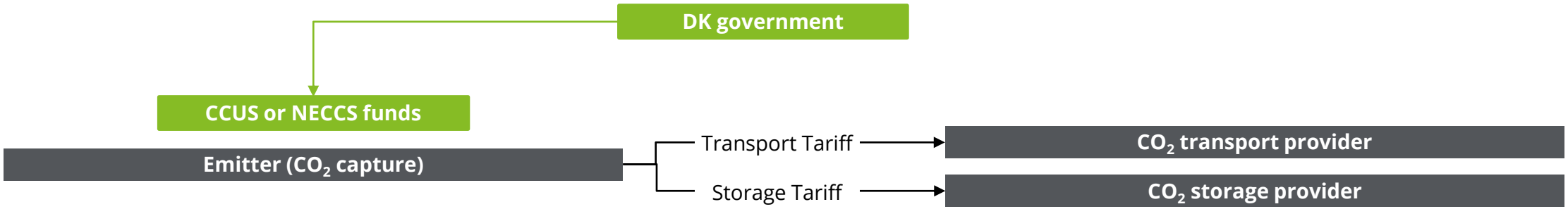




- CCS projects compete with other sustainable technologies in SDE++
- There is a maximum amount of subsidies emitter can apply for (the base rate upper bound)
- In case of the tariff increase and additional subsidy is needed, emitter needs to re-apply and might have a risk to lose the subsidy
- Granted subsidy is not adjusted for inflation during the 15 years period

Sources: SDE++ scheme, Deloitte analysis

Denmark has recently introduced two dedicated CCS subsidy schemes for emitters, but there is no dedicated support for transport and storage providers



Financials

- Emitters can apply for CCUS subsidy fund with fossil and biogenic CO_2 sources being eligible (total target to store 2,7Mtpa of CO_2 from 2029)
- Emitters can also apply for NECCS subsidy fund, dedicated to the negative emissions with only biogenic (including Direct Air Capture) sources being eligible (total target to store 0,5Mtpa of CO_2 from 2029)

- Free market approach, unbundled CO_2 transport and storage providers can set tariffs based on its expected returns
- CO_2 transport and storage providers can seek additional financial support from EU subsidy schemes (e.g., Connecting Europe Fund via Project of Common Interest status)

Risk Protection

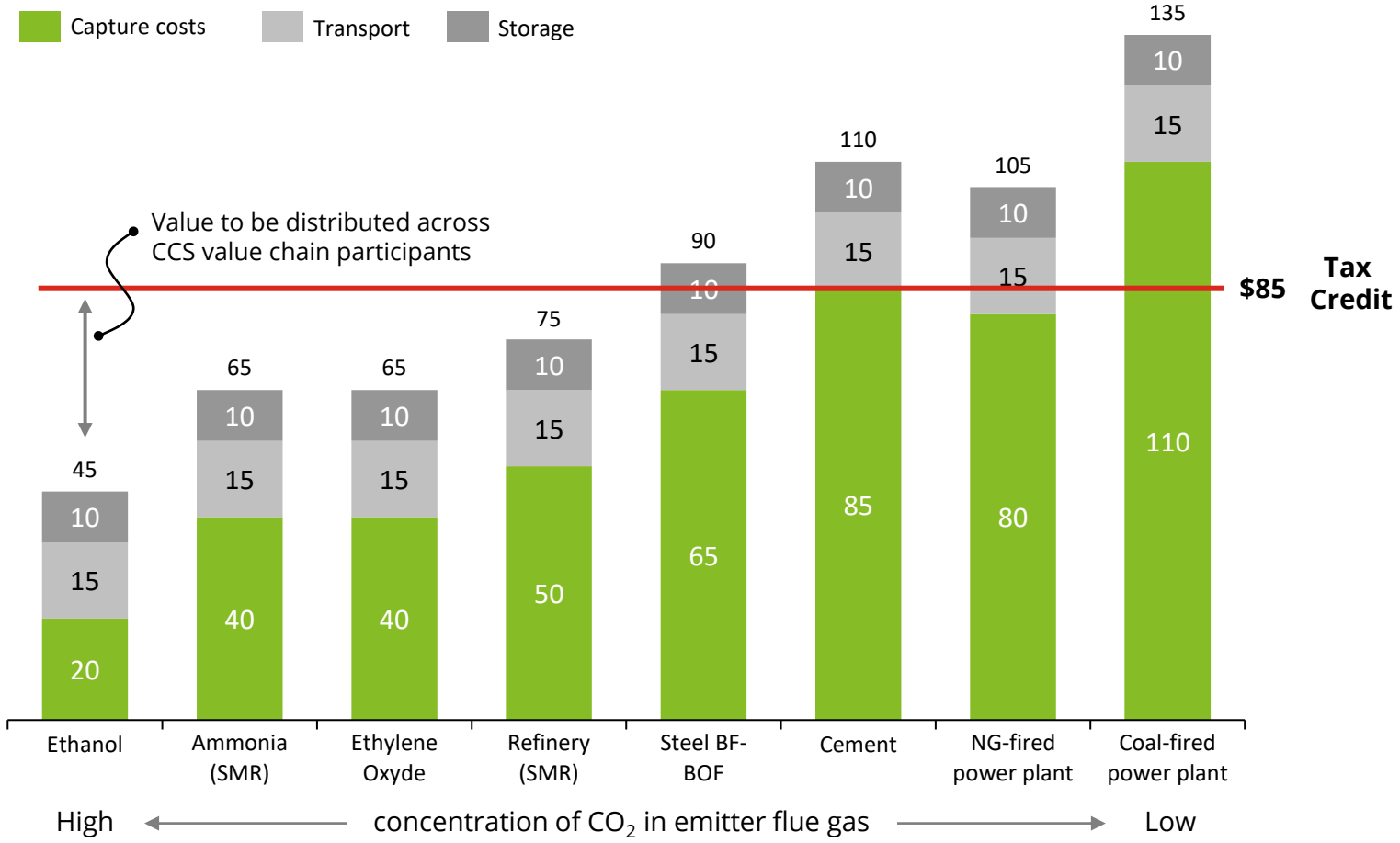
- No specific mechanisms to protect emitters against major risks

