ROTTERDAM CCS NETWORK PROJECT

CASE STUDY ON ‘LESSONS LEARNT’

The methodology and plan of the research

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INTRODUCTION

The Rotterdam Climate Initiative (RCI) is working hard to realise carbon capture and storage (CCS) in the Rotterdam area. CCS activities in Rotterdam commenced in 2006 and, until now, 18 major companies cooperated to provide feasibility level engineering studies for CO_2 capture projects and a CCS infrastructure network. The Rotterdam CCS Network Project can be characterised by:

- a broad cooperation between parties, with active commitment of industrial organisations;
- a vision that transcends single-source-single-sink projects and aims at a network, a hub function and focuses on the whole CCS chain of CCS, encompassing technology and organisational, legal and financial issues; and
- a local (political) commitment to a long-term approach which also transcends the region of Rotterdam.

The Rotterdam approach appears to be effective thus far. Domestically and internationally, people have expressed interest in the Rotterdam approach and the drivers behind RCI’s success in promoting the development and deployment of CCS.

Together, the RCI and the Institute phrased the following main research question: *What can we learn from the Rotterdam CCS project*? And formulated two subsequent objectives:

1. discover the lessons useful for the support of starting CCS projects around the globe; and
2. improvement of the Rotterdam CCS project itself.

The Rotterdam CCS project aims to create a final situation in which:

- multiple CO_2 sources will capture CO_2;
- the CO_2 is collected in an intermediate storage ‘hub’ by means of a common transport infrastructure; and
- the collected CO_2 will then be delivered by pipeline or ship to the end-user or stored in deep geological formations.

These kinds of projects are called *CCS Network Projects* or *CCS Hub Projects*. In this document, the name *CCS Network Project* will be used. The case study will thus be called: the *Rotterdam CCS Network Project* (or in short ‘the project’).

This document describes how the case study will be conducted (‘the methodology’) and contains an elaboration on the:

- background and research questions (Chapter 1);
- research framework and scope (Chapter 2); and
- plan of research (Chapter 3).

1. BACKGROUND AND CASE STUDY AIMS

This chapter will first describe the challenges and opportunities of CCS projects, with an emphasis on CCS Network projects. This will provide information on the expectations and initiators of these complex projects. The Rotterdam approach is described next in section 1.2. Finally this section concludes by establishing the main research questions.

1.1. CCS PROJECTS: CHALLENGES AND OPPORTUNITIES

CCS projects consist of a set of heterogeneous technologies with differing challenges. CCS covers:

- capture technologies;
- integration of these technologies in production processes (of e.g. electricity production);
- transport and compression technologies; and
- storage and monitoring technologies.

Even though CCS technologies are commercially available today; most of them still need to be integrated on a large scale at commercially acceptable costs (especially with regards to CO_2 capture technologies).

Not only are the technologies diverse, the conventions, habits and mindsets of the experts in the different industrial sectors are also quite dissimilar. Hence, the language of engineering studies or business plans is vastly different between the sectors involved. Furthermore, the legal and financial arrangements vary between the industries involved and one may say that the overarching ‘rules of the game’ for CCS are still ‘under construction’.

To come to the desired large-scale implementation of CCS, developments have to take place in the specific technology domains, in the interfaces between those domains and in the institutional arrangements surrounding the domains. These interdependencies are particularly apparent in CCS Network projects, as they comprise multiple CO_2 separation facilities and sinks, and a common CO_2 transportation and storage infrastructure.

CCS Network projects are typically proposed for regions with a high concentration of CO_2-emitting industries and sufficient capacity to store the emissions of these facilities. These regional characteristics allow planning for scale up from initial publicly supported demonstration to long-term commercial operation, providing opportunities for:

- large amount of potential CO_2 sources (and thus possible emission reduction);
- economies of scale resulting from shared infrastructure;
- participation of multiple stakeholders and industries, with the potential to develop business and financing structures that will underpin future commercial CCS markets;
- accelerated deployment of CCS and the integration of facilities that might not otherwise implement CCS, due to existing infrastructure and businesses;
- developing financial structures that address the different investment characteristics of the major elements of the CCS value chain: capture, transport, use and storage;
- cost reductions via the development of regional expertise and production capacity; and
- advancing the point in time at which CCS is commercially viable and government support is unnecessary.

CCS Network projects can be distinguished by their common CO_2 transportation and storage infrastructure and plans for future scale-up, presenting challenges additional to those faced by point-to-point CCS projects:

- *Investment risk:* the economies of scale in a CCS Network project are premised on over-sizing infrastructure to anticipate later demand. This carries higher up-front capital costs. There is a significant risk that later demand may not materialise, due to uncertainties about if and when CCS will become commercial. This would strand investment in oversized infrastructure.
- *Technical:* handling CO_2 from multiple sources complicates technical considerations regarding specifications for CO_2 quality and system balancing.
- *Commercial:* the participation of multiple stakeholders, both current and prospective, complicates commercial structures, terms and contracting, especially due to the need for early users and operators to bear disproportionate risk.
- *Political:* asking strained public budgets to support additional infrastructure based on the future needs of an unproven and non-commercial technology. CCS Network projects are more tangible to citizens and residents than simple CCS projects, so the local licence to operate the CCS Network will play an even larger role.
- *Storage:* in addition to future demand for disposal, CCS Network projects are premised on future availability of cost-effective and high-capacity storage. Locating and characterising to sufficient detail the structures most appropriate for high volumes of CO_2 is costlier, riskier and more technical difficult than for smaller, better characterised containers.

The challenge for a CCS Network project is to build an optimally sized network that manages and minimises all of the associated risks, including that each risk element is carried by the entity best able to manage that risk, both initially and over time.

This paragraph has sketched the challenges of CCS projects and CCS Network projects in particular. In summary: the projects are very complex and the challenges are distributed over a number of heterogeneous themes and parties. These challenges are also encountered in the Rotterdam CCS Network Project.

