Potsdam Institute for Climate Impact Research

Expertise for the Policy Planning Staff in the Federal Foreign Office

Towards a global CO_2 market

An economic analysis

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Executive Summary

Emissions trading schemes are a cost-effective instrument for achieving greenhouse gas emission reduction targets. Since the beginning of the year 2005, the European Union – a pioneer in international efforts to address climate change – has engaged in the trading of emission permits. Following the European example, other countries and regions are currently developing emissions trading schemes of their own. In the USA, for instance, two interstate emissions trading schemes are presently evolving: the Regional Greenhouse Gas Initiative (RGGI) in the East and the Western Regional Climate Action Initiative (WRCAI) in the West. In light of this development, it should be examined whether a **linking** of the various schemes with the European scheme would be economically sensible, what form such linking could take and which legal issues must be considered.

The following Expertise comes to the conclusion that the establishment of national and regional emissions trading schemes and their subsequent linkage offer significant promising prospects for international climate protection: The linking of emissions trading schemes leads to a **reduction of the costs of climate protection**, since companies have additional avoidance options at their disposal. Larger trading volumes and attendant improved **market liquidity** yield more stable price signals, which in turn stabilize investor expectations. **International distortions of competition** are eliminated through a uniform allowance price across regions. These conclusions are supported by an exploratory model developed at the Potsdam Institute for Climate Impact Research (PIK) within the framework of this Expertise.

In order to coordinate the gradual development of a global emissions trading system for companies, we propose the establishment of an **international clearinghouse**. This clearinghouse would maintain a record of the transactions between companies from the participating schemes in a joint allowance registry and thus ensure interchangeability of the permits. It could be domiciled at an international institution such as the Secretariat of the United Nations Framework Convention on Climate Change.

A clearinghouse is also sensible from the standpoint of **harmonization of framework conditions** as the key prerequisite for successful linking of emissions trading schemes. Harmonization is above all needed in regard to the measurement, monitoring and reporting of emissions, the penalty mechanism for non-compliance, the acceptance of project-based offsets, banking emission certificates between trading periods and the duration of the trading periods. Only in this way can it be ensured that linked schemes will also optimally contribute to achievement of the goal (emissions reduction at minimal cost). The clearinghouse would coordinate the harmonization of these framework conditions and serve as an exchange forum.

The Expertise stresses that the **decentralized** approach of linking regional emissions trading schemes is supplemental to the centralized approach of the United Nations Framework Convention on Climate Change (UNFCCC). In view of the current status of the international negotiations for addressing climate change, the decentralized development and gradual linking of emissions trading schemes would open up new scope for international action to protect the climate.

1. Towards a global carbon market

Emissions trading schemes combine a number of features that make them a preferred instrument of international climate policy: They enable a reduction of emissions where this can be done at the lowest cost; they permit direct control of the quantity of emissions (in contrast to a tax); and, because there is decentralized price formation on a free market, they avoid the necessity of complex government regulations: Equipped with the knowledge of the given current emission price, companies can freely decide how they wish to cut emissions. The less uncertainty there is concerning future emission prices, the lower the (cost-driving) risk associated with these decisions will be and the less fraught with uncertainty the calculation of the profitability of investments will be as well.

The EU Emissions Trading Scheme (EU ETS) is the world's largest trading scheme – in terms of both volume and number of installations – for cost-effective emissions reduction. Other schemes are presently evolving; in the USA, for instance, this is happening at regional level with the emergence of the Regional Greenhouse Gas Initiative (RGGI) in the northeastern part of the country and the Western Regional Climate Action Initiative (WRCAI) in the West.[1] International interest in the introduction of emissions trading schemes is picking up outside the political sector as well, however: Globally active investment banks such as Goldman Sachs meanwhile consider emissions trading a promising field for business activity (Wright 2007; Hepburn 2006), and a number of major firms in the USA and Europe (inter alia General Motors, DuPont, Alcoa and Vattenfall) have spoken out in favour of the introduction of a mandatory emissions trading scheme for companies (USCAP 2007; Vattenfall 2006).

These developments are occurring against the backdrop of considerable political uncertainty as to the future of international climate policy. The outcome of the negotiations on an international agreement for the post-2012 period is currently completely open. Precisely in the light of this situation, however, the possibility of developing and subsequently linking national and regional emissions trading schemes offers promising prospects for global climate protection: Even if the conclusion of a global climate protection agreement is delayed, emissions trading affords pioneers in the field of climate protection an opportunity to achieve

[1] Annex I contains a description of these schemes. In addition, several proposals for a national cap-and-trade system are currently discussed in the US Congress.

emission reductions cost-effectively without having to wait for such an agreement to be concluded.[2]

Creation of a globally integrated emissions market for companies through a *bottom-up* approach could give new impetus to the global negotiations for addressing climate change. The development and linking of regional emissions trading schemes can be an important incentive for the adoption of reduction targets by the parties to the negotiations in the UNFCCC process. If the corresponding integrated institutional structures are already in place or in the planning stage at the time an international climate protection agreement is concluded, this would simplify global efforts to protect the climate.

The following study shows that a geographical expansion of emissions trading is sensible both economically and from the standpoint of climate policy. In addition, it analyzes what conditions must be met on the way to a linked system and what political action is necessary in this regard. Fundamental economic aspects of an integration of emissions markets are discussed in Chapter 2. Chapter 3 then shows what linkage could look like in practice and which critical points must be considered in the process. Prospective features of an institutional framework for a global emissions trading system for companies are outlined in Chapter 4. Chapter 5 discusses what political action is needed and identifies aspects to be considered in the event that the EU ETS is linked with the regional schemes (RGGI and WRCAI) currently under development in the USA. Annex I gives an overview of the regional emissions trading initiatives in the USA and discusses several of the aforementioned potentially problematic aspects of these schemes, whereas Annex II examines the role of price corridors in inducing technological change. Annex III briefly presents the dynamic growth model developed at the Potsdam Institute for Climate Impact Research to assess the effects of linkage of emissions trading schemes.

2 The European Union has already announced that the EU ETS will be continued after 2012 in any case (Delbeke 2007).

2. The integration of emissions trading schemes from an economic perspective

In this chapter the opportunities and risks associated with linked emissions trading schemes are analyzed and assessed from the perspective of economic theory.

2.1 Economic arguments in favour of integration

From the perspective of economic theory, a linking of emissions trading schemes is recommended for three reasons:

- **Cost-effectiveness**: The total cost of emission reduction declines in the event of a linking of regions with different marginal abatement costs, since companies in a region with higher marginal abatement costs can buy allowances from companies with lower marginal abatement costs. Emissions are thus reduced where this can be done at the lowest cost.
- **Strengthening of the market**: Linking improves market liquidity. This increases the robustness of the price signal and lowers investment risks. In addition, the market clout of individual players or groups of players (cartels) is reduced.
- **Prevention of distortions of competition**: An extension of emissions trading counters distortions of international competition. With a uniform emission price there is no incentive for a migration of emission-intensive industries within the regions participating in emissions trading.

First of all, separate emissions trading schemes are generally not cost-effective, for the total cost of achieving an emissions target is unnecessarily high: In unlinked schemes, the marginal abatement costs normally differ. This is comparable to differing costs of goods production in the context of international trade theory. In emissions trading, too, the sale of an emission allowance from a low-price scheme to a high-price scheme is profitable for both sides – abatement costs are reduced without a concomitant increase in emissions.

Secondly, an extension of emissions trading helps to level the competitive playing field. Precisely in connection with the EU ETS the argument is repeatedly raised that ambitious reduction commitments in Europe would intolerably impair the international competitiveness of European industries. A further consequence could be a migration of emission-intensive industries to countries with low or no CO_2 prices. This would be undesirable not only for economic reasons but also for environmental reasons, as it could result in so-called "carbon leakage": Part of the European emission reductions would be lost as a result of a corresponding rise in emissions in countries without emission limitations. Carbon leakage thus leads to a shift in rather than avoidance of CO_2 emissions (Barrett 2000).

Economic modelling studies (Böhringer and Rutherford 2002; Bernstein et al. 1999) have analyzed and quantified the effects of carbon leakage. The leakage rate for CO_2 under the Kyoto Protocol, for instance, is estimated to be 8-20%.[3] The same studies also show that such undesirable side effects become less pronounced as more of the world's regions participate in emissions trading. The modelling calculations even suggest that global emissions trading would lead to a reversal of sorts in the carbon leakage effect: If CO_2 emissions have the same price everywhere, emission-intensive industries in countries marked by an already high level of emission efficiency will be strengthened and expanded.

