AN ANALYSIS OF THE PROSPECTIVE ROLE OF STATE-OWNED ENTERPRISES IN CO2 STORAGE ACTIVITIES IN THE NETHERLANDS

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Table of contents

1 EXECUTIVE SUMMARY

The Ministry of Economic Affairs and Climate Policy (EZK) has commissioned DNV with support from IOM Law to undertake an analysis of the prospective role of state-owned enterprises (SOE) in carbon dioxide (CO_2) storage activities in the Netherlands. The objective of this work is to analyse the necessity and the extent to which a SOE, for example Energie Beheer Nederland (EBN), should become directly involved in the realisation of CO_2 storage sites from the perspective of guaranteeing safety[1] during project development, operation and afterwards.

1.1 Conclusions

These following conclusions are not independent from each other and should be read as building upon each other.

- Our analysis suggests the primary role of Energie Beheer Nederland (EBN) in CO_2 storage activities should be as a *long-term steward* after the transfer of responsibility has been handed back to the State. We have not found justification for EBN to have an obligatory role for guaranteeing safety during CO_2 storage project phases *prior to transfer of responsibility*.
- The legal analysis has further shown that delegation of an obligatory safety role to a state-owned enterprise, such as EBN, prior to transfer of responsibility is at odds with OECD/G20 corporate governance guidelines and the EU framework for state aid and third-party access. This applies whether EBN has an equity stake or not.
- Interviewed representatives from industry and all government bodies except EBN do not support the delegation of a safety role to EBN during the operational phase of a CO_2 storage project. This has been anchored in the generally held consensus that there should only be one operator, as safety is the prime responsibility of the operator. We derive from the interviews that a safety mandate pretransfer of responsibility back to the State will cause confusion and potential duplication of safety roles for both an operator and the regulator SodM (State Supervision of Mines). There is the risk of conflicting responsibilities and conflicting outcomes of reviews. This could negatively impact safety, especially during operations, and result in overly expensive and inefficient assurance because operators may have to demonstrate prudent operatorship twice.
- Five models for EBN / SOE involvement were assessed. DNV analysis suggests that either Model 2 or Model 3 are preferred. In both Model 2 and Model 3, EBN takes the same role as in oil and gas activities (equity, non-operating partner, is not a licensee or co-licensee, and does not have a veto vote in a JV partnership) and is principally involved in the projects as the entity with delegated responsibility for long-term stewardship. Furthermore, SodM is the only state-owned enterprise with a mandate to guarantee safety. Model 3 differs from Model 2 by TNO-AGE being assigned responsibility for knowledge sharing instead of EBN. An advantage of Model 2 is fewer stakeholders to manage during project development and execution. Model 2 is the preferred model of a majority of the stakeholders interviewed by DNV. However, most importantly legal analysis favours Model 2 and 3 over models where EBN has an obligatory role in safety prior to the transfer of liability.
- Our analysis suggests that EBN is the most qualified state-owned enterprise to take the role as long-term steward and assume responsibilities in the case of unplanned withdrawal of storage license. To enable EBN to be prepared for a long-term stewardship role, it is recommended that involvement in CO_2 storage projects begins around the start of the process for the storage permit application. This would provide sufficient time for EBN to build corporate knowledge of the storage site. Earlier involvement of EBN could create a conflict of interest for EBN when storage sites are being selected. The frequency and timing of EBN involvement will vary over time, EBN involvement could be at a lower level initially during the pre-FEED and FEED (Front End

[1] Safety is interpreted to refer to both human and environmental safety, and to be a reflection of the ability of CO_2 storage sites to deliver environmentally safe geological storage of CO_2 to contribute to the fight against climate change, in accordance with the wording in the EU CCS Directive. In the CCS Directive, the purpose of environmentally safe geological storage of CO_2 is permanent containment of CO_2 within a dedicated CO_2 storage.

Engineering Design) phase, with no role in operations, and then involvement could increase prior to the transfer of responsibility back to the State.

- EBN has built significant relevant subsurface capabilities through its minority equity partner role for oil and gas activities. To be prepared for long-term stewardship, they will need to continue to build CO_2 storage competence with operator support. By becoming a non-operating partner, EBN will be privy to project information necessary to build this competence and gain sufficient level of project insight. This can also enable EBN to be prepared to assume operator responsibilities in the case of unplanned withdrawal of a storage permit. This implies that EBN should either establish the necessary competence and organisational set-up to qualify as an operator when taking this role, or establish outsourcing arrangements that can be activated in the case of unplanned withdrawal of the storage permit.
- EBN can help coordinate the CO_2 pipeline routing to CO_2 storage projects that can be developed in the Dutch sector of the Southern North Sea (SNS). For example, EBN could engage with commercial operators to map plans for CO_2 storage in or nearby their existing acreage during initial stages of CO_2 storage development in the Netherlands. DNV does not recommend EBN be involved directly or indirectly in selecting storage sites. This can represent a conflict of interest, since EBN is also part owner of many existing depleted fields (EBN is involved in 200+ production and exploration licences[2] and there are 250 producing fields currently in operation[3]). Such coordinating role will need to be organised according to EU state aid guidelines.
- EBN can facilitate sharing of international CO_2 storage best practices and HSSE (Health, Safety, Security and Environment) learning across projects. This is a form of knowledge management role. However, the possible delegation of this role to EBN has raised concerns from the operator community around the misuse of commercially sensitive information. This issue can be addressed through contractual arrangements.
- EBN has been building CO_2 storage competencies over the last couple of years. While EBN has some expertise in CO_2 storage activities, these capabilities are still limited compared to the major operators executing CCS activities in the Netherlands. EBN as an organisation has never operated oil and gas operations, and currently they do not meet the criteria for becoming an operator under Dutch Mining Regulation (Article 1.3.4.a.6.c), despite having staff with operator experience. Our analysis suggests that EBN should build CO_2 storage competencies by being an equity partner prior to taking upon a long-term stewardship role.
- EBN's equity share could for example range from 10% to 40%. The lower end is recommended. An SOE should not have a majority stake in a project giving them veto or undue influence of third-party access or concerns around conflict of interests. However, if CCS is not deployed at the pace required to meet the needs for the contribution of CCS to the Netherlands net zero target, the State could increase their equity stake to provide investor certainty.

[2] https://www.ebn.nl/en/data-centre/
[3] https://www.nlog.nl/en/oil-and-gas

1.2 Overview of research questions

Table 1: EZK research questions, sub questions and high-level evaluation.

Question 1		**Evaluation**
Is the involvement of a state-owned enterprise, in this case EBN, as an obligatory participant, shareholder, or in any other form, justified on the grounds of guaranteeing safety?		DNV has not found justification for EBN to have an obligatory role for guaranteeing safety during CO_2 storage project phases *prior to transfer of responsibility*.
Sub-questions	**Section**	**Evaluation**
What technical components and operational aspects of the CCS chain affect the safety of CO_2 storage?	Section 5 and Appendix 1	Components that can affect safety relate to containment risks (geological and mechanical) and HSSE aspects during operations and monitoring.
Is the current regulatory framework and recourse provided to the competent authority (EZK) and the supervising body (SodM) sufficient to guarantee safety at all times?	Section 4	The Dutch regulatory framework is fit for purpose, and the competent authority is provided with sufficient recourse to be able to guarantee safety at all times.
What are the foreseen benefits with regards to safety of delegating EBN an obligatory role in all CO_2 storage activities?	Section 6.4	We conclude there are no benefits to delegating EBN a safety role. There are also legal issues around corporate governance, third-party access and possible state-aid issues.
What alternatives to the involvement of a state-owned enterprise could be considered in order to guarantee safety?	Section 5.2	Independent third-party verification can be commissioned by the State to add an additional layer of assurance. A disadvantage with this is that it may reduce build-up of knowledge within the competent authority needed to assume responsibility for long term stewardship.
Are there examples of SOEs primarily responsible for safety aspects for CCS in other countries or are there analogues for direct state involvement in the safety aspects of other energy related industries.	Section 6.10	None identified for CCS. The nuclear industry has regulatory bodies overseeing safety i.e., similar role to SodM and site-licence companies (who may be financed through the State to operate) are responsible for nuclear safety. In the case of nuclear waste storage, site licence companies operate the storage

		facilities and nuclear regulators again oversee safety. The site-licence company may be state-owned and normally charge a fee for handling the waste.

Question 2		**Evaluation**
What other aspects should be considered in appointing EBN with an obligatory role in all CO_2 storage activities?		• Long term stewardship (primarily role). • Coordination role for offshore pipeline infrastructure • Sharing of international best practices and technical HSSE learnings. • Facilitating third-party access to transport networks and storage hubs.
Sub-questions	**Section**	**Evaluation**
Are there other co-benefits to an obligatory involvement envisaged, for example speed of deployment, investor certainty, coordination, prevention of over-subsidization, managing third-party access issues, stimulating the reuse of assets?	Section 6.8 and 6.10	See points for main Question 2. Additional co-benefits include increased investor certainty when SOE takes an equity stake and public acceptance in early stage of CCS development in the Netherlands. Commercial: Potential additional revenue stream for the Dutch government – like the current oil and gas model.
Are there potential disadvantages of obligatory involvement of a state-owned enterprise in CO_2 storage activities, for example efficiency (both in time and cost), risk exposure to the State, or state aid restrictions?	Section 3, 6.4 and 6.10	There are a number of legal issues with EBN having an obligatory involvement with a safety mandate, prior to transfer of responsibility back to the State. It can lead to illegal state aid, corporate governance breaches (OECD/G20) and infringement of EU third-party access rights. A safety mandate pretransfer of responsibility back to the State will also cause confusion and potential duplication of safety roles for both operator and SodM. Conflicting responsibilities could negatively impact safety and result in expensive and inefficient assurance.

Comment on the possibility of EBN managing a future revenue stream from CO_2 storage tariffs on behalf of the Dutch state, this could include revenue from the storage of domestic and foreign CO_2.	Section 6.10	If EBN takes an equity stake like in the current oil and gas model, then they could secure a revenue stream for the State. EBN can only take an equity stake if it does not have an additional safety role, for reasons outlined in Question 1.

Question 3 and sub questions		**Evaluation**
If obligatory involvement of EBN is deemed necessary to guarantee safety, to what extent and in which form can this participation by realized?		For EBN to be prepared for a long-term stewardship role, the form of involvement can be similar to the current oil and gas model where EBN has an equity stake but takes the role as a silent non-operating partner. This enables EBN to build up corporate technical knowledge of the storage site and have adequate familiarity with storage operations and monitoring to take on a long-term stewardship role, or assume responsibility for operations if storage licence is withdrawn.
Sub-questions	**Section**	**Evaluation**
At what stage during the development of a CO_2 storage site can it be considered for a state-owned enterprise to become involved?	6.6	Post site selection, around permit application in preparation for a long-term stewardship role.
If direct investment in a project is to be considered, what level of equity is considered appropriate to achieve the required level of participation and steering during CO_2 storage operations.	Section 6.10	Between 10-40% -. The lower end is recommended. An SOE should not have a majority stake in a project giving them veto or undue influence of third-party access or concerns around conflict of interests.
In the case of direct investment by EBN, please provide an estimate of the potential capital injection requirements from the Dutch state into EBN to allow it to fulfil its role as shareholder in storage activities between 2025 and 2050.	Section 6.11	Insufficient accurate information was available to make this estimate. A qualitative logic has been presented on how to make this estimate.

Question 4 Long-term stewardship		Evaluation
The suitability of EBN in carrying out the task of long-term stewardship, what alternatives could be considered?		No real alternatives have been identified. In the current landscape, EBN is the most suitable organisation to carry out the task of long-term stewardship.
Sub-questions	**Section**	**Evaluation**
Comment on the suitability of EBN having a combined role as both a CO_2 storage project developer *and* responsible for the long-term stewardship of closed storage sites.	Section 6.6--9	EBN is the most qualified state-owned enterprise to take the role as long-term steward. EBN has built significant relevant subsurface capabilities through its minority equity partner role for oil and gas activities. To be prepared for long-term stewardship, EBN will need to continue to build CO_2 storage competence with operator support. By becoming a non-operating partner, EBN will be privy to project information necessary to build this competence and gain sufficient level of project insight.

DNV

2 INTRODUCTION

The Ministry of Economic Affairs and Climate Policy (EZK) has commissioned DNV with support from IOM Law to undertake an analysis of the prospective role of state-owned enterprises in carbon dioxide (CO_2) storage activities in the Netherlands. The objective of this work is to analyse the necessity and the extent to which a state-owned enterprise, for example Energie Beheer Nederland (EBN), should become directly involved in the realisation of CO_2 storage sites from the perspective of guaranteeing safety[4] during project development, operation and afterwards.

The deployment of large-scale Carbon Capture and Storage (CCS) is seen as an essential transition technology for the Netherlands to reach its 2030 climate targets. Ensuring safety and preventing CO_2 leakage is key to enable this large-scale deployment. The government of the Netherlands regards the deployment of CO_2 storage as a success when the risk to the environment and the financial risks associated with CO_2 leakage are minimised, thereby minimising the costs of CCS to society as a whole.

The analysis in this report has considered the roles and capabilities of EBN and other government institutions in applying and enforcing the existing regulatory framework for CO_2 storage. This includes EZK as 'competent authority', and the State Supervision of Mines (SodM), responsible for advising the competent authority on permitting activities and enforcing the regulatory framework.

Currently there are two large-scale, offshore CO_2 storage projects being matured, PORTHOS and ARAMIS, both with EBN as a partner. A provisional decision has been made to deem it necessary that EBN takes an obligatory participation in all CO_2 storage activities. This also involves EBN becoming responsible for the long-term stewardship of CO_2 storage sites unless alternatives can be identified. This obligatory participation could be realized through the introduction of an additional statutory duty for EBN via the Mining Act.

However, the involvement of state-owned enterprises in CCS projects has led to some confusion and uncertainty as to what extent EBN can or should be involved in all future CO_2 storage activities in the Dutch sector of the North Sea. The private sector has asked the Minister for clarity with regards to whether or not any state-owned enterprise (SOE) will be given a new remit to become a shareholder in future CO_2 transport and storage infrastructure, outside of the PORTHOS and ARAMIS projects.

EZK has requested this research work be carried out by a third party, to address criticism from the National Audit Report 2021[5] after the extensions of EBN, Gasunie and TenneT roles in geothermal activities in the Netherlands.

EZK posed four main research questions:

1. Is *obligatory* involvement of EBN in Dutch CO_2 storage projects justified on the grounds of guaranteeing safety?
2. What are benefits and disadvantages of appointing EBN with an *obligatory* role in Dutch CO_2 storage projects?
3. To what extent and in which form can *obligatory* participation by EBN be realised?
4. Is EBN well suited to manage long-term stewardship of CO_2 storage sites?

DNV has addressed these questions by leveraging insights from involvement in CCS projects across the world. A multiple proxy approach has been taken to address these research questions. The following approaches were used:

- Legal analysis to examine third-party access and state aid consideration to CCS deployment in the Netherlands.
- Structured interviews have been conducted across a range of stakeholders inside and outside the Netherlands to understand possible models for SOE role in safety and long-term stewardship.

4 Safety is interpreted to refer to both human and environmental safety, and to be a reflection of the ability of CO_2 storage sites to deliver environmentally safe geological storage of CO_2 to contribute to the fight against climate change, in accordance with the wording in the EU CCS Directive. In the CCS Directive, the purpose of environmentally safe geological storage of CO_2 is permanent containment of CO_2 within a dedicated CO_2 storage.

5 In publieke handen, Algemene Rekenkamer [2021], retrieved from:

- Structured evaluation of alternative models for involvement by EBN in CO_2 storage projects.
- Evaluation of the recourse provided to EZK to guarantee safety at all times without direct involvement by EBN in CO_2 storage projects prior to transfer of responsibility to the State.

To underpin its research, DNV conducted over 17 structured interviews with key national and international stakeholders with CCS experience. To ensure the analysis reflected a broad range of views, Dutch operators, government organisations and NGOs with CCS interests were interviewed. In addition, governmental organisations external to the Netherlands from Europe, North America, and Australia were interviewed to gain their perspective on how different organisations have handled safety and long-term stewardship (Table 2). The stakeholder's list was disclosed and agreed to by EZK.

Table 2: List of Interviewed organisations and those unable to participate (regrets)

Governmental organisations involved in CCS project development outside the Netherlands	Dutch Governmental and NGOs involved in CCS activities	Dutch Operators involved in CO_2 storage projects
▪ Norway - Norwegian Petroleum Directorate ▪ Australia - Government of Western Australia, Department of Mines, Industry Regulation and Safety ▪ USA – U.S. Environmental Protection Agency ▪ Canada – Government of Alberta, Department of Energy	▪ EZK-Permitting ▪ EBN ▪ SodM ▪ Gasunie ▪ TNO-AGE ▪ Natuur & Milieu (Nature & Environment)	▪ TotalEnergies ▪ Shell ▪ Petrogas ▪ Neptune ▪ Vopak

The report begins by providing a background to current roles and responsibilities of the key actors in CO_2 storage in the Netherlands and their role in safety and long-term stewardship. Further, the pretext for the legal constraints around state aid and third-party access is described. We then evaluate the completeness of the Dutch regulatory framework in the context of the needed recourse for the competent authority in the Netherlands (EZK) to fulfil its role and explain the project maturation life cycle for typical CO_2 storage projects. The report then describes the parameters used to develop five models with different roles for EBN / SOE involvement in storage projects before presenting a comparative analysis of the five models.