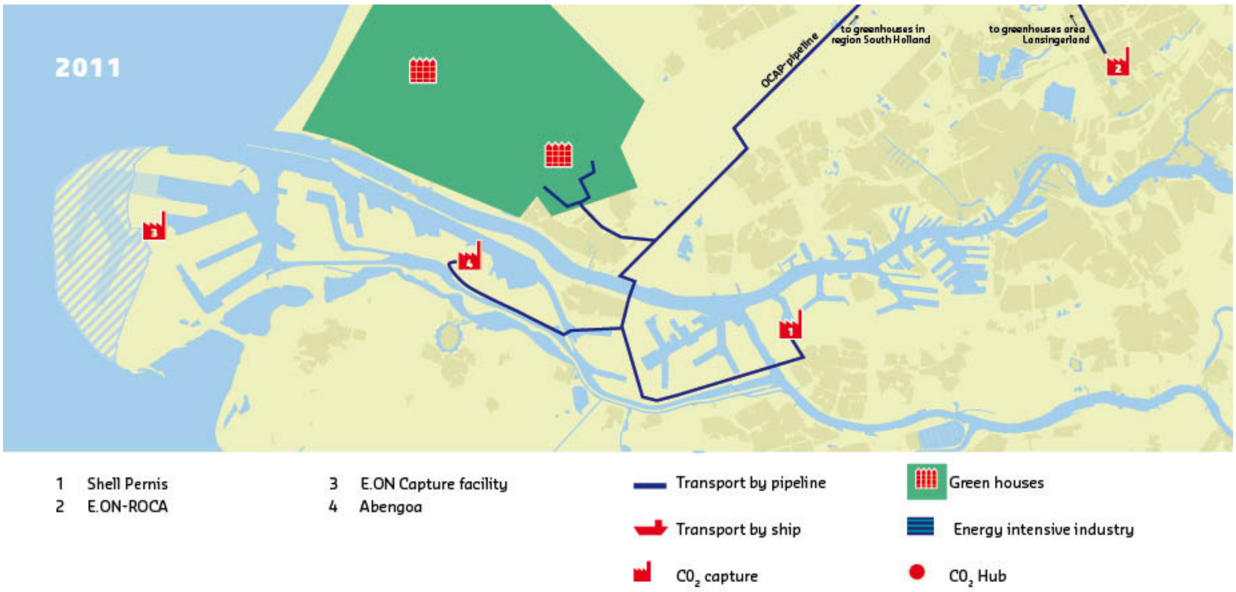
1.2. THE ROTTERDAM CCS NETWORK PROJECT

Rotterdam offers good opportunities for the development of a CCS network. Large CO_2 emitters are clustered in the area, and large potential offshore storage sites are accessible nearby in depleted oil and gas fields and other suitable geological formations. This network will connect multiple emitters to multiple storage sites. RCI expects this network to benefit both climate change policies and the investment climate in the port.

The Rotterdam approach on CCS started in 2006 and has delivered four status reports to date[1]. The Rotterdam CCS network can scale-up rapidly from a demonstration phase around 2015 (capturing and storing 3-5 Mt/year) to a commercial phase, handling as much as 20 Mt of CO_2 annually from the Rotterdam industry by 2025, providing the backbone for low-carbon industrial and economic growth in Rotterdam. This development is illustrated in the maps of Rotterdam-Rijnmond overleaf.

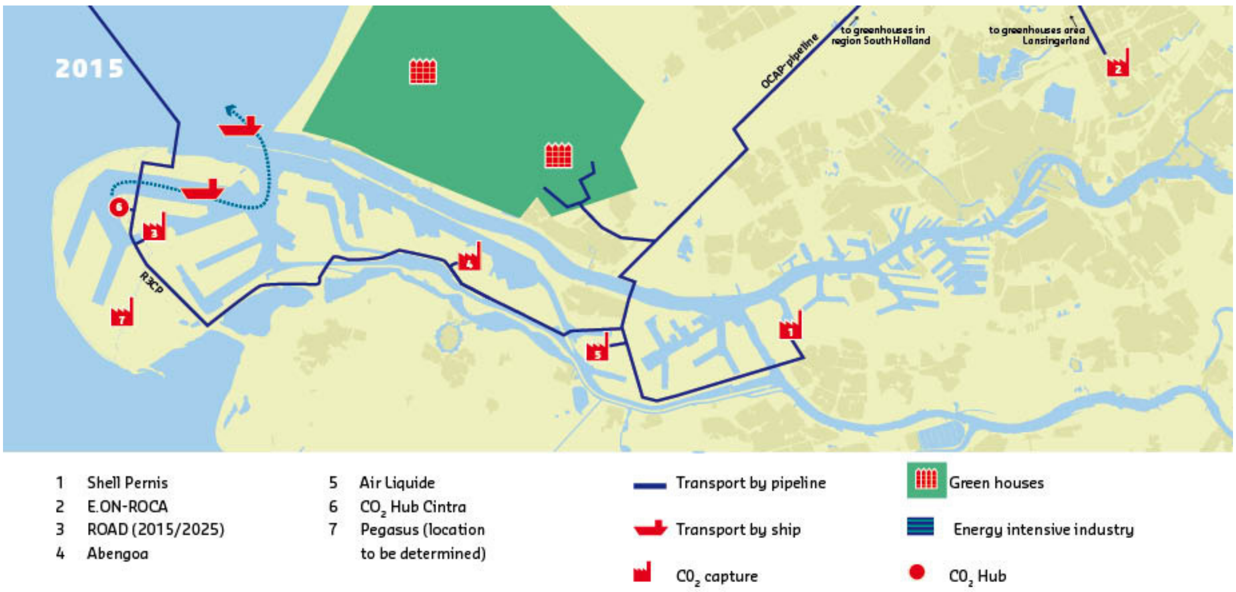
[1] The reports can be found at the website of the Rotterdam Climate Initiative: http://www.rotterdamclimateinitiative.nl/en/100_climate_proof/news/publications

