

Gothenburg Environmental Economics Report, September 2010

# The Progress of GHG Markets: Opportunities and Risks

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## **ABSTRACT**

The climate negotiations at the COP15 in December 2009 did not produce a new international treaty with binding emissions commitments but the Copenhagen Accord for dealing with post-2012 climate change. Given the current climate negotiation process it is unlikely that we will see a global climate agreement soon on a global cap between all Convention members participating in a single carbon market. We may be more likely to see a stepwise process moving towards this scenario, most likely involving linkages between different national policy programs when it comes to mitigation as well as offsetting emissions.

In such a process countries will offer commitments based on their domestic abilities, preferences and policies, norms and institutions. National and sub-national policies are thus likely to be the de-facto building blocks of nations' abilities to make and fulfill international commitments. However, also with multilateral mitigation programs without binding commitments, carbon markets will be needed as well as international authorities that support measurement, reporting and verification rules and the international registries. Such markets will necessarily be complicated and temporary in a world without an overarching binding agreement. There will be numerous tradeoffs between different kinds of second-best arrangements.

The purpose of this report is to build knowledge about the effects of the development of regional and international carbon markets and the auxiliary technology agreements that might be needed. Among the topics we address are: the evolution and integration of carbon markets, the impacts of policy and technology cost uncertainty on the cost of meeting targets through a carbon market mechanism, the effect of banking, price floors and ceilings, institutional constraints and technological change in the further development of carbon markets and their links to other environmental policy instruments, and the potential of REDD-plus to encourage sustainable forest development and climate mitigation.

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Markus Wråke is head of the Economics and Policy group at IVL and holds a PhD. in Environmental Management and Economics from University of Gothenburg. He has worked with climate change issues for over a decade and has extensive experience of the analysis of the design of market based climate policy instruments, and the implications for industry of climate policy. In particular, Wråke is dealing with efficiency implications of allocation methodologies, options for developing the EU ETS, how emission trading is affecting the European energy system and linkages between the EU and other policy jurisdictions. Wråke is also working with a wide range of assignments for the Swedish government and its agencies, as well as for large European companies and industry associations. He regularly acts as a reviewer for various academic journals and has also been commissioned by the EU as reviewer of proposals for Collaborative projects in the Framework Programme 7.

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## **PREFACE**

The development of economic instruments for climate policy is currently very exciting. As we write in the introduction:

“Just a decade ago there were only a handful of environmental economists in Europe who took much interest in tradable permits. Today there are many thousands who actively participate in the ETS”

This overview is dedicated to those thousands of people who are not professional environmental economists but who work in industry and have to respond to new policies as well as the many people in government who design and implement the instruments or negotiate its future development.

We are convinced that climate change is not only real and very important but also that the timeframe is unusually extended compared to that of most other policies. We are still just in the beginning of global climate policy. We discuss ambitions of phasing out carbon fuels completely in half a century but cannot agree on actual first steps for the next 5 years. This implies a double challenge for policy instrument design. Not only do we have to worry about the usual tradeoffs between efficiency and fairness or administration costs in the short run and the relationship between static and dynamic efficiency for the medium and long run, we also have to consider the design of intermediate policies for those countries, industries or regions that are willing to be pioneers which means that we have to build instruments that facilitate future adoption of more stringent goals by increasing numbers of participants over time.

The authors of this paper have all been working professionally – usually for their whole working career – on these issues. Most of us have been financed here in Gothenburg by Sida to work on environmental policies in developing countries and several of us have also been financed by Formas or MISTRA programs – in particular CLIPORE – or by Statens Energimyndighet, Göteborg Energi and other sources for some time and we would like to thank all of these donors for long run-support which is reflected at least indirectly in this work. This particular report is however written for and financed by the Swedish Environmental Protection Agency and we would therefore like to thank them for a particularly timely initiative. Some of the desk-officers at SEPA have also gone way beyond the usual call of duty and taken great personal interest and given valuable intellectual input into the work itself. This implies in particular to Max Åhman and Erika Budh, but also others

in their group who have participated in seminars and given us feedback. We owe them personal thanks for their care in reading and discussing as well as contributing to this document. Finally we would also like to thank Dallas Burtraw and Carolyn Fischer for comments and Selma Oliveira and Karin Backteman for editorial support.

## 1. INTRODUCTION

As human societies grow, natural resources tend to become more scarce. This first happened to land and the process of turning natural resources into (private) property is often referred to as ‘enclosure’, from the English custom of enclosing private land with hedges. After land, a number of other resources have been ‘enclosed’: rivers, parts of the oceans, radiofrequencies and even of genetic code. The ability of the atmosphere to act as a sink for our emissions of climate gases – most notably carbon dioxide (CO<sub>2</sub>) – is a limited and valuable resource at the global scale. In order for this resource to be used efficiently, some kind of regulation is needed. It is an understatement to say that this is a complicated task. The establishment of a global climate policy is a major historic process of which we are still only experiencing the beginning. The enclosure of the oceans (the Law of the Seas) took several decades to complete and climate change is presumably bigger so, from that viewpoint it would have been reasonable if it took longer. The trouble is that we do not have so much time: we should be in a hurry to start reducing emissions.

Ultimately, it is a matter of creation of property. For example, emissions trading rations access to the resource — in this case, the atmosphere — and privatizes the resulting access right—in this case, the right to emit CO<sub>2</sub>. A central question is how the property rights (here, emission allowances) are distributed among participants; how they are allocated. If designed appropriately, market based instruments like emissions trading, can offer significant cost savings compared to a command and control type instrument, in particular when abatement costs are heterogeneous and unknown to the regulator, which is often the case. This is an extension of one of the most basic lessons of economics – that of gains from trade and specialization. Sterner (2002) dedicates a section to showing (for the case of two companies and of linear marginal abatement functions) just how sensitively the cost savings depend on the divergence of marginal abatement costs between different sectors. For moderate differences in the marginal cost of abatement the difference between market based instruments and other instruments is not necessarily large but when the marginal costs differ very considerably then also the cost savings of using Market Based Instruments (MBIs) can be large.

Since the property created by the regulation is valuable, questions of fairness in results and in political process are of paramount importance. It is not just a matter of designing a instrument.

Either national or supranational bodies take upon themselves to act as owners and charge (tax) other economic agents (in a concerted manner). Alternatively, as in the case of the European Trading Scheme (EU ETS), property rights are created and allocated. This immediately raises the question of what allocation principle to use. There is considerable discussion in the economics literature about the efficiency and equity properties of different options, and there will likely never be consensus over what allocation mechanism is most appropriate to use in a global carbon market. In the meantime, different systems will be tried out and revised in regional markets such as the EU ETS.

Despite these complications it is essential that the process of restructuring our energy systems is started. These systems have great inertia so changes take a long time. Another benefit is that experience for global systems is gained. A third purpose is to provide an incentive to speed up research and development of new technology.

A number of national and regional carbon market initiatives are either already underway, seriously under discussion, or actively being revised. These can provide incentives for technological change and promote sustainable development goals in their own right, and also serve as stepping stones towards the development of more global systems.

Carbon pricing is an important mechanism for providing firms with incentives to invest in carbon abatement. However, for the foreseeable future carbon prices seem likely to remain lower than what is needed to stimulate large scale research, development and diffusion (RDD) of technologies that could radically reduce emissions, such as carbon capture and storage (CCS) or photovoltaics. This calls for additional policies that specifically support RDD. An example is feed in tariffs for renewable electricity; another is the EU decision to finance demonstration plants with CCS. Price formation in carbon markets involves a complex interplay between policy targets, dynamic technology costs, and market rules. Another important factor to address is risk. Risk is an inevitable consequence of the underlying uncertainties in the economics and science of climate change. There is also an inherent trade-off between flexibility and certainty in any policy design. On the one hand, there are benefits of retaining options to adjust policies to changing priorities and information, for instance new developments in climate science and in the international climate policy negotiations. On the other hand, there is a need to provide certainty to market actors. Uncertainty over prices in products or inputs will, on average, delay investments compared to a situation under certainty. Policy-makers therefore need to take risk into account when designing carbon markets, and

when forming expectations about how investors will respond to carbon market price signals. Likewise, companies will need to understand the key drivers and risk factors when formulating their investment and trading strategies.

Just a decade ago there were only a handful of environmental economists in Europe who took much interest in tradable permits. Today there are many thousands who actively participate in the ETS carbon market as well as in other markets, the voluntary offsets, CDM and JI and so forth. This has created a considerable demand for knowledge. To some extent this is covered by a plethora of newsletters covering the carbon markets but these focus on the short run movements and cater more to the needs of the trader than the analyst. Naturally it can be seen as a measure of success for the environment that the Financial Times regularly reports and discusses the movement in CERs and other emission rights. It is also premature to start criticizing “speculators” in these markets. The whole idea of using a market based instrument is to encourage firms to trade. At the same time, it would be naïve to disregard the fact that these markets are particularly complex. In addition to the complexities governing normal equity, such as movements in activity levels, interest and exchange rates, the emission markets are also governed by political decisions that are still at a very formative stage. One could add that there is bound to be a good deal of information asymmetry when it comes to understanding these markets. Particularly smaller agents who are far removed from the energy markets not to mention agents in developing countries suffer from some disadvantage when it comes to accessing information. We therefore believe there is a particular need for good overviews concerning the functioning of the emergent emission markets.

### *International Policy Framework*

Since climate change is a global challenge there can be no sensible long run policies in just a limited number of countries. The implementation of local policies depend on global treaties but at the moment we are in a period of history when local policies must be designed in the partial absence of global treaties – and with a view to facilitating the emergence of such treaties. The United Nations Framework Convention on Climate Change (UNFCCC) does of course imply obligations for all countries according to the famous wording; “common but differentiated responsibilities”. The trouble appears to start when the international negotiations start to become more precise concerning obligations. There are many challenges to face in the process towards a global policy framework that addresses climate change.

Stabilizing climate requires international coordination on efforts to reduce GHG emissions. The international policy framework and the instruments needed to achieve global participation require a fair distribution of resources as well as channels for financial and technology transfers to encourage the participation of emerging and developing countries. This framework also needs to be designed to increase the participation in mitigation by emerging countries with growing emissions and in the longer term also the least developed countries.

A renewed global agreement on GHG mitigation should reconcile these aspects taking a global approach which involves long-term targets supported by short-term milestones and a carbon market based on a stable international regulatory framework. Nevertheless, a global approach is also required from the perspective of international competition and the distortions that asymmetric national policy programs could cause such as the relocation of GHG-generating production to other countries causing unwanted carbon leakage and job losses. A global approach to mitigation requires that offset mechanisms are both expanded and improved such that they encourage financial transfers to developing countries as well as opens up for further participation of the private sector without market distortions.

However, the climate negotiations at the COP15 in December 2009 did not produce a new international treaty with binding emissions commitments but the Copenhagen Accord for dealing with post-2012 climate change. Given the current climate negotiation process it is unlikely that we will see a global climate agreement soon on a global cap between all Convention members participating in a single carbon market. We may be more likely to see a stepwise process moving towards this scenario, most likely involving linkages between different national policy programs when it comes to mitigation as well as offsetting emissions.

In such a process countries will offer commitments based on their domestic abilities, preferences and policies, norms and institutions. National and sub-national policies are thus likely to be the de-facto building blocks of nations' abilities to make and fulfill international commitments. This would likely be true in a scenario where negotiations under the UNFCCC continue to play an important role, and even more so if the current slump in that process persists. The stringency and effectiveness of a regime that is driven primarily bottom-up will be affected not only by expectations with regard to what other countries are willing to do, but also by the design of national and sub national policies. Also, the variety of policies that emerge is likely to reflect the political capabilities of decentralized leadership, and in many cases explicitly self-interested parties may capture these initiatives and partly divert their

intent. An example of this is the allocation of emissions allowances in the EU ETS. It was characterized by significant imperfections due to strategic decisions by individual Member States, in particular in the first phase of the trading scheme, made possible by the organization of the decision making process.

Also with multilateral mitigation programs without binding commitments, carbon markets will be needed as well as international authorities that support measurement, reporting and verification rules and the international registries. Such markets will necessarily be complicated and temporary in a world without an overarching binding agreement. There will be numerous tradeoffs between different kinds of second-best arrangements. A multilateral linking approach based on national policy programs, would require specific requirements to be met before different market-based approaches can be linked. While different allocation rules can be applied in different trading regimes, e.g. grandfathering may be offered in one system and auctioning in another, there are many other important requirements to take into account in the growth of carbon markets through linkage; penalties for non-compliance must be coordinated between linked systems, regulations on banking and borrowing must be similarly structured, price caps and price floors should be wisely chosen to not undermine design and operation, monitoring and reporting in trading regimes must adhere to some common principles. Different levels of stringency and other discrepancies could lead to unforeseen consequences such as massive and maybe unwelcome flows of permits.

The purpose of this report is to build knowledge about the effects of the development of regional and international carbon markets and the auxiliary technology agreements that might be needed. Among the topics we address are: the evolution and integration of carbon markets, the impacts of policy and technology cost uncertainty on the cost of meeting targets through a carbon market mechanism, the effect of banking, price floors and ceilings, institutional constraints and technological change in further development of carbon markets, carbon market's connections to other environmental policy instruments, and the potential of REDD-plus to encourage sustainable forest development and climate mitigation.

The report proceeds as follow: In chapter 2 we present an overview of various emerging carbon markets and in chapter 3 we discuss a number of important policy issues. Chapter 4 concludes and presents some suggestions for future research.

## 2. DESCRIPTION OF GREENHOUSE GAS EMISSIONS MARKETS

### 2.1 Overview

Through the Kyoto Protocol, a first grand bargain to secure acceptance by countries with concerns about the economic burdens of emissions' reduction targets was concluded (Aldy and Stavins, 2007). Three “flexible mechanisms” were designed to enable CO<sub>2</sub> emission reductions to occur in the cheapest locations across the world. The first mechanism, emission trading, can occur between countries with binding targets; the so-called Annex 1 countries (mainly industrialized countries, members of the OECD, plus the transitional economies of central and eastern Europe and the former Soviet Union) that agreed to various reduction targets, averaging around 5% below 1990 emissions by the first commitment period, 2008–2012. These countries are allowed to meet their domestic targets by purchasing credits from other countries that have exceeded their reduction targets. In the Kyoto Protocol the credits, each representing one tonne of CO<sub>2</sub>-equivalents, are called Assigned Amount Units (AAU).<sup>1</sup>

Second, is the Clean Development Mechanism (CDM) that allows credits from emission reduction projects in developing (non-Annex I) countries to be used in Annex-I countries to partially meet their own commitments under the Kyoto Protocol. Certified Emissions Credits generated through the CDM, called Certified Emission Reductions (CER) are generated through projects that reduce emission relative a baseline scenario. A central and contested aspect of the CDM (as well as of REDD and other project-based mechanisms in countries without overarching commitments) is “additionality”; each project must meet standards that should assure that it would not have been realized in the absence of the CDM mechanism. The assessment of each project is carried out by the CDM Executive board, a UN body. It is possible to buy CERs directly from projects that reduce CO<sub>2</sub> emissions, which are then called ‘Primary CERs’ or from companies who have bought larger quantities of Primary CERs and that are selling part of their own CERs portfolio to third parties, which are then called “Secondary CERs”.

Third, is the Joint Implementation mechanism (JI), also a project-based mechanism. In principle it is similar to the CDM, but it allows countries with binding targets to get credits from projects carried out in other Annex-I countries.

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<sup>1</sup> There is a small trade with AAUs . However, the trade is complicated and often coupled with green investment schemes, the revenue has to be used for “green investment”. Trade of AAUs is between governments and the prices paid are not public.

In addition to the mechanisms under the umbrella of the Kyoto Protocol, a number of regional, national and sub-national initiatives have emerged over the past decade. By far the largest is the EU Emissions Trading System (EU ETS), the centerpiece of EU climate policy. Other examples include the Regional Greenhouse Gas Initiative (RGGI), in which ten Northeast and Mid Atlantic states in United States are committed to reduce power sector CO<sub>2</sub> emissions; the Australian state of New South Wales (NSW) has in operation a program called the NSW Greenhouse Gas Abatement Scheme (GGAS) to reduce GHG emissions from the power sector; New Zealand is set to launch its national emission trading scheme in 2010 and through the Chicago Climate Exchange (CCX) member companies—today totaling around 300—have made voluntary but legally binding commitments to reduce GHG emissions. Some other initiatives are currently under analysis or early development. For instance, the Western Climate Initiative (WCI) covers a group of seven U.S. states and four Canadian provinces and Japan launched a trial domestic scheme based on voluntary participation in October 2008.

Finally, voluntary markets for emissions reductions that are not compliant with the Kyoto Protocol are also available for sale to corporations and individuals who want to offset their emissions for non-regulatory purposes, especially to cover emissions from air travel. Emission offsets in this latter category that are verified by independent agents, but not certified by a regulatory authority for use as a compliance instrument, are commonly referred to as Verified Emission Reductions (VERs). Since there is no cap on these emissions, VERs are not a standardized commodity. Nevertheless, there is active trading in VERs and they have become an alternative source of carbon finance and an incubator for carbon market innovation.

Review (Capoor and Ambrosi, various) of the state and trends of carbon markets—comprising both mandatory and voluntary initiatives—reveals that the overall carbon market has grown steadily since the launch of the EU ETS in 2005, reaching a total value transacted of about US\$ 126 billion at the end of 2008 (see Table 1). The vast majority of this volume has been exchanged through the EU ETS, followed by CDM market. Although CERs are fungible in the EU ETS,<sup>2</sup> they have been traded at different levels of discount as a result of the various risks that are involved. For instance, the risk that the project delivers fewer emission reductions than planned or that problems or delays arise within the UNFCCC administrative

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<sup>2</sup> Although there are limits to the volume of CERs allowed to flow into the EU ETS

process that approves CDM projects and issue reduction credits. Consequently, since secondary CERs come without the risks of primary CERs, they are traded at a higher price.<sup>3</sup>

**Table 1. Trends on Carbon Markets**

	2005			2006			2007			2008		
	Volume (MtCO <sub>2</sub> e)	Value (MUS\$)	Average Price (US\$/tCO <sub>2</sub> e)	Volume (MtCO <sub>2</sub> e)	Value (MUS\$)	Average Price (US\$/tCO <sub>2</sub> e)	Volume (MtCO <sub>2</sub> e)	Value (MUS\$)	Average Price (US\$/tCO <sub>2</sub> e)	Volume (MtCO <sub>2</sub> e)	Value (MUS\$)	Average Price (US\$/tCO <sub>2</sub> e)
<b>Allowance Markets</b>												
EU ETS	321	7908	24,64	1101	24357	22,12	2060	49065	23,82	3093	91910	29,72
New South Wales	6	59	9,83	20	225	11,25	25	224	8,96	31	183	5,90
Chicago Climate Exchange	1	3	3	10	38	3,80	23	72	3,13	69	309	4,48
RGGI	na	na	na	na	na	na	na	na	na	65	246	3,78
<b>Sub- Total</b>	<b>328</b>	<b>7970</b>	<b>24,30</b>	<b>1131</b>	<b>24620</b>	<b>21,77</b>	<b>2108</b>	<b>49361</b>	<b>23,42</b>	<b>3258</b>	<b>92648</b>	<b>28,44</b>
<b>Project-Based Markets</b>												
Primary CDM	341	2417	7,09	450	4813	10,70	552	7433	13,47	389	6519	16,76
Secondary CDM	10	221	22,10	25	444	17,76	240	5451	22,71	1072	26277	24,51
Joint Implementation	11	68	6,18	16	141	8,81	41	499	12,17	20	294	14,70
Voluntary Market	20	187	9,35	17	79	4,65	43	263	6,12	54	397	7,35
<b>Sub-Total</b>	<b>382</b>	<b>2893</b>	<b>7,57</b>	<b>508</b>	<b>5477</b>	<b>10,78</b>	<b>876</b>	<b>13646</b>	<b>15,58</b>	<b>1535</b>	<b>33487</b>	<b>21,82</b>
<b>Total</b>	<b>710</b>	<b>10863</b>	<b>15,3</b>	<b>1639</b>	<b>30097</b>	<b>18,36</b>	<b>2984</b>	<b>63007</b>	<b>21,11</b>	<b>4793</b>	<b>126135</b>	<b>26,32</b>

Source: Capoor and Ambrosi 2006, 2007, 2008 and 2009

CDM accounts for most of the project-based market activity with JI and the voluntary market having a small – but increasing - role. Nevertheless, primary CERs transactions have been constrained lately by the financial crisis and questions about the rules of eligibility post 2012, declining nearly 30% in 2008 (from nearly 552 million CERs in 2007). Many of the project addressing post-2012 emission reductions are still at the proposal stage and are likely to be influenced by the outcome of forthcoming international climate negotiations. The JI market has also experienced a slowdown, ending 2008 with just half of volumes transacted in 2007.

