

CARBON MARKETS' OPPORTUNITIES FOR CO₂ SEQUESTRATION

FROM CO₂ SEQUESTRATION TO CO₂ CERTIFICATES

In principle, a CO₂ sequestration project will like other projects that reduce emissions, generate CO₂ certificates. In order to gain certification, projects need to be independently verified by accredited auditors and officially registered. Stored emissions will be set against baseline emissions before the project was undertaken. Only avoided emissions will in this case lead to CO₂ certificates that can be traded. (See figures with the case)

WHAT CAN BE TRADED?

The following certified emissions (reductions) can be generated and traded by countries and companies (by making use of so-called Kyoto Mechanisms and (inter)national emissions trading regimes:

- **Emissions Reduction Units (ERUs):** emission reductions generated in Joint Implementation (JI) projects: one industrialised country (the investor) finances or undertakes a project in another industrialised country or Central and Eastern European economy in transition (the host) that reduces emissions. The investor and host country both have a (national) emission reduction target. Host and investor agree on the share of the credits and the price. Also companies can invest in JI projects and receive ERUs. They can use ERUs for their own emission target towards the national government or sell them on the market;
- **Certified Emissions Reductions (CERs):** emission reductions generated by making use of the Clean Development Mechanism (CDM). An industrialised country or entity finances or undertakes an emissions reduction project in a developing country. The industrialised country has a (national) emission reduction target whereas the developing country has no target. Host and investor agree on the share of the credits and the price. For companies there is the same possibility with ERUs;
- **Removal Units (RMUs):** these are emissions stored in forest projects and can be generated domestically or via CDM or JI.
- **Assigned Amount Units (AAUs)** are the emissions that are allowed for Parties (countries) under the Kyoto Protocol. Each government can allocate parts of their AAU to individual companies or sectors. We call these **Emissions Rights, Emissions Quota or Emission Allowances**. These Emission Rights get assigned to a company under an emission-trading scheme. When a company emits less than it is allowed to, that company can trade the surplus of emission rights to other companies, that have a shortage of rights or on the market.
- **Emission Credits (ECs):** a special type of credits can in some national systems be generated by a company or project developer through the implementation of an emission reduction or savings project, without having an emission obligation. This is for instance the case in the UK. These ECs can be traded nationally and not automatically on the international market

CARBON MARKET PRICE EXPECTATIONS

Based on recent transfers, market analysis and simulations¹ we can give the following best-guess market prices for distinct carbon markets - given their restrictions and life times -. Some schemes have a penalty, tax/levy, as are shown in the table.

Timeframe ► Carbon Market Price in €/ton CO2E //▼	1998-2001	2002-2005	2005-2007	2008-2010 Kyoto I	2010-2012 Kyoto I	2012-2017 Kyoto II	2017-2022 Kyoto II
Voluntary Market	1-3						
CDM ¹		1-5	1-5	5-7	5-7	5-10	5-10
NL CERU-PT ²	3-5	3-5	3-5				
NL ERU-PT ³	5-8	5-8	5-8				
JJ ⁴				8-10	8-10	10-20	10-20
Worldbank PCF ²	3-5						
Danish Market	4 penalty 3,5						
UK ET Market		7-8 levy 40					
Norwegian CO2 Market			7-15 tax 38				
EU GHG Market			5-10 penalty 50	10-20 penalty 100	10-20	10-30	10-30
Kyoto Market				10-20 penalty 130%	20-30 penalty 130%	20-30	20-40

¹ Clean Development Mechanism: projects undertaken in developing countries, without having emissions commitments, can generate Certified Emissions Reductions (CERs).

² Certified Emission Reduction Unit Procurement Tender, a program run by Senter, sponsored by the Dutch government; under that program the government will buy CERs from a host government from projects undertaken by companies in a tender procedure.