3 LEGAL CONSIDERATIONS FOR STATE INVOLVEMENT IN DUTCH CCS ACTIVITES

This section describes the current roles and responsibilities of the various parties involved in a Dutch CO_2 storage project, from the storage operator, state regulator and legislator. This section will also provide a background to implications of state aid for operations, long-term stewardship and third-party access issues relating to CO_2 storage which are different from conventional oil and gas activities in the Dutch offshore sector. This background provides context for the analysis of the prospective role of EBN or any other state-owned organisation having an obligatory role in guaranteeing safety during project development, operations and in the long-term stewardship phase.

3.1 Roles and responsibilities

Table 3 maps out the key roles and responsibilities for an operator, regulator and legislator relating to safety and long-term stewardship for Dutch CCS projects.

Table 3: Key roles and responsibilities for an operator, regulator and legislator relating to safety and long-term stewardship for Dutch CCS projects.

Role	Responsibilities
Operator	Under Article 22, 5th paragraph, of the Dutch Mining Act (Mijnbouwet)[6], an operator for oil and gas* activities are defined as: A person (natural person or legal entity) appointed by the holder of the permit to perform the actual operations or to commission their execution. <u>Operators must comply with Dutch legislation and regulations and therefore is responsible for ensuring safety of the environment and human health.</u> The operator must prove that it possesses[7]: 1. Management specialised in this field. 2. Suitably skilled and experienced staff capable of controlling the mining engineering processes. 3. A staff that is sufficiently knowledgeable about Dutch legislation and regulations. 4. An organisation capable of dealing with any disasters that might occur. 5. A Strategic Plan for performing a forementioned activities. 6. Sufficient financial reserves to carry out the aforementioned activities (for the record only). *It is expected the requirements for an oil and gas operator will map across to a CO_2 storage operator.
Regulator (SodM)	State Supervision of Mines (SodM) is the independent supervisor of mineral and energy extraction in the Netherlands. SodM has a mandated role to: ▪ Enforce the Mining Act (subsurface activities) and Gas Act (Transport) – non complacence can result in warnings, penalties or stop orders. ▪ Carry out independent supervision, including inspections (production facilities, drilling rigs and wells) and investigations. ▪ Advises the EZK whether a submitted application for a permit to permanently store CO_2 meets the requirements of the Mining Act.

6 https://www.nlog.nl/sites/default/files/opzet_eisen_operators_web_1_uk.pdf
7 https://www.nlog.nl/en/procedures-licences

Legislator and Competent Authority	The Minister of Economic Affairs and Climate Policy (The Minister) represents the State for all actions relating to the ownership of minerals. The Minister takes care of/decides on: • the establishment of an independent scientific knowledge programme, ensuring the input of national and international scientists and experts; • an application for a storage or exploration permit; • amendment or withdrawal of a storage permit in whole or in part; and • sending an application for a permit for the permanent storage of CO_2 together with the relevant documents to the European Commission. The holder of a permit for permanent storage of CO_2 shall provide the Minister with the following information at least annually: • the results of the monitoring of stored CO_2 indicating the technology used; • the quantities and characteristics of delivered and stored CO_2 streams, stating the composition of these streams; • proof that financial security or an equivalent has been established and maintained; and • other information which the Minister considers important for assessing the interests and for increasing knowledge of the behaviour of CO_2 in the storage facility. In case of the Minister withdraws a permit for the permanent storage of CO_2 at his own discretion or at the request of the permit holder, the Minister is responsible for: • monitoring; • corrective measures, and • the preventive and remedial measures of the Environmental Management Act. Monitoring concerns the level at which leakages or significant irregularities can be identified. If significant irregularities or the threat thereof are identified, the Minister shall intensify the monitoring. The Minister shall recover the costs that have been incurred after the withdrawal of the permit from the former holder of a permit for permanent storage of CO_2.

3.2 State aid considerations for CCS

3.2.1 State involvement in transport and storage operations

The starting point for any discussion on state involvement in CO_2 transport and storage operations is that states have sovereignty for the purpose of exploring and exploiting natural resources in their territory. This includes their territorial exclusive economic zones and continental shelves, as defined by art. 3 and arts. 55-85 of the UN Convention of the Law of the Sea[8], as well as onshore within their territories.[9]

The guiding principle of the CCS Directive is also sovereignty, which applies both onshore and offshore. Member States are free to allow or not allow CCS operations in their territory, decide whether to allow storage onshore or offshore, and impose stricter requirements for operations than those imposed by the EU, provided they are in line with the purpose of the CCS Directive. The State is authorised to take corrective measures, stop or take control of storage operations that do not meet the criteria for operations, and to determine whether or not the requirements for the post-closure transfer of liability to the state are met.

8 United Nations Convention on the Law of the Sea, signed 10 December 1982, entered into force 16 November 1994.

9 Directive 2009/31/EC on the geological storage of carbon dioxide [2009] OJ L 140/114 [CCS Directive], art. 2(1)

All permits granted for CCS-related activities (exploration, storage, and access to transport networks) are controlled by the Member States individually, pursuant to the minimum requirements in the CCS Directive. Should the State want to single-handedly operate its entire CO_2 storage industry, that is its sovereign right. However, as soon as market forces, private companies, or SOEs operating on market terms enter the field in Europe, state aid rules come into play to ensure a level playing field.

Regardless of whether the State decides to operate the CO_2 storage industry itself or not, the State plays a key role in CO_2 transport and storage operations, both due to their regulator role and role as owner of the subsurface in which storage will take place. Because of the strong notion of sovereignty, there are few rules regarding how states are to organize CCS activities in their territories. This also implies that the role played by state-owned enterprises is up to the States to define, as long as other ethical and legal requirements are met, such as for example the OECD guidelines on Corporate Governance of State-Owned Enterprises and EU state aid rules. In principle, this means that the Dutch State is free to designate EBN or any other SOE as operator for CCS activities in the Netherlands, as long as all requirements regarding, inter alia, state aid and other corporate guidelines are met.

3.2.2 State aid requirements

State aid as defined under EU law[10] is aid in any form[11] granted by a Member State to an undertaking that may give the company a selective financial advantage that distorts competition and affects trade between the Member States of the EU. Such aid is in principle prohibited depending on five cumulate qualifiers:[12]

1. State resources: This means that the funds (either directly or indirectly, in the case of non-monetary aid) in question should come from the State or be directed by the State.
2. The beneficiary of the advantage is an "undertaking": "Undertaking" is usually understood as an entity engaged in economic activity, regardless of its legal status and the way in which it is financed, including a state-owned entity. The undertaking must benefit from an economic advantage (in any form) which it would not obtain under normal market conditions.
3. Selectivity: The advantage must be selective in the sense that it favours an undertaking, certain goods, a location, a type of firm, or a sector over others.
4. Competition distortion: A measure is considered to distort or threaten to distort competition when it is liable to improve the competitive position of the recipient compared to other undertakings with which it competes. Generally, any aid granted in a liberalized sector will be found to distort competition.
5. Intra-EU trade affected: If the position of an undertaking is strengthened compared to that of other undertakings competing in intra-EU trade, this requirement is met. Intra-EU trade could be affected if the storage industry of one Member State is given advantages at the cost of other Member States' industries competing for intra-EU trade. It is not necessary to prove that trade has been affected, only the likelihood of such.

All state aid is in principle prohibited unless it fits one of the exceptions in the Treaty on the Functioning of the EU.[13] The European Commission is responsible for approving exemptions. In 2022, the European Commission adopted updated EU Guidelines on State Aid for Climate, Environmental Protection and Energy[14], which lists how and in what circumstances state aid for the purposes of combating climate change (which covers CCS) could be permitted.

The Commission's guidelines were updated in recognition of the need for state aid to reach the EU's 2030 and 2050 climate goals.[15] The guidelines are applicable to all technologies that contribute to the reduction of GHG emissions, with

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10 See in particular art. 107 of the Treaty on the Functioning of the EU [2012] OJ C 326/47 ["the Treaty"].

11 Ranging from direct subsidies and loans to the less obvious consulting services.

12 These are based on how the Commission, in its *Notice on the notion of state aid as referred to in Article 107(1) of the Treaty on the Functioning of the European Union* [2016] C/2016/2946 OJ C 262/1, and the EU Court understands and enforces art. 107(1).

13 These are listed in art. 107(2) or (3) of the Treaty.

14 Guidelines on state aid for climate, environmental protection and energy [2022 C(2022) 481 final].

15 Which are, respectively, 55% reduction and net neutrality.

CCS/CCU (Carbon Capture and Storage / Carbon Capture and Utilisation) highlighted explicitly as one of the technologies potentially eligible for state aid. The deployment of CCS/CCU is also highlighted as one of the limited ways in which the Commission can consider fossil fuel investment compatible with the 2030 and 2050 targets.[16]

The fact that the Commission has included CCS in the Guidelines gives the Member States a lot of flexibility in supporting it with state aid. In practice, this implies that as long as the requirements of proportionality, non-discrimination, and transparency (among others) are met, the Commission can allow state aid to CCS projects that would otherwise be illegal.

That being said, the inclusion of CCS in the Guidelines does not give an automatic right to support any future CCS activities through state aid. Until now, when CCS has been deployed primarily on a demonstration basis, the Commission has permitted a higher level of aid than would otherwise be allowed.[17] However, once the CCS industry reaches a commercial scale, the state aid framework will apply in full.

In Section 6 of this report, we are analysing the Dutch state's future involvement in a commercial CCS industry and how the different identified models for such involvement may either risk triggering illegal state aid or whether these forms of state involvement could be recognized pursuant to the state aid regime.

3.3 OECD guidelines on Corporate Governance of State-Owned Enterprises

The 2015 OECD Guidelines on Corporate Governance of State-Owned Enterprises[18] are considered the gold standard for how governments should manage and exercise their ownership of companies and how to make these companies more efficient, transparent, and competitive. The guidelines only apply to SOEs that operate on the market with an economic purpose and go hand in hand with the G20/OECD Principles of Corporate Governance.[19]

A general principle is that the economic activities of SOEs need to happen without unreasonable benefits or burdens compared to other companies. The guidelines also include recommendations on how to justify state ownership, the role of the State as an owner, issues related to SOEs operating in competitive markets, transparency, and responsibilities. One of the overarching recommendations is to clearly distinguish when the State is acting in its capacity as a business owner and in its other, e.g., regulatory or statutory capacities. This recommendation is key for the analysis in relation to the models identified in chapter 5 and an important element in terms of the recommendations coming out of this report.

The guidelines have multiple overlaps with the EU's state aid rules. Activities or behaviour that could be considered inconsistent with the guidelines could also, in some circumstances, be in breach of state aid rules. This is especially seen in instances where the State's involvement in a company results in market distortion and economic benefits that would not have come about under normal market conditions. The economic benefits could be direct or indirect – and it is especially the latter that is problematic from the perspective of the OECD Guidelines. The OECD guidelines are thus important to consider both independently and in relation to state aid, as what could be bad practices regarding managing SOEs could also constitute state aid.

16 Ibid, see especially pages 38-39, 50, and 93-100.

17 This is also described in the Commission's approval of other Dutch CCS demonstration projects, see: https://ec.europa.eu/commission/presscorner/detail/en/IP_10_1392.

18 G20/OECD Principles of Corporate Governance [2015], available at https://www.oecd.org/corporate/guidelines-corporate-governance-soes.htm.

19 OECD Guidelines on Corporate Governance of state-Owned Enterprises [2015], available at https://www.oecd.org/corporate/principles-corporate-governance.

3.4 Third party access considerations for CCS development

3.4.1 State involvement according to the CCS Directive

Chapter 5 (Article 21 and 22) of the CCS Directive sets out the rules governing third-party access to transport networks and storage sites. The rules are similar to the ones that apply under the Gas Directive.[20] However, the language is less comprehensive and detailed. The focus is first and foremost on setting out the guiding principles for third-party access to transport and storage infrastructure, namely non-discrimination and transparency.[21]

The Directive obliges Member States to take the necessary measures to ensure that potential third-party users are able to obtain access to transport networks and storage facilities. However, the Directive does not specify what these necessary measures are. Member States are thus free to decide how they want to ensure this, whether through physical control of transport networks or simply through permits and regulation, as long as it is done in a transparent and non-discriminatory way.[22] This interpretation is in harmony with third-party access issues in related fields, like electricity, and previous rulings by the Court of Justice of the EU.[23] As such, having a state-owned company directly involved in the operations to secure third-party access is not required. On the other hand, from a third-party access point of view, the Dutch State is free to directly involve themselves in operations to ensure third-party access if this is what the State considers to be the most efficient way of ensuring compliance with the requirements of the CCS Directive.

The rationale behind third-party access provisions is to ensure a high level of competition in markets where natural monopolies (according to the essential facility doctrine) would otherwise make it difficult or unfeasible, and that society will benefit from this increased competition.[24] Third-party access might further stimulate full use of available infrastructure, which may be important for an emerging industry with low margins. Access to sufficient infrastructure has been identified as one of the potential bottlenecks for full-scale deployment[25], which further emphasizes the need to fully utilise the already available infrastructure. The European Commission has further stated that in the future, open access infrastructure across borders in Europe would help ensure competitiveness and drive down costs, supporting the development of hubs and clusters as well as allowing the CO_2 emitters to choose between different solutions.[26]

The CCS Directive requires access to be provided in a transparent and non-discriminatory manner where the following is considered:

1. Reasonably available storage and transport capacity.
2. The proportion of CO_2 reduction obligations pursuant to international and EU law that the state intends to meet through CCS.
3. Technical incompatibilities that cannot reasonably be overcome; and
4. The need to respect the needs of the owner and operators of the storage or transport networks, and the interests of all other users of such.[27]

In practice, the requirements under Article 21 establish a right for third parties to, at least, be able to negotiate access to infrastructure (negotiated third-party access). Access can also be granted through so-called "regulated third-party access", where the regulator set conditions for connections and decide on tariffs rather than this being negotiated

[20] Directive 2009/73/EC concerning common rules for the internal market in natural gas [2009] OJ L 211/94.
[21] Eilertsen, Tonje. Tredjepartsadgang til transportnett og lagringsområder for CO_2. Sjørettsfondet. 2010. p.71
[22] See art. 21 of the CCS Directive and Roggenkamp, M. M. (2009). The Concept of Third Party Access applied to CCS. In M. M. Roggenkamp, & E. Woerdman (Eds.), Legal Design of Carbon Capture and Storage (pp. p. 273 - p. 285). (Energy & Law; No. 10). Intersentia, International Law Series.
[23] C-239/07 *Julius Sabatauskas and Others* [2008] EU:C:2008:551.
[24] Rydberg, N. and Langlet, D., 2015. Available at: https://www.globalccsinstitute.com/archive/hub/publications/190063/ccs-baltic-sea-region-bastor-2-work-package-4-legal-fiscal-aspects.pdf.
[25] Communication from the European Commission to the European Parliament and the Council. Sustainable Carbon Cycles. [SWD(2021) 450 final] - [SWD(2021) 451 final]. P. 18.
[26] Communication from the European Commission to the European Parliament and the Council. Sustainable Carbon Cycles. [SWD(2021) 450 final] - [SWD(2021) 451 final]. P. 18.
[27] See art. 21(2) of the CCS Directive.

between the operator and the third-party seeking access.[28] Any refusal to grant access must be duly substantiated and the Member States are obliged to ensure that operators, as long as it is not an unduly economic burden, make any changes to their infrastructure necessary to facilitate the access.[29]

The requirements of transparent and non-discriminatory access to infrastructure imply that third-party access shall be given on neutral terms. However, there is no direct requirement in relation to the operator's neutrality as such. Whether the operator is considered neutral will depend on the situation and it is up to Member States to decide whether to impose additional requirements in relation to this. However, it is worth noting that for third-party access frameworks in relation to for example electricity, regulatory developments have moved in the direction of more unbundling and operator neutrality requirements. Requirements for separation of control and ownership over production or supply on side and the electricity grid on the other, may be seen as an attempt to reduce the potential for conflict of interest and risk of discrimination in relation to access to the grid.[30] We assume the European Commission would have to take similar considerations for transport and storage infrastructure for CO_2 in a future world of commercial CCS, cross-border projects and a large number of stakeholders involved throughout the value chain.

3.4.2 State involvement according to the Dutch Mining Act

The CCS Directive allows the Member States to take into consideration preferences and national circumstances when implementing national arrangements for third-party access if the minimum requirements of the Directive are met. The overarching approach chosen for third-party access for CO_2 storage facilities and transport networks in the Netherlands are similar to the one applying to the gas regime. The third-party access provisions of Article 21 of the CCS Directive are transposed in the Mining Act, primarily Article 32, which obliges holders of CO_2 storage licences and transport network operators to allow "a person" requesting access to use, at reasonable conditions, its storage facility or transport network respectively. The valid reasons for refusal of access are listed in Article 32.2 and 32.3 and corresponds with those listed in Article 21.2-21.4 of the CCS Directive. Article 32.4 empowers the government to issue further rules by royal decree. To date, no such decree has been implemented.

