SETTING THE INCENTIVES RIGHT FOR TIMELY CCS DEPLOYMENT

NEW GAS PLATFORM

Creative Energy
Energy Transition

SETTING THE INCENTIVES RIGHT FOR TIMELY CCS DEPLOYMENT

Report by the Netherlands Working Group 'Schoon Fossiel'

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INDEX

ABBREVIATIONS

BAU	Business As Usual
CCS	Carbon Capture and Storage
CER	Certified Emission Reductions
CITL	Community Independent Transaction Log
DECs	Decarbonised Electricity Certificates
DG	Directorate General
DO	Domestic Offsets
EC	European Commission
EII	European Industry Initiative
EIT	Economies In Transition
EP	European Parliament
ERU	Emission Reduction Units
ETP-ZEP	European Technology Platform for Zero Emissions Fossil Fuel Power Plants
EU	European Union
EUAs	European Union (emissions) Allowances
EU-ETS (1/2/3)	European Emissions Trading Scheme (Phase 1, 2 or 3)
GHG	Greenhouse Gases
ITL	International Transaction Log
KP	Kyoto Protocol
LULUCF	Land Use, Land Use Change and Forestry
MS	Member State(s)
R&D	Research and Development
SET-Plan	Strategic Energy Technology Plan
UNFCCC	United Nations Framework Convention on Climate Change
U.S.	United States
VED	Verified Emissions Data

1 INTRODUCTION

Carbon Capture and Storage (CCS)[1] is generally seen as a promising future technology without which the EU would have little chance to achieve its GHG-mitigation targets for 2020 (and beyond). At the same time, CCS may contribute to enhancing security of energy supply insofar as it indirectly reduces the overall import dependency from typical gas- and oil-producing regions outside the EU.

During the last couple of years, interest in CCS has grown tremendously within the industrialised world. Also in typically coal-dependent industrialising countries such as China and India, interest in CCS has been growing. A range of studies has been carried out to analyse and identify capture options and their likely costs, transport modalities and storage potentials.[2]

Generally, it can be concluded that the speed of introducing CCS at a meaningful scale crucially depends on:

- the rate of launching meaningful pilot and demonstration projects in order to get to a stage of CCS commercialisation; and
- the balance of incentives for development and deployment of CCS on the one hand, and the net costs (i.e. including externalities) of CCS implementation on the other hand.

Without a timely demonstration and learning phase, and in the absence of appropriate incentives, commercialisation of CCS is unlikely.

In this report the following issues will be addressed:

- What could be the role of the EU-ETS in generating market-based incentives both within Europe and in the Netherlands in order to be able to develop CCS into a mature set of technologies within the next 10 to 15 years?
- Would the current set of incentives announced be sufficient to help CCS develop as such?

In order to structure the analysis, a distinction will be made between two sub-periods: present-2012 and 2013-2020 and beyond.

1 CCS is defined as a set of technologies that captures, transports, stores and/or fixes CO_2 either by means of geological storage, industrial use, mineral fixation and/or biofixation.

2 Among others IEA Greenhouse Gas R&D Programme (GHG R&D), 'CO_2 capture ready plants', May 2007; IPCC, 'Special report on carbon dioxide capture and storage', 2005; OECD/IEA, 'Prospects for CO_2-capture and storage', 2004; OECD/IEA, 'Legal aspects of storing CO_2', 2005; Kay Damen, 'Reforming Fossil Fuel Use, the merits, costs and risks of carbon dioxide capture and storage', PhD thesis, 2007.

2 THE EU-ETS 1-3: INCENTIVES FOR INVESTMENT

2.1 Policies, policy papers and studies relevant to CCS development and deployment

Recently, a series of policy relevant documents discussing CCS have been published, which will be briefly discussed below.

Paper on incentivising CCS in the EU (April, 2007)

In April 2007, a paper on 'Incentivising CO_2 capture and storage in the European Union' was published[3], which had been commissioned by the European Commission, DG Environment. This paper aimed at providing technical support for an enabling policy framework for CCS in the EU. It discusses "five groups of CCS-incentives," namely:

1. The EU-ETS (weak and strong version),
2. Member State based public support via investment support, feed-in subsidies or a CO_2 price guarantee,
3. An EU-level low-carbon portfolio standard with tradable certificates,
4. An EU-wide CCS obligation for all new fossil fuel based power capacity,
5. Public-private partnerships for realizing a CO_2 pipeline infrastructure.

The paper concludes that "although the EU-ETS is the most cost-effective instrument to reduce greenhouse gas emissions, there are substantial questions as to whether its weak scenario will lead to sufficient deployment of CCS in the short term because of low incentive levels and the 'innovation market failure'. If the 'strong' ETS scenario would be politically unfeasible, additional instruments on the EU and Member State level can be effective in correcting this failure (p. 6)."

With respect to CCS development and deployment the paper suggests that "it seems likely that the target of 10-12 demonstrations by 2015 is within reach, given the number of proposals in the EU and the willingness of Member States to dedicate funds to their implementation. However, rules on State Aid need to be revised, and the desirability of more structural incentives at the MS level, possibly in addition to EU level measures, should be closely examined for undesired interactions (p. 7)." In other words, the paper questions whether the EU-ETS incentives will be strong enough to add sufficient momentum to a timely CCS deployment and calls for additional support.

The ETP-ZEP EU Flagship Programme (October, 2007)

In October 2007, shortly after the above paper on incentivising CCS in the EU was published, the European Technology Platform for Zero Emission Fossil Fuel Power

3 Technical support for an enabling policy framework for carbon dioxide capture and geological storage. 'Task 3: Incentivising CO_2 capture and storage in the European Union', ECN, Norton Rose, Gig and ERM, Amsterdam/London/Katowice, April 2007.

Plants (ETP-ZEP) proposed the development of an EU Flagship Programme on CCS[4]. The paper recollects the importance of CCS in achieving Europe's climate change mitigation ambitions and stresses that CCS "will only be feasible, if there is sufficient economic incentive for it to take place". With respect to the 10-12 full-scale, integrated CCS demonstration projects, the ETP-ZEP proposed a timeline for achieving commercial viability of CCS by 2020. It also delineated a number of general principles, to which such a programme should adhere, such as: ensuring geographical and technological diversity of projects, proving that CCS works and is safe, demonstrating CCS technological innovations, etc.

In order to make "the Flagship Programme economically viable", ETP-ZEP (2007) concludes: "Member State funding alone will not achieve commercially viable CCS by 2020" even given the (upcoming) revision of the EU guidelines for State Aid, "whereby CCS demonstration projects are given 'préjugé favorable' status".

It also states: "if the Flagship Programme is to remain an EU-wide initiative, it therefore requires stable, market based funding mechanisms that close the cost gap between electricity production with and without CCS". As, according to ETP-ZEP, only an EU market-based funding mechanism can achieve this, it is emphasized that CCS should be fully accredited under the EU-ETS.

Based, among others, upon relevant documentation[5] within the ETP-ZEP Platform, the paper provides three incentive options in order to address the CCS incentive issue: 1) the EU-ETS, 2) Decarbonised Electricity Certificates (DECs), and 3) Feed-in tariffs. With respect to the EU-ETS, ETP-ZEP notes: "while it [EU-ETS] will serve as the main instrument for implementing CCS on a wide scale, it will not constitute a sufficient incentive for those willing to take on the considerable technological and commercial risks of setting up the first full-scale demonstration projects". Proposed options in this respect are: granting multiple credit allowances to Flagship programmes and recycling ETS auction revenues to CCS demonstration projects.

In other words, even the large European industrial CCS stakeholders express their doubt about whether the EU-ETS will provide sufficient incentive for those industrial players that would be willing to set up the first demonstration projects.

4 The EU Flagship Programme: The key to making CO_2 Capture and Storage (CCS) commercially viable by 2020, ETP-ZEP, 3 October 2007 (General Assembly, Paris).

5 ZEP: Analysis of funding options for CCS demonstration plants, Climate Change Capital, August 2007.

The EC Strategic Energy Technology Plan (SET-Plan; November, 2007)

The European Strategic Energy Technology Plan (SET), which was published by the EC in November 2007,[6] identifies a number of issues relevant for clean energy technologies in general in order to clear the ground 'towards a low carbon future'. The policy ambitions (or technology challenges) regarding CCS within the SET-Plan are to "enable commercial use of technologies for CO_2 capture, transport and storage through demonstration at industrial scale, including whole system efficiency and advanced research". The EC has thus proposed to launch a number of European Industrial Initiatives[7] (EII) - starting in 2008 - among which is the 'European CO_2 capture, transport and storage initiative'. The EII on CCS should "focus on the whole system requirements, including efficiency, safety and public acceptance, to prove the viability of zero emission fossil fuel power plants at industrial scale".

One of the remaining issues of this SET-Plan is how it will be financed, because so far no sufficient, real and firm financial commitments to achieve the stated ambitions regarding CCS have been made. In order to address this, "The Commission intends to present a Communication on financing low carbon technologies at the end of 2008", which "will address resource needs and sources, examining all potential avenues to leverage private investment, including private equity and venture capital, enhance coordination between funding sources and raise additional funds. In particular, it will examine the opportunity of creating a new European mechanism/fund for the industrial-scale demonstration and market replication of advanced low carbon technologies and will consider the costs and benefits of tax incentives for innovation".

In other words, the EC seems to agree that a comprehensive package of incentives other than through the EU-ETS will have to be implemented to develop and deploy low carbon technologies (incl. CCS) successfully and timely, and will launch initiatives to that end by the end of 2008.

The EC EU Energy Package for 2020 (January, 2008)

After adoption by the European Council of the EU Energy Package for 2020 in March 2007, the EC was invited to develop a package of proposals to meet the formulated energy and climate targets. The resulting policy package presented by the EC at a meeting of the European Parliament (EP) on 23 January 2008 serves the broader target of building, operating and organising a solid, long-term incentive structure for low-carbon technologies which would optimise among a number of policy goals in the area of: innovation and employment (Lisbon Agenda and various research agenda's), competitiveness (internal market), and security of energy supply and

6 COM(2007) 723 final, 'A European Strategic Energy Technology Plan (SET-Plan), Towards a low carbon future', Brussels, 22-11-2007.

