CATO-2 Implementation Plan CCS
(Work Plan PECSNL082917)

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1 Executive Summary / Introduction to the Implementation Plan

Background

The Dutch government considered Carbon dioxide Capture and Storage (CCS) as third option in their climate policy, after the implementation of energy saving measures and renewable energy. The programme 'Clean and Efficient: new energy for climate policy (VROM, 2007), states that the Dutch government will make financial resources available as 2010 for further development of CCS and that they will decide on funding large scale CCS demonstration projects.
With the start of the new Dutch parliament in September 2010 adjustments were made in the energy policy. The coalition agreements link the development of CCS to nuclear energy. It states that CCS will not start in the Netherlands before the first nuclear power plant has been permitted[1]. Explanation by the government made clear that this restriction applies only to commercial CCS projects and it does not affect (the planned) demonstration projects. The coalition text also mentions local public support as an important precondition for developing CCS projects. As a consequence, the Barendecht project has been cancelled. In the "Barendrecht project" Shell intended to store 200 kt CO_2 per year in two small empty natural gas fields for ten years. The CO_2 would come from their Pernis Oil refinery complex in Rotterdam. The project received 30 million euro financial support from the government. The project has been cancelled by the government, because of the delay in the project and the lack of local public support.

Demonstration projects will be essential in gaining further practical experience in the period between 2015 and 2020. If broad deployment of CCS after this period is required, learning from the demonstration projects is essential. In the demonstration phase, learning on technical, organisational, financial and legal aspects of CCS and getting the CCS chain up and running will be more important than achieving large CO_2 reductions (Mt CO_2). The commercial acceleration will have to take place in a subsequent phase, which will make use of the experiences gained. During the demonstration phase several small-scale pilots and a maximum of two large-scale demonstration projects will be implemented. The corresponding annual amount of CO_2 that will be captured, transported and stored can be up to 5 Mt CO_2. When CCS is implemented on a large scale during the commercial phase the annual amount of CO_2 that has to be dealt with might increase to 40 Mt CO_2 (ECN, 2007). The capture, transport and storage of these volumes of CO_2 require a proper strategy to implement CCS in a safe and efficient way.

[1] Gedoogakkoord VVD-PVV-CDA, 30 September 2010.

So far, the Dutch government has taken several steps towards a large-scale roll out of CCS in the Netherlands. Among the steps that have already been taken are funding of the Dutch CATO-1 and CATO-2 programmes, subsidising small scale capture projects and co-funding of a large scale demonstration project at the Maasvlakte (ROAD[2]-project)[3]. Furthermore, the Dutch government has indicated the need to decide on a long term strategy to organize transport and storage of CO_2 in the Netherlands (EZ/VROM, 2009). The EBN-Gasunie study 'CO_2 transport- en opslagstrategie' (EBN/Gasunie, 2010) provides building blocks for such long term strategy. The EBN/Gasunie report provides advice on the most optimal strategy to use Dutch gas and oil fields for CO_2 storage, the realisation of a cost-effective transport and storage infrastructure and the role of the Dutch government in managing these developments.

At the international level, several organizations have also worked on identifying and assessing steps necessary for the deployment of CCS (e.g., IEA, CSLF, US Interagency Task Force on CCS). The steps already identified at the national and international level will be a starting point for the Implementation Plan (IP) that is to be developed in CATO-2.

Goal and scope of the Implementation Plan

Currently, there one small scale pilot for CO_2 storage: in the offshore gas field K12-B Enhanced Gas Recovery is tested. Several other pilots for CO_2 capture and demonstration projects are planned or under construction. The government and involved parties work on creating the right conditions to get these and future projects implemented. Implementing CCS on a large scale is different from implementing a number of individual pilot and demonstration projects. Large scale implementation asks for different ways of regulating, organizing and financing CCS. Timing of decisions on these aspects will be crucial to get CCS successfully and efficiently implemented on a large scale after the demonstration phase. If CCS is to make a significant contribution to reducing CO_2 emissions in time the right conditions should be in place.

This Implementation Plan (IP) supports the Dutch government and other stakeholders in defining their roles and responsibilities in shaping the right conditions for the implementation of CCS in the Netherlands. Currently, there is no common understanding if and to what extent CCS should be part of the portfolio of greenhouse gas mitigation strategies. Some stakeholders see CCS as an intermediate and necessary strategy to reduce CO_2 emissions on the short and medium term to achieve our climate policy targets. Others see CCS as an excuse that facilitate the continued use of fossil fuels and should therefore not be implemented. At this point in time it is not clear what

[2] Rotterdam Opslag en Afvang Demonstratie
[3] Originally two small-scale CO_2 storage demonstration projects (30 million euro subsidy each) and three small scale capture project s (10 million euro subsidy each) were awarded by the government. Only one capture pilot is currently under construction, others were cancelled either by the government or by the operator.

long term future CCS will have in the Netherlands and it is therefore difficult to be prepared well for this uncertain future. This IP helps to explore different futures and corresponding strategies for CCS in the Netherlands.

The IP helps to create a common understanding between the different parties on who should act, how to act and when to act. The primary objective of the IP is to support the Dutch government and other stakeholders in getting prepared for implementation of CCS. It is of utmost important that developments will not come to a halt after the demonstration phase (after 2020) at the moment it is decided that large scale implementation of CCS is required in the Netherlands. A common understanding between the different parties involved of the needed actions and approach is essential.

The IP focuses on CCS in the Netherlands. However, it takes also developments outside the Netherlands into account, especially those in the European context, when they directly have impact on developments in the Netherlands. The IP is based on the views and visions of relevant stakeholders in CATO-2, but also outside CATO-2.

Results

The Implementation Plan (IP) for CCS is the result of a four year process (from 2010 to 2013). The main product that the IP delivers is a CCS roadmap for the Netherlands that concludes on the milestones, required actions and the timing of these actions to achieve the roadmap's 2050 vision on CCS. The roadmap includes the roles and responsibilities of the different stakeholders.
The IP covers the full period from now until the year 2050. If there is to be a large-scale roll out of CCS after the demonstration phase, the actions formulated as part of the roadmap will be concentrated in the period 2015 to 2030.
Secondly, the IP provides a discussion platform for all stakeholders. During the five year process several moments are build in where input and opinion of stakeholders are asked for. The aim is to create a common understanding of CCS roadmap.