The rules for third-party access in the Mining Act are not sufficiently detailed to provide the predictability and clarity a rapidly developing commercial sector needs. As the CCS sector evolves further, more detailed regulation is needed. The Mining Act and its subordinate regulation (the Mining Regulation and Mining Decree) could be the most suitable instruments to include more detailed provisions for third-party access.[31]

3.5 Responsibility of competent authority following withdrawal of licence

3.5.1 Long-term stewardship

The Mining Regulation Article 1.3.4b allows transfer of responsibility when the following conditions are met:

1. The stored CO_2 will be completely and permanently shut in.
2. The actual behaviour of the injected CO_2 is in conformity with the modelled behaviour.
3. There are no detectable leaks.
4. The storage location develops to a situation of long-term stability.
5. The storage facility is closed off and the injection facilities and surface facilities have been removed.

[28] Lako, P., van der Welle, A. J., Harmelink, M., van der Kuip, M. D. C., Haan-Kamminga, A., Blank, F., de Wolff, J., & Nepveu, M. (2011). Issues concerning the implementation of the CCS Directive in the Netherlands. Energy Procedia, 4, 5479 - 5486. https://doi.org/10.1016/j.egypro.2011.02.533

[29] See art. 21(3) and (4) of the CCS Directive and Woerdman E, Roggenkamp MM and Holwerda M, "Carbon Capture and Storage," *Essential EU climate law* (Northampton, Massachusetts 2021).

[30] Eilertsen, Tonje. Tredjepartsadgang til transportnett og lagringsområder for CO_2. Sjørettsfondet. 2010. p. 79-81.

[31] The Concept of Third Party Access applied to CCS. In M. M. Roggenkamp, & E. Woerdman (Eds.), Legal Design of Carbon Capture and Storage (pp. p. 273 - p. 285). (Energy & Law; No. 10). Intersentia, International Law Series.

6. A nominal period of 20 years has elapsed since the storage facility was closed off and injection facilities were removed. This period can be shorter or longer, as required for the operator to establish confidence with the Minister that the stored CO_2 is fully and permanently closed in.
7. A financial contribution to cover costs for 30 years of post-closure stewardship has been provided.

Essentially, transfer of responsibility can occur when the CO_2 store has been proven to be performing in a stable manor during the closure / post injection phase and the specific conditions of this closure period have been met. Article 31k of the Mining Act states the responsibility of EZK as the competent authority post transfer of responsibility. This includes responsibility for continued monitoring – typically at a less comprehensive and frequent level than the monitoring performed during operations (injection period and closure period) – and implementation of corrective measures if needed. The competent authority could delegate this responsibility to a designated SOE, such as EBN.

3.5.2 Intervention following storage licence withdrawal

According to Article 31h.1 of the Mining Act, a storage licence will when necessary be amended or withdrawn if:

- Leakages or significant irregularities are identified.
- It appears that the licence conditions are not complied with or that there is a risk for leakages or significant irregularities.
- This appears to be necessary on the basis of the most recent scientific findings and technological progression.
- The provided financial security or an equivalent arrangement appears to be insufficient.

When evaluating the suitability of EBN as a long-term steward of a closed storage sites, it is also relevant to consider the suitability of EBN to be given a mandate by the competent authority (EZK) to take this role. This implies that EBN would need to intervene, possibly on short notice, and temporarily take operator responsibility and legal obligations. Operator obligations would include:

- Updating monitoring plan and reporting monitoring results.
- Updating corrective measures plan and implementing corrective measures.
- Surrender allowances for any emissions, including leakages.
- Sealing the storage site and removing injection facilities.

Licence withdrawal has not occurred in Dutch oil and gas operations to date, highlighting the effectiveness of Dutch permitting process and regulations. While licence withdrawal for CO_2 storage activities is considered highly unlikely, there is still a remote possibility it could occur in an emerging industry. Having an obligatory role as an equity partner in all CO_2 storage projects would enable the designated SOE to be part of the regular communication in the project, and hence be better prepared to intervene on short notice. Nonetheless, to temporarily take operator responsibility means that the SOE must be technically competent to reliably operate a storage site or be able to commission such services. (Article 1.3.4a and b Mining Regulation)[32].

[32] Mining Regulation of the Netherlands (2018): Retrieved from https://www.nlog.nl/sites/default/files/2018-10-08%20%20english%20translation%20in%20pdf%20of%20mining%20regulation.pdf

4 EVALUATION OF COMPLETENESS OF DUTCH REGULATORY FRAMEWORK IN THE CONTEXT OF GUARANTEEING SAFETY

The European CCS Directive[33] is fully implemented in Dutch legislation through the Mining Act of the Netherlands (Mijnbouwwet), and the corresponding Mining Decree of the Netherlands (Mijnbouwbesluit) and Mining Regulation. The current evaluation is performed based on the English translation of these documents, which is available through NLOG – the Dutch Oil and Gas Portal[34]. In this section *Dutch legislation* will refer to the combined set of requirements for CO_2 geological storage projects in the three documents combined: Mining Act, Mining Decree and Mining Regulation.

The transposition of the CCS Directive into Dutch legislation follows closely the Directive, with additional clarification on certain aspects, such as what responsibilities are transferred to the state in accordance with Article 18 of the Directive.

The purpose of the current section is to determine if the current Dutch legislation and recourse provided to the competent authority (EZK) and the supervising body (State Supervision of Mines - SodM) guarantees that safety is prioritised at all times during the project full lifecycle. To this end, we will first evaluate what is required to guarantee safety, and then evaluate if there are gaps relative to the requirements of the Dutch legislation.

For this task we will first use ISO 27914[35] as a reference to determine the requirements that shall (required) or should (recommended) be addressed to guarantee safety and evaluate how these are addressed in the Dutch legislation. This will also entail an evaluation of the requirements to monitoring to manage the risk of leakage during operation and closure, and post-closure monitoring can be adequately addressed. We have used ISO 27914 as a reference since it is an internationally recognized standard that is applicable to CO_2 storage projects world-wide and has primary emphasis on managing CO_2 storage in a way that minimizes risk to the environment, natural resources, and human health.

Next, we will evaluate if the *recourse* provided to the competent authority EZK and the regulator SodM guarantees that safety is *prioritised at all times* during the projects' full lifecycles, without additional direct involvement in projects. A key question here is if the *recourse provided* to EZK, with regulatory enforcement by SodM, ensures that any activities or requirements considered necessary to guarantee safety which are not explicitly stated in the Dutch legislation can be effectively addressed without obligatory project involvement by a SOE prior to transfer of responsibility.

4.1 Synthesis of ISO 27914

ISO 27914 is intended to establish requirements and recommendations for the geological storage of CO_2 streams. The core purpose of the document is to promote commercial, safe, long-term containment of carbon dioxide in a way that minimizes risk to the environment, natural resources, and human health. ISO 27914 applies to projects with injection of CO_2 into porous geologic units for the *sole* purpose of storage, both onshore and offshore.

Application of ISO 27914 is voluntary, except when specifically required as part of applicable regulatory requirements. This is not the case in the Netherlands, so any application of ISO 27914 in Dutch CCS projects would voluntary.

Numerous existing standards are applicable to elements of geological storage projects. ISO 27914 is developed as an overarching standard that is intended to be a stand-alone document, but is not intended to fully replace other standards. The approach was to specify additional considerations or needs that are unique to safely managing CO_2 injection and storage, and reference other related recommended practice manuals or standards when relevant.

The structure of ISO 27914 broadly follows the life cycle of a CO_2 storage project:

33 European Commission. (2009, April 23). DIRECTIVE 2009/31/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL. Retrieved from https://ec.europa.eu/clima/policies/innovation-fund/ccs/directive_en

34 https://www.nlog.nl/en/legislation

35 ISO. (2017). ISO 27914:2017 - Carbon dioxide capture, transportation and geological storage — Geological storage. Retrieved from https://www.iso.org/standard/64148.html

- Clause 5: requirements and recommendations to pre-injection site screening, site selection, and site characterisation and modelling activities.
- Clause 7: requirements to the well infrastructure development and maintenance and decommissioning. This includes specifications for materials, design, construction and completions, corrosion control, evaluation, recompletion, workover and abandonment.
- Clause 8: requirements to injection site operations. This entails requirements to operations design, plans and procedures for operations (including routine and non-routine shutdown of injection), well interventions, and data acquisition monitoring and testing.
- Clause 10: criteria for site closure[36] and the plan and qualification process to demonstrate adherence to these criteria.

The standard does not suggest any requirements or recommendations following site closure. Also, while the standard acknowledges that permitting and approval by regulatory authorities will be required at different points in the project life cycle, it does not provide specific recommendations for implementing the permitting processes.

In addition, the standard has three clauses that are relevant for all stages of the project life cycle.

- Clause 4 provides recommendations to management systems. This includes specification of roles and responsibilities, stakeholder engagement, delineation of project boundaries, commitment to principles, planning and decision-making, allocation and competence of resources, communication, and documentation.
- Clause 6 describes requirements and recommendations for risk management. This clause acknowledges that risk management for CO_2 storage sites needs to be based on site specific knowledge and context, and that intrinsic technical risk and uncertainty will be dealt with on a site-specific basis.
- Clause 9 provides requirements and recommendations to monitoring and verification (M&V). The clause specifies required objectives of M&V, as well as requirements to the M&V plan.

4.2 Comparative analysis of Dutch legislation relative to ISO 27914

A detailed comparative analysis of ISO 27914 and the Dutch legislation could merit a full report on its own. This is not the intent of this section. Instead, we would like to highlight key areas where ISO 27914 provides additional guidance relative to Dutch legislation that can be important to incorporate to *guarantee safety*. In general, the legislation incorporates high-level requirements, whereas ISO 27914 provides information on how requirements can or should be met to align with industry best practice. However, as will be discussed in Section 4.3, the Dutch legislation also provides recourse to EZK to ensure that activities or conditions deemed necessary to guarantee safety, which are not explicitly required by Dutch legislation, can be incorporated into the licence conditions.

Management Systems: Does project proponent have the appropriate organisational set-up and procedures?

The legislation contains very limited information on the management systems for the applicant and holders of storage permits. The most related requirement is requirement 1.3.4a.6.c of the Mining regulation: *information that demonstrates that professional and technical development and training of the operator and of all personnel has been arranged for prior to, during and after cessation of the injection of* CO_2. This incorporates Article 8(b) of the EU CCS Directive.

[36] In the Netherlands, this is the point where responsibility is transferred to the competent authority in accordance with Article 18 of CCS Directive. Note that site closure is therefore defined differently in ISO 27914 relative to EU CCS Directive. In the EU CCS Directive, 'closure' of a storage site means the definitive cessation of CO_2 injection into that storage site.

Management systems differ between organisations, and it is not expected that that there will be full alignment between shareholders in a CO_2 storage project. But it is recommended that all involved parties should commit to some common principles and have agreement on the high-level practices to be deployed. ISO 27914 can be a useful vehicle for this. Guidance for meeting requirement 1.3.4a.6.c of the Mining regulation is, for instance, found in Clause 4.5.2.

For the purpose of guaranteeing safety, it is recommended that all shareholders commit to, and ensure that the project operator follows, the health, safety and environmental principles stated in Clause 4.3.4 in ISO 27914. Furthermore, to ensure a smooth handover to the competent authority (or a subsequent project operator), it is recommended that all shareholders ensure that documentation procedures are in alignment with Clause 4.7.

Site selection and characterisation: Is a suitable complex selected?

Article 26a of the Mining Act states that […] the holder of a licence for the exploration for CO_2 complexes that […] has demonstrated the suitability of a reservoir for permanent storage of CO_2, will, on the basis of his application submitted during the validity period of that licence, be granted a storage licence for the found storage reservoir. This implicitly states that a storage licence will only be granted if a storage complex is found to be suitable.

Clause 1.3.4a.1.a in the Mining regulation states that site characterisation of the storage complex shall be performed based on the quite detailed requirements in Annex 1 of the EU CCS Directive. The results of the site characterisation is submitted as part of a storage licence application. Adherence to the Annex 1 requirements is considered sufficient to provide the necessary information to determine if a prospective storage site is suitable. The requirements are also consistent and aligned with the requirements laid down in ISO 27914, but ISO 27914 provides additional detail and guidance. To exemplify, the requirements to geochemical and geomechanical characterisation and modelling in Annex 1 of the EU CCS Directive is high level, whereas detailed guidance is provided in Clause 5.4.4, 5.4.5, 5.5.4 and 5.5.5 in ISO 27914. DNV's view is that while Annex 1 provides guidance, it is not well suited to provide the basis for independent verification. Therefore, if independent verification of site suitability is contemplated, then it is suggested that this is performed on the basis of a recognised standard (e.g., ISO 27914) with more granular requirements.

Risk management: Will adherence to risk management requirements guarantee safety?

In accordance with the Mining Act (Article 31d.1.h), applications for storage permits shall address risk management. Article 29.c of the Mining decree states that this plan "shall at least contain a description of the measures to be taken to limit the risk of significant irregularity and the possible consequences thereof and shall comply with Step 3.3 (Risk Assessment) in Annex 1 of the EU CCS Directive. However, in DNV's view this Step 3.3 provides only high-level guidance. For instance, the description in Annex 1 of the EU CCS Directive does not:

- Provide guidance on the process for risk management and requirement to implement iterative risk assessments and risk management throughout all stages in the life cycle of a CO_2 storage project.
- Provide guidance on establishing risk evaluation criteria and how thresholds for acceptable risk are determined.
- Describe the broader contents of the risk management plan, e.g., organisational procedures for risk management and how risk management interfaces with modelling and monitoring activities.
- Provide requirements to documentation of risk assessments, including description of persons responsible for each risk scenario and the persons responsible for implementation of the risk controls.
- Processes for risk communication and consultation.

DNV is therefore of the opinion that solely adhering to the requirements in the Dutch legislation may not *guarantee that safety is prioritised at all times during the project full lifecycle*. DNV is further of the opinion that adhering to the requirements for risk management (Clause 6) of ISO 27914 *is* adequate to guarantee safety. Therefore, to guarantee safety, EZK and SodM may need to evaluate if risk management plans submitted as part of licence applications also incorporate additional information, as exemplified in the list above. SodM has, through its regulator role, the relevant competence and recourse to ensure that operators provide this type of information and detail.

Well infrastructure and operations: Will the well infrastructure and injection operations guarantee safety?

The Dutch legislation does not provide specific requirements to the development of the well infrastructure or the CO_2 injection operations. It contains some requirements that are relevant for the operations, such as requirements to specify the quantity and composition of the CO_2 streams to be stored (Article 26a.1.a of Mining Decree) and to submit data on the intended maximum allowable velocity and pressure at injection of CO_2 and the intended maximum allowable pressure of the stored CO_2 are based (Article 1.3.4a.1.e of Mining regulation). Solely adhering to requirements in the Dutch regulations may therefore, in DNV's opinion, not guarantee safe operations. SodM has, through its regulator role, the relevant competence and recourse to ensure that operators construct and operate wells in accordance with industry best practice to ensure safety.

Well infrastructure and CO_2 injection operations are covered in Clauses 7 and 8 in ISO 27914, respectively. These clauses provide significant guidance for well materials, design, construction and maintenance (Clause 7), and for safe operations and maintenance (Clause 8). These clauses can provide supplementary guidance to EZK and SodM to determine if the plans for construction and operation as part of the storage licence application (in accordance with Article 1.3.4.3.a) are sufficient to guarantee safe operations.

Monitoring: Is the required level of monitoring sufficient?

Requirements to monitoring (and associated monitoring plan) is stated in Article 29f of Mining Decree and Article 1.3.4a.4 of Mining Regulation. These requirements reflect the requirements of Article 13 in the EU CCS Directive and include compliance with requirements to the monitoring plan in Section 1 of Annex II to the EU CCS Directive. The requirements of Article 13 define the high-level objectives of monitoring, whereas Annex II provide requirements to specifications in the monitoring plan, including:

- Parameters to be monitored (including mandatory parameters),
- Technologies to be deployed (to be based on best practice available), and
- Locations and timing (spatial and temporal coverage).

The Directive also states that the monitoring plan shall be risk based (shall be established according to the risk assessment). This implies that both parameters to be monitored and technologies to be deployed should consider the risk reduction benefit and weigh this against the cost and effort required. Some mandatory considerations are required when selecting monitoring technologies, but there are no technologies that are mandated to be deployed. In addition, the European monitoring and reporting guidelines for GHG emissions for CCS projects (2010/345/EU) require that if leakage results in emissions or release to the water column, then the leakage is quantified.

The objectives stated in ISO 27914 to monitoring during the respective phases of a CO_2 storage project, as well as the specifications for the monitoring plan, are aligned with the regulatory requirements. ISO 27914 does, however, provide additional guidance and details on what should be documented in the monitoring plan. For instance, the Dutch regulations do not require specification of performance measures for the monitoring programme, i.e., criteria for evaluating the success of the monitoring programme. This is important to ensure that the monitoring programme can provide signals for timely implementation of risk treatment and allow the project risk management plan to meet objectives. The requirement to document this is reflected in Clause 9.4.2 c), d) and e) in ISO 27914, which requires specification of:

- […] the assumptions and expected conditions for which the monitoring plan is designed.
- Parameter changes that the programme is designed to observe.
- Performance measures to be met by the monitoring programme.

