INTERNATIONAL ENERGY AGENCY

Act Locally, Trade Globally

Emissions Trading for Climate Policy

OECD

INTERNATIONAL ENERGY AGENCY

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- to maintain and improve systems for coping with oil supply disruptions;
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- to improve the world's energy supply and demand structure by developing alternative energy sources and increasing the efficiency of energy use;
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Foreword

The threat posed by global warming has made climate policy one of the most important dimensions of energy policy. Rising CO_2 emissions world-wide confirm the need to act and to move away from the current energy trend. At their meeting earlier this year, the energy ministers of IEA member countries recognised that "we are not bound to any business-as-usual energy future." At the same time, governments are struggling to find practical and effective policy approaches to bring about the changes necessary to deliver a more sustainable energy future. Among them, market instruments such as emissions trading hold many promises, including lowering the cost of our global efforts to reduce CO_2 emissions.

The Kyoto Protocol has introduced emissions trading in international climate policy. In 2005, the European Union established a full-fledged emissions trading system for some 11 500 industrial sources. Other countries and authorities, both within and outside the Protocol, are considering this tool as a means to cut greenhouse gases, now and beyond 2012.

This book provides a comprehensive overview and analyses of existing emissions trading systems for climate policy, their strengths and weaknesses; it shows how trading systems could be used in sectors beyond industry, and in countries beyond the developed world. It discusses the complex relationship between commercial and non-commercial energy uses, CO_2 emissions, and development.

Emissions trading may not be the panacea, but, if implemented wisely, it has the power to trigger many of the local actions needed to curb the trend of global CO_2 emissions, and to do so at least-cost through global trading. This book also reveals the capacity of emissions trading to accommodate a range of concerns about climate policy, including cost uncertainties, competitiveness concerns, fairness, and development.

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Executive Director

Acknowledgements

This book was written by Richard Baron and Cédric Philibert, under the supervision of Rick Bradley. The following IEA staff also contributed to various parts of this volume: Martina Bosi, Katharina Hochmair, John Krbaleski, Alexandrina Platonova, Julia Reinaud, and Sierra Peterson, who also edited the final draft. The authors would also like to thank Erik Haites, Murray Ward and Peter Zapfel for useful comments. Sandra Coleman, Rebecca Gaghen and Loretta Ravera provided additional editorial input. Muriel Custodio supervised the production stage.

This publication was partly supported by France's agency for environment and energy efficiency (Ademe).

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Executive Summary

Effective response to the threat of climate change will require the global economy to shift to a low-carbon energy system in the coming decades. This transition may entail huge costs which policy makers want to minimise. A least-cost approach also improves public acceptability, minimises various economic impacts, and helps achieve climate stabilisation. Emissions trading is one effective means to reduce the cost of abating greenhouse gas emissions, at both international and domestic levels. Emissions trading's underlying principle is simple – sources are liable to meet emission objectives, in the form of tradable emission allowances, which must match emission levels. A source with cheap emission reduction opportunities can sell unused allowances to another that faces high abatement costs. Such transactions reduce the compliance costs and eventually create a price for allowances, which guides all sources' decisions to reduce emissions.

The 2005 entry into-force of the Kyoto Protocol spurred international carbon markets. Emissions trading systems are being developed, covering regional emissions from large industries, but are also being established at sub-national levels. Carbon markets promote projects in developing nations and those with economies in transition, which generate units of traceable emission reductions. With current energy policies, annual demand for allowances by OECD member countries should range between 800-1 100 million tonnes of CO_2 equivalent, over 2008-2012. Emission trends of countries with economies in transition (primarily Russia and Ukraine) show enough potential supply of allowances to satisfy this demand. Projects undertaken under the clean development mechanism (CDM) will also generate emission credits for use by industrialised countries.

Experience to date and current research on climate policy produce the following insights:

- Emerging emissions trading systems promise active trading and a potentially powerful price signal on the unit cost of carbon emission reduction to guide corporate budget decisions. The EU emissions trading scheme which covers the electricity sector and heavy industry caps about half of the European CO_2 emissions.
- The price of carbon does not currently affect all activities emitting greenhouse gases. In theory, domestic trading schemes may expand to incorporate activities beyond large stationary emissions sources. However, policy makers should account for market imperfections in certain end-uses when expanding existing regimes.
- New forms of emissions reduction goals and other features may facilitate more international participation in GHG abatement and in emissions trading. To mitigate uncertainties in reduction costs, these new brands can be: (1) targets indexed to economic growth, (2) a cap on the price of traded carbon, and (3) non-binding targets. However, the energy realities of most developing countries make them less prone to develop broad domestic greenhouse gas trading systems.
- A global market can technically incorporate domestic and regional systems, despite divergences in design.
- The current design of emissions trading systems does not yet provide an incentive sufficient to reduce emissions at least-cost. There is room for improvement.
- Whether domestic or international, emissions trading is not the panacea for the challenge of long term climate stabilisation. Nevertheless, emissions trading has the potential to play an important role as one measure to promote cost-effective emissions abatement.

From an international carbon price to domestic climate policy

Most existing domestic trading systems cover large energy-intensive industries and the power sector, while more than half of energy-related CO_2 and other GHG emissions are emitted elsewhere. As a consequence, the international price of carbon does not permeate the broad energy market and end-users. Countries committed to mitigating climate change have introduced other policies that reduce emissions from activities that have no direct link to the international CO_2 market.

Under the Kyoto Protocol, governments must meet emission targets representing all domestic emissions. The Protocol authorises international emissions trading mechanisms as a means of compliance with emission objectives, a boon to governments seeking emissions reductions at least cost. While they strive to implement domestic trading regimes and other policies to address their emissions, governments in most OECD countries will need to buy allowances on the international emissions market in order to most economically comply with their objectives. Participation will require considerable preparation and should be a priority for governments – on the buying and selling sides alike.

A number of countries – as well as private companies – have created funds to acquire emission units including via project-based mechanisms: the CDM allow generating emission credits for reductions in developing countries; Joint Implementation follows the same logic for reduction projects in industrialised countries. While there is clear demand, the supply of emission reductions, in particular from the CDM, appears to lag behind. Administration of project approval must be streamlined and scaled up to reflect this urgency, though without compromising projects' environmental integrity.

Can domestic trading systems deliver?

Political realities, concerns for competition, uncertainties over the future of the international regime, and the thus far limited experience of authorities in charge of emissions trading systems, hamper system operation at theoretical efficiency. The national allocation plans of the EU emissions trading scheme often lack mandate beyond 2012, though long-term planning is vital to sectors with long-lived capital stocks – power plants installed in the coming decade may operate until 2040, or beyond. Short-term emissions objectives discourage investments in more ambitious GHG reductions, which can only be cost-effective over the course of decades. Greater visibility is necessary now to trigger such decisions. The free allocation of allowances to new entrants and the cancellation of allowances when plants close also undermine the efficacy of the systems, as they do not encourage investors to take full account of the carbon cost. The treatment of these questions requires harmonisation to avoid countries competing to offer better investment conditions to industry at the expense of least-cost GHG mitigation.

At the same time, industrial energy users worry about the cost of meeting their cap and the rising cost of electricity, while much of their international competitors are unscathed. Energy policy makers must address the negative implications of this situation – in particular in removing the barriers to a broader engagement in mitigation and defining appropriate incentives.

From segmented to global market

Linking systems with various design features is feasible technically, although some differences in design may be harder to reconcile than others. Existing domestic systems have proven the feasibility of trade between regimes of emission objectives indexed on growth and those based on absolute caps. A broader issue relates to the emergence of trading systems that evolved separately and led to different price levels. Investments based on pre-existing price levels may become unfounded as linking occurs and, with it, a new equilibrium price. However, efficiency gains will argue strongly in favour of linking.

Beyond industry

Several design options for systems of emissions trade enable to include domestic sources beyond industrial activities. An *upstream system* shifts the burden of compliance from fossil fuel users to producers and importers. These firms must surrender allowances commensurate with the CO_2 content of their fuel sales inside the country. This option can be implemented in concert with existing, downstream, systems in which sources, large stationary users, are liable for emissions. Because upstream systems would function more or less as a new tax on small energy users, acceptability rests on credible ways to return the rent to the public.

Further, while a higher fuel price is conducive to less energy consumption in principle, a number of market imperfections stand in the way of an effective response to price changes. In "landlord-tenant" situations, energy users have little or no control on their energy using equipment and are therefore unlikely to react effectively to a price signal. These obstacles must be first addressed if the price signal of carbon markets is to be effective.

Transport is a priority for climate policy, being responsible for a quarter of global CO_2 emissions and the second fastest growing source after power and heat generation. As an alternative to an upstream system, car manufacturers could be made responsible for the CO_2 emissions of their products. This would foster quicker technical improvements in new cars, yet fuel use by these cars, the source of CO_2 emissions, would not carry an additional cost. If applied, emissions trading may not sufficiently reduce CO_2 emissions in road transport by itself, but provide transport, in the short run, with cheaper mitigation options from other activities.

The international civil aviation organisation endorsed the further development of emissions trading systems for international aviation open across economic sectors. It would curb these rapidly growing emissions, the bulk of which are not currently included in countries' emission inventories.

Broadening international participation

New types of emission targets will allow countries that have not ratified the Kyoto Protocol, nor have adopted emission targets yet, to participate in international emissions trading. Regardless of stance on the Kyoto Protocol, all nations would benefit from options to mitigate uncertainty surrounding GHG reduction costs. Dynamic targets, indexed to actual economic growth, could accommodate fluctuations in emissions related to changes in economic growth. Caps on the price of traded carbon could help industrialised countries to adopt more ambitious targets by adding certainty to their costs, alleviating a concern that may otherwise prevent participation.

Non-binding emissions targets allow developing countries to sell allowances on international GHG markets if their emissions are lower than an agreed level, without requiring them to buy if emissions are above. Were the international community to agree to this type of target, developing nations would be encouraged to look for domestic potentials for mitigation, which they could finance with international GHG markets, without compromising economic development.

Despite the theoretic allure of emissions trading systems, practicalities of developing nations' energy use often prevent an extensive use of domestic emissions trading. Persistent energy poverty, the paucity of conservation incentives in most energy sectors, and the institutional requirements of domestic trading all hamper developing nations' participation in emissions trade. Low energy prices and available income would make the pass-through of an internationally-determined price of carbon difficult to accept. Traditional reliance on biomass as a principal fuel source suggests that discouraging the switch to relatively efficient fossil fuel technology could be counterproductive to public health, the local environment and economic growth. Architects of energy policy in developing nations especially must ensure the return of any carbon rent to fossil fuel consumers.

Short of country-wide commitments, mechanisms can be envisioned to credit countries for reductions in specific sectors, based on targeted policies, e.g. in the transport or buildings sector, and sector-wide targets for industries. At domestic level, heavy industry and power generation seem most suited to structure emissions trading.

Transnational sectoral targets for global industrial activities that are concentrated among few players also offer an avenue for broader engagement in mitigation, with possibilities to link with international carbon markets. This idea is gaining ground as it may solve competitiveness concerns that hamper progress in international climate policy, although implementation may be complex.

Industrialised countries may adopt dynamic targets as well, or introduce price caps in future architectures. Price caps would take the form of unlimited supplementary allowances at an agreed price. Ideally, a cap on the price should be set above the anticipated marginal abatement cost. A much lower level would turn the cap into a tax and cancel the environmental benefits of more ambitious targets. When planning to link schemes of differing incentives, architects must account for the selective application of price caps, especially if the system includes several price levels or non-binding targets or both. In any case, only countries or entities in compliance should be allowed to sell on the markets. Different price caps across countries, if they were activated, would require a careful management of transactions, and may affect the carbon market's efficiency.

Dynamic targets, non-binding targets, price caps, all may encourage countries to adopt relatively more ambitious targets. These options reduce cost uncertainty, at the expense of greater uncertainty on short term abatement. However, because climate change is a cumulative issue, long term emissions trends matter more than short term variations.

Other policy instruments will be needed

What role will emissions trading play in the multilateral abatement of greenhouse gas emissions? Emissions trading provides market players and policy makers with information thus far absent from decision-making: the actual, unfettered cost of GHG mitigation in a range of economic activities. With cost-effectiveness delivered by the market, emissions trading allows policy making to focus on the acceptability of efforts required from various players through the allocation process, both at domestic and international level. As such, emissions trading appears foremost among instruments to mitigate greenhouse gas emissions.

Emissions trading is not necessarily practical to limit GHG from all sources; additional measures must shift energy systems away from carbon consumption. A number of market imperfections impede rational energy choices leading to lower, more efficient energy use. Current carbon markets only provide a short-term view; the long-term challenge of climate mitigation is not fully reflected in today's carbon prices. The spill-over effects of private R&D deter companies from engaging in appropriate technology developments. Government intervention in this domain is needed to foster new technologies, to go beyond existing short term abatement potentials, and significantly reduce GHG emissions from the energy sector.

INTRODUCTION: EMISSIONS TRADING AND CLIMATE POLICY

Climate change has become the most daunting issue of global energy and environmental policy. The atmospheric accumulation of anthropogenic greenhouse gases threatens to irreversibly change the Earth's climate, its natural systems, as well as to affect human activities. The Industrial Era's production and use of fossil fuels – namely, coal, oil and gas – have increased CO_2 concentrations over these past 250 years at a rate unprecedented in Earth's history. Among the six man-made greenhouse gases (GHGs), CO_2 is the principal contributor to global warming. The energy sector also emits other GHGs: N_2O from fossil fuel combustion; and CH_4 from coal mining, and also oil and gas, from extraction to distribution[1].

Global warming cannot be seen as a standard air pollution problem. Unlike the quick abatement of airborne mercury and SOx pollution, a sudden, complete halt to GHG emissions would provide no immediately measurable relief. Accumulation of past emissions in the atmosphere has already altered the global climate, a system of significant physical inertia. There exists no political solution nor technology to entirely stop global GHG emissions in the short run. Rather, global warming's mitigation requires our economic recognition of the seriousness of climate change. As consumers, we must encourage investment in efficient technology and signal preference for carbon-lean transport, industry, power generation, construction and agriculture.

IEA statistics indicate a 16% increase since 1990 in global CO_2 emissions from the energy use alone. The 2004 world energy outlook

1. N_2O and CH_4 are also emitted by other activities such as agriculture and chemical production.

projects CO_2 emissions to grow by some 62% by 2030 in the absence of additional abatement policy.[2] Governments may mandate technological change, a command-and-control approach that draws criticism for its economic inefficiency – more economical solutions than that imposed may be available, unbeknownst to the regulator. Among other instruments, policies based on economic mechanism harness market dynamics to reveal such solutions. Environmental taxes and permit trading systems regulate pollution by incorporating the cost of "externalities", those costs of activities not borne by the agents who undertake them. Ideally, economic instruments establish the price of these externalities at their marginal cost to society. In assigning a price to otherwise free pollution, these policies encourage polluters to seek the least expensive means to reduce emissions. Activities that entail a cost to society superior to their benefit will change or even stop – the optimal level of de-pollution being reached when marginal costs equalise marginal benefits to society.

A number of countries have introduced eco-taxes on various fossil fuels to lower greenhouse gas emissions. While these "carbon taxes" have lowered overall fuel use, attempts at their harmonisation have largely failed.[3] In addition, the negotiation of the Kyoto Protocol deflected international attention away from the international use of carbon tax and instead to emissions trading. Without setting a price for the externality, an emissions trading system defines instead the total emissions volume. Trading participants, constrained by an emissions cap, establish the externality's price through market transactions. Logically, participants subject to a high cost of domestic reduction will obtain less expensive reductions from other participants in the opposite situation. The multiplication of such transactions establishes a homogenous market price for emission allowances. In an efficient competitive market, the allowance price will reflect the marginal cost of constraining emissions.

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2. IEA 2004a, IEA 2004b.

3. See Baron et al., 1996, for an early review of carbon tax initiatives.

Emissions trading is particularly well-suited to address greenhouse gas emissions as both problem and solution are characterized by a multinational geography. Because GHGs affect the environment and atmosphere on a global scale, the precise location of emissions and of their reduction is of no environmental importance. A trading scheme of broad coverage enables emitters to locate the cheapest reductions without compromising overall environmental integrity.

Through the process of emissions allowances allocations, emissions trading directly addresses the disparate distributive impacts of the carbon constraint. While all sources trade emissions at a single price, their relative economic burden follows the stringency of their respective emission caps: the volume of allowances allocated to them at the system's outset. This secondary burden can further devolve on a source's clients, suppliers, and employees. Clients, in particular, will be encouraged to move towards less emission-intensive goods as they become relatively cheaper. The extra-cost for clients of polluting products will therefore contribute to the system's efficiency. In addition, sources are free to reduce emissions by any means most suited to them – emissions trading does not impose specific technologies or behavioural changes. Emissions trading's ease of implementation, potential for global coverage, and market efficiency have propelled the concept and its related mechanisms to the forefront of climate policy. As an instrument of emissions mitigation, trading first surfaced in 1992 in the UN Framework Convention on Climate Change's notion of joint implementation. Variations of emissions trading prove innate to the subsequent Kyoto Protocol (in articles 6, 12 and 17) and the European Union emissions trading scheme, henceforth identified as the EU ETS.

To date, most successful emissions trading systems have required clear emissions caps, eliciting the title "cap-and-trade". The guaranteed environmental outcome of an emissions target attracts those wary of the uncertain effect of environmental taxes. Naturally, a stringent cap on emissions may trigger unexpectedly high prices for GHG allowances and a high cost of compliance in the short term. As climate change is

Box 1

The theoretical sources of emissions trading

Economists spend much of their time attempting to understand how markets work. In the case of tradable permit schemes, the inverse is true – these markets existed first in theory. Their origins are usually traced back to a famous article, "The problem of social cost" by Ronald Coase (1960) that sharply critiqued the "Pigouvian tradition[4]" of environmental taxes. This work compelled the Canadian economist John H. Dales, in 1968, to suggest transferable pollution rights to limit pollution externalities. Various economists have fostered this concept in demonstrating the inefficiency and needless cost of command-and-control policies to control pollution and allocate natural resources. Instead, assuming a competitive market, many theorists have identified tradable permits as well-suited to curb ecological damage at least cost.

A series of papers in the 70s identified the criteria for selecting taxes and permit systems to maximise an environmental policy's net expected benefits (expected benefits less expected costs) when abatement costs remain uncertain.

Today, emissions trading is the name that tradable permit schemes take when applied to polluting emissions, in air, water or soil. Tradable permit schemes may also apply to fishing or hunting, to managing wetlands, to fostering waste recycling, to controlling agricultural production, to exploiting forests, lands or any natural resource.

4. *Named from the famous economist A.C. Pigou who suggested in 1920 using taxes to internalise the cost of externalities in his book* The Economics of Welfare*. For a defence of the Pigouvian tradition, see Baumol, 1972.*

a stock externality of decades of accumulated GHG, rather than of a given year's emissions, mitigation of slightly different design may be warranted. Since a limited variation in emissions at any point in time is of no importance to the global climate, more flexible quantitative targets could be considered to reduce compliance cost uncertainties. This, in turn, would encourage more comprehensive participation among emitters.

The Basics of Emissions Trading

Emissions trading is a broad concept covering "cap-and-trade" and "rate-based" regimes, and sometimes "project-based" mechanisms (see table 1 for a comparison).[5]

Government regulation through a market drives most tradable permit schemes – permits issued by governments to economic agents, most often firms, are recognised as a means to comply with a certain constraining policy. Tendered by a government, the permits can be traded. In the case of emissions, firms are given allowances to emit absolute volumes over a fixed period. Firms that can cheaply reduce their emissions to below the stipulated limit may sell surplus emission allowances to others that facing only more expensive options for reducing emissions. As a result, the total cost incurred by all companies in meeting the mandated reductions is below that of pure "command-and-control" environmental regulation. This efficiency benefits society as a whole.

In a few cases, tradable permit schemes have been created without government direction. However, most market actors will not account for a significant social cost of CO_2 emissions without governmental intervention. These firms are not inherently sceptical of environmental protection, but simply operating in a market context that discourages

5. See Philibert and Reinaud, 2004.

the cost of such stewardship unless it is widely coordinated among competitors. Thus, governments must direct emissions trading at a national level and international coordination would also facilitate progress in countries.