7 "European Industrial Initiatives [EEIs] aim to strengthen industrial energy research and innovation by mobilising the necessary critical mass of activities and actors".

environment/climate change. The Package includes[8] among others:

- A revision of the EU-ETS in order "to create borderless ETS […][9]",
- "Specific, binding national targets so that Member States know exactly what they have to do outside the ETS, in sectors like transport, buildings, agriculture and waste[10]",
- "New rules to stimulate carbon capture and storage[11]", and
- "New state aid rules[12]".

In short, although the EC covers a much wider area in this package than CCS, it clearly indicates that in order to stimulate such a technology, State Aid rules may have to be revised, and inclusion of CCS in the EU-ETS needs to be facilitated.

ETP-ZEP on the EU Flagship Programme (February, 2008)

In February 2008, the ETP-ZEP Platform responded to the above EC position by publishing its recommendations[13] on the implementation and funding of CCS for the EU Flagship Programme. It suggested that ten moderately sized commercial CCS projects would together carry incremental costs of €6-10 bn, or even more, compared to conventional power plants without CCS. Furthermore, they argued that:

"Industry hopes and expects that a large part of these costs will be justified by a return from the future revenues generated by the emerging low-carbon power market. Given time, a developing market and a staged investment process, it would be able to make prudent investments in the technology with its own funds. However, the accelerated process means that both the market and the costs of the Programme are subject to exceptional uncertainties. These arise primarily from:

1. The immaturity and uncertainty of a carbon market whose regulatory framework and implementation is still being decided at Government level,
2. The unrecoverable costs that will result from making accelerated investments in immature technology, without the time to climb a learning curve.

8 Based on the Speech to the European Parliament held by Jose Manuel Durao Barroso,'20 20 by 2020: Europe's Climate Change Opportunity, Brussels, 23 January 2008.

9 Brussels, 23.1.2008, COM(2008) 16 final; 'Proposal for a directive of the European Parliament and the Council, amending Directive 2003/87/EC so as to improve and extend the greenhouse gas emission allowance trading system of the Community'.

10 Brussels, 28.01.2008, COM(2008) 17 final; 'Proposal for a decision of the European Parliament and the Council on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020'.

11 Brussels, 23.1.2008, COM(2008) 18 final; 'Proposal for a directive of the European Parliament and the Council on the geological storage of carbon dioxide and amending Council Directives 85/337/EEC, 96/61/EC, Directives 2000/60/EC, 2001/80/EC, 2004/35/EC, 2006/12/EC and Regulation (EC) No 1013/2006'.

12 Community Guidelines on state aid for environmental protection, 2008.

13 The EU Flagship Programme for CO_2 Capture and Storage (CCS), 'ZEP Recommendations: Implementation and Funding', 21 February, 2008.

Following the precedent set by other low-carbon technologies, we therefore expect industry will share these costs and risks as partners alongside the Commission and other EU and Member State entities."

Moreover, the ETP-ZEP stressed that "the EU will need to provide financial support for its commitment to partnering industry in the Flagship Programme, in a form to be decided. The decision on the form of support to be applied is needed very rapidly (in 2008); identified options are an EU cash budget of several bn Euros, an allocation of auction revenues arising from Phase 3 of the European Emissions Trading System (ETS3), or the allocation of additional EU Allowances for CO_2 emissions (EUAs) under ETS3."

In short, ETP-ZEP recommends considerable public resources to cover the estimated €6-10 bn incremental costs of the Flagship Programme; possible sources are the EU-ETS and others.

Given the sheer size of the proclaimed resources needed for a successful launch of the Flagship Programme on the one hand and the lack of clarity about public support from the EC and the Member States on the other hand, a careful assessment of the expected CCS incentive schemes seems crucial. In particular the issue of the extent to which such incentives will be provided by the inclusion of CCS in the EU-ETS or otherwise, seems a recurring central element in the policy discussion on CCS incentives.

Another recurring key question is the extent to which the EC will be inclined to leave CCS initiatives to individual Member States, including the bulk of the corresponding financing needs, or whether it would try to boost, steer, co-ordinate and financially support CCS deployment centrally. This issue also relates to whether a CCS transport infrastructure would need to be supported at the EU-level, or primarily be left to individual Member States.

2.2 CCS incentives: Proposal for decision making

The EC in its January 2008 amendment of Dir. 2003/87/EC so as to improve the GHG emission allowance trading system of the community has proposed (p.5) that "installations undertaking the capture, transport and geological storage of greenhouse gases should be included in the Community system [i.e. EU-ETS]. While article 24 offers the appropriate legal framework for unilateral inclusion of such installations […], activities concerning capture, transport and geological storage of greenhouse gas emissions should be explicitly mentioned in Annex 1 of the Directive […]".

In the Annex (Annex 1, p. 34-6 of the Directive), the following CCS activities to be covered under the EU-ETS are mentioned: "installations to capture greenhouse gases for the purpose of transport and geological storage in a storage site permitted

in the proposed EC Directive[14] on the geological storage of carbon dioxide (proposal for a Directive)"; "pipelines for the transport of greenhouse gases for geological storage in a storage site permitted under Directive 2008/xx/EC (proposal for a Directive)"; and "storage sites for the transport of greenhouse gases for geological storage in a storage site permitted under Directive 2008/xx/EC (proposal for a Directive)".

In fact the position taken by the EC earlier, to include carbon capture, transport and storage activities in principle and generically under the EU-ETS, has been reconfirmed (the option to do so unilaterally already exists under article 24 of Dir. 2003/87/EC on EU emissions trading mentioned). According to the proposal for a Directive so as to improve and extend the greenhouse gas emission allowance trading system of the Community (COM(2008) 16 Final), CCS will be fully covered under EU-ETS-3. This means that power companies do not have to buy allowances to the extent that they apply CCS, or that grandfathered installations will be rewarded accordingly. This would be an important step forward in terms of CCS incentives, although, as the EC argues, it does not cover externalities of CCS deployment, such as learning-by-doing effects, security of energy supply effects, export promotion effects, global climate effects, and/or reduction in traditional air pollutants effects[15].

In its Summary Impact Assessment of the EC Directive on the geological storage of CO_2 of January 2008, the EC, however, also argues that "there is little evidence justifying going beyond the carbon market. For mandatory CCS the additional learning […] does not compensate for the cost of the policy, and the impact on other externalities is also not significant. For subsidy […] the impact on positive externalities seems not to match the level of the subsidy. For this reason the Commission recommends to enable CCS under the ETS, but not to make CCS mandatory or consider subsidy for the technology in the post-demonstration phase [authors' italics]".

14 Proposal for a Directive of the European Parliament and of the Council on the geological storage of carbon dioxide and amending Council Directives 85/337/EEC, 96/61/EC, Directives 2000/60/EC, 2004/35/EC, 2006/12/EC and Regulation (EC) No 1013/2006, Brussels 23 January 2008.

15 See for a discussion on potential CCS externalities under various policy scenario's: Commission staff working document; Accompanying document to the Proposal for a Directive of the European Parliament and of the council on the geological storage of carbon dioxide, Impact Assessment {COM(2008) X final}, Brussels 23 January 2008.

2.3 Incentives and timing

The above quote implies that for the post-demonstration phase CCS basically, as far as incentives are concerned, will have to rely almost entirely on its inclusion under the EU-ETS. This raises the issue of whether the trading scheme will provide sufficient incentives in the post-demonstration phase in order to get large-scale CCS activities off the ground near 2020. As far as the timescale of CCS introduction is concerned, the EU Flagship programme published on October 3, 2007 follows the sequence of steps shown in Figure 1.

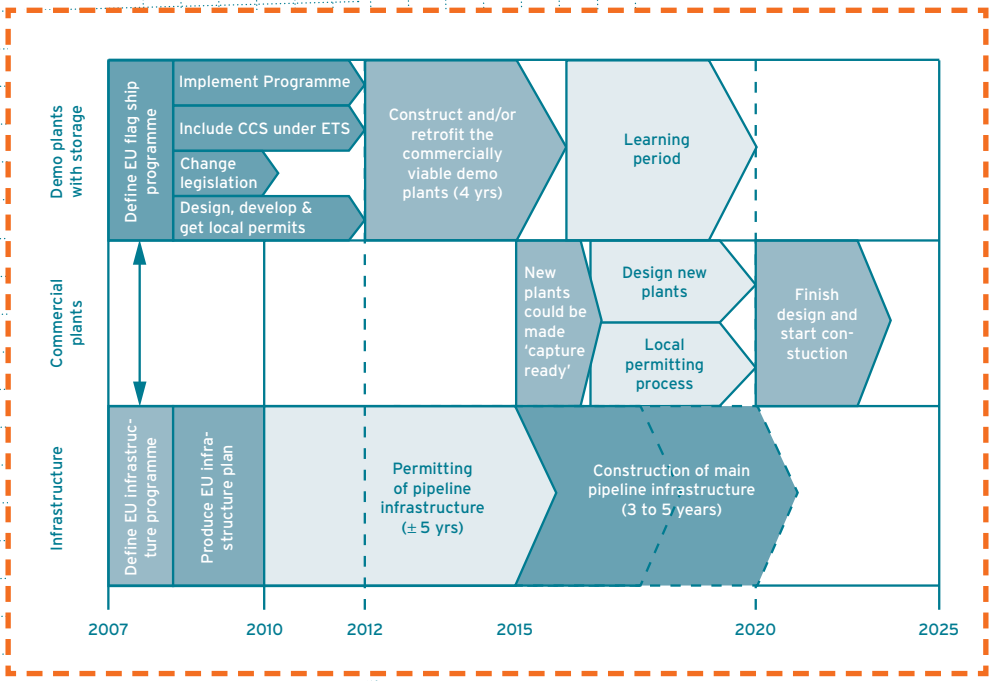

Figure 1 Proposed timeline CCS development and deployment (Source: ETP-ZEP, The EU Flagship Programme, General Assembly, Paris, 3 October 2007.)

The Figure shows a clear marker in 2012 (the end of EU-ETS-2) and in 2020 (supposedly the end of the CCS learning period and the beginning of the period of CCS maturity, and possibly also the end of EU-ETS-3 and of the post-Kyoto climate regime). In the following section, in line with the above 'Flagship timetable,' two sub-periods are distinguished:

1. 2008-2012: EU-ETS-2 (2.4),
2. 2013-2020 and beyond: the proposed EU-ETS-3 which coincides with the period leading to the year for which mitigation/efficiency/renewable targets have been set at the EU-level, and the period following that phase (2.5).