2 Approach to the Implementation Plan

Introduction

The activities to build the IP for CCS in the Netherlands comprises four tasks:

- **Task 1: Exploration of CCS visions**. What is the ideal image or the desired outlook for CCS, i.e. visions on the future (2050) of CCS? What are intermediate goals (2020, 2030, 2040)
- **Task 2: Analysis of CCS development paths.** What is today's situation? What are scenarios outcomes?
- **Task 3: Gap analysis.** What is the gap from ideal – described by task 1 on visions and scenario outcomes (task 2)?
- **Task 4: Roadmap development.** What specific actions must be taken to close the gap between today's situation, the anticipated situation in a certain development path (defined by scenario) and the ideal state (defined by a vision)? What resources are required to execute the activities?

Building the IP

Throughout this work plan for the Implementation Plan we use a number of terms that should be explained first. The key terms used in this work plan are vision(s), intermediate vision sketches, policy targets, current status, reference scenario, milestones, bottlenecks and (policy) actions. These are presented in Figure 2-1. In addition to this figure, Table 2-1 gives definitions for each individual term and a short explanation of its use in the IP.

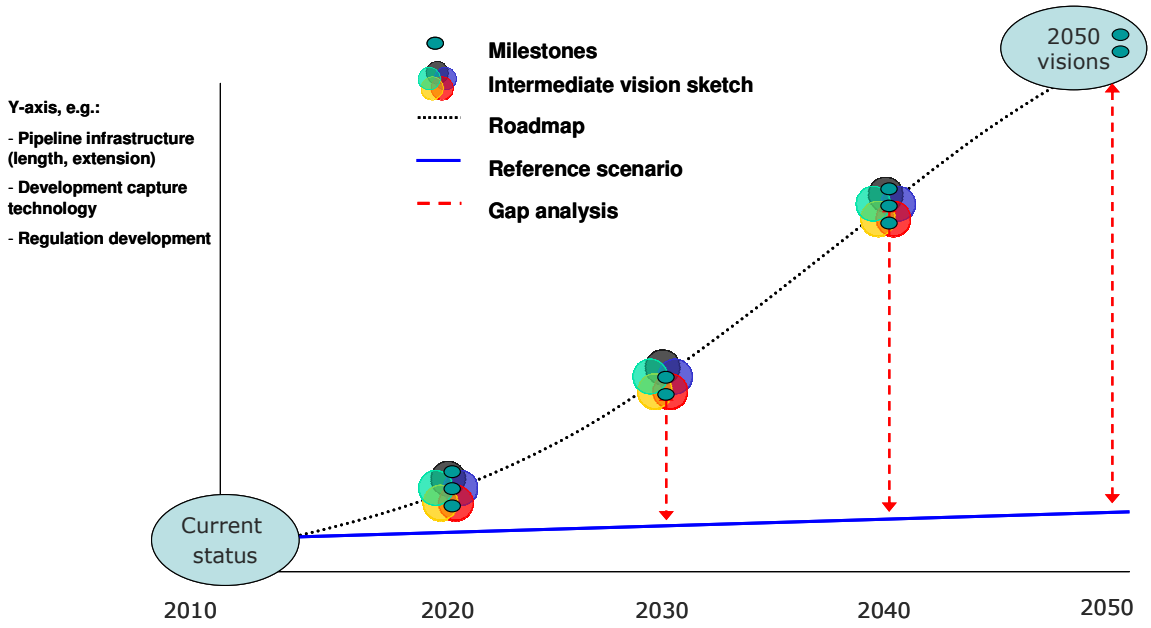


Figure 2-1 Methodology to construct the implementation plan for CCS

In Task 1 Exploration of CCS futures several **visions** for CCS are formulated. A vision is the imaginary picture of the future state of affairs that one aims to achieve at a given point in time. These visions will sketch preferable futures for the Netherlands with a focus on CCS. In principle, no constraints are set when formulating a vision. Examples of elements in such vision are that the Netherlands serves as CO_2 hub for North-West Europe by 2050 or that CO_2 will be stored in offshore storage fields only. In the IP several visions will be defined to explore different futures for CCS in the Netherlands. As a starting position, the project team will provide six visions. Once the six visions have been defined, one vision or one main vision with some elements of other visions will be selected as most desirable vision for CCS in the Netherlands. This selection will be done together with the stakeholders. For the resulting vision or combination of visions a roadmap will be developed.

The years between today and 2050 should be described as well, since it provides the storyline for reaching the vision(s). We will describe how the implementation of CCS in the Netherlands looks like in the years 2010, 2020, 2030 and 2040 in the case such vision needs to be materialised. We call the year 2010 **current status** and the years 2020, 2030 and 2040 **intermediate vision years**.

In Task 2 a **reference scenario** is built. This reference scenario is a business-as-usual scenario and includes all CCS developments that are currently underway. Figure 2-1 shows that the use of the reference scenario is to define the gap between the reference scenario and the vision and

consequently to indicate the efforts required to bridge de gap between the two. Getting insight in the gap between the scenario outcomes and the intermediate years of the vision will help to assess the effort required and resources that should be allocated to CCS to reach the intermediate vision sketches and, in the end, the vision(s).

In Task 3 we continue with a gap analysis. This task consists of three steps. First, the gap between the reference scenario and the vision is identified. A next step is to analyse this gap and define **milestones**, which are intermediate targets that should be achieved in order to able to achieve the vision(s). The last step is to find the **bottlenecks** to be encountered when trying to close the gap.

The final Task 4 is the roadmap development. In the previous task, the gap between the vision (and situation sketches) and the reference scenario is identified and bottlenecks analysed. In this task, concrete **(policy) actions** that address the bottlenecks are defined. These (policy) actions should close the gap and allow the vision to become reality. The time window for these policy actions is 2015- 2030.

