Mitigating project risks

Special Report to the Global Carbon Capture and Storage Institute

Maasvlakte CCS Project C.V.

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Executive Summary

Because of the innovative characteristics of the ROAD project it faces more risks than usual utilities projects. On the one hand, capturing, transporting and storing CO_2 on this scale implies having to manage new technical risks as the combination of the technologies involved has not yet been demonstrated. On the other hand, dealing with a project where the regulatory framework still has to be developed also creates risks at the project level. Therefore, regarding the particular challenges of risk management, Maasvlakte CCS Project C.V. ('MCP') committed itself to develop a risk management approach in order to carefully list, evaluate and treat by adequate measures the identified risks.

A summary of the main project risk categories is given. These risks have an impact on the four departments of the ROAD project team: Capture, Transport & Storage, Stakeholder Management and Project Office & Governance.

Six main categories were defined. These are:

- Capture (CAPEX and OPEX period);
- Transport & Storage (CAPEX and OPEX period);
- Interfaces (between the ROAD departments and with E.ON's Maasvlakte Power Plant 3 ('MPP3'));
- Project timeline (ROAD should be operational on 1 January 2015);
- Funding; and
- Permitting.

In Q4 2011 the Final Investment Decision ('FID') by the parent companies is expected. Most of the identified risks have a direct link to the timeline of this FID because if there would not be a positive decision in 2011, the timescale agreed with the European Commission ('EC') might be put at risk.

In this report, the risk management methodology developed by the ROAD project team is described and evaluated, including the description of the main project risks, mitigating actions and residual risks.

Since the beginning of 2011 the ROAD project started with an extensive risk management approach to list, evaluate and treat the identified risks. Also, using the knowledge within the parent companies and third parties, ROAD tried to identify unknown risks that had not been identified before. With the use of the knowledge from the parent companies and third parties, ROAD started the process of completing the risk register and initiated succesfull mitigating actions to eliminate/ downsize the risks where possible. Within the project management board, the confidence level is very high that the ROAD risk register is as complete as possible. Therefore the confidence is high that the project risks will be mitigated to an acceptable level.

ROAD's risk management process will be described more completely in the special report on handling and allocation of business risks.

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1. Introduction

In July 2009, Maasvlakte CCS Project C.V. ('MCP') submitted its project proposal to the European Commission, to apply for funding under the framework of the European Energy Programme for Recovery ('EEPR'). This marked the start of the 'ROAD project' ('Rotterdam Opslag en Afvang Demonstratieproject'; Rotterdam Storage and Capture Demonstration project).

Because the ROAD project is innovative, it faces more risks than usual utilities projects. On the one hand, capturing, transporting and storing CO_2 on this scale implies having to manage new technical risks as the combination of the technologies involved has not yet been demonstrated. On the other hand, dealing with a project where the regulatory framework still has to be developed also creates risks at the project level. Therefore, regarding the particular challenges of risk management, MCP committed itself to develop a risk management approach in order to carefully list, evaluate and treat by adequate measures the identified risks.

In this report, the risk management methodology developed by the ROAD project team is described and evaluated, including the description of the main project risks, mitigating actions and residual risks. This is done with the aim of helping similar projects to identify and treat their own project risks.

Note that this report is written regarding the status of the risks as of September 2011. Future actions with regard to the risk management will be described in ROAD's special report on handling and allocation of business risks in CCS demonstration projects.

The structure of this report is as follows:

- In chapter 3, the description and objectives of the risk management approach of the ROAD project is given. The implementation of the risk management approach is subsequently described from a project management point of view.
- In chapter 4, the top risks are summarized and explained, as well as their corresponding mitigating actions, resulting in a residual risk level that is described. This analysis is done for each of the 3 main parts of the project, as well as for other general critical themes:
    - Capture;
    - Transport & Storage;
    - Interfaces;
    - Project Timeline;
    - Funding; and
    - Permitting.

This report was written in line with the risk management strategy (phase 1) that was used during the writing of this report. Since August 2011 ROAD hired a specialized (offshore) risk management company to support in a more professionalized risk management process (phase 2). The company is CL Risk Solutions. They supported the project risk management process with the start of comprehensive risk workshops, organizing the web based system for risk management, individual risk assessment and follow-up assessments via their web based system.

This report is written for the Global CCS Institute and is part of the knowledge to be shared under the Funding Agreement between the Institute and Maasvlakte CCS Project C.V.

2. Project Factsheet

2.1 Project Overview

ROAD is the **R**otterdam **O**pslag and **A**fvang **D**emonstratieproject (Rotterdam Capture and Storage Demonstration Project) and is one of the largest integrated Carbon Capture and Storage (CCS) demonstration projects in the world.

2.1.1 Project objectives

The main objective of ROAD is to demonstrate the technical and economic feasibility of a large-scale, integrated CCS-chain. In the power industry, to date, CCS has primarily been applied in small-scale test facilities. Large-scale demonstration projects are needed to show that CCS is an efficient and effective CO_2 abatement technology within the next 5 to 10 years. With the knowledge, experience and innovations gained by projects like ROAD, CCS could be deployed on a larger and broader scale: not only on power plants, but also within energy intensive industries. CCS is one of the transition technologies expected to make a substantial contribution to achieving climate objectives.

2.1.2 Partners

ROAD is a joint project initiated by E.ON Benelux N.V. and Electrabel Nederland N.V. (GDF SUEZ Group). Together they constitute the limited partnership Maasvlakte CCS Project C.V. The intended partners of ROAD are GDF SUEZ E&P Nederland B.V. for the CO_2 transport and TAQA Energy B.V. for the CO_2 injection and permanent storage. The ROAD project is co-financed by the Government of the Netherlands, the European Commission within the framework of the European Energy Programme for Recovery (EEPR) and the Global CCS Institute.