An exploratory model developed at PIK for this Expertise yielded comparable results.[4] The PIK model, an intertemporal growth model, was used to examine the effects of unilateral and global emission limitations, with and without emissions trading, on two sample sectors in two sample countries. In addition to the expected efficiency gains, the model shows that *terms-of-trade* effects and carbon leakage are prevented by emissions trading.[5]

It is thus also possible to refute the objection raised by Copeland and Taylor (2005), namely that indirect effects of trade in goods could lead to an equalization of marginal abatement costs – i.e. to a cost-effectiveness of greenhouse gas reductions – even *without* international emissions trading. The modelling calculations conducted at PIK clearly show that emissions trading is indispensable for the economic efficiency of climate protection measures. The reason for these divergent results lies in the different basic assumptions: Whereas Copeland and Taylor (2005) chose a static approach with an exogenously given factor endowment, the approach taken at PIK was a dynamic one that focused on investment decisions.

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3 The leakage rate is defined as the percentage difference between the absolute increase in emissions in countries without emission limitations and the absolute decrease in emissions in countries with emission limitations (each relative to the business-as-usual scenario).

4 A brief technical description of the model is presented in Annex III.

5 Terms-of-trade effects can, however, also arise despite emissions trading if international trade in fossile fuels is included. This was not taken into account in the PIK model.

2.2 Critical aspects

Along with these advantages, however, the linking of emissions trading schemes can, under certain circumstances, have undesirable side effects as well:

- Distribution effects: The sale of permits from the low-price region to the high-price region in the wake of such linking leads to a short-term transfer of financial resources from the high-price region to the low-price region. In addition, individual companies are better or worse off.
- Free-rider effect: Governments could succumb to the temptation to issue additional allowances in order to generate additional income for their own countries from the export of allowances.

If the allocation of the allowances is made on a regionally separate basis, the linking of schemes with initially – i.e. prior to linkage – different allowance prices leads to an income transfer from the region with higher prices to the region with lower prices: The companies in the high-price region will acquire allowances from companies in the low-price region. Admittedly, each individual buyer company profits from the transaction, since it can lower the costs of its reduction commitment; from a political and economic perspective, however, a massive unilateral importing of emission allowances could give rise to criticism of the interlinked system.

At company level, moreover, the following distribution effects arise: Both the buyers of allowances in the scheme with higher prices and the sellers in the scheme with lower prices profit from a linking of the schemes; the sellers in the high-price scheme and the buyers in the low-price scheme, by contrast, are worse off (IEA 2005, 137f). A joint systemwide auction and a proportional pass-through of the proceeds to the participating states (Hepburn et al. 2006) could avert this problem. A compensation mechanism through which funds from the auction proceeds could be used to offset net differences in the balance of trade would likewise be conceivable.

It is essential for the linking of emissions trading schemes that the partners accept binding emission caps and that their compliance with these caps be credible to the respective other partner. If one government is more generous in allocating allowances to companies in its own country, these companies will be placed in a net seller position at the expense of the other country and at the expense of higher emissions, and the first country will thus on the whole gain additional income (Helm 2003; Kruger et al. 2007). Long-term partnerships extending over several trading periods would provide less incentive for such free-rider behaviour. A clear and credible signal of a willingness to commit to significant emission reductions in the medium and long term is therefore important and sensible.

2.3 Conclusions of the economic analysis

Overall, a linking of emissions trading schemes is to be viewed positively from an economic perspective due to the resulting efficiency gains and the protective effect against distortions of competition: The total cost of emissions reduction should decrease through the international linking of emissions trading schemes. It is, however, clear that the details of the design of the integrated schemes (e.g. specification of emission quantities, eligibility of project-based offsets) could have an influence on the environmental effectiveness and economic efficiency of emissions trading. In the following chapter it will be shown how a linking of emissions trading schemes can function in practice and what critical points must be considered in order to ensure the success of integration.

3. Prerequisites for linking emissions trading schemes

In Chapter 2 it was established that from an economic perspective the linking of emissions trading schemes leads to a reduction of mitigation costs. It would therefore appear sensible to link newly developed emissions trading schemes with existing schemes. With approximately 11,100 installations and an annual emissions volume of roughly 2.2 Gt CO_2, the EU Emissions Trading Scheme (EU ETS) is the largest existing allowance trading scheme for the limitation of emissions (Stern 2006; World Bank and IETA 2006a, b). A number of other emissions trading schemes in other parts of the world are currently in the planning stage or already in operation (see Sterk et al. 2006, for instance). In light of the particular importance of the United States as the world's largest economy, regional initiatives in the USA are of special interest in this context. Over the course of the next few years, the Regional Greenhouse Gas Initiative (RGGI) involving nine states in the northeastern part of the United States and the Western Regional Climate Action Initiative (WRCAI) involving the five states of California, Arizona, New Mexico, Oregon and Washington could evolve into full-fledged greenhouse gas emissions trading schemes.[6]

A number of aspects must be considered when linking emissions trading schemes in order to ensure that integration is effective both economically and in terms of climate policy. The following sections will address six key issues: harmonization and/or consolidation of allowance registries, the excess emissions penalty mechanism and implementation of a "safety valve", harmonization of standards for the monitoring of emissions, eligibility of project-based offsets, banking of allowances to later trading periods, and harmonization of trading periods.[7] Chapter 4 will then examine further challenges and prospective institutional framework features of a stable, integrated global emissions market.

6 See Annex I for a more detailed description of these two initiatives.

7 Depending on the specifics of post-2012 international climate policy – whether countries continue to trade in Assigned Amount Units (AAUs), for example – there will be further implications for the international linking of emissions trading schemes (see Blyth and Bosi 2004). In light of the uncertainty concerning the future global climate protection architecture, however, these implications will not be considered here.

3.1 Harmonization of registries for the transfer of allowances

Strictly speaking, in order to link emissions trading schemes it is only necessary to ensure at the technical level that the electronic allowance registries of the two regions are compatible with one another, i.e. that allowances can be transferred between the two schemes (Blyth and Bosi 2004; Sterk et al. 2006). In an allowance registry, a record is kept of who holds which certificates. Supplementation of the statutory foundations underlying the two schemes to provide for the mutual recognition of allowances from the respective other scheme as well as technically compatible registries are thus initially all that is necessary for a linking of trading schemes (Pershing 2006).

However, a joint consolidated registry enhances the trackability and transparency of the original allocations and the transactions based on them. It reduces uncertainties concerning possible errors (such as double counting) as well as the risk of manipulation and hence reduces the later need for corrections. Under the EU Emissions Trading Scheme, the European Commission maintains a consolidated Community Independent Transaction Log (CITL). The International Transaction Log (ITL) offers this opportunity as well. It contains a record of the transactions of the national registries under the Kyoto protocol including transactions of CDM- and JI-certificates. Trading of emission allowances under the Kyoto protocol is currently only possible if the national registries are linked to the ITL.

The future structure of interlinkages between different registers currently is an open question.

3.2 Harmonized penalty system and a uniform policy on price ceilings

In principle there are a number of options for penalizing companies whose actual emissions at the deadline exceed the amount of their emission allowances. One possibility is to require a company with excess emissions to buy the missing amount of allowances during the following calendar year at market prices, surrender these and also pay a penalty. This rule is applied under the EU ETS, for example, by obligating companies to subsequently produce sufficient allowances to make up the shortfall and to also pay a penalty of EUR 40 (trading period 2005-2007) or EUR 100 (trading period 2008-2012) per tonne of CO_2. A penalty regime of this kind consequently implies no price ceiling, and there is no correlation between breaches by companies and the market price for allowances.

Another possibility is to require companies to pay a specific fine for the allowances they failed to surrender but then relieve them of the obligation to produce the missing amount of allowances in the following calendar year. A scheme of this kind thus implicitly contains a so-called "safety valve", since companies can in effect buy allowances in the amount of the fine. The linking of a scheme with such an implicit (or also explicit) safety valve and a scheme without such a safety valve would in effect introduce the safety valve into the scheme without a safety valve: As long as the allowance price was above the safety valve price, companies from the scheme without a safety valve could continue to buy allowances from companies from the respective partner region until the price evened out (IEA 2005, 135f; Ellis and Tirpak 2006).