<sup>3</sup> From a theoretical point of view, as the marginal cost of abatement in developing countries is typically lower than in countries in Annex B, the cost of emission credits generated under the CDM should be lower than the EU ETS allowances. Therefore, CERs can serve as important substitutes for high priced EU ETS allowances, which will drive down EUA prices and, in turn, will lead to a reduction of the overall compliance costs with the Kyoto Protocol and to increase the liquidity of EU ETS. Although it is in theory expected that by linking EU ETS to CDM, EUA prices should go down, in practice, restrictions on the eligibility of using CERs in the EU ETS by Member States and the criteria of additionality imply that the EUA prices should decline to a lower extent. On the other hand, besides EUA prices, CERs are priced based on a number of other factors: the financial position of buyers and sellers, terms and conditions of the sale that affects the guarantees offered, the likelihood of generated volumes, the project validation and registration, the costs of the Project Design Document, sovereign risk, stage of project development, quality risk, delivery risk, registration risk and access to market (TFS Green, 2008). These factors create a price spread between EUAs and CERs that is smaller in the case of secondary CERs – given the existence of a guaranteed delivery. Nevertheless, from May, 2007 to August 2008, the price spread between secondary CERs and EUAs was about €6-7, widening to €10 at the end of that period due to the reaction to the European Commission's proposal for Phase III, which limited the availability of project-based credits for its Member States (Nazifi, 2009). In August 2010 this gap had narrowed to 2-3 euros/ton as the EUA prices have declined and the future supply of CERs after 2012 is uncertain.

In the following sections we describe the trends on mandatory carbon markets (starting with the ETS and then covering US and a few other national markets), CDM, Joint Implementation & REDD and then voluntary markets in more detail, explaining the main features of each program and finally synthesizing a few main issues for discussion.

## **2.2 The European Emissions Trading Scheme (EU ETS)**

European environmental policy has been traditionally dominated by command and control policies and emission taxes. In climate policy, however, emission trading has emerged as one of the key policy instruments. There are several reasons for this, one being the political momentum after the negotiations of the Kyoto Protocol where emission trading was included (partly as a concession to the US) as one of the “flexible mechanisms” along CDM and JI. Combining this with the fact that the EU had tried, and failed, to introduce a combined carbon-energy tax already in 1992-1994—long before Kyoto—favored the debate about a European trading regime. Contrary to a community wide tax, an emissions trading directive did not need unanimous support from all Member States, something that the European Commission was unable to rally for the energy-carbon tax in 1994.<sup>4</sup> In addition, experience with several small experiments in CO<sub>2</sub> trading within Europe – the UK Emission Trading Scheme, the Danish CO<sub>2</sub> trading program, the Dutch offset program and BP’s trading program - paved the way for emissions trading, Ellerman et al (2010) provide one of the more penetrating accounts of this process.<sup>5</sup>

The case for trading was set by a number of factors. Intellectually it was the contributions of Coase (1960) and his followers but equally important was the fact that the instrument was proven on a large scale in the US sulphur trading program. Politically, the stage was set by the difficulties just mentioned with taxes and the ambitions of the European Commission and other institutions to assert themselves in an important new area. Interest groups were favorably inclined (for various reasons, NGOs out of desperation about the difficulty with carbon taxation and industry partly out of fear of the same instrument and partly out of concern that nation states would build up a heterogeneous set of policies that would hamper

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<sup>4</sup> See Ikwue & Skea (1996) for an overview of the proposed EU carbon and energy tax, and the position of different member states in this issue.

<sup>5</sup> One of the subtle details of this whole process is that it seems to be driven not only by a strong desire to take a lead in climate policy but also a more general desire to advance the positions of specifically European policy making both in the international arena and vis-à-vis the European nations.

trade). The first detailed discussion of a tradable permit system began in March 2000 with the issuance of the Commission's Green Paper on GHG Emissions Trading. A number of working groups were set up to consider how the system might operate and about the feasibility of such a scheme. Based on the findings and recommendations of all working groups, a proposal was published in October 2001 by the European Commission suggesting the implementation of a GHG emissions trading within the European Community to enable certain businesses and industries to trade their allocations of CO<sub>2</sub> emissions. One key feature was the decision to focus on heavy industrial installations – and thus to go “downstream” – rather than upstream by regulating at the points of production or import of fossil fuel. Partly this was determined by fear that upstream permits would compete with carbon taxes and maybe ultimately threaten the latter which would not have been in the interest of neither finance nor environment ministers. Two years of reviews and amendments followed the release of the proposal, which was finally enacted in October 2003. Finally, January 2005 saw the launch of the European Union's Emissions Trading System (EU ETS); the largest emissions trading scheme in the world and the centre-piece in the EU efforts to reduce greenhouse gas emissions.

A key factor that helped shape the ETS was the 1998 Burden Sharing Agreement (BSA) of the Kyoto Protocol, in which each country was given a reduction target to comply by 2012; the EU ETS established a first trial phase from 2005 to 2007 and a second trading period from 2008 to 2012, which coincides with the Kyoto Protocol first compliance period. Phase I was intended to put Member States on the path to compliance by addressing the emissions reduction early enough to avoid dramatic reductions in the 2008-2012 period and to gain experience with the new instrument.

The ETS is a mandatory scheme within the EU. That is, all Member States must be a part of it. For new countries, participation is a precondition to become a member of the EU. In its current state, the EU ETS includes some 12 000 installations in the heat and power generation industry and in selected energy-intensive industrial sectors. These installations represent approximately 45 % of EU emissions of CO<sub>2</sub> and 30% of total greenhouse gas emissions.

One of the most challenging features of the EU ETS program is its simultaneously centralized and decentralized character. On the one hand, the European Commission—the central authority—determines who will participate in the market, the number of permits to be created, sets principles for allocation of allowances, rules for compliance and trading as well as

limitations on the use of CDM/JI credits for compliance under the EU ETS.<sup>6</sup> On the other hand, significant discretion is left to the Member States in deciding important rules and mechanisms.<sup>7</sup> One of the most central features of any emissions trading system is how the initial distribution of allowances is decided. In the first two trading periods EU ETS, each one of the twenty five Member States is responsible for the allocation of permits within its territory. The number of allowances that will be given in each country is laid out in a National Allocation Plan (NAP). The total cap in the EU trading system is then given by the aggregate of all member state allocation plans (Krueger et. al. 2007; Ellerman and Buchner 2007).

So far, allowances have mostly been given away free and allocation has been based on historic figures with some small amount to be auctioned (less than 5% for the first-phase and less than 10% for the second-phase). A great deal of rent-seeking has taken place in efforts to modify the various allocation principles. It has become common to refer to all free allocation based on some historic data as grandfathering (GF) although true GF implies the creation of rights based on past emissions that are never subsequently changed. EU practice has departed from this ideal in several ways: Firstly allocation was often in proportion to historic production and some administratively decided (“best practice”) level of emission intensity, sometimes referred to as benchmarking. In most countries, we furthermore could see that firms exiting the market (for instance by plant closures) lose their permits and new entrants gain permits. Although both allocation for new entrants and the “use-or-lose” rule for closures may appear to have some common sense, they do introduce a relationship between output and allocation, potentially fostering strategic action by firms in the permit trading scheme. For example, confiscating allowances after facilities close creates a subsidy for the continued operation of older facilities and therefore a disincentive to build new and cleaner facilities, see further Müller and Sterner (2008), Åhman et al (2007).

NAPs in the first period had to conform to a number of criteria set by the European Commission – among them, the total number of allowances proposed by each member should

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<sup>6</sup> These limits vary between 0% (Estonia) and 22% (Germany) of allowances.

<sup>7</sup> In the two first phases of the EU ETS, member states were free to establish domestic compliance procedures – monitoring, reporting and verification. Early analyses have shown that there could be several important differences in the monitoring and enforcement procedures among the member states. Discretion on the interpretation of monitoring guidelines may undermine some of the consistency that is necessary for an effective regime. However, initial variation in the application of guidelines will likely diminish over time as member countries as well as the European Commission take measures to harmonize procedures. Perhaps more serious are the broader differences in legal systems, enforcement cultures and administrative capabilities among the member states, which could create unfair competitive advantages for firms in member states with weaker enforcement regimes. Clearly, there are no quick solutions to these issues and they just mirror the broad variation in regulatory institutions and practices throughout the EU.

be lower than business-as-usual projections and they must not preclude achieving the target set by the EU burden sharing agreement to the Kyoto protocol. Nevertheless, the process of setting up the NAPs turned out to be complex, controversial and sometimes characterized by lobbying and strategic interaction between industry, Member States and the European Commission. Concerns over a ‘race to the bottom’ between member state allocations were augmented by the fact that not all Phase I NAPs were submitted at the same time.

For example, the UK NAP was published early and generally judged to be relatively stringent. Once other Member States had published their NAPs and these had turned out to be more lax, the UK filed a request to adjust its NAP and increase its allocation volumes. Although the request was disallowed by the Commission, the example indicates that the allocation process may contain elements of strategic behavior on the part of Member States. Another striking example of how the political dynamics affected the allocation process is how new entrants in the energy sectors have been treated. When the discussions on the design of the EU ETS started, there was a great deal of support for the principle that these plants should only receive a very small, if any, amount of free allowances. The position is supported by economic theory, relying on the argument that the primary motivation for free allocation is compensation for stranded costs, which new entrants obviously do not have. However, as it became increasingly evident that several Member States were going to give free allowances to new entrants also, support for the original position quickly eroded. The end result was a situation where new energy facilities in several Member States received free allowances worth more than the entire investment cost (Åhman and Holmgren, 2006). Worse still: Since the distinction between new entrants and capacity expansion can be fuzzy,<sup>8</sup> even expansions can become eligible. What’s more, since allocation is often based on emission forecasts, plants relying on high emitting fuels like coal receive more allowances than those that use natural gas or bio fuels. This creates incentives that are the exact opposite of what the ETS was intended to give.

It is instructive to follow more closely the development of allocation over time from the trial period 2005-7 through phase 2 and finally into the third phase starting 2013. In the trial period the process was strongly decentralized. Although they had to be centrally approved, individual countries had considerable discretion over the NAPs and there was a temptation for each government to give “its own” industry a generous allocation of valuable rights. Together

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<sup>8</sup> A sufficiently significant expansion can easily be made administratively and legally “separate” and may be reported as a new entrant.

with a general resistance towards this new mechanism and the poor quality of emissions data, lack of routines and sufficient time, it is not surprising that the overall allocation turned out to be overly generous. It is symptomatic that market participants did not understand this until an emissions inventory showed the market was long and then prices collapsed. The first period allocation was heavily criticized but in retrospect served the purpose of learning exercise very well by providing arguments for more harmonization, tighter caps and stricter control.

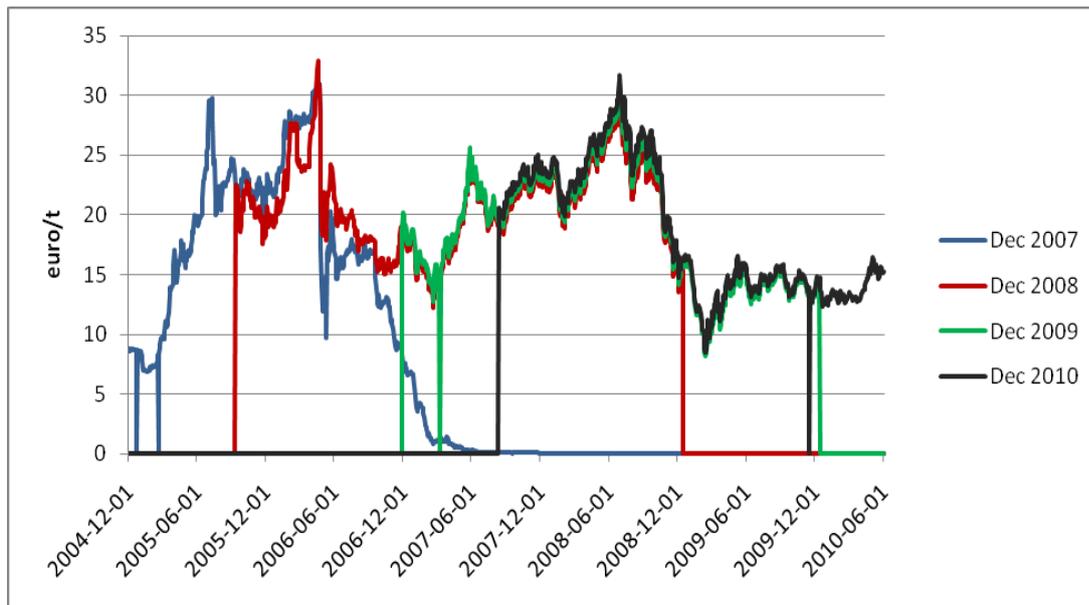
By the time the second period started (2008-12), a number of problems had already been straightened out. The data were significantly more reliable and predictable, the commitment to the trading system was more uniform across the whole EU and a greater understanding of some fundamentals was beginning to sink in. For instance, countries understood that their own (national) obligations in Kyoto are not national emissions but instead are calculated as the sum of *allowances allocated* in the ETS + other sector emissions. (Thus if country A has emissions from its installations that are equal to  $E_a$  and allocated permits  $A_a$ , actual emissions  $E_a$  may be bigger than  $A_a$  which means that country A's industries are net buyers of permits. If other sector emissions are called  $E_o$ , then, for the purposes of Kyoto, the national target for country A is not  $E_a + E_o$  but  $A_a + E_o$ ). This means that a country that is "generous" by over-allocating permits  $A_a$  to its industry will cause considerable trouble for itself by making it more difficult to attain national targets under the BSA. Since CDM and JI credits can be used in fulfillment of both Kyoto and ETS a tight allocation of permits in the NAP actually means that the burden of buying JI or CDM credits is turned over to industry rather than hitting the public budget. Furthermore the Commission also became more active in providing support, advice, guidance and other measures aimed at harmonizing practices across Member States. The Commission has also laid down detailed guidelines for the use of JI/CDM credits and many other rules relating to monitoring and compliance. There has been much discussion of benchmarking but it has met with a number of obstacles. The most important of these is that efforts to make benchmarks really "fair" take into account so many specificities of the industry that one tends to end up with very narrowly defined industries where basically plants would get an allocation essentially equal to their emissions, removing much of the incentives for trade and improvement and opening up for rent-seeking and corruption in the process of defining industries and benchmarks.

One of the lessons from the second period is that there is an inherent contradiction between using allocations to countries as an instrument to meet national Kyoto goals on the one hand and treating similar industries in different countries similarly on the other. At the same time, it

is clear that the balance between central harmonization and national discretion is moving quite fast towards central control and the third allocation phase will not allow too many of the inconsistencies and perceived injustices of the first two periods to be repeated.

A centralized allocation at a European level, or at least a common decision on the total volumes to be allocated, would mitigate this problem. However, such an approach had little initial support among Member States, several of which were still reluctant to endorse the creation of the trading system. Although the European Commission decided to reduce the proposed totals for the phase I in fourteen of the twenty-five NAPs submitted by the Member States - representing about 5% of the total cap - early assessments indicated that the allocation was still too generous and the trading system was criticized for not being stringent enough even before it was launched (Zetterberg et al. 2004).

Nevertheless, the first year of trading saw prices of emission allowances (EUA) which were higher than many observers had expected, peaking at over 30 €/ton early in 2006 (Figure 1). An important reason for this was that companies with installations that were short in permits (e.g., electric power producers in Western Europe), and thus needed to cover their emissions were disproportionately present in market during this early period. At the same time, the companies that held long positions, e.g., Eastern European companies were not as active, largely since the national registries were not yet in place (Ellerman and Joskow, 2008).



Note: “Dec 2007” refers to contracts for EUAs that expires in December 2007, i.e. for EUAs allocated for the 1<sup>st</sup> phase. Subsequently “Dec 2008”, “Dec 2009” and “Dec 2010” refers to contracts for EUAs that expires in the 2<sup>nd</sup> phase (2008-2012)

**Figure 1.** *EUA prices December 2004 - March 2010* Source: *Point carbon*

However, the spot prices fell dramatically in 2006 - after the first statistics over verified emissions in 2005 showed that the market was long on allowances (see “Dec 2007” prices above). The registries and other trading institutions were now in place and operating well. While the obvious explanation of the price break is an adjustment of expectations, EUA prices did not go to zero immediately. Moreover, the prices did not reach near zero levels until a year later as it became increasingly clear that weather and other factors would not create additional demand before the end of the first trial period.

Since very low allowances prices in phase II (2008-12) might seriously have jeopardized the credibility of the trading scheme, the European Commission repeatedly stated its intention to tighten the cap for the second trading period as Member States prepared their NAPs. The European Commission completed its review of the NAPs for the 27 Member States by early October 2007. Overall, the reviewed NAPs have been cut by 10.4% below the caps that were originally proposed by Member States, leading to a maximum of 2,098 million. This corresponds to a reduction of 6.0% below 2005 verified emissions (Capoor and Ambrosi 2008 and 2009).

The April 2008 release of 2007 verified emissions data was therefore eagerly awaited by market actors and observers since it was considered relevant for the analysis of estimated

shortfall in the Phase II allowance market (2008-12). The numbers showed that despite a mild winter, emissions had continued to rise within the EU ETS perimeter. Economic growth in the region had been higher than many analysts had expected and EU ETS emissions in 2007 grew by an average of 1% per year since 2005 – with more vigorous growth in the Eastern Member States. This caused some analysts to revise their forecasts slightly upward for the likely shortfall in Phase II, and eventually for their projections of EUA prices in Phase II. However, the recent downturn in the economy and subsequent fall in emissions, along with the setback for international negotiations at COP15 in Copenhagen, have put a downward pressure on prices in the EU ETS.

Figure 1 illustrates an inconsistency that can be interpreted in many ways. In 2006, the price of  $EUA_{2007}$  fell to 0 while the price of  $EUA_{2008}$  traded around 20 €/ton. The reason was that no banking of allowances was allowed between the first trading period, ending in 2007 and the second period starting in 2008. This discrepancy in prices of something that is virtually the same commodity – the permit to emit one ton of carbon dioxide - is a sign of inefficiency. Had banking been allowed, this inefficiency would have been avoided. On the other hand, the practical implementation and political economy of second- (third- or fourth-) best processes are not necessarily that easy. Some wise architects of the scheme may well have suspected that the first trial period allocation would be “long” (in the sense of big surpluses) and that this was one of the prices to be paid for rapid implementation in an environment full of skeptical nation states, incomplete accounting and of course strategic players. Although banking, *normally*, enhances efficiency through predictability – in this particular case it might well have been wise to not allow banking precisely since this was a trial period and it would have been detrimental to give excess allocations eternal life.

Throughout the period from 2006 to 2008 there was an intense process of assessment and stakeholder consultation that involved all the branches of the EU culminating in a final compromise in the Council of Ministers and European Parliament in December 2008, the so called “EU Energy Package”.<sup>9</sup>

For the EU ETS, this means that substantial changes will come, as of January 1, 2013. The most fundamental change is centralizing much of the allocation process. Instead of each member state drawing up a NAP, the cap will be set at the European level. This change will

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<sup>9</sup> The “Energy Package” builds on the Commission proposal of January 2007, “Energy Policy for Europe”, and its twin communication, Limiting Global Climate Change to 2°C. Both of these proposals were endorsed by the spring Council in 2007

reduce the risk of a repeat ‘race to the bottom’, seen in the first two allocation rounds. The cap in 2013 will start at the average total quantity of allowances allocated by Member States in 2008–2012, decreasing linearly to a 21%-reduction below 2005 levels by 2020. It is worth noting that the annual reduction rate is legally binding beyond 2020, unless a new decision is made. The EU has, in fact, laid out a default emissions reduction path, not only for the short term, but also further into the future. Should the EU move to an overall 30% reduction target, the cap of the ETS will be adjusted downward proportionally.