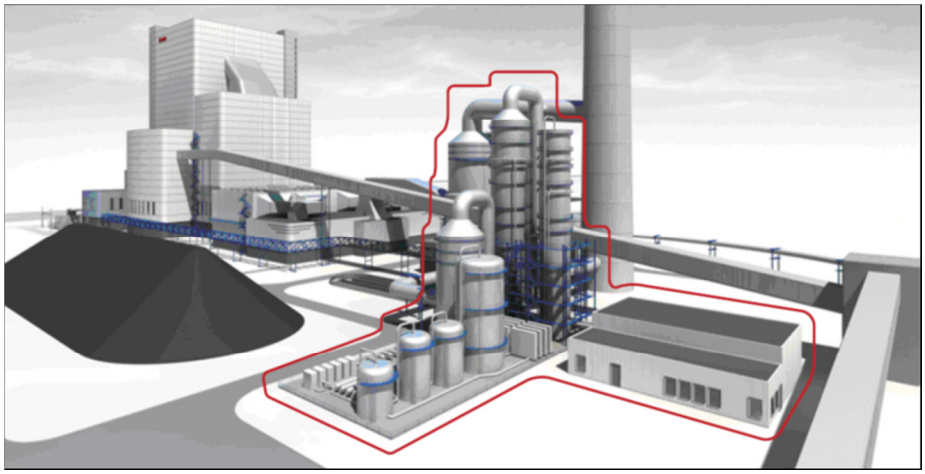
2.1.3 Project specifications

ROAD applies post combustion technology to capture the CO_2 from the flue gases of a new 1,100 MWe coal-fired power (Maasvlakte Power Plant 3) in the port and industrial area of Rotterdam. The capture unit has a capacity of 250 MWe equivalent and aims to capture 1.1 million tonnes of CO_2 per year. The capture installation is planned to be operational in 2015.

Location of the ROAD project CCS chain: Rotterdam port and industrial area and North Sea

Location of the capture unit: Maasvlakte Power Plant 3 (photo: E.ON)

From the capture unit the CO_2 will be compressed and transported through a pipeline: 5 kilometers over land and 20 kilometers across the seabed to the P18 platform in the North Sea. The pipeline has a transport capacity of around 5 million tonnes per year. It is designed for a pressure of 175 bar and a maximum temperature of approximately 80 °C.



250 MWe capture unit (post-combustion)

ROAD plans to store the captured CO_2 in depleted gas reservoirs under the North Sea. These gas reservoirs are located in block P18 (P18-6, P18-4 and P18-2) of the Dutch continental shelf, approximately 20 kilometers off the coast. The depleted gas reservoirs are at a depth of around 3,500 meters under the seabed of the North Sea. The CO_2 will be injected from the platform into depleted gas reservoirs. The estimated storage capacity is approximately 35 million tonnes.

2.1.4 Rationale for Rotterdam port and industrial area

The Rotterdam port and industrial area has a number of advantages that create favorable conditions to implement a CCS demonstration project like ROAD. The Rotterdam port and industrial area has many CO_2 point sources. Several new power stations prepared for the application of CCS (capture ready) are under construction. The Port of Rotterdam is relatively close to a large number of (almost) depleted gas reservoirs on the continental shelf under the North Sea, allowing for a small transport distance. These gas reservoirs meet the physical and geological properties for CO_2 storage and will become available in the next few years (from 2014 onwards). The Netherlands has a lot of knowledge and experience with both oil and gas extraction and storage of gas in aquifers and gas reservoirs. In addition, the complete CCS-chain is remote from residential areas.

P18-A platform at the North Sea (photo: TAQA)

2.1.5 Facts & Figures

Base installation: E.ON Maasvlakte Power Plant 3 (Rotterdam, The Netherlands)

- Output : 1.070 MWe
- Efficiency : 46%
- Operational : End 2012
- Capture ready

Capture Plant

- Technology : Post-combustion
- Capacity : 250 MWe equivalent
- Capture rate : 90%
- CO_2 captured : ~ 1.1 megatonnes / year
- Operational : 2015

Transport

- Pipeline
- Diameter : 16 inch
- Distance : 5 km onshore, 20km offshore
- Capacity : Gas phase :1.5 megatonnes/year
  Dense phase : 5 megatonnes/year
- Design specifications : 175 bar, 80 °C

Storage

- Depleted gas reservoir : P18
- Operator : TAQA
- Depth : 3,500 meters
- Estimated capacity : ~ 35 megatonnes
- Available : 2014

2.1.6 Planning

The high level schedule of the ROAD project is as follows:

14 July 2009	:	Application submitted for funding under European Energy Programme for Recovery
September 2009	:	Project selected for funding by European Commission
May 2010	:	Ministerial order Dutch funding published
	:	Grant Agreement signed by European Commission and ROAD Project
September 2010	:	Front-End Engineering Design studies Capture Plant completed
		Starting note Environmental Impact Assessment published
June 2011	:	Submitting Environmental Impact Assessment, permit applications
Q4 2011	:	Final Investment Decision
Q4 2011	:	Start execution phase (procurement, construction, etc.)
2014	:	CCS chain mechanically complete
2015	:	Start of operation CCS chain
2015-2019	:	Demonstration operation phase CCS chain
2020	:	Start commercial operation CCS chain

2.2 Maasvlakte CCS Project C.V.

The initiating parties of the ROAD project are E.ON Benelux and Electrabel Nederland / GDF SUEZ Group. Together they constitute the limited partnership Maasvlakte CCS Project C.V.