- No specific mechanisms to protect transport and storage providers against major risks

Sources: Danish Energy Agency, Deloitte analysis

IRA 45Q tax credit might be seen attractive however it is short for some emitters, has post-credit uncertainty and lacks support for low-probability high-impact events

Tax credit (45Q) mechanism in US (USD per ton of CO_2)

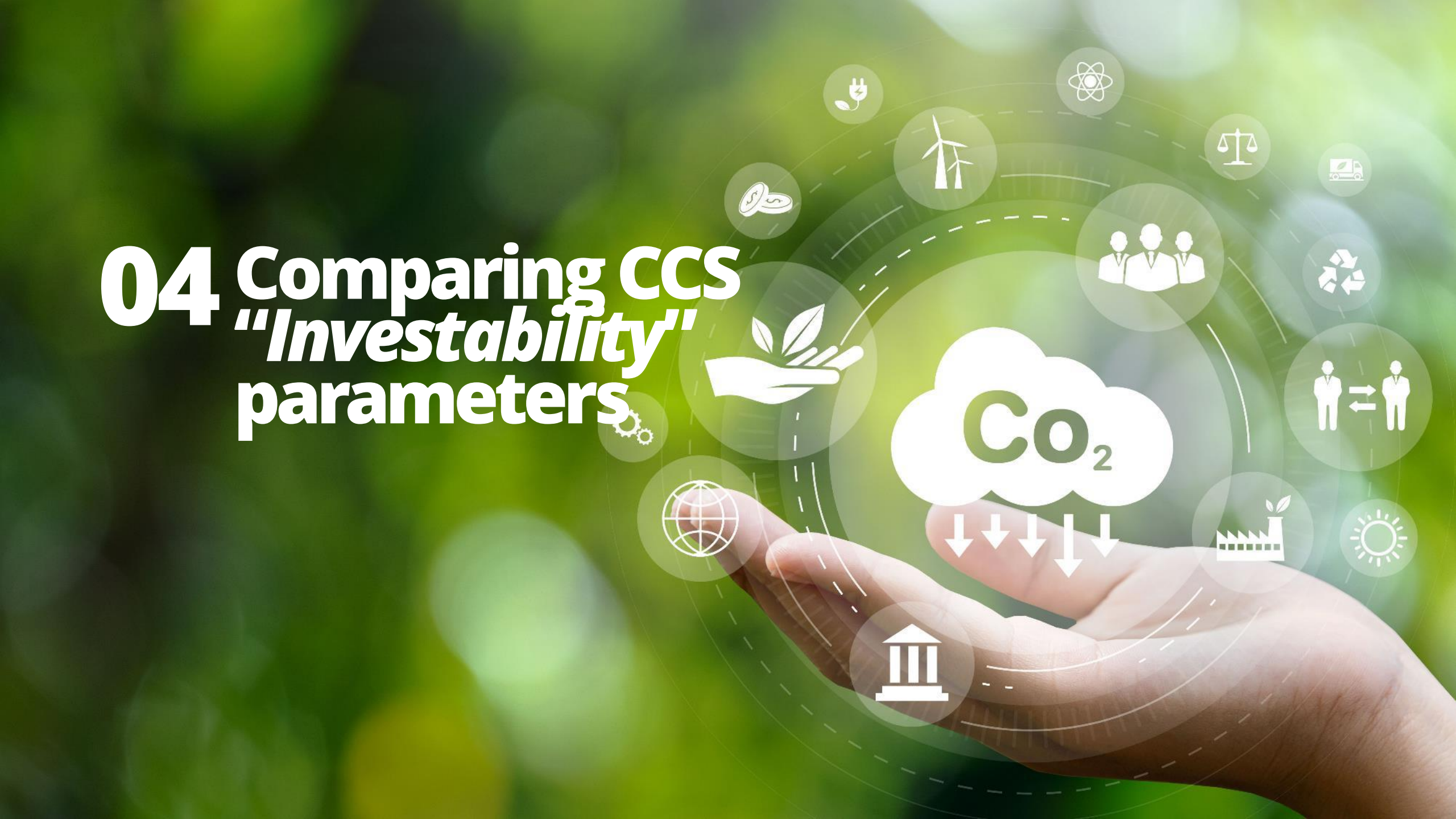


Comments

- **The Inflation Reduction Act (IRA) provides $85 tax credit per ton of CO_2 stored** in saline geologic formations from carbon capture on industrial and power generation facilities
- **The claim period is 12 years** and developers can receive a 45Q tax credit as a fully refundable direct payment as if it were an overpayment of taxes (during first 5 years)
- **$85 per ton of CO_2 stored is not sufficient** to make a viable business case for emitters with a low concentration of CO_2 in the flue gas (e.g., cement, power plants) considering additional costs of CO_2 transport and storage
- **Emitters can seek additional financing from other sources**, including IIJA and DoE grants although being limited and for specific purpose (e.g. FEED study)
- The **lack of risk-sharing mechanisms** and protections against low-probability high-impact events significantly **limits the bankability of certain projects**

Sources: IRA,IEA, expert interviews, Deloitte analysis

04 Comparing CCS *"Investability"* parameters



Only the UK framework demonstrates a holistic investable CCS proposition, while private-sector investments in other regions should be assessed on a case-by-case basis

Assessment of CCS "*Investability*" parameters

			UK	NL	DK	NO	US
Supporting policies & regulations	**National CCS targets**	• Signal acceptance of CCS as a viable technology contributing to climate targets achievement	*20-30 Mtpa by 2030*	*Not mentioned but flagship projects are supported*	*4-9 Mtpa by 2030*	*Not mentioned but flagship projects are supported*	*No mentioned but importance of CCS is acknowledged*