Annex II of the EU CCS Directive does, however, require *justification* of technology choice and specification of the *rationale* for the spatial and temporal sampling. This justification and rationale can be interpreted to include specification of the items above from Clause 9.4.2 c), d) and e) in ISO 27914.

Closure: Are the requirements to transfer of responsibility appropriately balanced?

The following four criteria must be demonstrated to be met for the Dutch state to accept responsibility for long-term stewardship (Article 1.3.4b.a of Mining regulation):

1. The stored CO_2 will be completely and permanently shut in (contained in storage complex).
2. The actual behaviour of the injected CO_2 is in conformity with the modelled behaviour.
3. There are no detectable leaks; and
4. The storage location develops to a situation of long-term stability.

This evidence is required to demonstrate compliance with Article 31j.1.a of the Mining Act. In addition, Article 31j.1.b-d requires that the storage facility is removed, that a nominal period of 20 years since end of injection has elapsed, and that a financial contribution to cover continued monitoring for 30 years is provided.

The criteria for site closure in ISO 27914 are broadly aligned with the above technical criteria 1-4, but with some notable differences. ISO 27914 does not stipulate a minimum period of monitoring after end of injection prior to a potential transfer to a competent authority. The rationale for this is that a time-based criterion does not reflect site specific circumstances and is not suited to guarantee safety. Therefore, only technical requirements are defined. The discretion to shorten the closure period is also provided to the Minister by Article 31j.1.c of the Mining Act.

Secondly, there is an important nuance. Even if criteria 2-4 above (or alternatively requirements in Clause 10.2.b in ISO 27914) have been demonstrated, the residual risk of any future loss of containment will not be zero. Hence, Requirement 1 cannot be demonstrated with complete certainty. Therefore, this requirement is replaced with the following condition in ISO 27914:

- The likelihood of future leakage of injected CO_2 and potential negative impacts on human health, the environment, or economic resources shall be demonstrated to conform to acceptance criteria established for the project.

DNV also considers that requirements in 10.2.b are better suited to guarantee safety than Requirements 2-4 above.

4.3 Evaluation of the recourse[37] provided to EZK

The recourse provided to EZK to guarantee safety consists of several elements, including:

1. The Dutch legislation
2. Enforcement of Dutch legislation by SodM
3. The discretion of the Minister to include additional conditions in the licence, if the Minister believes that they are necessary to ensure safety at all times
4. The option to delegate to a SOE an obligatory role in CO_2 storage project prior to transfer of responsibility
5. The delegation of the role of the competent authority as a long-term steward to a designated SOE

The evaluation in Section 4.2 supports that the Dutch legislation is fit for purpose. However, it also observes that adherence to the minimum set of requirements in the Dutch regulations may not guarantee safety at all times. This does

[37] Defined as *a source to help in a difficult situation*. In this case, we have interpreted *recourse* to mean that EZK and SodM has the authority and means to meet their obligations as a competent authority in accordance with the EU CCS Directive.

not factor in the additional recourse provided to EZK to include additional conditions in the licence, and SodM's remit. This discretion to the Minister is provided through Article 27.3.a of the Mining Act, which states that […] a licence for permanent storage of CO_2 will be refused if storage under the proposed exploitation conditions means that a significant risk of leakage or significant environmental or health risks exist, and Article 29 of the Mining Act.

Section 4.2 identified some requirements in the voluntary standard ISO 27914 that were additional to what is explicitly required by Dutch legislation, and for which DNV considered that alignment would be necessary to *guarantee that safety is prioritised at all times* during the projects' full lifecycles. These requirements relate to:

- Commitment to health, safety and environmental principles (management systems).
- Documentation systems throughout lifecycle (management systems).
- Risk management processes.
- Well infrastructure development and maintenance.
- CO_2 injection operations.
- Performance measures for monitoring programme.
- Acceptability of residual risk prior to transfer of responsibility.

We derived that compliance with regulations alone is not sufficient to guarantee that safety is prioritised at all times. However, the discretion of the Minister by Article 27.3.1 and 29 of the Mining Act enables the regulator SodM to incorporate and enforce additional conditions in the licence that are considered necessary to ensure safety at all times. DNV therefore believes that the recourse provided to EZK by points 1-3 in the list above is sufficient to ensure safety at all times in normal operations. This should also be sufficient to ensure that EZK with support from a designated SOE (recourse item 5 in list above) can take on the role as a long-term steward. Recourse item 4 is therefore not required for well managed projects.

In DNV's opinion, a question that should be answered to determine if recourse item 4 is needed, i.e. if an SOE such as EBN, should have an obligatory direct involvement in the operational and closure phases of a CO_2 storage project, is if EZK and SodM in its current function as competent authority and regulator have the level of competence and familiarity with CO_2 storage project operations to timely intervene and take necessary corrective actions if required. This question will be addressed in Section 6.6 where we review the suitability of EBN to take responsibility for obligations of the competent authority, if the storage licence is withdrawn as a result of failure to take necessary corrective measures.

The competent authority can withdraw the storage licence if one or more of the conditions stated in Article 31h.1 occurs. The competent authority may temporarily need to assume responsibility for continued site management, or take steps necessary to close the storage reservoir in accordance with Article 31l in the Mining Act, and prepare to close off the storage facility and remove injection facilities and above surface facilities in accordance with Article 31j in the Mining Act. To fulfil this role, the competent authority may need deeper familiarity with project operations and associated risk management and monitoring activities to timely take necessary corrective measures. This includes familiarity with the execution of the base case monitoring programme, knowledge of the triggers and implementation of a contingency monitoring programme, and competence required to execute relevant risk treatment and remediation actions.

5 CO_2 PROJECT MATURATION LIFE CYCLE AND LINK TO MANAGEMENT PLANNING AND DECISION MAKING

5.1 CO_2 storage project phasing

Figure 1 describes the generic technical steps operators normally undertake to mature a CO_2 storage project. CO_2 Storage projects can be broken down into the following four high level phases.

- Pre injection – project planning stage, from initial site screening to detailed project design and development of project infrastructure.
- Injection – when CO_2 is injected underground.
- Post-injection – Period after CO_2 injection stops, and the site is monitored by the operator to provide assurance of storage integrity (containment).
- Transfer of responsibility / Post closure – Period starting when responsibility for the storage site is transferred from the operator to a post-closure steward.

These four high level phases are further broken down by operators, into seven distinct project maturation phases (e.g., identify, assess, select, define, execute, operate and finally closure) to deliver a safe project. The maturation of a project is intrinsically linked to the risk assessment process, where all the technical, economic, commercial, organisational, and political risks are identified and evaluated. The output of the risk assessment process feeds directly into the business decision (decision gates) to progress a project from one stage to the next of the project maturation life cycle (Figure 1).

It can be seen a structured and systematic approach to risk management occurs at all stages of the project life cycle and the responsibility for this lies with the operator. Risk evaluation is done by personnel with the relevant competency and authority, in an integrated (technical and non-technical disciplines) project team.

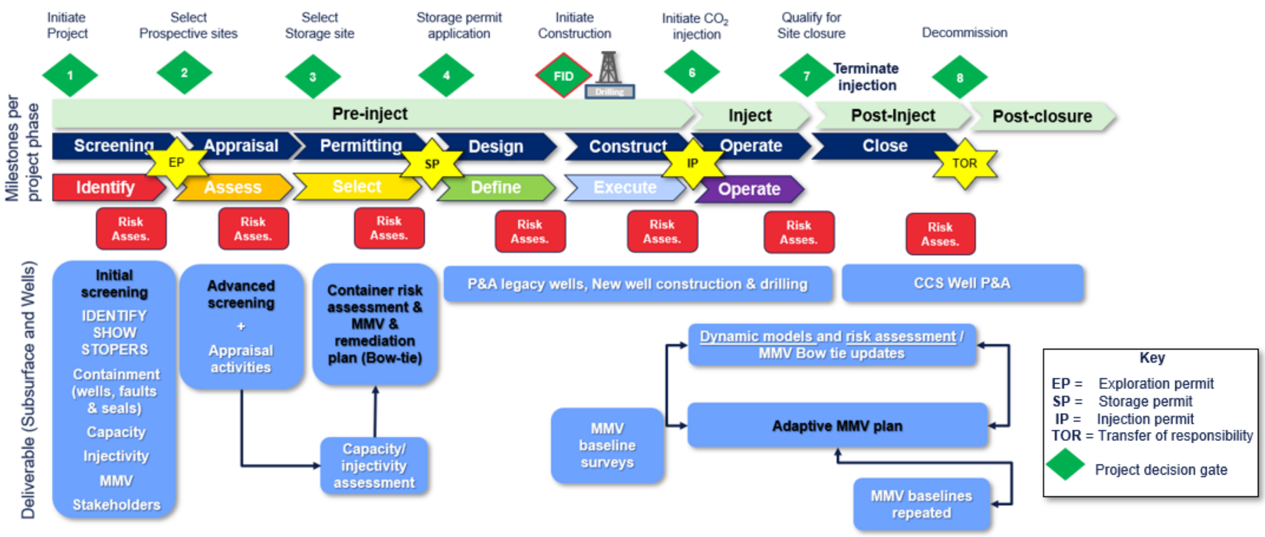

Figure 1: Storage maturation life cycle, with high level subsurface and well activities used to support risk management planning.

The following sub sections will describe the aim of each phase of the CO_2 project maturation life cycle. Under each phase a range of threats relating to sub surface containment, capacity, injectivity and monitorability and are assessed. An overview of general risk scenarios in offshore CO_2 storage projects that can have direct impact on safety are listed in Appendix A.

Identify / screening phase

The screening phase normally focuses on creating a portfolio of storage options (saline aquifers and/or depleted fields) within a region. This is the stage when the risk assessment is initiated for each potential storage site and project. The major storage showstoppers associated with capacity, containment, injectivity, monitorability and stakeholder issue per candidate storage site (storage lead) should be identified. The screening phase aims to identify candidate sites that could theoretically hold the desired capacity (volume of CO_2) and have no major issues in the form of containment (e.g., lack of seals, too high legacy well counts or fault density), injectivity (CO_2 can be injected at an economic rate over the lifetime of the project), monitoring (CO_2 can be monitored and remediated within economic limits) and stakeholder issues (e.g., no competing land use issues).

The screening analysis is typically based on the data available to the operator at the time. This could be from their own corporate databases, any additional purchases and or data found in the publicly domain. There are likely to be data gaps and it is normal at this stage. Such data gaps are addressed in the assess / appraisal phase. A portfolio of storage leads will be ranked based on results in the individual risk assessments. Several sites may be progressed to the appraisal phase. The screening stage should provide the necessary information to support a decision to invest in further appraisal activities. In some circumstances, if only depleted field options are being considered, a depleted field store can be selected at this phase.

The Dutch state is currently not involved in this phase of any CO_2 storage project. Neither would it be in a typical hydrocarbon development at this phase, as the exposure to the Dutch state is low.

Assess / Appraisal phase

The purpose of this step is to further assess the risks identified in the screening phase, through detailed appraisal actives for each prospective storage site. Each storage site needs to demonstrate sufficient connected capacity for a given volume, linked to a *commercial rate* of sustained injection, and that all containment risks can be managed with a feasible monitoring and risk management plan. Monitoring and remediation is also referred to as MMV: Monitoring, Measuring and Verification. Table 4 shows the storage risks versus the high-level subsurface and well engineering de-risking activity used to appraise individual storage complexes.

Table 4: Storage risk vs. subsurface work

Subsurface risk vs. activity	Containment	Capacity	Injectivity	Monitoring
Legacy well P&A analysis	X			
Well engineering concept work - location of new injector & monitoring wells or reuse of any existing wells	X		X	X
Static geological model of the storage complex	X	X		
Flow modelling with a reactive flow transport modelling (geochemical component)	X	X	X	
Geomechanical modelling	X	X		
MMV feasibility (preliminary monitoring plan)	X			X
Appraisal well data acquisition: Wells logs, fluid and pressure sampling, coring and production / injection test analysis	X	X	X	X

The risk assessments per prospect (storage site high graded in the screening phase) should be documented in a traceable and transparent manner and be recorded in a risk register. Storage site prospects with unacceptable risk will not be selected. Prospects with risk that can be reduced to a tolerable or acceptable level by cost effective remediation activities (e.g., well work overs), careful design of the injection strategy (avoiding the plume intersects a high-risk fault or legacy well) and MMV are eligible to be selected. In data rich areas, it could be conceivable to select a storage site at the end of a screening phase.

During this phase, the key technical data to demonstrate why one storage site has been selected above another is completed. This data is generally documented in several technical reports describing site appraisal activities, and normally include a risk register demonstrating the risk profile of selected storage sites, and a preliminary risk management plan with an accompanying preliminary monitoring plan. If the risk profile is biased or fails to address key risk considerations, then there is a possibility that the site will eventually prove to be not suited for the planned storage project. In a hydrocarbon project the operating partner provides the non-operator(s) with the key data for the selection decision, to explain why a certain storage site is put forward for a permit application, prior to starting the detailed permit application process.

Permitting Phase

The Netherlands permit awarding body EZK (the competent authority) requires a Containment Risk Assessment (CRA) as a key part of the licence application. The CRA should provide a full characterisation of the container complex and its predicted performance and provide a high-level description of injection and operating plans, relevant stakeholder engagement activities. In addition, a detailed risk-based, site-specific monitoring and remediation and closure plans plan will be created.

To enhance the understanding of identified risk scenarios, their likelihood of occurrence and potential consequences, and how they can be managed, the possible risk treatment[38] needs to be identified. A common way to visualise containment risk to support risk analysis and planning is via a full containment bow-tie analysis as indicated in Figure 1.

Typically, in hydrocarbon projects EZK as the competent authority and leading the permitting process will engage with applicants. SodM as the regulator does not engage with the operator prior to permit award, as this could be seen as a conflict of interest.

DNV recognises this stage as a key risk exposure to the Dutch state because they issue a CO_2 Storage permit. The permit is awarded by EZK based on advice from SodM (safety aspects), TNO-AGE (Dutch surface knowledge), RVO (financial aspects) and Mijnraad (overall assessment of the application).

Define

In this stage the detailed design of the wells (both new and legacy) and surface infrastructure is finished and approved. All costs are updated and finalised prior to taking the Final Investment Decision (FID). In a hydrocarbon development the non-operating partner(s) have been engaged through the process and is fully briefed prior to FID.

Execute

This is the beginning of the construction operations prior to CO_2 injection. Depending on the jurisdiction, an injection permit maybe required. This is currently not the case in the Netherlands. This is the phase where new injector or

[38] ISO 27914: Process to reduce a specified risk through implementation of risk controls.

monitoring wells are being drilled. Legacy wells may be plugged and abandoned or be converted to injector or monitoring wells if deemed suitable. MMV baseline activities are undertaken to establish environmental baselines in all environmentally sensitive domains prior to CO_2 injection. For offshore areas, this includes hydrosphere, aquatic marine environment, seabed and water column. MMV plans will be updated with the new baseline data prior to operations starting. The baseline data will be shared with the Dutch state (SodM).

In a typical hydrocarbon development, the silent / non-operating partners are informed on progress based on a pre-agreed engagement agreement.

Operate phase

This phase is when CO_2 is injected underground. The risk exposure to both operator and silent partner is at its highest. SodM, as the regulator, will be enforcing the Mining Act and require the operator to keep it updated on any results both positive and negative on the storage site.

A responsible operator will be continuously monitoring the risk profile of the project, updating the storage performance models (subsurface dynamic models with real time data), which feed directly into the project risk assessment frameworks. The risk assessment evaluation will be used to adapt / update MMV plans (Figure 1). If there is a non-conformance issue (for example a deviation from predicted movement of the CO_2 plume or an issue with a well) or significant irregularity (e.g., CO_2 migration outside the primary store) the operator must implement additional safeguards (e.g., increasing monitoring or take corrective actions such as stop injecting or reduce pressure by back producing fluids).

The entity responsible for long term stewardship activities should be regularly updated on the performance of the storage site. Involvement during the operation phase of the project is key to building up sufficient corporate knowledge (and capabilities) of the site storage performance.

Post injection and transfer of responsibility

Once the operator stops injecting, the operator will continue to periodically monitor the site to prove to the authority the store is stable. In preparation for the transfer of responsibility back to the State, the operator will update the storage performance forecast based on historical performance, which will in turn trigger an update the risk assessment and the forward looking MMV plan. It will also include any updates to risk treatment due to advances in technology. A qualification process can be carried out to demonstrate that a given site fulfils the closure requirements. The operator aims to show they have managed risks within acceptable levels during the project and the residual risks are acceptable.

In summary, while risk management planning is key to all stages of the CO_2 Storage project maturation, the key stages occur prior to permit application, and updated during the operating phase and closure phases prior to the transfer of responsibility back to the State for long term stewardship.

5.2 Options for quality assurance of safety risk management

The section above highlighted that quality assurance of risk management plans should occur at every stage of the project lifecycle. This can occur either through internal integrated technical QA/QC reviews by the responsible operator or third-party verifications. Third party certification may occur for the following reasons:

- The operator has outsourced some of the initial screening or appraisal work to a geotechnical service company. The operator wishes to be assured that the work meets a minimum internationally recognised standard.
- Obliged to do so by regulations.
- The operator may wish to do so for extra confidence in their own plans, e.g., if it's a first of kind project for that operator.
- To help build / maintain public acceptance for the project. In the latter case this would typically occur prior to injection, such an example was seen with the Shell Canada QUEST CCS project in 2010-11.
- Or where regulations are immature and third-party verification temporarily fulfils that role for early market leader projects in a region.