Another central change is that auctions will distribute approximately 50% of the allocations in the revised EU ETS, up from about 4% in phase II. Electricity producers will, by and large, receive no free allocation. In other sectors, 20% of allowances will be auctioned in 2013, increasing to 70% in 2020, ‘with a view to reaching 100% in 2027. The broader use of auctions in phase III is likely to improve the economic efficiency of the EU ETS. The specifics of how the auctions will be structured and implemented are still to be settled, however, and there are potential pitfalls which could undermine some of the positive effects. Making sure that auctions are not used for national interests, reducing the risk of collusion among firms, and minimizing administrative costs should be priorities. A reserve price in the auctions could act as a price floor in the market and increase incentives for investments in low-carbon technologies. How the revenues are used will also impact efficiency, as will the way costs, imposed on the economy by the EU ETS, are distributed among Member States, industries, and households.

Sectors where carbon leakage is deemed to be a significant risk will, however, be treated differently. The primary measure proposed by the EU to mitigate carbon leakage is free allocation of allowances to firms at risk. Such firms may receive free allowances, up to 100 % of a benchmark intended to represent the 10% most efficient firms in each sector. However, free allocation does not, in itself, alter the economic incentives that firms face at the margin. Only an expectation that future allocations will be affected by production decisions will increase the incentives for firms to maintain their activities in the EU. That is, there has to be an element of updating in order for free allocation to do more than strengthen the balance sheets of firms, for instance in the form of output-based and updated allocation. The advantage of using such a mechanism should, however, be weighed against the efficiency losses in terms of reduced incentives for conservation it would carry.

The ETS Directive also leaves open the option for border adjustments, although it seems unlikely that such measures will actually be implemented. However, the possibility of requiring importers to surrender allowances is mentioned in the directive, and some Member States have expressed support for such provisions.

There is a large and growing body of research that analyses the efficiency and desirability of such policies from economic, legal, and political science perspectives. The picture that emerges is ambiguous. Using border adjustments in the context of climate change has still not been tried legally, so whether such measures would be compatible with, for instance, the WTO is not clear. The political implications of using border adjustments, even assuming they are legal, are difficult to predict. If they result in less political will to cooperate multilaterally, the measures could prove counterproductive. Analyses of the economic incentives resulting from various kinds of border adjustments require detailed information on firm characteristics, trade sensitivities, substitution elasticities between products, etc. Further, as noted by Fischer and Fox (2009), the environmental effectiveness of import adjustments depends on how well they reflect the actual emission intensities of products (sometimes referred to as ‘embedded emissions’), while the competitiveness depends on how large the adjustments are for imported goods that may substitute those produced domestically. Finally, import adjustments do nothing to support domestically produced goods that are exported. Export rebates could do this, but that option is not explicitly mentioned in the ETS Directive.

Further, there are special agreements on the use of the auction proceeds for supporting for instance the implementation of Carbon Capture and Storage in the power sector, as well as a number of renewable energy projects. Finally a new agreement has been reached for the allocation between countries of ETS permits which contains both elements that are redistributive (more rights to low income countries) and that recognize early action (in Eastern Europe).

In the Energy Package, the EU has committed to reducing its overall emissions to at least 20% below 1990 levels by 2020, and declared a willingness to scale up this reduction to as much as 30% under a new global climate change agreement “provided other developed countries make comparable efforts”. As this criterion was not met at the COP15 in Copenhagen, the EU stated that it would stick to its 20% target. Recently however (May 2010), the EU Commission released a communication analyzing the opportunity to move unilaterally to a 30% reduction target. The Commission concludes that “The macro-economic analysis shows that the

incremental impact of stepping up the EU effort to 30% while the others remain at their low pledges in comparison to the current climate and energy package on the output of the EU's energy intensive industry would be limited/.../ While the absolute costs of meeting a 20% target have been reduced, representing a welcome relief for businesses facing the uphill battle of recovery, it also represents a risk that the effectiveness of the 20% target as a motor for change diminishes.”. While this is a strong signal, it remains to be seen if this is an indication that the EU will, in fact, move unilaterally to a 30% reduction target.<sup>10</sup>

The EU also set itself the target of increasing the share of renewable energy in overall EU consumption to 20% by 2020 (including a 10% target for renewable energy in the transport sector) and a 20% increase in energy efficiency. This so-called energy and climate package also seeks to promote the development and safe use of carbon capture and storage (CCS). Strengthening and expanding the EU ETS is however still central to the EU strategy. Emissions from the sectors covered by the system will be cut by 21% by 2020 compared with levels in 2005. Sectors able to pass along costs (for example, the power sector) will face full auctioning faster, while free allocation will be progressively phased out for those sectors exposed to international competition, with a view to reaching full auctioning by 2027.

Although there are still no definitive assessments of the effects of the EU ETS in terms of producers' and consumers' choices, economic activity, trade patterns and GHG reductions the first analyses are now beginning to appear and there is no doubt that the EU ETS has succeeded in imposing a price on CO<sub>2</sub> emissions; and this is by far the most significant accomplishment in climate policy to date.<sup>11</sup> Emitters of CO<sub>2</sub> in the trading sector now face price signals that reflect the fact that Earth's capacity to absorb greenhouse gases is limited. The price signal goes beyond the EU ETS; it also provides a basis for evaluating initiatives in the CDM, JI markets, other trading under the Kyoto Protocol and beyond, and emerging opportunities for carbon sequestration. Ellerman et al (2010) chapter 4 is dedicated to a preliminary investigation of whether free allocation has significant effects. They do of course find financial effects but little evidence of operational effects at least in the short term. The

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<sup>10</sup> The game theory involved here is complicated. Even a climate enthusiast must have mixed feelings about this suggestion since it might weaken the EU negotiating stance in future rounds. It is also worth noting that other countries do not appear to be attracted to the structure of this bid or propose similar bids. This could be a sign that they do not (yet ?) attach significant weight to the overall goal of reducing global emissions.

<sup>11</sup> One should mention that fuel taxes in Europe, Japan and a few more countries have actually for several decades implied an even higher price signal – although only for the transport sector. Even if these taxes were not exclusively or formally climate motivated they have actually implied big reductions in emissions, see Sterner 2007.

issue of whether there are investment effects of the new entry and closure rules is more open. Chapter 6 cites and summarizes a limited number of studies that evaluate the abatement effects of the ETS. As the authors point out, not much abatement could be expected of the first trial period but in all likelihood there was actually significant abatement! Since the permit price was (unexpectedly) high for two years and many plants did not know there was over-allocation, they did their best to adapt to relative prices and abate. In fact this is probably one overlooked explanation for a part of the phenomenon referred to as the first period over-allocation! Both macro-modeling and micro-evidence indicates that the trial period implied significant abatement that appears to cover all sectors and countries concerned and amount to reductions in the order of 2-5% of total emissions – or 120 to 300Mtons for the three year period.

In addition, the model of governance in the EU ETS has broken new ground in the experience with emissions trading regimes across multiple jurisdictions. It has provided new evidence on how variations in the institutional capability to implement emissions trading can be encompassed in a single trading program; this evidence is particularly relevant if we think about how a global trading regime might evolve. It is possible—indeed likely and desirable—that the EU ETS will either be developed to, or superseded by, better instruments. It is worth considering that the coordination problems would likely be larger in a truly multinational setting outside the EU and thus the advantages of the increasing centralization of allocation decisions to the central Commission would be harder to attain. The EU ETS has however created a powerful precedent and raised consciousness both concerning permit trading and climate change in the world. Considering the scale and urgency of the climate challenge, the EU ETS should be judged first and foremost on the merit of having been a pioneer activity.

### *Aviation and the EU-ETS*

According to IPCC (2007) estimates, aviation currently accounts for about 2 % of human-generated global CO<sub>2</sub> emissions and approximately 3 % of the potential warming effect of global emissions on climate change, 80% of which attributed to commercial aviation. Compared to the entire transportation sector, which generates approximately 20% of all anthropogenic GHG emissions, aviation's share of emissions is small, but steadily increasing. Indeed, in its relatively short history, commercial aviation has undergone tremendous growth. Since 1960, passenger traffic grew nearly 9% yearly, decreasing slightly to 5% since 1999.

With the exception of diesel motor cars and trucks, aviation is the most polluting mode of transport for the movement of both passengers and freight (Chapman, 2007). Aviation affects climate change not only through the emissions of CO<sub>2</sub>, but also through the creation of high-altitude ice clouds formed in the wake of the aircraft. High clouds increase the amount of solar radiation that is reflected. As a result, they have the potential to influence climate on a global and regional scale. The latter effect has been found to potentially play a major role in climate change accounting for the largest impact from the aviation sector (IPCC, 1999). Even in the context of future technological and operational improvements that will continue to decrease the emissions from aviation activities, experts believe that these improvements alone will not be sufficient to counterbalance the increase in emissions generated by the growth in global air traffic. Further action is then required in form of policy interventions. However, the policy design must take into consideration the mobile nature of the emission sources, the trans-national character of the activity and the fact that the total impact on climate change is wider than the direct effects of CO<sub>2</sub> emissions –and thus an overemphasis on CO<sub>2</sub> reduction might lead in the long run to the development of technologies with significantly higher emissions of other pollutants to compensate for the reduced CO<sub>2</sub> emissions.

So far, no global agreement on the reduction of aviation emissions has been reached. Nevertheless, the European Union decided in October 2008 (Directive 2008/101/European Commission), to include aviation within the EU emissions trading scheme (EU ETS) from 2012 onwards. The trading scheme will cover domestic flights within the European Economic Area (EEA), and flights between the EEA States and countries outside the EEA (European Commission, 2006).

The overall objective of the program is to reduce the impact on climate change of aviation emissions, and to ensure that aviation sector contributes to the achievement of the overall objective of the Community to achieve a 20%-30% reduction in emissions by 2020 compared to the 1990 level. The project is still in its initial stages: throughout 2010, operators must monitor and report ton-kilometer data, which is required for allocating free allowances. The European Commission is scheduled to publish total number of allowances and benchmarks in September 2011, with the final allocation and transfer of the emission allowances to operators' accounts expected to occur in February 2012.

The estimated reductions in CO<sub>2</sub> emissions as a result of including aviation in the EU ETS (all arriving and departing flights) are of 36% by 2015 (122 Mt of CO<sub>2</sub>) and 46% by 2020 (183

Mt of CO<sub>2</sub>) relative to the business-as-usual scenario in 2005 (European Commission, 2006). In addition, the inclusion of aviation in the EU ETS system is expected to generate changes in air traffic volumes (albeit very small), incentivize technological changes for air transportation (engine and combustor designs, lighter aircraft construction materials, more aerodynamic aircraft designs) and encourage other transportation modes due to substitution effects. The economic effects of the inclusion will mostly be felt by the final consumers of aviation services, since additional costs will most likely be passed forward from the airline companies to the consumers, assuming that passengers are fairly insensitive to price changes. However, a decrease in demand is still expected, both for cargo demand and passenger demand, albeit estimated to be small, especially due to the ability of the aviation industry to price discriminate between consumers. With regards to this last point, many short haul flights could be replaced by inter-city rail travel where the impacts per passenger kilometer can be much lower (Chapman, 2007). Nevertheless, this might require railway infrastructure investments and better integration with airports.

### **2.3 Carbon Trading Schemes in the USA, Australia, New Zealand and Japan.**

#### *United States Carbon Markets*

Despite the fact that the United States—through the Clean Air act and Acid Rain program—has pioneered emissions trading and that it has for many years been the largest GHG emitter (only recently to be surpassed by the much more populous China), a national carbon market has not yet been developed. In October 1992, President George H. W. Bush supported action on climate change, signing the UNFCCC treaty. However, in July 1997—before the Kyoto Protocol was finalized—the US Senate unanimously passed the Byrd-Hagel Resolution, stating that the US Senate would not ratify any protocol that did not include binding targets and timetables for developing as well as industrialized nations or that would result in serious harm to the US economy (Bang et al. 2007).

As US negotiators were not able to secure quantitative commitments for developing countries, the Byrd-Hagel Resolution prevented the Clinton-Gore administration from putting the Kyoto Protocol to a vote in the Senate. Although Vice President Al Gore symbolically signed the Protocol in 1998 he indicated that the Protocol would not be submitted to the Senate for ratification until there were clear targets for developing nations. Finally, in 2001

President George W. Bush's repudiation of the Kyoto Protocol made clear that the US Kyoto targets would not be implemented during his administration (See Brohé et al. 2009 for a detailed description of US climate policy).

Though the Bush administration consistently opposed any kind of mandatory limitation on US GHG emissions, favoring instead initiatives that relied only on voluntary cooperation (e.g., information campaigns) and technology subsidies, there have been a number of legislative cap-and-trade proposals at the regional level. Also, a wide variety of cap- and-trade proposals have been discussed in Congress and many initiatives are under way. For instance, in 2009 there are three regional cap-and-trade programs in operation or development within the US accounting for a total 26 states and 36% of total CO<sub>2</sub> emissions in that country,<sup>12</sup> and the Chicago Climate Exchange (CCX), a private and voluntary market for emission allowance trading between firms.

The Regional Greenhouse Gas Initiative (RGGI) was the first mandatory US cap-and-trade program for CO<sub>2</sub> (Brohé et. al. 2009). In 2007 the ten northeastern and mid-Atlantic states that are participating (Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island and Vermont) set a cap on CO<sub>2</sub> emissions from fossil fuel-fired power plants with an installed capacity of at least 25MW, covering in total about 225 facilities. The purpose is to reduce CO<sub>2</sub> emissions from the power sector by 10% by the year 2018. Participating states negotiated state-wide caps largely based on historical emissions. Aggregated, these state caps form the regional RGGI cap. The first compliance period began 1 January, 2009. However, forward trading of RGGI allowances started as early as March 2008.

Interestingly, most states are auctioning 100 per cent of emission allowances to industry and using the revenues on programs that promote renewable energy and energy efficiency or mitigating possible increases in energy prices to consumers. Covered entities are required to continuously monitor and report their emissions. As in the EU ETS, penalties for non-compliance will also be enforced according to each state's civil law in addition to the rules of the trading scheme regarding non-compliance.

The Western Climate Initiative (WCI) began in February 2007 when the Governors of Arizona, California, New Mexico, Oregon, and Washington signed an agreement directing

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<sup>12</sup> 10 Canadian states participate also in these programs.

their respective states to develop a regional target for reducing GHG emissions, participate in a multi-state registry to track and manage GHG emissions in the region, and develop a market-based program to reach the target. The WCI built on existing GHG reduction efforts in the individual states as well as two existing regional efforts. In 2003, California, Oregon and Washington created the West Coast Global Warming Initiative, and in 2006, Arizona and New Mexico launched the Southwest Climate Change Initiative. The Premiers of British Columbia, Manitoba, Ontario, and Quebec, and the Governors of Montana and Utah have since joined the original five states in committing to tackle climate change at a regional level.

The seven US states participating in the WCI represent about 20 per cent of the US economy, while the four Canadian provinces make up 70 per cent of the Canadian economy (See Brohé et al. 2009). The WCI cap-and-trade program is expected to cover about 90 per cent of the GHG emissions in participating American states and Canadian provinces, including those from electricity, industry, transportation, and residential and commercial fuel use. While the regional WCI cap will be the sum of all the individual state caps, the program's overarching goal is to reduce GHG emissions to 15 per cent below 2005 levels by 2020. To do this, the WCI regional goal remains consistent with the state and provincial goals and does not replace the individual goals. The specific individual caps and the combined regional cap for the years 2012 through 2020 will be set prior to 2012 when the program begins.

Finally, on November 2007 nine Midwestern governors and two Canadian provinces signed on to participate (Iowa, Illinois, Kansas, Manitoba, Michigan, Minnesota and Wisconsin) or observe (Indiana, Ohio, Ontario and South Dakota) in the Midwestern Greenhouse Gas Reduction Accord (MGA). Under MGA, participants agreed to regional GHG reduction targets including a long-term target of 60-80 per cent and develop a multi-sector cap-and-trade system to achieve the targets. In early 2009, this Accord was still in the planning stages.

The Chicago Climate Exchange (CCX) is a GHG cap-and-trade system in which a group of nearly 300 North American companies (as Motorola Inc., Ford Motor Co., IBM, Intel Corporation and DuPont, among others) have voluntarily agreed to reduce GHG emissions 6% below a baseline period of 1998-2001 by 2010. These companies can comply with annual GHG emission reduction targets through internal reductions, purchase of allowances from other companies facing emission limitations, or purchase of credits from emission reductions' projects that meet specific criteria. The CCX launched trading operations in 2003 with thirteen members.

The CCX clearly has benefited from the overall direction of climate policy within the U.S. as new regional initiatives began to take shape in the U.S. and as interest in and prospects for an economy wide Federal cap and trade scheme grew. The commodity traded on CCX is the Carbon Financial Instrument contract (CFI), each of which represents 100 metric tons of CO<sub>2</sub> equivalent (MtCO<sub>2</sub>.eq). CFI contracts are comprised of Exchange Allowances and Exchange Offsets. Exchange Allowances are issued to emitting Members in accordance with their emission baseline and the CCX Emission Reduction Schedule. Exchange Offsets are generated by qualifying offset projects. In October 2007, CCX claimed that its recent growth in membership had brought emission reductions of more than 540 MtCO<sub>2</sub>.eq (or about 7-8% of reported 2005 US GHG emissions).

The prospect of U.S. engagement in climate policy also attracted a major new exchange, the New York-based Green Exchange, into to the market. CCX also pursued an expansion strategy to other schemes and other regions. In August 2007, CCX started listing futures on CER contracts, followed in September 2007 by futures on EUA contracts and, in December 2007, listing CER options. By offering a wider suite of carbon financial products tracking several segments of the Carbon market, CCX hoped to attract more members.

The Waxman-Markey bill that passed in the House of Representatives in 2009 is very similar to the Kerry-Lieberman bill discussed in but currently (summer 2010) not likely to pass in the Senate. Table 2 summarizes the two climate bills' key components. As can be seen the reduction targets and rules for banking and borrowing are exactly the same, while the sectoral coverage, share of permits being auctioned and rules on prices floors and price caps, as well as share of domestic offsets differ slightly.

An interesting aspect of the US climate policy is that while the discussion regarding a climate bill appears so hard to pass in Congress, the Supreme Court has made it clear through their decision in *Massachusetts v. EPA* that action under the Clean Air Act (CAA) is legally required. Hence, doing nothing to reduce carbon emissions while waiting for a climate bill to go through the Senate (the Kerry-Lieberman bill), is not an option. While economic theory and empirics show that it is more efficient to use a carbon price (e.g. through a tradable emission permit scheme) to reduce carbon emissions than command and control instruments, researchers suggest that regulation of carbon under the CAA may not in the short run have large negative efficiency losses (for a discussion of this see e.g. Burtraw and Richardson 2010). This reasoning is based on that EPA focus their regulations in sectors where the

mitigation opportunities are relatively homogenous and where EPA has good knowledge about these options (and hence can reap the so called low hanging fruits). If the EPA follows this strategy, a regulation under CAA can rather be seen as a complement to a climate bill. Hence, even if the Senate does nothing, carbon emissions will be regulated through the CAA. However, in the long run, there will most likely be large efficiency losses if only the CAA is used to control carbon emissions, since CAA does not provide a nationwide carbon price.