Table 2-1 Key elements of the CCS implementation plan

Implementation Plan element	**Definition**	**Why is it important?**
Vision	Statement that briefly describes the desired situation of the system in 2050	Provides an agreed (and challenging) outlook to achieve
Policy targets	Key national and European climate policy goals. CCS implementation is needed to achieve these goals.	Set targets for the midterm period and boundaries to the vision that will be developed
Current status	Description of present situation on six defined dimensions to assess CCS: technological development, regulations, public engagement, economics, spatial planning and organization	Provides a starting point for the roadmap
Intermediate vision sketches	Description of the status of CCS according to the six dimensions in a certain year.	Defining intermediate situations for the 2020, 2030 and 2040, and supports the formulation of milestones and actions
Reference scenario	Possible developments of the system under study based on the current situation and (assumed) trends	Gives quantitative insight in the business-as-usual developments up to 2050
Milestones	A scheduled event/goal or target that should have been achieved at a specific moment in time. They are used to validate progress towards reaching the	Checkpoints to guide the development process towards the vision

Implementation Plan element	Definition	Why is it important?
	intermediate vision sketches and the 2050 vision.	
(Policy) actions	Formulation of actions and priorities for policy makers and other stakeholders	Provides the steps towards reaching the 2050 and identifies different roles and tasks of the stakeholders

3 Methodology

Task 1: Exploration of CCS futures

The aim of this task is to explore, define and select future visions on the implementation of CCS in the Netherlands in 2050.

3.1 Step 1: Define 2050 visions

In this first step we develop - together with stakeholders – vision(s) on possible futures for CCS in the Netherlands. At this point, 6 "draft" visions will be defined to comprise a wide range of CCS futures for the Netherlands. The visions defined can be anything between very ambitious and very passive with respect to deployment of CCS. Each vision will have its own set of characteristics that will distinguish it from others.
In an ideal situation, there is one vision that is shared among the stakeholders with one roadmap towards it. However, stakeholders in the CCS field may have very different views on the future of CCS and full consensus on one vision may not be achievable. In that case, the roadmap will include more than one vision.

Visions

Visions can be used to describe an ideal image or the desired end-state of development. A vision can be seen as an image of how a country, society, industry, etc. could be in the future and to plan how this vision could become a reality in a suitable way[1]. Constructing a vision becomes particularly important in multi-stakeholder efforts in which the different partners may have radically different ideas of what should be accomplished.

From more general definitions on visions we derive that a 2050 vision for CCS should comply to following conditions:

- it summarizes the purpose and intent of CCS;
- it describes on a high level what the energy system would look like when it includes CCS;
- it reflects a balanced view that will satisfy the needs of diverse stakeholders that have to adopt the technology as well as those of the developing/facilitating organizations; and
- may be somewhat idealistic, but should be grounded in the realities of existing or anticipated customer markets, enterprise architectures, organizational strategic directions, and cost and resource limitations[1].

The project team will define six visions on CCS in the Netherlands. By means of two brainstorms with the project team the elements that a vision should consist of have been defined. Table 3-1 presents the elements of a vision for CCS (left column) and the options (gradation) of the

elements (columns towards right end of the table). These elements and options are combined to create six different visions for CCS in the Netherlands. In a next step, the visions are worked out in more detail using the various options for each element.

Table 3-1 Options that can be used to construct a coherent vision (from each element one option will be selected per vision)

Elements of a vision	**Options of the element**				
The geographical scope of the CCS infrastructure in 2050	Netherlands alone – no neighbouring countries developing CCS on a large scale	Limited Import and Export of CO_2	European CCS network		
Type of CO_2 sources to which CCS is applied	Small pure sources	Large pure sources	Small sources with relative low concentration CO_2 in stack gases	Large sources with relative low concentration CO_2 in stack gases	
Status of CCS as a transition technology	Early	Middle	Late	CCS is not transition technology	
Netherlands as a country is a leader or follower regarding technological RD&D.	Leading on CCS technology	Leading on CO_2 capture technology	Leading on CO_2 transport technology	Leading on CO_2 storage technology	Following nation CCS technology

Output step 1:

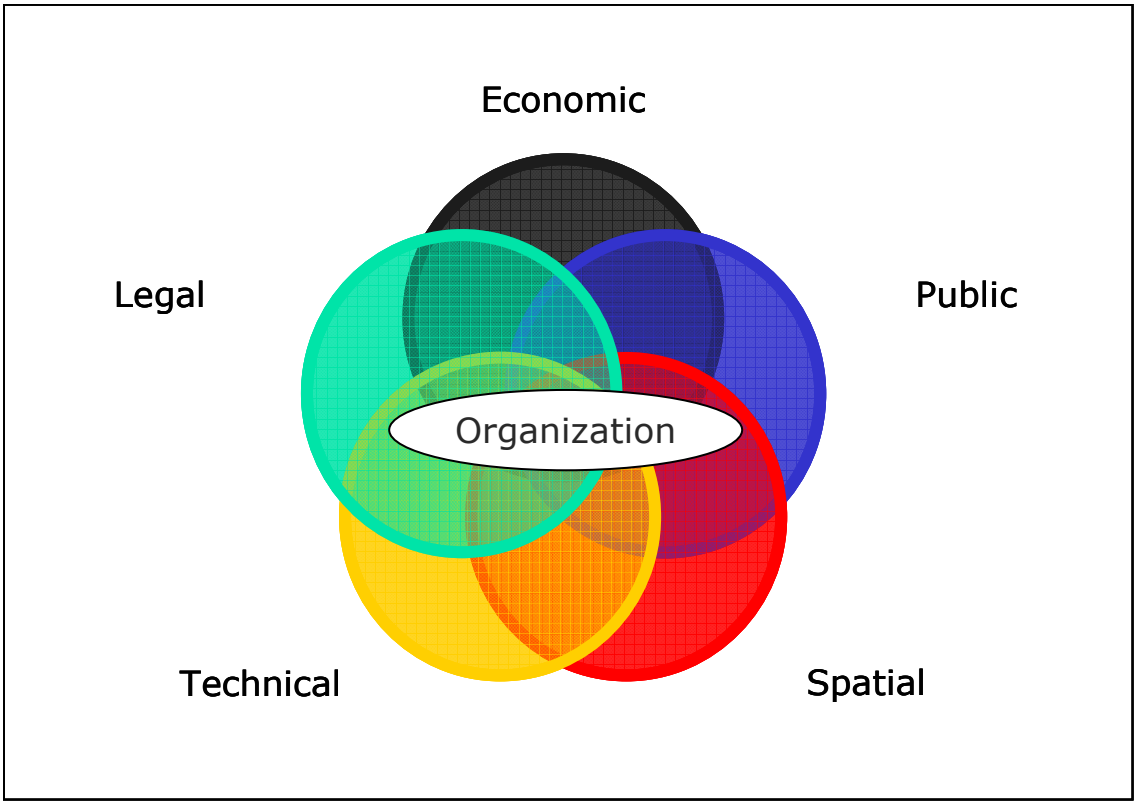
- 6 visions for CCS in the Netherlands

3.2 Step 2: Detailed description of the visions

In this step, the six visions that have been formulated in step 1 will be worked out in more detail. To facilitate describing the visions in a similar way we propose to make vision descriptions along six dimensions being 1) technological development, 2) regulations, 3) public engagement, 4) economics, 5) spatial planning and 6) organization. It should be noted that the sixth dimension 'organization' is part of all other five dimensions. The basic idea is that every dimension can be a bottleneck or driver during the implementation of CCS. Only when the dimensions fulfil a certain set of minimum requirements then CCS can move forward. When we distinct between these dimensions it can be more clearly presented what bottlenecks most likely may hinder the

development and implementation of CCS in the Netherlands. A short explanation on the dimensions and how these will be used can be found in Textbox 3-1.

Textbox 3-1 Explanation on the six dimensions



To allow for a consistent methodology to assess the 2050 vision(s), these future states will be described along six dimensions:

- Technological development
- Regulations
- Public engagement
- Economics
- Spatial planning and
- Organization.

Technological development describes the technical performance of capture, transport and storage technologies. The possible emergence of new technologies and concepts is also included in this dimension.

Legal describes the status of laws and regulations that are applicable to CO_2 capture, transport and storage projects or systems infrastructure.

Public engagement describes (not prescribes) the level and type of public engagement that accompanies the introduction and implementation of CCS projects or infrastructure.

Economics of CCS is described focussing on the cost and the projected development of cost of CO_2 capture, transport and storage options over time.

Spatial planning describes the spatial status and development of areas where CCS infrastructure may develop and how CCS will fit in these areas. This dimension is highly linked to the 'legal' dimension as spatial planning is typically a regulatory affair worked out by national or local competent authorities. The geographical scope of this dimension exceeds national boundaries and also CCS infrastructure and spatial planning in neighbouring countries will be taken into account.

Organization is the dimension that typically describes the linkages between above mentioned dimensions. It also describes how actors in the field are organized and steered.

For each dimension a set of indicators will be developed that facilitates the description of the dimensions. Each indicator has a unit of measurement and is obtained by means of e.g. modelling tools, literature and results of CATO-2 work packages. At this stage the use of modelling tools will be limited. One example is the cost per tonne of CO_2 captured as indicator for the dimension 'economics' (see table 3-2). This indicator will be used in the detailed descriptions of the visions. The description is one A4 per vision and serves the goal to illustrate the 2050 visions and supports the selection of visions in the next step.

Table 3-2 Overview of dimensions and preliminary indicators

Dimension of CCS system	**Indicator**	**Unit of measurement**	**Tool / CATO-2 WP input**
Economics	Cost of CO_2 captured	€ /tonne (difficult as reference is not straigthforward)	Scenario tool MARKAL-UU
	Overall cost of capture	MEuro (difficult as reference is not straigthforward)	Scenario tool MARKAL-UU
	Cost of CO_2 transported	€ /tonne	Scenario tool MARKAL-UU
	Overall cost of transport	MEuro	Scenario tool MARKAL-UU
	Cost of CO_2 stored	€ /tonne	Scenario tool MARKAL-UU
	Overall cost of storage	MEuro	Scenario tool MARKAL-UU
	Overall share of GDP	%	Scenario tool MARKAL-UU
	CO_2 price	€ /tonne	Input or model output depending on assumptions
Technological development	Technology status and expected development	Typical performance indicators: Efficiency (%) Capture penalty (%) Capacity (MW_e) Capture rate (%)	Literature review
	CO_2 captured	Cumulative CO_2 in Gt per sector and per technology	Scenario tool MARKAL-UU/ can also be a model input

Dimension of CCS system	Indicator	Unit of measurement	Tool / CATO-2 WP input
	CO_2 transported	Cumulative CO_2 in Gt	Scenario tool MARKAL-UU
	CO_2 stored	Cumulative CO_2 in Gt	Scenario tool MARKAL-UU/can also be a model input
Regulations	n.a.	n.a.	n.a.
Spatial planning	Status of national strategic plan on CCS	Qualitative	
	% / Mt of storage capacity officially earmarked in strategic governmental plans	%, Mt	
	Status of structure vision on CCS in neighbouring countries	Qualitative	
Public engagement	Public engagement- local	Qualitative	Literature
	Public engagement - general	Qualitative	Literature
Organization	Role of actor(s)		Actor role analysis/Interviews
	Market structure	Qualitative /quantitative ??	

Output step 2:

- List with set of indicators and information sources
- A4-descriptions of 6 visions

3.3 Step 3: Selection of the vision(s)

In this step the number of visions will be reduced. The 6 visions are presented to and discussed with a group of stakeholders called the 'think tank' (see section 4.3.2). The stakeholders are asked for feedback on the visions and together with the project team the vision(s) for which a roadmap will be selected. When the selection of the visions is agreed on the vision(s) will be visualized. The visualizations will be used throughout the roadmap development.

Output step 3:

- Selection of one or more visions
- Visualization of selected visions

3.4 Step 4: Detailed description of intermediate vision years

In this step we look back from the visions established for 2050 to the intermediate vision years 2020, 2030 and 2040 and define how CCS is developed at these points in time. Based on the A4 descriptions of the vision(s) the intermediate years are described for the selected vision(s). This

way the descriptions grow from one A4 to four A4s. The description of the view years is required to build the 'storyline' around the visions. At this point, no quantitative analysis is foreseen.