Currently in the Netherlands third party verification is not required for CO_2 storage activates operations. Figure 2 shows where internationally recognised third party verification can be obtained.

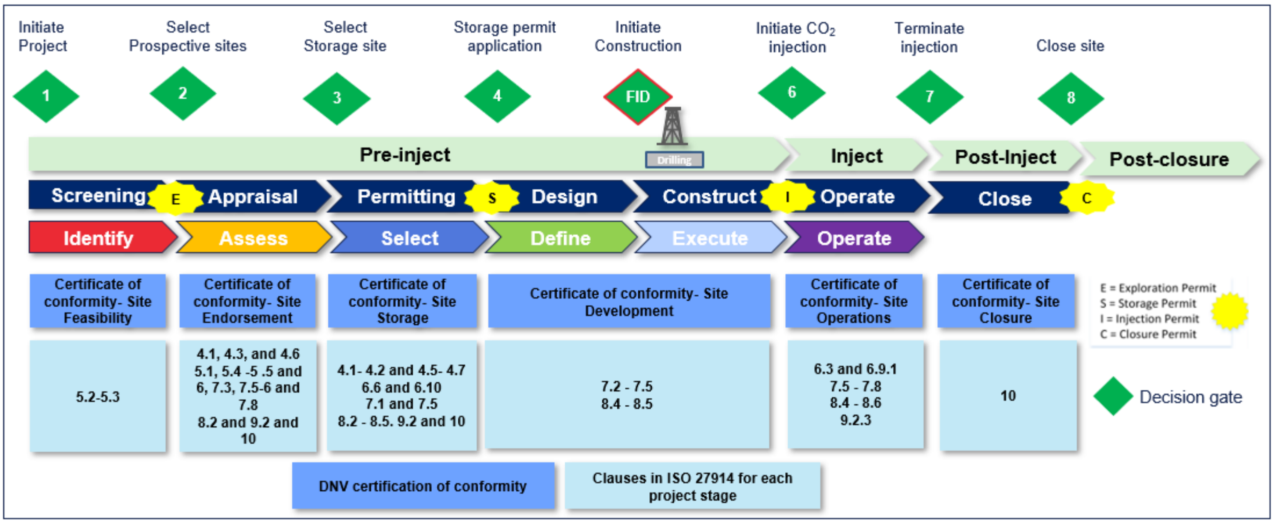

Figure 2: Project life cycle vs. third party verification.

6 MODELS OF STATE INVOLVEMENT IN CO_2 STORAGE ACTIVITIES

6.1 Introduction

The previous chapters have identified two situations where, based on the regulations, there is an obligation for the State to become actively involved in CO_2 storage activities to guarantee safety and long-term stewardship and where the traditional role division 'operator operates, the State regulates and supervises' might not be adequate:

1. Withdrawal of storage licence when the conditions of Article 31j.1 of the Mining Act have been met.
2. Withdrawal of the storage licence following invocation of article 31h.1 of the Mining Act.

In situation 1, all legal obligations associated with the storage site is transferred to the competent authority (EZK), and a designated entity, potentially EBN, is delegated responsibility for the obligations stated in Article 31k.1 of the Mining Act.

Situation 2 is considered to be unlikely to materialise, given the safeguards built into the Dutch permitting process and the robustness created through the multi-partner nature of a CO_2 storage project. However, if situation 2 occurs, then the competent authority is responsible for the obligations stated in Article 31l of the Mining Act. This entails assuming all operator responsibilities (continue the work with respect to storage in conformity with the conditions that attach to the licence) until a new licence has been granted. If a new licence is not granted, then the competent authority is also responsible for closing off the storage reservoir and removing the injection facilities and the related above surface facilities in conformity with the conditions of the licence. This competent authority would then also need to demonstrate conformity with the conditions for transfer of responsibility in Article 31j.1, and subsequently be the long-term steward.

To evaluate state *readiness* for both scenarios that could be triggered by regulation, and scenarios that are triggered by the desire to go beyond compliance, DNV proposes several models for state involvement through EBN, as its main vehicle. DNV also considers models with involvement of TNO-AGE and with no involvement of a SOE. These models are underpinned by a set of design parameters that will be presented in the next section. Using the design parameters, 5 plausible models can be generated, which in turn are evaluated using an evaluation framework and prioritised given stakeholder feedback. The evaluation of the models is performed with the objective to answer the following questions:

- Are the models legal and necessary to guarantee safety prior to transfer of responsibility to the State?
- Are any of the models a preferred option for the State to ensure readiness for its obligations under Scenarios 1 and 2?

Success criteria for the models and financial ramifications for the State are also discussed. The models are evaluated with the assumption that EBN is the designated entity that will be responsible for long-term stewardship, and the designated entity that will assume the obligations of the competent authority if Scenario 2 occurs. Hence, this involvement by EBN is considered to be the base-case situation, or Model 0. The models explored in the subsequent sections therefore examine the benefit and compatibility of additional roles compared to this base case Model 0.

6.2 Evaluation of models

EZK has requested DNV to identify and evaluate models for obligatory involvement by a SOE in CO_2 storage activities in the Netherlands and any other non SOE arrangements.

The current arrangement for EBN involvement in CCS projects is based on specific permission from the Minister of EZK. EBN involvement in the Porthos and Aramis is based on separate decree to Article 82 (2) of the Mining Act. EBN does not have a statutory duty to participate in all future CCS projects in the Netherlands. According to the Mining Act, the long-term liability of the CO_2 storage sites returns to the State after the withdrawal of the storage license from the operator. A provisional decision has been made to deem it necessary that EBN takes an obligatory participation in all CO_2 storage activities. This also involves EBN becoming responsible for the long-term stewardship of CO_2 storage sites, unless alternatives can be identified. This obligatory participation could be realized through the introduction of an additional statutory duty for EBN via the Mining Act.

To design potential future arrangements, a number of design parameters are proposed. The first parameter is where the safety role the State plays resides. On the one side, it could be covered by the current supervisor, SodM. On the other side, it could be fully covered by EBN.

The second parameter identifies the focus of involvement of EBN. EBN could be fully focussed on addressing safety aspects of CO_2 storage activities, or EBN could leave that to others, whilst focussing on coordination/orchestration of CO_2 storage activities from a national portfolio perspective.

The third parameter relates to the role that EBN would take in relation to knowledge sharing. It could either be passive and leave it to the operator community to share amongst themselves as they see fit or take a proactive role and drive knowledge sharing between the main stakeholder, possibly in tandem with TNO-AGE.

Then there is the aspect of when EBN would be involved during the CO_2 storage project lifecycle. Involvement could be mandated from project initiation or conversely only post closure, or any time in between.

The penultimate parameter addresses the type of role EBN would play to represent the State in CO_2 storage activities: this can vary from a silent commercial partner without any responsibilities in project execution to an operator in a CO_2 storage project.

The final parameter that DNV took into consideration is the share that EBN would take in CO_2 storage projects. This can obviously vary from 0% to a full 100%. The parameters with their extreme values are depicted in Figure 3.

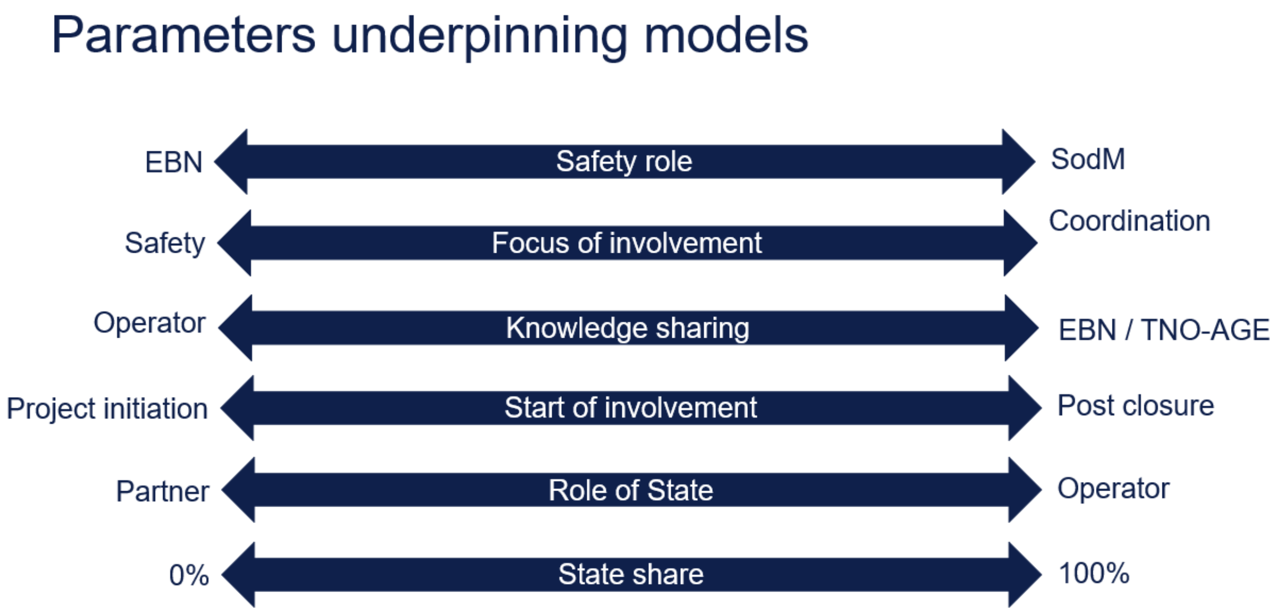

Figure 3: Parameters underpinning models for EBN involvement in CO_2 storage projects.

Based on these parameters, DNV constructed a long list of potential models, which was then purged for models that were merely theoretical and arrived at a short list of five credible options, which are presented Table 5.

Table 5: Credible options for EBN to be involved in CO_2 storage projects from a safety perspective and long-term stewardship perspective.

Model	Description of roles for EBN
1	• EBN is a commercial partner (10 - 40% equity share) similar to current oil and gas – silent partner. • EBN has an obligatory role to advise on safety. This could be in the form of an advisor or a dedicated EBN secondee embedded in each project team, working in the operator's office.
2	• EBN commercial partner (10 - 40% equity share) – silent partner. • EBN facilitates knowledge sharing across CCS projects. • Only SodM has a safety role. • Identical to current Oil and Gas model.
3	• EBN commercial partner (10 - 40% equity share) – silent partner. • TNO facilitates knowledge sharing across CCS projects. • Only SodM has a safety role.
4	• Third party verification on top of SodM current safety role. • No obligatory state role for EBN or TNO, and no equity share required.
5	• Statutory involvement of EBN as an advisor on safety, but no equity share required.

DNV has taken these five models forward for in-depth evaluation.

6.3 Overall model evaluation

DNV has scored each of the 5 shortlisted models based on their suitability for meeting the following objectives:

1. Legal compliance (Section 6.4):
    a. Addressing state aid constraints.
    b. Compliance with corporate governance guidelines.
    c. Facilitating third-party access.
2. Supporting roll-out of CCS in the Netherlands (Section 6.5):
    a. Improving safety.
    b. Providing investor certainty.
    c. Facilitating knowledge sharing.
    d. Minimise costs to the State.
3. Managing obligations of competent authority (Section 6.6):
    a. Preparedness for long-term stewardship.
    b. Preparedness for operator responsibilities following unplanned withdrawal of storage license.

The selection of these objectives where guided by the potential benefits of a SOE having an obligatory role in CO_2 storage projects.

6.4 Evaluation of models from a legal perspective

The evaluation of legal compliance related to OECD corporate governance guidelines, state aid and third-party issues merit an extensive analysis. The following sections 6.4.1-6.4.3 provide the legal background and scoring rationale. The analysis evaluates legal considerations related to the three different roles that EBN may take in the models presented in **Table 5**, i.e.

- Minority equity partner.
- Mandated safety advisor.
- Responsible for knowledge sharing across Dutch CCS projects.

Observations from the legal analysis is combined with the scoring on the other evaluation questions in Section 6.5. An overall recommendation is to make clear the distinction between the different roles which EBN may have in relation to the CCS activities. Without a clear distinction, there are concerns related to for example transparency, predictability and trust in the market. Challenges related to lack of separation of roles will thus complicate not only public perception, and could affect the ability to deploy CCS at commercial scale.

6.4.1 Evaluation against OECD guidelines on state-owned enterprises operating in commercial markets

In this section, we will analyse the implications of the OECD Guidelines on Corporate Governance of State-Owned Enterprises for the 5 alternative models.

Model 1 and Model 5 are concerning under the OECD guidelines. Under both models, EBN is a statutory advisor on safety, which could be problematic under several of the OECD recommendations. Such involvement could constitute an indirect economic benefit or burden to the licensees, both in and of itself, but also if EBN is seen to influence decisions through its advisory role regarding, for example, the transfer of responsibility, or in relation to third-party access.

Model 1, with EBN holding the parallel functions of statutory advisor and commercial partner in the project, constitutes a mix of roles, representing both public administration and business interests. This may result in an unintended and unreasonable benefit or burden compared to other companies, depending on the situation. This concern may be emphasized further if EBN is also taking over the long-term stewardship of the storage site, adding yet another role to the mix. Depending on the process of appointing EBN as long-term steward of the storage sites (whether it happens through procurement, legislation or a royal decree), EBN would either hold a commercial role as a contracted steward of the storage site or be EZK’s representative in a more regulated capacity after the transfer of responsibility.[39]

Model 5 -The potential conflict of interest and mixing of roles are more limited under Model 5, as the dual roles do not exist simultaneously for the project. However, being appointed statutory advisor during the operational phase may potentially constitute an issue under the OECD guidelines as EBN would still hold two different roles during the project lifetime, with the roles shifting between operations and post-closure. If Model 5 is chosen, we recommend careful considerations in relation to the organisational structures, internal communication, reporting etc., making sure that for example the same personnel is not involved as both advisors and long-term stewards and that commercial information EBN get access to as advisors is unavailable to the personnel handling long-term stewardship.

Models 2, 3 and 4 - The three remaining models have a clearer separation of roles. Model 4 completely keeps EBN out of the operational life of the project and thus leave EBN with the role as long-term steward of the project. We cannot find any challenges to the OECD guidelines under this model.

For **Model 2 and 3** (as well as for Model 1), EBN is both a commercial partner and long-term steward. This is not a direct conflict or mix of roles in the sense that EBN does not hold these roles simultaneously for individual projects.

39 We assume EBN will not be involved in assessing and approving the project for transfer but is appointed long-term steward after the fact.

However, EBN would have shifting roles during the lifetime of a project and at some point, EBN may be both commercial partner in some projects and long-term steward for others. Thus, the two roles may be overlapping in time after all.

EBN may have access to commercial and confidential information about the licence and the licensees as partner in the storage projects. This information should be unavailable to the part of EBN functioning as long-term steward. The practical organisation of the individual licences and how much information the operator shares with its licence partners may mitigate the risk. However, a careful internal organisation into separate units for commercial activities and long-term stewardship is recommended regardless, to emphasize the two distinct roles as commercial partner and long-term steward, avoid potential public perception challenges and confusion amongst involved stakeholders, as well as to avoid concerns regarding state aid.

6.4.2 Model evaluation against state aid implications of operational and long-term stewardship involvement

In this section, we will use the information presented on state aid in Section 3 to analyse the identified models for EBN's involvement. An important baseline for our analysis is that the projects in which EBN might be involved will be operating in a European market, with potential competitors offering infrastructure for transport and storage of CO_2 in countries like Denmark, Sweden, and Norway. In an integrated European market for transport and storage infrastructure, the emitters looking for a place to store their CO_2 will not only have to assess where CO_2 transport- and storage-capacity may be available to them. They need to consider which projects offers the technically best and safe storage infrastructure, at the lowest possible cost and risk. As such they will be shopping for infrastructure across borders. With mandatory involvement of EBN in all storage projects in the Netherlands, the analysis of potential competition distorting effects will focus on how Dutch licensees and projects may have an *advantage or disadvantage* compared to their European competitors.

Our analysis is based on the input provided by EZK in the request for proposal, clarifying information received subsequently through oral feedback, information gathered in the rounds of interviews, as well as on assumptions made by the project team. The project team has not reviewed permits, draft agreements, decrees, procurement strategies or other documents detailing, e.g., equity share and responsibilities, distribution of risk and liabilities, forms of reporting, handling of confidential information, and knowledge sharing, etc. These are elements that may, to greater or lesser extent, affect the observations and recommendations presented in this report. We therefore recommend analysing the model options in further detail before making a decision on model to select.

Model 1

There are two different assessments that need to be conducted regarding EBN's involvement under this model:

1. Evaluation of state aid implications of involvement as a partner in the project.
2. Evaluation of state aid implications of involvement in an advisory role.

Depending on the rationale for EBN's involvement as a partner and how its mandate is formulated, this might constitute state aid. If, for example, EBN's mandate for involvement is "guaranteeing safety", this may not stand the test of the Market Investor Principle and most likely constitute illegal state aid. If, however, EBN's mandate is like its mandate for oil and gas exploration and production (E&P) operations, namely "conduct efficient exploration and extraction, planned management and to oversee the sale of hydrocarbons", the focus on commercial operations would most likely be in compliance with state aid rules. EBN would take part in the commercial gains, costs, risks, and liabilities as any other company involved in CO_2 storage projects – and is consequently not likely to threaten or distort competition.