2.4 CCS and the EU-ETS 2008-2012

Whether or not CCS will develop into a mature, commercially feasible (given the various incentives) technology by about 2020 seems to depend strongly on the successful and timely launching of the Flagship Programme and on what can be achieved in terms of incentives during the preparatory stage until the end of 2012. The Working Group (werkgroep Schoon Fossiel[16]) would argue that if during this five-year period little progress were made with regard to establishing a predictable incentive system for CCS, setting up pilots and demos, and planning and designing infrastructure schemes within the EU, it is unlikely that CCS will develop into a full grown option in time. Therefore, incentives for investors and other relevant stakeholders need to be clear and convincing enough in order to act.

So far, little progress has been made in establishing such a clear set of incentives. Although some Member States have forwarded public support for CCS-R&D and pilots, public support throughout the EU has so far remained limited, whereas it is still mainly focussed on capture technologies. If, however, the Flagship Programme were to be launched with the objective to enable "10-12 full-scale, integrated demonstration projects in a variety of geographical and geological settings, Europe wide" (ETP-ZEFFPP, 2007, p.6) to be operational by 2015, the EU-ETS-2 phase will be needed to set the incentives right. This is particularly important since, as indicated above, the EC is not convinced about making CCS mandatory or subsidies for CCS in the post-demonstration stage (i.e. after about 2020).

For the period 2008-12, two sets of incentives for potential CCS technology investors can broadly be distinguished. On the one hand, specific incentives will be needed to get through the technology 'Valley of Death', such as subsidies, tax relief and other regulatory and legal measures, whereas on the other hand generic incentives could be offered through the inclusion of CCS in the EU-ETS (possibly combined with adjustments in the allowance allocation rules). In the following section, we will focus on the incentives through the EU-ETS only; for background information on additional support needed for the two envisaged demos in the Netherlands (through other means), the reader is referred to the respective business cases of Rijnmond and Eemsmond, which are likely to become available in the course of 2008.

EU-ETS 2008-12

After a somewhat disappointing EU-ETS-1 during 2005-07 with allowance prices popping up and down between virtually zero and about €30 per tCO_2, since January 2008 we have entered EU-ETS-2 where allowance prices so far have fluctuated around the €20-27 per tCO_2 level (see Figure 3).

16 See http://www.senternovem.nl/energietransitieng/Werkgroepen/schoon_fossiel/index.asp for more information on and publications of this working group (mainly in Dutch).

Figure 2 EUA price development EU-ETS 1 and 2 (December 2007) (Source: Point Carbon's Market Trader, Point Carbon, 11 March 2008.)

EU-ETS-1 was a learning phase, characterised by: over-allocation, windfall profits, and marginal incentives to realise real emission reductions. Most of the experience gained related to monitoring, verification and reporting by Member States and competent authorities. Other learning effects accrued to building EUA trading platforms and (National and Community) transaction logs. The over-allocation of EUAs became apparent around the publication date (15 May 2006) of the so-called Verified Emissions Data (VED) over the year 2005. This resulted in a substantial price drop of EUAs in 2006 (see Figure 2). After that, EUA prices declined to marginal levels of around €0.01 per tCO_2, which is highly insufficient to justify any investment in low carbon technologies[17]. Data in Table 2 show that at the aggregate level (i.e. EU-25), supply and demand fundamentals justified that the EUA prices

17 "The rate and direction of the technological change induced by the EU ETS crucially depends on the design of the scheme (Gagelmann, Frondel 2005; Schleich, Betz 2005). The general design of the EU ETS is governed by the EU Emission Trading Directive 2003/87/EC [...] and the country-specific design features are determined by the National Allocation Plans (NAPs) of individual MS".
"While the size of the ET [Emissions Trading] budget at the macro level of the NAPs indicates whether the EU ETS is environmentally effective in terms of reducing CO_2 emissions, the allocation rules specified at the micro level govern whether the emission reductions can be achieved at low cost to society. In particular, the allocation rules for existing and new installations and for closures govern incentives for innovation and long-term investments in low-carbon energy technologies and in energy-efficiency in the industry sectors. In terms of distribution, the micro plan also pre-determines the winners and losers of emission trading".
Both quotes from: Betz, K., et al., 'An early assessment of National Allocation Plans for Phase 2 of EU Emission Trading', 2006.

eventually became very low (average annual over-allocation[18] of about 7%, i.e. about 150 $MtCO_2$-eq./a) during the 2005-7 period. As a consequence, EU-ETS-1 has generated marginal environmental effectiveness in that only little real emission reductions, other than based on autonomous technological progress, have been achieved.

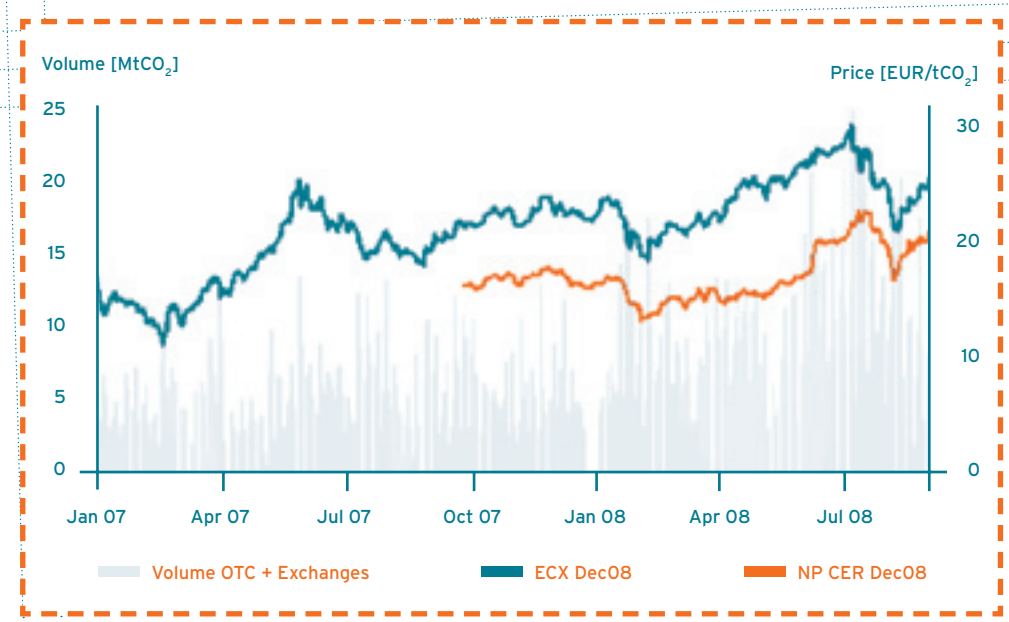

Figure 3 EUA volumes and prices (and CER) on ECX Dec08 futures (Source: CO_2-weekly by Fortis, 1 September 2008.)

In EU-ETS-2 the total allowed emissions level of the approximately 11,500 installations covered by the scheme is about 9.5% lower on average than during EU-ETS-1 (2081 Mt vs. 2,298.5 Mt[19]). This was the result of the corrections on earlier proposed national allocation plans (NAPs) by the EC (for basic data see Table 2).

18 On a micro-level, dependent on specific allocation rules and methodologies, there have been installations on a long or short EUA position, which justifies intra-member state and intersectoral trade in EUAs. Although the overall level of scarcity was not stringent in Phase I, which justifies a price one cannot simply speak of a general tendency to overallocate at the micro-level. The initial level of information assymetry in the market regarding long- and short EUA positions is a possible explanation of the high EUA Phase I prices experienced before april 2006.
For a more detailed discussion on Phase I and overallocation, see Buchner, B. and Ellerman, D. E. (2006),'Over-Allocation or Abatement? A Preliminary Analysis of the EU Emissions Trading Scheme Based on the 2005 Emissions Data'.

19 Note that due to an expansion of the EU-ETS coverage the data of both phases is not entirely comparable.

Allocation Ph I & II	$MtCO_2$-eq./a
EU-ETS 1 Cap	2,181.4 (2298,5[20])
VED 2005	2,012.54
VED 2006	2,028.97
VED 2007	2,051.93
EU-ETS 2 Cap	
Proposed	2,325
Allowed	2,081 (89.5% of proposed)
Optimum linking allowed	278.25 (13.37% of allowed)

Table 2 Allocation data EU-ETS 1 and 2 (for EU-25/27) (Source: various sources (see Table 3 for detailed EU NAP data).)

Thus far, the EU-ETS-2 cap seems to have created more scarcity in the market given the aggregate allocation level. The EU-ETS-2 allowance price (December 2008 delivery) development so far supports this impression as allowance prices have fluctuated during September 2005 to August 2008 within a range of about €12-30 per tCO_2, and ranges between €20-30 per tCO_2 since May 2007, both on the spot and futures exchanges (see Figure 2 and 3). However, as the analysis below shows, it remains uncertain whether during the remainder of EU-ETS-2, allowance prices will remain stable and broadly at current levels. Views on this seem to vary fairly widely[21].

As far as the EU-ETS-2 EUA price development is concerned, some experts tend to rely on information about the forward market where future contracts are traded for a few years ahead (for futures expiring after 2010 non-bilateral trade is virtually absent). They tend to focus on futures prices as a predictor of future spot prices. In doing so, one may, however, easily overlook that the allowance market is still immature and highly driven by sentiments (witnessing also the EU-ETS-1 developments). According to the PEWCENTER (May 2008), "the activity in commodity markets is often motivated more by financial considerations than that it is by needs for compliance trading. Financial transactions reflect the desire of emissions sources to hedge their positions as well as the activities of traders taking the other side of these hedges or otherwise speculating on movements in market prices. These transactions involve futures contracts for which many if not most of the positions taken are liquidated prior to their maturity thereby avoiding any

20 For Phase I and Phase II comparison Romania and Bulgaria (default) data has been included.

21 For Phase 2 respectively Fortis, UBS and Point Carbon expect an EUA price range of €27-48, €25-25 and €30-30, and for Phase 3 respectively Fortis, UBS, New Carbon Finance and Point Carbon project EUA price ranges of <€100, €40-40, €35-55 and €30-70.
Sources: Kris Voorpools, 'Special report: post 2012 ETS proposal – impact on Phase two price forecast', Fortis, Feb. 2008; Per Lekander et al, 'EU emission trading scheme', UBS investment research, Feb. 2008; 'EU-ETS deep dive analysis', New Carbon Finance, Feb. 2008; 'Updated fair price assessment, phase II EU ETS', Point Carbon, March 2008.

physical delivery. Trading for purposes of compliance will always be a part of observed trading but it can be a small part."