**Table 2.** *US climate bills in the House and Senate*

	American Clean Energy & Security Act (ACES) – Waxman-Markey (House bill)	American Power Act (APA) –Kerry-Lieberman (Senate bill)
Reduction targets	Compared to 2005 emissions: -17% to 2020, -42% to 2030, -83% to 2050 for 7 GHGs	
Sectoral coverage	Utility & industry sources (>25000 tCO <sub>2</sub> -e/yr), refineries from 2012 - ~80% of tot emissions (~5.5 GtCO <sub>2</sub> -e)	Utility (>25000 tCO <sub>2</sub> -e/yr) & refineries from 2012, industry from 2016
Auctioning	20% at start, phasing up to 70% by 2030	25% auctioning (refineries 100%) at start, phasing up to 100% by 2035
Price floor / cap	Price cap: US\$ <sub>2009</sub> 28 (5%inc/yr) 2012-2014, then 60% above 3-yr av. price	Price Floor: US\$ <sub>2009</sub> 12 (3%inc/yr) Price cap: US\$ <sub>2009</sub> 25 (5%inc/yr)
Offsets	<2 GtCO <sub>2</sub> /yr (50% domestic)	<2 GtCO <sub>2</sub> /yr (75% domestic)
Banking / borrowing	2-yr rolling commitment period with unlimited banking & borrowing; <15% borrowing from next 5 years, at 8% interest rate	

### *Australia*

Australia's New South Wales (NSW) GHG Abatement Scheme commenced on 1 January 2003 and is to remain in force until 2012 (Brohé et. al. 2009). Since January 1, 2005, the scheme also covers the Australian Capital Territory (ACT). In the scheme electricity retailers and large electricity customers are required to meet mandatory intensity targets for emissions of GHGs arising from the production of electricity they supply or use. They can meet their targets by either reducing their own emissions or by purchasing (offset) certificates (NSW Greenhouse Abatement Certificates or NGACs). NGACs are generated through the following activities: low-emission generation of electricity and improved generator efficiency, activities that result in reduced consumption of electricity or on-site generation of electricity, and

carbon sequestration into biomass. Renewable Energy Certificates are also eligible, but no other form of credit (e.g. CDM or JI) is eligible at this time.

Until 2007, the NSW GGAS was the second largest greenhouse gas abatement market with about 20.2 million certificates (each certificate representing 1 tCO<sub>2</sub>-eq) of emission reductions) exchanged through 2006 for a value estimated at US\$225.4 million (€173 million). The 2006 market represented a 3.3 times increase over the volumes transacted in 2005 and about 3.8 times increase in the value for 2005. However, uncertainties regarding the successor of the NSW GGAS have affected the volume traded.

In June 2007, Prime Minister John Howard had announced that the Australian Government would introduce a domestic emissions trading scheme (the Australian Carbon Pollution Reduction Scheme, CPRS) by 2012 at the latest, and possibly in 2011. Nevertheless, many of the policy design elements remain under consideration.

The cap of the CPRS is to be consistent with a long-term GHG reduction goal of 60% or more below 2000 levels by 2050 and a mid-term target corresponding to a reduction in emissions of 5 to 25% below 2000 levels by 2020, with the more stringent target being conditional on an international climate agreement including similar targets for other developed countries, as well as substantial emission restraint in major developing economies. The sector scope of the proposed CPRS is quite comprehensive, making the CPRS the overarching instrument to manage GHG emissions in Australia. All emissions of Kyoto GHGs from industrial processes, stationary energy, transport, waste and fugitive emissions would be covered from the start, while agriculture could be phased-in in 2015. Reforestation activities could be opted-in on a voluntary basis while emissions from (domestic) deforestation will most likely be addressed through other incentives (for the inclusion of offsets that reduce emission from deforestation in other countries, see section 3.5). The proposed CPRS perimeter (excluding agriculture) corresponds to about 80% of Australia's GHG emissions with approximately 1,000 entities regulated. Unlimited imports of eligible international units are considered.

Caps would be set five years in advance with proposed ranges (or gateways) up to 10 years into the future, taking into account the progress in international negotiations. This could also give the regulator the option to adjust the cap within the gateway depending on economic prospects for regulated entities. This approach of providing ranges and the option of adjusting caps within the given ranges, is maybe a useful innovation, and can provide society with an opportunity to adjust the level of effort based on scientific advice and technological progress.

Caps for the first five years and first gateways were supposed to be announced early 2010 (and were scheduled to begin in July 2011, with Australia's target under the Kyoto Protocol) but, the government recently decided to delay plans until the Kyoto Protocol expires 2012.

### *New Zealand and Japan*

New Zealand ratified the Kyoto Protocol in 2002, committing to reduce GHG over the first commitment period to return to 1990 levels (Jian et al. 2009). The first attempt to fulfill this target was to implement a carbon tax. The tax was seen as a transitional instrument towards full or partial emissions trading in the long run. However, the tax proposal met significant opposition and was abandoned. Instead, in late 2008, New Zealand passed into legislation a comprehensive ETS that includes all sectors and all gases. Nevertheless, in November 2008 the new government decided to suspend the barely started New Zealand ETS and to formally review New Zealand's climate change policy.

Some analysts see this as another step back for New Zealand, since the country's climate change policy has been under review much of the past nine years or so. At the time of writing (May 2010), a revised ETS is set to be launched in 2010. Some sectors' entry will be delayed, but the main principles of the originally proposed system have been retained.<sup>13</sup>

Japan is the world's 6<sup>th</sup> largest greenhouse gas emitter, following the United States, China, the EU-25, Russia and India, and its emissions are still on the rise. Under the Kyoto Protocol Japan has committed to reduce its greenhouse gas emissions by 6% below 1990 levels by 2008-2012. Japan launched in October 2008 a trial domestic scheme based on voluntary participation. Depending on the experience, the trial may be scaled up and followed by a scheme requiring mandatory participation. Potential participants voluntarily apply to participate, submitting their own emission reductions targets (either absolute or intensity-based) for review. In addition to their own internal abatement efforts, participants can meet their compliance objectives using allowances from domestic projects or Kyoto Mechanisms. By December 2008, fewer than 500 participants with targets joined the scheme, considerably

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<sup>13</sup> The structure of the abandoned ETS was designed around core pillars. First, the scheme would operate within the global cap on emissions set by the Kyoto Protocol. Second, market liquidity would be enhanced by allowing both sales to and purchases from international markets. Finally, forest landowners would derive credits for forestry activities that lead to carbon sequestration and face liability for subsequent release of carbon into the atmosphere. An interesting feature of the proposal was that it included all sectors in a progressive way; starting with forestry in 2008 through agriculture in 2013.

below the expectations of thousands joining (Capoor and Ambrosi, 2009; Van Asselt et. al 2009).

## **2.4 Clean Development Mechanism and Joint Implementation**

### *Primary and secondary CDM*

The Clean Development Mechanism (CDM) is an important part of the emerging carbon market and aims to achieve both sustainable development (SD) and cost-effective reductions of GHG in developed countries. The CDM can be characterized by how it operates and by an overview of the current status of the CDM project portfolio. The CDM is a market mechanism in the sense that the price of a certified emission reduction (CER), measured in tones of CO<sub>2</sub>-eq., is negotiated between buyers and sellers.

The CDM was originally seen as a bi- or multilateral mechanism where Annex 1 countries with emission reduction targets – or authorized public or private entities within these – could invest in project activities that reduced GHG emissions and contributed to SD in non-Annex 1 countries. However, the CDM has evolved and today also allows non-Annex-I countries themselves to implement projects reducing emissions—generally referred to as unilateral CDM—and sell the generated CERs on the international carbon market.

Participation in the CDM is voluntary but to have a project registered with the Executive Board, i.e. the governing body of the CDM, all parties involved are required to obtain a Letter of Approval from their Designated National Authorities (DNA). It is up to the CDM host country itself to define the SD criteria and, through their DNA approve that each CDM project meets these criteria. Methodologically, it is the responsibility of the project developer to document in a Project Design Document (PDD) that the emission reductions are ‘real, measurable and long-term.’ This means proving that reductions go beyond the business-as-usual scenario (the baseline) and hence are additional to any emission reductions that would have occurred in the absence of the project (the additionality criteria).

Currently, several types of CERs exist in the market: issued CERs or forward streams of CERs and primary or secondary market CERs. The primary market refers to issued CERs that have been generated and issued by projects already undertaken and forward streams that are supposed to be generated by projects that are under construction and expected to generate

credits between 2008 and 2012. The secondary market CERs consist of companies who have bought larger quantities of Primary CERs are selling part of their own CER portfolio onto third parties, which are then called secondary CERs. The price of secondary market CERs is usually higher because the entity takes all project risks.

**Table 3: CDM and JI projects by status of registration, project type and host region/country.**

	CDM			JI		
	No. of projects	Millions of CERs: Issued to date	Expected by 2012	No. of projects	Millions of CERs: Issued to date	Expected by 2012
...by project status:						
Registered	2 062	386	1 763	114	5.5	106
In pipeline	2 906	-	1 072	174	-	270
Total	4 698	386	2 836	288	5.5	377
...by type:						
HFCs, PFCs & N2O reduction	(%) 2.1	(%) 75	(%) 26	(%) 13	(%) 22	(%) 27
Renewable energy	60	13	35	33	12	9
Methane reduction & cement	20	6.1	20	49	32	46
Supply-side energy efficiency	11	4.2	11			
Demand-side energy efficiency	3.8	0.3	0.9	54	40	20
Fuel switch	2.2	1.1	6.1	9	0	3
Afforestation & reforestation	1.0	0.0	0.5	1	0	0
Transport	0.4	0.1	0.3	-	-	-
...by host region/country:						
Asia & Pacific	(%) 79		(%) 81	(%)		(%)
China	40		54			
India	26		16			
Latin America	17		14			
Brazil	7.1		6			
Mexico	3.3		2.2			
Southern Africa	2.5		3.3			
Middle East & North Africa	1.5		1.8			
Russia				38		61
Ukraine				15		18
Eastern Europe				41		14
EU + New Zealand				6		7

Source: UNEP Risoe CDM/JI Pipeline Analysis and Database (<http://cdmpipeline.org/index.htm>). April 15, 2010

Rapid changes have occurred in the CDM project portfolio since 2005. The number of projects has multiplied and grown from 91 projects in April 2005 to 2140 projects registered by April 2010, and with an equal number of projects awaiting registration, see table 3. Still, the primary market for CER has weakened considerably since the second half of 2008 under the weight of the financial downturn and amid lingering questions about the rules of post-2012 eligibility (Capoor and Ambrosi, 2009). Many of the policy initiatives addressing post-2012 credits are still at the proposal stage and are likely to be influenced by the outcome of international climate negotiations.

In terms of numbers of projects, the biggest project types are: renewable energy, methane emission reductions, energy efficiency and fuel switching. Transacted volumes in these three broad project categories alone totaled 323 MtCO<sub>2</sub>-eq., accounting for 82% of volumes contracted in 2008. In terms of CERs generated to date, however, the market is completely dominated by cheap reductions of the potent GHGs (HFCs, PFCs, and N<sub>2</sub>O) from industry, see table 3. Hydro, wind, biomass energy and energy efficiency of power generation at large industrial facilities led the growth of the CDM project in the pipeline (i.e., awaiting registration by the EB) and accounted for 70% of the number of projects and 65% of the volumes that entered the pipeline from January 2008 to March 2009. Hydro projects alone accounted for over a quarter of all projects and volumes entering the pipeline in this period. The number of projects in the pipeline targeting demand side management (e.g., efficient lighting) doubled to 14 over the same period; as did the number of solar projects. Some earned an extra transaction price premium because of their Gold Standard certification (Capoor and Ambrosi, 2009)

When the portfolio is characterized by the distribution of CDM projects across countries, a skewed geographical pattern emerges. As of 10 January 2010, the top four countries – measured by the number of projects hosted by each country – are: China (722), India (478), Brazil (166) and Mexico (120), which represents almost 75% of all CDM projects globally, see table 3. China alone is expected to deliver more than half of all CERs by the year 2012. Distributed by region, Asia and the Pacific and Latin America have taken the lead, hosting 75% and 22% respectively of all CDM projects. Sub-Sahara Africa, the Middle East, Europe and Central Asia are marginalized with only a few projects (48), comprising only 2.4% of all CDM projects (UNFCCC 2010).

In spite of the apparent achievements of the CDM inducing emission reductions in developing countries, the mechanism has been criticized on a number of accounts (see, e.g., Stern 2006, Tirole 2009). The most fundamental critique concerns the issue of additionality and the risk that CDM might create some perverse incentives: the Kyoto Protocol specifies that emission reductions are only to be certified under CDM if they are additional to any that would occur in the absence of the certified project activity. The CDM requires additionality to assure that CO<sub>2</sub> emitted in developed countries against a CER is not increasing the total level of emissions permitted under the trading scheme. Nevertheless, since there is no baseline against which such additionality can be assessed, governments might have an incentive to not impose regulations on emissions since a more stringent regulation would shift the baseline against which a potential CDM project would be evaluated. An important criterion for assessing additionality has also been the expected financial returns of the project; if deemed ‘too high’ without the carbon finance component, the project is not approved by the CDM Executive Board (CDM EB). The issue of additionality in the absence of an overall cap for a country is a fundamental flaw. In attempt to address this, the CDM EB has developed a range of criteria and an “additionality tool” that is intended to make the assessment more transparent. Ultimately though, the bottom line is that there is no baseline and there is no cap for the country and therefore true accounting or verification of additionality is infeasible. This same critique applies also to other mechanisms such as REDD that have no baseline and are to be used in countries with no overall cap. As correctly pointed out by the developing countries the lack of additionality also applies to monetary flows. Rich countries have repeatedly failed to honour passed promises of development assistance. Now they offer “additional” funding for climate investments but it is hard to demonstrate in a satisfactory manner that these flows are truly additional to the development assistance that might have been a baseline level.

A second point of critique has been the fact that transaction costs of the CDM have been rather high because of the requirements to demonstrate project additionality on a case-by-case basis. In practice, additionality is a complex concept since it involves speculation about what would have happened in the absence of the project obtaining carbon finance. Finally, CDM can only serve as transitional mechanism because it does not generate emission reductions above and beyond those required by developed country targets.

Although the CDM is supposed to foster sustainable development (SD), uncertainty prevails as to whether it does (Holm 2007, Muller 2007, Sutter and Parreño 2007). With regards to this point, non-Annex I countries can define the sustainable development requirements for CDM

projects in their country according to their own wishes. Competition among non-Annex I parties in attracting CDM investments could, therefore, create an incentive to set low sustainable development standards in order to attract more projects with low abatement costs. This could lead to a “race to the bottom” in terms of sustainable development standards with non-Annex I parties undercutting each other to attract CDM investments, weakening the sustainable development objective. Thereby, the absence of international sustainable development standards alongside a highly competitive supply side of the CDM is likely to cause a trade-off in favor of the cost efficient emission reduction objective. Neither Annex I countries nor single non-Annex I parties have direct incentives to implement strict sustainable development criteria.

Technology transfer is often mentioned as an ancillary benefit of the Clean Development Mechanism. However, it remains to see how important the mechanism can be in terms of stimulating the transfer of sustainable energy technologies to developing countries. Seres et al. 2009 provide a comprehensive analysis of technology transfer in the CDM to date that covers 3296 registered and proposed projects concluding that CDM contributes to technology transfer. They point out that technology transfer is more common for larger projects and projects with foreign participants and that is very heterogeneous across project types and usually involves both knowledge and equipment. In general, hardware technology transfers take place to a larger extent in projects that reduce non-CO<sub>2</sub> GHGs than in renewable energy and energy efficiency projects. One exception might be wind energy where all projects use technology from the EU (De Coninck et al. 2007).

Although there is no doubt that the CDM concept harbors some serious conceptual issues that will likely make it impossible as a long run instrument, it has nevertheless provided a very important basis on which to construct a more sensible and effective global climate policy. Maybe the biggest contribution of CDM to date has been to capture the interest of governments and companies in developing countries to view climate change mitigation as an opportunity instead of a constraint to growth. Another important contribution has been to provide experience and lessons on what has worked well and what could improve if market mechanisms are to be relied on to mitigate GHG emissions.

### *Joint Implementation*

Joint Implementation (JI) under the Kyoto Protocol allows the transfer of Emission Reduction Units (ERUs) between Annex I states. Just as CERs, the ERUs can result from projects

reducing GHG emissions in any sector of the economy, and they have to be approved by the relevant parties and be considered supplemental to domestic actions. In such sense, JI processes have similar processes and institutions as the CDM (Illum and Meyer 2004; Hepburn 2007). In terms of numbers of projects and amount of emission reduction expected, JI has however been much less successful than CDM, see comparison in table 3.

In Europe, most JI projects are hosted by countries in Eastern and Central Europe with countries in Western Europe as investors. In 2008, most projects concentrate on Russia and Ukraine, with a 68% and 18% market share of transacted volumes, respectively. As CDM, The JI market experienced a slowdown due to the uncertainty related to the post Kyoto agreement. The financial credit crunch that reduced global European and Japanese demand for compliance assets has also led to numerous projects (including several registered projects) failing to receive sufficient financing to be commissioned.

## **2.5 REDD-plus: Reduced emissions from deforestation and forest degradation.**

Each year about 10 million hectares of forest is cleared in the tropics, and even larger forest areas may be subject to degradation. The resulting carbon emissions amounts to around  $4.4 \pm 2.0\text{Gt CO}_2/\text{y}$ , constituting 6-17% of all anthropogenic  $\text{CO}_2$  emissions and rivaling the contribution of the global transport sector to climate change, though uncertainties still abound (van der Werf et al. 2009, Parker et al 2009).

Due mainly to concerns over risks for leakage and non-additionality, ‘avoided deforestation’ projects were excluded from the CDM and as a result developing countries have no incentives for reducing the emissions from deforestation and forest degradation under the current international climate regime. Since 2005, however, there is an ongoing discussion about the possibility of including Reduced Emissions from Deforestation and forest Degradation (REDD) in a post-Kyoto agreement. The basic idea of REDD is to compensate developing countries for reduced emissions from deforestation and forest degradation and to provide financial incentives for forest conservation.

Initially put forward by a coalition of rainforest nations, led by Costa Rica and Papua New Guinea, the proposal for a REDD mechanism has been one of the key issues in international climate negotiations in the last few years. There are a number of reasons for this. Firstly, it is an area where developing countries themselves have expressed willingness to contribute to

climate mitigation. Secondly, REDD holds the promise of being a win-win—or even win-win-win—solution, where developing countries earn revenue from selling REDD credits, developed countries lower the cost of meeting their emission targets through REDD offsets, and in addition large co-benefits from forest conservation in terms of, e.g., reduced biodiversity loss are created. Thirdly, the notion that large emission reductions can be achieved at a very low cost, with both the IPCC and the Stern review claiming that REDD is one of the least expensive abatement options available.

Although creating an environmentally effective, cost efficient, and equitable REDD system is a challenge both technically and politically (Angelsen et al. 2009a), the fact that both developed and developing countries are likely to benefit from the inclusion of a REDD component in a future climate regime means that negotiations over this issue have not been fraught with the same conflicts and difficulties as those over, e.g., overall emission targets. Consequently, at COP15 in Copenhagen REDD was one agenda item on which parties managed to essentially agree on a text. Here we will outline the key elements of that agreement, discuss some unresolved issues, give an overview of the bilateral and multilateral REDD initiatives that have been launched in the last years, and finally discuss their possible link to existing and emerging carbon markets.

#### *REDD-plus – outcome of the Copenhagen negotiations*

While a failure in terms of the overall climate regime, COP15 in Copenhagen saw a near completion of the negotiations on the structure of an international REDD mechanism (UNFCCC 2009), though there are still some outstanding issues and a number of crucial details that need finalizing. Many of these revolve around the thorny issue of baselines and implicitly additionality. One of the important issues that parties managed to agree upon was the scope of the regime: developing country parties should undertake forestry mitigation actions through (1) reducing emissions from deforestation and forest degradation, and through (2) conservation and enhancement of existing forest carbon stocks, collectively referred to as REDD-plus. “REDD” builds on assigning baselines anchored on deforestation rates which will (perversely?) reward countries with high (historic) rates. The “plus” refers to inclusion of conservation and enhancement activities that will also benefit countries with low rates of deforestation by create financial incentives to protect existing forests and even expanding them (though it is still not clear how forest conservation will be supported, as it does not lead to a reduction in emissions that are easily converted to carbon credits).

The expansion from REDD to REDD-plus was partly driven by the concern that if rewards were only given for reducing deforestation rates, and not maintaining existing forest carbon stocks, the incentive to participate would be limited for countries with large tracts of forest but currently low levels of deforestation. The result of this could be international leakage, whereby emissions reductions resulting from the REDD system would be offset by increases in deforestation rates in non-participating countries, drastically reducing the environmental effectiveness of the regime. However, the shift was also driven by countries such as India and China that historically have cut most of their forests and presently are increasing their forest cover again, and that saw a potential for getting remunerated for this development. (Notice again how the issue of additionality is always problematic as it would appear that countries are trying to get finance for activities that will be happening anyway).