2.2.1 E.ON Benelux

E.ON Benelux concentrates on the production and supply of electricity and gas to private customers and business customers in the Netherlands and Belgium. E.ON Benelux is primarily an electricity-generating company; the company can trade internationally and has its own professional sales organisation. The company was established in 1941 and since 2000 has been part of E.ON Energie AG. E.ON Benelux's power stations with a total capacity of 1,850 MW are located in the province of South Holland, the economic heart of the Netherlands. The company has approximately 600 employees. E.ON Benelux is based in Rotterdam.

2.2.2 Electrabel Nederland

Electrabel Nederland is a leading player in the Dutch energy market and part of the GDF SUEZ Group. With six state-of-the-art production locations and a total capacity of 5,103 MW Electrabel is the largest electricity producer in the Netherlands. Electrabel is a supplier of elektricity and gas to both private and business customers. Electrabel Nederland has 1,250 employees.

2.3 Intended Partners

Intended partners of Maasvlakte CCS Project C.V. are GDF SUEZ E&P Nederland B.V. for the CO_2 transport and TAQA Energy B.V. for the CO_2-injection and the permanent storage under the sea bed of the North Sea.

TAQA Energy
TAQA Energy is part of the Abu Dhabi National Energy Company PJSC (TAQA), an energy company that has worldwide interests in power generation, combined heat and water, desalination, upstream oil & gas, pipelines, services and structured finance. TAQA has a workforce of 2,800 employees and is located in Abu Dhabi, The Hague, Ann Arbor: Michigan, Aberdeen, Calgary and Amsterdam. In addition, TAQA has sustainable partnerships with companies in Africa, the Middle-East, Europe, North-America and India. TAQA is listed at the Abu Dhabi Securities Exchange (ADX).

In the Netherlands, TAQA Energy explores and produces gas and condensates from wells located onshore in the Alkmaar region and offshore in the Dutch North Sea. TAQA also operates a gas storage facility in Alkmaar and has interests in Dutch North Sea pipelines. 200 people work for TAQA directly and indirectly in the Netherlands both onshore and offshore.

GDF SUEZ E&P Nederland
GDF SUEZ E&P Nederland is one of the largest operators in the Dutch sector of the North Sea. With more than thirty production platforms and 300 employees, it is at the basis of the provision of energy to the Netherlands and several other countries.

Since its first successful drilling results in the Dutch North Sea, approximately forty years ago, GDF SUEZ E&P Nederland has grown into a leading operator. It has ample expertise and experience, always chooses the safest option and is continuously working towards the development of new techniques and improved methods. Continuity is ensured through exploration, takeovers and acquisition.

2.4 Financial contributors

The ROAD project is co-financed by the European Commission within the framework of the European Energy Programme for Recovery ("EEPR"), the Government of the Netherlands and the Global CCS Institute.

In response to the economic crisis, the European Council and the European Parliament adopted the Commission proposal for a European Energy Programme for Recovery ("EEPR") in July 2009. The EEPR funds projects in the field of gas and electricity infrastructure as well as offshore wind energy and CO_2 capture and storage (CCS). In total 12 CCS projects applied for assistance under the EEPR. In December 2009, the European Commission granted financial assistance to six projects that could make substantial progress with project development in 2010. These projects will receive overall funding of € 1 billion under the EEPR.

3. Risk management approach of the ROAD project

3.1 Approach

The ROAD project decided to develop risk management methods and tools based on available general or specific standards like:

- **ISO 31000** "Risk management - Principles and guidelines" (ISO 31000:2009, IDT); and
- **OSPAR Guidelines for Risk Assessment and Management** of storage of CO_2 streams in geological formations.

The ISO 31000 defines risk management as:

- coordinated activities to direct and control an organization with regard to risk; and
- risk is the effect of uncertainty on achievement of objectives.

The OSPAR Guideline risk definition is as follows:

- combination of the probability of occurrence of harm and the severity of that harm.