The assessment of the involvement as advisor is more complicated, especially when combined with the commercial role. Through its role as advisor, EBN could provide benefits to the licence and licensees through reduced risks and overall cost of the project, resulting in potential distortion of competition. Involvement through an advisory role in addition to being a commercial partner would most likely constitute state aid[40], depending on the financial arrangements.

As EBN is a commercial company with commercial projects, appointment as advisor could trigger state aid both for EBN directly, and indirectly for the licensees. It could, however, depending on how the mandate and governing mechanisms are structured, be permissible under art. 107(3)(c) TFEU and the CEEAG (Treaty on the Functioning of the European Union and European Parliament resolution on the Climate, Energy and Environmental state Aid Guidelines)[41], depending on the scope and proportionality of the advice/aid. The aid must also meet the proportionality requirements of the CEEAG.[42] To be permissible, the state aid would have to be reported to the European Commission which will take into account, inter alia, the potentially distorting effects of the aid and EBN's involvement, whether it is proportional to the aim to be achieved (ultimately the reduction of CO_2 emitted into the atmosphere).

If this Model 1 is chosen, it would be important to keep EBN's regulated or statutory and commercial roles separate to avoid that EBN's involvement in the project as a commercial partner facilitates reduced risk and liability for the licensees compared to their European competitors. Such careful internal organisation and separation would also be necessary to avoid EBN's commercial activities benefiting financially from the advisor role funding. Further, if EBN is going to assume long-term stewardship, it is important that EBN is treated like any other commercial partner during the operational phase, in terms of for example information flowing to and from the licence and the regulatory bodies. The double role of EBN as both a statutory technical advisor and the entity designated for transfer of responsibility must be carefully balanced as any benefit derived from this statutory involvement could constitute state aid.

Model 2

The assessment of this model is like that of Model 1 but with the complicating advisory role removed. Thus, only the first of the two assessments made for Model 1 is needed, as well as the observations regarding long-term stewardship. With the advisory role removed, EBN's involvement could still constitute state aid depending on the financial arrangements. We refer to the section above for the assessment of EBN involvement as commercial partner and long-term steward. Model 2 thus reduces the risk of EBN's regulatory and commercial roles being mixed and the existence of any unfair advantage as a result of access to information or advantages related to the transfer of liability for long-term stewardship, as analysed above.

Model 3

The analysis for Model 3 is similar as for Model 2, with the complicating advisory role removed from the equation. We refer to Model 1 for the analysis of EBN's involvement as commercial partner and long-term steward.

TNO-AGE participation as a facilitator of knowledge sharing could potentially also constitute state aid, depending on how the involvement is enabled, i.e., whether it is a statutory, predetermined requirement or through an open procurement procedure. Also, as TNO-AGE would potentially serve as a mandated advisor, it would be important to ensure that its commercial activities do not benefit competitively from this involvement. In order to ensure compliance with state aid and competition rules, care would have to be exercised both in relation to information-flow and payment. It is observed that TNO is familiar with holding such dual roles, with well-functioning organisational structures and

40 Depending on the duration, nature and financing of such advisory rule, it could potentially fall under the concept of "consultancy services", defined further in, e.g., section 4.13 of the CEEAG.

41 See section 4.13 of the CEEAG.

42 See, inter alia, para. 4.13.3 of the CEEAG.

procedures to safeguard confidential information floating from TNO-AGE to the commercial arm of TNO and thus avoiding unfair advantages distorting competition.

Model 4

This model is as a starting point not problematic from a state aid perspective, as EBN's only role would be in long-term stewardship. However, similar to the case for Models 1-3, how EBN manages this role in relation to its commercial activities would be subject to scrutiny. If EBN is appointed long-term steward and receives public funding to conduct these activities, EBN needs to organize these activities such that the E&P activities are not indirectly subsidized.

For this model, public procurement rules would have to be carefully followed in relation to the third-party verifier procured from the market to reduce the risk of potential state aid implications. For a public procurement to constitute state aid, it must trigger the cumulative criteria explained in Section 3.5. As most public procurements above the de minimis threshold[43] are financed through state resources and meet the selectivity, distortion and effects on trade requirements, the main concern would be to determine whether the procurement gives the undertaking an advantage it would not have received under normal market conditions. This can, generally, be avoided by using a competitive, transparent and non-discriminatory tender procedure.[44]

Model 5

For this model, EBN no longer has a double role as commercial stakeholder and advisor, as analysed in Model 1. This kind of involvement could, however, still potentially constitute state aid, depending, inter alia, on how actively involved in the project EBN would be, its influence over decisions, whether it would serve as a statutory, independent "centre of knowledge" and offer the same services in a non-discriminatory way for all CCS projects (i.e. whether the statutory requirement is formulated in a general way or exclusively through detailed or specific regulations), and how "hands-on" EBN would be mandated to be. The assessments made for Model 1 in relation to the advisory role applies for Model 5 as well.

As for the other models, we also for this model recommend careful management and internal organisation of EBN, ensuring that its commercial E&P activities do not benefit competitively from its involvement as an advisor on safety and long-term steward.

Observations

From a state aid perspective, Models are 2, 3 and 4 have the lowest risk of being in conflict with state aid regulations, provided careful internal organisational structures and public procurement processes are implemented. These models may reduce the risk of EBN's regulatory and commercial roles being mixed and the possibility or perception of EBN taking advantage of its access to information or role in long-term stewardship, to benefit itself or its partners. These models seem acceptable from the perspective of the OECD guidelines as well.

As pointed out in the analysis, EBN's involvement may still constitute state aid regardless of the involvement as advisor, depending on the financial arrangements, internal organisational structures, etc. It could, however, be permissible under art. 107(3)(c) TFEU and the CEEAG. Provided the model meets both the *positive conditions* (inter alia that the aid facilitates the development of an economic activity that benefits society at large and aligns with EU policies and that the aid has an incentive effect)[45] and the *negative conditions* (inter alia that there is a need for state intervention, that the aid

43 Commission Regulation (EU) No 1407/2013 on the application of Articles 107 and 108 of the Treaty on the Functioning of the European Union to de minimis aid [2013] OJ L 352/1.

44 Nóra Tosics and Norbert Gaal, *Public procurement and state aid control — the issue of economic advantage*, available at https://ec.europa.eu/competition/publications/cpn/2007_3_15.pdf

45 See sections 3.1.1-3.1.3 of the CEEAG.

is appropriate and proportionate, given in a transparent matter, does not unduly distort competition and trade, and that the positive effect are more than the negative), such aid may be sanctioned.

6.4.3 Model evaluation from a third-party access perspective

In Section 3, we presented some general observations and main rules for third-party access (TPA). In this chapter, we will use that background information to analyse the identified models. An important baseline for our analysis is that the Dutch state is not required to be directly involved in the operations to fulfil its obligations. Further, as a comprehensive framework for TPA to transport and storage infrastructure is still to be implemented in the Netherlands, another important benchmark for our analysis is the TPA provisions of the CCS Directive, and how the proposed models would fit within this framework.

Model 1

This model is potentially problematic with regards to the requirements for third-party access to be transparent and non-discriminatory access under Article 21 of the CCS Directive. EBN's involvement in both hydrocarbon operations and storage operations implies a potential for EBN to be competing for CO_2 volumes. For example, EBN might need CO_2 for enhanced oil recovery operations, which are potentially more profitable than CO_2 storage operations. This situation becomes more concerning with EBN's dual role as commercial partner and statutory advisor on safety.

An owner of pipeline and storage facilities would aim for the highest possible tariff on third-party use with an as high as possible risk exposure to the third-party user to reduce its own risk, while the third party would look for facilities with low tariffs and low risk. The regulator or an entity with regulatory/government-delegated functions would most likely target the best socio-economic exploitation of the facilities, taking previous and future investments into consideration.[46]

Combining all these interests in the same entity for management and balancing, is in essence a *conflict of interest*, even if EBN is not the actual operator in either the E&P projects or the CO_2 storage operations and would have to go with the majority in the licence. Even if the actual risk for mismanagement, abuse of power or biased behaviour may be low and the likelihood of either competing with or tying into the E&P projects is also low, the perception and acceptance amongst competitors, third-party users and taxpayers may suffer.

A stakeholder with an interest in all licences for CO_2 transport and storage could start viewing all the facilities and licences as one[47], which may or may not align with the interests of the other licensees and stakeholders. This issue is further complicated by the fact that the licensees would have a different stake and share in each of the projects, implying they are not able to see all the transport and storage infrastructure as one. This dilemma should not be underestimated as EBN would have an interest in all the licences as both a commercial partner and legally mandated advisor. Depending on EBN's actual involvement through the advisory role, this aspect could be detrimental to a commercial CCS industry. An influential advisor representing the regulator inside the projects has potential to influence and control the commercial stakeholders' business decisions and plans to align with political agendas, at the expense of commercial and efficient operations. Such control may be necessary to further develop the CCS industry, but such influence should not come from inside the project itself but rather through permits, decrees and other orders from EZK.

Potential issues could be remedied through TPA requirements in permits and independent regulatory oversight (if a model of negotiated access is chosen), or through strict regulatory scrutiny (if a model of regulated access is chosen).

EBN's advisory role would have to be construed very carefully to ensure it will not have any undue benefits because of its dual role as both the representative for the regulator and its involvement in operations, through a clear separation of roles, communication, reporting, etc. However, this model is still not something to be recommended due to the potential

46 Nygaard, Dagfinn. Andres bruk av utvinningsinnretninger. Sjørettsfondet. 1997. p. 331.

47 Nygaard, Dagfinn. Andres bruk av utvinningsinnretninger. Sjørettsfondet. 1997. p. 331.

for and perception of a conflict of interest. The balancing of transparency, confidentiality, commerciality and non-discrimination would be challenging to demonstrate, regardless of actual compliance with the requirements in Article 21.2 of the CCS Directive. What has to be avoided is the opportunity for or perception that EBN abuses its dominant position to benefit itself in a way that is harmful to competition or market integration.[48]

Model 2

Under this model, TPA-related concerns are similar to those for Model 1, in which we identified issues related to EBN's multiple roles: regulated role as a statutory advisor on safety, stakeholder and potential customer and competitor. The model has the potential of giving EBN too much influence over the negotiated TPA process. The risks related to conflict of interest are reduced in Model 2. However, EBN would still be both a licensee and stakeholder in the infrastructure on the one side and a potential customer or competitor on the other. That being said, in accordance with what was stated above, the *risk of an actual conflict of interest is low due to the low likelihood of either tying in or competing with the E&P projects*. The biggest challenge and most potent conflict of interest is having both a regulated role and a commercial stake in the licence, as analysed in Model 1.

We do recommend, however, to provide a comprehensive legal and regulatory framework for TPA, such that the presence of EBN in the licence is not seen as a guarantee of transparent and non-discriminatory access, the stakeholders involved get a predictable and transparent set of requirements, and further that *SodM has compliance framework to operate under when auditing and enforcing*. The operator of the licence is the party responsible for potentially negotiating with the third party and upholding the requirements in laws, regulations and permits, supported by the other licensees through votes and approvals pursuant to their joint venture agreement and permit requirements. As long as EBN is not the majority shareholder in the licence and thus not the operator, the influence EBN has to ensure TPA is limited to the weight of the internal licence vote.

Model 3

The analysis is similar to the analysis for Model 2, with EBN as a commercial partner only. Due to the above-mentioned risk assessment of the involvement as both commercial partner and potential customer or competitor, EBN's involvement under this model is not likely to have any significance for TPA, as long as its *financial involvement is not used to exert undue influence to benefit it in its other roles*, in accordance with the OECD Guidelines and essential facilities doctrine. TNO-AGE's involvement may be positive as the licence could potentially get objective advice on TPA, which the licensees would not feel compelled to follow if not in line with their commercial interests. Further, as the industry is used to TNO having both a commercial and statutory role, the fear of sharing technical and other confidential information with TNO-AGE, to enable TNO-AGE to produce well-informed advice may be limited.

As for Model 2, we recommend providing a comprehensive legal and regulatory framework for TPA to secure predictable and transparent requirements for the stakeholders involved. The presence of EBN in the licence should not be seen as the guarantee of transparent and non-discriminatory access, as EBN will participate as a commercial stakeholder like the rest of the licensees.

Model 4

This model is unproblematic from the perspective of EBN, as it would not have any role other than being the entity designated for long-term stewardship. However, this model will not provide any significant benefits either, compared to a default situation in which the Dutch state implements a framework for TPA and requires the operator and other licensees

[48] See, inter alia, p. 8 of the Commission's 2010 Interpretive Note on TPA under the Gas Directive and the rules and principles governing it. This document does not apply directly to the CCS regime but has significant interpretive value because of the similar ways that TPA obligations are formulated in the Gas and CCS Directives: https://energy.ec.europa.eu/system/files/2014-10/2010_01_21_third-party_access_to_storage_facilities_0.pdf

to comply. Having SodM involved as regulator and inspector would however ensure some of the E&P regulator and inspector experience and perspective are taken into consideration and utilized in the CCS industry. This is positive for both perception and acceptance amongst involved stakeholders.

As for Model 2, we recommend providing a comprehensive legal and regulatory framework for TPA, such that SodM has a solid compliance framework to operate under when auditing and enforcing. Further, this provides for predictability and transparency for the involved stakeholders.

Model 5

This model is potentially problematic, depending on the involvement with TPA and actual influence on the decisions made. In this model, there is no conflict of interest in the form of EBN having two distinct roles as regulator and commercial partner in the same project. Regardless, there are some other concerns the licensees may be facing by having EBN as an integrated advisor on safety, appointed by the Dutch state. As an example, such involvement would require organisational safeguards related to confidential information and it should be made clear from the start what mandate EBN would have. The licensees will be reluctant to share necessary commercial information with the advisor if they fear the information might be shared with the Dutch state.

EBN, as an advisor on safety, could influence evaluations of technical aspects and capacities with regards to third parties' access to infrastructure. This would be unfortunate if EBN had not received all the necessary information to do so. If the licensees in addition feel compelled to follow the advice given, they may end up with unintentional discriminatory or inefficient solutions. EBN's potential role in evaluating compliance with Article 22.4 of the CCS Directive, on the obligation for operators to ensure that necessary enhancements are made when access is denied as long as it is economical or when a potential customer is willing to pay, must be clarified and potentially excluded, to ensure non-discrimination.

It should further be examined whether SodM or another government agency or entity would be better suited for this, as EBN's potential involvement in other hydrocarbon projects, and likely involvement in the transport networks, could bring the impartiality of EBN as a technical advisor into question and threaten the perception of compliance with Article 22.2 of the CCS Directive with regards to non-discrimination, regardless of the concern raised in the first paragraph.

Observations

If the objective is to find models where EBN can be involved in ensuring safety, we believe Models 2 or 3 would allow for EBN's participation while constituting the least threat to transparent and non-discriminatory TPA.

Under Model 2, the risk of conflict of interest – or at least the perception of such – is present because of EBN's role as a commercial licensee and potential customer and competitor. Further, when EBN holds an interest in all the licences, they may view the infrastructure as one, which may not be aligned the interest of the other commercial licensees, with smaller and varying stakes. However, this can be *remedied* through the regulatory framework for TPA. As long as EBN is not the majority shareholder in the licence and not the operator, its influence over TPA is limited and, if balanced and mandated correctly, unproblematic from a TPA perspective.

Under Model 3, EBN's influence as a result of its financial stake must be carefully balanced similarly to the case for Model 2. Model 3 should, if balanced and mandated correctly, be unproblematic from a TPA perspective. TNO's involvement under this model would be a good way to ensure that the advice given to the licensee is objective. Further, the industry is used to TNO-AGE's involvement, and this is a well-established model. Model 3 could have an advantage over Model 2, as the potential risks of technical or other confidential information being shared might be mitigated, because of the different, established role of TNO-AGE.

6.5 Evaluation of model's ability to support CCS roll-out in the Netherlands

The analysis in the previous section is grounded in law. The evaluation of objectives 2a-2e and 3a-3b relates to non-legal factors of having EBN or not, obligatory involved on the grounds of guaranteeing safety and additional co-benefits such as improving safety, investor certainty, knowledge sharing and coordination of pipeline infrastructure.

6.5.1 Improving safety

Model 1 and 5 where EBN has an obligatory role in safety, are both poorly suited to improving safety. A safety mandate pretransfer of responsibility back to the State will cause confusion and potential duplication of safety roles for both the operators and the regulator SodM. There is the risk of conflicting responsibilities and conflicting outcomes of reviews. This could negatively impact safety especially during operations and result in overly expensive and inefficient assurance because operators may have to demonstrate prudent operatorship twice. There is a generally held consensus that there should only be one operator as safety is the prime responsibility of the operator. If EBN were to have a safety mandate, it could result in interference in operational decision making which could have negative consequences.

Therefore Models 2 to 4, where EBN has no obligatory role in safety are preferred.