Having said that, carbon markets increasingly seem to follow the price patterns of oil and gas markets; correlations have recently increased (i.e. since 2007) to 0.7 or more[22]. The economic argument could be that oil price increases are broadly followed by comparable gas price increases and that this stimulates coal consumption of power generators with consequent increases in CO_2 emissions. This would increase EUA demand. In actual practice, however, the strong correlation between oil/gas and EUA prices may be also the result of the need for an anchor in an otherwise fairly immature EUA carbon market, i.e. without a clear sense of direction of its own. High oil/gas prices will inspire the use of coal, but only to the extent: that relative coal prices lag behind, the use of coal does not become cleaner (via CCS or otherwise), that oil and gas are not replaced by non-coal sources (renewables or nuclear), and that switching is technically and economically feasible within a reasonably short time-frame.

One may therefore question to what extent the current very high correlation between EUA and oil prices is based on economic fundamentals or on the need for a powerful price-anchor[23].

For the understanding of the future EUA price level it is therefore important to also focus on the economic fundamentals in greater detail. Most EU-ETS analysts seem to agree that the level and direction of the allowance market variables are to a large extent determined by what will happen with regard to:

a. the degree, to which the linking option is activated (including domestic offsets),
b. generic allowance demand factors, such as economic growth, energy and climate policy trends, energy prices, and weather conditions,
c. the impact of the banking facility enabling to transfer EUAs from EU-ETS-2 to EU-ETS-3, in combination with the allocation regime during EU-ETS-3.

22 Source: Reuters News (22 May 2008), 'Carbon's correlation to energy prices strengthens'.

23 For a recent study that questions the role of market fundamentals in explaining oil price rise and volatility, see "The role of market speculation in rising oil and gas prices: a need to put the cop back on the beat", Staff Report prepared by the Permanent Subcommittee on investigations of the Committee on homeland security and governmental affairs U.S. Senate, June 2006.

a. The linking option

One particular issue with a significant potential allowance price impact relates to the so-called Linking Directive (Dir. 2004/101/EC), which is an amendment to the EU-ETS Directive (Dir. 2003/87/EC). The Linking Directive offers Member States the freedom to allow, to a limited extent, their installations covered by the EU-ETS regime to fulfil their commitments under the scheme by using Kyoto project-based credits. This option has been activated by a number of Member states for EU-ETS-2 so that in theory the volume of all allowances allocated EU-wide can be enlarged by 13.4% of Kyoto credits.

Although in theory the EU-27 EU-ETS-2 emission allowance level can be increased by 13.4% (see also Table 3), the percentages differ among Member States. Some Member States allow a linking of 20% of allocated allowances whereas others remain between 10 and 15%. Based on this facility, the theoretically maximum demand for Kyoto credits from the EU-ETS (i.e. from EU-27 as a whole) during EU-ETS-2 amounts up to about 1.39 bn tCO_2. The degree, to which Kyoto credits can and will be used for compliance obviously depends on how perfectly the market allows for arbitrage (for more detailed information on the demand/supply balance of external credits, see Annex 1).

Currently, for EU-ETS-2 the linking option has been delayed in the absence of national emission registration systems covering all individual EU member states (the EC has decided to wait until full coverage is reached before linking to the Kyoto registration system, which is expected to be achieved by April 2009 at the latest). If the current registry problems will be overcome, however, there does not seem to be any serious economic obstacle for using Kyoto credits for compliance[24] because transaction costs of using certified and issued Kyoto credits instead of allowances are negligible.

As it is demonstrated in Annex 1, it seems that, without arbitrage, (opportunity) costs of the abatement action on which the Kyoto credits are based, will inherently be lower than those of EU allowances. If so, there is no reason why installations and/or traders would not engage in arbitrage so that Kyoto credit- and allowance prices will tend to (further) converge.

24 Even over 2008, at least if the system works before April 2009.

NAPs and VED	Cap/a/a EU-ETS 1	2005 verified emis-sions	2006 verified emis-sions	2007 verified emis-sions	Propo-sed cap/a EU-ETS 2	Allowed cap/a EU-ETS 2	% allo-wed of propo-sed cap/a EU-ETS 2	%linking allowed EU-ETS 2	Linking absolute value EU-ETS 2	Total Cap (EUA + Linking) EU-ETS 2
Germany	499	474.61	477.56	487.01	482	453.1	94	20	90.62	543.72
UK	245.3	242.48	251.14	256.58	246.2	246.2	100	8	19.7	265.9
Poland	239.1	202.32	208.63	209.6	284.6	208.5	73.3	10	20.85	229.35
Italy	223.1	225.88	227.08	226.37	209	195.8	93.7	14.99	29.35	225.15
Spain	174.4	183.62	178.6	186.5	152.7	152.3	99.7	20	30.46	182.76
France	156.5	131.27	123.29	126.63	132.8	132.8	100	13.5	17.93	150.73
Czech Rep.	97.6	82.46	83.63	87.83	101.9	86.8	85.2	10	8.68	95.48
Netherlands	95.3	80.35	76.7	79.87	90.4	85.8	94.9	10	8.58	94.38
Romania*	74.8	70.8	70.8	69.6	95.7	75.94	79.35	10	7.59	83.53
Greece	74.4	71.27	69.97	72.72	75.5	69.1	91.5	9	6.22	75.32
Belgium	62.1	55.36	54.78	52.8	63.33	58.5	92.4	8.4	4.91	63.41
Finland	45.5	33.1	44.62	42.54	39.6	37.6	94.8	10	3.76	41.36
Bulgaria**	42.3	40.6	40.6	40.6	67.64	42.27	62.49	12.55	5.3	47.57
Portugal	38.9	36.43	33.08	31.18	35.9	34.8	96.9	10	3.48	38.28
Denmark	33.5	26.48	34.2	29.41	24.5	24.5	100	17.01	4.17	28.67
Austria	33	33.37	32.38	31.75	32.8	30.7	93.6	10	3.07	33.77
Hungary	31.3	26.04	25.83	26.84	30.7	26.9	87.6	10	2.69	29.59
Slovakia	30.5	25.23	25.54	24.52	41.3	30.9	74.8	7	2.16	33.06
Sweden	22.9	19.38	19.88	15.35	25.2	22.8	90.5	10	2.28	25.08
Ireland	22.3	22.44	21.7	21.25	22.6	22.3	98.6	10	2.23	24.53
Estonia	19	12.62	12.11	15.33	24.38	12.72	52.2	0	0	12.72
Lithuania	12.3	6.6	6.52	6	16.6	8.8	53	20	1.76	10.56
Slovenia	8.8	8.72	8.84	9.05	8.3	8.3	100	15.76	1.31	9.61
Cyprus	5.7	5.08	5.26	5.4	7.12	5.48	77	10	0.55	6.03
Latvia	4.6	2.85	2.94	2.85	7.7	3.43	44.5	10	0.34	3.77
Luxembourg	3.4	2.6	2.71	2.57	3.95	2.5	63	10	0.25	2.75
Malta***	2.9	1.98	1.98	1.98	2.96	2.14	71	0.00 (tbd)	0	2.14
EU 25	2,181.4	2,012.54	2,028.97	2,051.93	-	-	-	-	-	-
EU 27	2,298.5	2,123.94	2,140.37	2,162.13	2,325.38	2,080.98	89.49	13.37	278.25	2,359.23

Table 3 EU-ETS 1 and 2 basic NAP data on allocations and linking. (Source: various official EC data sources.)

* Romania: as Romania only started participating in the EU-ETS in 2007, 2005 and 2006 values are default estimates. 2007 data for Romania are verified emissions.

** Bulgaria: as Bulgaria only started participating in the EU-ETS in 2007, 2005 and 2006 values are default estimates. No verified 2007 data for Bulgaria was yet available (so current value default estimate is used).

*** Malta: for Malta also default estimates have been used for 2005, 2006 and 2007.

The Linking Directive applies a 1:1 conversion factor for EUA/Kyoto credit (i.e. CERs and ERUs) conversion. So, if all Kyoto credits allowed for under the Linking Directive would be used, the EU-wide annual amount of allowances available during 2008-12 reaches a level of 2,359 $MtCO_2$. This amount is approximately the same as all individual Member State caps taken together (i.e. 2,325 $MtCO_2$-eq./a) for EU-ETS-2 (see Table 2)!

Although a 1:1 comparison between EU-ETS-1 and 2 caps is not entirely justified as new installations and new sectors have been included and the opt-out provision in Phase 1 has been abolished in Phase 2, the correction factors do not seem large enough to take away the impression that allocation, on aggregate and on average[25] (including allowances available through linking), does, ceteris paribus, not seem to add substantial scarcity to the EU-ETS system for Phase 2 as compared to Phase 1 (see also Table 2).

A particular, recent discussion emerging in the EU is if domestic offsets, if activated, could be used in the EU-ETS. This discussion relates to Phase 3 only (Phase 2 does not seem to recognise linking via domestic offsets) and will therefore be discussed in greater detail in Section 2.5 next. The concept is that abatement achieved domestically in sectors not covered by the EU-ETS would be credited because it is equally effective as any other project-based abatement. Such credits would then be accepted within the EU-ETS, thus adding to potential overall allowance supply. The current EU-ETS-3 proposal foresees such provision for domestic offsets, while linking Kyoto credits in this Phase will be ruled out (unless a 30% EU-mitigation target for 2020 can be agreed upon internationally).
To what extent allowance supply may be increased through the domestic offset facility remains to be seen, but since the EU-ETS sectors represent less than half of the economy (and the non-EU ETS sectors therefore more than half of the economy), the potential would seem significant.

b. Generic allowance demand factors

Clearly overall economic growth in the EU is a strong determinant of energy use and therefore emissions. Given the aftermath of the credit crisis that we are currently facing, EU economic growth projections for the next couple of years have recently significantly been revised downwards with growth figures of a full percentage-point less than anticipated about a year ago. This would have a serious downward impact on emission trajectories.