TABLE 1

Definitions of various emissions trading schemes

	Cap-and-trade	Rate-based trading	Project-based credit
Application	Applies to all emissions	Applies to emission relative to some defined standard (e.g. emissions per unit of output)	Applies to emission *reductions* below defined baseline
Allocation method	Allowances are *allocated* by the regulatory authority	Credits are *generated* when a source reduces its emissions below the standard	Credits are *generated* when a source reduces its emissions below an agreed baseline
Market dynamic	Participants (and possibly outsiders) can buy and sell allowances	Participants (and possibly outsiders) can buy and sell allowances	Project hosts sell to those participants obliged to purchase external reductions
Coverage/ participation	Participation in the programme is mandatory although trading is not	Participation in the programme is usually mandatory – sources must meet existing standards	Participation in the programme is voluntary for project hosts
Examples	Article 17 of the Kyoto Protocol; US SO_2 allowances programme	US phase-out of lead in gasoline	Clean development mechanism and joint implementation (Kyoto Protocol)

Allocation Modes

Two features characterize the design of most emerging GHG trading systems. First, as "downstream regimes," they grant emissions allowances directly to emissions sources. Second, allowances are distributed for free, largely based on historic emission levels, a procedure known as "grandfathering." Tietenberg (2002) notes that grandfathering builds the political support to implement a cap, as *"existing users frequently have the power to block implementation while potential future users do not."*

Grandfathering is one form of free allocation that recognises that sources' current emissions are the results of past investment and production choices, made before knowledge of the future emissions constraint. Grandfathered allowances reflect the state of play at the moment when the GHG constraint took effect. Allocating authorities must obtain reliable data on past emissions as the basis for allocation, and negotiate sector-by-sector, company-by-company or even installation-by-installation to justly distribute allowances. The least complex method of grandfathering applies a single reduction target to all emitters. However, this common constraint is usually tailored to the specific circumstances of individual sources. A free allocation need not be based on historic emissions, as shown in the EU ETS's reserves for new entrants, namely sources without a record for their emissions.

Auctioning allowances avoids this source-by-source negotiation, instead requiring all covered emitters to buy allowances commensurate with their expected emissions. The allocating authority's role thus diminishes to fixing the overall quantity of condoned pollution and to organising an auction in which whereby sources enjoy equal and unfettered access to the pool of allowances. Once auctioned, allowances can be traded freely. Auction profits can be used for the general budget, to cover the administrative cost of the auction, or to compensate negative distributive impacts of the new emission constraint.

In theory, each allocation method produces a system of equivalent economic efficiency. Whether allowances are distributed for free or sold to sources, their market value creates an opportunity cost, since any unused allowance can be sold at a profit by its holder. Emissions above the initial allocation require the purchase of allowances commensurate with the quantity in excess. The allowance price thus serves as an incentive to mitigate emissions up to the precise point where the reduction cost equals the allowance price. Should a source need more reductions than those available at this cost, it would wisely buy reductions from the allowances market rather than invest in more expensive reductions on its premises. Clearly, those sellers supplying the market can reduce emissions beyond their own required constraint at a cost that is less or equal to the market price of allowances.

Industrial sources participating in emissions trade will devolve the opportunity cost of emissions and allowances to their product prices. Within a market sector, consumer demand should adjust accordingly to favour products entailing the least pollution in their manufacture. The efficiency of emissions trading hinges on both the incentives to reduce pollution at least cost during production and on the response of consumers now bearing the cost of the prior externality, as signalled by the price of goods.

In practice, price transparency may be more complex than economic theory suggests. Companies facing severe competition from players exempt from the GHG constraint may hesitate before raising their product prices by the full opportunity cost of grandfathered allowances if this entails a potential loss of competitive market share. Had the allowances been auctioned, firms would have no choice but to pass these opportunity costs to consumers. Further, as noted in the discussion of the EU ETS (see chapter 3), the period covered by the allocation and the treatment of new entrants and installations closures can each distort the economic behaviour of sources under emissions constraint.

The principle difference between these two modes of allocation is the beneficiary of the initial carbon rent, as the allocated CO_2 allowances represent new assets for its holder. Grandfathering generates "windfall profits" for participating firms, freely transferring initial allowance value from the government to emissions sources. Auctioning generates revenues for the government. In former, emitters receive allowances at no cost; in the latter, the emitting source pays the full price of allowances.[6] Any combination of free distribution and auction can be used to allocate the allowances – this mix can adapt to the environmental or political context. The lump-sum subsidy of the grandfathered, free allocation can be justified as compensation for the carbon constraint's damage to the value of existing capital. However, the emission permit should not become a perpetual property right of those sources operating at the time of the constraint's introduction.

Well-examined alternatives to grandfathering and auctioning include a rate-based allocation, in which allowances are freely distributed in a quantity based on production. A design of lower environmental certainty, rate-based allocation encourages sources to produce more to receive more allowances. Sources in a competitive market that guard their market share by insulating clients from the brunt of allowances' opportunity cost remove one option to reduce emissions at least cost. This inhibition arises also when the quantity of allocations remain subject to periodic renegotiation, as discussed later in the context of the EU ETS.

Outline

After having been the subject of numerous publications and articles on its potential use in climate change mitigation policy, emissions trading has now moved to a large-scale implementation stage. Chapter 2,

6. OECD, 1999a.

"The Kyoto Protocol Mechanisms" presents the implementation of emissions trading tools at international scale and an outlook of the emerging markets under the Kyoto Protocol.

Chapter 3, *"Emissions Trading: Targeting Sources"* reviews domestic, regional and corporate-based emissions trading systems, presenting a wealth of options for implementation.

To date, emissions trading schemes have primarily engaged heavy industries: steel, cement, building materials and glass; and installations producing power and heat. Chapter 4, *"Looking beyond Industrial Activities"* offers a critical assessment of possibilities to expand emissions trading beyond industrial sources.

Only select industrialised nations have embraced emissions trading in international accords and in domestic policies. However, the architecture and incentives of emissions trading encourage comprehensive participation. Chapter 5, *"Broadening and Deepening,"* presents the means by which all concerned nations may participate in international emissions trade.

Chapter 6 offers a short concluding assessment on what we have learned about emissions trading and options for its future configuration in the light of lessons learned and the challenges presented by the energy sector.

THE KYOTO PROTOCOL MECHANISMS

The year 2005 has proven to be decisive in the practical development of emissions trading. The February 2005 entry-into-force of the Kyoto Protocol validated emissions trading and other so-called flexibility mechanisms as instruments of compliance with international mitigation targets. Providing countries with a least-cost approach to GHG mitigation, the Protocol's mechanisms will continue to influence domestic policy setting. This chapter introduces the Kyoto Protocol trading mechanisms, and discusses their respective roles.

Overview of the Three Mechanisms

Emissions targets established by signatories to the Kyoto Protocol have fostered an international market for GHG emission allowances, the generic term for all trading units that will be used throughout this book. These countries' targets, termed assigned amounts, serve as the caps prerequisite to emissions trading. Table 2 lists the negotiated emission goals of industrialised countries that have ratified the Protocol and of two that have not, Australia and the United States. For countries with an asterisk, the indicated target is as modified by the EU burden-sharing agreement in application of Kyoto Protocol article 4.

The Kyoto Protocol authorises three flexibility mechanisms to enable its signatories to meet their emissions objectives between 2008 and 2012. They are the following:

- "Emissions trading" of the Protocol's article 17 enables the above countries with emission commitments listed in its Annex B to transfer and acquire assigned amount units (AAUs) to and from other Annex B countries.

Table 2

Greenhouse gas emission objectives under the Kyoto Protocol

(reductions by 2008-2012 from 1990 levels)

Country	Objective	Country	Objective
Australia	*+8%*	Lithuania	-8%
Austria*	-13%	Luxembourg*	-28%
Belgium*	-7.5%	Monaco	-8%
Bulgaria	-8%	Netherlands*	-6%
Canada	-6%	New-Zealand	0%
Croatia	-5%	Norway	+1%
Czech Republic	-8%	Poland	-6%
Denmark*	-21%	Portugal*	+27%
Estonia	-8%	Romania	-8%
Finland*	0%	Russia	0%
France*	0%	Slovak Republic	-8%
Germany*	-21%	Slovenia	-8%
Greece*	+25%	Spain*	+15%
Hungary	-6%	Sweden*	+4%
Iceland	+10%	Switzerland	-8%
Ireland*	+13%	United Kingdom*	-12.5%
Italy*	-6.5%	Ukraine	0%
Japan	-6%	*United States*	*-7%*
Latvia	-8%		

Note: * Countries whose objectives were modified by the EU burden-sharing agreement. Australia and the United States have not ratified the Kyoto Protocol.

- "Joint implementation" (JI) under article 6 of the Protocol allows an Annex I entity to use emission reduction units (ERUs), achieved in a GHG reduction project undertaken in another industrialised country, for its own compliance. JI is sometimes considered redundant with emissions trading since the achieved reductions could also be transferred to the buyer as AAUs under emissions trading.
- The clean development mechanism (CDM) featured in article 12 resembles JI but covers reduction projects in developing countries. The CDM requires its projects to further the aims of sustainable

development, a criterion left to host countries' assessment. A project must be approved (validated) by an accredited independent entity and the emission reductions must be certified by a different accredited independent entity. Afterwards, the project must be accepted (registered) by the executive board and the emission reductions must be accepted by the executive board before it issues the corresponding certified emission reductions or CERs[7]. The valid generation of CERs began in the year 2000, whereas that of JI ERUs, to be used against the Kyoto targets, must take place during the 2008-2012 period.

Once issued and transferred to their buyers, ERUs and CERs can be transferred again via emissions trading. Parties are also allowed to trade so-called removal units (RMUs) from land-use, land-use change and forestry activities undertaken in Annex B countries.

At the UNFCCC's 7th Conference of the Parties in Marrakech, the Parties approved the use of these Flexible Mechanisms without deflecting attention from the primacy of domestic reductions in nations' compliance with the Kyoto Protocol. Indeed, the Protocol delineates the supplemental nature of its flexibility mechanisms relative to domestic action. Though Parties must demonstrate the relative contributions of the mechanisms relative to domestic reductions, the Marrakech Accords do not propose a method to quantify whether or not Parties have respected the so-called "supplementarity principle".

The three mechanisms of the Kyoto Protocol will be discussed with more detail below. We first turn to quantitative estimates of their utility as carbon-constrained parties seek to minimise the cost of achieving their emissions objectives between 2008 and 2012.

7. There are two types of CERs generated by afforestation and reforestation projects, whose reductions may not be permanent – forest fires could offset sequestration enabled by a CDM project. Such CERs may either be termporary (tCERs) or long-term (lCERs).

Box 2

Compliance with Kyoto Protocol emission commitments

The following calculation verifies a party's compliance with the Kyoto Protocol:

Emissions (2008-2012) *< or = **initial assigned amount** + acquired AAUs + acquired ERUs + acquired CERs – transferred AAUs – transferred ERUs – transferred CERs + acquired RMUs – transferred RMUs*

Transfers and acquisitions of various Kyoto allowances can start occurring as soon as parties to the transaction are eligible under the mechanism used for their transaction.

The first period of compliance with the Kyoto Protocol includes an additional period for fulfilling commitments (also known as the grace period) of 100 days to enable parties to trade following the period of commitment itself. Because emission inventories take time to finalise, parties may realize only in 2012 a deficit of emissions reduction units for the period just preceding. The quick procurement of the missing units assumes, of course, that parties with surplus units would be willing to transfer them after 2012.

Supply and Demand Outlook

How large will the international market for Kyoto emission allowances be? Can it be liquid enough to provide a stable price signal? Who is most likely to buy and to sell? The responses to these fundamental questions are not yet clear, but various studies of future emission trends and the latest Kyoto countries' emissions inventories can provide a first assessment. In what follows, we have used the IEA world energy outlook (WEO) reference scenario's projections of energy-related CO_2

emissions.[8] The WEO projects energy needs and related CO_2 emissions for regional groups including the EU-25, other OECD regions, and countries with economies in transition (EITs). The WEO indicates an upper range of trading needs across these regions: it assumes the introduction of no new policy to reduce emissions beyond those that have been implemented as of July 2004. The resulting trend in energy-related CO_2 is then combined with other GHG emissions and removals by sinks to evaluate countries' compliance situation in the year 2010, the middle year of the Kyoto commitment period.

The WEO's regional analysis suggests a demand by industrialised signatories to the Kyoto Protocol, including the 25 nations of the European Union, for some 840 million tonnes of CO_2 equivalent ($MtCO_2e$) in the year 2010. EITs, whose emissions have plummeted since 1990, would be in a position to sell some 1,190 $MtCO_2e$ of allowances that year. This would leave the Kyoto regime with excess emissions of about 350 $MtCO_2$, assuming that EITs transfer their excess allowances in full to other countries. Projections of the security and environment-driven world alternative policy scenario[9] of the WEO indicate an excess of allowances totalling approximately 530 $MtCO_2e$ across all industrialised countries.[10] Excluded from the WEO's calculations, the clean development mechanism will augment the potential supply of units for compliance with Kyoto objectives.

These estimates further exclude the trading that needs to occur within the regional groups here defined. The aggregated demand of the 25 countries of the European Union masks individual countries' trading positions and the necessary CO_2 trade between EU Members. The European environment agency's projections of GHG emissions in European countries reveal a significant demand for allowances in some countries and a substantial allowance surplus in others.[11] Assuming

8. IEA, 2004b.

9. IEA, 2004b.

10. Buying regions would demand an average of 700 $MtCO_2e$ each year, while sellers could offer as much as 1 235 $MtCO_2e$ for transfer.

11. European environment agency, 2004, Annex 1: Actual and projected greenhouse gas emissions by EU-15 member states, *and* Annex 2: Actual and projected greenhouse gas emissions by the new EU member states.

existing mitigation measures, these projections show a trading surplus of some 250 $MtCO_2e$, supplied mainly by transition economies, and an excess demand from other countries that would quickly absorb this amount. A more accurate gauge of the trading potential among the 25 EU countries must therefore include these cross-border, inter-regional transactions under the EU ETS. However, our projections of trading's contribution to international climate change mitigation would also require data on net transactions at industrial level, thus far unavailable.

Neither the reference nor the alternative policy scenarios account for changes in energy prices to reflect a carbon price. If emissions trading were to transfer 530-840 $MtCO_2e$ each year independent of the transfers within regions like the EU, the resulting price of carbon would encourage buyers to reduce emissions before they spend on international allowances.[12] The strength of this price response depends on domestic fossil fuel users' reception of and reaction to the international price of carbon. Our estimates, 780 to 1 090 $MtCO_2e$ if we include potential transfers between EU countries, should therefore be considered an upper bound.[13]

Predicting prices at which the above transactions will occur is very difficult. Even among Kyoto parties, markets are likely to be segmented and several prices could coexist for different allowance types (CERs, ERUs, AAUs). Several factors will influence the choice of compliance instruments:

- Countries must meet certain eligibility requirements before being entitled to acquire or transfer AAUs. Among others, large potential sellers Russia and the Ukraine are not yet eligible.
- Despite their vast surplus of AAUs, Russia, the Ukraine and other EITS may not sell now at any price, as Parties can bank unused AAUs for future sale or use. Too low an international carbon price

12. In theory, the potential profit from investing in mitigation projects to generate credits for international sale should compel potential sellers to act accordingly. However, projected supply already exceeds projected demand.

13. These numbers resemble the estimate provided by PointCarbon, a company specialized in carbon markets, with Western Europe, Japan and Canada recording an excess demand of 5.3 $GtCO_2$ over the five-year commitment period i.e. 1.06 $GtCO_2$ annually (Hasselknippe, 2005).

could trigger the large-scale banking of allowances. Potential buyers would require alternative means of compliance: employing domestic mitigation or purchasing CERs from the CDM.

- Several countries and private investors have already committed to buy CERs from CDM projects only now being approved. In fact, some countries have expressed a preference for project-based CERs and ERUs over the AAUs representing a far from stringent country target. The EITs, emerging from the Kyoto Conference with emission targets well above their projected emissions, hold most of this so-called hot air.
- Valid for compliance with the EU ETS, inexpensive CERs are particularly attractive to investors in the context of very high prices for regional EU allowances (EUAs). These transactions do not affect Kyoto compliance yet, however, as European industry must first meet its 2005-2007 emission goals.

As these projections indicate, international emissions trading holds great promise for nations seeking to comply with GHG emission commitments in the absence of adequate domestic reductions. A central question is whether these international transactions and the price of GHG emissions will have a direct impact on the behaviour and choices of GHG sources, including energy users, and in fact minimise overall emissions reduction costs.

The next section describes the mechanism of international emissions trading under article 17 of the Kyoto Protocol and its potential role in countries' strategic compliance.

Emissions Trading: a Market Instrument for Industrialised Countries

Emissions trading under Article 17 is the main mechanism for transfer of allowances under the Kyoto Protocol. As such, it creates the infrastructure for a potential international market of Kyoto allowances. Other than AAUs, the Kyoto countries' emission allowances, ERUs, RMUs and CERs can be traded through article 17 as soon as they have been issued. Emissions trading also provides the umbrella for international transactions across domestic emission trading systems such as the EU ETS – the latter adopted a second commitment period that is identical to the Kyoto commitment period. The robustness of this mechanism to deliver GHG mitigation at least cost hinges on two main pillars, described below.

Eligibility criteria and the commitment period reserve

Cap-and-trade regimes require well-developed systems to monitor, report and review emissions data and compliance, and signal institutional stability to international markets. Countries have not yet established the institutions required by allowance transactions, though governments already provide national emissions inventories.[14] In 2008-2012, emissions inventories will determine participants' carbon market position: the credit volume to offer or procure in international trade. For the market to function, governments and other participants must provide reliable emissions data. To further ensure honourable trade, parties to the Kyoto Protocol have delineated eligibility requirements for participation in international transfers and acquisitions under the Protocol's article 17. These include:

- The ratification of the Kyoto Protocol.
- The definition of the country's assigned amount – i.e., its emissions cap – in terms of CO_2 equivalent emissions.
- A national system to estimate greenhouse gas emissions and removals by sinks (forestry, land-use change).
- The establishment of an electronic registry to record Kyoto units, connected with other nations' registries to secure international

14. Among them, Austria has identified its central bank as the trading agent for the country's international emissions trading activity (Natsource, 2003).

transactions. An international transaction log (ITL) connects registries and ensures the coherence of proposed transactions between nations.

- The country's inventory: the annual, quantitative, report of emissions and removals of greenhouse gases.

Once deemed fit for trade, a party may transact with other eligible parties. Within its own jurisdiction, the party may entitle certain entities to trade allowances internationally. The Kyoto Protocol refrains from ruling on the conduct of these entitled trading firms; domestic penalties for non-compliance are not compulsory.

To avoid countries overselling AAUs, it stipulates that each party must maintain a commitment period reserve (CPR) of allowances which should not drop below 90% of the party's assigned amount, or 100% of five times its most recently reviewed inventory, whichever is the lowest.

These totals account for all allowances, including those generated by Kyoto mechanisms and sinks. The commitment period reserve prevents parties from selling AAUs beyond their means in the absence of an international penalty that might otherwise deter such behaviour. This overselling would compromise seller's compliance and enable those unwitting buyers to emit in excess. In this market, buyers are not liable. Overselling creates an artificially-oversupplied market, depressing allowance prices to below their value and misguiding GHG reduction strategies.

On the other hand, the required reserve does not prevent a country that must ultimately buy compliance allowances from occasionally selling on the market. The 90% rule must be read as the authorisation for any party to transfer up to 10% of its initial assigned amount to other Parties during the commitment period. As such, the reserve cannot entirely prevent the risk of overselling. Instead, it represents a compromise between the latter and the risk of restricting market liquidity through tightly controlling nations' potential supply to the market.[15] In a market experiment organised by the IEA and the Scandinavian carbon exchange Nord Pool, one government allocated entirely its transferable 10% to those domestic entities it had authorized to participate in international trade.[16] Were these entities to account for 50% of a country's total assigned amount, enabling their trade of 10% of the national total could entail the possibility to enter the international market with 20% of their allowance holdings. Allowances in hand, entities thus had the possibility to speculate without restriction on the carbon markets.[17]

The withdrawal of the expected US demand for AAUs has clearly reduced the need for the commitment period reserve. We showed earlier that projected supply is now larger than demand, creating an incentive to limit sales rather than oversell allowances.

Governments as market players

The Kyoto Protocol does not prevent parties from devolving parts of their assigned amounts to industries or other entities, thus allowing their access to international trading. Several countries have seized this opportunity, especially in Europe, where many installations of carbon-intensive industry and the power sector have received an individual emissions cap to enable participation in international emissions trade. Starting 2008, such transactions will occur under article 17. Despite this semblance of auxiliary autonomy, the Kyoto party remains ultimately liable for its total compliance objective.

Sectors, sources, and sinks without access to the international carbon market need to play their part in the party's compliance strategy. The government can implement other policies to address these activities, ranging from fiscal instruments, to standards, more traditional command-and-control or information campaigns to change behaviours.

15. See Baron, 2001, for an analysis of the commitment period reserve.

16. Baron, Boemare and Jakobsen, 2002.

17. Haites and Missfeldt, 2004, find that the CPR provides liquidity comparable to or better than that of existing emissions trading markets.

Not all these measures may be effective; governments may find them too costly and decide to supplement these efforts with acquisitions from the international carbon market.