Map 1: Rotterdam Climate Initiative CCS network – 2011



Map 1 shows the present situation (2011): Several companies, active in RCI, already operate CCS projects. OCAP delivers CO_2 from the Shell refinery to greenhouses. With the addition in 2011 of Abengoa as a source of CO_2, OCAP continues to expand these deliveries. E.ON’s CHP plant, RoCa, also delivers CO_2 to greenhouses. Other examples include GDF SUEZ, who operates a small-scale CO_2 injection project in an offshore gas field (K12B) since 2004, and the pilot capture plant called *CO_2 catcher* at the E.ON Maasvlakte coal-fired power plant. This pilot was part of the CATO R&D programme.

Map 2: Rotterdam Climate Initiative CCS network – 2015-2020

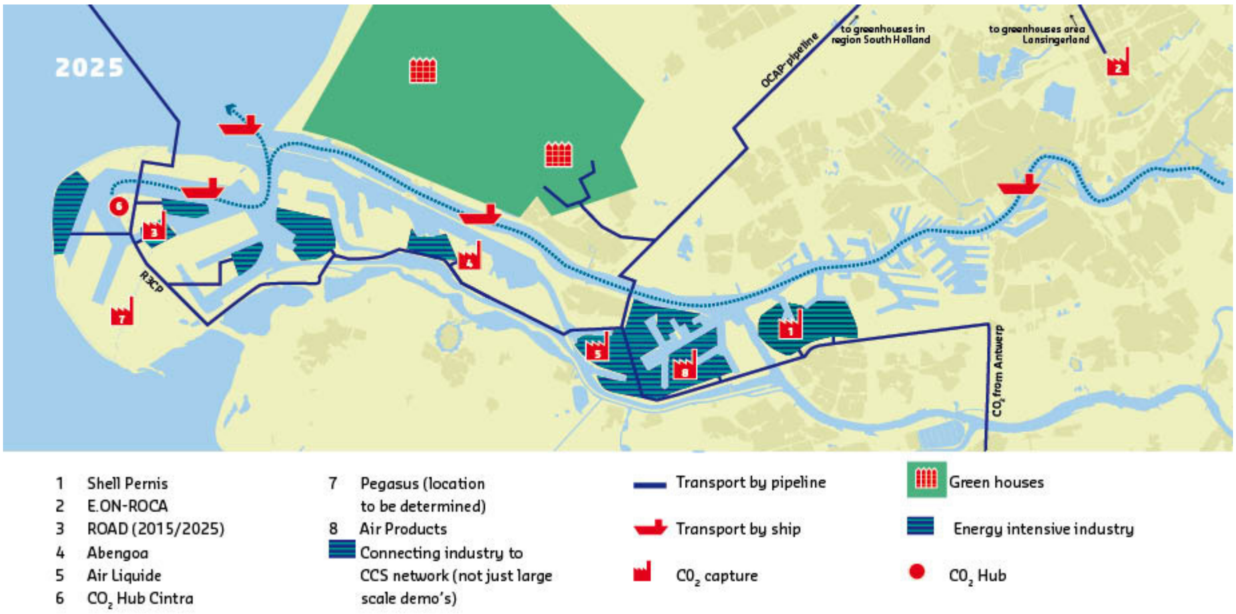


The second map shows the developments projected for the period between 2015 and 2020, when the CCS network will evolve into its demonstration phase. Large-scale demonstrations are required as stepping-stones towards full-scale implementation. These demonstration projects will:

- lead to the development and improvement of capture technologies;
- enable cost reductions for CCS; and
- become the start of the CCS network.

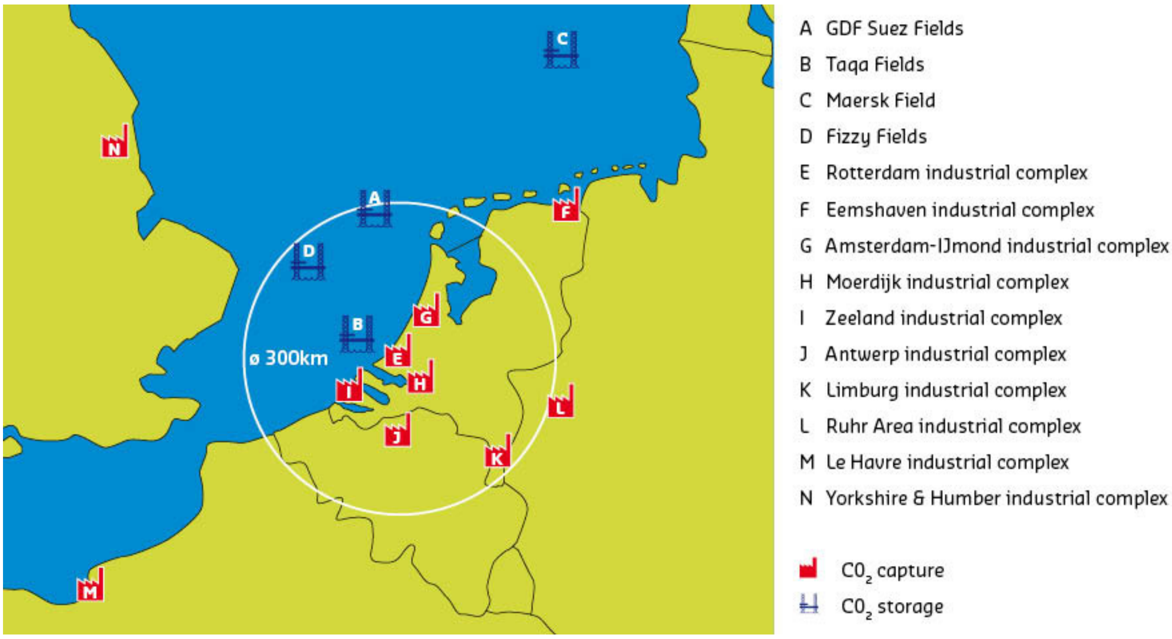
Currently the most prominent demonstration project is the ROAD project, which has been granted funding from both the EU and the Dutch governments. In the ROAD project, E.ON Benelux and Electrabel group GDF Suez have formed a joint venture to build a post-combustion carbon capture unit with a capture capacity equivalent to 250 MW generation at the new coal-fired power plant E.ON is building at Maasvlakte. RCI also expects at least one hydrogen production facility (operated by Air Liquide and Air Products) to apply CCS by 2015. By then, the CO_2 hub will have started its first operations and initial offshore storage may take place at the depleting P18 gas fields operated by TAQA energy.