25 Please note that Member States do generally not allocate EUAs on an equal spread per annum and that thus in individual years within Phase II significant shortages, as well as surpluses, can occur. However, as installations are allowed to bank (and borrow within period) surpluses between years and within a specific trading period, this effect is likely to be marginalised.

In addition, some studies have indicated that the gradually changing weather patterns may also have a non-negligible mitigation impact, especially if the trend of mild winters in the last decade would continue and if there would be no increase in persistent droughts.

Energy prices and therefore, albeit with a delay, incentives to raise energy efficiency fluctuate. It is well possible that, if EU-wide and worldwide economic growth would tend to slow down during the next years, energy prices will peak around now and gradually decline in the near future. If so, the incentives to increase energy efficiency may still work, while energy prices themselves are already on their way downward. In such a case, emissions may slow down by the combined effect of less economic growth and a strong energy efficiency trend.

In other words, normal variations in weather, economic growth and other factors will typically be responsible for BAU emission variations of, according to some sources, 5 to 10%.[26] Consequently, if a number of factors coincide (surprisingly low economic growth in the EU, favourable weather conditions, surprisingly high levels of energy efficiency improvement, etc.), emissions in the EU may well be 100-200 Mt/CO_2 less than BAU (and vice versa if trends are opposite).

c. The impact of the banking

There is no limit to the banking option, i.e. to hoard allowances for later use, irrespective of whether such a later moment will be in a next EU-ETS phase. Through banking, the allowance owner looses the interest foregone on the capital embedded in the allowances. However, this loss could be compensated by a higher allowance price later on. So, it is up to the allowance owner to optimise the allowance portfolio based on his/her allowance price expectations.

Generally, there will be an incentive to bank allowances when there is a growing expectation that allowance prices will increase at a rate which is, on average, higher than the interest rate. This will have an impact on the market conditions as it enhances scarcity at an earlier stage, but reduces scarcity later on. Obviously, a large stock of allowances may create significant allowance price volatility if market expectations suddenly change.

This also raises the question to what extent allowance scarcity in EU-ETS-2 will be lower than in EU-ETS-3. Although it is yet to be seen how scarcity will evolve after 2012, even with the likely contours and design features of the EC plans for Phase 3 becoming clearer, there is increasing evidence that in fact aggregate scarcity during Phase 2 will be very limited. From the various literature sources that have analysed the overall picture of allowance demand and supply sources, it can be concluded that, with inclusion of the Linking Directive, all net demand can probably be met

26 Ellerman and Joskow, 'The European Union's Emissions Trading System in Perspective', MIT, PEW Center, May 2008.

through the use of CERs and ERUs, which are the only KP credit types allowed for compliance during EU-ETS-2 (for an extensive overview see Annex 1). Moreover, there is an additional indirect credit supply stock which is most likely even larger, namely the surplus AAUs of mainly Central and Eastern European countries. Since Kyoto Parties can use AAU surpluses for compliance purposes[27], AAU and CER/ERU markets are linked. Consequently, the AAU overhang under the KP may translate itself into a CER/ERU overhang under the EU-ETS[28].

The available data (Annex 1) suggests that the cumulative supply of AAUs during 2008-12 can range from 2.5 to 7 bn, depending on the range of assumptions chosen. In addition, the cumulative supply of CERs and ERUs during the same period has recently been projected at a conservative figure of around 2 bn. (reflecting among others the CDM success story). More optimistic estimates, however, indicate that CER/ERU supply could easily grow to 3 bn. At the same time, corresponding cumulative credit demand under the Kyoto Protocol and the EU-ETS (Phase 2) combined is projected to range between 2.3 and 2.8 bn (of which about 1.1 bn based on EU-ETS). These demand projections do not yet take into account the current EU-wide economic slowdown and may therefore need to be revised downwards.

When comparing these supply and demand figures, while assuming that the current obstacles to AAU, CER and ERU markets and related arbitrage activities will be removed during this commitment period, it can be concluded that Phase 2 is not characterised by credit scarcity. In the most 'pessimistic' case, cumulative credit supply surpasses cumulative credit demand four times; in the most 'optimistic' case projected supply still surpasses demand by a factor of about 2.

The extent to which the likely credit supply overhang during Phase 2 will be channelled through to Phase 3 via banking remains to be seen and it obviously also depends on the expected net demand during Phase 3 (see 2.5). Even if the current ERU/CER linking in Phase 2 would no longer exist during Phase 3, the impact of linking will still be felt in Phase 3 via the credits banked. Should the linking option be fully exploited by the EU-ETS installations, about 1.4 bn JI/CDM credits would be acquired. And if all installations would bank all those credits, in theory a similar amount of credits could be activated during 2013-20, or about 175 m per annum.

27 The idea that Annex 1 Parties would collectively decide not to acquire (all) AAUs for compliance purposes, or to only use the KP art. 17 facility to a limited degree, is ruled out in this analysis; the idea that the suppliers of AAUs would collectively decide to only put a limited amount on the market during the KP commitment period was however taken into account. See also Annex 1.

28 Based on the calculations and data provided in Annex 1 during EU-ETS 2, there is a (public) 'demand shift potential' between CERs/ERUs and AAUs by the EU-15 (mainly deficit countries) ranging from 330 to 390 $MtCO_2$ (assuming the EU-10, mainly Eastern European countries, does not intend to purchase AAUs as they are already in surplus).

2.5 EU-ETS-3, 2013-20

A few studies[29] have tried to analyse the likely development of the EU-ETS-3 allowance market and to project supply and demand patterns. In these studies, a number of key variables have been distinguished which are likely to have a decisive impact on allowance prices:

a. the allocation regime during EU-ETS-3,
b. the impact of the banking facility enabling transfer of EUAs from EU-ETS-2 to EU-ETS-3,
c. the degree to which the linking options are activated (e.g. via domestic offsets).

a. The allocation regime during the third phase

Presently, little is known about the eventual shape of the Phase 3 allocation regime. However, the EC has released its recommendation for improving the EU-ETS for Phase 3, which includes the suggestion to linearly reduce the annual EU-ETS cap from 1,974 Mt in 2013 to 1,720 Mt in 2020. After correcting for differences in system coverage between Phase 2 and 3, the recommended EC cap boils down to a 36 Mt annual average reduction during Phase 3. Although it remains to be seen how the above recommendation will be translated in final political decision-making, it provides the most accurate picture available for assessing future EUA prices so far.

b. The impact of banking

As has been argued above, there is no limit to the banking facility. Both Phase 2 EUAs and CERs/ERUs based on Phase 2 linking can be used freely for Phase 3 compliance. Depending on assumptions regarding market players' banking behaviour, this could lead to various scenarios. Assumptions may range from a situation in which almost all CERs/ERUs that can be acquired under Phase 2 (about 1.4 bn) will be used in Phase 3, as well as some EUAs stored on top of that, to a situation in which a considerable part of CERs/ERUs will be used during Phase 2 in order to avoid taking new mitigation action now. Since projections so far have suggested a cumulative Phase 2 abatement requirement in the order of 0.5 bn tCO_2 at most, which, by the way, is within the natural annual variation based on generic allowance demand factors of 5-10% mentioned earlier, even under the second assumption still approximately 0.9 bn credits could be banked to Phase 3. If the two assumptions are translated into some ballpark figures, the former could result in a Phase 3 banking-based credit supply of 1.5 bn (1.4 bn CER/ERU banking + 0.1 bn EUA banking), while the latter boils down to a supply of about 0.9 bn.

c. The degree to which the linking option is activated

The EC has so far clearly indicated that it wants to terminate the Phase 2 linking provision because of their concern that it could act as a disincentive for EU-ETS installations to increase mitigation activities themselves. A final position on this, however, has not yet been taken and will depend on future successful international climate negotiations that may inspire the EU to adopt the 30% mitigation target for

29 For sources, see footnote 21 and 30.

2020 rather than the 20% unilateral mitigation target. It has been announced that if a 30% target would be adopted, (elements of) international linking will remain.

At the same time, the EC has clearly opened the door for a new linking vehicle, i.e. the use of domestic offsets for creating allowances accepted within EU-ETS-3. Although the EC clearly wants to make such a facility contingent upon harmonised project rules, exclusion of double counting, and no interference with other mitigation policies in the EC, this new facility offers great potential as the EU-ETS covers less than half of the EU economic activity. Typically, firms that are too small to participate in the EU-ETS and that want to take clear mitigation initiatives may be interested in exploring this option. One could think of domestic offset activities in small-scale decentralised energy production, agriculture, the built environment and transport sector, etc., which, once triggered enough, collectively may grow into a very substantial effort and therefore source of supply of additional allowances during Phase 3.

It is very hard to predict the possible Phase 3 allowance supply based on possible domestic offsets. Nonetheless, since this option would be available for over half of total EU emissions' activities, and since probably no-one can a priori be ruled out from taking domestic offset initiatives, it seems reasonable to assume a cumulative additional emission reduction in non EU-ETS sectors of about 0.5 bn tCO_2 during 2013-20, or about 2.5% of a broadly estimated cumulative 20 bn tCO_2 (of non EU-ETS EU emissions).

Some sensitivity analysis

Different assumptions with respect to the numerical values of the above three key variables will obviously lead to quite different projections of the credit supply-demand balance during Phase 3. Such an assessment is carried out below based on a number of assumptions (in line with two recent publications by Deutsche Bank[30]):

1. On average EU BAU emissions grow by 0.5%.
2. During 2008-20 annual CO_2 savings increase to 90 Mt/y via energy efficiency measures, and 220 Mt/y via increased renewable energy production.
3. There will be no new types of additional allowance demand from sources outside the EU-ETS, such as other emissions trading schemes.
4. The allocation caps are in conformity with the EC announcement, i.e. declining from 1.974 bn tCO_2 in 2013 to 1.72 bn tCO_2 in 2020.