Given the inertia inherent to various energy uses, sectoral CO_2 emission trends indicate a prominent role of governments in carbon markets during the Kyoto Protocol's first commitment period. While some industry may participate in international emissions trading, transport emissions in particular are rising (by some 108% and 21% between 1971, 1990 and 2002, respectively, as shown in figure 1).[18]

Further, some Annex B countries have already registered emissions well above their Kyoto objectives, representing emissions from all sectors. That emissions trading engages industrial sources in some countries should not imply that governments will require industry to bear the entirety of the compliance burden. Current allocation plans in the EU suggest that governments are careful not to treat industry harshly, in light of unconstrained international competition. This leaves governments with the responsibility to offset these emission increases above Kyoto targets, whether they originate in industry or other activities.

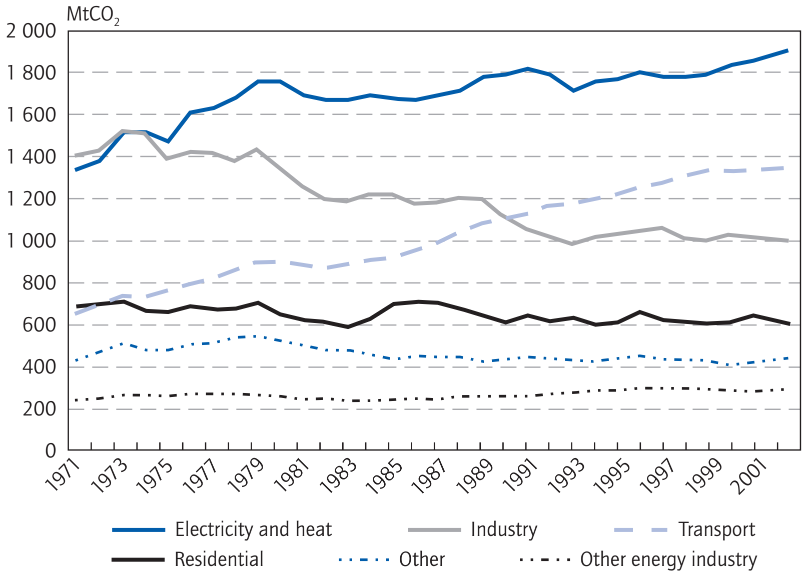
Natsource (a carbon market broker and CDM fund operator) estimates government purchases to account for 45% to 73% of all direct international purchases, based on range of supply and demand scenarios.[19] Governments are likely to be heavy weights in the international carbon market, both in the amount of their acquisitions through article 17 and in their innovative funding vehicles for projects (the Netherlands' CERUPT and ERUPT programmes are two examples). The lead time for these CDM and JI projects and their insufficient credit production relative to the volumes demanded by buying nations both favour emissions trading as the primary means of emissions credits procurement.

18. See Baron and Colombier, 2005, for a discussion of governments' involvement in international emissions trading.

19. Government purchases in Natsource's analysis are estimated to range from 45% of 186 $MtCO_2$ to 73% of 1051 $MtCO_2$ in the year 2010 (Natsource, 2003). We find a total demand in line with the upper range of this study.

FIGURE 1

Sectoral CO_2 emissions in countries with Kyoto Protocol commitments (1971-2002)



Source: IEA, 2004a

Preparations for government trading

Given the role of government institutions in currency and bond markets, government intervention in international emissions trade may seem a foray into familiar territory. Market intermediaries and exchanges would provide vehicles for such transactions. However, some aspects of governments render them unique actors in carbon emissions trade.

First, as some countries' demand, or supply, taken individually, could represent a significant share of the total market, how these large players intervene on the market is not a trivial question. A pattern of regular transaction of small volumes would increase market liquidity, while single transactions to acquire the bulk of several years' worth of allowances could unsettle the market and trigger price spikes. Symmetrically, large sales would depress carbon prices.

Governments, because of the public nature of their activities and finances, may also be more vulnerable than other market players. Through emission statistics such as the IEA's "CO_2 emissions from fossil fuel combustion", and official GHG inventories that are reported annually to the UNFCCC, all market players will have full knowledge of each nation's compliance and trading needs. Within a nation's budget, funds consecrated to trading activities may also indicate a government's "willingness to pay" for units, as is already the case with government-financed carbon funds. Both aspects – transparent trading needs and financing – suggest that governments will be best served by a strategy of regular trading, rather than infrequent participation in transactions of market-destabilizing volumes. Governments' regular trade, without implying speculative activity, may also dampen price fluctuations over the commitment period and minimise overall compliance cost. To date, other than through carbon funds, very few countries have started organising themselves for the large transactions required to establish compliance.[20]

Several governments have expressed preference for project-based units, those emissions reductions traceable to specific investments and activities. Two market aspects drive this favour:

- First, the general perception that project-based reductions may be less-expensive than AAUs largely controlled by two countries: Russia and Ukraine.
- Second, the environmental benefit of a project is easy to identify, while an AAU transfer cannot be traced to a specific reduction; it is simply a difference between the selling country's verified emission inventories and the politically-determined assigned amount.

To date, governments have not expressed intentions to acquire AAUs from their counterparts in countries with surpluses.

20. Among them, Austria has identified its central bank as the trading agent for the country's international emissions trading activity (Natsource, 2003).

From rounds of UNFCCC negotiation, countries with economies in transition emerged with assigned amounts far greater than their projected needs in the first commitment period. As such, other nations have expressed concerns over acquiring AAUs that represent emissions reductions occurring even in the absence of the Kyoto agreement.[21] In response, EIT nations holding this hot air have engineered several environmental strategies to improve the image of their assigned amounts, as detailed in box 3.[22]

Governments may also choose partners in their emissions trading transactions, rather than indiscriminately purchase units on the international market regardless of their country of origin. AAU transactions may thus become part of the broad agenda of countries' international relations.

Government trading: least-cost compliance?

The inter-governmental nature of the cap-and-trade regime established under the Kyoto Protocol may well separate the economist's ideal of an emissions trading regime and the reality of market and political determination. In theory, all sources should face a single price of carbon that drives reductions at the lowest overall cost. The confrontation of international supply and demand will determine this price, whose fluctuations should be mirrored by all sources' fossil fuel consumption. The cost-effectiveness of emissions allowances trade requires these theoretical conditions and assumes perfect market conditions.

In reality, governments have already launched several climate change mitigation measures designed without consideration for the current or expected price of carbon. As only the nascent domestic trading schemes and project-based mechanisms account for a carbon market, some mitigation policies will deliver emission reductions at marginal costs independent of the international price of carbon. Any assessment

21. Canada, among others, has stated that it will not allow "hot air AAUs" but will allow "green AAUs".
22. See also Korppoo, 2003, and Blyth and Baron, 2003.

Box 3

Making emissions trading attractive: the green investment scheme

At the 1997 signing of the Kyoto Protocol, EU emissions remained at 1990 volumes, while North America's had grown by 14%, and those of Russia and Ukraine had dropped by 30%. As discussed above these countries could hold 1 190 $MtCO_2$ of excess allowances annually, during the five-year commitment period.

Green investment schemes (GIS) have been promoted to improve the environmental efficacy of transactions involving such surplus allowances. Profits generated from the sale of allowances would fund environmentally-sound projects within the EITs. While the GIS funds may finance the production of additional emissions reductions, its comparative advantage over other mechanisms like JI and emissions trading may be its potential to finance capacity building and activities like the establishment of inventories and emissions monitoring systems.

Nations selling surplus AAUs would implement GIS domestically; buyer and seller nations could bilaterally establish the schemes' operational details. Russia introduced the concept in the formal climate negotiations in 2000, with few details of possible implementation. At present, Bulgaria is exploring efficient implementation in collaboration with the World Bank.

of emissions trading's role in reducing the costs of climate change mitigation must account for this dynamic.

Until the carbon price signal influences all aspects of energy consumption and policy, governments must represent those activities isolated from the international market. However impractical to distribute the changing price of carbon among all fossil energy products, governments ought to implicate all energy users, sources and sinks of GHG, in the cost of compliance with GHG emission goals, if compliance is to be met at least-cost strategy. Otherwise there is a risk of a disconnect between governments' compliance strategies through international emissions trading and project-based mechanisms, and specific trends in sectors such as transport where inertia of infrastructure and technology, but also economic and social considerations, have so far created strong resistance to change towards low CO_2 emissions.

Project-based Mechanisms: Raising High Expectations

Joint implementation

Under article 6 of the Kyoto Protocol, joint implementation authorises investment in projects generating GHG emission reductions (called "emission reduction units" or ERUs) in Annex B nations. According to the Marrakech Accords (2001), ERUs are fully fungible with others Kyoto units and can be used by Annex B countries in compliance with their Protocol obligations.

Since both host and investor countries have Kyoto commitments, the transfer of ERUs from one country to the other would not influence the total assigned amount, that is, the emission cap, under the Protocol. Despite this guarantee of general environmental integrity, JI projects must meet two additional criteria. First, JI must complement domestic GHG mitigation efforts of buying nations. Second, ERUs must represent reductions that would not have otherwise occurred. The ERUs are calculated as a difference between the JI project's measured GHG emission and the "baseline emission level" that would be observed in the project's absence. As detailed in the following discussion of the clean development mechanism, additionality remains difficult to gauge. Under JI, the host country government can decide unilaterally whether a project is indeed additional, as soon as it meets JI's eligibility criteria; this is JI under track I. Under track II, the host can use an international process to assess the project.

JI projects can start generating ERUs in 2008. As established in the Marrakech Accords, participation in JI requires a country to:

1- Be a Party to the Kyoto Protocol.
2- Calculate and record its assigned amount (available emissions quota, AAUs) in accordance with relevant modalities and decisions.
3- Establish a national emissions and transaction registry.
4- Establish a national system to estimate anthropogenic GHG emissions by sources and removals by sinks.
5- Annually submit most recent inventory to the UNFCCC, including the national inventory report and the common reporting format.
6- Submitted the supplementary information on assigned amount and made adjustments to it.
7- Designated focal point in charge of approving JI projects.
8- Established national guidelines for approving JI projects that recognize stakeholders' comments, and detail the procedures of monitoring and verification of projects.

While the first six requirements resemble those of emissions trading under article 17 of the Protocol; the last two are specific to JI.

Under track I, JI supposes full compliance with the above requirements, authorizing investing and host countries to independently gauge additionality, and monitor, verify and issue ERUs.

Under track II, host countries must comply only with the first three requirements, but make their projects subject to a compulsory international verification procedure. Track II was established to encourage investment even in those nations without well-developed institutions of emissions trading and JI projects. The JI supervisory committee verifies ERUs. Given the stringent verification process of track II, its implementation may soon resemble that of the CDM and incur similar problems.

JI's supply capacity is difficult to estimate, even as those countries investing early in the mechanism have already secured ERUs. Shaped by the same currents of emissions markets, the JI credit supply depends on the extent to which host countries can quickly establish investment institutions to limit transaction costs. Countries endowed with the largest potential ERU supply, Russia and the Ukraine will be eligible for track I JI before 2008, and Russian officials started indicating a preference for track II JI. In the end, the time required by projects' development prior to the generation of credits must influence strategic investment in JI. The investment climate in EITs is another important factor for the success of joint implementation.

Finally, the EU ETS may have profoundly shaped the market for JI credits. As the scheme now covers installations in ten EITs, a range of installations once considered potential JI projects and are now embedded in the EU ETS. The EU system does not preclude JI projects; its Directive indicates how to reduce the risk of counting emission reductions twice in case a project is undertaken in the Directive's perimeter. However, the establishment of a more systematic trading system where JI could have emerged may considerably reduce its prospects: the EU scheme enables allowance transfers with lower transaction costs, as it bypasses any additionality test.

The clean development mechanism: trading opportunities with developing countries

History

The CDM was created in Article 12 of the 1997 Kyoto Protocol. It is the only flexibility mechanism aimed at developing countries, enabling GHG mitigation projects undertaken in developing countries to earn certified emission reductions (CERs) that can be used by Annex B countries towards their emissions commitments under the Kyoto Protocol. In so doing, the CDM is also supposed to assist developing countries in achieving sustainable development. The CDM fits in the category of project-based mechanisms – any project can be attributed emission reductions provided it can prove its emissions are lower than an agreed baseline.

Several expectations accompany implementation of the CDM. That the CDM will reduce compliance costs and improve liquidity of the greater GHG market surfaces among the most popular expectations. Opportunities presented by the CDM include investor access to volumes of low-cost potential reductions, and the transfer of renewable energy and energy efficiency technology to developing nations, boosting their sustainable development.

Unfortunately, concerns regarding the CDM's incentive structure match expectations of the mechanism's benefits. On the demand side, investors are naturally inclined to maximise reduction units to reduce their compliance cost, assuming CERs are cheaper than domestic reductions. On the supply side, stakeholders in developing countries are encouraged to approve projects that maximise reductions and revenues from their sales, without liability for a country cap. With such concurrent interests, there would be a tendency to inflate statements of achieved reductions. Such overstatement would compromise environmental integrity as not all CDM reductions units would represent real abatement. This legitimate concern motivated the rather complex set of rules now governing the CDM and, in particular, what is known as the "additionality" of projects: the measurable reduction of emissions that can be attributed to the project alone.

CDM rules

The 2001 Marrakech Accords outline the modalities and procedures for the implementation of the CDM. They include a decision for the "prompt-start" of the mechanism, authorising it to start prior to the entry-into-force of the Kyoto Protocol. In addition, it required the development of simplified modalities for small-scale CDM projects.

Box 4

Main features of the Clean Development Mechanism

The purpose of the CDM shall be to assist non-Annex I Parties in achieving sustainable development and in contributing to the ultimate objective of the UNFCCC, and to assist Annex I Parties in achieving compliance with their emissions commitment under the Kyoto Protocol.

Governance

The CDM executive board *(EB) supervises the CDM, under the authority and guidance of the Parties to the Kyoto Protocol (referred to as COP/MOP), and is fully accountable to them. Composed of ten members and ten alternates from Parties to the Kyoto Protocol, the EB must meet no less than three times a year. The mandate of the CDM EB includes:*

- *Recommend new modalities and procedures for the CDM to the COP/MOP.*
- *Approve new methodologies for monitoring, the calculation of baselines, and project boundaries.*
- *Review provisions to encourage simplified modalities, procedures and the definitions of small-scale projects.*
- *Be responsible for the accreditation of operational entities, and make recommendations to the COP/MOP for the designation of operational entities.*
- *Develop, maintain and make publicly available a compendium of approved rules, procedures, and standards.*
- *Develop and maintain the CDM registry.*

Certified emission reductions (CERs)

Operational entities designated by the COP/MOP must certify emission reductions credits generated by each CDM project, on the basis of:

- *Voluntary participation approved by each Party involved.*
- *Real, measurable, and long-term benefits related to the mitigation of climate change.*
- *Reductions beyond any that would occur in the absence of the CDM project.*

Timing

CERs can be generated beginning in the year 2000. CDM project participants must choose between two crediting periods for their projects:

- *A maximum of 7 years which may be renewed twice.*
- *A maximum of 10 years, without an option to renew.*

Other criteria

- *The host country alone judges the CDM project's capacity for sustainable development.*
- *Annex I Parties shall refrain from using CERs from nuclear plants.*
- *Afforestation and reforestation are the only sinks projects allowed (i.e. "halting deforestation" is not eligible under the CDM) and their volume is restricted to 1% of the Annex B base-year emissions.*
- *Public funding for the CDM from Annex I parties is not to divert official development assistance (ODA).*

Sources: Kyoto Protocol (Article 12) and Marrakech Accords (Decision 17/CP.7)

Table 3

CDM project cycle

Step	Definition	Responsible entity
1. Project design document	This document details the proposed CDM project: description, monitoring plan, baseline methodology, and GHG calculations.	Project participants
2. Validation and registration	The CDM project is independently evaluated and validated on the basis of the project design document and confirmation from the host government that the project assists in achieving sustainable development and that participation is voluntary.	Designated operational entity (DOE)
	Registration occurs when the validated CDM project is formally accepted.	Executive board
3. Monitoring	The implementation of an approved monitoring plan is a condition of verification and involves the collection and archiving of all relevant data necessary for establishing GHG emissions by sources occurring within the project boundary during the crediting period.	Project participants
4. Verification and certification	Verification is the periodic independent review and determination that GHG reductions have occurred as a result of a registered CDM project activity during the verification period.	Designated operational entity
	Certification is the written assurance that a project activity achieved the GHG reductions stated during the specified time period.	Designated operational entity
5. Issuance	CERs are issued to the host party's account.	Executive board

Source: Adapted from United Nations Conference on trade and development and the Earth Council carbon market programme (UNCTAD, 2002), A layperson's guide to the clean development mechanism: the rules from Marrakech, www.unctad.org/ghg

While the Marrakech Accords provide general guidance, the details of CDM continue to evolve through a process of learning-by-doing under the supervision of the EB. The CDM rules guide the operation of its executive board and its panels. They also guide the accreditation, validation and registration of projects, as well as the development of emissions baseline methodologies and the issuance of CERs.[23] The development of emissions baselines and the demonstration of a project's additionality are essential to CDM projects: they address the above-mentioned concern and establish the credibility of the instrument in reducing GHG emissions in countries not otherwise constrained by an emissions cap.

The CDM also requires participating nations to designate a national authority for project administration. In developing countries, the designated national authority (DNA) verifies that proposed CDM projects meet any planning and legal requirements, and that projects support national sustainable development goals. To date 88 nations have established DNAs (71 in non-Annex I countries), representing over half of the 152 Parties that have ratified the Kyoto Protocol. However, some of the DNAs are yet to develop procedures for approving projects. Table 3 describes the CDM process for a project.

Governance

As detailed in box 4, the ten member executive board authorises CDM projects. Board members are required to possess appropriate technical and political expertise and to act without national allegiance. In practice, however, the board's composition is largely a political process. The executive board accredits designated operational entities (DOE) to validate and certify CDM projects and related emissions reductions. It also issues the CERs which are entered in the official CDM registry.

Several panels and working groups support the executive board. Expert panels advise the board on methodologies to calculate emissions baselines, the basis from which emission reductions can be attributed to projects. Working groups assist the board in developing methodologies for emission baselines and monitoring plans for afforestation and reforestation, and small-scale projects.

23. See http://cdm.unfccc.int/Reference/Procedures for a detailed description.

Regulatory developments

The EB seeks to develop the CDM into an attractive market mechanism. As of September 2005, 21 CDM projects had been registered in activities covering renewable energy, landfill CH_4 capture and HFC-23 elimination, among others.[24] These projects would amount to 6 $MtCO_2e$ of credits generated annually. Nine other projects requested registration. The board has rejected 39 and approved 23 baselines methodologies in areas ranging from landfill gas recovery to water pumping efficiency improvements. Four "consolidated" methodologies pertaining to renewable electricity, landfill gas, and partial substitution of fossil fuels in cement manufacture have also been approved. In approving these consolidated methodologies, the EB seeks to cover a general category of project types. This represents a positive albeit limited development. In addition, 14 methodologies for small-scale renewable energy, energy efficiency improvement and other (agriculture and low-GHG emitting vehicles) projects have been approved. Further, over 50 baseline and monitoring methodologies are also under consideration by the EB, representing both new and re-submitted methodologies.

A prime critique of the EB has been its sluggish review of new methodologies. In response, the board has reduced the average period of deliberation from 220 days as of January 2004, to 110 days by February 2005. Over the same period the maximum time of decision has fallen from about 320 days to about 145 days.

In October 2004, the EB provided a validation tool of the additionality of proposed CDM projects (see figure 2). Implementation of the tool is not mandatory.[25] Prior to its registration, project participants determine the eligibility of a proposed CDM activity,[26] defining realistic and credible alternatives to the project that can form the baseline scenario

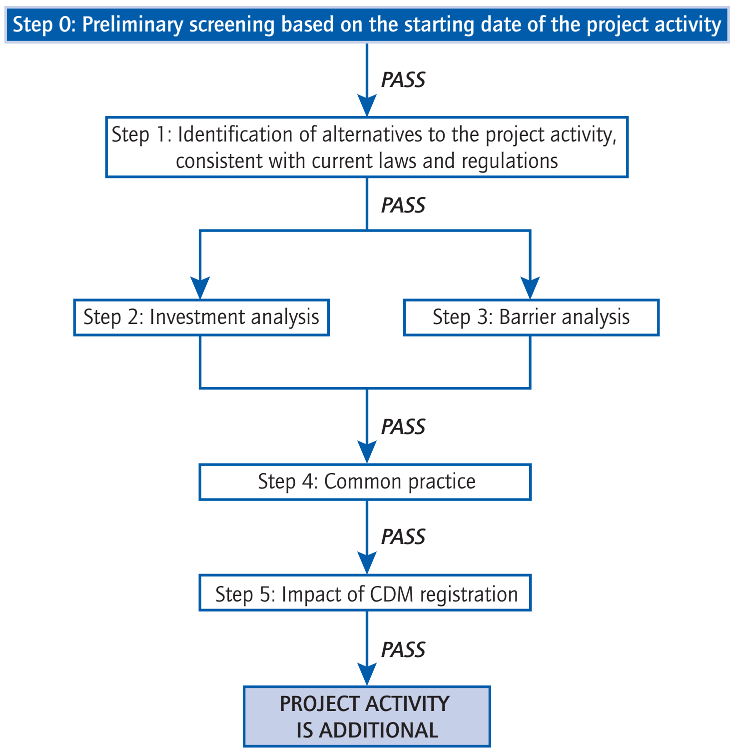
24. Ellis and Levina, 2005.