Map 3: Rotterdam Climate Initiative CCS network – 2025



As indicated on Map 3, the demonstration projects form the stepping-stones towards full-scale deployment of CCS by 2025 in the Rotterdam area, enabled by the establishment of the Rotterdam CCS network. RCI anticipates that the demonstrations will capture and store CO_2 on a maximum capacity and that an increasing part of the Rotterdam industry will apply CCS by 2025. The three maps also indicate the connections that RCI expects the CO_2 network to make outside the Rotterdam-Rijnmond region. Overleaf is a map of North-western Europe, showing the locations of those connections.

Map 4: Rotterdam Climate Initiative CCS network expanding to other regions outside Rotterdam



The CCS networks described above can create economies of scale and help to lower the overall cost of implementing CCS. Perhaps the most attractive benefit of a Rotterdam-based CCS network is that it would accelerate CCS deployment by providing a common user CO_2 transport and storage infrastructure with associated facilities such as transhipment and processing. This may persuade large emitters who are currently considering implementing CO_2 capture, and trigger the application of CCS by small emitters lacking the means to support a standalone CCS system.

RCI has signed Letters of Cooperation (LoC) with a number of companies and these letters confirm the intention of parties to develop CCS and enhance the cooperation between signatories. Under the banner of the RCI alone, more than 20 major companies are involved in the development of CCS projects (see Table 1). It is promising to see that a large number of Rotterdam-based companies show great commitment to join forces in order to realise CCS in Rotterdam and to contribute to the Rotterdam CCS network. Some of these initiatives involve setting up pilot projects, while others focus on full-scale implementation in the longer run. Combined, they cover the entire chain of capture, transport, use and storage.

Table 1: Companies contributing to the development of a CCS network in the Rotterdam area.

CO_2 Capture	CO_2 transport	CO_2 storage
E.ON	Gasunie	NAM
Electrabel / Gaz de France Suez	Port of Rotterdam	Gaz de France
Shell	OCAP	Wintershall
Air Products	Stedin	TAQA
Air Liquide	Vopak, Anthony Veder, Air Liquide, Gasunie (Consortium)	Maersk
AVR		
C.Gen	Maersk	
Corus	Gaz de France Suez E&P	

Other stakeholders include representatives from the local communities, the Dutch and EU governments, NGOs, and other companies in the port of Rotterdam who are interested in implementing CCS at a later stage. A *CCS Business Platform* was created to provide a platform for information exchange and learning in a public-private setting. Over the past few years, RCI and its partners have gained thorough knowledge on CCS and today they are at the forefront of global CCS developments. RCI will continue to build on this momentum to help address key challenges in developing the Rotterdam CCS network. The current agenda includes the following goals and activities:

- conducting an independent storage assessment, a detailed technical and economic study of potential CO_2 storage sites off shore Rotterdam;
- supporting emitters in the Rotterdam area that seek governmental support, such as in making bids for EU funding for CCS from the *New Entrant Reserve 300* package (NER 300);
- providing a framework for companies and the Dutch government to cooperate so as to negotiate key commercial and financial terms for establishing a shared CO_2 transport and storage infrastructure;
- investigating and advising on a long-term commercial and regulatory framework that supports CCS and low-carbon industry additional to the EU Emissions Trading Scheme (ETS);
- establishing a dialogue with the public and with non-governmental organizations to increase mutual understanding of each other's views on the application of CCS; and
- cooperate with other CCS regions throughout Europe.

The Rotterdam Network Project shows a way to deal with the challenges of CCS as described in the previous section. Can others learn from this experience? In the next section, we will discuss the research questions that will guide this case study.

1.3. DETAILED RESEARCH QUESTIONS

Until now, the Rotterdam CCS Network Project has been successful in terms of realising its ambitions. The following unique selling points of the approach are often referred to when describing the Rotterdam CCS network approach.

- **Broad cooperation** between parties, with active commitment of industrial organisations;
- **Vision** that transcends single-source-single-sink projects and aims at a network, a hub function and focuses on the whole chain of CCS (from capture until storage; encompassing technology and organisational, legal and financial issues).
- **Local (political) commitment** to a long term approach which also transcends the region of Rotterdam.

The research questions to be answered in this case study are based on what others think they can learn from the Rotterdam approach. These external expectations are mainly focused on the strengths listed above, and more specifically on how to realise and maintain them. Lessons learnt might therefore relate to successful advocacy, organising support, availability of resources and funds, analysing options and technologies; cooperating and communicating with stakeholders, etc.

The main research question of the case study is: *what can we learn from the Rotterdam CCS Network project*? The objective is to make available the lessons learnt from the Project and translate them into general guidelines or best practices, which can help other network projects to build on and improve their projects.