We describe the intermediate years using the same dimensions and indicators as used for the visions, namely technological development, regulations, public engagement, economics, spatial planning and organization. For example, the indicator 'volume of CO_2 transported' might be described as one element of the 2050 vision and should therefore be described for the intermediate years as well. Besides describing the intermediate years 2020, 2030 and 2040 also the current situation (2010) will be described along the six dimensions and the defined set of indicators. This is the actual starting point for all CCS developments.

Output step 4:

- Extension of the A4-description of the selected vision(s) with the view years 2020, 2030 and 2040 (from 1 A4 to 4 A4s)
- Description of the 2010 situation

Planning Task 1

The planning of Task 1, step 1 to 4, are schematically presented in the figure below. Task 1 starts in Q4 of 2010 and is finalized in Q2 of 2011. One workshop with the Think Tank is scheduled in Q1 2011.

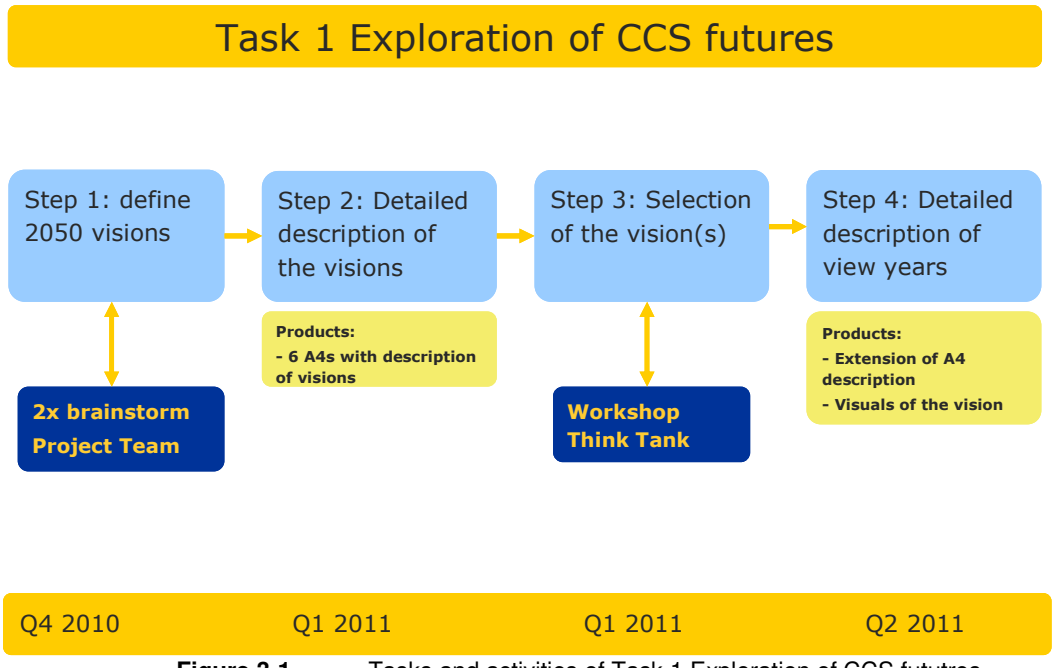


Figure 3-1 Tasks and activities of Task 1 Exploration of CCS fututres

Task 2: Analysis of CCS development paths

The aim of this task is to define a reference scenario for CCS in the Netherlands.

3.5 Step 1: Selection of reference scenario

In this task, we develop a reference scenario. The reference scenario will be used in the "Gap Analysis" where the gap between the reference scenario and the vision(s) will be defined. This will be done in task 3.

The project team will explore existing reference scenarios and select one that will be used in the IP. A possible reference scenario might be the Reference Outlook (Referentieramingen in Dutch) of ECN. The Reference Outlook is a plausible assessment of the development in the Dutch energy economy up to the year 2020. For the period 2020 to 2050 we will extrapolate the Reference Outlook.

Textbox 3-2 The use of scenarios

Scenarios

A scenario can be defined as a plausible and often simplified description of how the future may develop, based on a coherent and internally consistent set of assumptions about driving forces and key relationships. Scenarios include information about goals, expectations, motivations, actions and reactions of actors in the (modelled) system.

Scenarios are typically forecasting exercises that are based on the current situation and observed and expected trends. They are used to sketch possible or probable futures and thus not necessarily preferable futures. Building scenarios with for instance modelling tools will have the benefit of providing more detailed and quantified data on, for instance, costs and techno-economic developments of climate policies with and without CCS over time. It is typically a quantitative tool that can be used to give quantitative information (amount of CO_2 stored, total capital requirement etc.) on a possible future state of the CCS technology given certain boundary conditions.

Output step 1:

- Selection of the reference scenario
- Adding current CCS developments to the selected reference scenario

3.6 Step 2: Description of the reference scenario

When the reference scenario has been selected this scenario is to be described in the same way as the vision. For the years 2010, 2020, 2030, 2040 and 2050 the reference scenario is described along the six dimensions.

Output step 2:

- Description of the reference scenario (five A4)

Planning of task 2

Task 2 is executed in the same period as task 1 and will be finalized at the end of Q1 2011.