25. This was clarified by the executive board and also specified in a CDM decision at COP 10.

26. This description does not include various sub steps. See http://cdm.unfccc.int/EB/Meetings/016/eb16repan1.pdf

FIGURE 2

CDM additionality tool



Source: UNFCCC, http://cdm.unfccc.int/EB/Meetings/016/eb16repan1.pdf

(step 1). Project participants can then proceed to either step 2 or 3. Under step 2, project promoters must determine the necessity of revenues from the sales of CERs to bolster the economic or financial status of the project relative to alternatives. Under step 3, project participants identify technological barriers, investment and other barriers that may impede successful implementation of the project, but not of its more GHG-intensive alternatives. A credibility test determines the extent to which the proposed project type has already integrated into the relevant sector or regions (step 4). Finally, step 5 requires the project participant to explain how the registration of the project activity as a CDM activity is essential to clearing the economic and financial obstacles or other identified barriers to its prior implementation.

The EU 2003 approval of the linking directive enables installations covered in the EU ETS to use CERs and ERUs, along with EUAs compliance. Making CERs fungible with EU allowances creates a potentially significant private sector demand for CERs, dependent on the installations' needs to acquire units outside the EU, as well as prices of EUAs relative to those of CERs. As the price of EUAs has more than doubled (to EUR 20) in the past six months, the price gap between EUAs and CERs has steadily grown. The logic used by the World Bank (2005) to estimate carbon prices helps to explain this gap. In setting a price range of USD 5 to USD 10/tCO_2, the World Bank noted the risk inherent to CERs forward contracts, as regulatory uncertainty may hamper their timely delivery over the first period of the EU ETS. Last but not least, the fundamentals of supply and demand are different: CERs are bought for compliance in 2008-2012 by countries including countries outside Europe, while EUAs are traded for compliance in 2005-2007 among industrial players with their own set of targets and mitigation options. As CERs alone are unlikely to satisfy all demand of the EU ETS, the prices of EUAs is not likely to fall to the price level of CERs.

The structural developments coincide with exponential growth in the demand for project-based reduction credits. Indeed, private firms, industrial groups, governments, and multilateral organisations have pledged more than USD 3 billion to carbon credit procurement funds in the past six years. The following section introduces this nascent field of carbon finance.

CER market

Uncertainties surrounding the Kyoto Protocol's ratification and undefined implementation procedures both constricted early development of the CDM market. Without regard for these early obstacles, Haites (2004) estimated an annual demand for CERs of 250 $MtCO_2e$ in 2010, at a price of USD 11/tCO_2e. His modelling assumes that the CDM market would respond to a price hike driven by limited sales of surplus AAUs by Russia and Ukraine. Based on an observed annual CER flow of 200 $ktCO_2$ per project, and accounting for crediting prior to 2008, around 1 300 projects could meet the CER demand in 2010.

As examined below, the CER market is one driven by supply, in that demand far outstrips the limited quantity of CERs.[27] Buyers are therefore likely to purchase all CERs that enter the market as it remains uncertain that non-Annex I countries will supply enough GHG emission reductions before the close of the Kyoto Protocol first period.

Governments have pledged to purchase the largest volumes of CERs to date.[28] However, the decision of the United States to not ratify the Kyoto Protocol reduces potential CDM demand from expected volumes and likely prices for credits.[29]

Beyond the EU, the extent to which nations will devolve part of the burden of Kyoto compliance to their private sector remains unclear. This uncertainty creates limited incentives for the private sector's participation in the CER market: unless sources face direct caps or other forms of emission commitments, they are not likely to acquire CERs.

While current private sector demand remains tepid, potential supply of the CDM grows each month. As of July 2005, Point Carbon lists around 1 700 proposed CDM and JI proposed projects in its CDM and JI project pipeline database. Of these, some 447 projects represent a potential yield of 679 $MtCO_2e$ by 2012.[30] A further 186 announced projects could add 336 $MtCO_2e$ to this supply. Considering only the

27. World Bank, 2005.

28. World Bank, 2005.

29. Australia's decision has less bearing on the CDM demand – in spite of not having ratified the Protocol, the country is projected to meet its Kyoto goals with domestic measures only.

30. Point Carbon, CDM & JI Monitor, 26 June 2005 (www.poincarbon.com). These include only projects arriving at the Project Design Document stage.

CDM, the World Bank estimates proposed projects to fill less than 500 $MtCO_2$ of the Kyoto compliance gap of 5 500 $MtCO_2e$ over all five years of the first period.[31]

Several aspects of the CDM project approval hinder efficient supply of the CER market. Of principal frustration has been the supply-side's sluggish response to rapidly growing demand. Although more than 20 methodologies have been approved, as of September 2005, only 16 projects have been registered, a sliver of those projects completing the project design document. Regulatory uncertainty associated with CDM projects and the complex and time-consuming project cycle have proven the most stubborn obstacles to the flow of the project pipeline. Project additionality has also been difficult to assess, further slowing the approval process. While the additionality tool has mitigated some uncertainty as of late, its non-mandatory implementation can be viewed as merely shifting the uncertainty to the validator.

In addition, the absence of any price signal for emission reductions beyond 2012 severely curbs investment in CDM projects, given their lead time. Further reducing interest in smaller projects (those generating fewer than 50 000 CERs per year[32]) is the significant transaction cost of preparing project design documentation and securing validation. However, this is not reflected in the balance of projects currently registered with the EB, evenly split between large and small projects.

Despite the slow start, there are signs that the flow of projects might improve in the near future. A survey by the EB secretariat found that 151 projects are expected to request registration over the 12 months to 30 June 2006 and 91 new methodologies are expected to be submitted over the same period.[33] The window for some projects is slowly closing in the absence of a post-2012 carbon price since there

31. http://www.worldbank.org.ru/ECA/Russia.nsf/0/edf54b2376837f24c3256f6d0052f050/$FILE/dec22-2004-file4_eng.pdf

32. Estimated minimum fixed costs for a project are EUR 150 000. The estimated minimum project size is 50 000 tCO_2 (KfW Carbon fund).

33. http://cdm.unfccc.int/EB/Meetings/020/eb20_an4.pdf will not be not enough time to recover the return on investment. At the same time, project approval must quicken for some of the "prompt start projects" generating reductions between 2000 and November 2004, to guard their substantial CER volumes. For example, over 8 million CERs set to be generated by Brazilian CDM projects by 2012 are at risk of negation.[34]

Considerations and future challenges

Constructing a market-based instrument of global application from the theory of article 12 of the Kyoto Protocol has proven to be a daunting task. The CDM executive board's ascendance of a steep learning curve must be appreciated. The following challenges remain.

Given expectations that the CDM would contribute a non-trivial, even if not sufficient, supply of CERs for compliance with Kyoto commitments, the mechanism's institutions must be considered. With current resources, the CDM executive board and panels cannot meet the regulatory task at hand. All involved must fulfil other concurrent full-time professional obligations. Given this paucity of time and attention, the board can meet only five times per year to review methodologies and projects. The EB secretariat reported a budget deficit of USD 2.93 million, likely to compound administrative inertia over the second half of 2005.[35] The G8 Summit pledged in July 2005 to fund the EB through the end of the year; however, resources over the longer term remain forthcoming and merit consideration at future conferences of the parties.[36]

The entire CDM process would benefit from improvements in capacity and expertise of the executive board. Greater reliance on business and project expertise could also enhance the CDM decision-making process.

34. PointCarbon 19 April 2005, CDM & JI Monitor.

35. http://cdm.unfccc.int/EB/Meetings/020/eb20rep.pdf

36. Note that the CDM is expected to be financially self-supporting through a "share of the proceeds from certified project activities", according to Article 12 of the Protocol.

At the same time, better explanation of the rationale for decisions may help project proponents to anticipate the assessment of their proposed methodologies and proposed projects. To this end, it is encouraging to see recent developments (e.g. such as web casting of EB meetings and improved stakeholder consultation) that are working to enhance communications between the executive board, its panels and project proponents.

The executive board only responds to, and cannot control, the flow of submissions of proposed methodologies, applications for accreditation, requests for registration and requests for issuance of CERs. The vast majority of approved methodologies have not yet been used and most projects that have completed their public comment period have not yet requested registration. These delays indicate some reticence by project participants and host countries, which must be addressed.

Project proponents face two major hurdles: the approval of the project's baseline methodology and the demonstration of its additionality. Project proponents must either use an already approved baseline methodology or submit a new methodology. Initial projects in a field require their own specific methodology. This method for the counting of emissions reductions must be approved by the methodologies panel. Without clear assessment criteria, the approval process for methodologies appears risky to project proponents. It has also proved time-consuming – counting three months at best and often six to nine months. Broadening the scope for so-called consolidated, more generic baseline methodologies would quicken the approval of projects.

Projects must then demonstrate their additionality. This requirement is difficult to implement, especially when proving *"what would have happened otherwise"*. The private sector argues that this requirement is not compatible with its practice. As the additionality tool is viewed neither as a compulsory nor definitive methodology, some uncertainty will persist in project approval.

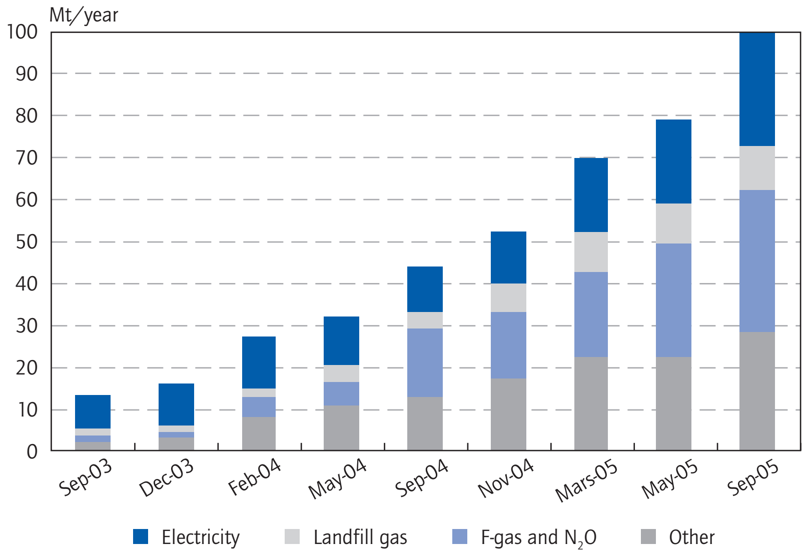
The additionality problem does not, however, taint all CDM projects. Proof of additionality is fairly simple for those projects capturing emissions that would otherwise be released to the atmosphere, such as HFC-23, N_2O, methane from coal mines, landfills, wastewater treatment, and manure, among others. The quantity of emissions captured, used, or destroyed in such projects could be accurately metered. In fact, projects in these fields have proved increasingly attractive, as illustrated below.

CDM and energy choices

The creation of the CDM fuelled expectations for the worldwide transfer of innovative GHG mitigation options. Foremost in the energy sector were hopes for energy efficiency projects and almost cost-competitive renewable energy technologies. However, the OECD's recent review of 501 proposed project activities indicates these promising ideals losing CER market share to non-CO_2, non-energy related projects, characterised by their low cost (figure 3). The latter projects accounted for over half of the total proposed projects as of September 2005. They also often present low risks in terms of their additionality, since end-of-pipe reductions provide no other returns than CERs, and benefit from already approved baseline methodologies. Coincident with this rise in the incentives for investment in end-of-pipe projects is a marked decline in the number of CERs from energy-related projects. In particular, the share of renewable projects' reductions fell from over 50% in September 2003 to 21% in May 2005, a trend reflecting the activity's relatively high abatement cost. The number of projects which proposed energy efficiency and fuel switching is relatively small (i.e. less than 4%) and their importance is declining, probably a result of the difficult proof of additionality. This trend is likely to continue in the foreseeable future as projects with emission reductions that can be generated both quickly and more cheaply are funded first, to meet first period commitments. Without the certainty of a post-2012 price signal, the CDM cannot change the course of energy production and use in developing countries.

FIGURE 3

Portfolio of proposed CDM project activities



Source: Ellis and Levina, 2005

This dim prediction has prompted the development of proposals to strengthen the CDM: less stringent criteria for additionality, a systematic discounting of the CERs generated, and a combination of the two.[37] An acclaimed approach is to cover sectors and GHG reduction policies with a baseline-and-crediting system, in the model of emissions trading.[38]

Carbon funds

The past two years have proven transformative to international carbon finance. As of June 2005, pledges by carbon funds and government tenders totalled USD 3.7 billion. While some projects secured funding

37. Yamagata, 2004. Japanese researchers have challenged the view that weakening the rules for additionality would come to the straight advantage of developing countries (Asuka and Takeuchi, 2004).

38. Bosi and Ellis, 2005.

through bilateral transactions, many others have attracted support of pooled funds. Established by nations, private firms, and organisations, credit procurement funds are summarised in table 4 and table 5. If efficiently managed, such funding could generate between 200 and 400 $MtCO_2e$ of credits, assuming a price between USD 5 and USD 10/tCO_2e per project-based emission reductions. Not all the funds publish the quantity of credits that they intend to acquire for 2012.

Carbon funds procure credits for emission reductions that can be traced to individual projects, a possibility that does not exist in transactions of international AAUs. The perception of environmental integrity attracts governments and institutional investors.

Firms contributing to carbon funds do not all face emission constraints as those imposed by the EU emissions trading scheme. Industry in Japan is committed to emission objectives through a voluntary agreement by the Keidanren, the federation of Japanese industry. The Japanese firms' finance of carbon funds validates expected credits as compliance tools with their voluntary commitments.

Only naturally, financial institutions specialised in project finance play a prominent role in carbon funds management. The World Bank is the largest player in the credits market and, as of April 2005, manages four funds on behalf of individual countries, in addition to four multilateral funds. The European Bank for Reconstruction and Development has created a fund dedicated to central and eastern European economies. The Asian Development Bank's CDM facility supports projects in 15 countries. Some countries have also established their own facilities to select and finance carbon mitigation projects. The Dutch have pioneered this method of credit procurement. Launching the ERU-PT and the CERU-PT tender programmes in 2000-2001, the government of the Netherlands has paved the way for a number of similar government-led initiatives.

Table 4

Overview of multilateral carbon funds

Type	Name	Investors	Launch	Investment Goal
Public-Private Partnerships	World Bank biocarbon fund	Public and private entities	2004	USD 100 million
	World Bank community development fund	Public and private entities	2003	USD 128 million
	World Bank pan-European carbon fund	European Investment Bank	2005	USD 100 million
	World Bank prototype carbon fund	Public and private entities	1999	USD 180 million
	Andean Development Corporation's Latin American carbon programme	Private and public entities, including the Dutch government	1999	USD 45 million
	Asian Development Bank's CDM facility	Public and private entities	2003	USD 70 million current budget
	Baltic Sea region energy cooperation (BASREC) testing ground facility (TGF)*	Governments of Denmark, Finland, Iceland, Norway, Sweden. Germany intends to contribute	2003	EUR 30 million
	European Bank for Reconstruction and Development's multilateral carbon credit fund	Public entities, including 9 EU governments	2005	EUR 50-150 million
	KfW	Private and public entities, including the German carbon fund	2004	EUR 50 million
	Singapore-ASEAN carbon facility	Public and private entities	2003	USD 120 million
Private Funds	Asia carbon fund	Public and private entities	2005	EUR 200 million
	EcoSecurities – Standard Bank carbon facility	Private and public entities, including the Denmark carbon facility	2003	DKK 59 million
	European carbon fund	CDC – Ixis, Fortis Bank	2005	EUR 105 million
	Japan GHG reduction fund JBIC-JGRF-JCF	Japan carbon fund	2004	USD 141.5 million
	Natsource's greenhouse gas credit aggregation pool	Public and private entities	2005	USD 130 million
Approximate funding total: USD 1.67 million				

* The TGF is also open to private investors.

Table 5

Overview of government carbon funds

Type	Name	Investors	Launch	Investment Goal
Own Tender	Austria JI/CDM programme	Austria	2003	EUR 72 million
	Belgium JI/CDM tender	Federal Government of Belgium	2005	EUR 10 million
	Climate fund	Canada	2005	CAD 1 Billion
	Denmark JI/CDM programme	Denmark	2004	EUR 100 million
	Finland JI/CDM pilot programme	Finland	2003	EUR 20 million
	French carbon fund	France	2005	EUR 50 million
	CERUPT	The Netherlands	2001	EUR 32 million
	ERUPT	The Netherlands	2000	EUR 50 million
	Sweden international climate investment programme	Sweden	2000	SEK 350 million
	Government of Japan	Japan	2005	JPY 5.7-8 billion
	Swiss Climate Penny	Switzerland	2005	EUR 65 million
Through Multilateral Institutions	World Bank Netherlands clean development facility	Government of the Netherlands	2002	EUR 136 million
	World Bank Danish carbon fund	Danish investors only: public and private	2004	USD 30 million
	World Bank Italian carbon fund	Italian investors only: public and private	2004	USD 80 million
	World Bank Spanish carbon fund	Spanish investors only: public and private	2004	EUR 170 million
	IFC	Netherlands carbon facility	2002	USD 44 million
	IFC-IBRD	Netherlands European carbon facility	2002	USD 70 million
	Rabobank carbon procurement department	Netherlands	2003	EUR 45 million
Approximate funding total: USD 2.06 billion				

Sources: CDC, 2005, and others.

Kyoto Mechanisms: an Early Focus on Projects

Current emissions projections indicate that Parties seeking Kyoto compliance will rely heavily on emissions trading, Joint Implementation and the clean development mechanism. Market pioneers concentrated on the development of project-based supply of emission reductions. The credits produced by such measurable, on-the-ground reductions appeal to policy makers. Because of the relatively low efficiency and the obsolescence of energy-using and other equipment in countries hosting these projects, these GHG reductions were expected to be relatively cheap.

While it was expected that renewable energy and energy efficiency would represent the lion's share of credits generated by such mechanism, the market seems to have found cheaper potentials to generate GHG abatement (landfill methane, HFCs). Current trends indicate this mechanism's negligible influence on the fundamentals of global energy investment.

The rest, and in fact the bulk, of the supply side should consist mostly of so-called "hot air", those AAUs for which buying Parties have not yet shown great enthusiasm. In addition, with the uncertainty of the Kyoto Protocol status until early 2005, the absence of operational registries and the ineligibility of any country to engage in trade explain the scarcity of forward transactions.

Even with substantial domestic efforts to reduce domestic emissions between now and 2008-2012, emissions trading should account for an important share of Kyoto Parties' compliance. Government purchases will represent the bulk of international transactions under emissions trading. In preparation for such sizeable demand for their allowances, economies in transition are burnishing the image of their "hot air", hoping to attract initially reluctant buyers to their green investment schemes. Only time will tell whether cost considerations will guide the investment decisions of government and entities or whether procurement will follow the environmental integrity of the acquired AAUs.

As such, the Kyoto mechanisms do not assign a carbon cost to all GHG sources. The market cannot be assumed – it must be organised. Governments must establish domestic tools to devolve the international price of carbon to domestic sources. The cost-effectiveness of the Kyoto mechanisms hinges on such domestic implementation. The next chapter examines the emerging emissions trading schemes employed or considered by governments and entities worldwide.

EMISSIONS TRADING: TARGETING SOURCES

A variety of domestic and regional emissions trading initiatives is emerging, each with specific designs and at different stages of implementation. For parties committed under the Kyoto Protocol, emissions trading at domestic level is both a means to implement Kyoto commitments and a potential relay for the international price of carbon to be delivered to domestic entities. Others, at various levels of country governments, are considering this tool as a least-cost approach to their GHG emissions. After a description of existing systems, we consider whether and how emissions trading systems of various designs could co-exist into a broader trading regime.

The EU Emissions Trading Scheme

History and context

Since the early 1990s emissions trading has garnered attention as an effective instrument of pollution control.[39] The United Kingdom and Denmark[40] pioneered domestic GHG trading. Denmark's system focused on installations of power generation, which has spurred dramatic fluctuation in the country's total emissions over the years. The UK emissions trading scheme explored many facets of this mechanism as applied to industry, including different target types (absolute or output-based), the use of auctions to encourage voluntary participation in the system, and the design of a transaction gateway to avoid inflating the overall cap as entities subject to output-based targets can transfer surplus to capped entities. The implementation of the Danish

39. Ellerman et al., 2003.
40. Stowell, 2005.

and UK trading schemes has proven invaluable to the design of subsequent systems, such as the EU emissions trading scheme, introduced in January 2005.