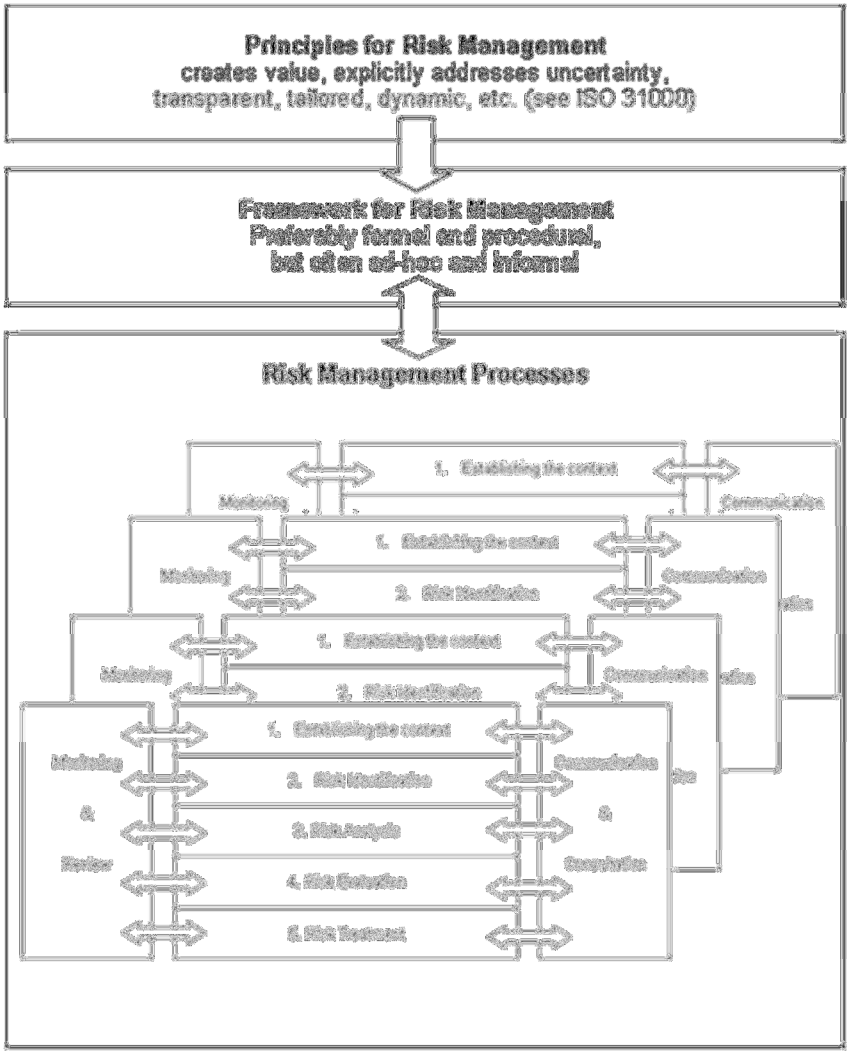


Figure 1: General overview of risk management, based on ISO 31000

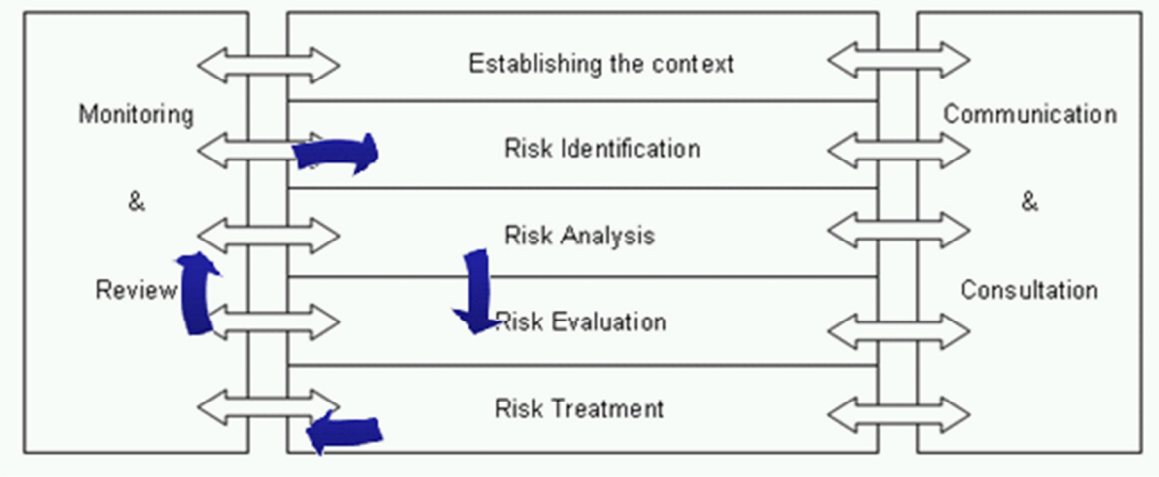


Figure 2: The CCS monitoring – risk assessment cycle as part of the ISO 31000 risk management process

The methodology followed by the ROAD project is hence to create a dynamic cycle of risk identification, analysis, evaluation and treatment, which is regularly reviewed. Input from internal teams, third parties and the parent companies can be used at each stage and the results of the risk management approach are used by the ROAD management board in its communication with the parent companies of the ROAD project in order to get a positive Final Investment Decision ('FID').

3.2 Objectives

The specific objectives of the ROAD's risk management approach are the following:

- identification and tracking over time of the top 10 risks;
- organizational procedure to ensure all major risks are covered;
- methodology to rank the risks and define the level of "acceptance" for a given risk;
- methodology to keep an overview of all risks;
- satisfying both parent companies risk management standards;
- ensure that the risks are addressed in each discipline;
- ensure that the risks related to the interfaces are addressed;
- ensure each risk is managed by (at least) one person; and
- track the risk matrix over time, as an input for knowledge build-up.

3.3 Implementation in project organization

3.3.1 Risk review

First of all, it was necessary for the project to identify all the internal and external resources that would give an input to identify the risks. This means that one person per ROAD department received the responsibility to collect all the risks in his/her own domain (Capture, Transport and Storage, Stakeholder Management, Project Office & Governance), helped by the other experts of their department.

Of course, in order to ensure that all the risks were identified, it was necessary to create bridges between the 4 ROAD departments, especially regarding the interfaces and the link between technical, financial and regulatory aspects.

This has been done via the organization of internal risk workshops, per theme (capture, transport, storage, interfaces, commercial agreements T&S, regulatory framework, funding, permitting and reputation) and with the participation of experts from the different

departments. In order to have an external view on the project and to put experts together, third parties were also invited to contribute to the risk review and evaluation, e.g.:

- safety risks indicated by e.g. Tebodin, Marin, Royal Haskoning;
- environmental risks, indicated by Royal Haskoning; and
- workshop with TNO ($CATO_2$ framework).

Since the outcome of these risk workshops were mainly treated as business risks, refer to ROAD's special report on handling and allocation of business risks in CCS demonstration projects for the qualitative analysis of these risks.

3.3.2 Determine the risk exposure

Based on the methodologies used by the parent companies, each risk is evaluated in terms of likelihood and financial impact, the combination of both aspects giving the project risk exposure. If the risk exposure is higher than the acceptable level (determined according to the methodologies of the parent companies), this means that a mitigating action has to be taken to bring the project risk exposure below the acceptable level.

In this phase of the project ROAD focused on the financial impact of the risks (also when the undesired occurrence would be reputational, environmental or safety related).

3.3.3 Select the risk owner

In order to ensure that all risks with an excessive risk exposure are being treated, the mitigation of each risk is the responsibility of one person, namely the risk owner.