³ Emissions Reduction Unit Procurement Tender, executed by Senter, sponsored by the Dutch government; under that program the government will buy ERUs from a host government generated from projects undertaken by companies in a tender procedure.

⁴ Joint Implementation: projects undertaken in another industrialized country, generate ERUs. Host and investor agree share and price.

⁵ Prototype Carbon Fund: via this fund programmed by the Worldbank countries and companies invest in reduction projects distributed over developing countries and countries in transition.

⁶ The certificates can – according to the current situation and plans - not be sold on the UK, Danish, Norwegian or European market. These markets don't accept input of project-based carbon certificates yet,

¹ Analysis including that made by Natsource, CO2e.com, Pointcarbon.com , Ecoscurities, RIVM

because that could lead to inflation of the emissions budget. The UK and the EU will reconsider this at a later stage.

ANALYZING THE MARKET

When analysing the carbon market (see Table) we see that various prices occur on the different regional and national markets. When determining your strategy you should keep the following in mind:

- It is important to realise that ultimately (around 2010) there will be one, international carbon market, that market will lead to one, global carbon price. Nevertheless, buyers and sellers can have preferences for a specific market and allow sub-optimal revenues. For instance, company A can favour to sell in country B or has agreements with country B.
- As shown above under Carbon Market Price Expectations we see that various prices are expected to occur on the different regional and national markets. In the mean time - as long as markets are not connected or not fully developed - buyers will look for the lowest prices and sellers will look for the highest prices. Nevertheless, the several markets influence the carbon price in other market. Due to the fact that CO₂ credits can be acquired in CDM or JI markets will lower the prices in other markets. On the other hand, in situations where markets are still under development, prices tend to be low anyway, due to uncertainties and risks.
- Regarding projects with a long lifetime or with leakage or permanence risks project developers need to address and minimise the risks. As a project developer you need to consider how you are going to minimise the risks. In other cases, such as sinks projects (sequestration in forests) developers separate a percentage of emissions stored as preventive buffer. For this purpose, developers retain 10-20% of the certificates and not sell this share on the market.

WORKING ON THE CASE

For this exercise the participants will be split into groups of maximum 10 persons. The group will be led by process managers, which is appointed by the organisations. Together as a group you will have to try to solve the cases.

YOUR ROLE

The aim of this exercise is to discuss and analyse in what way the emerging carbon trading market can deliver financial opportunities for CO₂ sequestration project. We want you to put yourself in the position of a project developer that wants to implement a CO₂-sequestration project. Your aim as a project developer is to try and maximise the income for your project (through selling the CO₂-credits) but also to minimise the (financial) risks.

SOLVING THE CASES

The characteristics of the carbon market will give you ample opportunities to hedge risks and to generate revenues up front or to accept revenues in the future or to utilise greenhouse gas credits as project insurance. We ask you to solve the next two cases.

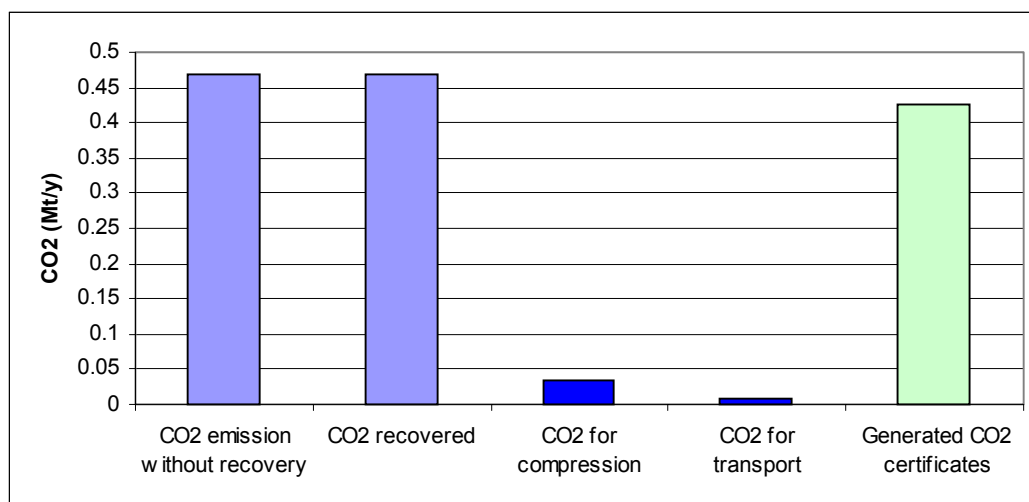
CASE I:

CO₂ CAPTURE AND STORAGE IN AN AQUIFER OF RECOVERED CARBON DIOXIDE FROM NATURAL GAS-PROCESSING.

You are a gas company that wants to develop a project to capture the CO₂ emitted with the gas handling and you want to store the CO₂ in an aquifer. You have extraction site in different parts of the world (in industrialised as well as developing countries). None of the countries where you are located did implement a domestic emissions trading scheme.

PROJECT CHARACTERISTICS:

- Natural gas is extracted from hydrocarbon fields. Recovering the carbon dioxide reduces the CO₂ content of natural gas. The natural gas produced is added to the grid (standard procedure);
- The recovered CO₂ is compressed, transported and stored into an aquifer (additional procedure);
- Production capacity: 100 million GJ of natural gas/year;
- CO₂ stored: 470.000 tons per year;
 - CO₂ emissions from compression of CO₂: 35.000 tons per year;
 - CO₂-emission from transport of CO₂: 8.000 tons per year;
 - Generated CO₂ certificates 427.000 per year;
- Total investments: 45 million Euros
- Specific reduction cost: 25 Euro/ton CO₂ (15% discount rate);
- Storage capacity: 20 years.



POSITION ON THE CARBON MARKET

In the time frame 2002-2022 the carbon storage certificates vintage could amount 427.000 per year. When the company considers taking a carbon market position it is necessary to pay for verification, to minimise risks and to have insurance. It is therefore practical to keep 20% of the certificates as buffer to pay these transaction costs. A comparable procedure is done with CO₂-storage projects in forests. Doing so, the company can generate yearly 314.600 certificates to be sold on the carbon market.

It is your challenge to use the above information and to look for opportunities this company has on the carbon market. Make especially use of timing and phasing of market positions and to develop several market strategies (see also under Introduction).

SOLVING THE CASE

Question 1: How can the company optimise revenue opportunities from the carbon market?

We ask you to design several carbon market strategies:

- 1. Strategy, selling credits during the project;*
- 2. Strategy selling credits in advance and in the early phase of the project;*
- 3. Strategy selling credits against higher prices in later phases of the project.*

Question 2: What is the impact of carbon market opportunities on companies' need for subsidies and investments for project development?

Question 3: What is the impact when the carbon markets collapses halfway the project?

CASE II:

USE IN EOR OF RECOVERED CARBON DIOXIDE FROM COAL-FIRED POWER PLANT

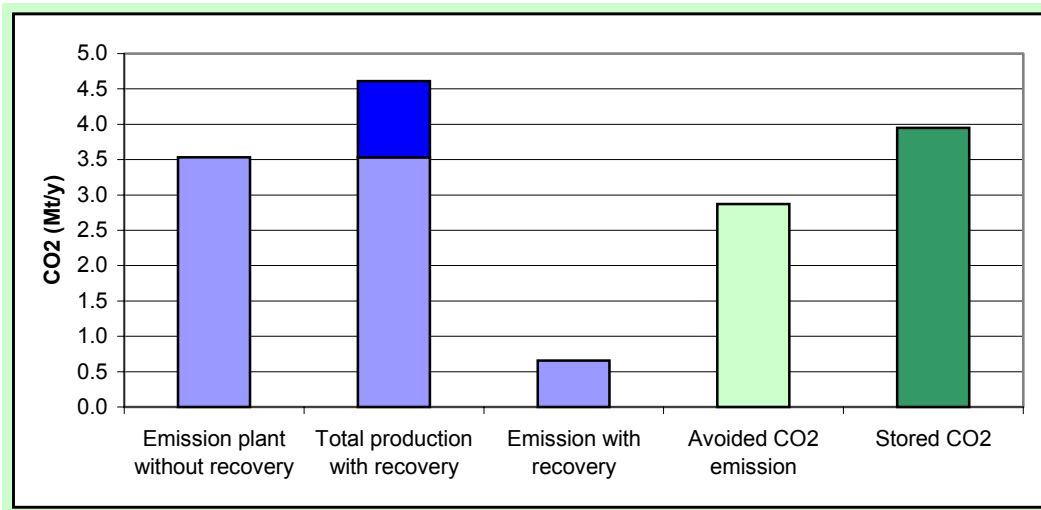
You are an energy company that considers building a coal fired power plant and equip this with a CO₂ recovery system. The recovered CO₂ is used for enhanced oil recovery. In this case it is in an oil field not far from the power plant. You are a world-wide operating energy company. The power plant in this case is situated in Denmark and you got an emission cap under the Danish system, namely to stabilise your emissions at current levels

PROJECT CHARACTERISTICS:

The main data are

- 600 MWe coal-fired super-critical power plant with CO₂ recovery (efficiency of 37%, without recovery 46%). Power is added to the grid (standard procedure);
- The recovered CO₂ is compressed, transported and used for enhanced oil recovery (EOR);
- Production of power plant: 4.8 10⁹ kWh/year; coal use: 47 PJ/year;
- Baseline emissions (without recovery): 3.5 Mtons/year;
- CO₂ production power plant with recovery emissions: 4.4 Mtonnes/year;
 - Cumulative CO₂ recovered and stored: 4.0 Mtonnes/year (90% recovery of CO₂ production of the power plant);
 - CO₂ emissions from transport and storage: 0.2 Mtonnes/year;
 - Net avoided CO₂: 2.9 Mtonnes/year against the baseline of 3,5 Mton;
- Revenues CO₂ for use in EOR 16 euro/tonne CO₂;
- Specific avoidance costs (including revenues of EOR): 40 euro/tonne CO₂-avoided. (15% discount rate);
- Total investments: 380 mln Euros
- Storage capacity: 25 years.

Table 3. Graphical representation of CO₂ production and emission of a coal-fired power plant without and with CO₂ removal.



POSITION ON THE CARBON MARKET

For this project, it is important to note the considerable emissions increase due to the recovery itself (see second column, figure 2). Certificates for storage will only be issued for CO₂ stored, against the baseline (project without recovery). Therefore, in the time frame 2002-2022 the carbon storage certificates vintage could amount to 2,9 Mton per year. Considering risks and insurance the company could retain 10% of the certificates, netting the available CO₂ stored for the market to 2,32 Mton per year.

It is your challenge to use the above information and to look for opportunities this company has on the carbon market. Make especially use of timing and phasing of market positions and to develop several market strategies (see also under Introduction).

SOLVING THE CASE

Question 1: How can the company optimise revenue opportunities from the carbon market from this project? (Consider where you want to locate the project)

We ask you to design several carbon market strategies:

1. *Strategy, selling credits during the project;*
2. *Strategy selling credits in advance and in the early phase of the project;*
3. *Strategy selling credits against higher prices in later phases of the project.*

Question 2: What is the impact of carbon market opportunities on companies' need for subsidies and investments for project development?

Question 3: What is the impact when the carbon markets collapses halfway the project?