Under the Kyoto Protocol, the European Union committed to reducing its common emissions of greenhouse gases by 8% from 1990 levels during the 2008-2012 period. Under article 4 of the Kyoto Protocol, the EU-15 negotiated a burden-sharing agreement that split this common target into 15 of varying stringencies. As such, EU-15 nations emerged from the Kyoto agreement with domestic targets that accounted for current emissions, relative economic development and their domestic idiosyncrasies. Individual states' targets thus range from +27% for Portugal to -28% for Luxembourg (table 2). As Kyoto Parties, EU member states can use mechanisms to offset emissions above these agreed objectives.

In October 2003, the European Parliament and the Council of the European Union adopted Directive 2003/87/EC, establishing a scheme for greenhouse gas emission allowance trading within the Community.[41] This date marks the birth of the EU ETS title, though the scheme's design was amended in October 2004, primarily to enable use of the Kyoto project-based mechanisms.[42]

Consideration of economic efficiency in reducing emissions also motivated the EU's selection of a cap-and-trade system. This consideration is of principal importance for industrial installations competing for market share on the basis of production costs. With Kyoto covering only a portion of the global economy and industry, the carbon constraint's impact on the competitive advantage of European industry must be minimised. Within the EU-25, a homogenised marginal cost of CO_2 may maintain a level playing field among direct competitors.

41. See Lefevere, 2005 for a detailed history of the EU ETS.

42. Directive 2004/101/EC of the European Parliament and of the Council, generally known as the Linking Directive since it establishes links with other mechanisms under Kyoto.

Starting January 2005, approximately 11 500 plants across the EU-25 have been authorised to buy and sell emissions allowances representing their CO_2 emissions over 2005-2007, subject to transaction registries' function. The system covers about 45% of the EU's total CO_2 emissions. The emerging price provides all sources with a clear market incentive to control emissions, buying EU allowances (EUAs) when reduction costs exceed the market price, or selling them if at a profit.

Main design features

Industrial facilities and others covered by the EU ETS are first subject to a three-year commitment period (2005-2007); the second phase will coincide with the five years of the Kyoto Protocol's first commitment period (2008-2012). As specified by the Directive, each subsequent phase will also cover five years.[43]

The EU ETS applies to CO_2 emissions of the following sources: energy activities from all sectors with combustion installations above 20MW of thermal rated input, oil refineries, coke ovens, and, subject to certain size criteria, producers of iron and steel, cement, lime, glass, ceramics, and pulp & paper. EU ETS is a downstream trading system assigning emission constraints to point sources. Starting in 2008, the EU emissions trading Directive allows member states to expand other sectors and GHGs, provided these have been approved by the Commission. This enlargement would require the provision of adequate monitoring and reporting systems.

Member states must each develop national allocation plans (NAPs) specifying the amount and method of EUAs allocation. The Directive requires allowances to be distributed for free based, *inter alia,* on

43. The Kyoto Protocol does not specify when a second commitment period would start, nor how long it would last. The only reference to a second commitment period can be found in Article 3.9 which stipulates that Parties to the Protocol "...shall initiate the consideration of [commitments for subsequent periods] at least seven years before the end of the first commitment period."

historical emissions – so-called grandfathering. Up to 5% of the total amount can be auctioned in the first period (2005-2007), and up to 10% in the second period (2008-2012). Member states can choose to reserve a certain number of allowances for new entrants who would receive an allocation before starting production. The reserve is integral to the emissions cap. Once fixed by the NAP, neither the allocated total nor the reserve can be augmented, although some member states have decided to replenish the reserve by purchasing allowances with public funds in the market.

Each Member State must also account for allowances that would have accrued to installations that close during the commitment period. Should the plant's operator be issued allowances for the remainder of the period, or instantly surrender its remaining allowances? Domestic treatment of plant closure and new entrants may compromise the general trading scheme's efficiency.[44]

The October 2004 approval of the linking Directive enables installations to use credits from the Kyoto Protocol's project-based mechanisms (JI and CDM) to meet their emissions targets. As noted in our earlier discussion of the CDM, this must be "supplemental" to domestic action. ERUs cannot be used before 2008, while CERs can be also used for compliance with commitments during 2005-2007. Each member state must limit the use of CERs and ERUs to a specific percentage of the allocation of each installation. In all, installations can comply with their ETS target by surrendering the following:

- EUAs, be they their own or those acquired from other installations covered by the EU ETS.
- CERs (starting 2005) and ERUs (starting 2008). Because CERs can also be used in the Directive's second commitment period (2008-2012), they may carry a premium as a commodity that can be banked beyond the first period.

44. See Ahman et al. 2005.

The EU ETS does not recognise AAUs that have not been issued as EUAs. Essentially, this restriction prevents industry from releasing more emissions through extensive reliance on surplus AAUs allocated to countries with economies in transition. Practically, this creates two GHG markets among Kyoto parties: the EU-25's industry-based market for CO_2 allowances, potentially including more gases and activities in subsequent periods, and the broader market under Kyoto, where all gases can be traded. As mentioned earlier, this market is likely to be dominated by government transactions. Project-based mechanisms could link these two markets.

Operation of the EU ETS follows an annual cycle.

- Allowances for each year must be distributed by 28 February and must be surrendered for compliance by 30 April the following year. Installations can surrender either allowances, CERs or ERUs, commensurate with their measured emissions. The delay between the issuance of the following year's allowances and the surrender of the previous year's allowances enables the borrowing of EUAs received, say, in 2006, to comply with 2005 emission goals. This time flexibility could help installations to plan mitigation investments to reduce overall costs.
- At the end of each calendar year, installations have four months to gather allowances to comply with the previous year's objective. Unused EUAs can be used for the following year within one period. Only France and Poland allow limited banking from 2005-2007 to 2008-2012.
- If an installation does not surrender allowances commensurate with its reported emissions, it must pay a penalty of EUR 40 per excess tonne of CO_2 (EUR 100 in the second period). In addition, it must surrender the missing allowances in the next calendar year. As a result, the financial penalty does not cap the price of allowances.

The European Commission provides the community international transaction log (CITL), a multinational system of linked electronic registries for EUAs, but no central trading place. This registry system is separate from trading activity. Not all trades produce a change in the ownership of allowances. When a trade culminates in a change of ownership the registry system will transfer allowances between accounts. No money can be exchanged via the registry.[45] Once the CITL and the ITL – international transaction log – have verified the transfer, the registries execute it.

The legal frame of the EU ETS does not specify how and where the market operates. Companies with commitments may trade allowances directly with each other, via a broker, an exchange or another market intermediary.

National allocation plans

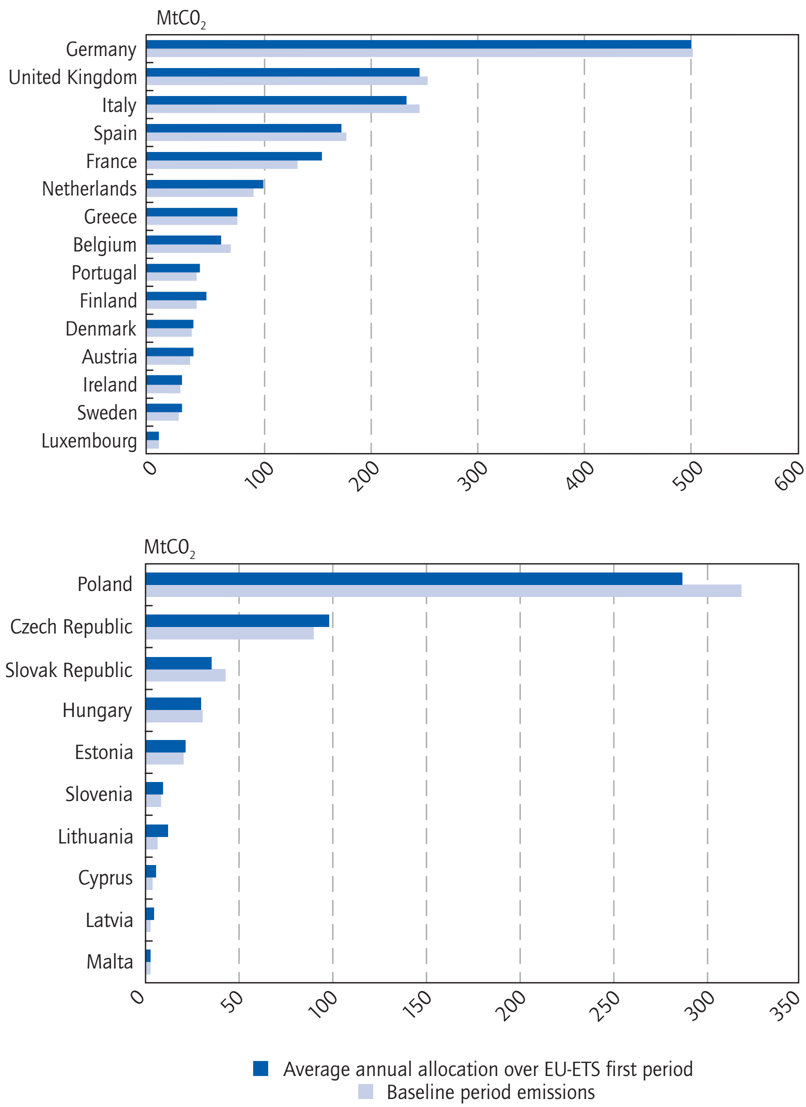
National allocation plans (NAPs) are the backbone of the EU trading scheme, as they define individual installations' allocations, and other conditions of the system's operation within each country. The Directive provides eleven allocation criteria that member states reference in crafting their NAPs. Among these criteria is the requirement of consistency between the national allocation scheme and the member states' commitment under the Kyoto Protocol.

Of primary importance is the overall level at which the cap has been set, indicating the level of effort required from participants in the system. Overall, the Commission estimates total allocation for the first commitment period (2005-2007) as representing a minor reduction from business-as-usual trends, and a slight increase from recent emission levels. It remains much lower than 1990 levels for this set of sources. This general view conceals important differences across countries and sectors, as hinted in figure 4, which displays overall allocations relative to base year emission levels for most of the EU countries. We note that countries have used different base years to

45. Account holders must propose a transfer of units (e.g. EU allowances or Kyoto units - AAUs) into another account within the registry or within another national registry.

Figure 4

Allocations relative to baselines
(EU 15 and new Member States)



Source: National allocation plans.

calculate reductions required by different sectors. In the end, the twenty-five countries' national allocation plans show a number of variations that reflect the primacy of capped sectors in the national economy, as well as the general economic context.

Coverage

The percentage of total greenhouse gas emissions covered within each nation by ETS ranges from approximately 20% in France to 69% in Estonia. Differences stem mainly from the contribution of the power sector to the country's total emissions. The number of installations participating in ETS ranges from 2 in Malta to 1849 in Germany.[46] There exist of course great differences in the size of installations, as 55% of installations covered by the trading scheme emit only 3% of its total emissions.[47]

Computing the allocation

For installations recording historic emissions, states employed various formulae to calculate credit allocation. The Dutch NAP provides an example of such a formula:

A = *HE.G.EE.C*, where

A - Total allocation to an individual installation
HE - Historic emissions (2001-2002)
G - Sector growth (2003-2006)
EE - Relative energy efficiency
C - Correction factor to remain below the overall emission objective

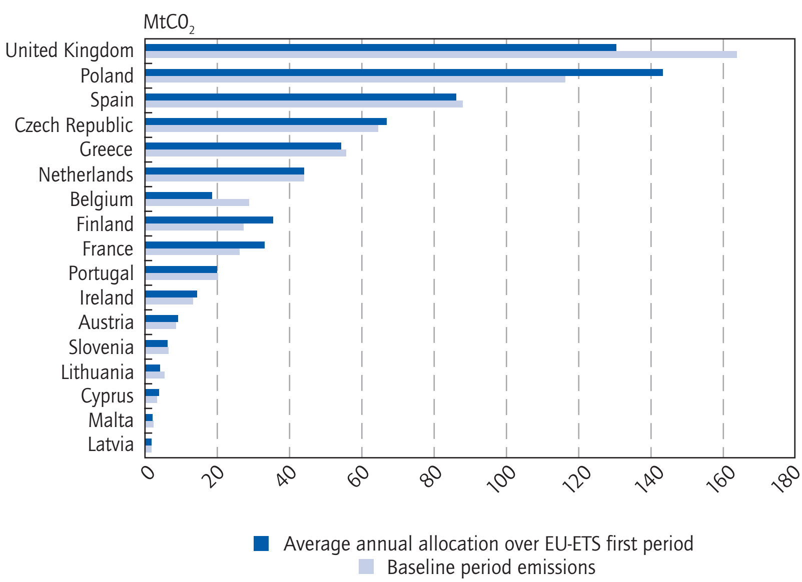
46. *European Commission, press release, 20 June 2005.* Emissions trading: Commission approves last allocation plan ending NAP marathon.

47. *Seb Walhain, presentation at Chatham House conference* – Emerging carbon markets, can they deliver? 16 June 2005.

Of critical importance in the above is the correction factor, as it defines the stringency of the allocation to specific sectors. Indeed, between nations, large differences arise in volumes allocated to identical sectors. As illustrated (see figure 5), allocated emissions for the electricity sector range from 30.9% above the baseline (Finland) to 21.5% below the baseline (UK). Baseline emissions are differently identified from plan to plan, beyond the different choice for reference years – e.g., they include sometimes installations that have operated in the baseline period but no longer at the time the allocation plan was elaborated.

FIGURE 5

CO_2 allowances in the European electricity sector



Note: data are not available for all EU countries.

Baseline periods

National allocation plans invariably list an emissions reduction target relative to emissions in 1990, following the example of the Kyoto Protocol. However, this historic baseline is rarely used in calculating emissions allocations over the first period of the ETS. For the established EU-15 and most of the EITs, base years begin in 1998. Only France includes emissions from as far back as 1996 in the average used for power generation. Malta and Cyprus, as non-Annex I countries under the UNFCCC, do not face binding emissions reductions under Kyoto and have calculated allocations following projected business-as-usual emissions growth.

Most European governments used a unique set of base years to calculate allocations to each sector covered by emissions trading, before adjusting allocation formulae with the coefficients for efficiency and emissions reduction potential, among others. NAPs with heterogeneous baselines often seek to correct for abnormal events affecting emissions, e.g., a particularly harsh winter in Latvia. France, too, calculated baseline emissions for its twelve trading sectors from eight distinct reference periods, citing divergences in prior emissions reduction efforts, among other motivations.

Accounting for growth

An instrument of emissions reduction, the emissions trading scheme nevertheless allows for emissions growth commensurate with economic expansion. However, these economic considerations must be made in the allocation at the outset, rather than during the commitment period. The French environment ministry had originally proposed a special for economic growth. The European Commission withheld approval for France's 4.5 $MtCO_2$ reserve for unexpected economic growth during the period. Deeming the reserve "excessive", the Commission then noted that this ex-post allocation would undermine the value of allowances meant to represent a constrained commodity. The Commission rejected ex post adjustments in 13 other plans.

Rewarding early action and efficiency

Most nations do not compensate operators directly for early action – that is, efficiency and CO_2 mitigation measures introduced prior to the EU ETS. The Czech Republic, Germany, Hungary and Poland budget early action reserves in their total allocations.

To encourage more efficient use of energy, many NAPs have identified allowances in the new entrants' reserve for plants installing new combined heat-and-power generation between 2005 and 2007. Most notable among these reserves is Spain's 36.09 $MtCO_2$. Other national allocation plans reward co-generation during the calculation of an installation's grant: in Luxembourg, installations with CHP received an allocation based on a correction coefficient of 1, a more favourable treatment than the standard correction factor of 0.91 used to calculate allowances for other activities (see equation above).

Auctions

While the Directive sanctions the distribution of up to 5% of a nation's total allowances through auction, only Hungary, Denmark, Ireland and Lithuania will auction a percentage of their total allocations. Twelve nations plan to auction allowances remaining in their new entrant reserve at the end of varying periods: annually, or at the end of the first period.

Installation closure

For the purpose of allowance allocation, definitions of plant closure vary among the national allocation plans. Among those states employing a definition based on marginal reductions, Germany and Luxembourg set a threshold of 10% of a plant's average annual baseline emissions to indicate closure. In the majority of the national allocation plans, undistributed allowances replenish the new entrants reserve. Most importantly, plans differ on whether installations should be issued allowances for the remainder of the period upon closure.

Treatment of new entrants

Member states follow several means to incorporate new installations into the emissions trading scheme. Aside from the exceptional cases of Malta and Cyprus, where no new growth is planned before 2007, each state operates a new entrant reserve of allowances that expires at the end of the first period. Allowances for new entrants are generally distributed without charge on a “first-come, first-served” basis.

Austria provides an example of how allocations are calculated for those installations entering emissions trading without historic emissions data. A new entrant’s first period allocation represents the combination of the fixed figures of its approved capacity and that of its trading sector average and its expected capacity use, assuming an efficiency level based on the best available technology. Latvia uses the following formula, in the case of thermal power plants:

$$EQ = \frac{N_{el}.T.R.100}{\eta}, \text{ t } CO_2, \text{ where}$$

EQ Total allocated credits

N_{el} Total installed electric capacity, MW

T Number of working days, h/year (5000 is assumed in the absence of reference data)

R Emission factor, t CO_2/MWh

η Thermal efficiency, in % (in the absence of reference data, 40% is assumed if using coal or peat and 50% if natural gas)

As noted above, allowances no longer required by closing plants often funnel back to the new entrant reserve. Whether these reserves are general or specific to each trading sector is another variable of the NAPs. The majority of states operate a reserve open to all installations.

Transfers

Following a plant’s closure, several states authorise the conditional transfer of emissions allowances to the other installations of its operator.

In the Austrian NAP, this transfer must credit "better capacity utilisation" within the pool of a unique operator. Even then, the mechanism is subject to further consideration. Germany takes a slightly different approach, enabling the transfer of allowances between installations of comparable production within three months of one's closure, regardless of operator. This limit may be extended to two years, given the technical impossibility of quickly commissioning a new plant. Allowances allocated to the closed installation may be transferred to another for four years. Following this initial period, allocations to the new installation will be based on a compliance factor of one for the next 14 years. The plant's allocation will then be calculated on the average annual emissions of the new installation over this period, rather than treated as a new entrant.

Banking

In the first commitment period of the EU ETS, only France and Hungary have allowed entities to bank unused EUAs for use in the second period. The concern is that any EUA banked from 2005-2007 adds one unit more to the burden of the Kyoto Party's otherwise fixed assigned amount. The possibility to use CERs, whose validity extends to the Kyoto commitment period, creates an option for entities that wish to bank: they should surrender EUAs for compliance with 2005-2007 and reserve unused CERs for later use.

EC approval of national allocation plans

According to the Directive, NAPs must be approved by the European Commission, following criteria as listed in the EU ETS Directive, such as the need to prevent over-allocation. In reviewing the 25 NAPs over two years, the Commission identified three common faults:

- The overall allocation in 2005-2007 may jeopardise compliance with the Kyoto target.
- The volume of allowances allocated exceeded projected emissions.

- Many countries left open the possibility of ex-post adjustments through two means. Redistribution of allowances from closing plants among participating companies and reserving a portion of the total allocation in a reserve to account for unexpected output growth beyond new entrants. However, according to criteria 10 of the NAP guidance document, allocation cannot be changed during the trading period to make up for potential differences between the situation based on which allowances were calculated, and the actual situation during the trading period. The Commission argued that this would create uncertainty for business and for the allowances market.[48]

Through the various adjustments and revisions that the Commission required to see implemented in NAPs, it is generally believed that the Commission ensured the scarcity of allowances, henceforth creating the incentive to trade and enabling an effective trading system. The Commission's assessment of NAPs has meant a reduction of some 290 million allowances, or 4% of the total allocated to EU industry.[49] Observers and market players estimate that the scheme currently faces a 200 $MtCO_2$ shortfall over the three-year period.[50]

What drives prices under the EU ETS?

The first nine months of 2005 recorded EUAs transactions totalling more than 170 $MtCO_2$, with each trading day adding some 2 $MtCO_2$ to this number. This is a striking increase from 107 $MtCO_2$ traded worldwide in 2004. Prices rose rapidly as the European trading infrastructure became operational (see figure 6).[51]

48. European Commission (2004a).

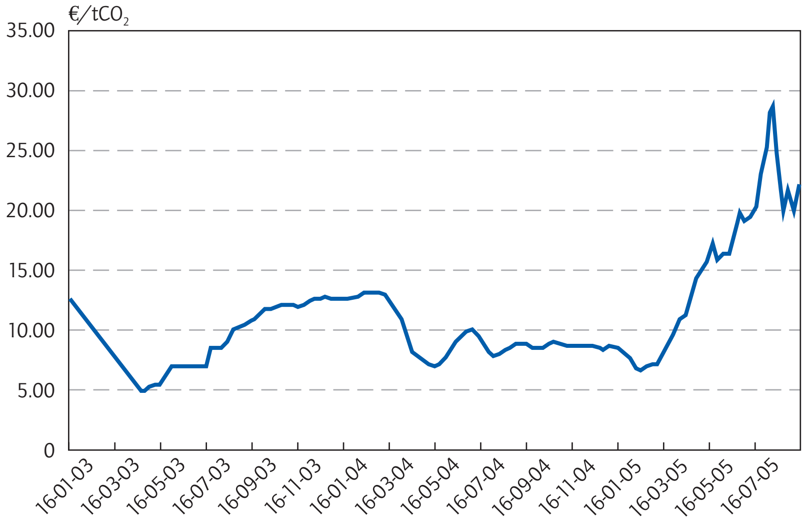
49. European Commission, 20 June 2005, see above.