The COP15 agreement also includes safeguards aiming to assure that the implementation of REDD-plus is carried out in “full and effective participation of relevant stakeholders”, respecting the knowledge and rights of local communities and indigenous peoples (UNFCCC 2009). These wordings are a response to the fears of some that REDD, through increasing the value of forests, might adversely affect poor forest dwellers and the inclusion of safeguards was forcefully promoted by a diverse group of civil society organizations.

The agreement further endorses a phased approach to REDD-plus, where the implementation of mitigation activities will depend on “national circumstances, capacities, and capabilities” and where funding will have to come from a variety of sources, both private (carbon markets) and public (bilateral and multilateral funds). In the early phases of REDD-plus, where the main focus will be on building institutional capacity for monitoring land use change, assessing the main drivers and developing policies for controlling it, the main source of financing will likely be through international funds. In later stages, when the effectiveness of enacted policies can be monitored and verified and performance based payments can be applied, the possibility of tapping into the global carbon market will be larger.

The Copenhagen SBSTA deliberations also made some progress on how to set the reference levels (RLs) under which countries will be compensated (through carbon credit sales or international funding) for emission reductions. The determination of country RLs is paramount to the REDD system as it affects not only the environmental effectiveness of the REDD regime, but also the distribution of the financial benefits from REDD and hence the incentives for tropical countries to participate in the scheme (Angelsen et al. 2009b). The

higher the RL, the larger the incentive for participation, but also the risk for non-additionality of emission reductions.

The SBSTA chose to promote “historical emission levels” as the basis for RLs, albeit adjusting for “national circumstances” (UNFCCC 2009). While this represents a step forward in terms of the REDD-plus negotiations, the choice of historical baselines as the basis for RLs is problematic from two points of view. Firstly because historical deforestation may not be a good predictor of future forest clearing (Angelsen 2008). Secondly, because the multi-causal nature of tropical deforestation implies that historical deforestation rates have been highly volatile, responding to changes in, inter alia, national policies, world market prices on forestry and agricultural products, and exchange rates. Hence the choice of time period may greatly influence the RL (Persson & Azar 2007). For instance, in the Brazilian Amazon, even if annual variations are reduced by taking a 10-year average, basing the RL on historical emissions in the period 1990-1999 or 1996-2005 makes a difference of about 100 Mt CO<sub>2</sub>/yr.<sup>14</sup> Countries will of course have an incentive to set their RL as high as possible, risking to create a system where emission reductions that are not additional are being credited.

As an illustrative example, consider the fact that deforestation rates in the Brazilian Amazon dropped by more than 60 percent in the period 2005-2009 (Nepstad et al. 2009). How much of the associated “emission reductions” should the Brazilian government be credited for? This depends on how much of the decline in clearing that is a result of policies (e.g., crack-down on illegal logging and expansion of protected areas) and how much that was a result of reduced profitability in the soy and beef industries during that time period.

Finally it is worth noting that while neither the UNFCCC (AWG-LCA) nor the Kyoto (AWG-KP) negotiation track came to a conclusion, the Copenhagen accord makes frequent references to a REDD mechanism, though the details of such a mechanism and its share of the total funding set out by the agreement is still unknown. This implies that even if the UNFCCC and Kyoto negotiations—under their extended mandates—do not reach an agreement, the existing REDD-plus text could in principle be picked up and finalized under the auspices of the Copenhagen Accord.

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<sup>14</sup> Based on an updated version of the model used for the analysis in Persson & Azar (2007).

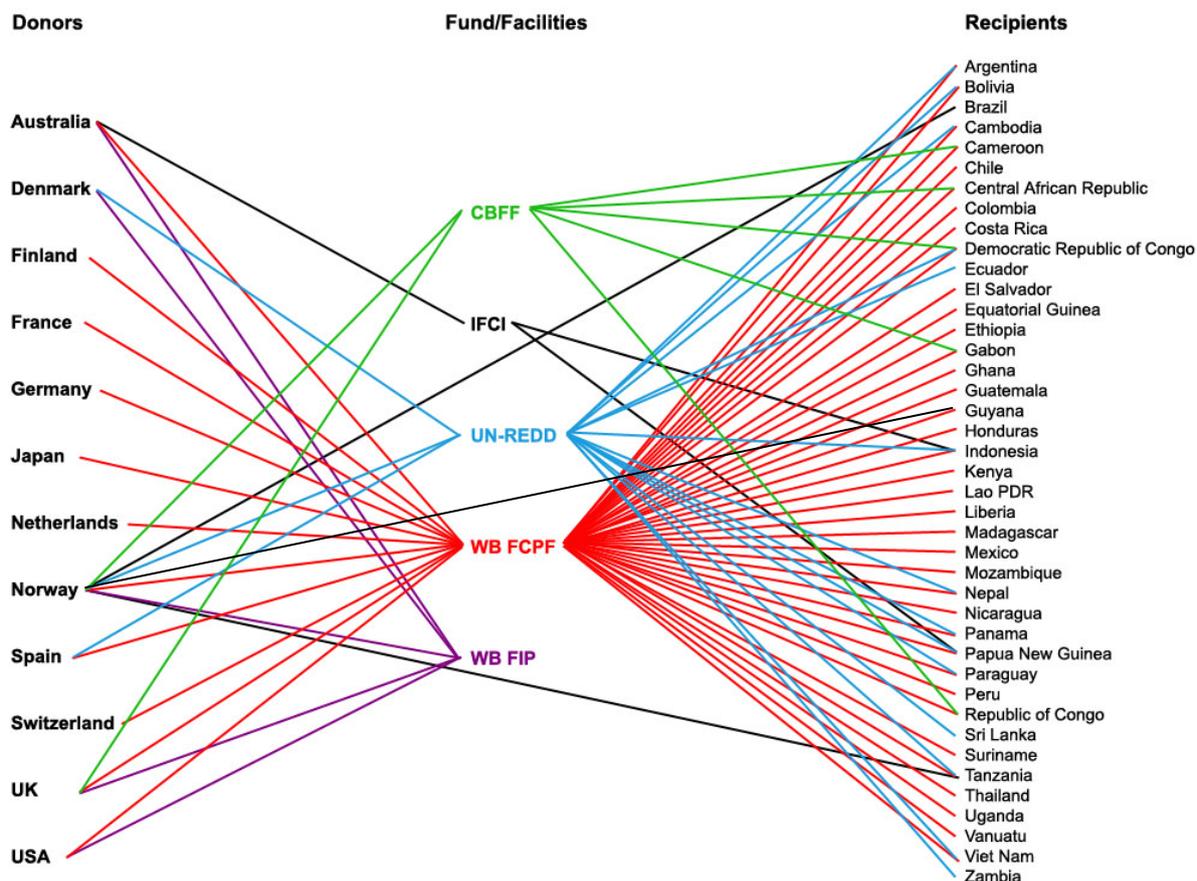
*The emerging REDD-plus landscape – existing initiatives and links to carbon markets*

In parallel to the UNFCCC negotiations, a number of bilateral and multilateral REDD-plus initiatives have been launched. The main initiatives—the United Nations’ Collaborative Program on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (UN-REDD), the World Bank Forest Carbon Partnership Facility (WB-FCPF), the World Bank Forest Investment Program (WB-FIP), the Congo Basin Forest Fund (CBFF) and the International Forest Carbon Initiative (IFCI)—, their funders and recipient countries are displayed in figure 2.

The main focus of all initiatives has so far been on the first phase of the REDD, building monitoring and policy capacity in the forestry sector in tropical countries. In doing so they have struggled to find a balance between on the one hand moving forward and gathering experience that may inform the REDD negotiations, while at the same time anticipating what the outcome of those negotiations will be (Westholm et al. 2009).

The UN-REDD program, with a total funding of close to 80 million USD, aims specifically to provide financial and technical assistance to its 9 program countries for identifying drivers of deforestation, possibilities to address these, and developing methods for monitoring forestry emissions.

Similarly, the WB-FCPF through its ‘Readiness fund’, with a total of 110 million USD pledged, aims to assist countries in developing a national reference emission scenario, adopting national REDD strategies for reduced emissions, and designing and implementing REDD monitoring, reporting and verification (MRV) systems. So far 9 out of the 37 participating countries have submitted so-called Readiness Preparation Proposals (R-PPs), outlining the country’s REDD strategy. Although criticized for insufficiently addressing, e.g., governance, land ownership and tenure issues (Davis et al. 2009), three countries (Indonesia, Panama, and Guyana) have had their R-PPs approved and are eligible for up to 3.6 million USD of readiness funding from the WB-FCPF.



**Figure 2.** *Multilateral and bilateral REDD initiatives and funds (Westholm et al., 2009).*

With their strong focus on readiness activities none of these initiatives are likely to start delivering verified REDD credits any time soon, though the ultimate aim of the WB-FCPF is to remunerate a small number of countries for reduced emissions from deforestation and land degradation through its ‘Carbon fund’. Similarly, the WB-FIP aims to achieve verified emission reductions by initiating and facilitating transformational change in developing countries forest policies and practices, though recipient countries for the totally pledged funds of about 330 million USD are still to be announced.

The role of Norway deserves a special mentioning in this context. Norway—having pledged to allocate 500 million USD annually to REDD initiatives—is the main funder of all of the above mentioned REDD funds and have also initiated bilateral cooperation with Tanzania, Guyana, and Brazil (through the Amazon Fund). While acknowledging the need for initial

capacity building, Norway has underscored the importance of focusing on emission reductions from the start and basing REDD funding on performance against credible reference emission levels as soon as possible (NME/NMFA 2010).

Although the initiatives on the REDD supply side are still in an incipient stage, the discussions on the demand side – international carbon markets – are in some cases quite well ahead. Though details may change as the legislative process moves on, the proposed US cap-and-trade system (US Congress 2009; see also section 3.2) includes three mechanisms for reducing the emissions from deforestation. Firstly, the Supplemental Pollution Reduction Program will set aside a certain share of all allowances in the cap-and-trade system each year—5 percent in 2012-2025, 3 percent in 2026-2030, and 2 percent in 2031-2050—and transfer these to countries that enter into bilateral or multilateral REDD agreements. Through sales of these allowances it is expected that funds would be generated that would meet the objective of reducing emissions from deforestation by 720MtCO<sub>2</sub> annually by 2020, and 6GtCO<sub>2</sub> cumulatively by 2025. Note that these reductions would be additional to those resulting from the cap-and-trade system; i.e., they are not offsets.

Secondly, the system allows for 2GtCO<sub>2</sub> of offsets *annually*, half of which should come from international activities such as REDD (cf. the CDM, expected to deliver around 0.7 GtCO<sub>2</sub>/yr by 2012). Thirdly, the system includes a strategic reserve of emission allowances that will be auctioned if allowance prices reach a certain level. The proceeds from this will be exclusively used for purchasing international REDD credits, that in turn will be used to ‘refill’ the strategic reserve. Finally it should be noted that to be eligible sellers of REDD credits they need to fulfill a number criteria and requirements consistent with a REDD-plus agreement under the UNFCCC.

The proposed Australian CPRS scheme (see section 3.2 above) opens for unlimited international offsets, including REDD, and seemingly applying much less strict prerequisites for their generation than the US system (Goodman & Roberts 2009). On the other end of the spectra is the EU, who has been reluctant to include forestry offsets in the ETS due to environmental integrity concerns. What the EU proposes is a twofold strategy: (1) similar to the proposed US legislation, to use parts of the proceeds from allowance auctioning to fund REDD activities in developing countries through the establishment of a Global Forest Carbon Mechanism; and (2) to test the recognition of REDD credits for country compliance under a Post-Kyoto deal, given that the overall objective of the regime is ambitious enough (EU

Commission 2008). Only for the period after 2020 could inclusion in the EU ETS be considered, and only “after a thorough review of the experience of using deforestation credits for government compliance” (EU Commission 2008).

### *The effectiveness and cost of REDD*

The effect of REDD on international carbon markets will be determined by how successful REDD will be in arresting deforestation and forest degradation in the tropics. This, in turn, will depend on the policies adopted nationally to implement REDD-plus and how REDD-plus payments will compete with other land use options. While hundreds of REDD pilot projects have already been launched, and large donors have started different REDD+ initiatives, it has been argued that “most planned national policies to be implemented are comparable to measures tried in the past – often with disappointing outcomes.” (Angelsen et al. 2009a, p. xiii). If REDD-plus policies are to have an effect they have to learn from where previous attempts to reduce deforestation failed and succeed in building political support for forest conservation in tropical forest countries (Sunderlin & Atmadja 2009).

Also, the notion that reducing the emission from deforestation is inexpensive often relies on simplistic assumptions regarding the effectiveness of carbon payments in actually changing land use decisions in tropical countries, e.g., disregarding transaction costs and assuming full additionality and zero emissions leakage. In addition it is important to note that while REDD payments may offer an incentive for reduced deforestation, climate policy will also augment the willingness to pay for bioenergy, raising the demand for, and price of, agricultural land and hence the profitability of deforestation. This implies that REDD may not suffice to make forest clearing for high yielding bioenergy plantation, like palm oil, unprofitable (Persson & Azar 2009). As a result, realizing REDD may turn out to be both more challenging and costlier than what is generally held. This, of course, will have implications for the role of REDD in international carbon markets in the future.

## **2.6 Voluntary markets**

Unlike the regulated markets, the voluntary markets do not rely on legally mandated reductions to generate demand. Therefore, they sometimes suffer from fragmentation and lack of widely available information (Bayon et. al. 2009). As a consequence, the voluntary market is remarkably diverse, both in terms of carbon transactions, market players and standards.

This lack of uniformity, transparency and registration in the voluntary market has been subjected to heavy criticism and created wariness among buyers, who have expressed lack of trust in the voluntary market, since transactions may carry real risks of non-delivery. Nevertheless, the tremendous growth of the voluntary carbon market over the last several years indicates that it has the potential to become an active driver of change. These markets have not only become an opportunity for citizen consumer action, but also an alternative source of carbon finance and possibly an incubator for carbon market innovation.

## **2.7 Sectoral approaches and other new market mechanisms**

Sectoral approaches are being discussed as a means to mitigate competitiveness and leakage concerns in trade exposed sectors in countries with stringent climate policies, while at the same time creating incentives for emissions reductions otherwise not realized. Sectoral approaches are also argued to have the potential of increasing financial flows to and investment in developing countries, as well as facilitating future linking between carbon markets (Fujiwara, 2010). There are basically three types of sectoral approaches currently discussed (Zetterberg and Holmgren, 2009 and Fujiwara, 2010):

- Sector-CDM: a CDM crediting mechanism based on established baselines in sectors, which would replace the current project based CDM in advanced developing countries.
- Sectoral no-lose mechanism: encouraging emissions reductions in specific sectors in developing countries. Emission reductions below an established no-lose target (which is non-binding) renders credits.
- Sectoral emission trading: based on a sectoral emissions cap.

Several other innovative market mechanisms have also been proposed the last two years as the idea of sectoral approaches, as forwarded by the EU, has been met with resistance from several developing countries. Among those new market mechanisms are “crediting NAMAs (national appropriate mitigation actions)” and technology based crediting schemes.

More research is necessary concerning for example how to integrate sectoral approaches and other offset mechanisms with carbon markets, but also issues related to how to make sectoral approaches work in practice, e.g. issues related to benchmarking are needed.

## **2.8 The development of emerging markets**

It should be clear from the above that the way carbon markets function in practice may differ from the simple textbook version of permit markets. For instance, as shown by Wråke (2009) and Müller and Sterner (2008) detailed design issues such as closure and entrant provisions matter a lot for market efficiency, and for the ability of carbon markets to foster cost-effective emissions reduction. It is routinely asserted that, in comparison with less flexible instruments (e.g., emission standards, technology subsidies etc.), even permit markets with (moderately) poor designs can represent relatively cost-effective policies. The reason is that carbon pricing permits substantial flexibility in firms' and households' compliance strategies to reduce emissions (including the search for new technology). One might however wonder whether this really is true, in these circumstances – with all the departures from conditions normally associated with optimality? We believe that the true answer to this question requires that we understand just how large an undertaking the climate challenge really is. We need to reduce emissions by something like 80% or more over half a century – when we hopefully will become more numerous and prosperous. It is even possible that we one day – in say 2050 – will be discussing what we today would see as the difference between 80 and 90% of current levels. This itself is a 50% abatement and will be no trivial task even with the more advanced technology of tomorrow. Presumably such a step will require very high carbon prices and very tough mechanisms for control and verification as well as some very difficult negotiations about how to share the burden of costs and permits. Similarly in 2030 we will be taking the crucial steps on the way. It is in the future that abatement costs will be really high and the benefits of a market based system sizeable. That is what we have to prepare for. The abatement costs from 2010 to 2020 are presumably small in comparison but since we are preparing for a global and century-long transition, it is important to make the building blocks and systems as functional as possible from the start.

One of the stylized facts about policy making is that simplicity and clarity are good. The first part of this paper has tried to give a brief outline of some of the major facets of current carbon trading and cannot claim to have an instrument that is clear and acceptable. In fact it is easy to be frustrated. After years, even decades of reasonable understanding, the response of the World community has still to make a dent in the curves showing emission increases. Climate economists have been successful at publishing but not very effective at persuading the policy makers to undertake actual emission reductions. It is natural to stop and ask, are we in a blind alley, polishing models that are doomed to be swept away or forgotten – or are we witnessing

the rather arduous birth of a new social paradigm? One observation from history is that it is often hard to see which trends are just reflections of some temporary fad and which are here to stay. We have already pointed to the fact that compromises with political feasibility have several times led us into policy choices that are quite obviously second best. Sometimes experience leads quite seamlessly to corrections within a few years as experience and evaluations accumulate. On other occasions, bad design choices risk doing permanent damage.

It would be good to know, if the ETS and other instruments we have been discussing are permanent features of the emerging climate regime or just random aberrations. We must find out which aspects of the policy cluster we have in front of us are here to stay and which may be readily discarded. In spite of our quest for design simplicity, it is probably an illusion to think that one grand system will be created “on the drawing board”, agreed upon through international negotiations and then implemented. Instead, it is likely the very patchwork of local initiatives and the arduous work of resolving inconsistencies and incongruencies that arise as they are linked that will provide the backbone for the coming global climate regime. In other words, similar to the establishment of currency schemes (e.g., the Euro) the development of international (and global) carbon markets will develop in a largely bottom-up fashion. As regional markets develop more countries will have an incentive to join in.

The accumulation of climate gases is a process with inexorable inertia that just continues to accelerate as we discuss. Just to stop emissions from growing, would be very difficult and require strong policy instruments because of the high income elasticity of fossil consumption. At the same time – freezing the level of emissions is far from sufficient – they need to be reduced – ultimately by at least 80%. We would actually need reductions of say 2% per year starting immediately – but we are very far from this. Considering the rather draconian policies needed one may wonder if we are on the right track and what role instruments such as the ETS, CDM, REDD and so forth can play – considering all their actual weaknesses.

It would be pretentious to say we had an answer to these questions. If one wants to be optimistic one can point to other changes that have been fairly rapid in the past such as the fall of the Soviet states and the Berlin wall or Apartheid – or for that matter, the sudden ease with which we can nowadays regulate phenomena such as smoking or the use of seat belts – which were once considered intricately tied to personal freedom and impossible to affect through policy. It is true that the most important variable may be political acceptability of sufficiently

tough measures, but that begs the question of how opinions are built. We know that sudden and drastic processes are hard to implement. We know that the scarcity rent associated to the “enclosure of the atmosphere” is so big that it would normally take many years of negotiation to agree on the complex distributional and fairness issues. However we do not have that time. Therefore we are forced to select at each moment the instruments that meet the least resistance. Practical policymaking is the art of doing what is possible. Doing this without falling into pitfalls that increase resistance to climate policy such as treating different installations so differently that there is an outcry, or avoiding price chocks that are detrimental is quite a challenge.

In chapter 3 we have collected a number of design issues that we believe are particularly important for the future success of climate policy and well-functioning carbon market: institutional requirements, linking, volatility and uncertainty, banking, multiple instruments and finally technological change.