3.3.4 Risk Treatment

Once the risk is being identified as non-acceptable, a multidisciplinary team (eventually assisted by third parties and/or parent companies) lead by the risk owner identifies the possible counter measures:

- Is it possible to remove the risk?
- Determine and implement counter measures (technical, financial, process, policy).
- Determine and implement action plans.
- Evaluation and identification of new risks.

The five figures below show the layout of the risk register used by ROAD.

1	2	3	4	5	6	7	8
ROAD_Risk Register							
Risk ID	Communication level (C/N/P)	Risk Description (Cause)	Consequences (Effect)	Risk Status	WP_NO	WP_Sub_No	WP_Name

Figure 3: ROAD's risk register classification: ID, Communication level, description, effect, status, project department number, budget group, department

9	10	11	12	13	14	15	16
Financial Impact Inherent Amount (* 1000)	Financial Impact Residual Amount (* 1000)	Financial Impact Inherent score	Financial Impact Residual score	Reputational Impact Inherent score	Reputational Impact Residual score	Environmental Impact Inherent score	Environmental Impact Residual score

Figure 4.1: ROAD's risk register classification: financial impact, reputational impact, environmental impact, safety impact and likelihood before and after corrective measure, exposure levels

17	18	19	20	21	22	23	24
Safety Impact Inherent score	Safety Impact Residual score	Likelihood Inherent Score	Likelihood Residual Score	Financial - Risk Exposure	Reputational - Risk Exposure	Environmental - Risk Exposure	Safety - Risk Exposure

Figure 4.2: ROAD's risk register classification: financial impact, reputational impact, environmental impact, safety impact and likelihood before and after corrective measure, exposure levels

25	26	27	28	29	30	31
Design (Quality)	Performance	CAPEX	OPEX	Time Schedule	Permitting	Regulations/ Legal

Figure 5: ROAD's risk register classification: several types of impact related to the specific risk

32	33	34	35	36	37	38
Counter Measures Risk Response Planning	Approval by/ Report to.	Action Owner	Action Start date	Action End date	Action Urgency	Comments/Notes

Figure 6: ROAD's risk register classification: possible counter measures, responsible, action owner, action begin- and end date, urgency, comments (e.g. rationale for the choice of the counter measure)

3.3.5 Action plan monitoring

Once the counter measures are defined and put in an action plan for implementation (what, who, when, costs), it is of prime importance to carefully monitor the action plan:

- periodic evaluation of action plans as an input for project management; and
- implemented in the top risks presentation to the project management and parent companies.

ROAD CCS	***Permitting (Example)***	***Creation Date***	dd/mm/yy
		Last Revision	dd/mm/yy
		Approval Date	dd/mm/yy

	Horizon	*Owner	
	Recurrent		

* Mandatory

									Financial Impact	
Risk assessment (average scenario)										
2010	***Financial impact***		***Non-financial impact***		***Likelihood***		**Severity**		***Control Level*** **(9)**	***Exposure level*** **(10) = (8)*(9)**
	Valeur / *(Value)* (1)	Score (2)	Nature (3)	Score (4)	in % (5)	Score (6)	*Expected Loss* (7) = (1)*(5)	Score (8) = max[(2);(4)] + (5)		
Inhérent						**0,0**	0			**0**
***Residual**						**0,0**	0			**0**
***Target residual**						**0**	0			**0**
	Valuation	Rating	Reputation Humain or other	Rating	*Valuation*	Rating	I(EUR)*P(%)	Score P+max(I)	*Levels* 1 - *Green* 2 - *Yellow* 3 - *Red*	Score *Severity** *Control*
	KEUR	*0 to 5*		*0 to 5*	0% to 100%	*0 to 5*	KEUR	0 to 10		0 to 30

Figure 5: ROAD's action plan layout (1)

SUMMARY OF THE RISK

A - IDENTIFICATION

***Description of the risk*:**

***Scope*:**

***Risk exposure indicators*:**

***Action plan 2010**

Title of the action	Description	*Deadline*	*Manager*	*Comments*
<Action 1>		<dd/mm/yy>		
<Action 2>		<dd/mm/yy>		
<Action 3>		<dd/mm/yy>		

Figure 6: ROAD's action plan layout (2)

3.3.6 Update risk cycle

An important step is to periodically update the risk register, including an identification of possible new risks. The reflection about the evolution of the risk can also give the necessary input to evaluate the project:

- implement a decision matrix in the risk register;
- evaluate expectation vs. actual outcome;
- monthly/quarterly report to the parent companies; and
- reports to third parties (European Commission, Dutch Government, the Institute, etc.).

The risk register was updated on a monthly basis with the management board of ROAD. Prior to these sessions each department's top risks were discussed during the separate team sessions in which mitigating actions were developed and evaluated. The risk sessions with the management board were internally facilitated by the risk officer. In the draft monthly reports to the parent companies feedback on the risk management was requested. To ensure 'bridging' across functional areas fixed two-weekly meetings were planned between the core teams of Capture and Transport & Storage. Minutes were made during these meetings so decisions taken could be sent to the interested/ necessary parties and were also discussed during management board meetings.

During the monthly updates of the project top risks a lack of offshore risk experience was noted. A specialized third party was hired to support ROAD in the build up of a professional risk management process. This was done around August 2011 and therefore this process will be described in ROAD's special report on handling and allocation of business risks in CCS demonstration projects.