6.5.2 Investor certainty

If a SOE organisation has a commercial stake in a project, private investors may perceive the investment less risky, due to a firm government financial commitment. If this is indeed the case, Models 1, 2 and 3 support this assumption, compared to Models 4 and 5 where no EBN equity stake exists.

6.5.3 Knowledge sharing

Only a handful of major operators (e.g., Equinor, Shell, Chevron) have developed and executed CO_2 storage projects. As the industry grows, many new players will enter the market. A co-benefit of EBN involvement is to share international best practices and technical HSSE learnings to accelerate learning in an expanding sector. All models where EBN (Model 1 ,2 and 5) and TNO-AGE (Model 3) participate support this co-benefit. Model 4 (Third party verification) does not support knowledge sharing activities because no SOE involvement exists.

6.5.4 Cost to the state

Any model where EBN has an equity stake will initially require investment by the State on top of the SDE++ subsidies provided for CCS activities. Model 1, 2 and 3 where EBN takes a silent partner role, all require EBN to take an equity stake in a project. The level of State investment will depend on the equity stake. Currently in EBN Oil and Gas activities their equity stake varies between 10% and 40%, on average 40%. It is expected CCS activities will in the future generate revenue. Hence, there is an opportunity for the State to get full return on their investment. Models 1 to 3 score an amber colour because the cost to the State depends on the exact stake taken. Models 4 (Third party verification) and 5 (EBN no equity stake) are a low cost to the State, but also do not create a potential revenue stream in the future.

6.6 Evaluation of ability to manage obligations of competent authority

To manage the obligations of the competent authority, EZK needs to ensure that the State can assume responsibility for long term stewardship following transfer of responsibility to the State. Furthermore, in the case of unplanned withdrawal of a storage licence, the competent authority must take the role of an operator until a new license is granted, and, if a new licence is not granted, close off the site and manage the responsibility of an operator after injection is terminated and the injection facilities and the related above surface facilities are removed. This implies that a key objective of the State is to ensure that the competent authority itself (EZK), or a delegated entity (e.g., EBN), has the competence and right organisational set-up to manage these obligations.

To be able to fulfil the obligations, EZK would need the following:

1. Access to all relevant information regarding history of operations, monitoring systems, risk management plans and procedures, and models for predictive modelling.
2. An organisational set-up to manage long-term stewardship, and, if needed, take-over of operator responsibilities. The latter may entail contractual arrangements with contractors that can be activated as needed.

SodM will throughout the project receive project reports and have oversight of operations as stipulated by the requirements in the Mining Act, the Mining Decree and the Mining Regulations. However, SodM as a regulatory body is not well suited to also assume responsibility for operations or long-term stewardship.

The models that prepare EBN the most for long-term stewardship responsibilities and assume authority in case of licence withdrawal, are the Models 1-3 where EBN has an equity share. Holding an equity share allows for agreements to be made as part of their shareholder role to ensure that EBN can be well informed for all eventualities. This could include certain models and other data required for continuing operations in the case of unplanned withdrawal of licence. If EBN intends to manage obligations of the competent authority in the case of unplanned handover through activation of contractual arrangements with contractors, then it is important to ensure that EBN also has permission to transfer necessary information, data and models to the contractors.

As a partner, EBN would have superior access to data and background information to the storage complex design, operating philosophies and key business decisions compared to being solely an advisor (Model 5 safety advisor – no equity share) or not being involved in the project (Model 4 - Third part verification only). This exchange of information and understanding occurs, through regular partners meetings through the majority of the life cycle of the project. Hence EBN would continuously learn from operators and become very familiar with the respective projects. Access to this information would not be guaranteed if EBN has an advisory role as the exchange of information is more voluntary in nature. EBN would become reliant on data in the NLOG system or any additional data received from SodM in the case of licence withdrawal.

However, as pointed out in the legal analysis, commercial information about the licence and the licensees should be unavailable to the part of EBN functioning as long-term steward. The need for this separation may imply that an arrangement where information sharing with EBN should occur in a manner where this separation principle is honoured.

In summary, we conclude that a continuous involvement by EBN would be required to be adequately prepared for both long-term stewardship role and the eventuality of an unplanned withdrawal of a storage license. This *continuous* involvement could be facilitated through an obligatory equity stake in all CO_2 storage projects. It is considered *unlikely* that EBN alone can efficiently step in and take over operator responsibilities if they are provided all information reactively when a situation that leads to a withdrawal of a storage licence occurs. With the right organisational set-up and contractual arrangements, they could however mobilise on short notice.

To be prepared for the above roles, it is recommended that EBN's involvement as an equity partner in CO_2 storage projects begins around the start of the process for the storage permit application. Involvement prior to permit application, would be a conflict of interest, as EBN are a partner in many depleting oil and gas fields. EBN is involved in 200+ exploration and production licences[49], of the 250 currently producing fields[50]. Involvement of EBN in selection or prioritization of candidate storage sites could therefore be influenced by EBN's commercial stake in the respective fields, and for instance lead to non-prioritisation of candidate sites in saline aquifers.

49 EBN Data Centre: https://www.ebn.nl/en/data-centre/

50 NLOG Dutch Oil and Gas portal: https://www.nlog.nl/en/oil-and-gas#:~:text=Oil%20and%20gas%20have%20been,therefore%20called%20'small%20fields'

6.7 Overall scoring of the models

For the overall scoring, DNV used a colour-code scale, see Table 6. The resulting scores can be found in Table 7.

Table 6: Scoring legend.

Colour code	Description
	Model is poorly suited to meet objective
	Model requires implementation of mitigating actions to meet objective
	Model is well suited to meet objective

Table 7: Model scores. Refer to relevant text sections for explanation behind the scoring

	Model	State aid?	Governance guidelines?	Third-party access?	Improves safety?	Investor certainty?	Knowledge sharing?	Cost to state?	Preparedness for long-term stewardship?	Preparedness for unplanned license withdrawal?	Main beneficiary?
1	EBN non-operating partner with advisory role on safety	Depending on the situation – see relevant section	Incompatible dual roles, not advised by OECD/G20 guidelines	Depends on the permit contract – see relevant section	Duplication & confusion with SodM and operator role			Depends on equity stake			EBN
2	EBN non-operating partner without safety role. Safety is overseen by SodM	Risk is low but depends on the situation		Risk is low but depends on the situation				Depends on equity stake			All parties
3	EBN non-operating partner, TNO-AGE leads technical knowledge sharing. Safety is overseen by SodM	Risk is low but depends on the situation		Risk is low but depends on the situation				Depends on equity stake			All parties
4	Third party verification on top of SodM safety role - no obligatory involvement of EBN / TNO-AGE					No EBN equity stake			No involvement of an SOE prior to transfer of responsibility	No involvement of an SOE prior to transfer of responsibility	Operators
5	Statutory involvement of EBN as an advisor on safety, but no equity implications		Incompatible dual roles, not advised by OECD/G20 guidelines	Depends on permit contract because potentially, EBN has three roles	Duplication & confusion with SodM role		Must ensure confidential information		Lack of equity stake would limit access to information on the project history	Lack of equity stake would limit access to information on the project history	EBN

In summary, the scores can be explained as follows:

Model 1 reveals that it would score low on its capacity to improve safety and compliance with OECD/G20 corporate governance guidelines. It would create duplication and confusion with SodM's role and there are risks effecting separation of company owners and regulator role. From a state aid perspective, this model could also constitute illegal state aid, depending on its implementation.

For this model to address knowledge sharing requirements, it would need to ensure that confidentiality obligations are met. On the positive side, this model builds corporate knowledge within EBN to be ready for a future stewardship role and could score well on costs to the State, depending on the percentage level.

Model 2 generally shows positive evaluation scores. Its ability to address third-party access issues depends on the permit contract – as the safety role is removed in this model. Equally, the cost to the State depends on the equity share.

Model 3 has a similar scoring profile as Model 2.

Model 4 shows three areas of low scores. The score for its ability to provide readiness for long-term stewardship could be improved if operators share data with state via TNO and permit applications. Third-party access issues can be circumvented depending on the permit contract and would need active oversight from SodM. The model scores well on addressing state aid issues, as third-party verification would be subject to public procurement.

Finally, **Model 5** scores low on its impact on safety improvement and long-term stewardship activities. Furthermore, it would create confusion with SodM's role. Also, the model could constitute illegal state aid – depending on the situation. Whether the model poses third-party access issues depends on the permit contract. It would need active oversight – given the potential of EBN having more than one role.

In conclusion, models 2 and 3 have the highest scoring profile.

6.8 Stakeholder views

Parallel to the development of the set of models, DNV has undertaken a wide range of interviews to gauge stakeholder views on the role of the state in CO_2 storage activities. Interviews have been conducted with operators active in the Netherlands, organisations active in the CCS value chain, as well as with government bodies both domestically and internationally. Furthermore, an NGO has been consulted. Also, EBN itself was interviewed.

Interviews focussed on the role of the state regarding safety, although room was provided for input on other benefits State participation could offer to the successful implementation of CO_2 storage activities in the Netherlands.

All operators have shared that the existing model of EBN as a non-operating partner in O&G activities has worked well but they do not see the need for EBN to have an additional safety role. Operators indicate that it would cause confusion as operators are responsible for safety and the role would likely conflict with SodM's safety role. The industry and the majority of the government bodies do not wish to see EBN take on an operator role or be directly involved in operations. All Dutch stakeholders interviewed expressed that there can only be one operator on a project (''one captain of a ship'') because it leads to unsafe situations during operations. Furthermore, it was questioned whether EBN at this moment in time has the right skills set to be able to work on-par with the safety competence residing within major operators.

International stakeholders generally do not see the benefit of state participation in CO_2 storage activities from a safety perspective. These stakeholders indicate that safety is ultimately a responsibility for the operator, with the State in a supervisory role through well-established oversight mechanisms. The concern that the State needs to ready itself for its long-term stewardship role through active participation in CO_2 storage projects was not felt as an immediate trigger for action. Preparation for such a role is seen as an activity that will require *attention* over the next decades.

Some stakeholders suggested that CO_2 storage activities should be centrally led and coordinated (optimal pipeline routing offshore) by the State in the early phase of CCS deployment, primarily to ensure that market failure is addressed. EBN could help facilitate efficient spatial planning activities for storage given that it knows all the subsurface operators, through its current oil and gas activities. EBN could engage with operators identify suitable depleted fields and aquifers, the likely volume and timing of use for CO_2 storage. This role was not seen as a mechanism to enhance safety. Only one stakeholder suggested that the full project ownership should reside with the State, but the actual project development and execution is outsourced. It was unclear how this could practically be realised.

Most stakeholders, including those from abroad, welcome a State role in the beginning of CO_2 storage activities – particularly for the State to address market failure and help *coordinate development* of the full value chain, e.g., by coordinating efficient pipeline development to CO_2 storage sites. The coordination could involve approaching operators to see if there is reasonable likelihood that a CCS project could be undertaken in their acreage in the foreseeable future. It was stressed by operators, that the State should not decide which areas are suitable for Storage, given the State's stake in certain depleted fields. Such a role would not require an equity share.

Most interviewees indicated that there is a role for the State in facilitating knowledge sharing across portfolio of projects. Stakeholders suggested that this could be a role for EBN, provided concerns around misuse of confidential project information to other operators is addressed. Sharing HSSE best practices is not seen as an issue. Sharing of commercial intellectual property will not be tolerated by any operator and will lead to trust issues with the State and could reduce investment and prevent a competitive market being created if these concerns are not acted upon.

The current EBN skill set required to fulfil the State's role in long-term stewardship may not be adequate, some stakeholders suggest. Although this is a longer-term issue, for which there is time to close any skills gaps, it deserves attention when EBN is given such a role.

Many Dutch stakeholders are voicing that division of roles and responsibilities within the development of CO_2 storage projects in the Netherlands is not fully developed. Parties welcome that there is clear blue water between organisations and the State should provide the clarity.

Note that the interviewees have not been exposed to the models, nor the scoring mechanism. The combination of a top-down (model construction) and a bottom-up (stakeholder interviews) approach thus suggest that the stakeholder interviews largely confirm DNV's selected models 2 and 3 for EBN's role.

In Figure 4, DNV has summarised the stakeholder views through mapping the model parameters onto the findings of the interviews.

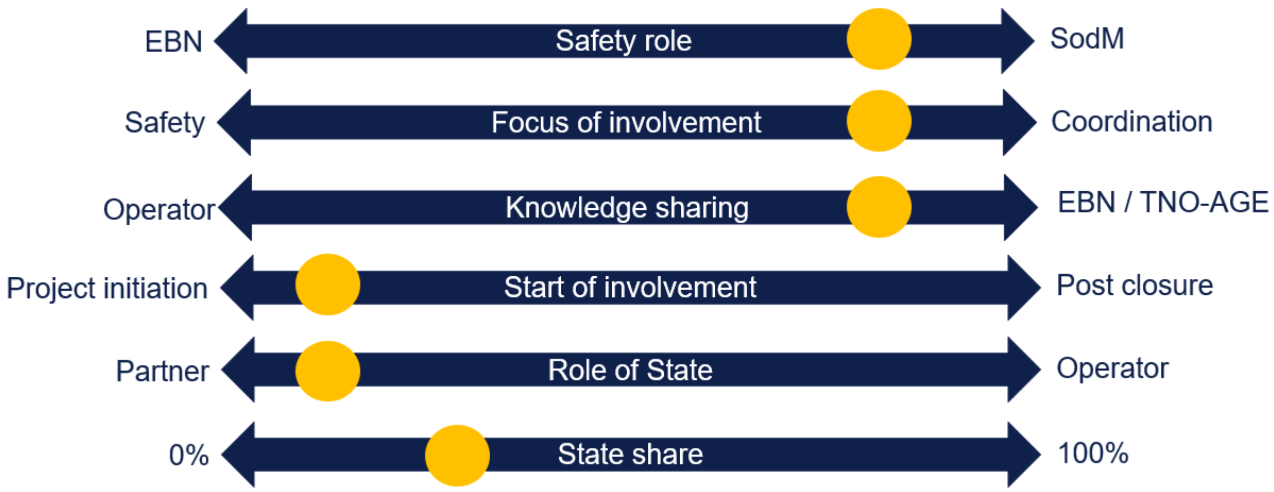

Figure 4: Interview findings mapped onto model parameters.

6.9 EBN competencies

EBN is an organisation of approximately 150 people and has always had a non-operator partner role in conventional oil and gas activities in the Netherlands.

EBN has around 75 personnel engaged in technical oil, gas, CCS and geothermal activities. Around 28 personnel are engaged in CCS, 15 with an operator background, 5 personnel from an E&P consultancy background, 6 EBN development (started EBN as juniors), 2 from outside E&P industry (Tata Steel, Sasol). Seven out of the 28 staff are contractors.

Breakdown of the staff disciplines involved in CCS:

- Geoscientist - exploration geologists: 2.
- Geoscientist - production geologists: 3.
- Reservoir engineers: 7.
- Process / flow assurance engineers: 3.
- Facility engineers - platform: 3.
- Facility engineers - well engineers: 3.
- Production engineer: 1.
- PSO operations manager: 2.
- Technical subsurface manager: 1.
- Team lead technology: 1.
- Technical integration: 2.
- Programme support (non-technical): 15 (commercial, legal, finance, PA).

Of these staff, 6 have CO_2 storage expertise, which is in the field of reservoir engineering and flow assurance. It is unknow if this expertise is from previous industry projects. EBN fills technical gaps with contractors and consultants to execute their subsurface work. These include SGS Horizon for subsurface modelling, Phoenix for geomechanical modelling and TNO for chemical reaction modelling. Overall, it appears EBN had subsurface capabilities (due to their current oil and gas role), but when it comes to MMV capabilities this is untested. EBN have no experience of CO_2 storage monitoring, this would need to be developed in-house or be outsourced for a long-term stewardship role.

EBN has a technical team with some operator expertise, but lacks major projects CO_2 storage expertise and would be unable to compete with a major operator. In order to become an operator, EBN will need to demonstrate to EZK that it has sufficient capabilities to manage CO_2 storage projects in alignment with regulations and ensure safety at all times. Given the limited direct CCS project expertise within the team, the current quality and comprehensiveness of EBN's technical capabilities is unclear. However, EBN can build the necessary capabilities over time, e.g., by learning from operators as a partner, which is currently happening in the Aramis and Porthos projects.

If EBN is granted long-term stewardship responsibility, the monitoring to be done is realistically mainly seismic and seabed analysis after decommissioning has occurred. EBN can build this capacity/capability over the years to come. However, if EBN is delegated the role of long-term stewardship, it is envisioned that they will also need to be prepared to assume operator responsibilities in the case of unplanned withdrawal of a storage permit. This implies that EBN should either have built the necessary competence and organisational set-up to qualify as an operator when taking this role, or EBN would need to establish outsourcing arrangements that can be activated in the case of unplanned withdrawal of the storage permit.

EBN provided job description profiles for a range of subsurface roles, from which it is clear they are trying to build operator competency. While some staff have operational competency from previous operator roles, EBN as an organisation thus far has not been an operator or received a permit to operate.

EBN has provided their project management system (PMS). Their PMS is complementary to the major Dutch CCS operators. EBN's ability to scale the process and make if fit for purpose when required in unknown. The ability to scale the PMS process effectively and safely is key, when dealing with projects on accelerated timelines.