	CCS legal and regulatory	• Establish a legal framework, including permitting and operation, closure and post-closure obligations	*Adaptation of EU CCS Directive*	*Adaptation of EU CCS Directive*	*Adaptation of EU CCS Directive*	*Adaptation of EU CCS Directive*	*Various federal and state legislation*
	CCS commercial framework	• Establishing a structured commercial framework, including economic incentives, legal structures and market mechanisms	*CCS business models*	*Only subsidy for emitters*	*Only subsidy for emitters*	*Not available*	*Only tax credits for emitters*
	Cross-boarder CO2 shipping	• Enable a cross-border, single market approach on CO_2 transport and storage	*Provisional application of LP Article 6*	*Bilateral agreement BE/NL*	*Bilateral agreement BE/DK*	*Provisional application of LP Article 6*	*Not relevant*
Emitter economics	**Carbon pricing**	• Incentivize emitters to consider CCS solution	*UK ETS*	*EU ETS and carbon tax*	*EU ETS and carbon tax*	*EU ETS and carbon tax*	*No carbon pricing mechanism*
	CCS subsidies	• Provide a stable support scheme to make CCS projects economically acceptable for emitters	*National Budget CCS Infra fund*	*SDE++ scheme*	*CCUS support scheme*	*Not available*	*IRA 45Q tax credit*
	Additional funding	• Give an opportunity for CCS projects to get an access for broader innovation and infrastructure funding	*Not relevant*	*EU Innovation Fund Connecting EU fund*	*EU Innovation Fund Connecting EU fund*	*Enova EU Innovation fund*	*IIJA and DoE CCS funding and state-level support*
Risks mitigation	**Cross chain risk**	• Support complex CCS value chains during the first phases of infrastructure development	*CCS business models*	*Emitters and T&S providers bear all risks*	*Emitters and T&S providers bear all risks*	*Emitters and T&S providers bear all risks*	*Emitters and T&S providers bear all risks*
	CO_2 leakage risks	• Protect project against low-probability high-impact events during the technical and operational maturity of the CCS solution	*CCS business models*	*T&S providers bear all risks*	*T&S providers bear all risks*	*T&S providers bear all risks*	*T&S providers bear all risks*