4. Summary of risks, mitigating actions and residual risk

The following sections summarize the ROAD project top risks, as for September 2011. The build-up of each section is the following:

- Project risk description and possible consequence.
- Description and rationale of the corresponding mitigating actions to reduce/remove the associated risk. Note that not all the mitigating actions are yet in place.
- Description of the residual risk, still to be taken into account by the ROAD project

Note that a main part of the (short term) top risks are considered as such because of the uncertainties that will remain at the date of the Final Investment Decision (FID), which is expected in Q4 2011. If the FID date would have been later, some of the risks would have disappeared, highlighting the time dependence of the identification and evaluation of the risks. In any case, the reader must be aware that the summary given below is only valid at the time of redaction of this report, namely September 2011.

Some previous risks are not mentioned as they have been already handled or removed at the date of the redaction of this report.

The risks that are not considered top risks will be discussed in ROAD's special report on handling and allocation of business risks in CCS demonstration projects.

4.1 Capture

4.1.1 CAPEX evaluation

The risk related to the CAPEX is that the actual CAPEX outcome will not be the same as the previously forecasted CAPEX, which could lead to:

- Unacceptable high CAPEX if overestimated – risk of project stop at FID
- Unforeseen costs if underestimated – financial risk during project execution

For the CAPEX risks of Capture three main costs were taken into account. These are:

- Capture plant (EPC contract with the supplier)

As no FID was taken in November 2010, the EPC contract could not be signed before the end of 2010, leading to the need to renegotiate parts of the contract (the selection process for a capture plant supplier is described in ROAD's special report on CO_2 capture technology selection methodology) which could not be fixed and to a reimbursable contract due to the delay. The overall scope of the contract was clear and can still be applied for the final contract. Further clarification meetings were held with the selected (but also with the non-selected) supplier. Negotiations were also performed and will continue until end of this year, in order to update the final EPC contract and making it ready for signature by the end of 2011.

- Interfaces with MPP3

Accuracy of the scope of works included in the technical scope for the interfaces with MPP3.

- Construction

Accuracy of the estimates on the number of construction workers.

Mitigating actions

Capture:

- Value engineering. As FID will expectedly be taken in Q4 2011, a value engineering phase, in between the FEED and the detail engineering phase, was added. The aim of this value engineering is to optimize the design further, to minimize capital and operational expenditure and to adjust to previously unknown permitting requirements if necessary. The value engineering phase lead to 11 ideas to optimize the design and to reduce the

expenditures, which did not have an significant impact on the overall design and equipment and therefore also no impact on the permitting and consenting documents.

- Start of detail engineering phase incl. HAZOP – August 2011
- Defining compressor specifications based on the transport and storage flow assurance study – September 2011
- Updating technical specifications (employer's requirement) due to value engineering workshop and FEED study phase – Q3 2011
- Clarification and negotiation final bid – Q4 2011. In February 2011 a reimbursable contract has been signed with the chosen supplier, which will be valid until FID is taken. After that the EPC contract will be signed.

Interfaces:

- Preparation of tie-ins report reports with MPP3 such as flue gas and steam. Those reports were drafted between August and December 2011.
- Long lead items (like the compressor) can be ordered after FID has been taken. Only some tie-in decisions need to be taken in Q4 2011 before FID is taken in order to fit with the planning of MPP3. For these a tie-in report is prepared.

Overall:

- Land lease agreement – 2011
- Monitoring plan – Q3 2011
- Insurance – Q4 2011

Residual risk

Capture:

- The residual risk for the ROAD project is the higher costs after final negotiation for the FID bid expected in Q4 2011. The project scope has not changed and the risk will be reduced once the EPC contract is signed.

Interfaces:

- Scope of work, man hours and tariffs were defined on budget estimates per tie-in, except for the flue gas tie-in. Out of scope work and increasing market prices could potentially be a financial risk for theproject. But these are not expected to be significant.

4.1.2 OPEX evaluation

The risk related to the OPEX is that the actual OPEX outcome will not be the same as the previous forecasted OPEX, which could lead to:

- Unacceptable OPEX costs if overestimated – risk of project stop at FID
- Unforeseen additional costs if underestimated – financial risk during operational phase

When evaluating the OPEX, the challenges are linked to the capture plant performance, electricity and CO_2 price volatility and maintenance costs.

- Performance: ROAD will build a new CO_2 capture plant with technology that has not been operated on such a large scale. High OPEX costs are created on the steam consumption and electricity usage during operation. Also the solvent consumption could vary. These bandwidths are guaranteed by the supplier, but could need adjustments during the first year of operation to have the most efficient effect.
- Price volatility: for the operational period certain electricity and CO_2 prices were assumed. When the electricity price is outside of the assumed bandwidth these operational costs would vary accordingly.
- Maintenance: the assumption was made that a new capture plant that only has to run for a 5-year period would not need a lot of maintenance. But when an important spare part is needed, consequence could be that operation is stopped for months. Impact would be the loss of funding, in addition of the costs of the maintenance itself.

Mitigating actions

- Performance: a performance study on the modeling of the capture plant has been launched, in collaboration with experts of the parent companies. Goal was to model the design deliverance and compare these with the supplier guarantees – Q3 2011.
- Reliability: a reliability study was done on the capture design to check the availability of the capture plant – Q3 2011.
- Price volatility: 2 studies were performed (ECN and KEMA) to investigate the running regime (running hours and load profile) of MPP3 and the forward prices for electricity and CO_2 for the years 2015-2020. The prices for peak/off peak were taken into account and the bandwidths will be discussed with the parent companies and incorporated into the budget.
- Maintenance: all equipment considered as critical is covered by a spare part.

Residual risk

- Performance: lower availability of the capture plant. This has been taken into account in the business case. In the first year ROAD assumed a low availability that will slightly go up in the second year with a high availability in the last three years resulting in an average availability of 90%. This will give the supplier time for adjustments during the first year of operation.
- Price volatility: did not change. To predict the market after a 3 year forward period is very difficult. ROAD takes into account the prices made available in the 2 studies.
- Maintenance: failure of equipment not covered by a spare part is unlikely.