Safety valves crack the emission cap: While the intention behind cap-and-trade emissions trading schemes is to control the absolute quantity of emissions, the issuing of additional allowances through a safety valve mechanism undermines precisely this objective. Moreover, if a price ceiling is set too low, this can reduce the incentive to develop low-emission technologies. Thus if one of the schemes to be linked rejects a safety valve on principle, none of the other schemes can have a safety valve either.[8]

3.3 Harmonization of standards for the monitoring, reporting and verification of emissions data

Confidence in the standards for monitoring, reporting and verification (MRV) of emissions is important in order to guarantee market stability. Harmonization of these standards increases such stability. Slight deviations should not present a problem as long as care is taken to ensure that errors or irregularities in measurement, monitoring and reporting do not necessitate later adjustments of the emissions data and/or compromise the confidence of the market players in the validity of the allowances (Blyth and Bosi 2004; IEA 2005, 134; Sterk et al. 2006).

3.4 Harmonized offset certificate import quotas and types of project-based offsets

If international project-based offsets such as those from Joint Implementation (JI) or the Clean Development Mechanism (CDM) continue to be tradable in the future, or if states introduce such mechanisms at national level to enable emission reductions in sectors other than those covered by emissions trading schemes, then the arrangements governing recognition of these offsets should be harmonized between the schemes to be linked. In principle, differences concerning the recognition of certain types of projects (afforestation projects, for example) or different quotas for the amount of project-based offsets that may be

[8] While various mechanisms are being discussed to limit the impact of safety valves in one of the linked schemes on the other scheme(s) (exchange rates, for instance; see also Sterk et al. 2006), such mechanisms would considerably increase the complexity of linkage and thus impair the efficiency of the overall system.

used per installation do not pose an obstacle to the linking of emissions trading schemes (Ellis and Tirpak 2006). In light of the implications of these arrangements, however, they can be a critical issue in negotiations on the linking of emissions trading schemes (Sterk et al. 2006; Blyth and Bosi 2004; IEA 2005, 129f).

Three arguments speak in favour of a harmonization of allowable project types and quotas prior to the linking of emissions trading schemes: First of all, a high project-based offset quota for companies in one of the schemes increases the number of tradable allowances in both schemes, causing the allowance price of the linked schemes to fall (provided that project-based offsets are cheaper than normal allowances) (Blyth and Bosi 2004). If the linked regions have different (perhaps implicit) ideas as to what constitutes a reasonable (minimum) allowance price, a low price and high quota in one scheme could give rise to disagreements if the quota for project-based offsets in that region is perceived to be too generous.

Secondly, arbitrage possibilities fraught with potential for political conflict can arise for companies in the region with a high project-based offset quota if these offsets are cheaper than the market price for normal allowances[9] (IEA 2005, 129f): These companies can buy project-based offsets inexpensively and then sell normal (more expensive) allowances in the other region, generating an income transfer.[10]

Thirdly, reservations on the part of one of the two partner regions concerning the environmental effectiveness of certain types of projects (such as afforestation projects) can culminate in that region's unwillingness to even indirectly accept offsets based on such projects (for even if companies of region A are not allowed to use such project-based offsets, they can acquire "normal" allowances from companies of region B that become available as a result of the latter's use of these project-based offsets). If such offsets were cheaper than other certificates, a larger quantity of these offsets would be generated through integration than would have been the case if the schemes had not been linked (Blyth and Bosi 2004; IEA 2005).

While exchange rates (see section 4.3) could address the problem of regionally different arrangements for project-based offsets in linked schemes, their introduction is complicated and prevents the establishment of a uniform emission price, diminishing the economic

9 And also perhaps stem from national project-based offset mechanisms. See in this context the description of the RGGI in Annex I.

10 The possibility of putting their own companies in a more favourable position through more generous quotas could be an incentive for governments to increase the quotas. A harmonized arrangement would rule out this incentive.

efficiency of integration. A mutual agreement on maximum quotas for certain types of project-based offsets therefore appears to be the best solution to this problem.

3.5 Banking of allowances

Companies can bank allowances from earlier trading periods in order to use them in later periods. This can reduce price volatility between periods and thus enhance planning certainty for companies. If allowance prices are expected to rise in the future, banking can under certain circumstances also increase the effectiveness of an emissions trading scheme from the standpoint of climate policy because companies have an incentive to reduce emissions quickly in order to carry allowances forward into later periods and then sell them at a profit (Newell et al. 2005; Stern 2006, 332f; Burtraw et al. 2006).[11]

Even if one of the participating regions limits or does not permit the transfer of allowances, the upshot of its linkage with emissions trading schemes that do permit the (unlimited) transfer of allowances is that all companies can transfer their allowances: At the end of a trading period they can sell their allowances to companies in the respective other region and then buy them back again later. In the event that one of the regions feels a limitation of transferability is wise, the relevant arrangements should be harmonized (by introducing a limit on transferable allowances per installation, for instance) (Sterk et al. 2006; IEA 2005; Blyth and Bosi 2004). A limitation of transferability can make sense in order to prevent the use of allowances from earlier trading periods marked by overallocation, in other words, to prevent the banking of "hot air".

3.6 Harmonization of trading periods

The body of literature on the linking of emissions trading schemes yields different answers to the question of whether the trading periods (within which allowances that have been issued can be used at any time) of linked schemes should be harmonized. Sterk et al. (2006) argue that differences in trading periods do not present a problem. Quite the contrary: Such differences, they contend, can improve market liquidity, since temporary market shortages in one scheme at the end of the trading period can be offset by purchases from another scheme that is at the beginning of its trading period.

[11] Burtraw et al. (2006) furthermore argue that the transferability of allowances (banking) increases the political stability of emissions trading schemes: Through the transfer rule companies can accumulate assets; in the event of abolition of the emissions trading scheme they would have to write off these assets. They consequently have an incentive to support the continued existence of the scheme.

Ellis and Tirpak (2006) point out that if trading periods are not harmonized, surplus allowances from an existing scheme A can impair the environmental effectiveness of a subsequently linked scheme B. In general it can be argued that in the case of partially overlapping trading periods, overallocations from earlier periods will be transferred to later periods: If allowances are available at a low price in scheme A at the end of a period, they will be sold to scheme B where the period is just starting, and it will consequently not be necessary to use the allowances issued in scheme B. Since the trading periods overlap, these surplus allowances will then again available to companies from scheme A during the next trading period.

Even if allowance allocations do not ultimately yield a surplus, it is clear that harmonized trading periods afford policymakers the possibility of controlling the total amount of allowances in a trading period without uncertainties. If this is desirable, the trading periods of the schemes to be linked should be harmonized.

3.7 An international clearinghouse

It is hence apparent that in addition to the creation of a joint allowance registry, a number of scheme features should be harmonized in order to avoid undesirable effects when emissions trading schemes are linked. We therefore propose the creation of an **international clearinghouse** to maintain the joint registry and to back up and facilitate the necessary harmonization and coordination process. In the case of the EU ETS, the European Commission is presently fulfilling this clearinghouse function with the Community Independent Transaction Log (CITL), within the framework of which the national registries of the EU Member States are interlinked. If the EU ETS were to be linked with emissions trading schemes in other parts of the world, it would make sense for such a clearinghouse to be domiciled at an international body (at the UNFCCC Secretariat, for example).

In addition to maintaining the international registry, this clearinghouse could serve as a forum for regular consultations between representatives of the participating schemes and for the coordination of both ongoing operations and further steps such as linkage with additional schemes or harmonization of scheme features.[12] In addition, sensitive market information

[12] In principle, the greater the extent to which the features of the schemes to be linked have already been harmonized, the fewer uncertainties and perhaps undesirable effects of linking there will be (IEA 2005). Consultations and talks between representatives of different schemes are thus highly advisable already during the development phase of new schemes; conversely, schemes that are already in operation should also be willing to undergo modifications if necessary.

(such as emissions data) could be jointly published at specified times.[13] Ellis and Tirpak (2006) suggest that a periodic review of linkage be undertaken within this joint clearinghouse framework to consider issues such as changes in the design of participating schemes.[14] The following discussion of further (possible) framework features of a global emissions trading system additionally underscores the future need for coordination of linked emissions trading schemes.

[13] The publication of actual emissions data by the European Commission in spring 2006 prompted a sharp drop in the allowance price. In addition, information leaks afforded some market players advantages and caused market uncertainty. It thus became clear how important the coordinated publication of key information (above all emissions data) is for price formation on emissions markets. Coordinated publication of such data can reduce undesirable market volatility.