Based on these assumptions, projected cumulative BAU EU-ETS-3 emissions are 16.66 bn tCO_2 with a corresponding cumulative cap of 14.77 bn tCO_2. The difference between the two, 1.89 bn tCO_2, will need to be covered by the combination of: i) credits banked during Phase 2 (ranging from 0.9 to 1.5 bn tCO_2, see above), ii) allowances based on domestic offsets (ranging from 0.0 to 0.5 bn tCO_2, see above),

30 'The ETS Review: a first reaction', Deutsche Bank, 24 January 2008, and 'Getting tigther: why the Phase 2 cap is even tougher than it looks', Deutsche Bank, 8 April 2008.

and iii) the residual abatement required by additional activity of the EU-ETS installations. Clearly, the latter residual variable will determine allowance scarcity and therefore allowance prices. Given that the available-allowances-based banking and domestic offsets may vary between 0.9 bn and 2.0 bn tCO_2, the residual mitigation effort required would range between 0 and about 1 bn tCO_2 during 2013-20, or about 0-125 $MtCO_2$/a average (corresponding with 0 to 6-7% of the annual cap). Therefore, little can be said a priori about the eventual scarcity situation during EU ETS-3. The random factor based on generic allowance demand variability (about +/- 100-200 $MtCO_2$/a) may therefore typically play a crucial but rather unpredictable role during that Phase.

To put it differently, there is a thin line between a Phase 3 scenario without any noticeable allowance scarcity and a scenario in which such scarcity is strongly felt. Which of the two will eventually become reality basically depends on a set of fairly coincidental, hard to predict and uncontrollable factors. Most likely clarity about the real Phase 3 scarcity situation will only arise as Phase 3 progresses.
It is therefore difficult to see how such an uncertain EUA scarcity scenario can act as a solid guide for long-term capital-intensive investments in CCS and other innovative technologies.

3 INCENTIVES FOR CCS BEFORE THE MATURITY STAGE

Much has been said already about the incentives, both financial and non-financial, that are required in order to help technologies involved to successfully pass through the learning stage preceding market maturity. These need not be repeated here. During this stage between basic R&D and commercialisation of CCS, common externalities indicate that private market players will not carry the CCS knowledge base any further without external support. This implies that there is a clear role for public funding during the pilot-demo stage. Since the costs of developing and applying the first sets of CCS technologies are commonly higher than the final costs, once large-scale application is feasible, incentives need to be significant and predictable. The EU-ETS incentive may play some role during this stage, but is very unlikely to provide an incentive that is high and stable enough to carry the industry through the transition phase. This is more so given the policy desire to get through the transition stage relatively quickly in order to be able to implement CCS on a commercial basis as of about 2020.

So far, public support for CCS pilots and demos has remained fairly modest throughout the EU, although initiatives, especially towards establishing significant demo projects under the EU Flagship Programme, are now progressing in a number of Member States. The issue of how the pilot and demo development could be supported has therefore become rather acute: if one wants to achieve the EU target of having 10-12 CCS demos operational by 2015, there is little time left to prepare for that. This also requires that incentive schemes will be properly designed soon. Thus far, incentives have typically been based on EU-ETS incentives, state aid of individual EU Member States (possibly under 'préjugé favorable' conditions), or otherwise.

Given the expected amount of funding required to get the 10-12 demos up and running (see the ETP-ZEP mentioning €6-10 bn in incremental costs or even more), a recent Netherlands' proposal has suggested to use about 20% of the EU-ETS allowance auctioning revenues for energy transition support, including CCS. If half of the about 1.85 bn annual average allowances under the Phase 3 cap would be auctioned against prices ranging between €15-25[31], EU-wide auction revenues for the whole 8-year period could range from €110 to 185 bn (or about €12.75 – 23 bn per

31 Note that the assumption that about half of the allowances would be auctioned is a very conservative one. It is well possible that this share will be larger than that. Note also that during Phase 2 only about 75 $MtCO_2$ of EU allowances will be auctioned (source: see footnote 32), or about 4% of the EU cap and about 35% of what was maximally allowed (200 $MtCO_2$). During Phase 3 the power sector is scheduled to be subject to auctioning for all their allowances; the precentage for EU-ETS sectors exposed to heavy international competition, is scheduled to be increased stepwise from 20% to 100% auctioning from 2013 to 2020.

annum), which surely is a potentially substantial amount of funding that could become available for clean energy technology investments.

Assuming a share of the Netherlands in the overall EU-wide allowances of about 4%, and assuming that 10% of the Dutch auction revenues would be used for domestic funding of CCS demos, the above would imply that annually an amount of between €55-93 mn would be available annually for CCS support, or about €440-740 mn during Phase 3.

The problem, however, is that if demos are to be operational in 2015, funding support will be needed much earlier than 2013. For Phase 2 auctioning is likely to remain restricted to 75 $MtCO_2$ per annum for the whole of the EU-ETS[32]. Against EUA prices of about €20, this amounts to €150 m per annum (or about €750 m for Phase 2), which is far too little to provide the support needed for the energy transition, let alone for the 10-12 CCS demo plants which are part of that transition.

This timing problem is even more urgent in the Netherlands, where cumulative auctioning revenues during Phase 2 can theoretically amount to 43 $MtCO_2$ at most (assuming 10% maximum auctioning in Phase 2), while at least two demo projects are foreseen. Because discussions on auction design[33] are still ongoing, because of the risk of EUAs leaving the country via foreign buyers[34], and because of the possible competitive impact of auctioning, there are still questions as to how, according to what procedures and for what entities EUAs will be auctioned, let alone what share of any auction revenues could be made available for CCS support[35].

In line with the Phase 2 NAP of the Netherlands, however, it has been indicated that only about 16 $MtCO_2$ (cumulatively) will be sold on the market during Phase 2[36].

32 Source: report by Point Carbon Advisory Services (March 2008): EU ETS Phase 2, 'The potential and scale of windfall profits in the power sector' p. 6-7.

33 Letter to Parliament, 'Aanpak veilen emissierechten 2008-2012', 18 February 2008.

34 When designing an EUA auction individual Member States generally are expected to aim for revenue maximisation. This objective could imply open bidding for both domestic as well as foreign entities (either being EU-ETS installations or even financial institutions). Although from a revenue maximisation perspective more bidders can be desirable, auctioning off part of the National A llocation to foreign entities might become an important issue. Up to this point no clearly defined auction design/format has been proposed, nor have quantitative cost-benefit assessments been published on potential trade-offs of specific auction formats both in terms of price-effects (e.g. due to strategic gaming behaviour) and distributional effects.

35 Moreover, as in Phase 2 the distribution of auction revenues is most likely to be in the hands of the individual Member States, the announced harmonisation of Phase 3, which could just as well include EU-wide auctioning, might face political resistance as to the distribution of the expected revenues of such an auction.

36 Phase 2 National Allocation Plan of the Netherlands (Nederlands Nationaal toewijzingsplan broeikasgasemissierechten 2008-2012, geconsolideerde versie juli 2008).

Assuming, again, a credit price of about €20/tCO_2, the return of these sales will be in the range of €300-350 m. Assuming that 20% of these returns would be earmarked for CCS support, this would boil down to an amount of only €60-70 m during the entire second phase. Given the high ambitions of the Netherlands in launching CCS pilots and demos, this amount is highly insufficient. Therefore, the issue of financing CCS deployment in the Netherlands, and its timing, is urgent and needs to be resolved via additional support mechanisms.

CONCLUDING SUMMARY

1. The EUA market analysis has shown that EUA prices both for Phase 2 and Phase 3 are very hard to predict because of the large number of still unknown variables. The most important ones for Phase 2 are:
   a. the extent to which the linking option is activated (including domestic offsets),
   b. generic allowance demand factors, such as economic growth, energy and climate policy trends, energy prices, and weather conditions,
   c. the impact of the banking facility enabling a transfer of EUAs from the second to the third phase of EU-ETS, in combination with the allocation regime during the third Phase.

   For Phase 3[37]:
   a. the allocation regime during the third phase,
   b. the impact of the banking facility enabling a transfer of EUAs from the second to the third phase of EU-ETS in combination with
   c. the extent to which the linking options are activated (e.g. via domestic offsets).

2. Supply-demand assessment for Phase 2 suggests potential aggregate oversupply and for Phase 3 anywhere between clear credit scarcity and no scarcity at all. A fortiori, nothing final can be said about post 2020 EUA prices, assuming that the ETS will then still exist, even if EC officials tend to present carbon price expectations for 2020+ in the order of €40-45/tCO_2[38].

3. Meanwhile, actual EUA prices increasingly tend to positively correlate with oil prices, for which expectations for the next decade fluctuate widely.

4. Consequently, the EU-ETS cannot be expected to provide a clear sense of direction as a key incentive for CCS investments. Most of the literature on the investment-uncertainty relationship suggests that carbon price uncertainty due to behavioural aspects on average will lead to postponement of investments[39].

37 Also all design features of Phase 3 are not yet fully clear even if the EC has meanwhile expressed its desire: to centralize allocation, to switch from traditional grandfathering towards auction-based allocation for at least some categories of installations, to further restrictions on linking, and to extend the installations' coverage of the system.

38 E.g. Scott Brockett (DG Environment) during the 'Conference on CCS in a low carbon energy future', The Hague, June 30, 2008.

39 For a literature review and some original analysis, see S. Fuss, 'Sustainable energy development under uncertainty', PhD thesis, University of Maastricht, 24 April, 2008 (notably Chapter 2-4).

5. It is important to note that in theory price incentives for CCS should be such that externalities are also taken into account (see COM(2008) XXX, p.21), e.g. impacts from learning by doing, benefits related to security of supply, technology export promotion, and other net environmental effects.

6. So far, public support for CCS pilots and demos has remained fairly modest within the EU, although initiatives, especially towards establishing significant demo projects under the EU Flagship Programme, are now progressing in a number of Member States. Incentives have thus far been typically based on unilateral CCS/EU-ETS incentives, state aid of individual EU Member States (possibly under 'préjugé favorable' conditions), or otherwise.

7. Given the expected amount of funding required to get the 10-12 demos up and running (see the ETP-ZEP mentioning €6-10 bn in incremental costs or even more), a recent proposal has suggested to use about 20% of the EU-ETS allowance auctioning revenues for energy transition support, including CCS. If half of the about 1.85 bn annual average allowances under the Phase 3 cap would be auctioned against prices ranging between €15-25[40], annual EU-wide auction revenues for the entire 8-year period could vary between €110-185 bn (or about €13.75-23 bn per annum).