50. E.g. Stefan Jüdisch, Fifth IEA-IETA-EPRI workshop on greenhouse gas emissions trading, www.iea.org.

51. World Bank, 2005.

Figure 6

EU ETS CO_2 prices for calendar 2005 allowances



Source: Point Carbon, IEA, Argus.

Until recently, bilateral transactions and those conducted via brokers accounted for the majority of EUA transfers. In addition, in the past year, seven CO_2 exchanges have emerged in the EU: Climex, a Dutch exchange focused on small GHG emitters; the UK-based European Climate Exchange (ECX); the Leipzig-based European Energy Exchange (EEX); the Austrian Energy Exchange (EXAA); Scandinavia's Nord Pool; France's based PowerNext, and Spain's Sendeco, open to both small and large emitters. These platforms will each offer either spot, forward or futures contracts. However, the expected volume of the carbon market does not allow for this many exchanges, as illustrated by the June 2005 announcement by ECX and Powernext of their formal cooperation to trade both spot and futures contracts.

Energy commodities and EUAs differ most significantly in the immediacy of their demand: there exists no daily or hourly need for emission allowances, while industrial installations require a steady energy supply. Installations subject to the EU ETS must meet demand only once yearly to cover twelve months of emissions. Further, installations already hold the vast majority of the needed allowances. Nonetheless, traders hedge against EUA price movements to maximise profits. This fundamental difference between CO_2 and standard commodities renders the carbon market less liquid and deep than that of another commodity like oil.

Despite active trading and rapid growth in price since January 2005, the EUA market remains the preserve of relatively few actors. Participants expect the growth of a carbon spot market to accompany the launch of national registries: as of September 2005, only 11 of the 25 registries were in operation.

Spot contract trading will encourage much more general coverage than that of forward transactions and, thus, fewer market distortions.[52] Fundamentally, comprehensive participation would follow a stringent, shared environmental constraint. Installations with allocations sufficient to cover their needs will be less motivated to trade than those with a deficit in allowances, required to seek least cost compliance.

Several factors will influence the unit price of carbon under the EU ETS:

- The stringency of emissions caps. This is a function of the initial allocation – it is assumed that allocations are lower than business-as-usual emission projections – and of the economic environment of the underlying activities. For instance, a sustained demand for steel would obviously increase emissions in the near term and drive demand for allowances. Similarly, demand for electricity-intensive products would also put pressure on the power sector to marginally reduce emissions per unit of output.

52. According to market players, there has been a problem with credit or legal clearance between counterparties. Sources reported being unable to trade with particular counterparties due to a preference for a different contract, while for others, credit clearance is still an issue. Lack of clearance can mean that on occasions the best offer or bid may not be from cleared counterparties, forcing the buyer or seller to seek the next best bid or offer and thus distorting the true market level. This problem may be of a transitional nature, however.

- The external supply of project-based mechanisms. An abundant supply of CERs (and ERUs in 2008-2012) could dampen the price of EUAs, as EU firms fill compliance shortfalls with inexpensive CERs and ERUs. The comparison of current prices confirmed the expectations that EUAs will be more expensive the project-based units (EUR 5-7 per tCO_2 against EUR 10-25 for EUAs). As previously noted, it is not yet clear that CDM and JI can adequately supply the Annex I Kyoto parties' demand for credits. However, relatively relaxed emissions constraints could limit demand for EUAs and increase the relative share of project-based units in firms' compliance.
- Relative fuel prices. For some industries, especially power generation, the price of gas relative to the price of coal drives operating choices. All other variables being equal, a relatively high gas price encourages the use of coal, driving demand for CO_2 allowances. If such a phenomenon is sustained and EUA supply tightens, CO_2 prices may reach a level that favours gas, a cleaner fuel, as more competitive. Choices in fuel switching will be further examined below.
- Weather: temperature, rainfall, cloudiness. A dry year in Scandinavia is likely to trigger more demand from fossil-based generators and increase emissions – a scenario that has frequently caused Denmark's emissions over the past two decades, as its coal-based generation supplanted power usually produced by defaulting hydro plants in Norway and Sweden.[53]
- Regulatory features. Several NAPs specify[54] the operator forfeit of EUAs to be allocated to closing plants. As operators cannot sell any of these allowances, they are discouraged from closing inefficient plants to reduce emissions. This should, in a tight market, propel prices up. We will discuss plant closure in more detailed below.

53. "A warm, wet and windy winter would lower actual emissions, power consumption, CO_2 prices and UK gas prices... improve the hydro situation and increase wind production. It would lower the utilities' income substantially but bring them closer to compliance." Carbon Market Europe, 1 July 2005.

54. For instance: Austria, Denmark, Finland, France, Sweden, the United Kingdom. Others, like Germany, Hungary, Portugal, or Slovenia make it possible to transfer to firms that are opening plants.

Because not all registries are operational and EITs thus far reserve their allowance supply, purposes of speculation rather than those of compliance probably drive trading. Only when compliance requirements dominate allowance demand will the market's carbon price reflect the actual marginal cost of an avoided tonne of CO_2.

As of June 2005, the coal-to-gas spread in power generation was primarily responsible for EUA prices of EUR 25/tCO_2.[55] At this price, gas-based generation would theoretically surpass coal-based generation on the power market.[56] At this early stage, any increase in gas prices is immediately followed by an increase in EUA prices.[57] The theoretical dynamic of CO_2 and electricity prices is addressed below.

CO_2 prices in electricity markets

Electricity market competition has grown parallel to the development of carbon market. The competition in the generation and supply of electricity has been introduced to improve this industry's economic efficiency with an aim to deliver electricity at lower prices. Under perfectly competitive conditions, the value of CO_2 allowances should be reflected in the short-run generating costs of fossil-fired plants and thus in wholesale electricity market prices. This phenomenon is well known to economists and had been documented by IEA through its market experiment with the electricity industry.[58] Yet the impact of rising electricity prices is the industry's focus in its complaints about the EU ETS's effects on international competition.

Wholesale electricity prices incorporate generation costs through complex means that breed disagreement on how current electricity

55. There is a tendency to look only at the power sector to explain CO_2 market price movements, as its technology options and related CO_2 emissions are well known and it represents more than 50% of the total emissions in the scheme. There may be mitigation options in other sectors that could influence the price of traded carbon although these are not on analysts' radar screens at the moment.

56. However, market analysts pointed out that this spread is much higher in the UK, where a large capacity to shift from coal to gas exists in the near term. The current price may therefore not reflect the broad EU picture.

57. Chatham House conference: Emerging Carbon Markets: can they deliver? June 2005.

58. See IEA, 2001, and Baron, Boemare and Jakobsen, 2002, for a report on the BASREC-Nord Pool simulation.

prices reflect market fundamentals. In this context, the impact of EUA prices on end-users' electricity prices is difficult to quantify. The sections to follow predict how prices should behave in the electricity markets.

In theory the spot electricity price serves as the reference for all traded contracts, including those of longer duration, assuming a credible spot market. This is the case in Nord Pool, the Nordic electricity market. Likewise, the European Energy Exchange, located in Germany, has a financial market for standardised contracts that use the spot price as a reference. In less organised markets, consumers may consider grandfathered allowances soft costs, since their price is not paid by power producers, and negotiate a lower price for their electricity. Industrial consumers argue that such negotiation margin does not exist in organised markets.

Short-term prices

Short-run marginal costs (SRMC) are essential to competitive market price. To determine wholesale price, many power markets rely on a central day-ahead auction in which generators submit individual offers of quantity and price. The system operator determines the market price from these offers and bids on the demand side. The process produces a merit order dispatch which indicates which generators and technologies will sell to the market and when.[59]

In this context, plants' generating costs should fully account for the value of carbon emission allowances. The production of fossil-fuel based electricity always competes with the opportunity to sell the corresponding quantity of CO_2 allowances on the allowance market. However, other considerations may guide the firm's decision to reflect the full opportunity cost in power prices. Among these factors, the total generation capacity on the market, the fuel mix, the demand curve, and the method of CO_2 allocation applying to new entrants. The availability of capacity on the power market entails different outcomes:

59. *The price is determined on the basis of the marginal bid that meets the marginal unit of demand, which forms the system's price for a particular trading interval. The market operator (which is not necessarily the system operator) then dispatches generation to meet demand in real-time subject to network constraints.*

- If the demand approaches the upper bound of the market supply capacity, competitive pressure from extra available capacity will be low or nill. In this case, CO_2 emitting generators should add the full opportunity cost of CO_2 to their prices. Danish generators have been able to fully pass the cost of the CO_2 penalty to prices in the Scandinavian markets.
- The case of extra available capacity presents two further scenarios:
  - Two technologies like nuclear and coal-based, characterized by a gap in short-term marginal cost, compete to supply the market. In this case, the carbon cost would not change the power plants' rank in the merit order.[60] Thus, market power price would fully reflect the opportunity cost of CO_2 allowances.
  - Competition among generators is such that incorporation of the carbon cost would change generators' positions on the merit order. As illustrated in figure 7, the coal-based generator may sell at a price below its marginal cost in order to preserve its share of the wholesale market. Producers may follow this strategy because grandfathered permits represent a lump-sum subsidy which cover part of their losses.

Investment in new generation capacity

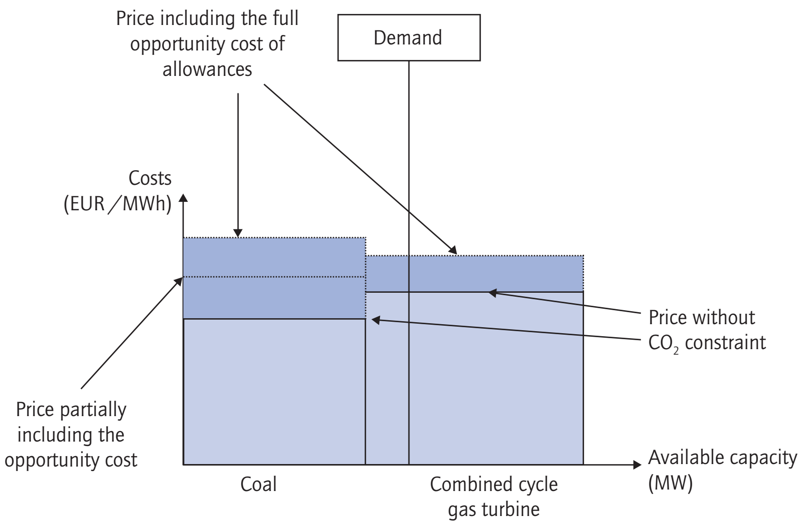
Ideally, an effective emissions trading system would require long-term power prices to increase by the value of emission allowances. In effect, to encourage investment in new carbon-lean capacity, expected wholesale prices need to cover the future long-run marginal costs of generation, including that of CO_2. These costs include operating and capital costs required for new capacity.[61] In liberalised markets, long-run marginal cost should cap electricity prices. If electricity prices exceed this level for an extended period, new plants should be built to provide power at lower prices, though still at a profit, depressing long-term prices.

60. In this case, marginal generator is not a pivotal supplier over a particular interval of the aggregate supply curve, regardless of the carbon price.

61. Forecasted future market prices are still, often, tracking current market prices. Therefore, the prices which actually encourage plant construction are current market prices that are above the long term marginal costs.

Figure 7

Change in merit order triggered by the CO_2 price



If new entrants into emissions trading are allocated part or the totality of their allowances for free, they will tend to choose more CO_2-intensive technologies than if they had to fully cover their emissions with allowance purchases. In effect, the free allocation acts as a subsidy for CO_2 emissions in an environment where CO_2 carries a cost, as illustrated in table 6. Assuming current coal and electricity prices and a price of carbon of EUR 20/tCO_2, investment in coal-based generation would be discouraged if new entrants were to buy the totality of allowances needed to cover their emissions, as shown by the negative return on investment displayed. Even if generators are not granted allowances matching their projected emissions, and must purchase allowances later, they will enjoy a relatively higher profit.

Table 6

Investment cost with or without gratis allocation

CO_2 price: €20/tCO_2		New entrants receive a free allocation matching projected emissions	New entrants must buy allowances to cover emission
Fuel price	€/GJ	1.7	1.7
Fuel costs	€/MWh	14	14
Cost of capital	€/MWh	13	13
Variable maintenance costs	€/MWh	3	3
Fixed O&M costs	€/MWh	4	4
Cost of CO_2 allowance	€/MWh	16	16
Subsidy from gratis allocation	€/MWh	16	0
Power price	€/MWh	47.12	47.12
Return on investment	€/MWh	11.9	-4.1
Profit and losses	%	25	-9

Neuhoff et al. (2005) highlight the drawback "updating", the approach to allocation taken in the EU ETS. Under updating, allocations are based on emissions in the preceding years, creating an opportunity cost to not-emitting. This affects the way the price signal is passed through in the EU ETS: in theory, the opportunity cost should equal the price of carbon. Here it is reduced by the incentive to produce and emit more, in order to obtain a higher allocation in the next round. As a result, electricity prices should not fully reflect the allowance price at the margin.

The carbon price will affect electricity prices, as the recently observed increase in electricity prices seems to confirm. However, the extent to which the carbon constraint will determine investment decisions and long term energy prices will depend on the treatment of new entrants vis-à-vis their allocation and on the use of updating as an allocation method.

The role of electricity, coal, gas, and CO_2 price uncertainties on investment decisions is a strategic dimension thus far absent from static cost analysis (see box 5).

Box 5
Investment under uncertainty

Stringent climate policies would very likely require power plants to associate costs with carbon emissions. Coal-fired power plants emit substantially more CO_2 per kWh than plants using other fuels. High CO_2 prices could therefore damage their competitive market condition as consumers sought cheaper power from other producers. Fortunately, coal-fired power stations can mitigate this risk. Among these, fuel switching: the power plant replaces coal with a carbon-lean fuel such as natural gas. Per kWh, gas plants emit 40% less CO_2 than coal plants.

Electricity prices (e.g. in wholesale market), fuel costs (coal and gas), and the carbon value guide decisions to repower a coal plant into a gas plant. Optimal plant management must weigh the financial risks and benefits of fuel switching. Because the investment is irreversible, rational behaviour may dictate delayed investment until resolution of the gravest market uncertainties. This implies that a higher CO_2 price might compel fuel switching. A real options analysis quantifies the price increase required.[62]

According to a study undertaken by EPRI, the price of CO_2 at which it is economic to invest in fuel switching in the United States is USD 35/tCO_2 assuming certainty in CO_2 prices, power and fuel prices. However, accounting for uncertainty in these prices would drive the price to USD 55 before the investment is deemed profitable.[63]

62. Investors often use real options theory for valuing options on financial markets and apply them to 'real' assets. Financial options are characterised by a fundamental asymmetry of risk – the holder has the option, but not the obligation, to gain ownership of an underlying asset (e.g. a stock) at a certain price. Once taken, the decision to exercise the option is irreversible. Many investment decisions share these same characteristics. Real options analyses can give a picture of the trigger point for an investment decision that differs significantly from that provided by analyses based on net present value.

63. EPRI, 2003.

Implications for industrial competition

The EU ETS is embedded in the broader regime created by the Kyoto Protocol, but applies only to a subset of countries and industrial activities whose products, in some cases, face competition from industries without emission constraints. Emissions leakage could happen if the latter were to gain considerable competitive advantage – while constrained sources reduce their emissions, their efforts, and the policy's effect, would be offset by increased emissions elsewhere.

Earlier IEA work has examined the possible consequences of emissions trading for several industries – considering both the direct and indirect costs associated with emissions trading, assuming an average allowance price of EUR 10 per tCO_2.[64] Industrial survival will hinge on firm's capacity to reflect the additional cost of emissions constraint in the price of their product without losing market share to non-carbon constrained competition.

The electricity sector may be the only in a position to reflect part or all of the opportunity cost of holding CO_2 allowances, as opposed to the actual abatement cost plus the cost of acquiring allowances if emissions rise above targets. With a low effect on prices of CO_2 intensive products, the EU ETS loses a means to achieve reductions at least cost, that is, the substitution of least-CO_2 intensive products for those that carry a carbon constraint.

Based on this arguably low price of EUR 10/tCO_2, participation in the EU ETS would only modestly impact the cost structure of energy intensive industries. Non-cost aspects of competitive edge are more difficult to assess. Higher CO_2 prices, local circumstances, especially power prices, and higher exposure to foreign competitors could of course alter these conclusions. Even an installation not constrained by the EU ETS may find its market share affected by the EU ETS. While EU aluminium-smelting is not covered by emission trading, rising electricity

64. This discussion is based on Reinaud, 2004.

prices may gravely damage its position in the world markets. Imports in steel and aluminium products could increase their market share in Europe in spite of freight costs and border tariffs.

In the short run, we find that the gratis allocation of allowances to industry limits the impacts on industry's costs, when compared to allocation by auction of allowances.[65] Economists consider grandfathering to be a transitory measure, introduced to minimise the negative effect of a new constraint on productive equipment purchased before such constraint. For the price signal to operate unhindered, new entrants should acquire allowances from the market to completely offset their emissions. Policymakers have chosen otherwise, with most NAPs introducing reserves for new entrants.

To preserve their competitive edge, many industries voiced their strong preference for output-based targets over the absolute targets stipulated by the EU ETS. Some argue that this choice would facilitate the adoption of more ambitious reduction goals, at once enabling industrial growth and reducing emissions relative to each sector's technology capability.[66]

However, others have argued that relative targets may foster regulatory capture where authorities come to be dominated by the industries regulated.[67] The establishment of relative targets would require careful examination of industrial engineering and process, a domain where industry itself controls the access to information and thus the strategic advantage. In addition, the measure of "output" to be used for output-based targets may turn out to be very difficult, for instance when an industry's products are not homogenous.

65. A study focused on the effects of the EU ETS on the UK industry arrives at similar conclusions (Carbon Trust, 2004).

66. See, e.g., IEA 2002a, and chapter 4 in this publication for arguments in favour of dynamic targets for countries, on grounds that may apply also in the case of industry.

67. See, e.g., Quirion, 2005. The theory of regulatory capture argues that regulation may be turned into a "process whereby interest groups seek to promote their private interest... Over time, regulatory agencies come to be dominated by the industries regulated" (Posner, 1974).

Further, dynamic targets seem to imply a free allocation: a company that meets the intensity objective is not obliged to buy or sell credits. A new entrant that meets the criteria of technology efficiency cannot be asked to acquire allowances covering its emissions, as this would constitute an absolute cap. Dynamic targets prevent new entrants from realising investments that fully reflect the cost of the constraint on emissions. Dynamic targets subsidise production: any increase in output triggers increase in the source's holding of allowances. Rather than lowering its output, it will be less inclined to pass the cost onto consumers, hereby reducing the allowance subsidy. This negates part of the economic signal provided by emissions trading – and its efficiency in controlling pollution.

Allocation only partly determined by output and the requirement that new entrants purchase a portion of their needed allowances both strengthen the price signal of relative targets.[68] These alternatives balance the health of international competition and the incentives to reduce CO_2 emissions, but at the price of greatly increased complexity and the risk of regulatory capture. Capping the price of allowances also mollifies concerns about excessive compliance costs. In both cases, however, governments and taxpayers would bear the cost of industry's excess emissions. Each alternative requires either a purchase of allowances on the market or more costly reductions in other parts of the economy, as the country would still need to meet its cap.[69]

As EU policy makers engage developing regions in multilateral abatement, common concerns of emissions trading effects on competition and associated leakage must be at the fore of negotiation. EU concerns over competitive advantage and leakage may otherwise undermine the sustainability of industry's emission reductions under the EU ETS.

68. For instance, a difference of 10% in output, compared to expectations on which the allocation was based, would only entail an adjustment of 5% of the allowances. The other 5% would need to be bought on the market. Similarly, intensity targets for countries are only one form of indexed targets (see chapter 5)

69. The case may be different if countries' targets were themselves indexed or price-capped.

Projected developments

During the first period, the Directive does not apply to the aluminium, chemicals and transport sectors – let alone small businesses, services and residential buildings, unless their combustion plants are above the 20 MW threshold. The Directive does provide for the possible future extension of the scheme to other sectors (e.g., aluminium, chemical industry, road transport, aviation, etc.) and to other gases. As the scheme now faces its first real-life test, the debate is already focusing on the revision of the Directive.