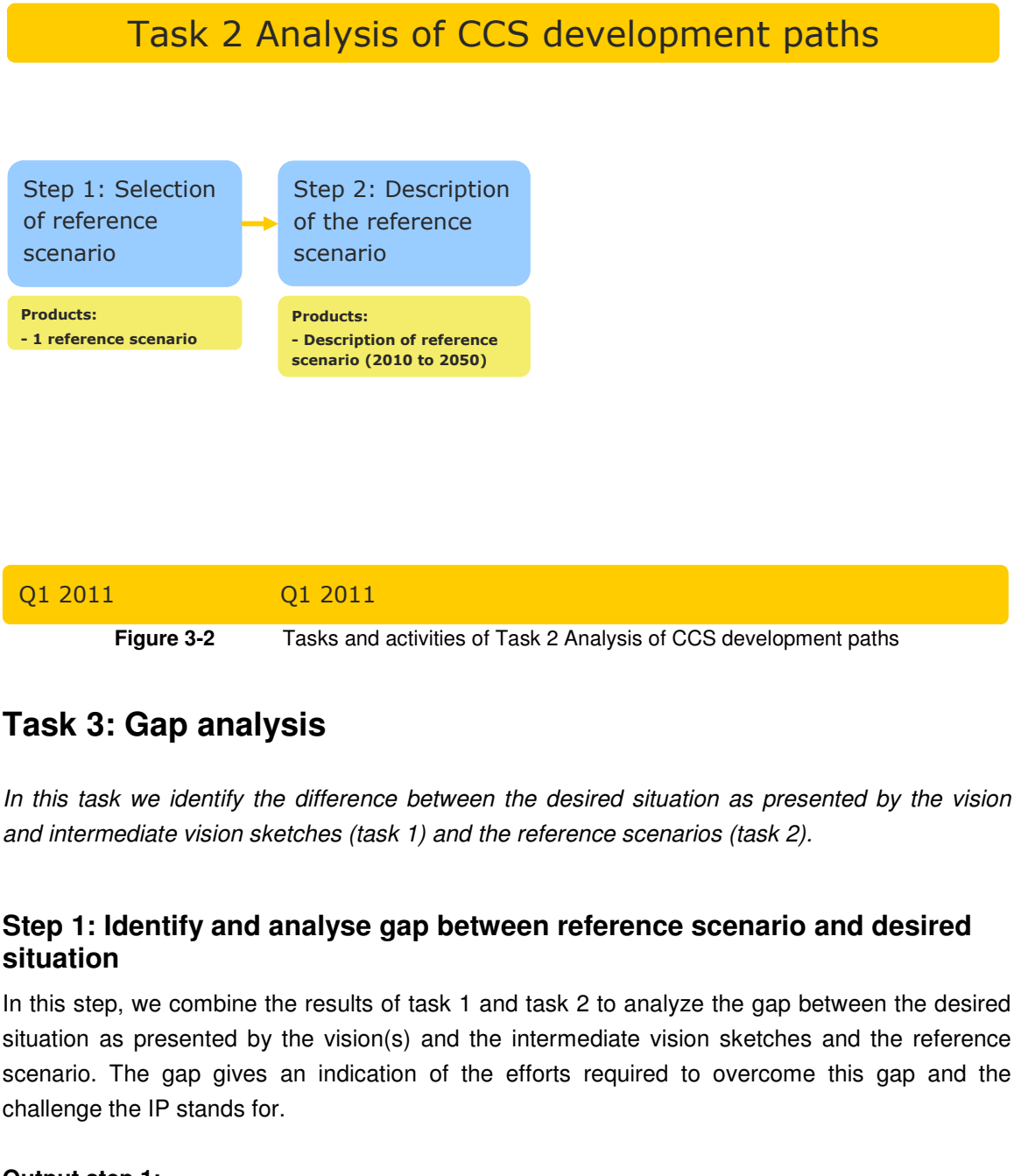


Figure 3-2 Tasks and activities of Task 2 Analysis of CCS development paths

Task 3: Gap analysis

In this task we identify the difference between the desired situation as presented by the vision and intermediate vision sketches (task 1) and the reference scenarios (task 2).

Step 1: Identify and analyse gap between reference scenario and desired situation

In this step, we combine the results of task 1 and task 2 to analyze the gap between the desired situation as presented by the vision(s) and the intermediate vision sketches and the reference scenario. The gap gives an indication of the efforts required to overcome this gap and the challenge the IP stands for.

Output step 1:

- Descriptions of the gaps that exist on all six dimensions (technological development, regulations, public engagement, economics, spatial planning and organization)

Step 2: Formulate milestones

In this step we identify the milestones that have to be achieved at a specific moment in time in order to achieve the desired 2050 end-state of a vision. Milestones are intermediate targets that should be achieved at a specific point in time to be able to achieve the 2050 vision. We identify milestones on all six dimensions: technology, legal, spatial planning, public acceptance, economics and organization. The inventory of milestones used input from previous steps where the gap has been identified.

Output step 2:

- List with milestones for the years 2020, 2030, 2040 and 2050 (descriptions, deadlines)

Step 3: Identify expected bottlenecks to achieve the milestones

Based on the gap analysis and identified milestones in step 2 we will identify bottlenecks that (may) occur depending on the CCS development phase and the position that various stakeholders may take with respect to CCS. Again, we will use the six dimensions technology, legal, spatial planning, public acceptance, economics and organization.

We will identify the bottlenecks by using a group participation method such as the policy lab (collaborative computing). This kind of method brings a decision-making group together in a room outfitted with a set of hardware (a network system and a computer for each participant involved), software (tools which enable electronic brainstorming and structuring of ideas) and process facilitation (preparation and management of the electronic meeting). The think tank and some other representatives of the stakeholders will be invited to participate in this session of the policy lab.

Output step 3:

- List with bottlenecks

Planning task 3

Task 3 will be finalized by the end of 2011. The bottlenecks found are input to task 4 where policy actions will be defined to overcome the bottlenecks.