8. The problem, however, is timing, i.e. for demos to be operational in 2015, funding support is needed much earlier than by 2013. For Phase 2 auctioning is likely to remain restricted to 75 $MtCO_2$ per annum for the entire EU-ETS. With EUA prices of about €20, this amounts to €150 m per annum (or about €750 m for Phase 2), which is far too little to provide the support needed for the energy transition, let alone for the 10-12 CCS demos that are part of that transition.

9. For the Netherlands there is a comparable timing problem, which is probably even more urgent. In the Phase 2 NAP of the Netherlands, however, it has been indicated that only about 16 $MtCO_2$ (cumulative) will be sold at the market during Phase 2. Assuming, again, a credit price of about €20/tCO_2, the return from these sales will be in the range of €300-350 m. Assuming that 20% of these returns would be earmarked for CCS support, this would boil down to an amount of only €60-70 m during the entire Phase 2. Given the high ambitions of the Netherlands in launching CCS pilots and demos, this amount is highly insufficient. Therefore, the issue of (timing of) supporting CCS deployment needs to be resolved fast.

40 Note that during Phase 2 only about 75 $MtCO_2$ of EU allowances will be auctioned, or about 4% of the EU cap and about 35% of what was maximally allowed (200 $MtCO_2$). During Phase 3 the non-exposed power is scheduled to be subject to auctioning for all their allowances; the precentage for exposed sectors is scheduled to be increased stepwise from 20% to 100% auctioning from 2013 to 2020.

10. Support for CCS development by using part of EUA auction revenues during Phase 3 looks promising,[41] but will be too late also in the Netherlands' case.

Recommendation

- In view of the most likely insufficient incentives (in terms of level, direction and predictability) from EU allowance price development for CCS investment to guarantee a sufficiently rapid transition of CCS into a mature technology by 2020,
- Since auctioning all or part of the EUAs will also fail to provide sufficient financial support for CCS in time,
- Given the high ambitions of the Netherlands' government, both in terms of 2020 mitigation target and in terms of CCS targets, aiming for two envisaged Flagship demos (Eemsmond and Rijnmond) to become operational by 2015,
- Since without strong and timely support our country runs the risk of losing a potential CCS front-runner position within Europe, and
- Since the business cases for the potential Flagship demos are likely to be presented during the second half of 2008,

The working group 'Schoon Fossiel' concludes that the EU ETS in its present design will most likely not be able to provide sufficient incentives to realise the CCS demos foreseen in the Netherlands, even if in addition auctioning revenues will be used for the same purpose.

The working group therefore recommends the government: to influence the EU-decision making in such a way that the chances that CCS will be deployed via the EU ETS are strongly increased; and to provide sufficient additional funding support and other incentives for the realisation of the two demos. The working group urges the government to provide clarity on these issues at short notice, preferably before Spring 2009.

41 A back-of-the-envelope calculation, assuming a share of the Netherlands in the overall EU-wide allowances of about 4%, and the use of about 10% of the Netherlands-based auction revenues for domestic funding of CCS demos, suggests that annually between €54-90 m would be available for CCS support, or about €400-700 m during Phase 3.

ANNEX 1 DEMAND AND SUPPLY OF EXTERNAL CREDITS

Demand and supply basics

There are several types of emissions credits that can be traded within the various emissions trading systems already operational or under construction. Together with the allowance allocations that determine scarcity within the various trading schemes, the actors within these trading systems, which are either allowed to trade/supply credits or have certain commitments in terms of compliance, determine the supply and demand dynamics. However, the 'rules of the game', conditions and provisions under which credit trade can be established, set the stage. Table A.1 gives an overview of the supply and demand basics of emission credits as it currently is.

Supply	Credits (currency)	Demand
Annes 1 governments (long) EU-ETS Installations (long) Non-EU-ETS Installations Dev. countries (public & private)	AAUs EUAs ERUs and/or via DOs CERs VERs Credits from other ETS	Annex 1 governments (short) EU-ETS Installations (short) Non-EU-ETS Installations Dev. countries (public & private)

Table A.1 Demand and supply basics of emission credits

What will be the net supply of CERs/ERUs during 2008-2012?

When the EU's Community Independent Transaction Log (CITL) is fully operational and linked with the International Transaction Log (ITL), it will be possible to use Kyoto-credits for compliance of individual installations within the EU-ETS 'linking boundaries'. However, as the CITL will only become fully operational until the last EU Member State completes its national registry, and as currently (March 2008) the bulk of the national registries is only partially operational, the desired connection between the CITL and ITL has not materialised yet. Due to the fact that the CITL-ITL has been delayed for a couple of times already, Phase 2 trade in 2008 is affected as EU Member States are reluctant to issue EUAs as long as, the ITL cannot record EUA trade, which would require a re-run of all transactions done prior to the link date. However, as the CITL-ITL link is to be established by April 2009 Phase 2 trade on the whole seems not severely affected.

Whether or not the theoretical maximum of linking can be achieved mainly depends on the supply of Kyoto credits (CERs and ERUs). A number of studies/sources[42] on expected (cumulative) CER supply for the period 2008-12 have been published providing estimates ranging from 1.83 up to as much as 4.4 bn CERs (depending on different assumptions).

IDEA carbon in its December 2007 Update of the Global Carbon Report revised down its figures on expected credit supply (mainly CERs) with about 9% in comparison to its September report to a level of 1.85 bn CERs up to 2012. It did so by means of a revision of the relevant parameters in their Econ Carbon Market Model. This model allows assumptions (or estimates) to be made on expected annual economic growth, expected credit supply, credit import into the EU-ETS and coal- and gas price projections, which altogether are deemed to be the main determinants of EUA price development. The model projects that with "a cap of 2,081 $MtCO_2$ per year combined with revised growth and energy price expectations results in an expected annual shortfall of 206 $MtCO_2$" and "since the cap is smaller than permissible CER/ERU imports, the EU market should settle in the same €22 (18-26) range as [the model projects for] the Kyoto market".

The EU-ETS (EU-27) aggregate expected credit (or allowance) shortfall of 206 $MtCO_2$/a is based on a baseline emission scenario[43] of about 2,287 $MtCO_2$/a during Phase 2. Baseline scenarios cannot be verified, and can only assume/estimate the level of emissions during a given period, in this case in the absence of the EU-ETS. Given the theoretically maximum cap of 2,360 $MtCO_2$/a (incl. maximum linking), compliance within Phase 2 should in general not provide serious problems or create serious scarcity. Even with a suboptimal linking of about 80%[44] of currently allowed level (for instance due to the fact that smaller installations are unaware of the linking option), the estimated baseline demand could still be matched by external

42 Michaelowa, A., 'How many CERs will the CDM produce by 2012?'. Discussion paper, Climate Strategies, September 2007. 'Global Carbon Report, December 2007 Update', IDEAcarbon (ECON), December 2007. ICECAP, 2007 (based on presentation held at 5 september 2007 at the Latin American Carbon Forum), calculates an expected supply of CERs of 2.2 bn tCO_2 cumulative up until end 2012 and assumes a total potential supply of AAUs of 7.5 up to 8.7 bn tCO_2.

43 The estimated economic growth projections used in the December 2007 Update model simulation are: Households 3.4%/a; Service sector 3.6%/a; Power intensive industry 4.0%/a; and Other industry 3.9%/a.

44 This 'discount factor' is arbitrarily chosen and mainly represents a discount that stems from EU-ETS not knowing that there is a possibility for them to acquire external credits. However, as there is little known about the intended use of the linking directive by EU-ETS installations, and especially those installations from Kyoto surplus Annex I countries (i.e. Eastern Europe), this discount factor could differ significantly. Currently, 18.4% (or 51.24 $MtCO_2$) of the total EU-27 Linking quota does not belong to EU-15 countries. Nevertheless, as EU-ETS installations are generally large, they can be expected to behave in a more rational manner, so that awareness and willingness to 'link' is higher as economic profits can be made by arbitrage.

credit supply. As far as the aggregate EU-27 verified emissions data levels for 2005-07 in Phase 1 are concerned, the second Phase should experience an average annual rise in CO_2-emission levels of about 40 Mt (or about 1.85%/a) before any real scarcity[45] will be created in the credit market.

One can always argue about the validity of specific assumptions made in baseline emission scenarios. However, economic growth projections in the Econ model, at least for the short term, on average differ significantly from official EU economic growth projections. According to the EU's Autumn Economic Forecast, 2007-09 economic "growth in the European Union economy is expected to decelerate from 2.9 in 2007 to 2.4 in both 2008 and 2009". This is substantially lower than the rates applied in the Econ model (see footnote 43). In the meantime EU growth projections have recently been revised downwards again in the aftermath of the credit crisis. Note that with lower average economic growth rates, the level of expected emissions declines and so would credit demand. This has strong implications for the level of expected credit shortfall.

CER supply is developing extremely well. As of February 2008, there were 3,082 projects in the CDM pipeline (UNEP/Risoe Centre; Fenhann et al., March 2008). The pipeline build-up in terms of number of projects and expected CERs is shown below (Table A.2).

CDM pipeline basic data	# of projects	kCERs expected up until 2012
Registered projects	948	1,200,010
Request registration	146	123,769
At Validation	1,988	1,170,911
Total	3,082	2,494,690

Table A.2 CDM pipeline basic data
(Source: UNEP Risoe Centre (Fenhann, March 2008).)

The amount of about 2.5 bn CERs expected to be offered up until 2012 is based on the assumption of an issuance success rate of 95% (pipeline average) for registered projects and an 85% registration rate for validated projects. Fenhann et al. (7 March 2008) also provide estimates for an additional expected CER supply from new CDM projects. Assuming an original supply of about 467 m CERs/a up to 2012, and assuming an 0.85 registration and 0.95 issuance rate, this boils down to an

45 Real scarcity in this particular case arises on the point where actual emission levels are higher than there are (internal/external) credits (allowed/available) within the market. 'Artificial' scarcity arises due to information assymetry between buyers and sellers, due to parties that take speculative positions on the credit market and any other credit trade related distortions, such as inadequate trading infrastructure (i.e. delayed physical linking of transaction logs, etc.). Note: that in this calculation no correction has been made for the expansion of the ETS system from Phase 1 to Phase 2.

expected additional cumulative (up until 2012)[46] CER supply of 375 m CERs (or 75 m CERs/a). In conclusion, according to the Fenhann et al., during 2008-12 about 1.83 bn CERs are likely to be issued and available for trading internationally.
In addition, an expected amount of 188 m ERUs is likely to be issued (from projects in the pipeline) before 2012[47], which pushes total expected credit supply up to about 2.0 bn.