[14] The possibility of de-linking the schemes as well as a procedure for doing so should preferably already be agreed prior to the commencement of integration in order to avoid conflicts at a later stage (Ellis and Tirpak 2006).

4. Future framework features of a global emissions trading system

Scarcities and expectations about the future are the most important price determinants in any market. The main difference between an emissions trading market and other markets lies in the fact that the available quantity of allowances (in other words, the scarcity) depends on the results of political negotiation processes based on scientific findings and that expectations about the future are largely expectations about future emissions targets (Grubb and Neuhoff 2006).

Money markets are confronted with a similar problem in regard to the determination of the money supply. Central banks that are bound by instructions from governments always run the risk of having to accommodate government fiscal policy. It is therefore presumed that dependent central banks are burdened with a higher risk of inflation. Past experience in this regard has resulted in the allocation of competence for control of the money supply to independent central banks. In order to ensure the stability of quantities and expectations in an emissions market (and in order to thus stabilize the incentive for companies to invest in low-emission technologies), an emerging international network of emissions trading schemes could in the medium and long term broaden the range of instruments of the joint clearinghouse to encompass measures that serve to enhance the stability of the allowance markets and further the achievement of their goals.[15]

In the longer term, an international institution could therefore emerge to coordinate the common emissions market on the basis of certain instruments (along the lines of the U.S. Federal Reserve Bank or the European Central Bank) and objectives (such as market stability, compliance with a politically defined emissions target, equal treatment of all participants) that have been clearly and jointly agreed from the very beginning. The possibility of such an institution is suggested by Grubb and Neuhoff (2006) and Yohe (2007), for instance:

> *"Faced with these conflicting pressures, governments may need to learn from monetary policy, in which the need for credibility of commitments to tackle inflation led to the establishment of independent central banks with clear mandates, and ultimately the creation of the European Central Bank…Establishing a long-term, clear and credible*

[15] In principle, these reflections pertain not just to the requirements of *linked* emissions trading schemes but rather to the very functioning of emissions trading schemes themselves. However, the more regions of the world (or individual sectors in China or India, for example) an emissions trading scheme comes to include and the more heterogeneous the features of the individual schemes are, the more important the measures discussed here could become.

foundation for allocating allowances under the EU ETS, and managing its diverse international linkages, could require thinking of a similar order." (Grubb and Neuhoff 2006)

"It strikes me, as an aside, that the Federal Reserve scheme of the United States (the FED) is an example of an institution designed to accomplish all of these tasks. While surely in a different context, the FED confronts the same sorts of short-term versus long-term tensions with the same sorts of price or quantity policy tools and protected from political manipulation by carefully designed insulation." (Yohe 2007)

The various functions of a clearinghouse have already been outlined in Chapter 3. In the following sections, four areas will be briefly discussed in which an enlarged clearinghouse could play an active role and thus promote achievement of the goals of emissions markets. The institutional framework examined here is to be understood as a suggestion. Further studies would be necessary in order to analyze the following points (among others) in greater deatil: the centralized auctioning of allowances, the creation of a joint competition authority and the introduction of exchange rates. In closing, thought is given to question of whether a carefully defined independence of the clearinghouse (along the lines of central banks, for instance) can improve the functioning of emissions markets.

4.1 Centralized auctioning of allowances

If the timing of auctions is not coordinated, decentralized auctioning of allowances (by governments) harbours the possibility that in an extreme case, for instance, an auction might take place somewhere across the system every two weeks – a scenario that would be undesirable by virtue of the transaction costs alone (Hepburn et al. 2006). A minimum of coordination therefore appears sensible. Moreover, regional auctioning of allowances could give rise to distribution effects that would be prevented by a central auction (see Chapter 2).

Instead of having auctions handled by national authorities, systemwide allowance auctions could be conducted by the joint clearinghouse and the proceeds could be forwarded to the member states or to specific technology and research funds according to a previously defined distribution formula. If the expertise required for auctions need only be based at one location (at the joint clearinghouse), this lowers the transaction costs of the entire system.

In principle, auctions eliminate a number of dysfunctional incentives that go hand in hand with grandfathering and benchmarking and that can ultimately lead to a subsidization of high-emission technologies (such as coal-fired power plants) (see Grubb and Neuhoff 2006): If, as in the case of grandfathering, the allowances are allocated on the basis of emissions in past trading periods, there is an incentive to produce *more* emissions and, in an extreme case, to even invest in obsolete coal-fired power plants instead of low-emission installations in order to obtain more generous allocations in subsequent periods. In the case of benchmarking, coal-fired power plants are allocated more generous allowances than gas-fired power plants even though gas-fired power plants produce substantially lower emissions per unit of power generated; the latter's relative advantage over coal thus does not fully come into play in an emissions trading scheme. Above all, however, neither in the case of benchmarking nor in the case of grandfathering must investors take the full costs of future emissions into account in their capital budgeting: Because allowances are allocated free of charge, future emissions are of no financial consequence. If all allowances are auctioned, by contrast, these costs would indeed figure in investors' calculations.

4.2 Joint competition authority

In order to ensure smooth functioning of the markets, many markets have a competition authority endowed with clearly defined competences which can intervene in the event of undesirable (previously defined) market disturbances. An international competition authority for emissions markets would check for potential cartel formation or price collusion between companies on the allowances market. In addition, it would keep an eye on the market and, if necessary, take steps to effectively combat market-damaging speculation or irrational excesses. These cause unnecessary market volatility that diminishes the economic efficiency of an emissions trading scheme and must therefore be avoided. Such an international competition authority could perhaps also be institutionalized within the framework of the clearinghouse as a forum for cooperation among the different national competition authorities.

4.3 Exchange rates to balance asymmetries

If the RGGI scheme were to be linked with the EU ETS, an exchange rate would be needed between the two emissions trading schemes since the schemes' units of measurement differ: Whereas the EU ETS measures emissions in metric tonnes, the RGGI is based on the unit "short tonne" (1 short tonne = 0.907 metric tonnes). The clearinghouse would have to take such exchange rates into account in the registries.

Moreover, there are a number of situations in which the introduction of exchange rates could be desirable: If, for example, one region thinks the emission cap of a partner scheme is insufficiently stringent for some reason or considers the monitoring regime for emissions reports in the partner region problematic, or if a government introduces project-based offsets from programmes in respect of which no agreement on recognition has been reached or increases the import quota for such project-based offsets or introduces a safety valve (i.e. issues an unlimited quantity of allowances at a certain price), an exchange rate could be introduced (Blyth and Bosi 2004; IEA 2005, 125; Burtraw et al. 2006; Sterk et al. 2006). Allowances from this region would then have a lower value in other regions (they might only be valid for 0.8 tonnes of emitted CO_2, for instance). Flexible exchange rates thus fulfil the function of a penalty mechanism.

Through the introduction of exchange rates, however, the overall system becomes more complicated and the full efficiency advantages of a uniform emission price are not realized. A harmonization of critical scheme features would hence be preferable to the introduction of exchange rates. In the event of irreconcilable differences concerning the design of the partner schemes, however, the introduction of exchange rates would be preferable to a complete de-linking of the schemes.

4.4 Independence of the clearinghouse?

If an emissions trading scheme is planned and implemented under conditions of uncertainty (in regard to avoidance costs or climate sensitivity, for example), governments are confronted with the problem of stabilization of expectations of the market players. These expectations hinge crucially on the credibility of a government's commitment to its announced policies.

First of all, there can be an incentive for governments to change their policies as soon as the desired changes in behaviour (e.g. investments in low-emission technologies) have been achieved – to cut energy prices, for instance. In this case companies that have made lower expenditures (fewer investments in low-emission technologies) enjoy a competitive advantage over innovators if climate protection targets are lowered. To put it differently: Under the new framework conditions, the change in behaviour no longer has any economic value for companies (Hepburn 2006). Secondly, in the event of new information or changing political preferences governments can come under pressure to belatedly intervene in market events. As a consequence of these uncertainties for companies, the discount rate for their capital budgeting increases and fewer investments are hence made than would be economically and environmentally necessary and possible (Hepburn 2006).