### **3. DESIGN ISSUES**

The financial crisis of 2008 and other fluctuations in the recent years have provided some important lessons for the design of climate change policy. Changing prices in energy markets, macroeconomic shocks, uncertain climate change policy and uncertain international climate policy regime all cause uncertainties and volatility in carbon market prices. Cap-and-trade markets have occasionally experienced significant price volatility. People point to the fact that EU ETS permit prices varied significantly during the first trading period with prices reaching less than one Euro per ton. This was however during the very special trial period as already described. A more relevant comparison is perhaps the volatility experienced on NOX markets in the US.

A policy instrument that is more robust to shocks, and thus, more likely to persist, would increase the expected payoffs of investments in new technologies and emissions reductions relative to a system that is less robust. Hence, a well-designed global climate regime should be resilient to large and unexpected variations in economic and technological factors that drive costs of abatement and emissions. In some cases, such stability may only be reached through the use of multiple policy instruments and/or hybrid policies.

On the other hand, a more global and integrated carbon market will likely emerge in the coming years, with different types of links between EU ETS, CDM and JI to other initiatives. The ETS is fundamentally linked through the Linking Directive of 2004. Although there might be advantages of further linking carbon markets, a linked system might also deepen the negative impacts of economic volatility and uncertainty over the effectiveness of cap-and-trade schemes. We have to accept that we are in a phase when the instruments and institutions are being built. The fact that the system is not global and all-encompassing implies a number of features that give it “second-best” characteristics (such as not allowing banking between periods). This in turn can give rise to price fluctuations and to avoid these one might very well find it useful to institute a system of floors and ceilings to the permit prices.

In this section we discuss the implications of economic volatility and uncertainty for policy design. We start our analysis by discussing some of the institutional prerequisites for trading and discussing the potential applications in developing countries. We then discuss the advantages and disadvantages of the emergence of links between carbon markets. Then, we analyze the potential consequences of economic volatility and uncertainty on the effectiveness of carbon markets and the challenges imposed by integration. In order to deal with volatility and uncertainty, the regulator might make use of banking, borrowing and/or complement cap-and-trade programs with other policy instruments, for example, price floors and ceilings. In section 3.1 - 3.4 we discuss these policy options. An important circumstance where multiple policy instruments could be argued for is when there is uncertainty regarding the marginal cost to reduce carbon emissions. The use of multiple policy instruments might also be desirable in the presence of political constraints and multiple externalities. Market failures in technology markets due to credit constraints and knowledge spillover and the lack of existing policy measures to adequately internalize these failures (e.g., patents) could motivate additional policy interventions; studies show that environmental policies alone will not overcome the technological market failures, and they therefore need to be combined with policies aimed at promoting R&D and technology learning. Different types of information failures – hampering firms’ and households’ ability to make efficient choices in the market – may also justify complementing policies. In section 3.5, we analyze the potential for the use of multiple instruments in general while in section 3.6 we address the issue of how permit markets influence innovation and technological change as well as how the choice of policy design can be affected by anticipation of future technological progress.

### **3.1 Institutional requirements for trading in developing countries**

We have in sections 1-3 described many of the features of this emerging mix of policies. The attentive observer has of course noticed that the institutional requirements have been fairly daunting. Particularly the implementation of the EU ETS has required years of hard work at verifying emissions – just to take the most basic point – and then building routines for emission tracking, trades, verification and so forth, not to mention the politics of allocation.

Naturally there has also been a considerable amount of learning by market participants and a rapid development in trading, from simple bilateral trades to the development of more and more sophisticated instruments such as swaps and options. One characteristic of the market that is often discussed is its price volatility. One needs to be careful here – because volatility itself is not necessarily a sign that a market is not functioning well – to the contrary, volatility shows rapid adaptation and signaling in response to new information: if you want zero volatility you choose a price instrument such as a tax (or a command and control instrument – but then the underlying market forces are merely hidden). The empirical evidence of price volatility so far is considered in Ellerman et al 2010 ch 5. They show that the level of volatility is not unreasonable and in fact comparable to the price volatilities of various energy carriers such as gas, oil and electricity. The only exception to this is for one or two quarters when new information or new legislation was introduced but this is very much an artifact of the novelty of this scheme. There is thus no strong indication of *excessive* volatility.

Not only has this entire development been a gigantic challenge for the nations of Eastern Europe but even countries such as the UK originally implemented very heavy-handed systems. One may therefore wonder whether trading can be an instrument that is more broadly used in developing and transitional countries. Since most of future emissions will be in developing countries and since many of the cheapest sources of emission reduction are believed to be in low income countries, it is of considerable interest to try to gauge whether the legal and human resource and other factors are indeed available in such countries.

Many donors and advisors have promoted the use of market-based instrument as the key to more effective environmental protection in the developing world. However, there has been rather limited experimentation with tradable permits in less developed countries. Santiago,

Chile was one of the first cities outside the OECD<sup>15</sup> to implement a tradable permit program to control air pollution and we will in this section make specific reference to this experience as an indicator of the ability, at least for mid-income countries to implement permit trading. In spite of some institutional capacity constraints, the free market environment of the Chilean economy, the general acceptance of air pollution property rights by polluters and the serious air pollution problems led the environmental authority to introduce a cap and trade program in 1992. This program was intended to reduce emissions of particulate matter coming from large boilers, which at the time accounted for more than 40 percent of total point sources emissions (Coria and Sterner 2010).

Santiago's experience shows us the challenges of designing successful trading programs in less developed countries at early stages of the environmental protection. Since at the time the program was implemented there was not an environmental institution capable of managing the trading program, a new governmental office was created for that aim. The Program of Control of Emissions Coming from Stationary Sources, PROCEFF under the Department of Health (SEREMI, Secretaría Ministerial de Salud), was given the responsibility of developing a comprehensive inventory of sources and their historical emissions, allocating and keeping an updated record of permits as well as monitoring and enforcing emissions. Within a short time, the first general environmental laws were passed, and in 1994 the National Environmental Commission (CONAMA) was created to coordinate all governmental offices involved with environmental jurisdiction (for example, the departments of transport, economy, and fisheries) and to design new policies to deal with pollution problems (Del Fávoro 1994, pp.40 and Pizarro 2007). Since then, CONAMA has promoted implementation of additional trading programs for other stationary sources and pollutants. The actual implementation and management of these programs has however remained under SEREMI. The fact that institutions and actual regulation evolved so quickly - in some cases simultaneously with or even superseding legal bases - has complicated implementation – but on the other hand, we recognize this feature from the way the EU ETS has evolved so this is not necessarily fundamentally different in Chile compared to the EU! Trading is officially “recognized” as a policy instrument by the law that created CONAMA. However, the law did not specify the allocation mechanisms, duration, or other characteristics of the permit schemes. Before this law, there was just a Supreme Decree, rather than a law, which

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<sup>15</sup> In 2010 the final decision was taken to accept Chile's entry into the OECD but they were not members when this scheme was being planned and implemented.

established a specific program for large boilers. Although the large boiler decree was passed in 1992, because of limited resources, the regulator concentrated its regulatory activity on the completion of the inventory and the allocation of permits and did not track trading activity until the process was completed in 1998 (Coria and Sterner 2010 and Coria et. al 2010).

Grandfathering the permits was a politically necessary price for acceptance but (like in the EU) it prompted a rent-seeking behavior that allowed the regulator to more readily identify sources that were not in the original inventory, but it also created incentives for false reporting, particularly given the poor historic record of sources and emissions (Montero et. al. 2002). In fact, the lack of accurate information led the new authority to over-allocate permits, creating a significant excess number of permits in force and preventing the market from fully developing, in the sense that many sources relied on autarkic compliance instead of participating in the permits market. As the program progressed, the environmental authority realized that the initial allocation was too generous and reduced the number of permits in force by reducing the permits granted to existing boilers and increasing the offsetting rate—that is, the number of permits sources need to buy in order to emit particulate matter. These regulatory interventions have affected the tenure of emission permits and hamper trade since firms prefer to keep permits in excess instead of selling them in order to deal with the uncertainty regarding eventual new changes.

The design of the schemes has proven to be inadequate in three ways. First, requirements for prior regulatory approval of every transaction, besides the limited resources devoted to SEREMI, have implied a delayed response of the regulator to the offsetting requests by polluters. Indeed, the average period required for a transaction to be approved in the period 1998-2003 was about 20.5 months. Fortunately, the time required for the transaction process last has been falling (Coria and Sterner 2010). Second, institutional and legal constraints have prevented SEREMI to set fixed and automatic monetary penalties for emissions violations, affecting the capability of the regulator of enforcing the policy. Instead, non-compliant firms have faced sanctions that are imposed through administrative procedures. Sanctions are decided on a case-by-case basis and they might include a note of violation as well as a wide range of lump sum monetary sanctions (Palacios and Chavez 2005). As a consequence, almost 30 percent of large boilers included in the program have not meet their obligations with regards to the cap on emissions at some point of the period 1997-2007. Finally, the lack of expertise and resources led SEREMI to under-provide information to the market. Information about emission permits in force, actual emissions, penalties, noncompliance and reports of

early trades and prices have not been publicly available. This has increased transaction costs since price information required by firms to take investment and compliance decisions is not easily available. In addition, it has affected the credibility of the scheme since when penalties for noncompliance are not clear and are at the discretion of the regulator, they can easily be manipulated. This is particularly the case when noncompliance is explained partially by the delayed answer of the regulator to an offsetting proposal by firms.

In spite of these weaknesses, at least some of the aggregate emissions caps have been met and the trading activity has increased through time. However full cost-effectiveness has not been achieved and a number of design modifications could have substantially improved the efficiency of the Santiago system:

- Better records and measurement of emissions;
- More certain tenure over the permits;
- A simple and stable scheme of penalties;
- Transparent and evenly applied enforcement;
- Avoiding rules that hamper trade, (e.g. the offset rules that provide a bias against trade)
- Enhancing public access to information about trading and compliance.

All in all, we conclude that the trading programs in Santiago, Chile, suffer from serious flaws in design and implementation. Rights need to be clarified and simplified, as do sanctions. Institutions need to become more efficient and transparent. Nevertheless, one could point to the fact that it took the United States several decades of experimentation before they arrived at the current market design of their environmental trading programs. Chile has managed to establish environmental trading schemes in a relatively short time, during which they also developed the legal bases and institutions. As we have seen, the EU institutions have been struggling with several of the same problems and there are probably many of the EU countries that would not have succeeded in implementing a good system had it not been for the considerable pressure brought by the EU Commission and by the very prominent international attention to this issue.

It is hard to judge what this implies for other countries, but it seems clear that countries with similar income levels and institutional maturity as Chile should be able to develop well-functioning permit trading schemes. This should apply to most of the middle-income or “emerging” countries of Latin America or Asia, as well as countries at comparable levels of development in Africa, such as South Africa. These countries are anyway, the countries that have currently emissions that are sufficiently large to warrant immediate application of this type of instrument.<sup>16</sup> One should also remember that many of the other policy options to permit trading, such as taxation, also imply a need for sophisticated monitoring and institutions. It is not quite clear whether – and to what extent - trading schemes require significantly more “maturity,” than tax systems<sup>17</sup> nor is it certain that institutional maturity should be a definitive criterion when judging which countries can and should develop trading schemes. More practical experience is needed here.

When it comes to other carbon markets, in the current state, CDM enables developing countries without caps to participate in emissions’ trading. However, as discussed previously, delays and inefficiencies along the project cycle have led to higher transaction costs, reducing the attractiveness of this mechanism and preventing some countries to enter the CDM pipeline (see also Michaelowa and Jotzo 2005 and Ellis et. al. 2007) These issues have been raised by a broad range of stakeholders and led to an array of proposals of how to enhance, expand or evolve the mechanism in order to improve participation by the private sector in developing countries (see IETA 2008). Together, these proposals can be classified into three main issues: strengthening governance; improving the efficiency of the CDM process; and broadening the scope of the mechanism. Efforts to ameliorate some problems could already be observed in early 2009. Over the past year, the number of validators and verifiers have doubled, which could keep reasonable timelines for turnaround.

The CDM EB has also been trying to find ways to improve the quality, relevance and consistency of information flows within and between the CDM communities (Capoor and Ambrosi, 2009). This is a relevant improvement since complexity combined with unclear communication contribute to increase the likelihood of errors made in applying

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<sup>16</sup> It is not realistic to assume that the very smallest and poorest of developing countries would play a prominent role in the first wave of application of permit trading.

<sup>17</sup> The suggestion that tax systems require less maturity would seem to imply that it does not matter very much if companies fail to pay the full and correct tax payment but that it would matter more if they participated in permit trading based on false or incomplete information.

methodologies, delaying registration and issuance and jeopardizing timely project financing and implementation.

Finally, proposals to increase the transparency of approval processes are also under consideration, including wider dissemination of the proceedings of the EB meetings and webcasts and posting of the completeness check templates and checklists for project participants.

The most serious flaw of the CDM is as mentioned related to the issue of baselines and additionality and this appears to be a fundamental flaw meaning that the CDM can only be a temporary bridging mechanism. On the other hand, if major developing countries (as China or India) adopt emission caps, trading rules should enable nation-to-nation trades. This also requires significant institutional capacity. A cap-and-trade system's environmental integrity depends on the overall cap, but also on the effectiveness of emissions monitoring and enforcement provisions. Likewise, if cap-and-trade programs in developing countries are linked to existing initiatives, the link's effect on total emissions will depend not only on the decided total cap, but also on the effectiveness of monitoring and enforcement provisions in each scheme.

Firms' compliance with a cap-and-trade system depends, on the allowance price, and on the technical ability to detect violations. In addition, the legal ability to deal with them violators through effective sanctions is very important. The higher the price, the greater is the incentive for noncompliance. Therefore, if a link reduces the allowance price in the system with poorer monitoring and enforcement, such a link could actually reduce noncompliance in that system, and thereby reduce total emissions under the linked systems.

### **3.2 Linking carbon markets and the effect on carbon prices**

The development of a transatlantic link between the EU ETS and a potential US carbon market has high priority for the EU (Tuerk et al., 2009) since a US-EU carbon market would constitute the major share of an OECD-wide system and would send a strong political signal regarding the future development of international climate policy based on a global carbon market.

When it comes to the opportunity to link these schemes, the links can be either direct or indirect. Direct links allow trade between different schemes and can be either unilateral or bilateral. A unilateral link allows entities in a scheme to purchase and use allowances from other scheme, but not vice versa. For example, Norway accepted Phase I EU allowances for compliance purposes, but the EU did not accept Norwegian allowances. Another example is the unilateral link between EU ETS and CDM.

In a fully bilateral link allowances can be freely traded between two schemes and each scheme's allowances are equally valid for compliance in both schemes. If there are more than two schemes, the link becomes multilateral. Nevertheless, even if neither scheme recognizes the other's allowances, two schemes can become indirectly linked through a direct link that each has with a common third scheme. As a result of trading between each of the two schemes and the common scheme, developments in one of the indirectly linked schemes can affect the supply and demand for allowances in the other scheme.

Hence, changes in the allowance price and emissions level in one scheme can affect the allowance price and emissions level in a scheme with which it is indirectly linked (Jaffe and Stavins, 2007). For example, since in Australia there is little scope for domestic offsets, the current proposal is for unilateral linking with unlimited access to credits from the CDM and JI, but no bilateral linkages to start with, although full linking with selected partners is envisaged in the future. In the same line, New Zealand's proposal enhances market liquidity by allowing both sales to and purchases from international markets.

There are major advantages of linking carbon markets. It might establish related carbon prices in different regions and reduce any competitive distortion that might arise from isolated carbon markets, and also signal commitment that can enable further cooperation in climate change policy. In the absence of administrative restrictions, direct multilateral linking should lead to full price harmonization across the linked schemes.<sup>18</sup> Furthermore, linking carbon markets is likely to reduce transactions costs, increase market liquidity and increase efficiency and cost savings simply by redistributing emission reductions across linked systems without affecting the aggregate level of remaining emissions under those systems.

Nevertheless, a linked system might import volatility from partner systems (McKibbin et. al., 2008) and have important distributional impacts since allowance trading resulting from

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<sup>18</sup> On the other extreme, unilateral links of small schemes to a larger one should not affect the price of the larger scheme significantly.

linking will raise the allowance price in one of the linked schemes while reducing the other scheme's allowance price. The final impacts on each participant will depend on whether the participant is a net buyer or seller of allowances and on the extent of the price changes. Since prices of energy and other emissions-intensive goods are affected by carbon prices, they will rise in the case of the participants, whose allowance price rises, affecting their competitiveness, and they will fall in the case of those participants whose allowance price fall.

Carbon leakage from emission reductions under a cap-and-trade system occurs if the sources whose emissions increase are outside of the cap's scope of coverage (due to changes in relative carbon prices). Therefore, linking can affect the level of leakage from each scheme, with a net effect that either increases or decreases total leakage from the linked schemes, depending on if the permit price in a region or country increases or decreases due to the linking (Jaffe and Stavins, 2007).

So far, the emergence of national and regional carbon markets has been characterized by a virtual absence of institutional structures for the governance of trading between different markets, which might limit the type of linking that is feasible in the short run. Thus, while indirect links through CDM are likely in the coming years, the development of multilateral direct links will require an institutional framework governing the relationship between emissions trading schemes. Such institutional arrangement should be in charge of a range of oversight functions: ensuring market access and market transparency, as well as providing accountability procedures, recognition of the validity of foreign reductions and harmonization of major barriers to multilateral trading, as differences in the relative stringency of targets and design features of cap-and-trade schemes (for instance, banking provisions, rules governing new entrants and closures, compliance periods and allocation methods). The development of such arrangements is likely to occur through an evolutionary process of progressive market integration.

In the absence of previous linkage, a one-way linkage between mandatory schemes and CDM can reduce the cap-and-trade schemes' allowance prices, relative to what they would be without the linkage, but should not cause significant distributional impacts. This is because the only entities made worse off by such a linkage are net sellers of allowances in the cap-and-trade system, and other entities that indirectly benefit from higher allowance prices in that system, such as renewable electricity generators. Nevertheless, even with such a link, these

entities are likely better off than they would be without a cap-and-trade scheme (Jaffe and Stavins, 2007).

The cost savings from linking a cap-and-trade scheme to CDM might be lower in the case of pre-existing links between CDM and other cap-and-trade schemes, as the EU ETS. In such cases, participants in each cap-and-trade scheme compete against each other for credits. If there is a sufficient large supply of credits in CDM at a price below the least stringent cap-and-trade scheme's allowance price, links between cap-and-trade schemes and CDM can cause allowance prices of all of the linked cap-and-trade schemes to converge even though the systems are not directly linked with one another. However, if there would be shortage of credits in CDM, competition can push the price of CERs up to levels high enough to maintain price differences between the cap-and-trade schemes linked to the CDM.

Furthermore, the risk of leakage is greater when linking cap and trade schemes with CDM (compared to linking with other cap-and-trade systems) due to the additionality problem (discussed in section 2 above). In CDM, credits are awarded for reductions in emissions from an agreed baseline level that is not observed. If an inappropriate baseline level is set, some credits may be awarded for emission reductions that would have occurred even if the credits had not been granted.

Finally, we should reflect on the political economy aspects of linking. Countries have failed to reach broad agreement to introduce instruments at a global or other large geographical scale up to now. Instead countries adopt individual, uncoordinated national schemes (or regional schemes) and *then* they think they can be linked. Does this linking not introduce similar problems that hindered a broader geographical agreement to start with? It is not unlikely that this is the case. Suppose two regions are linked. Region A has a more ambitious climate policy and a higher marginal abatement cost than region B. Then linking will imply equalization of marginal abatement costs and a flow of emission rights from B to A. The political ramifications of this may be considerable, particularly with big differences in permit prices (table 1 shows that in 2008 there was a price differential of 400-700% between US and EU markets).

If A truly desired simply to give a bigger contribution to the global good of climate stability then the decision makers and population of A might be happy. They reached their goal at lower cost by buying rights from B. B would presumably also be happy since they get paid. However things may be more complicated. Industry that needs to pay for emission permits in

B will definitely be a group that is unhappy over the higher permit price. Decision makers in A may also be disappointed: particularly if they had a vision of promoting R&D and the development of certain technologies through the very fact that they had managed to engineer a high permit price.<sup>19</sup>

Thus, while the development of global carbon markets builds on the presumption that the geographical location of emission reductions is a secondary issue (and should thus be endogenously determined), policy makers may think otherwise and therefore give priority to domestic reductions. In anticipation of stricter climate policy targets in the future, countries may opt for capturing the benefits of first-mover strategies, and this makes the issue of linking more complex.