What will the net supply of AAUs amount to during 2008-2012?
In addition to project-based credit supply via CDM or JI, Annex 1 countries can also sell part of their national budgets, denominated in Assigned Amount Units (AAUs). The potential supply of AAUs is significantly larger than expected supply of CERs and ERUs and therefore is an important element in analysing the EU-ETS performance, even given that AAUs cannot be traded within the EU-ETS.
As far as the supply of AAUs is concerned, most projections suggest a fairly large amount to be put on the market by Russia, Ukraine and some other Eastern European countries. Although AAU trading has been developing slowly so far, the activity is expected to grow fast as commitment period progresses. Some considerable deals have recently been struck between the Netherlands (buyer) and the Czech Republic, between Japan (buyer) and Hungary (10 $MtCO_2$ and optional another 30-40 $MtCO_2$), Poland and Russia, and Finland (buyer) and Russia.
Table A.3 shows the relative and absolute compliance targets in relation to reported 2005 aggregate GHG emissions for most Annex 1 countries (or economic regions). The data is grouped according to the surplus/deficit position of Annex 1 countries. It shows that for 2005 there is a theoretical budget overallocation of about 885 $MtCO_2$-eq./a even if U.S. demand is included. However, as the U.S. has not ratified the Kyoto Protocol, U.S. demand (at least on the Federal level[48]) is expected to remain negligible. This leads to a theoretical oversupply of Annex 1 emission allowances of 2,334 $MtCO_2$/a. This implies, with no economic and emissions growth, in both surplus and deficit countries, a theoretical cumulative (2008-12) oversupply of about (2,334 x 5 =) 11.7 bn tCO_2 (excl. LULUCF).

46 Given the fact that many CDM projects run longer than the 2008-12 Kyoto Committment period and thus generate CERs in the 2013-20 period, an estimated CER issuance for that period of about 490 m CERs/a (or 4,409 m CERs cumulative) is expected.

47 For more detailed information on expected ERU supply, see: http://cdmpipeline.org/publications/JIpipeline.xls

48 With some individual States setting GHG emissions trading schemes, either credit demand and/or (eventually) AAU demand could result. However, external credit supply to those regional schemes (i.e. such as the Regional Greenhouse Gas Initiative; RGGI) is often focussed at domestic offset projects in non-included sectors.

GHG Emissions and Targets		Demand					Supply			
		Country					Country			
		EU-15	Canada	Austra-lia	Japan	U.S.	EIT	Ukraine	Russia	Poland
Excl. LULUCF	Base year	4,258	596	418	1,272	6,229	5,597	924	2,990	587
	2005	4,193	747	525	1,360	7,242	3,629	419	2,133	399
	Target (%)	-8	-6	8	-6	-7	-8	0	0	-6
	Target (#)	3,917	560	451	1,196	5,793	5,149	924	2,990	552
	Deficit/surplus (2005-%)	-7.0	-33.4	-16.4	-13.7	-25	29.5	54.7	28.7	27.7
	Deficit/surplus (2005-#)	-276	-187	-74	-164	-1,449	1,520	505	857	153
Incl. LULUCF	Base year	4,040	473	500	1,180	5,529	5,574	872	3,166	554
	2005	3,878	730	522	1,264	6,432	3,560	360	2,289	367
	Target (%)	-8	-6	8	-6	-7	-8	0	0	-6
	Target (#)	3,717	445	540	1,109	5,142	5,128	872	3,166	521
	Deficit/surplus (2005-%)	-4.3	-64.0	3.3	-14.0	-25.1	30.6	58.7	27.7	29.6
	Deficit/surplus (2005)	-161	-285	18	-155	-1,290	1,568	512	877	154

Table A.3 GHG emissions (p/a) and GHG targets for main Annex I countries (Source: based on UNFCCC GHG (rounded) data, 2008.)

Therefore, based on reported emissions data and quantified emissions targets, without the demand from the U.S. and with an expected significantly reduced demand from Canada, there will be a substantial relative oversupply of AAUs. The oversupply level during EU-ETS-3 will be determined by: economic growth rates and specific emission trajectories of individual economies and/or regions.

Several authors have tried, through extrapolation and by taking into account economic growth and energy efficiency projections, to make qualified 'guesstimates' of the expected cumulative supply of AAUs (either directly tradable, or via so-called Green Investment Schemes[49]) during 2008-12. An authoritative, albeit somewhat dated, source is Haites (2004) who combines information available from various sources (mostly countries' National Communications submitted to the UNFCCC secretariat with emission projections for 2010) on the potential AAU supply (several sources since then have shown a roughly similar picture). Haites projects an overall cumulative AAU supply potential of about 6.75 bn AAUs during 2008-2012![50]
In other words, if this potential supply would enter the market and be combined with CER and ERU supply, overall credit supply under the Kyoto Protocol would probably become several times as big as expected demand. Under these circumstances, market competition would prevent credits from reaching any serious price level.

49 This are schemes in which seller and buyer country agree that (part of) AAU receipts will be used for green investment in the seller country.

50 A more recent estimate by ICECAP 2007 (presentation held at the Latin America Carbon Forum), a total potential global AAU supply in the range of 7.5 to 8.7 bn tCO_2 has been calculated.

In order to remain on the conservative side, one could assume, as Haites does, that credit suppliers would carry out cartel-like action by effectively limiting the actual supply of AAUs4 to, say, 40% of the potential supply only (assuming credit suppliers can organise this). But even then supply would still amount to 2.7 bn AAUs.
In a more recent study, the World Bank in its Report on the 'State and Trends of the Carbon Market' (May 2007) estimates a potential AAU–supply, for the period 2008-12, in the range of 6.3 – 7.1 bn tCO_2 (see Table A.4).

Total (bn tCO_2)	6.3 – 7.1
Russian Federation	3.2
Ukraine	2.2
EU-8+2	0.7 – 1.5
Other EITs	0.2

Table A.4 Estimated supply of AAUs ($MtCO_2$-eq.) 2008-12 (Source: World Bank, May 2007.)

Such a substantial influx of AAUs can, indirectly, cause serious distortions of the market dynamics within the EU-ETS. This is especially the case when governments' demand for credits would shift from CERs and ERUs to (assumed to be) easier/ cheaper to obtain AAUs. This could significantly increase the supply of CERs and ERUs, available for EU-ETS installations[51]. Aspects such as banking AAUs into post-2012, price expectations, procedural matters, and several political and other factors, all play a crucial role in determining expected supply of AAUs in 2008-12. But even taking into account the different assumptions on these aspects, AAU supply estimates range from about 2.5 to about 7 bn or even more.

With respect to demand, the World Bank (May 2007) recently projected potential demand for the EU (15), the EU-ETS, Japan and the Rest of Europe, New Zealand, Australia and Canada.

51 One can argue that the option for national governments to shift their credit demand from project-based credits to AAUs provides a moral hazard issue, i.e. by shifting such demand, the availability of the linking option and therefore EU allowance market scarcity may be unduly affetced.

Country / Entity	Distance to Target (WB '07 data)	Distance to Target (UNFCCC data; excl. LULUCF yr 2005 and own calculations)	Expected demand (or compliance gap)	CDM/JI Contracted (WB '07 data)	Residual demand for KMs	Domestic and/or internal action (estimate)	Additional credit demand (estimate)	AAU demand (estimate)
EU-ETS (EU-27)	-	1,113 Expected private demand; EU-15 908 and EU-n10 205	- WB '07 estimate 1,140 with 900 – 1,400 range	506 Distribution of contracted credits over ETS installations unknown)	634	127 Based on total of 20% of res. demand for fuel switch, energy efficiency, biomass co-firing and other renewables deployment	507	0
EU-ETS (EU-15)	1,250 (900-1,500)	908 Share linking demand	908 Own estimate	-	-	-	-	-
EU-15 govts	1,300	1,380	472 =1,380 – 908; WB '07 estimate, 450, and 534 intended use*	143	329	- Already discounted in national targets	Intended 391/0 Compliance 329/0	Intended 0/391 Compliance 0/329
EU-ETS (EU-n10)	-	205	205 Assumed	-	-	-	205	No AAU purchase for compliance expected in EU-n10
Japan (public/ private)	500	820	820	266	554	183 Based on 33% domestic goal of res. demand	371/0	0/371
Rest of Europe and N-Zealand	200	200 WB '07 estimate	200	2	198	50 Based on 25% domestic action: authors assumption	148/0	0/148
Australia	-	370 Excl. LULUCF and 90 surplus when incl. LULUCF	185 50% compliance estimate based on positive LULUCF impact	0	185	37 based on 25% domestic action: authors assumption	148/0	0/148
Canada	1,300	935 Excl. LULUCF and 1,425 deficit when incl. LULUCF	468 50% compliance estimate based negative LULUCF impact and relative compliance burden of >30%	0	468	94 Based on 25% domestic action: authors assumption	374/0	0/374
Total	4,200-4,800		3,258	917	2,368	491	712–2082/ 712-2144	0 - 1761

* An estimate of 534 (106,8 x5) $MtCO_2$-eq. of intended use of the KM by information provided by 17 EU Member States. Source: Greenhouse Gas Emissions trends and projections in Europe 2005, European Environment Agency (EEA), 2005.

Table A.5 Demand and residual demand for credits and allowances for 2008-12 (Source: World Bank, May 2007 and own estimates and calculations (on Canada and Australia).)

Table A.5 shows the expected credit and allowance demand for 2008-12. Note that distance-to-target data are based on 2005 data and not corrected/adjusted to projected emission trends. Given past trends, most Annex 1 countries are likely to experience some degree of emissions growth. This leads to higher deficits in the developing countries and lower surpluses in (mainly) Economies in Transition (EITs).

Assumptions on whether or not national governments fulfil their residual demand (6th column, in Table A.5), either fully via KP credits, via AAUs, via domestic action, or via some composite of those options, will determine the scarcity level for Kyoto credits.

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