4.2 Transport & Storage

4.2.1 Commercial negotiations

The risks related to the commercial negotiations are both an unacceptable delay and/or a too high CAPEX that would stop the project.

The storage concept is not yet finalized as results of studies are still expected. The commercial negotiations with TAQA are not completely finalized yet, due to regulatory uncertainties and complexity of the site including ownership. A delay in contract finalization could mean a time delay of the project, resulting in higher CAPEX and possible loss of funding.

Mitigating actions

- Commercial arrangements with TAQA are being finalized, on different levels with the partners. The aim is to finalize commercial arrangements with TAQA in Q4 2011.
- Alternative transport and/or storage fallback options have and are being reviewed since all the commercial arrangements for transport and/or storage are not definitve yet.

Residual risk

- Extra CAPEX and OPEX costs for the alternative storage solution.
- Timeline issues for the alternative project planning, which means potential funding or long lead items issues.

4.2.2 CAPEX evaluation

The risk related to the CAPEX is that the actual CAPEX outcome will not be the same as the previously forecasted CAPEX, resulting in:

- Unacceptable high CAPEX if overestimated – risk of project stop at FID
- Unforeseen high additional costs if underestimated – financial risk at execution phase

Materials and construction works cannot be contracted before the FID. The risks are the uncertainty to determine the actual prices/ costs for the T&S scope at this moment. Also, the results of the important studies currently performed are to be expected around or after the FID. The following risks (which have higher project costs as an impact) are taken into account:

- uncertainty on the prices of the materials;
- uncertainty on the scope of the project work;
- change in project scope due to feasibility to inject and store CO_2;
- other route for the pipeline;
- the planned horizontal directional drilling (HDD) plan is not sufficient and more engineering is needed; and
- uncertainty on the pipeline flow (two phase dense flow, more water than expected in the pipeline, etc.).

Mitigating actions

- Procurement philosophy for the materials that have to be ordered. The price of current (forward) proposals and the timeline will be incorporated.
- Concept select study (starting at the intake of the compressor till the reservoir bottom) to select the most optimal CO_2 transport, injection and storage concept. Also taking into account a minimal energy demand required and physical requirements, like the size of the platform.
- Route survey (offshore finished, onshore almost) for the route of the pipeline. Taking into account all constraints regarding harbor and shipping lane crossing.
- The flow assurance study will define the detailed specifications of the compressor and pipeline (insulation type, etc.).
- Proposal of material purchase options to base FID on actual offers.
- In addition to the technical work performed the commercial framework for the pipeline has been thoroughly discussed. The main contracts that have been discussed are:
    - Construction agreement (2011): subcontracting the engineering, procurement, construction and commissioning of the pipeline;
    - Operating and services agreement: arranging the operating and maintenance of the pipeline; and
    - Transportation agreement: the commercial arrangement for the actual transport of CO_2
- For storage a monitoring plan provides information where the injected CO_2 is finally stored. The goals of the monitoring plan for P18 are:
    - prove the top seal integrity;
    - calibration of flow simulations; and
    - model the effects of CO_2 injection, the mitigation pathways, the effects on cap rock and faults. Therefore a 3D geological model has been built. The model has been historicallyy matched with the gas production data available
- Cap rock and fault integrity study is to evaluate the impact of induced stress changes, resulting from past gas production and future CO_2 injections, on top seals and faults.

Residual risk

Because of the phase the studies are in, there is now a 25% contingency on the budget. The flow assurance study will generate phase 1 results around September 2011. The contingency will then

be lower than the current 25%. Around November 2011 the phase 2 results are expected from the flow assurance study. Contingency is expected to be 10-15% because of the detailed engineering performed. FID is expected after the phase 2 of the flow assurance study. The procurement phase is expected from Q1 2012.

4.2.3 OPEX evaluation

The risk related to the OPEX could result in:

- Unacceptable high OPEX if overestimated – risk of project stop at FID
- Unforeseen additional costs if underestimated – financial risk during the operational phase

The regulatory uncertainties (regarding implementation of the European CCS directive) cause uncertainties on storage costs (e.g. monitoring costs) and long term liabilities, which could potentially become unacceptably high. Both the base case and all potential alternatives face these uncertainties. A consequence of the regulatory uncertainties could be a higher amount (for monitoring) per ton CO_2. Since the ROAD project aims to capture (at least) 4 million tons the potential cost increase could be very high.

Mitigating actions

- ROAD monitors the regulatory process and offers support to the civil servants of the Ministry, for example by actively participating in the stakeholders meetings.
- ROAD is closely involved in the application process for the storage permit, addresses the key issues and finds solutions for these issues. Transfer of responsibility to the competent authority and financial mechanisms for certainty.
- Commercial framework has been discussed (not yet signed) with the operator. The commercial framework consists of three contracts:
    - Project Development Agreement – Q4 2011
    - Transporting, Processing, Operating and Services Agreement – Q4 2011
    - Storage Service Agreement – Q4 2011
    - Fixed contracts both for transport and storage – Q4 2011

Residual risk

- Regulatory uncertainties still exist. ROAD expects to have more clarity on monitoring costs and liabilities around Q3 2011. There is still a possible high impact on the project costs.
- Commercial framework proposals are to be reviewed. Residual risks are still there until proposals are signed by both parties.

4.3 Interfaces

The risk related to the interfaces regards the timing and costs, which could result in:

- A delay in the connections between ROAD and MPP3, putting at risk the funding and the project economics
- If the costs are not correctly estimated, it could result in unforeseen additional costs

In addition to the risk independently related to the capture, transport and storage, there is still a risk related to the whole chain of capture, transport and storage of CO_2. One major risk would be if the project is not operational as of 2015. This could be due to interfaces between capture, transport and storage or because of the interfaces between the capture unit and MPP3 plant of E.ON.