It can therefore be sensible for governments to transfer market oversight to an independent institution. The basic rules of conduct for such an institution would be laid down in a transparent manner from the very beginning; like the FED or the ECB, for example, it could, at its discretion (i.e. not strictly bound by rules) and in accordance with its prescribed duties, take decisions concerning the deployment of previously specified measures to stabilize the market (Newell et al. 2005) without being exposed to direct political pressure in the process.[16] This institution could, on the one hand, by virtue of its very existence and, on the other hand, through its conduct on the market enhance the credibility of – and the confidence of companies in – a long-term, stable and functioning emissions market (by taking effective action to counter market-damaging speculation, for instance). Independence of this institution in framing its market policy would be desirable because it would then be able to act in a stable and consistent manner regardless of changes in government and shifts in political currents and thus build the necessary reputation and stable expectations among market participants.

Decisions concerning medium- and long-term emission reduction targets can thereby continue to fall within the purview of the political sector. The task of the market oversight authority would consist solely of enhancing the credibility and stability of the trading scheme through deployment of carefully defined instruments on the basis of specific transparent objectives.

[16] Such a discretionary market oversight regime would be in contrast to a strictly rule-bound regime that spelled out from the very beginning which measures the market oversight authority could take in which cases.

5. Conclusions: Need for action to harmonize emissions trading schemes

The previous chapters have shown that even an initially fragmented emissions trading system can be sensible both economically and from the standpoint of climate policy. Various conditions were discussed that must be met on the road to a global system. The possibility of developing and linking national and regional emissions trading schemes opens up new scope for action in the area of global climate protection, especially in light of the current status of the international negotiations addressing climate change: Even if the conclusion of a post-2012 climate protection agreement should be delayed, pioneers in the field of climate protection could effectively limit their emissions within the framework of internationally linked emissions trading schemes. If integrated institutional structures for global emissions trading have already been created or are in the planning stages at the time a new international climate protection agreement is concluded, this would in any case simplify international efforts to address climate change.

Establishment of an international clearinghouse is proposed for the maintenance of the joint allowance registry and for the coordination and harmonization of the linked trading schemes. There is a need for harmonization above all in regard to the measurement, monitoring and reporting of emissions, the excess emissions penalty mechanism, the acceptance of project-based offsets, the rules governing transferability of allowances between trading periods and also the duration of trading periods.

In addition to the EU Emissions Trading Scheme, as mentioned earlier, two regional schemes are presently evolving in the USA. The following section briefly outlines the action that will be necessary in the event that these regional U.S. initiatives are linked with the EU ETS.

5.1 Linking regional U.S. initiatives with the EU ETS

Nine states from the northeastern part of the USA are involved in the Regional Greenhouse Gas Initiative (RGGI): New York, New Jersey, Connecticut, New Hampshire, Delaware, Maine and Vermont already belong; Maryland and Massachusetts will join in the course of the year 2007. In the medium and long term, Rhode Island, Pennsylvania and Ohio could also become members. The plan is to introduce a cap-and-trade emissions trading scheme for all electric power plants with a capacity of more than 25 MW as of 1 January 2009. The states will distribute the allowances individually to the affected installations in their respective territories. The initial quantity of allowances will remain constant until 2014 and then decline at an annual rate of 2.5% between 2015 and 2018, i.e. by a total of 10% by 2018 (RGGI 2005).

On 26 February 2007, the governors of the five western states of Arizona, California, New Mexico, Oregon and Washington signed an agreement to develop a joint regional cap-and-trade scheme within the framework of the Western Regional Climate Action Initiative (WRCAI) (Marris 2007, California 2007, Eilperin 2007, Point Carbon 2007a). Together the five states emit a total of 800 million tonnes of CO_2 equivalent per year, or approximately 11% of all U.S. CO_2 emissions (Point Carbon 2007a, Marris 2007). By the summer of 2007 the states will set a regional emissions reduction target, and in the following year an emissions trading scheme is to be designed which from the states' perspective is to set the stage for the development of a national scheme (California 2007).

Interestingly enough, contacts have already been established between representatives from California and the EU ETS within the framework of the Market Advisory Committee (Market Advisory Committee 2006). In a forum such as this, critical issues pertaining to a linking of these schemes can already be discussed at an early stage. To the extent possible within the framework of an economic expertise, a number of primarily legal aspects are discussed in the following that will probably have to be taken into account – over and above the minimal necessary harmonization discussed earlier – in the event of a linking of the EU ETS with regional U.S. initiatives prior to 2013. By the end of 2007 the Foundation for International Environmental Law and Development (FIELD), on behalf of the European Commission and in cooperation with other subcontracting partners, will prepare a legal expertise on the international linking of emissions trading schemes which will systematically examine the legal issues associated above all with a linking of the EU ETS with regional initiatives in North America.

1. Article 25 of the EU Emissions Trading Directive (EU 2003) must be amended on legal grounds, since it currently does not permit linking with states that have not ratified the Kyoto Protocol (Thomson 2006).
2. Regional emissions trading schemes such as the RGGI or a potential scheme in the western part of the USA are implemented at sub-national level. The EU's negotiating

partner would hence not be a third country as prescribed in Article 25 of the Directive. Here either an alternative route must be found or the Directive must be amended.

3. Article 25 must perhaps be amended to provide that no international agreement on linking must be concluded with a state participating in the RGGI, since the United States Constitution prohibits the states from entering into any international treaties. (Thomson 2006, Engel 2006). One possibility would be to adopt an amendment permitting the allowances of the U.S. installations involved to simply be accepted in the CITL accounts of the trading EU companies even without an international agreement (Engel 2006, 82). In return, U.S. companies – like any person – can already acquire EU allowances (EUAs) (EU 2003).
4. In contrast to the allowances issued under the EU Emissions Trading Scheme, allowances from a U.S. scheme do not have the status of allowances tradable under the Kyoto Protocol (so-called "Assigned Amount Units", AAUs) with which governments can substantiate the fulfilment of their reduction commitments. This problem can, however, be overcome through the creation of a "gateway" (see Sterk et al. 2006).

5.2 Open questions

The Expertise has given rise to a number of questions to be explored in further research. To begin with, the effects associated with an essentially rule-bound versus a discretionary (perhaps independent) market oversight authority for emissions trading schemes should be identified and discussed. The necessity of a competition authority and the specific scope of its duties should also be addressed in greater detail.

In this context, further attention should also be devoted to the implications the introduction of exchange rates could have for the linking of emissions trading schemes. How could exchange rates be calculated? If a price corridor is to be established (see Annex II), what instruments should a market oversight authority have at its disposal for controlling this corridor? What lessons can be learned from the field of monetary policy?

The implications of centralized systemwide auctions and the proportional forwarding of proceeds to the participating states must be explored as well (see Hepburn et al. 2006). A compensation mechanism could be examined within the framework of which trade imbalances arising from emissions trading could be equalized with funds from auction proceeds. The potential effects of non-harmonized trading periods on linked emissions trading schemes also warrant further analysis.

The legal issues associated with linking, such as a linking of the EU ETS and regional initiatives in the USA, must be examined in greater detail. To this end the European Commission has charged the Foundation for International Environmental Law and Development (FIELD) with preparing a legal expertise in which these aspects will be examined in greater detail. The results are to be presented at the end of the year 2007.

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Annex I – Regional initiatives in the USA

Regional Greenhouse Gas Initiative (RGGI)

Nine states from the northeastern part of the USA are involved in the Regional Greenhouse Gas Initiative (RGGI): New York, New Jersey, Connecticut, New Hampshire, Delaware, Maine and Vermont already belong; Maryland and Massachusetts will join in the course of the year 2007. In the medium and long term, Rhode Island, Pennsylvania and Ohio could become members as well. The plan is to introduce a cap-and-trade emissions trading scheme for all electric power plants with a capacity of more than 25 MW as of 1 January 2009.

The emissions of the affected installations, measured in short tonnes[17] (RGGI 2007), and the initial quantity of allowances for each state (annual cap) are listed in Table 1. The states will distribute the allowances individually to the affected installations in their respective territory. The initial quantity of allowances will remain constant until 2014 and then decline at an annual rate of 2.5% between 2015 and 2018, i.e. by a total of 10% by 2018 (RGGI 2005).

The table suggests that an overallocation of allowances could ensue; however, emissions from 2009 onward cannot automatically be projected on the basis of emissions from the year 2003. Official modelling results assume there will be a "short" market (RGGI 2005a), whereas Patrick (2006) cites independent modelling results (without specifying sources) that project a substantial overallocation.