Similar concerns prevail in the case of linking markets for renewable energy credits (e.g., international green certificate schemes). Governments often perceive substantial domestic gains (e.g., industrial development, diversity of the fuel mix etc) from promoting renewable energy and may therefore be unwilling to engage in international harmonization of support schemes (Söderholm, 2008).

### **3.3 Effectiveness of carbon markets under economic volatility and uncertainty**

Under uncertainty about the cost of mitigation, a single policy instrument cannot simultaneously guarantee a certain emissions reduction at a certain cost. While a cap-and-trade policy (or a quantity instrument in general) guarantees certainty in emissions reduction by capping aggregate emissions at an uncertain cost, a tax (a price instrument) guarantees certainty in the marginal cost of uncertain emissions reductions. However, certainty in incremental costs does not imply certainty in aggregate costs. Hence, under a tax as well as a cap-and-trade policy, macroeconomic shocks, changes in relative energy prices and changes in abatement costs can cause variation in aggregate social costs.

In a seminal article, Weitzman (1974) showed that the policy choice that is most efficient under uncertainty depends on whether making a mistake in setting a cap or a tax changes the

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<sup>19</sup> Naturally stereotypes can be misleading but it is commonplace to observe that European politicians appear to view the permit price as an end in itself. They want a high permit price since they believe it will create new technologies that are needed and will give a competitive edge in the future. US politicians are more prone to seeing the cap as the goal and then thinking that as long as the quantity goal is met, it is better if the price is low and thus disruption to competition etc is minimized.

abatement costs relatively more or less than the damage of avoiding emissions. If future abatement costs become unexpectedly high under a tax regime, emissions would be higher than expected since the incremental cost (i.e., the cost that must be paid in order to emit an additional unit of pollution) would be still given by the tax. Instead, under a cap, permit prices would be higher than expected but aggregate emissions would be given by the cap. The outcome from Weitzman's analysis is that if the expected social cost of paying higher permit prices under the cap-and-trade policy (and uncertainty) exceeds the corresponding cost of foregoing abatement under the tax, then the tax would be more efficient.

The climate change policy literature usually comes to the conclusion that a tax in general is more efficient than a cap because of the stock character of atmospheric CO<sub>2</sub>, the latter making the marginal cost of foregoing another unit of abatement relatively stable. For instance, Pizer (1999a) uses a global integrated climate economy model to simulate the consequences of uncertainty and to compare the efficiency of taxes and permits empirically. His results indicate that an optimal tax policy generates gains that are five times higher than the optimal permit policy. However, the situation may change if the regulator expects damages to be highly sensitive to emissions, as would be if the climate system is approaching a threshold beyond which costly irreversible climate changes occur (positive feedback effects in the climate system is one example) then the cost of foregoing abatement may dominate such that a cap-and-trade program results in lower risks.

Besides, the analyses usually build on essential simplifications such that the regulator and the industry are both efficient in adapting to a volatile market which may not be the case in reality (see e.g. Pizer 1999b and Newell and Pizer 2003). Since a cap-and-trade system fixes the cap and allows the price to vary, there are incentives for the industry to hedge against future uncertainty as well as speculation which may or may not reinforce the volatility. This has also several other effects. Since the regulator is controlling the cap, different industries may either gain or lose from a change in the cap, which opens up for lobbying or even corruption under politically unstable regimes. Moreover, a cap-and-trade policy may also lead to emissions leakage either to unregulated sectors or countries with more lax policies. The leakage may offset the benefits of limiting emissions under a cap-and-trade policy (but this is true for all policies that put a price on carbon). Under a tax policy the options for integrating offsets such as CDM or REDD may also be quite different.

Price volatility under a cap-and-trade policy can also generate adverse incentives to invest in cleaner technology (Yang and Blyth, 2007). Under price volatility, the industry is constrained to form less precise expectations about energy prices than under a tax. It is well known from economic theory that uncertainty in returns can discourage investment. Yang and Blyth argue that Real Option Analysis (ROA) may be a better tool than the conventional discount cash flow (DCF) for regulators and industry to quantitatively analyze the impacts of climate change policy uncertainty and energy price uncertainty on energy sector investment. The ROA approach explicitly addresses the presence of flexibility and irreversible investments, and thus takes the opportunity cost of waiting into consideration and assigns a value to this option (Dixit and Pindyck, 1994).

The effects of macroeconomic shocks on an internationally harmonized tax and a cap-and-trade policy have been analyzed by McKibbin et al. (2008). They use a dynamic general equilibrium model to analyze how shocks affect emissions reductions, prices and welfare under quantity and price instruments. They find that climate policy may either increase or decrease the effects of the shocks. On the contrary to a tax, a cap-and-trade policy affects the transmission of shocks across regions. In the case of a financial crisis, a cap-and-trade policy with a fixed cap has less flexibility for utilizing low cost emission reductions than a tax. Moreover a cap-and-trade policy (or quantity instruments in general), seem to buffer macroeconomic shocks as carbon prices increases and decreases in business cycles.

In the literature is also argued that a global climate policy framework should have an inbuilt mechanism that deals with the cost uncertainty (McKibbin et al. 2008, Hennlock, 2009). Frameworks that are based on countries committing to targets for emissions reductions will be more difficult to agree upon in climate negotiations, and the stability of any agreement as such may be vulnerable to asymmetric future shocks. A climate policy framework (involving certain effort-sharing rules) needs to be robust against future shocks (Hennlock, 2009).

A global cap-and-trade market might become vulnerable to local shocks as they transfer in the global cap-and-trade system to other regions such that they contribute to global economic crises. Transparent mechanisms may therefore be needed that smooth extensive short-term price volatility, which is also the rationale for introducing price floors and ceilings on carbon markets. The industry can then either obtain permits on the carbon market or buy them from the regulator at a specified price that could be adjusted over time.

Theoretically, a price floor in a capped market turns the instrument into a hybrid between a tax and a cap-and-trade policy. As such, a hybrid inherits properties of both the tax and the cap-and-trade system (Roberts and Spence 1976). It is straightforward to show that setting the price floor sufficiently high or the cap sufficiently low will mimic a pure cap-and-trade and a pure tax, respectively (Philibert 2006). The hybrid may therefore capture some of the advantages of both instruments giving regulators more flexibility to adjust the system. Consequently, the industry has less incentive for hedging against future uncertainty as the tax payment usually becomes correlated with its profits. Moreover, the removal of price uncertainty from the industry creates, *ceteris paribus*, less incentive for lobbying and corruption. While price uncertainty is reduced for the industry it increases for the regulator, in terms of emissions reductions, as the burden of uncertainty cannot be eliminated but moved between quantities and prices. Several studies have proposed this type of scheme for carbon emissions (see e.g. Pizer 1999b and 2002).

Uncertainty from unpredictable economic growth and energy prices, as well as development of abatement technologies has been studied in an analysis assuming the target of reducing emissions by 50% until 2050 (Philibert, 2008). He finds that price caps and price floors significantly could reduce economic uncertainty. Price floors would reduce the level of emissions beyond the target when realized abatement costs are lower than predicted. Price caps could reduce expected costs by about 50% and at a lower level of uncertainty. In contrast to the EU-ETS, price caps and floors are important components in the US approach to deal with greenhouse gas emissions in RGGI (a reserve price in auction), and the Waxman-Markey and Kerry-Lieberman bills.

Finally, assessments of climate policy induced uncertainty should be made in light of other market factors, which affect investments. For most firms, the carbon price would have to be significantly higher than today to have the same impact on investments and cost variability as, for example variations in fuel prices, demand for energy and commodities, currency fluctuations and political turmoil. As already mentioned above, the actual volatility of the ETS has not been very high compared to that of e.g. energy markets (except for one or two instances that are related to its novelty – such as the first release of verified emissions in 2005).

### 3.4 Banking and borrowing

A standard statement on emissions trading is that banking and borrowing—allowing participants to either save allowances to use them in later commitment periods or to use allowances from future periods at an earlier date—enhance economic efficiency by several means. They reduce overall compliance costs by allowing inter-temporal flexibility; they increase liquidity by increasing the quantity of allowances available to the market and the volume of allowances traded. Finally, *they also improve price stability*. If inter-period banking is not allowed, allowance prices are likely to be unstable at the end of each compliance period. In case of surplus, allowances are worthless and their price should fall to zero. In case of excess of emissions, the allowance price should raise sharply at the end of the period (Ellerman and Montero, 2007). In complicated real world situations, it is often perceived that there are arguments for some limitations on banking and particularly borrowing as we will see below.

The Directive for the EU ETS allowed unrestricted transfer of surplus allowances into future years with one exception: banking allowances during Phase I (2005-2007) to meet their obligations during Phase II (2008-2012), except through advance agreements for purchase of CERs. Banking is allowed within commitment periods but was prohibited between Phase I and Phase II. Two main reasons may explain the ban on inter-period banking by Member States. Firstly, banking of allowances would have lead to higher emissions in Phase II of the EU-ETS than the emission level committed to in the Kyoto-period (2008-2012). Second, the inter-period ban on banking would avoid negative side effects at the EU ETS level since it might have been problematic for Member States to forecast in 2006 the amount of banked allowances when drawing up their National Allocation Plans (NAPs) for 2008-2012. In the presence of unexpected large amounts of banked allowances, sectors non-covered by the EU ETS would have needed to make additional abatement efforts.

Several studies have analyzed and quantified the economic inefficiencies of the ban on banking. For instance, Alberola and Chevalier (2007) analyze empirically the impact of the intra-period banking restrictions on the EUA prices during Phase I, pointing out that low allowance prices might be explained by banking restrictions and that they undermined the ability of the EU ETS to provide an efficient price signal. In the same line, Bosetti et. al. (2008) quantify the effects of banking on the timing of investments in carbon-free

technologies and on R&D investments; cost reductions in terms of avoided GWP losses with respect to an inter-temporally rigid carbon market range between 9% and 15%.

Borrowing improves firm's opportunities to rationalize investments over time, similar to banking. However, it also introduces an element of moral hazard; firms that acquire an emissions debt have an incentive to work for a relaxation of the emissions cap or even a suspension of the trading system in order to wipe out that debt (Wråke, 2009). Borrowing is not allowed in the EU ETS. However, as there is an overlap in dates between when allowances are allocated for the coming year and when allowances covering emissions for the previous year have to be surrendered, in practice borrowing from the next year's allocation is permitted.

### **3.5 Multiple policy instruments**

The use of multiple policy instruments to solve environmental problems is common. Taxes, subsidies, tradable emission permits, information disclosures, technology standards, and regulations are often used in different combinations with each others. In Sweden, several policy instruments have been used to target the regulation of CO<sub>2</sub> emissions; for example the CO<sub>2</sub> tax, the Climate Investment Program (KLIMP), support of energy efficient technology, and the tradable emission permits scheme (EU-ETS).

From a policy perspective it is important to understand under what circumstances the use of multiple policy instruments is optimal, and hence what characterizes a situation where the adoption of multiple policy instruments is adequate. Benneer and Stavins (2007) analyze this issue extensively, and they base their findings on a large number of articles in this area. Therefore, a large part of this section is devoted to summarize their findings. It should be noted that in practice the use of multiple policy instruments can be motivated on economic efficiency grounds but also based on arguments about what is politically feasible in a second-best setting. In this section we briefly discuss both the economic and the political arguments.

In the economics literature the basic approach is to study one optimal policy instrument, or to compare two competing policy instruments with each other (for example taxes and tradable emission permits). However, the possibility of using one optimal policy instrument to solve an environmental problem is often only a text-book construction which has little to do with the real world. In fact, given that we do not live in a perfect world (or as economist like to call

it: a first best world) where there are no market failures or other constraints affecting the implementation of a policy instrument, using multiple policy instruments might be optimal. This type of reasoning originates from the theory of second-best (Lipsey and Lancaster, 1956) where it is shown that if we are diverging from a first best world with perfectly competitive markets, then a policy instrument that would be optimal in a first best world might not be welfare improving in a second-best setting.

For example, assume that a policymaker wants to implement a carbon tax to correct for the environmental externality of CO<sub>2</sub> emissions. In a first best world, the optimal tax would be the Pigovian tax (Pigou, 1920) where the marginal damage of carbon emissions is equal to the marginal cost of emission reductions. However, in reality other taxes will already be implemented, and many of these taxes are distortionary, such as the income and capital taxes, and this needs to be taken into account when implementing the carbon tax. Hence, the Pigovian tax alone might not be the optimal second best tax. In this particular case there are two opposing effects: firstly, the policy maker can use the revenues from the carbon tax to reduce the distortionary taxes (the revenue recycling effect) at the same time as the tax correct for the negative externality of carbon emissions, so called “double dividend”. Secondly, the carbon tax will interact with the already existing taxes and reduce after tax returns (the tax interaction effect). The total effect of the carbon tax will be the sum of these effects. Goulder (1998), shows that it is likely that the tax interaction effect dominates the revenue recycling effect. However, it is clear that the revenue recycling effect will reduce the cost of implementing the carbon tax (due to the tax interaction effect), and hence in a second-best world it is not optimal to implement only a carbon tax but to combine it with reductions in other distortionary taxes. This has also been a strong argument for auctioning of tradable permits compared to free allocation of the permits (grandfathering), since with auctioning the revenue raised can be used to reduce distortionary taxes, which will increase welfare.

Benjamin and Stavins (2007) discuss other circumstances when multiple policy instruments might be optimal and we will focus on those relevant for the climate change area, namely: multiple externalities; imperfect information and externalities; uncertainty regarding marginal cost to reduce emissions; and stakeholder support.

### *Multiple externalities*

When a policy is implemented to reduce the externality of carbon emissions, there could be effects on other externalities, and these need to be accounted for. Two examples of particular

importance for the climate change area are the effect of a carbon price on other pollutants (other negative externalities), and the effect of a carbon price on the positive externalities of technological innovation.

Both these examples argue for coordination of policy instruments. In the case of other pollutants such as sulfur and NO<sub>x</sub>, there are potential benefits of co-control since CO<sub>2</sub> control is expected to lead to large declines in pollutants that stem from combustion of fossil fuels. Using a tradable emissions permits program without the possibility to adjust the cap (with for example a price floor) will reduce the possibility for co-control, since a cap is not only the maximum amount of emissions allowed, but also the minimum amount of emissions that will occur. It is also crucial to account for the effect that reducing these emissions might have on climate. This is an area where more research is needed.

Regarding the positive externalities of technological innovation, it is important that the implemented policy does not hinder technological innovation. While market-based policy instruments such as carbon taxes or tradable emissions permit schemes create incentives for technological innovation (see also section 3.6), policy instruments such as technology standards will generally provide fewer incentives for technological innovation, unless the regulations are specifically designed so as to encourage flexibility. Studies show that market-based environmental policies alone will not overcome the technological market failures and environmental policies need to be combined with policies aimed at promoting investments (see e.g. Jaffe et al., 2005); the issue of carbon policy and technological change is discussed further in section 3.6.

#### *Imperfect information and externalities*

Many consumers lack information to make well-informed consumption choices. For example, consumers who want to buy a new more energy efficient car, refrigerator, or want to choose the least carbon intense food are in need of information. While a carbon price does provide such information we know that there are difficulties since many consumption goods are imported from countries without a carbon price, and hence to rely only on the price as the only source of information is difficult. A carbon tax or tradable emission permit scheme complemented with a labeling scheme or disclosure program could then be welfare improving.

Information programs (e.g., labeling schemes) could also be important for facilitating the introduction of energy efficient technologies in the market. Due to the presence of asymmetric information the buyers of energy-using equipment may face difficulties in assessing the energy performance of this equipment, and this may result in adverse selection effects where the most energy efficient products are not supplied in the market.

### *Stakeholder support*

Legitimacy or political support is an important aspect of any policy implementation (Beetham, 1991). Even if auctioned permits have been shown to be preferable to free allocation not only due to the revenues recycling effect (see Åhman et al., 2007, for a discussion on the effect of the EU-ETS allocation system), we have seen very little auctioning historically (however, in the recently implemented RGGI, permits are auctioned). One reason for policy makers to allocate permits for free is to increase the political support for the scheme. With free allocation the firms are compensated for the increased regulatory burden. Also, the opposition to environmental taxes in the US as well as the EU explains why tradable emission permits schemes are easier to implement than taxes. Stakeholders lobby against taxation is simply too strong and successfully hinders what might be optimal levels of taxation (and may also hinder permit schemes from being sufficiently tight). Thus political economy may motivate the use of multiple policy instruments. For example, auctioned permits could be combined with industry specific corporate tax-cuts, or a hybrid system such as the one described earlier in section 3.4 can be implemented instead of a tax to increase political support for the policy. Stakeholder support is not only important at the consumer or industry level, but has also proven to be crucial for international agreements such as the climate change negotiations. Developing countries did not have to agree to binding targets in the Kyoto Protocol even if this could be argued for on cost-effective grounds.

Hence, there are several circumstances when multiple policy instruments can be argued for on welfare improving grounds. However, the existence of multiple policy instruments in practice does not always meet these requirements. Sometimes multiple policy instruments may be the result of the need by various competing or complimentary political decision makers at various levels to show activity. Still, when shaping a future GHG market it is important to be aware of these circumstances, and in particular a hybrid scheme could have many advantageous characteristics both in terms of creating flexibility when co-controlling other air pollutions, dealing with uncertainty regarding marginal abatement costs and legitimate the policy.

### 3.6 Technological change and carbon markets

It is frequently argued that the nature and the pace of technological change as well as the associated innovation activities will be key to addressing climate change in the future. In this section we discuss the extent to which (mandatory) carbon markets may induce the development of new – and less costly – abatement technologies. We first provide a brief review of the theoretical and empirical literature on the potential innovation impacts triggered by different types of climate policy instruments, with particular emphasis on emissions trading schemes. Here the term innovation is primarily used for a new or improved (e.g., less costly) product or the use of new or different material. Innovations can however differ in the sense that some are radical and fundamentally alter the energy system and any associated supply chains (e.g., the electric car) while some are largely incremental and path-dependent (e.g., coal blending in electric power plants) (Kemp, 1997).<sup>20</sup> Later in this section we discuss some important policy issues, such as the importance of complementing policy instruments to promote innovation as well as the timing and commitment strategies of the regulating agency.

The incentive for innovation refers to the benefit a firm enjoys from developing a new technology. In other words, firms will be willing to allocate resources to, for instance, environmental R&D activities if the results will be lower abatement costs. The theoretical studies on policy instrument choice and innovation (see Requate, 2005, for a comprehensive survey) essentially show that there exist a number of different outcomes contingent on particular assumptions about, for instance, the degree of competition in the output market and/or in the carbon market itself, the slope of the marginal damage function, uncertainty, which timing and commitment strategies are available for the regulator etc. Overall therefore it is virtually impossible to present a unanimous ranking of policy instruments with respect to their innovation-stimulating effects (Fischer et al., 2003). Still, market-based instruments tend to perform better than command and control policies (such as technology standards or performance standards). The reason is that in the latter case the firm would have no incentive to perform beyond the pre-determined standard, while market-based instruments such as carbon taxes or markets for tradable allowances induce firms to conduct low-cost abatement beyond the current level (since this reduces tax or allowance payments).

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<sup>20</sup> The discussion focuses mainly on research and development (R&D) of new technology, and thus not on the adoption of existing technologies. Still, it should be acknowledged that this distinction is far from straightforward. For instance, technology adoption may induce significant learning-by-doing impacts, and therefore any policy design that affects adoption, such as the treatment of new entrants and closures (Ellerman, 2008), may also have an impact on technological progress.

The latter results are however mainly valid in the case where innovation is a private good, and thus where the incentives considered concern only the firm's own gains from lower abatement costs (Fischer, 2003). In practice, however, innovation is typically a public good implying that some of the new knowledge may benefit other firms, which can adopt the new technology (at a price). These 'knowledge spillovers' (for which the innovator is not compensated) imply that R&D activities will be underprovided from a societal perspective. This in itself can be an argument for using additional technology support. In this setting the conclusions on how different policy instruments affect innovation become more ambiguous. Moreover, the specific design of the policy instrument rather than the choice of the instrument itself may be more influential for innovation outcomes (e.g., Vollebergh, 2007). In the following we pay particular attention to some key differences across the various market-based instruments: emission taxes, freely distributed allowances and auctioned allowances.