Mitigating actions

- The flow assurance study will define the detailed specifications of the compressor (interface capture and transport) and the pipeline study (insulation type, etc.) is monitored by both the transport team as the capture team.
- Formal Interface meetings between the T&S team and the Capture team with written Minutes of Meetings ('MoM'). With these MoM's the decisions made for the interfaces between the departments are archived and responsible action owners (mainly from capture team) defined. During the project board meetings these decisions are discussed and approved.

Residual risk

- Because of the project specific characteristics (CO_2 capture plant on a large scale, specific compressor, and heater needed on the platform) there is always a likelihood that operational delay occurs at the start of the project. Residual risk is that the CO_2 storage will be delayed and the ROAD project cannot store the required 4 million tons of CO_2.

4.4 Project timeline

The original project planning had a 6 months buffer, but due to a delayed FID, procurement and construction is delayed and no buffer is left. If the CAPEX period is delayed and substantial costs have to be made after 1 January 2015 these costs might not be eligible. Impact is a cost increase for the parent companies and loss of Dutch funding when ROAD does not store the required amount of CO_2 before 1 January 2020.

Mitigating actions

- Formal planning manager has been selected who will monitor the critical path of the project - 2010
- Procurement time buffer for the long lead items – Q1 2011
- FID end 2011 at the latest

Residual risk

- An assumption is that the ROAD project will have a delay of 3-6 months (commissioning period after 1 January 2015) in which the costs are not eligible.

4.5 Funding

As explained in the previous chapter, project delays could have a significant impact on the funding, like a partial or total loss of it, inducing unacceptable costs for the project.

In July 2009, Maasvlakte CCS Project C.V. (MCP) submitted its European Energy Program for Recovery ("EEPR") Grant Application for the ROAD project. The project plan foresaw an ambitious timeline as it aimed for significant early expenditures and commitments. The main focus therefore was to develop the project in 2009 and 2010 to such an extent that an FID could be taken by the end of 2010. After this FID, still in 2010, it would then be possible to commit to an Engineering, Procurement and Construction ("EPC") contract for the capture plant and to commit to laying the envisaged pipeline. Nevertheless, there was a delay of the FID to Q4 2011.

The risks related to the funding are hence as follows:

- The delay of the FID to Q4 2011 has as effect that expenditures and commitments are delayed as well. Impact could be the loss of total or partial funding from the EEPR and the Dutch funding.
- Some project costs non-eligible because not respecting the best value for money principle (EU Grants standard).
- Failure to report on other strict requirements to the European Commission which could lead to non-eligibility of costs.

Mitigating actions

- Hand in the new work plan and budget - Q1 2011
- Ensuring EEPR Grant Agreement and Dutch Ministerial Order for funding the ROAD Project are agreed upon, finalized and signed - Q2 2010
- Set up the formal procedure for best value for money. A decision matrix should be made for (contract) expenditures above € 60 thousand - Q1 2011
- Setting up the (financial) administration and reporting processes – Q1 2011

Residual risk

Assumptions are:

- New work plan accepted
- (Original) budget expenditures as agreed with the EC and Dutch government are made before 1 January 2015
- Amount of non-eligible costs according to the best value for money principle until the FID decision is known

4.6 Permitting

For the permitting process please refer to ROAD's special report on the permitting process.

The main risks related to permitting are the following:

- The relevant permitting regime has undergone a number of changes in 2009 (State Coordination Scheme) and 2010 (Act for the Environmental Impact Assessment; WABO). These changes caused a lack of clarity about the process that should be followed and the identity of the relevant competent authorities, for both ROAD and the authorities, and the need to restart some activities, resulting in delays.
- The environmental consent application for the capture plant received only few comments from the Environmental Protection Agency of Rotterdam area. ROAD could facilitate these comments. The only discussion point that emerged was how to measure the air emission from the stack: should the emissions from the capture plant be treated differently from the emissions from MPP3, or should they be treated as one mixed stream? From the discussion in May it emerged that the first approach could and should be chosen.

Mitigating actions

- Submission of additional studies underpinning the application for a permit under the Nature Protection Act for Capture
- Additional study on potential archeological obstacles in the pipeline trajectory
- Discussing the final draft EIA and permit applications with the authorities and the Commission for Environmental Impact Assessments
- Submitting the storage plan for the P18-4 storage permit and the State Zoning Plan (D5.3)
- A strong working relationship with the authorities has been established in Q3/Q4 2010 and even grew stronger under the time pressure. ROAD also submitted information collected during the permitting process to the Ministry of Economic Affairs, Agriculture and Innovation, responsible for the zoning plan that concerns the pipeline.

Residual risk

- Uncertainty on the permit status when FID has to be taken by the parent companies
- If permitting process is delayed (by ROAD, authorities etc.) this could have a significant impact on the overall project delay
- Further calculations with regard to the indirect cost effects have to be made in case of a time delay on the critical path.

Acronyms and Citations

Acronyms

CAPEX	Capital Expenditure
EEPR	European Energy Programme for Recovery
EIA	Environmental Impact Assessment
EPC	Engineering, Procurement and Construction
EC	European Commission
FEED	Front End Engineering Design
FID	Final Investment Decision
HSE	Health, Safety and Environment
Institute	Global Carbon Capture and Storage Institute
MCP	Maasvlakte CCS Project C.V.
MPP3	Maasvlakte Power Plant unit 3 (E.ON)
OPEX	Operational Expenditure
ROAD	Rotterdam Opslag en Afvang Demonstratie