Moreover, the project initiator, RCI, wants to use this case study as an evaluation of the last four years and wants to draw lessons on how to improve the Rotterdam CCS network project concerning all possible aspects. To be able to fulfil these goals we need to answer the following questions:

- **The ‘how’ question**
  How could you describe the historical development of the Project? What has happened in the development of the Project?
- **The ‘value’ question**
  What do different stakeholders see as the successes and strengths of the Project?
- **The ‘why’ question**
  Why has the Project been successful? Which causal relations can be found between elements of the Project approach and its success?
- **The ‘reflection’ question**
  What are the weaknesses of the Project and what could have been done better?
- **The ‘learning’ question**
  What could others learn from the Project with the aim to improve their project activities, businesses and practices? How can we generalise the strengths and weaknesses of the Project?

Tailoring the answers to the research questions above to various stakeholders involved in CCS projects, is of prime importance in order to facilitate the uptake of the results from this case study. The researchers carrying out this case study, in their exchange with external stakeholders, have encountered many different mindsets that could colour the receipt of the main outcomes of this study. For example, a local government official in a certain region that wants to start a CCS Network Project has a very different perception (and information needs) than an entrepreneur who has to make a sound business case. These differences will be made visible in the presentation of the results of this case study (see next chapter for more information).

2. RESEARCH FRAMEWORK AND SCOPE

No ready-to-go recipe exists for the development of a CCS project as well as for the execution of the present case study. There are simply no real world examples. The slogan for CCS Network Projects as well for the present case study will have to be: **learning by doing**. For the present research, that especially relates to the chosen research method. This requires a transparent approach; an open and flexible attitude; an interactive structure during the study and a reflection on the method afterwards. The transparent approach is achieved by making choices as explicit as possible.

This chapter will describe in more detail the methodological choices and contains:

- research framework (Section 2.1.);
- narrative perspective (Section 2.2.); and
- plan of research (Section 2.3.).

During the study we will also arrange a ‘learning to learn’ attitude by using the instrument of interactive workshops to reach out to and learn from other CCS projects. And finally this will result in a report that will reflect on the method described in this document.

2.1. THE INNOVATION MANAGEMENT FRAMEWORK

Given the challenges described in the previous chapter, it is important that the chosen research framework addresses the issues regarding innovation and complexity. Therefore the chosen research framework for this case study is the Innovation Management (IM) approach[2], which has proven to be useful and applicable in practice, and it is the basis of the innovation policies of the OECD, the European Union and several national authorities, including the Netherlands. The central idea of the IM approach is that the success of development pathways towards a sustainable economy is not only defined by the technical and economic characteristics of a technology, but also by the quality of the innovation system that surrounds that technology. The basic idea of a technological innovation system is that the innovation process is strongly influenced by a network of actors (organisations) that are developing, advocating or opposing the technology and by an enabling (institutional) environment that legitimises, regulates and standardises the new technology. A well performing innovation system accelerates technological development, while a poorly functioning innovation system hampers technological innovation.

In the last decade, scholars have worked on examining which key activities determine the performance of a technological innovation system. The chosen framework articulates seven key activities (or system functions) of an innovation system. These system functions are briefly described below and to make them more tangible, examples are provided from the Rotterdam CCS Projects.

Function 1: entrepreneurial activities
Entrepreneurs are the core of any innovation system. These ‘risk takers’ perform the innovative (pre-) commercial experiments; seeing and exploiting business opportunities. The risky projects of the entrepreneur are necessary to reduce the uncertainties that result from new knowledge, applications and markets.
Examples of entrepreneurial activities in the Rotterdam case: the choice of E.On to start a pilot plant at their site (CO_2-catcher); the decision of E.On and Electrabel to develop the ROAD project; the development of a business case for transport (Port Authority and partners) and the creation of a Hub function with ships (Vopak and Anthony Veder).

Function 2: knowledge development
New business opportunities are often based on new knowledge. Therefore, the variety of

[2] The assessment of other research approaches for this case-study and the reasoning for choosing the IM approach is documented in a separate paper that can be requested from the author.

technological options provided by technological R&D is a prerequisite for every innovation process.
Examples of knowledge development from the Rotterdam case: the research component of the CO_2-catcher (TNO); active participation of RCI and its industrial partners in the national CCS research program CATO.

Function 3: knowledge diffusion
To make sure that all organisations in the system work consistently to achieve optimal results, the exchange of knowledge is essential. This is especially important where R&D meets government and market, because policy makers and entrepreneurs can use the latest technological insights, while R&D agendas can be adjusted to changing societal demands.
Examples of Knowledge diffusion from the Rotterdam case: the RCI CCS Business Platform of the Deltalinqs Energy Forum; the composition of the annual RCI CCS Update reports; cooperation of industrial parties and local authorities (municipality of Rotterdam and Port Authority); RCI's involvement in all kinds of national and international meetings and conferences, like the GHGT-10; the activities of the IEA-GHG programme, the Global CCS Institute, the CSLF and the European Commission around sharing of knowledge.

Function 4: guidance of the search
There are multiple technological options available in the broad portfolio of climate mitigation solutions. Moreover, in the CCS chain itself the technological options available varies widely and resources are spread over all these options. Consequently, there may be insufficient resources for either one of these options to mature. Therefore, it is important to create a selection process that facilitates a convergence in technology development. To this end, the organisations in the innovation system need to provide guidance for the selection of technological options involving policy targets and expectations about technological options.
Examples of guidance in the innovation process from the Rotterdam case: The Rotterdam CCS approach with its goal of achieving 20 million tonnes of CO_2 stored annually in 2025 and the vision of how to achieve that goal (see RCI 2010) guides the development of CCS in Rotterdam on a high level; the Strategic Deployment Document and Strategic Research Agenda for CCS of 2006 and their successors in 2010 of the Zero Emission Platform in Europe provide guidance on a more detailed technological level (see www.zeroemissionsplatform.eu).