The literature suggests (e.g., Requate, 2005) that overall emission taxes provide a stronger incentive to invest in R&D as compared to freely distributed allowances. The reason is that the allowance price falls with the diffusion of new technology, thus implying that the adopting firms will not be willing to pay as much for the innovation under the (now cheaper) allowances as under a (constant) emission tax. Fischer et al. (2003) show that if the (single) innovator is able to exercise market power, this can raise the gains to innovation in that a lower allowance price means that the innovator does not need to pay as much for the rest of its emissions. However, this benefit only emerges in the case of auctioned allowances. The choice between auctioned allowances and an emission tax is however ambiguous. The efficient policy will depend, in part, on the slope of the marginal damage curve,<sup>21</sup> and on how imperfectly the innovative technology can be imitated. For instance, emission taxes provide more innovation incentive if imitation is difficult, while auctioned allowances perform better in the case with substantial knowledge spillovers to the adopting firms (Fischer, 2003).

The above indicates some important implications for the design of mandatory tradable allowance scheme such as the EU ETS. For instance, within the EU ETS freely distributed allowances have been the dominant allocation principle while the innovation impacts of auctioned allowances typically are greater (see also Gagelmann and Frondel, 2005). The announcement of full auctioning for the electric power sector starting in the year 2013 may thus induce more innovation activities in this sector compared to the case where allowances

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<sup>21</sup> For instance, the steeper the marginal damage curve the more do tradable allowances dominate the tax regime (Fischer et al., 2003).

are freely distributed. Moreover, the price-reducing impact of innovation may be limited in the EU ETS due to the relatively wide sector-scope of the scheme. Innovations in one sector may not be of interest to the other sectors, and for this reason the impact on allowance price may be small (and even non-existent) (Fischer, 2003). In a broad-based allowance market, the incentives to innovate in a given sector will thus resemble closely the corresponding incentives under an emission tax.

Most of the empirical studies on the potential innovation effects of emission allowance markets have focused on the pioneering US systems such as the Acid Rain Program and the Lead Phase-out Program (Vollebergh, 2007). For the former case Popp (2003) investigates innovations in the so-called scrubber technology, one of many strategies to abate sulphur dioxide emissions under the Acid Rain program. He compares the outcomes under the allowance program versus the command and control approach that was in force before 1990. He uses patent data and data on the diffusion of this technology in a large number of power plants during the time period 1972-1997. The results show that both policy instruments induced lower scrubber costs, but the switch to allowance trading did not induce more innovation overall. Nevertheless, the introduction of an allowance market improved the sulphur removal efficiency of the scrubber technology, thus implying a more targeted and environmentally benign technological change. Another important – and largely unexpected – innovation induced by the Acid Rain Program was the improved ability to pursue coal blending, thus mixing high- with low-sulphur coal in power plants (Burtraw, 2000).

Many other studies confirm the positive impact of allowance markets<sup>22</sup> on the deployment of existing technologies and incremental innovations, but some also question their effectiveness in inducing radical innovations (e.g., Kemp and Pontolgio, 2008). The latter result can be attributed in part to the lack of stringency (i.e., generous allocation and thus lenient targets), and predictability of many existing allowance markets (e.g., Gagelmann and Frondel, 2005).

Still, in many instances carbon pricing need to be complemented by other policy instruments that address significant barriers to radical innovation. These include R&D support to address the issue of knowledge spillovers (see also below), but also infrastructure investment in order to reap the benefits of network externalities and economies of scale (e.g., Sherman, 2008).

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<sup>22</sup> As shown in Sterner and Thurnheim (2009), also price based policies such as the refunded emission payment can have strong effects on technological innovation and diffusion.

At the policy level the EU ETS is frequently expected to induce significant innovation (e.g., European Commission, 2007), but given the novelty of this scheme empirical studies of its innovation impacts are scarce. Schneider et al. (2009) and the accompanying paper by Rogge and Hoffman (2009) are exceptions, though. They perform a large a number of interviews to trace the impact of EU ETS on technological change and adoption in the German electric power sector. Their results show that EU ETS has affected both the pace and the direction of technological change, although the authors also acknowledge that it is difficult to empirically separate the effects of EU ETS on the one hand and the general development of EU climate policy on the other.

Power generators and technology suppliers have significantly increased their R&D budgets during the last ten years, and the pricing of carbon has been an important motive behind this increase. Moreover, the main innovation impacts of the allowance scheme are to be found in coal-fired power generation. R&D efforts are directed towards increasing the fuel efficiencies of both new and existing plants; in the past such efforts were only induced by fuel savings but with a price on carbon there is an additional benefit of improving efficiency. However, the EU ETS appears also to be a prime motivator behind the strong R&D activities in the carbon capture and storage (CCS) technology, and firms are, for instance, teaming up with chemical process technology providers to acquire the necessary chemical-engineering know-how. These impacts of EU ETS on R&D and innovation can in part be understood by the fact that the electric power sectors in most European countries had not faced explicit climate policy instruments before the advent of EU ETS.

In contrast, R&D activities in the competing technologies have been much less prevalent. For instance, neither gas-fired generators nor wind power developers in Germany claim to have increased their R&D efforts as a result of EU ETS. In the wind power case, the feed-in tariff system in Germany is instead the most important driver of innovation activities. Overall these experiences of EU ETS point towards a rather path-dependent process of technological change in which R&D efforts largely build upon and reinforce existing competencies and know-how. This probably depends on the power of lobbies over policy making and clearly, these issues are in need of more research.

So far in this section we have implicitly assumed the presence of an essentially myopic regulator, who does not anticipate a new technology and therefore commits *ex ante* to, for instance, a certain emissions cap that is efficient with respect to the existing technology.

However, as pointed out by Fischer (2003), just as “the amount of innovation depends on [...] price signals, getting the right price signals depends on the amount of innovation,” (p. 11). The environmental economics literature has paid increased attention to the strategy space of both the regulator and the regulated agent. This strand of research shows, for instance, that under perfect foresight and competitive conditions *ex ante* commitment and *ex post* optimal policies generate very similar allocations (e.g., Requate and Unold, 2003). However, in imperfect markets the policy conclusions are less clear. One relevant example is where there exists a monopolistic innovator, who can determine the price of his new technology. Here a policy commitment to a certain emission tax level will minimize the distortions from this monopoly situation, while an allowance market would be more distorting given that the innovator will be able to influence the price of allowances.

Moreover, the regulator’s optimal response to innovation is complicated by the presence of significant uncertainty in abatement costs (due to the difficulty in predicting innovation outcomes). In the case of allowance markets, which cap emissions, too little abatement will take place in the presence of innovation. However, since the environmental damages of carbon dioxide emissions are relatively insensitive to the rate of emissions at any particular point in time, the efficiency benefit of reducing volume uncertainty would be limited. Thus, in the case of uncertainty in abatement costs due to future innovation activities, a constant tax on carbon emissions would be favoured (Pizer, 1999a).

In a recent paper, though, Weber and Neuhoff (2009) examine the effect of firm-level innovation in carbon abatement technology (i.e., the new knowledge is a private good) on the optimal design of carbon allowance markets, with or without a price cap and a price floor, respectively. They show that in the presence of innovation the optimal emission cap decreases, and this can lead to a higher than expected carbon price so as to provide sufficient incentives for private R&D. This tends to speak in favour of carbon allowance markets versus carbon taxes. In allowance markets certainty about emission outcomes are obtained at the cost of increased price uncertainty (compared to an emission tax), but when prices increase this serves as an additional innovation incentive.

Finally, while it is clear that allowance markets such as the EU ETS can have significant innovation-promoting impacts, other policies may be necessary to spur an efficient level of innovation (see also section 3.4). As was noted above, R&D activities generate knowledge with substantial public good characteristics. This means that a single firm cannot generally

reap the benefits of its investment in new knowledge, and it does therefore not have enough incentives to undertake such activities. An important policy lesson from this is that even if policies to correct for environmental externalities are in place, the level of environmental R&D may be suboptimal (and too low). Two types of market imperfections call for two types of policy instruments (Jaffe et al., 2005), but while carbon pricing should be the engine of climate policy it is less clear how technology policies should be designed in practice.

Although the social benefits of R&D activities in new abatement technology are higher than the private ones, it must be acknowledged that this is the case for many R&D activities throughout the entire economy (including many environmental projects). This implies that the opportunity cost of specific R&D projects may also be high, and the economics literature suggests that technology policy should – as a starting point – primarily address a broad set of knowledge spillovers through generic policy instruments (such as patents and broad R&D subsidies) rather than focus on R&D and innovation activities in one specific activity or sector (e.g. Otto et al., 2006). As noted by Fischer (2008):

”the role for publicly supported innovation is strongest when some spillover effects are present and at least a moderate share of the social costs – including the marginal damages of emissions – is reflected in the price. [...] While mitigation policy must be the engine for reaching environmental policy goals; technology policy can help that engine run faster and more efficiently, but it only helps if the engine is running.” (p. 500)

Thus, technology policy is no substitute for emissions pricing. Indeed Parry et al. (2003) show that the welfare gains from environmental innovation may not be much greater than the corresponding social benefits of cost-effectively abating carbon emissions by means of existing technologies. This highlights the importance of developing and maintaining efficient carbon markets; if emissions are under-priced and/or adoption behaviour distorted, any new carbon-free innovation will not be sufficiently exploited. For instance, the introduction of auctioned allowances and more efficient plant entrants and closure provisions in the EU ETS and other similar carbon markets could therefore well be just as important for innovation outcomes as public R&D and technology support.

#### **4. CONCLUSIONS AND FUTURE RESEARCH AREAS**

The first years of the EU ETS have demonstrated that it is possible to design and implement a large-scale trading system in a relatively short period of time. In fact one may well argue that the practical success of this scheme stands out in comparison to the deadlock in the overarching global negotiations. Phases I and II have provided opportunities for institutional learning, development of market infrastructure, and empirical assessments, which will be critical to future improvements of the system. Clearly, considerations of political feasibility, special interests, and perceived fairness have been key parameters in the design of the EU ETS, and they will no doubt continue to be so in the future. A simpler trading system with fewer distorting elements would be more economically efficient, but may pose greater political challenges to design, launch and/or implement, in part because it would leave less room for pursuing other policy objectives than least cost emissions reductions, such as stimulating certain technologies, developing new fuels, or including additional industries.

The initial years of the EU ETS have provided a large-scale testing ground for trading a new environmental commodity. The lessons learned are diverse and not all experiences are positive. For example the process of setting up the National Allocation Plans turned out to be complex, controversial and sometimes characterized by lobbying and strategic interaction between industry, Member States and the European Commission. Also, related to the free allocation of allowances; new energy facilities in several Member States received free allowances worth more than the entire investment cost. Worse still: Since the distinction between new entrants and capacity expansion can be fuzzy, even expansions can become eligible. What's more, since allocation is often based on emission forecasts, plants relying on high emitting fuels like coal receive more allowances than those that use natural gas or bio fuels. This creates incentives that are the exact opposite of what the ETS was intended to give.

One of the lessons from the second period is that there is an inherent contradiction between using allocations to countries as an instrument to meet national Kyoto goals on one hand and treating similar industries in different countries similarly on the other. At the same time, it is clear that the balance between central harmonization and national discretion is moving quite fast towards central control and the third allocation phase will not allow too many of the inconsistencies and perceived injustices of the first two periods to be repeated. A centralized allocation at a European level, or at least a common decision on the total volumes to be allocated, would mitigate this problem.

The future development of the EU ETS is closely tied to the international climate policy regime. The most important attribute of a policy instrument is how much it reduces emissions and it is reasonable to assume that any country or region will not set sufficiently tough emission reductions for itself without seeing that other countries are taking on similar programs. At the same time it is hard to negotiate and conclude international deals if there are no successfully operating schemes to use as a model. This is a classical catch 22 situation: international agreements are needed in order to design good instruments and functioning instruments are needed to allay the fears of some negotiators that carbon abatement will not work or will stifle all economic activity.

We are now in an interregnum between the first awakening to the climate problems and the more or less stable period of transition that will hopefully come with a long-run global treaty. This interregnum may be fairly protracted as the new global institutions or agreements will not be built over night. They require the settling of both intellectual and ethically tainted cost-sharing issues. They also require some proof or persuasive evidence that it is possible to transition away from the fossil-based economy. One important role of the various, temporary national and regional instruments and schemes that will be built during this decade is to demonstrate that this is possible without excessive damage to the economy or social fabric. It is possible that no single global agreement is reached but instead the temporary institutions, instruments and schemes built successively transition into a global scheme.

It is important to judge policy instruments keeping this time dimension in mind. While cost effectiveness is of paramount importance, it applies particularly in the long run. Not every single detail and step will necessarily pass a narrow test of efficiency. Normally banking is a good feature of a permit system but it may well have been wise not to allow it in the first trial period of the ETS since this was a trial period and it would have been detrimental to give excess allocations eternal life. Also, sometimes countries may be prepared to take a risk and develop a new technology or policy partly to demonstrate its feasibility. This may give some first-mover advantage but it may also be in a sense altruistic (and not cost-efficient). If no-one ever takes a first step, it is clearly hard to set a whole group in motion.

The problems of linking schemes such as the EU ETS to other trading systems should perhaps be seen in this light. If it had been completely easy to link schemes, it would probably also have been easy to agree on a joint design in the first place. The decision to link is in fact likely to cause a number of problems. It will no doubt require some changes in design of the various

schemes, but it could perhaps provide a workable roadmap to real global integration – precisely because it will force policy makers to deal with problems of harmonization.

This report is intended to provide a perspective on the problems to be faced and the opportunities ahead in constructing global carbon markets. The scientific literature provides arguments for establishing a strong price signal for carbon in order to attain future climate targets cost-effectively. The practical experiences so far are however at best a “good start”. This should come as no surprise in an imperfect world “where the income and wealth effects of proposed actions are significant and sovereign nations of widely varying economic circumstance and institutional development are involved,” (Ellerman and Joskow, 2008, p. iv). Still, for this reason we believe it is useful to provide an overview of the practical experiences of existing carbon markets to date, and highlight some important implications for policy as well as for future research. The EU ETS has not been perfect: Nevertheless, invaluable information has been gained from it. Policy makers would be wise to make use of it, be they supporters of emissions trading or sceptics of such policies.

The report comprises a global outlook on the development of carbon markets, including both theoretical advances and practical, empirical developments, and we highlight the fact that specific design issues – e.g., plant entrants and closure provisions, linking mechanisms, the design of price floors and ceilings etc. – play an important role in influencing the overall efficiency of carbon markets. These issues therefore require particular attention in the establishment of new and or revised trading schemes. We see now that there will be no rapid progress on establishing a grand all-encompassing climate regime. Instead it appears we will get some moderate progress in terms of systems that are in various ways partial: They may cover certain sectors, certain groups of countries, certain gases, different types of economic agent or activity and so forth. There will, in a second step, be pressure to coordinate or link these systems and for instance facilitate the use of credits for emission reductions from forestry, agriculture and other sectors and carbon markets.

Inevitably this process will provide a rich palette of examples of what we euphemistically call “second best”. It will also, incidentally open up interesting fields of research which will also be practically important.

In general future research efforts should have an even stronger focus on the establishment and functioning of carbon markets in second-best settings. Some attention has already been paid to the impact of pre-existing tax distortions on labor and capital, but increased emphasis must

also be laid on the existence of, for instance, policies focused on particular technologies or sectors. Among other topics that will be important we have many of those we have touched on in chapter 3.

These include:

- Institutional requirements for the development of policy instruments such as permit trading in various countries. Similar issues need to be addressed for tax instruments, subsidy and technology instruments and for the handling of adaptation and mitigation payments in developing countries. In fact one of the most significant accomplishments of the COP15 negotiations was the pledge by the developed economies to establish a source of financing (\$100 billion annually by 2020) to support mitigation and adaptation activities in developing economies. Creating the institution(s) to disperse the funds remains a significant challenge.
- The economics, practicalities and politics of a number of quite technical issues related to permit trading such as: distributional effects linking different schemes; dealing with volatility and uncertainty, through devices such as banking and or borrowing, price collars and finally dealing with technological change and new information on climate sensitivity. Given the importance of future technological progress for combating climate change research that addresses the impact of different combinations of policy instruments on technological change is particularly important.
- Experience shows that the acceptability of policies hinges quite significantly on distributional issues. It is often not the total cost that is decisive but rather how it is distributed among vested interests that are more or less well-endowed to deal with costs and more or less powerful when it comes to lobbying. In this area more research is needed because relatively little has been done in the past, because it is important, and because we are getting access to more and more useful tools not least through the development in behavioral economics as well as collaboration between economics, political science, psychology and other disciplines.
- Given the importance of future technological progress for combating climate change, research that addresses the impact of different combinations of policy instruments on technological change is particularly important. Nevertheless, society will not benefit much from technological progress if the policy architecture is not flexible enough to

allow for updating of environmental targets when cleaner technologies become available. Since the choice of policy instrument influences firms' decision to adopt new technologies that reduce abatement costs and the environmental policy targets are conditioned on industry-wide aggregate abatement costs, the incentives to adopt new technology provided by different policies have important implications with respect to the need for policy adjustment. Therefore, it is also important to understand the effects of the choice of policy instruments on the optimal policy response to technological change.

- The economics and politics of multiple instruments. This includes both the need for multiple instruments to deal with multiple market failures and objectives as well as the inevitable need to deal with the plethora of instruments that are decided at different levels and by different organizations in society. As an example, the understanding of interrelationships between the EU ETS and domestic policies to support renewable energy technologies, and how these are influenced by other policy concerns and constraints (employment, industrial policy etc.), is still in its infancy.
- There is good reason to believe that we will see separate solutions for actual implementation for various industry categories or branches and this will require detailed research concerning integration, sectoral approaches and linking. The same applies for the prospects for separately formulating treaties and policies for new gasses and new sectors such as the domestic sector, small industry, heating, transport, forestry, agriculture, international aviation etc (and then later maybe linking them again). In this connection more work is needed on the allocative implications of harmonized tax schemes in different countries and how these can be coordinated with trading schemes.
- Policy acceptance may be just as important as environmental effectiveness and economic efficiency for future climate policy. Research that gives guidance on how to address potential trade-offs between acceptance, effectiveness and economic efficiency would therefore facilitate a more ambitious climate change policy. More broadly, a whole range of ethical and distributional aspects within and between generations need to be addressed in parallel to requirements of economic efficiency. For example, depending on its design a carbon pricing system may be either progressive (affecting the rich more than the poor) or severely regressive (affecting

poor people the most). Whatever the case it will have consequences for the political feasibility of the policy. Hence development of tools to mitigate unintended transfers of wealth following from the use of pricing instruments, for instance by compensating consumers through designation of allowance value to various purposes, and cost management and price control could be very important.

- The establishment of carbon markets typically involves compromises (e.g., the use of free allocation of permits in EU ETS). However, such compromises may interfere with an efficient market design and they therefore come at a cost. If our understanding of the magnitude of these costs are improved policy makers could be helped in identifying the most important issues for improvement. In a word, while the research so far has highlighted a number of distortions in existing permit markets, future research efforts should also investigate the magnitude of these distortions.<sup>23</sup> Comparative studies in order to shed light on policy options in different contexts could be useful.
- Design issues related to existing and emerging offset mechanisms will be crucial for offset mechanisms efficiency and future potential.
- Research related to the interaction between climate policy and other policies, in particular in the area of trade.

Moreover, future research also needs to address the scope for developing political and administrative institutions that can secure a long-lived and stable carbon market. We need to understand that this is a very long run process where cost efficiency is important in the long run but getting functional institutions in place and securing global acceptance is more important than short run efficiency of individual schemes. Creative research is required when it comes to issues such as the future of CDM and REDD+ which have fundamental problems of additionality and baselines but on the other hand hold the promise of being interesting to low income countries that are otherwise hard to integrate into a global scheme.

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<sup>23</sup> It is sometimes argued that carbon pricing represents an ineffective policy instrument since it may be difficult to implement high carbon prices for political reasons. However, it is useful to distinguish between policy acceptance (the scope for getting the policy implemented) and policy effectiveness (once the policy has been implemented). A high carbon price will be effective, but the scope for implementing such a price may differ depending on, for instance, allocation rules, competitiveness concerns and revenue recycling schemes etc.).

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