Patrick (2006) furthermore assumes that the focus on electric power plants and the associated volume of emissions under the RGGI scheme will lead to lower market liquidity.

The functioning of the RGGI emissions trading scheme is explained in a Memorandum of Understanding (RGGI 2005, amended by RGGI 2006c). The jointly developed "Model Rule" (RGGI 2007) forms the basis for implementation of the scheme in the individual participating states.

[17] One short tonne is equivalent to 0.90718474 metric tonnes.

State	Emissions in the year 2003	Annual cap 2009-2014
New York	49.5	58.3
Maryland	30.0	Unknown
Massachusetts	24.5	24.2
New Jersey	19.8	20.7
Connecticut	7.7	9.7
Delaware	4.9	6.9
New Hampshire	5.3	7.8
Maine	4.9	5.4
Vermont	0.02	0.1
Total	**148**	

Table 1: CO_2 emissions (Mt CO_2) of electric power plants (>25MW) in RGGI states in the year 2003 and their envisioned cap for the first period 2009-2014.
Sources: Environment Northeast (2004), RGGI (2005), converted into millions of metric tonnes.

The method for distributing the allowances (auction, grandfathering) is left to the individual states. However, each of the states must auction at least 25% of the allowances and use the proceeds from the auction (i.e. from 25% of the allowances) to finance energy efficiency programmes, renewable energy funds, tax relief or other public benefit programmes and to fund administration of the scheme. New York has already announced that it will auction 100% of its allowances, as has Vermont; official representatives from Connecticut and Maine have also already spoken in favour of auctioning all of the allowances in their states (Point Carbon 2006a, RGGI 2005).

The RGGI scheme provides for the use of project-based offsets inter alia from a new project scheme created specifically to this end in the RGGI states or in any other U.S. state or jurisdiction (RGGI 2007, 104ff). The following types of projects are eligible thereunder:

- Landfill methane capture and destruction;
- Reduction in emissions of sulphur hexafluoride (SF_6);
- Sequestration of carbon due to afforestation;
- Reduction or avoidance of CO_2 emissions from natural gas, oil or propane end-use combustion due to end-use energy efficiency; and
- Avoided methane emissions from agricultural manure management operations.

Further project types could follow (RGGI 2005). These projects can be located in the RGGI states as well as in any U.S. state or jurisdiction that (a) implements an emissions trading scheme and/or (b) has entered into a corresponding memorandum of understanding with an RGGI state (RGGI 2006c). Projects initially commenced on or after 20 December 2005 are eligible. They must meet specified additionality criteria, i.e. they must be motivated by the RGGI scheme (and by no other public programmes). These criteria, the bases for calculating the number of allowances generated and further details are explained at length in RGGI (2007). An installation can normally cover no more than 3.3% of its emissions with offsets.

The scheme provides for a two-stage safety valve arrangement: An "Offsets Trigger Event" is deemed to have occurred if the average regional spot price for CO_2 allowances equals or exceeds a specified threshold price (initially US$ 7 per tonne) for a period of twelve months. A "Safety Valve Trigger Event" is deemed to have occurred if, over the course of the preceding twelve months, the average regional spot price for CO_2 allowances equals or exceeds US$ 10, plus 2% per year as of 2006, as adjusted by the Consumer Price Index (CPI) (RGGI 2007). When the first safety valve trigger is reached, the percentage of offsets an installation may use increases to 5% (RGGI 2006c). When the second safety valve trigger is reached, the given compliance period may be extended by one year, i.e. for a maximum compliance period of 4 years. In addition, offsets from international trading programmes (most likely CDM, JI, EU ETS) may also be fully credited. The percentage of usable offsets per installation then increases to 10% for the compliance period (RGGI 2006c). The safety valves are each only triggered for a period of one year.

The scheme foresees unlimited banking of allowances between trading periodes (RGGI 2005, 2007). A working group is to monitor whether there is any leakage of emissions under the RGGI scheme, i.e. whether there is any increase in electricity imports in the RGGI region, and consider potential options for addressing such leakage (RGGI 2005).

The scheme is to be implemented by the participating states individually until 31 December 2008; technical documents (such as the "Model Rule", RGGI 2007), etc. are to be drafted collectively. A collective "Regional Organization" (RO) with a board of directors (RO Board) consisting of leading representatives from the energy regulatory and environmental agencies of the participating states will coordinate the ongoing administration of the scheme. The Regional Organization will thereby have the character of a technical assistance organization: Regulatory and enforcement authority with respect to the scheme is reserved to the participating states (RGGI 2005). The Regional Organization is to be established in the course of the years 2006/2007. The responsibilities of the RGGI Staff Working Group will then be successively assumed by the Regional Organization. Even though the states are implementing the scheme individually, various possibilities for cooperation within the framework of the Regional Organization are currently being explored (RGGI 2006a):

- joint auction of allowances;
- a joint emissions and allowance tracking system;
- joint model guidance documents; and
- cooperation in the implementation of a programme for usable project-based offsets (RGGI offsets programme).

Implementation of the offsets programme is to be stepped up at the beginning of 2007 (e.g. creation of tools for evaluating the additionality of emissions reductions, clarification of legal issues and negotiation of memoranda of understanding with other U.S. jurisdictions).

The RGGI emissions trading scheme will be legally launched on 1 January 2009 (RGGI 2005, 2006b). A review of the scheme is scheduled for the year 2012. In the event that a federal emissions trading programme is launched, the installations covered by RGGI scheme will be integrated into such a programme.

Some observers see the RGGI primarily as an opportunity for testing certain design features of emissions trading schemes (such as the auctioning of allowances) and only secondarily as a vehicle for substantially reducing the emissions of the participating states (Kruger and Pizer 2006).

Western Regional Climate Action Initiative (WRCAI)

Following Governor Schwarzenegger's announcement in the summer of 2006 that a regional emissions trading scheme would be introduced to reduce greenhouse gas emissions in California, the governors of the five western states of Arizona, California, New Mexico, Oregon and Washington signed an agreement on 26 February 2007 to develop a collective regional cap-and-trade scheme (Marris 2007, California 2007, Eilperin 2007, Point Carbon 2007a). Together the five states emit a total of 800 million tonnes of CO_2 equivalent per year, or approximately 11% of all U.S. CO_2 emissions (Point Carbon 2007a, Marris 2007).

Within the next six months, the states will set a regional emissions reduction target, and within the next 18 months an emissions trading scheme is to be designed which in the states' view is to set the stage for a national system (California 2007).

Prior to the announcement of a regional initiative, California's plan had provided that a Market Advisory Committee should propose a design for an emissions trading scheme by 30 June 2007 that would also permit linkage with the RGGI emissions trading scheme and the EU ETS (California 2006). Among the members of this committee are leading representatives of the RGGI and the EU ETS (Market Advisory Committee 2006).

California's climate protection target envisions a reduction of emissions to 1990 levels by the year 2020. This is equivalent to a 25% reduction in emissions relative to 2006 levels. By the year 2050 emissions are to be reduced to 80% below 1990 levels (California 2006).

One of the main problems involved in the design of a regional emissions trading scheme for the western states is the fact that California, for instance, imports up to 25% of its electricity, above all from Nevada. Thus far, however, Nevada has refused to join the new scheme. In the event that the regional scheme was actually implemented in the West, an arrangement would have to be found for imported electricity. One possible approach envisions a so-called "load-based" arrangement under which it is not the power producer who must present allowances for his emissions but rather the power retailer who must present allowances for the emissions generated by the power sold. This, however, creates the problem that (a) the emissions of the power producers in other states would have to be known and (b) the producers in the neighbouring states would export electricity from "clean" and renewable sources but would themselves use electricity from "dirty" sources (Burtraw et al. 2006). Burtraw et al. (2006) argue that through this approach, however, it would also be possible to combat the problem of the "Commerce Clause", which prohibits arrangements that discriminate between in-state and out-of-state companies: A load-based arrangement would treat power producers in all states the same.

In California, the "Emissions Performance Standard" (EPS) prescribes that for a transition period starting on 20 June 2007, power retailers in California may no longer enter into long-term contracts with power producers whose power plants generate higher emissions than a modern combined-cycle natural gas plant, defined as approximately 0.5t CO_2 per MWh (Point Carbon 2006a, b).

Several legal aspects of regional initiatives in the USA

Engel (2006) and Burtraw et al. (2006) analyze several critical legal aspects of state-launched regional initiatives for emissions trading schemes in the context of the federal system of the United States. The authors of the present Expertise are not lawyers and therefore cannot make any qualified legal assessments themselves; as a consequence, only statements from the aforementioned papers are discussed in the following.