Function 5: market creation
Innovations often have great difficulties in competing with the existing technologies that form the market. So, if there are good (societal) reasons to implement new technology, a protected space in the market environment has to be created in which the technology can develop, otherwise it will be out-competed by the incumbent market players and technologies. Market formation can be done through forming niche markets in which organisations can learn about the technology or through creating competitive advantages by tax regimes or consumption quotas.
Examples of market creation from the Rotterdam case: RCI activities to aim at policy instruments that will support the commercialisation phase of CCS (see RCI 2009); building a physical collection network for CO_2 will create opportunities for industrial parties to deploy CCS earlier and more cost effective.

Function 6: resource mobilisation
Human and financial resources are a necessary input for all activities in the system and can be enacted through e.g. private equity and governmental subsidies.
Examples of resource mobilisation from the Rotterdam case: National and European subsidies / funds that support development of the Project (EEPR, NER300); investments of E.On and Electrabel in form of money, time and people to ROAD; financial support of RCI to industrial parties for making sound plans for the European funding schemes (EEPR, NER300); cooperation of industry and scientific institutes to obtain funding for the next phase of the national research programme (CATO-2).

Function 7: creation of legitimacy
The introduction of new technologies often leads to resistance from established organisations, or society. Advocacy coalitions can counteract this resistance by putting technologies on the agenda and advocacy for resources or favourable tax regimes. If successful, advocacy coalitions can grow in size and influence and they might become powerful enough to facilitate the successful deployment of the new technology.
Examples of creation of legitimacy from the Rotterdam case: RCI lobby to support Rotterdam projects at national and international level to obtain a share of available financial resources (European Commission); the formation of the National Taskforce CCS, including industrial parties, regional partners, financial institutions and environmental NGO (the CEO of the Port Authority of Rotterdam is member of the Taskforce); the public debate around the Barendrecht CO_2 *storage project.*

It is worth noting that the functions do not simply determine the performance of the innovation system independently. Instead, they are expected to reinforce each other over time. The successive fulfilment of functions can result in positive feedback loops. For example, positive research outcomes (Function 2: knowledge development) can result in increased confidence in the technology amongst industry and policy makers (Function 4: guidance of the search). In turn, they can increase their investments in technological development (Function 6: mobilisation of resources), leading to more knowledge development and project activity (Function 1: entrepreneurial activity). However, a similar negative feedback loop can emerge when research results are disappointing and organisations cease to invest in technological development. Therefore, feedback loops can accelerate both the rise and decline of the innovation system.

From the above, one can deduce that the functions of innovation systems have a close connection to what is considered important in the case of the development of a CCS innovation system, or a CCS project. All relevant elements are covered by one or more functions. Therefore, at first sight, the function vocabulary appears to match the research needs. In order to meet the needs of the various stakeholders involved in CCS projects, the concept of spectacles is introduced in the following section.

2.2. NARRATIVE PERSPECTIVE: SPECTACLES AND SPECTATORS

The aim of this case study is to draw lessons that can be used and understood by a broad variety of interested stakeholders. This target group does not need to have precognition of the scientific background of the research framework, as the research results themselves should be self-explanatory. The results from the analysis with the chosen framework therefore have to be translated to the vocabulary of the interested person. Because of the multitude of stakeholder needs, many vocabularies are possible. Four archetypical stakeholder types (‘spectators’) have been chosen to reflect that multitude of vocabularies. The ‘spectacles’ of the archetypes will be used to provide a narrative perspective on the results. The four chosen archetypes or spectators are:

1. The **entrepreneur**: sees CCS as a technology and a business case. *Example:* the manager of a company who wants to build a CO_2 capture facility in a certain location, such as the ROAD project in the Netherlands, Hatfield in the UK, or another projects as identified by the Institute[3].
2. The **network organiser**: sees CCS as a complex network project that has to be organised. *Example:* the project leader of a CCS Network Project, like the the Rotterdam Network Project, CarbonNet (Victoria, Australia), Collie SW Hub in Australia, or CO2Sense in Yorkshire (UK).
3. The **policy maker** (civil servant): sees CCS as part of a broader (innovation) policy framework, which fits within the dominant policy targets (such as the goals for energy

[3] Global CCS Institute, 2011, The Global Status of CCS: 2010, Canberra. Australia.

security or climate change mitigation). *Example:* a government official of the United States Department of Energy (USDoE) charged with designing a CCS deployment strategy.

4. The **politician** and executive: sees CCS as part of the arena where multiple public interests are considered and balanced and where feasibility in terms of dominion plays a large role. *Example:* the Indian minister of Energy, the Governor of the Province of Hebei in China, the Prime Minister of Australia or the former Prime Minister of the Netherlands, Ruud Lubbers, now chairman of the RCI Council and strongly involved in the Rotterdam CCS Network project.

What does it mean to 'use a certain set of spectacles'? Consider the example of a politician. In the first instance, the researcher using those spectacles needs to familiarise him or herself with the role and the characteristics of the spectator. What are the priorities of the politician? Do CCS projects have an impact on other issues in his constituency, especially with regard to division of power, the absence or presence of political support, the economic cost-benefit balance for the region? How do politicians in this region handle decision-making: top-down, consensus driven or other? Who are his/her normal allies and how do they function in the regional network? When are the next elections and is CCS or climate change in general a significant issue?