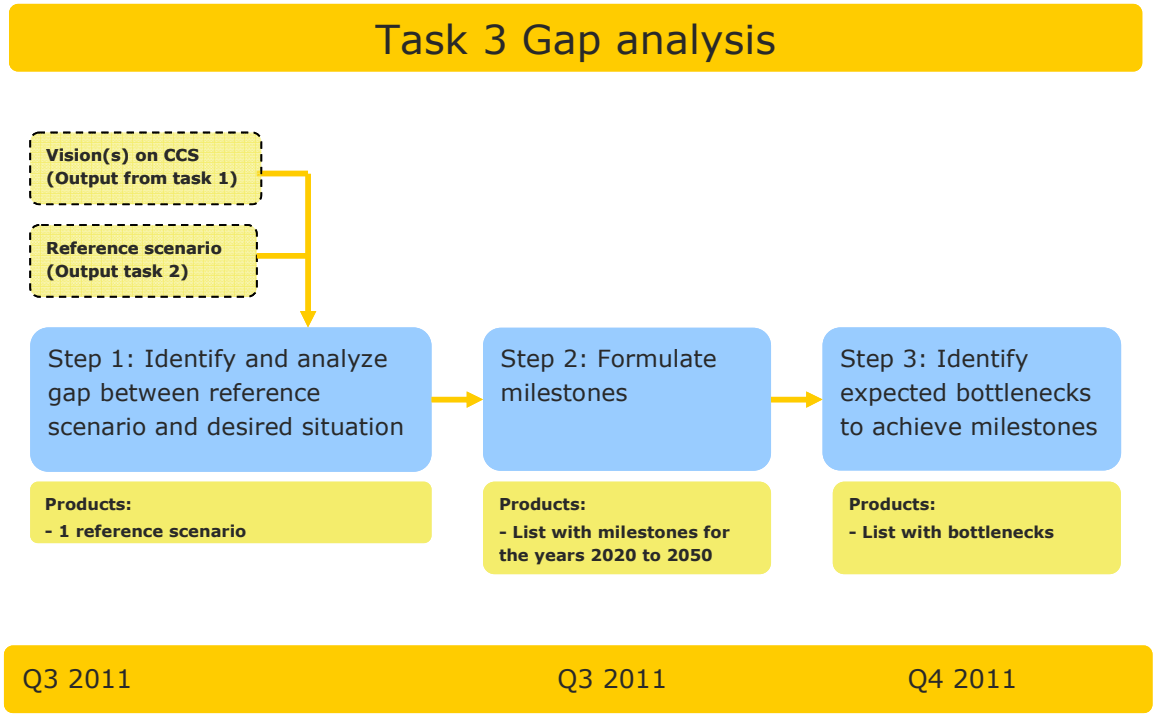


Figure 3-3 Tasks and activities of Task 3 Gap analysis

Task 4: Roadmap development

The aim of this task is to elaborate a roadmap for the implementation of CCS and define policy actions that are needed to the desired end-state of 2050 vision(s).

Step 1: Formulate options to mitigate the bottlenecks

Once the inventory of bottlenecks is complete, we start working on potential solutions and formulate policy actions to mitigate the bottlenecks. For each (policy) action we will address following issues:

- The organization who is responsible for the action
- The time frame of the action
- The risks involved on fulfilling this action
- The needed partners
- The organization frame

The timing, responsibilities and costs of the policy actions will be investigated. Actions have to be formulated that are required in the various visions to close the gap between today's situation and

the ideal state. In addition to actions, we also aim to assess the resources (capital, labor etc) that have to be deployed to make these actions possible. This assessment may have qualitative and quantitative components.

For this step, we will also use a policy lab. The think tank and the some representatives of these stakeholders will be invited to participate in this session of the policy lab. Based on the results of the policy lab, the CATO-partners formulate the actions, which should be taken by the government to achieve the milestones and vision.

Output step 1:

- Definition and timing of policy actions

Step 2: Set up of the roadmap

In this step we will put together the roadmap using all outputs of the foregoing tasks and steps. The core of the roadmap is the required policy actions needed to achieve the milestones and in the end to reach the 2050 vision. The roadmap will be shared with all stakeholders and will be available via the website of CATO-2.
At the time of writing this work plan, no decision has been made yet on what the appearance of the roadmap should be. Since the value of the roadmap increases when it gets broad support across the different stakeholder groups a communication plan will be established. This plan will include the approach to disseminate the results of the IP.

Output step 2:

- CCS Roadmap, with per vision:
  1. List of identified milestones and bottlenecks to the implementation and development of CCS;
  2. List of key policy actions and priorities and present these by means of a roadmap;
  3. List of key actions and priorities for RD&D research and industry and present these by means of a roadmap;
  4. Identification of responsibilities/roles among actors; and
  5. Timeline of the actions formulated.

Step 3: Dissemination of road map

The aim of this step is to get attention for the results of the road map, start discussions and find support for it. First of all, we will make a communication plan that states what type of product(s) we will disseminate and how to do this. The start of making a communication plan is

Output step 3:

- Communication plan for the dissemination of the roadmap
- Visuals supporting the roadmap

Step 4: Roadmap version 2.0

In the final year of CATO-2 (2012 – 2013) one update of the roadmap is foreseen. The first step to do this is collecting comments on the first road map. Participants in CATO-2 will be asked to put forward their comments on the roadmap. Possibly, one or more workshops will be organized to collect and accommodate these comments. The project team will work out an improved version of the roadmap – roadmap version 2.0.

Planning task 4

The planning of task 4 is flexible. If the first version of the roadmap is available earlier in time also the dissemination of the roadmap will be done earlier. A period of one year is now reserved for updating the roadmap.

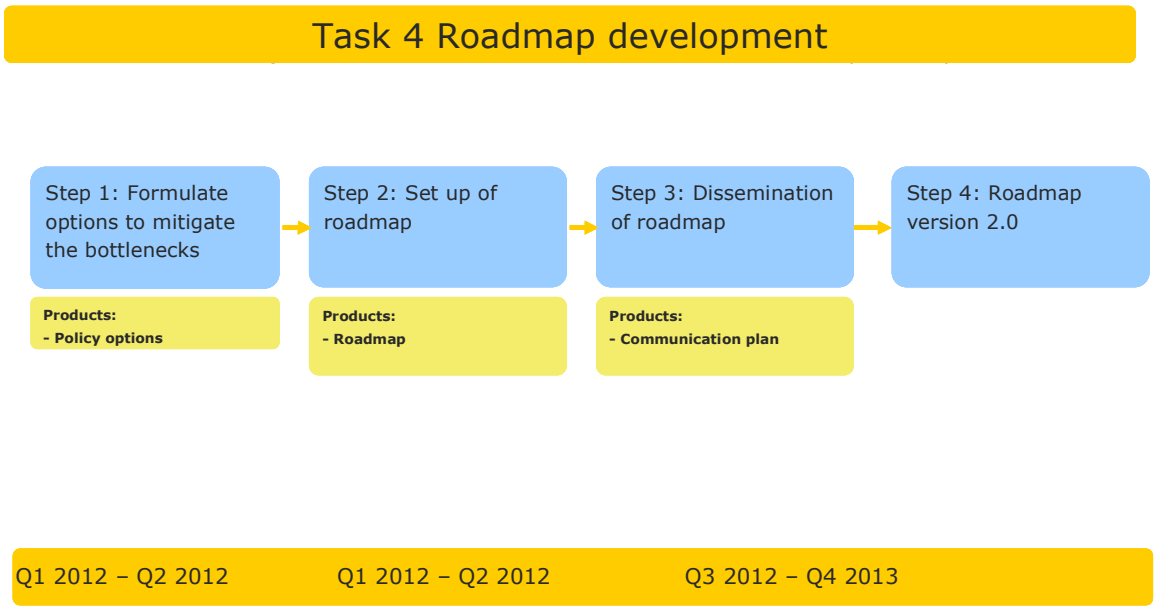


Figure 0-4 Tasks and activities of Task 4 Gap analysis

4 Planning and organisation

4.1 Overall planning

The overall planning of the tasks from year 2 to year 5 is presented in **Error! Reference source not found.**. A detailed planning of the tasks and activities is given in previous sections.