Engel (2006) points out that voluntary, nonbinding regional cooperation and measures would not pose any problem at all. Reciprocally binding measures, however, could give rise to a number of issues: In this case, Engel holds (2006, 74f), the consent of Congress would be required. This would transform such initiatives into an "interstate compact". However, the "Compact Clause" of the U.S. Constitution (Article I, Section 10) states:

> *"No State shall enter into any Treaty, Alliance or Confederation… No State shall, without the Consent of Congress… enter into any Agreement or Compact with another State, or with a foreign Power…" (quoted after Engel 2006, 74)*

The Supreme Court of the United States has ruled that while the Compact Clause does not apply to every "compact" or "agreement", it does apply to those which meet the following criterion:

> *"…directed to the formation of any combination tending to the increase of political power in the States which may encroach upon or interfere with the just supremacy of the United States." (quoted after Engel 2006, 75)*

Thus a binding scheme under which states could impose emission commitments upon each other could, in Engel's opinion (2006, 74f), transform an agreement on regional emissions trading into an interstate compact; since such an agreement would encroach upon the regulatory authority of the federal government, the Compact Clause could come to apply. No definitive legal ruling on this issue has been handed down yet in regard to emissions trading schemes. Consideration should thus be given to the potential legal implications of an introduction of reciprocal commitments under the RGGI or WRCAI scheme.

Another critical point arises from the previously discussed problem of emissions leakage. A ban on the import of goods (such as electricity) from other states would collide with the "Commerce Clause", which bans discrimination in interstate commerce. In order for such discrimination to be legal, it must be authorized by the "unambiguous intent" of Congress (Engel 2006, 78).

Annex II – The impact of the price level on technological progress

If schemes with different emission prices are linked, this can not only bring the aforementioned efficiency advantages but also give rise to potentially problematic effects. The perhaps most important of these is the incentive effect of the allowance price on the development and market introduction of low-emission technologies (induced technological change, ITC) (Edenhofer et al. 2006): In principle, the development and introduction of low-emission technologies is only profitable from the companies' perspective if they can reckon with a certain minimum emission price in the long term (Hepburn 2006; Newell et al. 2005; Kruger et al. 2007). If the allowance price declines as a result of linking, this also reduces the incentive of companies to develop and introduce low-emission technologies.

Very low allowance prices[18] or the expectation of very low emission prices due to expiring trading periods, for instance, can in general result in a situation where climate policies cannot induce the degree of technological change that is necessary in order to substantially and economically viably reduce the emissions of the global economy by the end of the 21st century: Innovative companies always run the risk that low allowance prices in the future will make their investments in ambitious low-emission technologies (such as renewable energies, carbon dioxide capture and geological storage) unprofitable and hence a competitive disadvantage.

To ensure stable allowance prices that are high enough to induce technological change, policymakers must set long-term and consistently stringent emission caps.[19] Unambiguous time horizons and review periods create further stability. The European Commission is currently revising the national allocation plans of the EU Member States and, in the process, is enforcing stricter emission reduction targets. This process highlights the problems associated with the specification of a stringent long-term cap: It cannot be expected that a long-term, environmentally and economically optimal cap for an emissions trading scheme will simply be theoretically deduced[20] and then implemented in practice: The allowance price

[18] At the beginning of 2007, the allowance price in the EU ETS was approximately EUR 1 per tonne of CO_2 (Point Carbon 2007b).

[19] Other scheme features have an influence on the allowance price as well, such as the quantity of eligible offsets from avoidance projects. The details of regulation of these features must likewise be taken into account when considering the incentive function of the allowance price.

[20] Assuming certain principles and mechanisms for global distribution of the burdens entailed in the reduction of emissions, if complete information were available concerning the damage to the climate and the characteristics of technologies, optimal reduction targets could be calculated for individual countries and sectors. However, information on the damage caused by climate change and about future technologies is

– along with the amount of the initially unknown avoidance costs – is always also an outcome of political negotiation processes in which states can have an incentive to extend their emission caps (see Chapter 2).

Therefore – as the second-best solution after ambitious reduction commitments – a combination of minimum and maximum prices for allowances can stabilize the price expectations of innovative companies and thus create greater investment certainty for ambitious avoidance projects (Hepburn 2006; Newell et al. 2005). For a variety of reasons, moreover, such a price corridor could increase the economic efficiency and political stability of emissions trading schemes. It is important to point out in this context that minimum and maximum prices would be unnecessary if information were complete and players behaved rationally: In such case the intertemporal emission quantity would simply be set so that the marginal avoidance costs were equivalent to the marginal damage costs, and a reasonable market price for emissions would then emerge which was sufficient to induce technological change and the market introduction of low-emissions technologies.

In reality, however, players neither have complete information nor do they always behave rationally: The exact intertemporal damage and avoidance costs of climate change are unknown, for instance; the ability of policymakers to credibly announce long-term regulation is limited; and herding effects are repeatedly observed on the markets. There are consequently a number of arguments in favour of an introduction of minimum and maximum prices in emissions trading schemes; these are addressed in the following. It must be noted that in the interest of preventing speculation, the exact minimum and maximum prices should not be common knowledge.[21] In conclusion, several instruments for controlling minimum and maximum prices in emissions trading schemes are discussed, whereby all these instruments are based on the assumption that the emission cap is specified by the political sector.

A price corridor can increase the economic efficiency of an emissions trading scheme

In Hepburn's (2006) opinion, minimum and maximum prices in an emissions trading scheme are an important hybrid instrument for controlling emissions because they enable a mix of price and quantity regulation of emissions. Weitzman's (1974) classic economic analysis of the relative advantages of price and quantity regulation under uncertainty showed that a price

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incomplete and uncertain. Due to the uncertainties inherent in the assessment of these factors, they cannot be definitively established.

21 Suitable mechanisms for administration of the price corridor and prevention of speculation must be identified (see remarks later in this Annex).

instrument (CO_2 tax) is preferable where the marginal damage curve is relatively flat, since in an emissions trading scheme the welfare loss in the event of (under uncertainty) incorrectly set taxation rates is less than in the event of an incorrectly determined quantity.

In the case of climate policy, the marginal damage curve over a short-term horizon (5 to 10 years, for example) is indeed flat: Due to the inertia of the climate system, the marginal damage will hardly change if an additional 100 million tonnes of CO_2 are emitted or reduced in the short term. Numerous economists (such as Stieglitz 2006) therefore recommend a CO_2 tax for an economically efficient avoidance policy.

Only over a longer planning horizon (e.g. several decades) does the possibility of abrupt changes in the earth system (such as a melting of the Greenland ice cap, changes in monsoon dynamics) yield a steep or erratic marginal damage curve that makes quantity regulation more advantageous (Hepburn 2006): Drastic damage is avoided because – in contrast to the situation under a tax – the quantity of emissions is specified.

Minimum and maximum prices can reduce the welfare loss in the event of incorrect specification of the emissions quantity under uncertainty. They combine the efficiency advantages of a CO_2 tax with a quantitative system. If, moreover, the allowances additionally issued when the price ceiling is reached are withdrawn from the market when the allowance price drops below that threshold value, the ecological integrity of the scheme can be preserved as well (unless the price reaches the price ceiling and stays there).

Avoidance of herding effects

The term “herding effect” is used to designate the behaviour of market players who do not base their decisions rationally on market data but instead on the behaviour of other players. Especially under uncertainty and in cases of speculation, herding effects can play an important role. As a result of herding effects, the emission price can be extremely high or low, and market volatility can increase. A price corridor can prevent such extreme developments.

Stabilization of the expectations of market players

Where a credible minimum allowance price is guaranteed over the long term, the effect for companies is that the economic profitability of their investment projects is guaranteed as long as the discounted costs per avoided tonne of CO_2 are lower than the minimum price (Newell et al. 2005). A minimum price thus offers companies investment certainty, whereby this certainty increases in proportion to the decrease in the companies' expectation of a decline in or elimination of the minimum price and/or the emissions trading scheme altogether (Blyth and Hamilton, 2006).

A maximum price for allowances gives companies the certainty that their avoidance costs will not exceed a certain threshold. It thus reduces the expectation that an emissions trading scheme could be fundamentally changed or that trading could be suspended altogether if the allowance price exceeded a critical level over a longer period of time, which could lead to changes in the political assessment of the desirability of the ETS. In this way confidence in the long-term viability of the emissions trading scheme can be enhanced (Hepburn 2006).