After acquisition of that role, the researcher has to rephrase the results of the analysis in such a way that a politician would directly recognise the results as being said in his/her own vocabulary, as if a colleague politician is talking to him/her. For the storyline and lessons learnt from a CCS network project this could mean (for the political spectacles):

- A focus on the description of the network of executive/political stakeholders (e.g. CEOs, public executives such as mayors and ministers, high level political party member in the region, the members of councils or parliaments).
- One of the first things a politician wants to know is: who has which position towards CCS and what are their interests? In the CCS case: which high level persons have a favourable attitude (and why) and which organisations are opposing the technology (and why)?
- Next, they might want to know what the possibilities for influencing persons and positions are. What could be political trade-offs: what is negotiable and what is not? For instance, a new CCS project that would require additional use of coal could be sensitive in some areas. The question then is: is coal with CCS acceptable for some of the opponents or do they need other trade-offs to be convinced?
- **Not** a focus on technical aspects, or on development of business cases for a particular CCS project, unless they have an impact on the position of the executive/political persons or the decision making process. A serious delay in the development of business cases that can hamper the realisation of projects are important to know for a politician, because she/he has to be prepared for de-risking the operation. Therefore it is important to:
    - describe in some detail the process of decision making, on the industrial side as well as on the government side; and
    - focus on events and arguments that have a regional impact with regards to the political relations and economic welfare or could have large media impact.

Spectacles are firstly meant to tailor the results for different types of audiences, but they also help to structure the analysis. The resulting storylines per spectator/audience type are not totally disjoined, as certain events like the acquisition of resources are considered important for all audiences. However, if you look through certain spectacles you see another picture, e.g. seeing different priorities, have a different view on the most important hurdles and the feasibility of the project will be assessed differently.

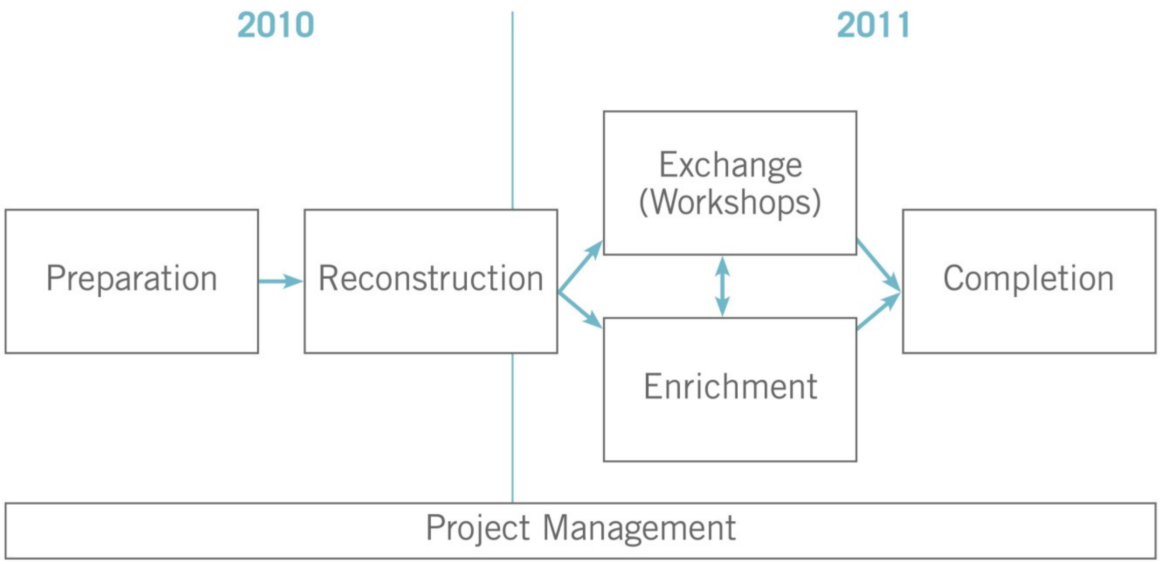
In the following Chapter, the plan of research is described and the relationship between the innovation management framework and the narrative (‘spectacles’) perspective is further explained.

3. PLAN OF THE RESEARCH

The research plan can be divided into four main activities:

1. reconstruction;
2. exchange;
3. enrichment; and
4. completion.

The first step, 'reconstruction', will deliver an interim report on the outcomes of the analysis described in the previous chapter. The interim results are the starting point of the second phase, i.e. an interactive and iterative phase, in which the project team will test the outcomes with similar projects in other regions. These 'exchange' and 'enrichment' phases consist of two key activities: hands-on workshops with CCS project proponents and additional research to cover iteratively what we have learnt in those workshops. In the figure below, you will find an overview of the case study plan, including a first estimate of the planned dates. The main elements of the research plan – i.e. reconstruction, enrichment and completion – will be described in more detail below.



3.1. RECONSTRUCTION

The research itself will start with the reconstruction phase. In this phase the chronology and the story lines are established and the analysis on the strengths and weaknesses of the Rotterdam CCS Network project is carried out. The Innovation Management framework comes with a methodological analytical tool: i.e. event history analysis. This tool will be used for data collection and will deliver an event database and a factual storyline.

In an event history analysis one will first map all events related to the case being studied. These events will be put in an event database. Every event that influences the development of the Project has a relation to a specific part of the innovation system. Some examples: posing clear and quantitative goals for CO_2-emission reduction or CCS deployment, as is the case in the Rotterdam Project, influences the expectation of parties and gives guidance to the innovation process (Function 4). Participation of companies like E.On, Vopak and Anthony Veder indicate that entrepreneurs see interesting business opportunities in the development of CCS projects. Each event will thus be linked to one (or more) of the seven functions identified in the Innovation Management framework. In the database each event will also contain information on the organisations involved.

The next step is to order these events chronologically and to validate this storyline with the people involved in the project. After this first round of interviews a story around the line of events can be created. This narrative would point at the important events and delivers some form of causal relation between the events. Based on the storyline, the development of the seven functions can also be evaluated, resulting in an overview of well-developed and less-developed functions: a map of the (functional) strengths and weaknesses of the project.

Once insight is created in the historical development of the project and the strengths and weaknesses of the project are identified in terms of the fulfilment of system functions, the goal is to evaluate the factual storyline with the narrative perspective and to test the results in interviews with stakeholders.