6.10 Financial implications of delegating EBN an obligatory equity stake in CO_2 storage projects

The current equity stake of EBN for conventional hydrocarbon development is maximum 50%, but typically around 12% to 40%, and it provides an additional revenue stream for the Dutch government. The equity stake is organised through the Joint Operating Agreements, *geassocieerde deelneming* or a joint venture. In this arrangement EBN is a non-operating partner, they are not a licensee and do not get a veto vote under the Cooperation Agreement.

If the prime role of EBN involvement in CO_2 storage activities is long-term stewardship, the equity stake does not need to be more than the current 40%. The interview responses recommend EBN having an equity stake between 10% and 40%, with a preference on the lower end. An SOE should not have a majority stake in a project giving them veto or undue influence of third-party access or concerns around conflict of interests.

Historically, most CC(U)S projects have been associated with gas processing, where the business case for the full value chain is determined by the total additional cost compared to no capture, and the revenue from the sale of CO_2 (for enhanced oil recovery - EOR) or the reduced cost of the CO_2 emissions. The projects have therefore had a positive business case if the cost of capture, transport and storage combined per tonne of CO_2 captured is less than the revenue from the sale of CO_2/reduced emission cost per tonne of CO_2. The CO_2 EOR industry in the US has been a commercial industry where the price paid by the CO_2 EOR operators has been higher than the cost of capture and transport.

We now see the contours of a new business model within the CCS industry, where storage hubs are being developed that can take CO_2 from multiple different emitters. The Northern Lights project and the Northern Endurance Partnership are example of storage hubs in Europe. These hubs will charge a tariff per tonne of CO_2 from each emitter, and essentially provide CO_2 storage as a service. This may include transport of CO_2 to the storage site. The revenue from the tariff that the storage hubs will charge will be higher than their average lifetime cost of the CO_2 (transport and) storage. Hence, following a successful project that has operated for many years and utilised the full storage potential, this will be a commercial operation that allows the operating joint ventures to secure a profit.

Thus, if the Dutch state through EBN takes a minority equity share in all CCS projects, it may benefit from commercial rewards obtained from tariffs for transport and storage that are higher than the overall cost. This commercial benefit can be a significant revenue stream for the Dutch state if the carbon price put on CO_2 emission from relevant industries creates a positive business case for CCS, and therefore a willingness to pay for storage. However, a large share of the CAPEX investment is typically made prior to initiating any injection. This is spent on infrastructure development, site characterization, and drilling and construction of wells. This up-front investment mimics the front-loading of CAPEX investments in oil and gas developments. Equity shareholders in CO_2 storage hubs will therefore need to share the burden of the up-front investment, and hence the investment risk. In early stages of CCS deployment, CO_2 storage hubs are being developed before contractual commitments have been made with the emitters that are candidates for providing CO_2 for storage. Depending on the contractual arrangement, the emitters can pay per tonne of CO_2 provided, or the emitters may agree to a front-loading of payment to cover part of CAPEX.

6.10.1 Financial risk exposure versus possible revenue stream

By mandating that EBN should have an equity share in all CO_2 storage projects, the Dutch State takes part of the investment risk and thereby reduces the hurdle of getting projects off the ground. This can be seen as a risk sharing mechanism while a commercial market for CO_2 does not yet exist, and this will increase investor certainty that projects will not be cancelled, and can operate reliably. This way of investing in CCS projects can be a strategy to stimulate that the pace of deployment of CCS in the Netherlands is sufficient to meet policy targets. Over time, as projects start injecting, the storage hubs are expected to provide return on investment, and a revenue stream for the State.

Nonetheless, by taking a commercial stake in all CCS projects, the Dutch state will carry a financial risk exposure. This financial risk exposure should be weighed against the possible revenue stream to the State. For the benefit (revenue stream) to outweigh the financial risk exposure, the tariffs for storage should incorporate a risk premium. This risk premium should incorporate a likelihood-weighted average of costs that can occur from unforeseen events.

The Dutch legislation (Article 29j of the Mining Decree) stipulates requirements to financial security, which shall cover costs for implementation of corrective measures associated with unforeseen significant regularities, and any surrender of emission allowances (see Article 29j.2.a-c in the Mining decree). This does, however, not cover financial risk to the commercial partners as a result of early termination of the project, or increased costs due to, e.g., operational issues.

The Government of Alberta, Canada, has established a post-closure stewardship fund for CCS projects. This fund shall cover all costs to be borne by the Government for managing its responsibilities as a post-closure steward after a closure certificate has been issued. Each CCS project in Alberta pays a fixed fee per tonne of CO_2 injected and stored into the fund. In accordance with recommendations from the Alberta Regulatory Framework Assessment, recommendation 54[51], the rate to be paid for each tonne injected is set on a risk-based and probability-weighted basis, and is based on the specifics of each individual CCS project. In other words, the rate is determined based on the risk profile of each individual project. DNV supported the Government of Alberta to develop the methodology for calculating this rate. We propose to use the same principles to estimate the financial risk exposure to the Dutch state by allowing EBN to take an equity stake in CCS projects. To this end, we differentiate between three key components.

1. Costs for managing significant irregularities[52]. This includes costs associated with measures to prevent or stop leakages from occurring, such as intensified monitoring or drilling new injector wells, and possibly remediation and surrender of emission allowances if leakage has occurred. The financial capability to cover these additional costs is guaranteed by the provision of financial security required by Article 29j of the Mining Decree.[53]

2. Cost for escalation of operational costs (not related to significant irregularities). This includes costs related to operational changes, such as not having sufficient capacity and therefore needing to stop injection into original reservoir and start injection in other reservoirs or at other locations in the same reservoir requiring new wells. These additional costs are principally a commercial concern and are not covered by the financial security required by Article 29j of the Mining Decree.

3. Loss of expected revenue. This may occur as a result of lack of ability to secure supply of CO_2 from emitters for the planned duration of the project, or that the project stops injection earlier than planned, e.g. due to issues with capacity, injectivity or containment or bankruptcy of operator. These additional costs are also principally a commercial concern and is not covered by the financial security required by Article 29j of the Mining Decree.

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51 Alberta Energy, Carbon Capture and Storage – Summary Report of the Regulatory Framework Assessment, p. 95. https://open.alberta.ca/dataset/5483a064-1ec8-466e-a330-19d2253e5807/resource/ecab392b-4757-4351-a157-9d5aebedecd0/download/6259895-2013-carbon-capture-storage-summary-report.pdf

52 EU CCS Directive: 'significant irregularity' means any irregularity in the injection or storage operations or in the condition of the storage complex itself, which implies the risk of a leakage or risk to the environment or human health.

53 Operators are required (by Article 29j of the Mining Decree) to provide financial security for these costs, in the event that the State withdraws the storage license following Article 31h of the Mining Act, and needs to recover costs in accordance with Article 31k.4 of the Mining Act.

Each of these components can be risk assessed. This means estimating the probability that the event will occur, and the cost impact if it occurs. The probability weighted cost impact is then obtained by multiplying likelihood and cost impact. The risk weighted financial risk exposure to the state can then be expressed as follows:

$$\text{Financial risk exposure} = \sum_{\text{all events (component 1+2+3)}} \text{probability(event)} * \text{cost(event)}$$

The tariff for storage should then ideally be set such that the project gets a positive Net Present Value with the financial risk exposure incorporated into the model. It is noted, however, that it may be appropriate for governments to carry a greater part of the financial risk, or introduce risk sharing mechanisms that allow early projects to get off the ground, and then take a more neutral shareholder role in projects once the CCS industry has been well established.

Prior to transfer of responsibility, operators of CO_2 storage projects are obliged to provide a financial contribution with which the anticipated costs, but at least the estimated monitoring costs, incurred during a period of 30 years after transfer. This is financial contribution is expected to be covered by the profit from the life of the CO_2 storage project.

6.10.2 Alternative mechanisms to stimulate financial risk sharing

There are other ways to stimulate deployment of CCS by financial risk sharing. For instance, this can be done through direct governmental funding, through investment into pipeline infrastructure connecting emitters with storage hubs, and through establishing higher carbon prices or other subsidy mechanisms. Direct investment into all CO_2 storage projects that have reached permit application stage through a mandatory equity stake is, however, considered to provide a level playing field among projects in the Netherlands, and stimulate development when the investment risk is highest.

Financial risk sharing by the State also occurs in the Netherlands in other industries. Nuclear waste storage is one example. In the Netherlands, COVRA, a 100% state-owned company, is responsible for storage of nuclear waste. COVRA charges a fee to parties who need to store their waste. The Autoriteit Nucleaire Veiligheid en Stralingsbescherming (ANVS) oversees nuclear safety, also of the COVRA operations. In the UK, the recently formed Nuclear Waste Services (NWS), a division of the Nuclear Decommission Authority (NDA) acts as a nuclear site licence operator and provides waste services to its customers. NDA is government funded, with the Office of Nuclear Regulations (ONR) Decommission, Fuel and Waste division being responsible for regulating safety.

Here we see that the State operates waste facilities directly and via contracts with the supply chain and may have an income stream to (part) cover the expenditure. The nuclear industry has built up many years of experience and as such is not directly comparable to the nascent CCS industry.

APPENDIX A: RISK SCENARIOS WITH POTENTIAL SAFETY IMPACT

The international standard ISO 27914:2017 identifies six main performance criteria for CO_2 storage projects:

1. Sufficient capacity.
2. Sufficient injectivity.
3. Long-term containment.
4. Absence of geomechanical impacts (seismicity or earth deformations) sufficient to cause adverse impact.
5. Modelling and cost-effective monitoring are feasible.
6. Operational safety and environmental protection, i.e., avoidance of impacts to health, safety and the environment stemming from construction and operation of wells and the project surface infrastructure, and from project interactions with non-project human activities local to the project site and surrounding area.

The standard states that risk identification shall be performed for threats to each of the above performance criteria. In this report, however, the emphasis is on risk scenarios in *offshore* CO_2 *storage projects* that can have *direct* impact on safety. This applies to the threats to performance criteria 3, 4 and 6. We will therefore focus on describing key risk scenario (and associated risk treatment actions) for these three performance criteria. Risk scenarios for performance criteria 3 – Long-term containment – will be divided into two broad categories:

- Loss of containment due to migration along geological pathway.
- Loss of containment due to migration along engineered pathway (wells).

Risk scenarios for performance criteria 4 will focus on the potential for geomechanical impacts resulting in damage to infrastructure that could have knock-on effects on safety or the environment. Finally, for operational safety and environmental protection, we will focus on issues that are specific to CO_2 storage, i.e., additional to issues encountered in offshore exploration and production (E&P) activities. This implies that the main focus will be on the potential for events that can result in CO_2 releases that may impact human health or the environment.

Table 8 highlights some common risk threats to all CO_2 storage projects. However, each storage project will have a unique risk profile. The site-specific risk assessment determines the likelihood of occurrence, post mitigation activity for any identified threat.

Table 8: Risk scenarios in *offshore* CO_2 *storage projects* that can have *direct* impact on safety.

Threat - Wells	Risk description	Risk treatment	Receptor
Legacy abandoned wells (platform removed)	Wells have been cut at seabed <u>Uncontrolled flow up</u> abandoned wellbores caused by: ▪ Cement plug failure ▪ Casing failure due to cement bond failure allowing flow behind casing to shallower formations For depleted field settings, CO_2 release could be accompanied with hydrocarbon (HC) release	▪ Design injection strategy to avoid these wells where possible ▪ Re-abandon old wells *if they can be reentered* ▪ Incorporate into adaptive MMV plan if a key risk	**Environment:** Shallow geosphere to aquatic environment

Partially abandoned wells on existing platform	Pressure build-up in existing well bores (primary barrier failure) In a depleted field setting CO_2 will flow up the well bore along with HC if the cement plug failed or cement bond fails on the casing in the primary or secondary store.	▪ Pressure monitoring at surface. On indication of leak, reinstatement of well integrity required.	**Environment:** Shallow geosphere to aquatic environment **Human health:** Exposure on the injection platform if well-head fails
Reuse of platform production wells for injection	Insufficient wall thickness (especially considering the CO_2 cooling effects or corrosive effects of acidic CO_2 and impurities with backflow of brine during well shut in) on the conductor and/or surface casing for the entire injection period	▪ Full thermal stress analysis of projected well lifecycle ▪ New wells will need to be drilled if the well integrity is deemed unsatisfactory over the lifetime of the project	**Environment:** Shallow to aquatic environment Human health: in the highly unlikely scenario if the secondary wells barrier fails (well head) – see above
Injection / monitoring platform wells	Release of CO_2 on surface platform ▪ Failure of primary and secondary surface barrier e.g., Tubing leak in the annuli (primary barrier) combined with a leak in the secondary barrier (well head / Christmas tree system) ▪ Casing flow (loss of cement bond integrity) *For depleted field settings,* CO_2 *release could be accompanied with HC release*	▪ Well control assurance - regular monitoring of primary and secondary barriers (well head / Christmas tree seals) ▪ Shut in the well - Well intervention with rig (qualified for CO_2 service) ▪ Abandonment of well	**Environment:** Shallow geosphere to aquatic environment **Human health:** HSSE exposure on the platform
Subsea wells	Release of CO_2 from subsea well head(s) A fishing trawler or ships anchor could damage the wellhead assembly	▪ Follow standard oil and gas procedures for installation of subsea well head assemblies e.g., fishing trawler proof caps and shipping exclusion zones	**Environmental:** Aquatic environment
Pipelines	Release of CO_2 at the seabed ▪ Shipping or fishing damages a pressurized CO_2 pipeline Corrosion of CO_2 pipeline	▪ Risk identification workshops focusing on CO_2 pipeline design, material selection, leak detection systems fabrication, installation, operating philosophy Apply standard Oil and Gas industry guidelines for offshore pipeline installations such as burying and weighting the pipeline and shipping exclusion zones	Aquatic environment

Threat - Faults & fractures	Risk description	Corrective measures / risk mitigation	Environmental receptor
Flow of CO_2 up a fault in the primary or secondary seal	▪ Faults and fractures can provide a natural leak-paths through the overburden lithologies (geosphere) potentially to surface ▪ Reactive transport – CO_2 (acidic fluid) reacts with the cement within the fault/fracture zones allowing flow (fault becomes conductive – open to flow)	▪ Avoid sites with a high fault density or known “open” faults (faults that leak) or where the CO_2 plume would intersect a critically stressed fault – observations of gas chimneys, fluid escape features or nearby shallow gas features would be cause for consideration ▪ Incorporate in injection strategy and the MMV plan if a key risk	Subsurface - container complex Environmental risk

Threat - geomechanical impacts	Risk description	Corrective measures / risk mitigation	Environmental receptor
Geomechanical impacts of CO_2 injection	**Geomechanical event** ▪ Induced seismicity Injection pressure exceeds fracture pressure or fault reactivation pressure ▪ Natural seismicity ▪ Subsurface upheave Potential impacts - Activation of a flow pathway along a fault - Soil movement that can cause damage to infrastructure or installations	▪ Advanced geomechanical studies (e.g., modelling) to assess the maximum injection pressure to be applied per well. ▪ MMV plan typically incorporates pressure monitoring manage pressure storage site within agreed limits.	Shallow to aquatic environment

Threat - Acidic fluid	Risk description	Corrective measures / risk mitigation	Environmental receptor
Operational safety and environmental protection	Dense phase CO_2 release onto the surface installation impacting personnel on the offshore facility, caused by a mechanical failure of a well riser, well head failure, accident during well works over activity ship collision, human error etc..	▪ Operational philosophy will incorporate all aspect of CO_2 handling to create CO_2 compliant safety case for installations, be they manned or unmanned ▪ CO_2 storage into a depleted fields will likely require a dual safety if	Human health: HSSE exposure on the platform

	▪ CO_2 has a high expansion ratio (Joule-Thomson effect). It can expand by 300 time when depressurised from super critical phase at atmospheric conditions. This results in a very strong cooling effect and displace O_2 in air leading an asphyxiation risk	CO_2 and HC present on the installation ▪ Material selection of metals and non-metallic elastomers	

APPENDIX B: ACRONYMS

ANVS	Autoriteit Nucleaire Veiligheid en Stralingsbescherming
CCS	Carbon Capture and storage
CCU	Carbon Capture and utilisation
CEEAG	European Parliament resolution on the Climate, Energy and Environmental state Aid Guidelines
CO_2	Carbon dioxide
CRA	Containment Risk Assessment
DNV	Det Norske Veritas
E&P	Exploration and Production
EBN	Energie Beheer Nederland
EOR	Enhanced Oil Recovery
EZK	The Ministry of Economic Affairs and Climate Policy
FEED	Front End Engineering Design
FID	Final Investment Decision
G20	Group of Twenty
HC	Hydrocarbon
HSSE	Health, Safety, Security and Environment
M&V	Monitoring and Verification
MMV	Measuring Monitoring and Verification
MTPA	Million tons per annum
NDA	Nuclear Decommission Authority
NWS	Nuclear Waste Services
OECD	Organisation for Economic Cooperation and Development
ONR	Office of Nuclear Regulations
RVO	Rijksdienst voor Ondernemend Nederland
SNS	Southern North Sea
SodM	State Supervision of Mines
SOE	State owned enterprise
TNO-AGE	TNO Advisory Group Economic Affairs
TFEU	Treaty on the Functioning of the European Union
TPA	Third party access

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