The European Commission started a "comprehensive overview with stakeholder involvement" on 1st January, 2005 and will produce a report by mid-2006. The review takes account of:

- The extension of the scheme to other gases and sectors. Recent communication indicates that aviation may be a candidate for such extension.
- The effects of system on competitiveness, including international competition.
- The impact on electricity prices.
- The harmonisation of national allocation methods for CO_2 emissions which, in its current form, leaves member states with considerable room for interpretation.

However, any thorough review of the Directive will need approval by the Council and Parliament, a process which can take several years, and there are doubts concerning the feasibility of any significant change to the Directive to be ready for the 2008-2012 commitment period.

Looking beyond Europe's frontiers, the Directive makes it possible to link the scheme with other similar systems established in industrialised countries that have ratified the Kyoto Protocol, and "should examine whether it could be possible to conclude agreements with countries listed in Annex B which have yet to ratify the Kyoto Protocol."[70] This would require a bilateral agreement between the EU and interested parties.

Norway has already announced that it seeks to link its own domestic emissions trading system with the EU ETS, on the ground that it would benefit from access to such a large allowances market.

An early assessment

As a unique market-based instrument for environmental policy, the EU ETS is unprecedented in its coverage of activities and emissions, and its expected contribution to internalising the cost of GHG emissions in the economy. As the Kyoto Protocol trading mechanism do not specify whether and how countries should devolve parts of their commitments to so-called domestic entities, the European institutions mark significant progress. The EU ETS acknowledges that industry itself is best equipped to engineer emissions reductions at lowest cost and, as such, is the ideal economic agent to participate in a cap-and-trade regime. The scheme, with some 11,500 installations and a diversity of activities, should guide creation of an international, liquid, GHG emissions market.

Such a major policy endeavour progresses through learning-by-doing among policy makers and liable entities alike. The importance of this transition should not be dismissed: at this moment, installations shift from an environment without a carbon constraint to one in which carbon carries a cost. This transition requires market development, the rise of competing exchanges and market intermediaries. New business practices must be developed accordingly.

The initial phase of the EU ETS does not impose drastic cuts in industry's emissions, reflecting the limited time allocated to mitigate between the negotiation of national allocation plans, expected,

70. See Article 25 in Directive 2003/87/EC and paragraph (18) in Directive 2004/101/EC.

although rarely delivered, by 31 March 2004, and the actual start of the commitment period on 1 January 2005. For this reason, in the absence of an international commitment before 2008, the absolute level of reductions in this first commitment period cannot serve to measure the system's success.

Eventually, the system must be assessed against its initial objective: the establishment of proper incentives to invest in reductions at least cost. Policy makers have also sought to guard against negative impacts on competition and the possibility of serious emission leakage. A grandfathered allocation and reserves for new entrants reduce the direct cost to industry. European industry presents the effects of a wholesale power price incorporating the full marginal cost CO_2 emissions as potentially more damaging than the direct cost of industry's own emissions. When considering the limitation of these indirect costs, policy makers must keep in mind that a full, unhindered price signal ensures a least cost outcome, in the absence of market failures. The apparent trade-off between the competitive edge and the risk of leakage on the one hand, and the effectiveness of the emissions trading scheme on the other, will remain important in future developments of the scheme.

The first nine months cannot provide evidence adequate to assess the efficiency of the EU ETS. However, a few pernicious aspects of the EU ETS may justify an "early warning", even if solutions are not obvious.

A short-term bias

Most NAPs cancel the issuance of allowances to closing plants. If the allocation were left intact, for a period to be determined, Ahman et al. (2005) point that *"if it is profitable for the operator to close an installation and sell the allowances to a more efficient plant, this will be the efficient solution and the intended effect of the trading scheme".* As a result, *"the withdrawal of allocation based on an observed economic decision such as plant closure turns the allocation into a* *subsidy to production, because the firm earns the allocation if and only if it continues to operate the installation."* Under the current rules, operators choose between maintaining operation and expecting an allocation for this plant, and shutting down, losing the current allocation. As such, an allowance price of sufficient height should deter the less efficient and most CO_2-intensive plants from prolonging their operation. Here, the mechanism encourages behaviour to the contrary.

This paradox exemplifies the more general problem of short-term bias. Given inertia in industry's energy-using capital stock, this issue merits serious consideration now. To efficiently and entirely integrate the carbon constraint, investment decisions must be based on future allowance allocations. As of now, installations can access reserve for new entrants and are then rolled in the next NAP with a five year allocation. A longer-term allocation would provide two clear benefits:

- A stronger incentive to allowance holders operating less efficient plants to stop operations, as they would be encouraged to use remaining allowances to start a cleaner, larger plant, or sell unused allowances. Note that at present, only a very high price of carbon can trigger such a decision, since most NAPs, if not all, cancel the issuance of following years' allowances. Even the favourable case of operator retention of four year's worth of allowances would require a much higher carbon price to trigger closure than if it held 10 to 15 years worth. The current price under the EU ETS is therefore higher than under longer-term allocations combined with the right to retain unused allowances.[71]
- Longer-term allocations would provide certainty that is coherent with the life-time of energy-using equipment, especially in power generation. A generator that knows its general allocation over more than a decade would be in a better position to invest now in the appropriate CO_2-lean technology than if the allocation were determined each five year, partly on the basis of current emissions.

71. See Ahman et al., 2005, and Neuhoff et al., 2005 for a similar point. A long term allocation has a precedent: the US SO_2 allowances programme established emission reductions over thirty years at the outset.

At this early stage of international abatement efforts, allocating emission allowances over many years is politically difficult, hindered as it is by uncertainties over other countries' participation and by the significant rent transfer that long-term allocation would imply – the current system covers more than 2 billion tonnes of CO_2 annually, traded around EUR 20/tCO_2.[72] Policy makers should nonetheless be aware that updating the allocation each five year based on historical emissions, and the cancellation of allowances when installations close discourage reductions at lowest possible cost.

Industrial investments, among other energy-using expenditures, must be guided by the need for much more significant reductions, if climate policy objectives are to be met. To ensure most efficient investment, governments must provide clear signals regarding the long term, in the form of future emission goals. Potential concerns about future abatement costs could be mitigated by the use of allowance price caps, detailed in chapter 5.

EU ETS and global emissions trading

The EU ETS has been purposely isolated from the broader emissions trading regime under article 17 of the Kyoto Protocol, even if it may well become its core. As it is, EU industry cannot acquire AAUs from governments to use in compliance with its EU ETS objective. This isolation can be seen as a means to satisfy the Kyoto requirement that use of its flexibility mechanisms supplement domestic actions.

The linking Directive does create a bridge between the EU ETS market and other transactions for Kyoto compliance. Both governments and EU industry will have access to CDM and JI units. Most probably, these two mechanisms will not produce enough credits to bring the prices of both markets together. This suggests a loss in economic efficiency: abatement costs for some will be higher than for others.

72. Source: PointCarbon, quoted price as of 26th April, 2005 (www.pointcarbon.com).

This dynamic may generate two alternative scenarios. In the first, following the outcome of government-based and other AAU transactions outside the EU ETS, EU allowances would trade at a much higher price than AAUs. Exposed to international competition, European industry may suffer from a price of EUAs, higher than that paid by AAU-supplied, or non-constrained competitors. In this case, governments would use AAUs to offset, at relatively low cost, surplus emissions from domestic sources that are suffering from international competition – domestic transport, residential buildings, services, assuming that they too incur the cost of the carbon constraint.

In the second scenario, the EUA price may become the reference for international transactions, especially if large sellers are in the position to control prices, whereas there is no reason why mitigation costs in sectors not covered by the EU ETS should be identical to that of the industry-based trading scheme. Neither of these outcomes may be realised. However, policy makers should recognise the limited efficiency of a system where a tonne of CO_2 carries many prices, despite the single reduction goal set by the Kyoto Protocol.

GHG Emissions Trading Systems beyond the EU

The following section reviews the development of emissions trading in Canada, Norway, and Switzerland, and the role of emissions trading and project-based mechanisms in Japan and New Zealand's climate policy. Those regional and voluntary trading initiatives described include the Australian state and territory emission trading system; the regional greenhouse gas initiative of nine US States; the proposed Korean emissions trading programme; the Chicago Climate Exchange (CCX); and the corporate tradable permit systems of BP and Shell.

Canada

Since the mid 1990s Canada has analysed designs for domestic emissions trading (DET), since implementing two voluntary schemes: the Ontario-Quebec pilot emissions reduction trading (PERT) programme with provincial coverage between 1996 and 2000, and the greenhouse gas emissions reduction trading (GERT) programme. Established jointly by federal and provincial governments in collaboration with industry and environmental groups, the GERT functioned between 1998 and 2001.[73] PERT and GERT provided industry and governments with pragmatic experience in emissions trading, and spurred the development of Canada's emissions trading infrastructure.

A project-based emissions trading system, PERT authorised the crediting of reductions relative to a project's baseline emissions. The scheme covered several air pollutants, including the six greenhouse gases. Under the PERT rules, emission reduction credits could be created by emission reduction projects that were quantifiable, verifiable, surplus to the requirement of any regulation or voluntary commitment. A given project could not generate credits under some other system. In total, PERT reviewed over 50 projects representing around 19 $MtCO_2$. However, the majority of the credits purchased were bought by Ontario Power Generation to comply with its voluntary corporate CO_2 target, which was not a PERT baseline.

Of similar design, GERT was a baseline-and-credit scheme covering the six greenhouse gases. The programme generated ten projects: fuel switching, wind and solar power, forest and geological sequestration among them, that reduced approximately 380 000 tonnes of GHG per year.[74] However, similar to PERT, the GERT scheme resulted in only a small number of trades. This is a common result in voluntary schemes where there are potential sellers but few buyers.

73. For further information see http://www.city.toronto.on.ca/eia/pdf/ds_tor_et_rpt1_final_june25.pdf; http://www.er.uqam.ca/nobel/oei/emissions/en/context2.html

74. http://www.gert.org/Final/020930%20GERT%20Final%20NR%20-%20English.pdf

Building on the above experience, and its *2002 climate change plan for Canada*[75], the Canadian government announced plans in April 2005 to introduce a mandatory baseline-and-credit scheme which aims to close the majority of the country's Kyoto gap of 270 $MtCO_2$ by 2012. Notably, two market-related initiatives are earmarked to deliver almost 60% of the total reductions needed[76], including: the climate fund, established to purchase 55 to 85 $MtCO_2$ in emission reductions on behalf of the government; and the establishment of an overall reduction target of 45 $MtCO_2$ for the large final emitters (LFE) – the oil and gas, electricity, mining and manufacturing sectors – facilitated by domestic and international emissions trading.

The government has set the following design parameters for the LFE domestic emissions trading system:[77]

- The system will cover about 700 businesses, with 80 to 90 of these businesses accounting for approximately 85% of the LFE GHG emissions.
- The system provides for the purchase of so-called technology investment units from the government's greenhouse gas technology investment fund, at a price of CAD 15 per tCO_2e. Access will be limited to 9 $MtCO_2e$, as such investments are not expected to generate emission reductions until after the first Kyoto commitment period. This feature, known earlier as the price assurance mechanism, creates a cap on the price of compliance. The details of implementation remain to be enumerated.[78]

75. http://www.climatechange.gc.ca/english/publications/plan_for_canada/

76. The Partnership Fund with provinces and territories (55-85 Mt); strengthening existing residential, industrial and transport greenhouse gas reduction programmes (up to 40 Mt) account for the 60%. See http://www.climatechange.gc.ca/kyoto_commitments/

77. http://www.climatechange.gc.ca/kyoto_commitments/

78. A system of contractual agreements (covenants) between government and industry, with a regulatory or financial backstop, had been proposed but was found to add considerable complexity to the system. Further, the covenants allowed for downward adjustments to minimise competition distortion which would have made the overall target more difficult to manage.
See also http://www.nrcan-rncan.gc.ca/media/newsreleases/2002/2002147_e.htm and http://climatechange.gc.ca/english/newsroom/2005/plan05.asp

- The general target consists of fixed sectoral targets to be developed for each activity, relative to its emissions intensity. Process emissions, which only decreased production can reduce, will be subject to a 0% reduction target over 2008-2012. Emissions from all other sources will be reduced by 15%. However, these targeted reductions from other emissions cannot exceed 12% of the total emissions.
- Targets for new facilities and facilities under major transformation will be based on 'best available technology' performance standards. In the event that an LFE closes during the period of the scheme, it will be entitled a permit allocation based on its level of production in its last year of operation and will be required to settle any emission-related obligations.
- To comply, LFE firms can either invest in their own production technology or purchase credits elsewhere. The Canadian government has authorised the use of credits generated by other LFEs, investment in domestic offsets (GHG reduction projects undertaken beyond LFEs activities), and the purchase of international units: ERUs, CERs, but also eligible AAUs ("surplus carbon", an indication of Canada's concerns about the purchase of "hot air") with criteria to be defined.

The comprehensive design of the system will be developed for public review and comment during 2005, with full implementation unlikely to occur before 2008. Canada is considering linking its system with those of other Kyoto Parties, and has also started a dialogue with North-eastern United States and New South Wales, in Australia.

One novelty in Canada's proposed system is its price cap mechanism, rendering moot concerns over indefinitely high compliance costs – provided LFE can access the government's fund for units. The government therefore assumes responsibility for compliance and must itself acquire units on the international market or drive domestic reductions to compensate for LFEs' possible excess emissions. Linking this system with others without price caps may also require intricate choreography, as is discussed later in this chapter.

Norway

Norway introduced a domestic emissions trading system on 1 January 2005, with a scope that is in principle similar to that of the EU ETS. Norway's system covers emissions from 51 installations in the energy production and the process industries: mineral oil refining and the production and processing of iron and steel.[79] These sectors produced 5.5 $MtCO_2$ annually, on average between 1998 and 2001, representing 10-15% of the country's emissions. Installations covered by the national CO_2 tax (almost EUR 40/tCO_2), notably those of the offshore oil and gas sector, are initially excluded from the scheme. The expected low price of allowances compared to the tax was perceived as discouraging reductions achieved so far in the sector. Inclusion would also have meant a double penalty. Abolition of the CO_2 tax would add 50 to 60 additional combustion installations, including in the pulp and paper industry.

The cap-and-trade system's first commitment period runs from 1 January 2005 to 31 December 2007. In March 2005, the government approved a plan to grandfather 20.5 $MtCO_2$ allowances to covered installations, 91% of installations' applications. The system allows for emission growth over 2005-2007, reflecting projected changes in scope, in the nature of some installations and some new entrants. Such allocations are of course depending on actual changes taking place. Excess allowances will be cancelled.

Similar in some features to the EU ETS, the Norwegian scheme recognises the Kyoto mechanisms and penalises non-compliance at EUR 40/tCO_2. It permits banking during, but not across, commitment periods.

79. Point Carbon, Carbon Market Europe, 17th December, 2004; also http://odin.dep.no/md/english/doc/regelverk/acts/022051-200015/dok-bn.html

The Norwegian government expects the system to yield between 500,000 and one million tonnes in annual reductions. As this represents less than 10% of Norway's Kyoto target, access to a liquid and sizeable market of emission allowances such as the EU ETS will be essential to the cost-effective compliance of Norwegian companies.

The government had indicated earlier that it would consider expanding the system from 2008 to include as many sources of emissions as practical through an upstream system allocating allowances to fossil fuel producers and importers. With the adoption of the EU ETS design features, Norway seems to move away from this option. Chapter 4 explores how to broaden the scope of trading beyond industrial sources.

Norway is currently exploring linking its system with the EU ETS – either via the mutual recognition of allowances enabled by Article 25 of the EU Directive, or as part of the European Economic Area. Those issues that must first be resolved include whether Norway would be required to implement the EU Directive immediately or from 2008, and whether the offshore sector should remain outside the system.

Switzerland

Switzerland introduced a CO_2 Law in May 2000 to reduce CO_2 volumes by 10% by 2010 in preparation for compliance with the nation's Kyoto commitment.[80] To this end, Switzerland requires reductions in heating and process fuel and motor fuel emissions by 15 and 8% respectively. Nearly a thousand Swiss companies have also pledged to cut their plant and factory emissions by 15 to 20% by 2010. However, data from SAEFL (Swiss agency for the environment, forestry, and landscape) project existing measures to lower overall emissions by only 3.8% below 1990 volumes, the rise in transport emissions outweighing industry's emission reductions.

80. http://www.environment-switzerland.ch/swissflex/eng/emissionstrading/ch/index.html

In this context, Switzerland introduced a voluntary domestic emissions trading to yield additional GHG reductions. Currently under development, the Swiss cap-and-trade scheme is expected to cover approximately 5 $MtCO_2$, or 40%, of industrial emissions. Under the scheme, companies will be able to sign a legally binding commitment to reduce the energy-related CO_2 emissions in exchange for an exemption from a CHF 35/tCO_2 tax on heating and process fuels.[81]

Allowances will be allocated relative to negotiated caps for 2008-2012. The reduction targets should be calculated to account for CO_2 reduction measures already implemented and output projections for 2012, and the reduction potential of both technical and economical feasibility. The government uses industry benchmarks to determine reduction targets for small to medium enterprises. As of September 2005, some 300 entities had agreed to emission targets, with some 200 more underway.

Entities need to purchase allowances from the domestic or international market to cover excess emissions. Emissions allowances not immediately needed for compliance can be banked to future commitment periods. The government also authorised scheme participants to purchase JI and CDM credits up to 8% of their allocated allowances for use under the domestic emissions trading scheme. New entrants with best available technologies must offset emissions by domestic mitigation projects and CDM/JI credits, with the latter limited to 30% of their emissions.

In the event of non-compliance, the expected penalty will be a retrospective payment of the CO_2 tax, plus interest for each tonne of CO_2 emitted since the tax exemption was granted.

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81. As part of its June 2005 announcement, the Swiss government also announced the introduction of the private "climate cent" foundation launched by the Swiss oil association on a trial basis. The foundation will levy a surcharge of CHF 1.5 cents per litre of gasoline and diesel sold. The scheme is expected to raise revenues of around CHF 100 million and aims to reduce Swiss CO_2 emissions by 1.8 $MtCO_2$ annually during the Kyoto's commitment period. Of these reductions, the foundation is allowed to use up to 1.6 $MtCO_2$ of credits from abroad annually, suggesting that the purchase of units abroad will serve the majority of the reductions.

Elaboration of detailed regulations on the use of the Kyoto flexibility mechanisms and the establishment of a national registry of emissions allowances by mid-2006 both support the construction of the Swiss emissions trading scheme and provide for its possible linking to the EU ETS. The Swiss government will hold a technical meeting with the European Commission to explore this possibility.

Switzerland has established a framework that translates its Kyoto commitment into carbon prices – emissions trading covers large industrial sources, while smaller energy users and households will pay a carbon tax. The government will recycle all revenues from the tax to the population and companies. It has no intention to acquire allowances on the international market.

Japan

Under the Kyoto Protocol, Japan has committed to reducing its 2008-2012 greenhouse gas emissions by 6% from 1990 volumes. However, with GHG emissions in the fiscal year 2003 up 8% greater than 1990 volumes, the Japanese government is examining additional mechanisms to deliver cost-effective emissions reductions. It intends to use project-based mechanisms under Kyoto and also considers the use of economic instruments to this aim.[82]

Building on earlier experience with a virtual emissions trading scheme,[83] Japan's ministry of environment (MOE) established a voluntary emissions trading scheme in May 2005. The cap-and-trade scheme is set to run from April 2006 and will cover 34 firms. Participating companies have pledged to cut a total of 276 380 tCO_2 per year, or 21% of their emissions over the past three years, for which they will receive government subsidies.

82. Under the threat of an environmental tax, the Keidanren (federation of Japanese industry) introduced a voluntary action plan in 1996 which covers around 80% of CO_2 emissions from industry and energy conversion and aims to deliver a cut in GHG emission of around 50Mt.

83. For further details see http://www.env.go.jp/en/topic/cc/040707.pdf.

The MOE proposes a design that includes aspects resembling UK's 2002 auction:

- Before an operational period covering April 2006 to March 2007, participants will be subsidised to improve energy efficiency or promote renewable energy that yield a measurable GHG emissions reduction. The maximum amount of subsidy for each participant will be one third of the new facilities' costs and will be capped at JPY 200 million per site (roughly EUR 1.4 million).
- During the operational period, participants will be given emissions allowances equal to base year emissions (the average of 2003-2006 emissions) less emissions savings expected from new measures.
- At the end of the operational period, participants will need to demonstrate that they have allowances to cover their emissions and will be able to rely on CERs from the clean development mechanism as well as on traded allowances. Participants unable to meet their targets will need to return their subsidies.

The budget of this scheme has been set at JPY 2 596 million (around EUR 19.1 million). It is expected to yield total GHG emission reductions over the life of the subsidised installations of around 3.7 $MtCO_2$, at a cost of about JPY 700/tCO_2, or EUR 5.2/tCO_2.