Sources: Deloitte analysis

05 Conclusions

Our conclusions are looking into next actions that could be taken to make CCS-as-Service attractive for private investments and scale up to reach the climate targets

Provide dedicated financial support for emitters

- **Europe has firmly established the most advanced carbon emission trading scheme**, **incentivising emitters to reduce carbon emissions** in order to avoid paying the price per ton of CO_2 emitted
- As CCS is still too expensive, a **Contract-for-Difference type subsidy would effectively allow emitters to bridge the gap between the total CCS costs and EU ETS prices or US tax credit** and make the project economically viable
- **Tailoring the subsidy instrument specifically to CCS**, e.g. allowing for certain recalculations of the required subsidy amount, **would provide the necessary stability and predictability**

Protect against low-probability high-impact events

- **CCS applications are limited to a few operational projects** in North America and Europe with the majority using CO_2 for enhanced oil recovery. However, **the empirical data of operational CCS performance is limited**
- **The first full large-scale commercial CCS projects** in Norway, the Netherlands and the US **received significant support from the EU and US governments. However, a few projects will not be enough to de-risk this solution for private-sector investors**
- **Guarantee-type of risk protection** (e.g., regulated asset-based model or EU ETS-baked fund) **could be established to support in case of low-probability, high-impact events** (e.g., CO_2 leakage) until the insurance instruments are developed and affordable

Ratify European cross-border CO_2 shipping

- **Europe has a potential to develop two large-scale CO_2 storage domains –** one **in the North Sea** and another **in the Mediterranean Sea**. This would allow Europe to build optimal CO_2 transport and storage infrastructure
- Recently, the **first few bilateral agreements on cross-border CO_2 transport for permanent storage offshore were signed** (e.g., Belgium and Denmark). **If other European countries follow suit, this could open a common CO_2 transport and storage market**
- This will also **allow emitters to connect to storages in the most economical way**, and **CO_2 storages to achieve the economies of scale while minimizing commercial risks** by gaining access to a broader set of emitters

06 Deloitte and CCS

Deloitte is positioned to lead on CCUS development around the world

The Deloitte CCUS service offering encompasses the entire value chain – from an emitter to a CO_2-disposal & utilization business, as well as important stakeholders, as service companies and regulators

Technology & Innovations

Scan of the technology & innovation landscape to understand readiness levels, opex & capex costs, risk of adaptations and development of fit-for-purpose technical specifications

Market Insights

Insights on the market potential on sectoral / emitter level relevant for CCUS-technology company as well as CO_2-disposal company to understand "supply / demand" and "window-of-opportunities"

Funding & Subsidies

Selection of project specific options with details on the funding / subsidy mechanisms, consideration of eligibility, as well as support in filling and application process

Policies & Regulations

Analysis of the local regulatory framework and an impact on the CCUS-related activities, including licenses, cross-boarder regulations, emissions reduction regulations etc.