The first step for this evaluation is to couple the four spectators of the narrative perspective, i.e. the entrepreneur, the network organiser, the policy maker and the politician – to the IM functions. What type of events influence their behaviour and how will this occur? The spectacles have many similarities with the IM functions. The *entrepreneur*, for instance, has a high interest in Function 1: entrepreneurial activity and the availability of funds for demonstration projects (Function 6: resource mobilisation).

By using these profiles to evaluate the factual storyline, you will achieve an impression of what the key events are, according to a certain type of audience, the main relationships of events and also the main strengths and weaknesses of the Project. In fact, the interviews with some 'real' and involved spectators will add an extra dimension to the evaluation: they can verify the interim results and also phrase alternate descriptions of key event and lessons learnt. In short, this results in an evaluation of the factual storyline from the different perspectives.

The data collection for the reconstruction phase of the case study exists of three parts:

1. **Document analysis** – chronology and analysis of events based on internal RCI documents.
2. **Media analysis** – chronology and analysis of events of media attention for the Rotterdam project.
3. **Interviews** – with those directly involved in the Rotterdam Network Project and with outsiders.

These three parts are described in more detail below.

3.1.1. Document analysis

The analysis of the documents starts with the archives of RCI. Additionally, the documents should be ordered chronologically, possibly also in hardcopy. This activity determines which essential confidential documents are missing in the archives and if possible access to these needs to be arranged. A solid register of the documents and cross-references is a prerequisite. A digital spreadsheet is used for that registry. This database will be analysed according to the Event History Analysis outlined above.

This phase of the analysis will be parallel to the first round of interviews. The results of and questions from the document analysis have to be mirrored by the findings of the interviews (and vice versa).

The document analysis will result in a summary report.

3.1.2. Media analysis

The goal of this activity is to get a clear picture of what the media report on the Rotterdam CCS Network project (particularly newspapers) and what can be deduced from those reports about the strength and weaknesses of the Project. The analysis starts with acquiring the databases and media logs that already are operational within the Dutch national research program (CATO) and within the RCI. This data is supplemented by a survey of the LexisNexis media database. The results of these activities will form a media event list (also registered in a spreadsheet according to the Event History method).

The media analysis will result in a summary report.

3.1.3. Interviews

Interviews are an important part of the reconstruction. Questionnaires were established during the design of the analytical framework. The interviews will be used to explore the (arguments for) opinions of the interviewees on the strengths and weaknesses of the Rotterdam approach and to identify key events. The interviewees will also be asked to give ideas for improvement for the Project and to share what lessons they have learnt through their involvement in the Project.

In total around 30 interviews will be carried out in three different stages:

1. The first stage will involve about five internal (RCI) persons. The interviews with internal (RCI) persons involved will primarily be used to substantiate the results of the other analyses and to explore possible gaps in information/results.
2. A second stage with about five external and five internal stakeholders. This group should give some understanding of the perception of external persons on strength and weaknesses of the Project. The interviews with the internal persons are meant as a second validation step of the results and on additions of the storyline and lessons learnt.
3. The last stage is meant to be a final check on the results of the analysis. The interviewees will be high-ranked officials in the Rotterdam area from industry and the national government. This section will be carried out after the first draft report of the two analyses is completed and the interviewer can check the main findings of the analyses.

The interviews will be recorded and transcribed. The interviews are anonymous and only project team members should have access to the interviews transcripts

The interviews will result in a summary report.

3.2. EXCHANGE

Interactive exchange will be facilitated in workshops with the target groups: those project initiators who could use the results and lessons learnt from the case study in their own situation. There are two main topics to be discussed in the workshop:

- **Lessons learnt**: are the results complete (seen from the demand side)? Are the results clear (does one understand and recognise the results)?
- **Translation:** what possible clues or leads can be discerned on mismatches to the local situation in other similar projects outside Rotterdam? In this way the workshops function as a reality check and the main means for the Enrichment phase discussed below.

If we consider those two goals of the workshops as being equally important, this means that the workshops should be held in different regional/cultural settings. Therefore, the proposal is to cover all main CCS regions, i.e. North America, Australia, Europe and Asia.

3.3. ENRICHMENT

The Enrichment phase contains two parts: the 'translation' and a refining of the reconstruction. This phase will be carried out in parallel and iterative with the *exchange* phase. This choice was intentional, as both phases should interact to be as effective as possible. The approach of the translation is based on a discussion document: one of the fundamental documents of the workshops. The workshops themselves deliver input for the translation and the refining of the reconstruction.

One of the possible problems of exchanging lessons learnt is that there could be a mismatch between the local circumstances (physical, legal, cultural) of Rotterdam and the projects in other regions of the world. Therefore, the lessons learnt need to be translated to the local context. Every workshop will therefore lead to a refinement of the reconstruction analysis. The results of the Enrichment phase will be covered in a final report on the reconstruction and a discussion paper.

3.4. COMPLETION

The research should be completed in a useful way after the exchange and enrichment phase is concluded. This expected date of delivery of the final report is in the third quarter of 2011.

ABBREVIATIONS/ACRONYMS

CATO	CO2 Capture, Transport and Storage (in Dutch)
CCS	Carbon Capture and Storage
CEO	Chief Executive Officer
CO2	Carbon Dioxide
DOE	(United States) Department of Energy
EC	European Commission
EEPR	European Energy Programme for Recovery
EU	European Union
ETS	Emissions Trading Scheme
IM	Innovation Management
LoC	Letters of Cooperation
NER300	New Entrant Reserve 300 funding scheme
NGO	Non Governmental Organization
RCI	Rotterdam Climate Initiative
ROAD	Rotterdam Capture and Storage Demo project (in Dutch)
TNO	Dutch Organization for Applied Scientific Research (in Dutch)
UK	United Kingdom
ZEP	Zero Emissions Platform

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