Task 1 Exploration of CCS visions covers the full second year of the CATO-2 program and part of year 3. By the end of 2010 the draft visions will be ready and in the first half of 2011 the visions are worked out in more detail (including the descriptions of the intermediate years). In task 2 the reference scenario is defined using existing scenarios. The results of Task 1 and Task 2 are input to task 3 where we analyse the gap between the reference scenario and the ambitions for 2020, 2030, 2040 and 2050. Task 4 involves the actual development of the roadmap. One update of the roadmap is foreseen. Detailed planning of these tasks will be done during the roadmap development.

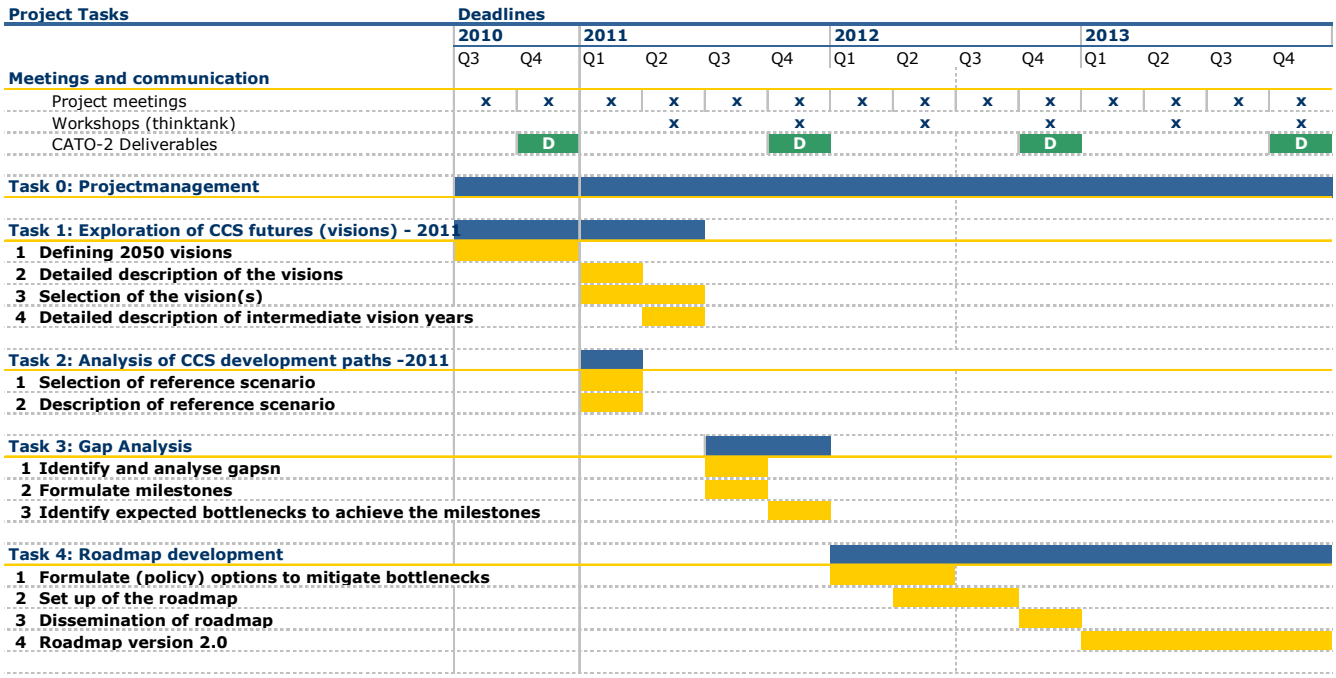


Figure 4-1 Overall planning for the Implementation Plan

4.2 Communication

Communication of the progress and results of the IP is an essential part of the project. Towards the end of the project communication of the results becomes more important, because the CCS

roadmap gets its final appearance. For the launch and dissemination of the CCS roadmap a communication plan will be established in Task 4.
During the project the project team will present (intermediate) results to the CATO-2 partners. A suitable moment might be the annually organized CATO-2 day.

4.3 Organisation

4.3.1 Project team

The project team consists of Ecofys, TNO, ECN and Utrecht University. Ecofys coordinates the project.

4.3.2 Stakeholders

The value of a roadmap depends on the support of stakeholders. A widely supported roadmap can become a strong instrument to steer and anticipate to future CCS developments in the Netherlands. Common understanding between the stakeholders on the needs, actions and planning of the implementation of CCS is a key requirement. The aim of this Implementation Plan to formulate a roadmap for CCS development in the Netherlands therefore relies heavily on the active participation the different stakeholders. We distinguish a number of stakeholders categories, classified according to their degree of participation.

Group 1: CATO-partners

- Composed of Ecofys, UU, ECN, EBN, TNO
- Direct involvement
- Responsibilities: managing the process, organize workshops, outreach activities, carry out the 4 step IP process

Group 2: Think tank

- CATO-2 partners: 1 representative for each category: emitters, transporters, operators, knowledge institutes, government and NGO's. Each category should select its own representative.
- Direct involvement
- Responsibilities: participate in workshops, provide written feedback on draft and final documents

Group 3: Stakeholders

- All parties that are related to CCS and should know about the IP
- Indirect involvement
- Responsibilities: The stakeholder group is informed on a regular basis on the progress of the IP. Feedback is appreciated, but no active involvement is required.

Group 4: End users

- All parties involved in CCS in and outside the Netherlands

4.3.3 Workshops

The input of stakeholders to the roadmap is accommodated by means of organising workshops. The project team plans to organize two workshops per year to actively involve the Thank Tank.

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