Business Models

Full-scale financial model to get insights on financial attractiveness of various business models (i.e. operation / owner) as well as on impact of key parameters (i.e. CO_2-price)

CO_2-accounting & taxation and value creation options

Impact of CO_2-accounting and carbon-taxes on the business case, as well as recommendation of additional value creation options to boost returns of projects

We have supported the most important CCUS projects…

Technology & innovation | Policies & Regulations | Business models | Market insights | Technology & innovation | CO_2 accounting & taxation

Financial model and risk assessment for CCUS project

Porthos CO_2 TRANSPORT & STORAGE

Deloitte performed analytical procedures on the financial model of Porthos, including revenue, opex, capex and decommissioning parts for the transport and storage components of the CCUS value chain. Deloitte also analyzed risk profiles to determine appropriate discount rates for project valuation and analysis of value distribution across the chain. The financial model is used to support decisions, commercial agreements, and financing applications.

Technical and commercial feasibility study

Northern Lights

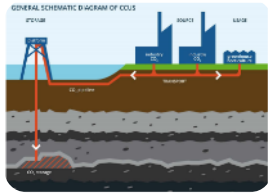
Deloitte supported the Norwegian government's plans to develop a full-scale CCUS value chain in Norway by 2024. Deloitte advised Fortum Oslo Varme throughout the concept study, FEED and piloting of carbon capture from its waste-to-energy facility in Norway, with a focus on business model, procurement strategy, cost control, planning. Deloitte also carried out detailed modelling of uncertainties around capital and operating cost requirements and supported stakeholder negotiations.

Operational & technical due diligence for CCUS project

Porthos CO_2 TRANSPORT & STORAGE

Carried out an in-depth operational due diligence on P18-A platform analyzing opex and capex costs, maintenance, production profiles and reserves, as well as decommissioning liabilities. The detailed map of key cost drivers, risks and opportunities is used for commercial negotiations, economic forecast scenarios and strategic decisions.

Grants & incentives advisory for CCUS projects



For two CCUS projects in Belgium and The Netherlands, Deloitte conducted an assessment of available grant and subsidy opportunities. After the feasibility has been demonstrated, Deloitte formulated the business plan (including the financial and implementation plans), for Innovation Fund and SDE++ applications, and submitted the required documentation to the relevant regulatory bodies.

… across multiple stakeholders and for multiple services

Technology & innovation | Policies & Regulations | Business models | Market insights | Technology & innovation | CO_2 accounting & taxation

Market model to assess commercial potential for CCUS

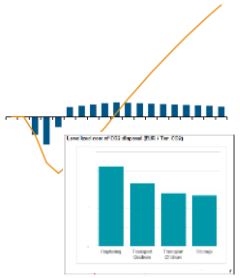
Assisted European O&G client with determining the value creation potential and window of commercial opportunity for CCUS in North-West Europe. This involved the development of an integrated source-to-sink market model which captures the key supply and demand drivers, forecasts logistically and commercially accessible CO_2 volumes, and models emitter choices, optimizing on a cost basis. The model supports strategic investment decisions.

Financial advisor to UK Government on CCUS Programme

Department for Business, Energy & Industrial Strategy

Deloitte advised the UK Government's Department of Business, Energy and Industrial Strategy (BEIS) on the £1 billion grant CCUS Commercialisation Programme of 2013-15, aimed at procuring up to two new-build power and CCUS projects. This involved the structuring and drafting of the tender documentation and evaluation of the bids received, providing input on the structuring of a contract for difference to support full chain CCUS projects, and assessing project financing aspects.

Life-of-asset economic model to screen CCUS project options



Supported a multinational O&G client with determining the key value drivers for CCUS projects and mapping the value-risk distribution and economic benefits across the CCUS value chain. Deloitte developed a life-of-asset economic model and carried out a bottom-up analysis of key cost drivers, potential revenue streams and tariff structures, and quantified impact of subsidies, grants, incentives, carbon pricing, and long-term liabilities on project economics across each segment of the CCUS value chain. The model output was used to screen investment opportunities and optimize decisions in respect to CCUS participation, operating models, and pricing formulae .

Advise on future-proof corporate structure for CCUS projects

ebn

In the context of potential (new) investments in carbon capture and storage and other new businesses in the Netherlands, EBN asked Deloitte to provide an integrated advice on a future-proof corporate structure that best supports these investments. Through interactive workshops with the client's senior management, we have identified and prioritised the possibilities and hurdles from a legal, commercial, financial, governance, tax and audit perspective.

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