ANSWER CASE I:

Question 1

- ◆ **COST:** The company's cost is 25 euro per ton CO₂ recovered i.e. 11.175.000 euro per annum (470.000 x 25). This is 235.000.000 euro over 20 years.
- ◆ **STRATEGIES:** Based on the aforementioned, we can develop the following market strategies:
 - ◆ Strategy I) When the company sells each year the vintage of CO₂ sequestered, sales are:
 - between 27.684.800: lower price of 3 euro from 2002-2007 and 5 euro from 2008-2022 per ton
 - and 142.070.000: higher price of 5 euro from 2002-2007 and 30 euro from 2008-2022).
 - This means that at most the company can half its cost during the project, while cost reduction accelerates in the last 8 years;
 - ◆ Strategy II) The company can choose to generate earlier revenues by selling sell options for future storage certificates. Usually, this can be done for lower prices. Lowest income through this strategy is 18.876.000 euro, gained between 2002 and 2005! (carbon price 5 euro)
The companies make capital, before investing. This can in general be done via brokers or bilateral to companies that want to assure to have enough certificates in future emission commitment periods. Also insurance companies and carbon investment funds are active on this segment of the carbon market.
 - ◆ Strategy III) The company can choose to increase future revenues by storing the certificates in order to sell at a later stage. In particular, the period at the end of the first Kyoto commitment, and the true-up period (when countries are allowed to get into compliance) carbon prices are expected to be around 30 euro. When all available certificates are sold, the company would gain 188.760.000 euro

Question 2:

It is possible that after a few years during the Kyoto Protocol commitment period the carbon market collapses. That can happen when the market is flooded with cheap credits or when there is no demand because Parties and companies resist complying with the agreed commitments. In that case, companies with early revenues are happy to have taken that strategy. Companies that have relied too much on future credits for project development will find they have taken the wrong strategy.

Question 3:

Experiencing the potentially higher revenues when selling the CO₂ assets at a later stage stresses the importance for companies to attract investments by companies and subsidies by governments for the start-up period (2002-2008).

ANSWER CASE II

Question 1:

- ◆ **COST:** The company's cost is 40 euro per ton CO₂ recovered i.e. 160.000.000 per annum (40 Mton x 40 euro). This is 5.120.000.000 euro over 25 years. These costs can be perceived as standard investments to make the natural gas useful for the grid. After verification, issuing and registering by the Emissions Authority the company has the possibility to earn some of these investments back on the greenhouse gas market.
- ◆ **STRATEGIES:** Based on the aforementioned, we can develop the following market strategies:
 - ◆ Strategy I) When the company sells each year vintage of 2.32 Mton CO₂ sequestered, sales are:
 - between 262.160.000: lower price of 3 euro from 2002-2007 and 5 euro from 2008-2027;
 - and 1.391.400.000: higher price of 5 euro from 2002-2007 and 30 euro from 2008-2027).
 - This means that at most the company can half its cost during the project, while cost reduction accelerates in the last 13 years;
 - ◆ Strategy II) The company can choose to generate earlier revenues by selling sell options for future storage certificates. Usually, this can be done for lower prices. Lowest income through this strategy is 290.000.000 euro, gained between 2002 and 2005! (carbon price 5 euro)
The companies make capital, before investing. This can in general be done via brokers or bilateral to companies that want to assure to have enough certificates in future emission commitment periods. Also insurance companies and carbon investment funds are active on this segment of the carbon market
 - ◆ Strategy III) The company can also choose to increase future revenues by banking the certificates options in order to sell them at a later stage. In particular, the period at the end of the first Kyoto commitment, and the true-up period (when countries are allowed to get into compliance) and further commitments periods carbon prices are expected to be around 30 euro. When all available certificates are then sold, the company would gain 1.470.000.000 euro

Question 2:

It is possible that after a few years during the Kyoto Protocol commitment period the carbon market collapses. That can happen when the market is flooded with cheap credits or when there is no demand because Parties and companies resist complying with the agreed commitments. In that case, companies with early revenues are happy to have taken that strategy. Companies that have relied too much on future credits for project development will find they have taken the wrong strategy.

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