Instruments

In conclusion, several instruments for controlling a price corridor will be discussed. A number of authors have proposed different steps that a market oversight authority could take to keep the allowance price within certain limits. The implications of such steps, above all the possibilities they each afford for speculation, should be examined in greater detail in further research projects. Experience in the field of monetary policy should prove extremely valuable in this context, since the central banks are confronted with similar problems. In order to avoid speculation, the exact price corridor pursued by the market oversight authority should not be made public.

1. Buy-up of allowances if the price permanently falls below a certain minimum price and the market oversight authority sees reason to intervene in the market. The objection to this move is that it could cause price volatility on the market as soon as the allowance price drops significantly, since the market players could reckon with intervention by the market oversight authority (and thus with rising prices). The funds for buying up allowances could stem from the auction proceeds. Hepburn (2006) suggests that depending on the price floor and the price ceiling, a private financial institution with substantial monetary reserves could be willing to guarantee the risk of price floor maintenance in exchange for a share of the distributions from the sale of allowances (price ceiling).

2. Additional auctioning of allowances if a certain maximum price is exceeded for an extended period of time. These could then be withdrawn from the market as soon as the price permanently drops below the maximum price.

3. One-time issue of allowances that are only valid for one year at a specific price (McKibbin and Wilcoxen 2006). This would obviate the necessity of repurchasing the additionally issued allowances.

4. Splitting of allowances; both positive splits (e.g. 1 allowance → 1.5 allowances) and reverse splits (e.g. 1 allowance → 0.8 allowances) are conceivable (Newell et al. 2005). This would be equivalent to a change in the emission cap, however.

5. Hepburn et al. (2006) and Neuhoff (2006) propose that at least 10% of the total quantity of allowances be auctioned while maintaining a minimum price (EUR 20 per allowance, for example). Since in the event of an overall short allocation a number of buyers would acquire allowances at such minimum price, this would, in Neuhoff's (2006) opinion, be equivalent to the systemwide introduction of a minimum price.

6. Newell et al. (2005) propose indirect regulation of a price corridor: Several companies (all that receive free allocations, for instance, or major emitters, or all holders of emissions accounts over a certain account size) could be obliged to hold a certain quantity of unused allowances in their emissions accounts (along the lines of the reserve requirements imposed by the FED on banks, which are obliged to keep a certain amount in reserves at all times and not disburse this amount for loans). These allowances would initially be distributed according to a specific allocation mechanism. While the reserves would be held by the companies, the market oversight authority would determine how these reserves would be used. In this way the market oversight authority could control the quantity of allowances in circulation and thus influence the price level, just like the FED can influence the market interest rate through the reserve requirements it imposes. An increase in reserves would raise the market price, whereas a reduction in reserves would lower the market price. If the price deviated from a corridor set by the market oversight authority, the authority could intervene.

   In effect, this scheme would lead the holders of allowances to keep an eye on the price themselves: Because they would know in advance that the market oversight authority would react to prices above/below the corridor, they would sell/buy allowances themselves at an early stage in order to prevent an adjustment of the reserve that could force them to sell/buy under disadvantageous conditions.

Thus the market oversight authority would avoid direct market intervention (buying and selling of allowances). In the event of high prices, moreover, it would not be necessary to immediately issue additional allowances (which would have to be taken out of circulation again – the quantity of allowances issued remains constant under this approach).

Annex III – Description of the dynamic trading model

Two countries are given. Each country has a representative household that maximizes its intertemporal welfare and thus determines the behaviour of "its" country. The first welfare theorem ensures that such a solution is equivalent to a decentralized approach with explicit markets and profit-maximizing companies. Preferences, production, climate policies and international trade are described in the following.

Preferences: The instantaneous utility function of a household is given by[22]

$$U = \alpha \log(C_C^d) + \beta \log(C_I^d) + \gamma \log(C_C^f) + (1-\alpha-\beta-\gamma)\log(C_I^f) \quad ,$$

whereby

C_C^d - consumption of domestic consumer goods

C_I^d - consumption of domestic capital goods

C_C^f - consumption of foreign consumer goods

C_I^f - consumption of foreign capital goods

α, β, γ - constant parameters, determine optimal relative shares

The so-called "Armington assumption" is thus implicitly given: The representative household differentiates between goods produced domestically and goods produced abroad which are imperfect substitutes. Furthermore, the model permits the consumption of "pure" consumer goods as well as capital goods. While the latter are used mainly in production, they can also be consumed (computers, for instance). By specifying certain parameter values, this function can also be deactivated.

Production: Each country has a stock of capital *K* and labour *L*. These two production factors can be deployed in the two sectors "consumer goods" and "capital goods", where they generate the output *Y*.

$$\begin{aligned} Y_I &= F(t, K_I, L_I)\, M(\sigma_I) \\ Y_C &= G(t, K_C, L_C)\, N(\sigma_C) \\ mit\ \ & K_I + K_C = K \\ & L_I + L_C = L \\ & \sigma_I, \sigma_C \in (0,1] \end{aligned}$$

[22] Due to space constraints, the time dependence of the variables in the notation has been omitted.

The functions F and G represent technologies. Production efficiency increases at an exogenously given progress rate. The sector-specific control parameters σ represent the efforts made to reduce emissions; they have a value of 1 in the *business-as-usual* scenario. The abatement cost functions M and N determine the loss in output under the given emissions control parameter σ.

Emissions: The goods production of each country causes emissions, whereby the emissions intensity can be controlled by the parameters σ_I and σ_C.

$$E = E_I + E_C = \sigma_I \, \varepsilon_I \, Y_I + \sigma_C \, \varepsilon_C \, Y_C$$

The parameters ε_I and ε_C define the sector-specific *business-as-usual* emissions intensity. It is hereby additionally assumed that the capital goods sector is relatively more emissions intensive than the consumer goods sector ($\varepsilon_I > \varepsilon_C$).

Climate policies: Caps in the form of *exogenously* given maximum emissions Q are built into the model through an auxiliary condition:

$$E + ET \leq Q$$

Here ET stands for the emission permits additionally acquired through international emissions trading. The cap Q of the two countries can thereby differ, or one of the countries may not have any cap at all.

Accumulation: The countries' stock of labour is assumed to be constant. Their stock of capital changes through depreciation (rate δ) and through investment I.

$$\frac{d}{dt} K = I - \delta K = I^d + I^f - \delta K$$

It is hereby assumed that the companies do not differentiate between domestic and imported capital goods, i.e. that the Armington assumption does not apply to them.

Trade: The model features trade in goods, capital and emission allowances. The budget equation

$$p_C^d Y_C + p_I^d Y_I + r \cdot NFA = p_C^d C_C^d + p_I^d \left(C_I^d + I^d\right) + p_C^f C_C^f + p_I^f \left(C_I^f + I^f\right) + \Delta NFA + p_E \cdot ET$$

applies for each country, whereby NFA represents the net foreign assets. On the left hand side of the equation is hence the national income (gross domestic product plus factor income), on the right side is the absorption (consumption, investment, current account, emissions trading).

Maximization problem: Both countries now simultaneously maximize their net consumption, i.e. they solve the following intertemporal optimization problem (ρ is the rate of pure time preference):

$$\max \quad \int e^{-\rho t}\, U[C(t)]\; dt\,,$$

With the aid of the so-called "Negishi algorithm", a numerical solution is found in which all the above-mentioned auxiliary conditions are satisfied and the markets are cleared. Compliance with the emission target at minimal cost is thereby automatically ensured. However, the absolute amount of these costs hinges on the choice of parameter – especially the maximum permissible emissions – and the activation or deactivation of emissions trading. This then yields results for the temporal development of all variables, e.g. *terms of trade*, the price of emission permits, and trade volumes. The most important qualitative results are:

a. If only one country limits its emissions, this country will be affected by a negative terms-of-trade effect and a downsizing of its emissions intensive sector (in the absence of emissions trading).
b. International trade in emission permits (under perfect competeition) is necessary for the equalization of marginal abatement costs, and is sufficient to completely neutralise terms-of-trade effects.
c. Without international emissions trade, countries with a less stringent cap specialize increasingly in emission intensive goods; with international emissions trade countries with a stronger limit on emissions increase their specialization in emissinon intensive goods.