The Japanese government has considered a mandatory trading system linked to the EU ETS as part of its Kyoto Protocol target attainment plan (KPTA). The draft plan sets out the reduction targets prerequisite to emissions trading.[84] However, the role, if any, of a mandatory system in achieving the KPTA targets has not been determined.

84. http://mail.ceps.be/cc3/23; For industry, which accounted for 38% of greenhouse gas emissions in fiscal 2003, the plan calls for emissions reductions of 8.6% by 2010, compared with 1990 levels. In fiscal 2003, industry's emissions were down only 0.02% compared with 1990. For the transport sector, which accounted for 21% of fiscal 2003 emissions, it would allow a 15% increase, or slower growth than the current 17%. In fiscal 2003, the transport sector's emissions were up around 20% over 1990 levels. For the home, office, and business sector, which accounted for around 30% of fiscal 2003 emissions, it would allow an 11% increase, compared with the current target that calls for a 2% reduction. In fiscal 2003, the sector's emissions increased by 33% compared with 1990 levels. The plan also calls for GHG reductions of by 1.6% through JI and CDM.

Japan's public and private sectors have developed capacity for international project-based mechanisms. In December 2004, two government-owned banks and 31 corporations established the Japan greenhouse reduction fund (JGRF) to invest in Kyoto mechanisms.[85] Investors share access to the pool of generated GHG emission credits. The JGRF is expected to invest USD 141.5 million in 30 to 40 forestation and other greenhouse gas reduction projects in developing countries and EITs.

In addition, in March 2005, the government launched a programme to provide up front payments for GHG emission reduction projects under the Kyoto mechanisms, up to JPY 8 billion in the fiscal year 2005.[86] The programme will subsidise of up 50% of project development, equipment and construction costs in return for credits. Project credit prices will be set on a project-by-project basis according to project risk, delivery risk and market price trends.

Japan is still debating the relevance of a full-fledged domestic emissions trading, in light of other policies and the voluntary commitment of Japanese industry. The government and private entities are also pursuing a number of routes to acquire units from the international market, making Kyoto mechanisms an important part of its compliance strategy. Japanese officials have often expressed their willingness to pay for real, additional reductions in other countries.

New Zealand

New Zealand's latest greenhouse gas inventory measures a 22.5% increase in emissions between 1990 and 2003. Electricity generation, transport and agriculture are responsible for most of this increase. Sustained growth in gross emissions is should push New Zealand's

85. www.jbic.go.jp/english

86. http://www.meti.go.jp/english/information/downloadfiles/JCIF/meti.pdf; http://www.iges.or.jp/en/cdm/pdf/activity01/01_MOEJ.pdf emissions some 11% above its Kyoto target of 0%.[87] The government has commissioned a fundamental review of its climate change policy. This review will likely consider the implementation of a domestic emissions trading scheme. In this context, we review the central economic instruments of New Zealand's existing climate change policy.

In April 2007, the government will introduce a carbon tax, initially set at NZD 15/tCO_2e, to encourage consumption of sustainable energy over fossil fuels. The expected annual net revenue, estimated at NZD 322 million, will be recycled back to consumers. At the same time, the government has stated its intent to establish an emissions trading scheme as an alternative to the carbon tax, given a functional international carbon market, and a price reliably below its carbon tax cap of NZD 25/tCO_2e.

The government has also given firms or industries whose international competitive position may suffer from a carbon tax the choice to apply for a negotiation greenhouse agreement (NGA). Under a NGA, firms receive full or partial exemption from the carbon tax in exchange for agreeing to an emission intensity target through 2012, moving them towards their sector's world's best practice for GHG emissions. The flexible aspects of these NGAs, banking, authorised offsets, and trading of emissions reductions and surpluses, could facilitate the later establishment of a domestic emissions trading scheme.

By the end of April 2005, 14 of New Zealand's internationally-competitive and energy-intensive industrial firms had applied for NGAs. However, progress on finalising NGAs has been slow – beyond the two completed NGAs, just four applicants are currently proceeding with negotiations. Government officials have initiated an acceleration programme to precede the wave of applications in anticipation of the impending carbon tax.

New Zealand has also been actively developing international project-based mechanisms. The project to reduce emissions (PRE) provides an

87. http://www.climatechange.govt.nz/resources/reports/annual-report-05/annual-report-0405.pdf annual tender for projects to offer emissions reductions beyond business-as-usual emissions in return for either AAUs or ERUs, in the case of eligible JI projects. To date, around 11 $MtCO_2e$ have been awarded to 42 projects including 13 wind farms, 12 hydro projects, 6 bio-energy projects, 5 landfill gas projects, 4 geothermal projects and 2 co-generation projects. Efficiently managed, these could add 840 MW of generating capacity to New Zealand's energy system.

New Zealand relies marginally on emissions trading to manage domestic GHG emissions. Its carbon tax and incentives to domestic mitigation projects complement its portfolio of economic instruments. The government is nevertheless considering domestic emissions trading if an international carbon market turns out to provide a cheaper, practical alternative.

Korea

Korea has not committed to any specific emission goal under the Kyoto Protocol. The Korean government has established in 2005 the first institutions of its planned emissions trading scheme.[88] The scheme's taskforce is currently reviewing two options for a pilot domestic emissions trading program: one been submitted by the ministry of commerce, industry and energy (MOCIE); the other by the ministry of environment (MOE). Features common to both options include: voluntary participation subsidised by the government; and an initial coverage of CO_2, to be expanded to all six greenhouse gases later.

If Korea moves forward with its CO_2 emissions trading system, it will be the first non-Annex I Party to do so.[89] The possibility of linking this system with those of other Kyoto parties would probably require a new mechanism, as the transfer of GHG allowances between non-Annex I and Annex I parties remains the domain of the project-based CDM.

88. PointCarbon; 25 April 2005.

89. With the exception of Cyprus and Malta, which are participating in the EU ETS.

Australia

Although Australia has not ratified the Kyoto Protocol, it has committed to limit its overall GHG emissions to 108% of 1990 levels over 2008-2012 and looks to meet this goal. The Australian government expects that its mandate, combined with those of state, territory and local governments, and businesses, will reduce annual energy-related emissions by 94 $MtCO_2$ between 2008 and 2012.[90]

Australian state and territory governments now investigate emissions trading as a mechanism to meet their individual climate change policy commitments. Indeed, the states of New South Wales and Queensland have already implemented emissions trading schemes restricted to the electricity sector (see New South Wales' greenhouse gas abatement scheme – NSW GGAS – in box 6). The Queensland's "13% gas scheme" will require electricity retailers and other liable parties to draw at least 13% of their electricity from gas-fired generation. The scheme was introduced on 1 January 2005 and will operate for fifteen years, providing a stable investment climate.

By September 2005, the majority of the NSW GGAS 151 accredited projects were related to electricity generation from landfill gas, coal seam methane and hydro; and commercial and industrial energy efficiency. Indeed, generation and energy efficiency certificates comprise 15 million and 1.4 million of the 16.4 $MtCO_2e$ reductions now registered. Market players have traded approximately 5.4 $MtCO_2e$ in spot sales at an average price of AUS 12/tCO_2e, with forward prices projected to rise above that level.[91] The scheme regulator expects that supply of certificates will be tight, with demand for certificates expected to rise from 2 million in 2003 to 20 million over the 2007-2012 period.

90. http://www.deh.gov.au/minister/env/2004/mr06dec04.html

91. The market price is higher than the penalty price since the penalty is not tax deductible – the Australian marginal corporate tax rate of 30% puts the after tax penalty at AUS 15.

Box 6

New South Wales' greenhouse gas abatement scheme

The NSW GGAS aims to reduce the per-capita GHG emissions entailed by electricity consumption in New South Wales from 8.65 tCO_2e in 2003 to 7.27 tCO_2e over 2007 to 2012. This objective requires mandatory benchmarks applied to electricity retailers, generators that supply directly to retail customers (i.e. >100 GWh per year), and some major energy users.[92] Annually, the state benchmark is multiplied by total state population and the total volume of electricity sales to produce the electricity sector benchmark in tCO_2e. Each participant is then allocated a share of the benchmark relative to its share of the total state electricity demand. That allocation is then compared with a participant's total emissions, calculated by multiplying each retailer's purchased electricity volume by the state benchmark.

Each participant must surrender a number of abatement certificates each year to balance their excess attributable emissions. The penalty for non-compliance is AUS 11/tCO_2E. Abatement certificates are created by project proponents who reduce emissions in line with the rules of the scheme. Projects can be in power generation, energy efficiency, carbon sequestration from reforestation or afforestation, and industrial processes for large electricity users – the latter being non-transferable. Project methodologies are in line with CDM and JI approaches and employ a combination of performance benchmarks and project-specific baselines. Once accredited, projects are subject to regular audits. Sellers are liable for the validity of abatement certificates.

92. *Full details of the system are available at www.greenhousegas.nsw.gov.au. The Australian capital territory joined the scheme in January 2005.*

An early independent assessment of the NGAS performance questioned the scheme's efficiency. In particular, the study found that the system's complex design hinders the determination of additionality.[93] For example, plants constructed and operating well before the scheme began generated over 95% of certificates created in 2003. It is worth pointing out, however, that any allocation based on a benchmark is bound to create winners – sources with excess allowances – and losers – sources with a shortfall of allowances – at the time it is introduced. The system's true environmental performance may only be assessed properly in time, as the benchmark creates a general incentive for reductions.

In March 2004, state and territory leaders agreed to the establishment of a working group to develop a national emissions trading scheme to include all state and territory jurisdictions.[94] In developing the scheme, the working group aims to enable compatibility with Kyoto mechanisms, and harmonise existing state and territory measures with the national emissions trading scheme while reasonably dividing the economic burden between jurisdictions.

To date, the working group has developed ten design principles to guide the establishment of the national emissions trading scheme:[95]

- A cap-and-trade approach will be used.
- The scheme will be national and compliance sector-based, as national coverage should maximize the number of market participants, and, in turn, market depth and liquidity. National participation should reduce the cost of compliance and administration and maximize the number of offset opportunities for participants.
- The emissions cap must account for the national emissions abatement target and how this burden of reduction is shared between sectors constrained by the scheme and those outside of it.

93. http://www.ceem.unsw.edu.au/documents/ceem_DP_050408_000.pdf

94. See http://www.cabinet.nsw.gov.au/greenhouse/emissionstrading

95. Progress to first ministers of state and territory government (December 2004).

The system should provide a long-term signal recognizing both Australia's Kyoto target and development beyond 2012.

- The scheme will initially include stationary consumption of electricity, gas and coal, which accounts for around half of total national GHG emissions. Electricity generators will assume liability for their emissions; liability for gas and coal will be further elaborated to enable maximum coverage with minimum administrative and transaction costs, price signalling where it can best influence market behaviour. When assigning liability, system architects will consider whether other policies are better placed to deliver abatement for these sectors.
- The scheme will cover all six greenhouse gases under the Kyoto Protocol.
- Permits will be distributed both through a gratis allocation and auctioning. The mix of annual and long-term permits currently considered could provide additional investor certainty and spur the development of hedging markets.
- A penalty should be set to encourage compliance and to establish a price ceiling for the permit market.
- Mechanisms will be included to reward early emission reductions and account for new entrants.
- The system authorizes participants to use offsets, that is, those reductions generated outside the scheme including units from land-use change and geologic sequestration. However the extent of their use remains to be determined.
- Exemptions, free allocation of permits or subsidies will address any adverse effects.

In December 2004, state and territory government leaders commissioned the working group to continue analysis of a national system beyond these ten design principles. This new mandate includes the examination of how emissions trading affects regional and international commerce to determine a reasonable distribution of the economic burden between the state and territories, an aspect not yet studied in depth.

The initiative launched by Australian state and territory governments enumerates sound principles for the design of any future trading scheme. Of particular note is the importance of long-term emission goals to enable the participants' strategic investment in cost-effective compliance. Successful implementation of this long-term regulatory signal would instruct the many emerging systems that cover industrial sectors of relatively slow capital turnover.

State initiatives in the United States

The United States has introduced a number of domestic trading systems to tackle local and regional pollution, from lead in gasoline to SO_2. Although legislative proposals applying emissions trading to greenhouse gases have been introduced in both houses of the U.S. Congress, none have been adopted by either body. Indeed, during the senate debate on the energy policy act of 2005 in June 2005, an amendment authorizing a cap-and-trade scheme was rejected while an amendment establishing an incentives program to accelerate deployment technologies that could reduce U.S. emissions intensity was adopted. However, the senate added a non-binding "sense of the senate" to the bill stating that the Congress should enact a comprehensive and effective national program of mandatory, market-based limits and incentives on emissions of GHG that slow, stop and reverse the growth of such emissions. This language was not included in the final version of the act that emerged from the house-senate conference.

At the state level, some states have taken initiatives to promote emissions to control GHG emissions through emissions trading schemes. In April 2003, nine northeast and mid-Atlantic states in the US, representing 14% of the country's total emissions, agreed to work cooperatively, through a process known as the regional greenhouse gas initiative (RGGI), to develop a regional strategy to reduce greenhouse gas emissions from power generation.[96] Central to RGGI is the development

96. Participating states include Connecticut, Delaware, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island and Vermont. In addition, Maryland, the District of Columbia, Pennsylvania, the eastern Canadian Provinces and New Brunswick are observers in the process. See http://www.rggi.org of a multi-state cap-and-trade emission trading system. RGGI's action plan established guiding principles for the programme design, including:

- Emphasizing uniformity across the participating states and building on existing successful cap-and-trade programs and mechanisms.
- Ensuring that the program is expandable and flexible, allowing other states or jurisdictions to join the scheme.
- Starting the program simply by focusing on a core cap-and-trade program for power plants. In a subsequent design phase, reliable protocols for offsets (i.e., creditable reductions outside the power sector) and additional sectors could be introduced.

In August 2005, RGGI's staff working group issued a package proposal for the region's cap-and-trade system.[97] It is proposed that the programme start in 2009, going out to 2020, with a review in 2015 to consider extending emission limits beyond 2020. Other features include the following:

- The cap is set at some 136 $MtCO_2$ (150 million short tonnes) from 2009 to 2015, followed by a 10% reduction between 2015 and 2020. The initial cap is the average of the highest three years between 2000 and 2004. Each state receives a share of the total.
- Not unlike the EU ETS, allowance allocation is left to each state. However, a regional strategic carbon fund will be financed with 5% of states' emission budgets. All states also agreed to propose that 20% of the allowances "will be allocated for a public benefit purpose" such as energy efficiency improvements to mitigate negative price effects on end-users, the promotion of renewable energy sources and other GHG reducing options in power generation. States can also create reserves (set asides) for new entrants.
- The programme will authorise offsets, with projects in landfill gas, SF6, afforestation and efficiency improvements in various fossil fuel end-uses. More activities could be included at a later stage,

97. RGGI, 2005.

including the possibility to use EU ETS allowances and CDM emission reductions. However, the use of offsets is limited to 50% of the difference between projected, business-as-usual emissions, and the emissions cap, with specific limits to be introduced at a later stage, and evaluated by 2015.

The RGGI will monitor the evolution of electricity trade with other states to assess whether increased imports may be caused by the emission cap and therefore cause leakage in the system. The initiative sees its strategic carbon fund as a means to compensate such leakage through GHG reductions outside the cap-and-trade system itself.

California is also considering the introduction of an emissions trading system[98]. In June 2005, California announced plans for a reduction in GHG emissions to 2000 levels by 2010; a reduction of GHG emissions to 1990 levels by 2020; and a reduction of GHG emissions to 80% below 1990 levels to 2050. The Californian environmental protection agency has been charged with coordinating development and implementation of voluntary strategies to achieve these targets. The agency is due to make its first progress report on this work in January 2006, including an assessment of options for a cap-and-trade system. This is part of a broader west coast governors global warming initiative covering Washington and Oregon as well.

The US states' initiatives to establish CO_2 trading systems raises the interest of policy makers outside the US, as a future opportunity to establish links with the country's climate change mitigation efforts. System features may differ only marginally from the EU ETS and other emissions trading schemes, and allow for links across systems if and when all parties agree.

98. This is part of a broader west coast governors' global warming initiative covering Washington and Oregon as well. They have agreed to implement various emission reduction initiatives and to study the feasibility of a cap-and-trade programme.

Chicago Climate Exchange

The Chicago Climate Exchange (CCX) is a voluntary private sector emission trading programme open to emission sources and offset projects in the United States, Canada, and Mexico, between 2003 and 2006. Offset projects also include those in Brazil.[99]

The CCX is a cap-and-trade system designed and governed by its own members, each contractually bound to reduce their GHG emissions by 4% below the average of their 1998-2001 emissions by 2006. CCX membership counts more than 50 public and private entities from a range of industries spread across North America. In 2005, CCX announced the extension of the programme from 2007 to 2010 entailing a 6% reduction in emissions below baseline by 2010.

The CCX programme covers all six greenhouse gases. Offset projects include forest and agricultural sequestration in the United States and fuel switching, landfill methane destruction, renewable energy and forestry projects in Brazil.

The programme offers members a periodic sealed-bid auction of a small number of allowances (less than 1%) withheld from each member's allocation. Auction proceeds are returned to CCX members in proportion to their percentage share of the total auction pool.

In 2003, the first annual compliance period, members recorded reductions at 8% below their emission reduction commitment, totalling almost 20,000 tCO_2. Provisional data for 2004 indicate a reduction of 16% from baseline.

Total volume traded on CCX, as of 31 May 2005, was 2.5 $MtCO_2e$ and the average daily volume traded to date is around 9,000 tCO_2. Average instrument prices reached record highs of around USD 2.47 (2003 vintage) in July 2005.[100] Such results are surprising since members

99. http://www.chicagoclimatex.com/

100. The market price is constrained by daily price limits that range from USD 2.84 for 2003 vintage contracts to USD 2.33 for 2006 vintage contracts.

easily exceeded their voluntary commitments in the first two years of the scheme and have therefore accumulated excess allowances, bankable for future use.

A voluntary programme, CCX is a unique combination of a cap-and-trade system, an offset mechanism, and a dedicated exchange. The low price of traded allowances in comparison with those of EU allowances and CERs reflects the voluntary nature of commitments taken to date.

Emissions trading systems in multinationals

BP's emissions trading

Between 1998 and 2001, BP operated two systems of emissions trade: a pilot involving twelve business units, and a subsequent company-wide system that targeted a 10% reduction relative to 1990 greenhouse gas emission levels by 2010. In trading emissions, BP sought experience with an instrument expected to be introduced as environmental policy. In successfully demonstrating emissions trading as a decentralised mechanism to reduce emissions of business units, the energy group hoped to forestall the implementation of costly policy like an emissions tax.

Introduced in 2000, the company-wide emissions trading scheme encompassed more than 120 of BP's business units from 100 countries.[101] Each business unit was assigned annual emissions allowances derived from the company-wide 2010 target and the business unit's 1998 emissions. An initial volume of 5% of total allowances could be banked from one year to the next; borrowing was not permitted. Credits could also be earned for forestry and energy efficiency projects.

Business units could retain emissions credits allocated to closing plants closures and those implicated in "special events" like temporary plant shutdowns, though were required to surrender divestiture-related credits.

101. The pilot trading scheme (1998-2000) involved few trades and revealed little about the cost of reductions. Rather, the pilot primarily focused on issues such as rules for establishing the mechanics of trading and raising company awareness of the climate change issue.

New business units without a historic benchmark were allocated free permits (subtracted from the total cap) based on an emissions forecast. Allocation methods were also honed during the scheme as the trading system yielded real information about costs, and new business activities were later required to acquire permits on the market.

Business unit managers' performance contracts accounted for compliance with emissions caps, creating the prospect that promotions and bonuses were thus partly driven by the managers' performance in the emissions trading system.

BP's business units identified a wide range of emission reductions throughout the firm's international operations, including the capture and sale of methane previously flared or vented, and efficiency upgrades of the turbines driving gas through pipelines. Business units of exploration and production enjoyed access to a USD 25 million capital fund to invest in projects that reduced emissions, but would not otherwise return sufficient profit.

By the end of 2001, BP had met its 10% goal – spending approximately USD 20 million to implement its GHG reduction strategy and realising almost USD 650 million in savings. The scheme compelled the trade of 4 $MtCO_2$ at an average price of USD 40/tCO_2.[102] However, no money changed hands within the organisation and permit prices were not representative of the true cost of carbon faced by managers. Rather unit prices were set by traders speculating on supply and demand.

BP's success in reducing emissions has often been linked to its emissions trading system. An assessment of BP's experience with emissions trading system, based on interviews with key managers and traders, found that BP's commitment to climate change mitigation and the detailed inventory of its emissions spurred by the trading system may have driven much of the reductions.[103] The trading system served more as a device to

102. http://www.bp.com/genericarticle.do?categoryid=98&contentId=2000329; http://r0.unctad.org/ghg/sitecurrent/carbon_mi/commercial.html

103. Victor and House, 2005.

reveal reduction costs. The system operated like a "safety valve": managers let the market operate until the cost surpassed what the company was willing to tolerate. The design of the scheme did not spur long-term investments. Most reductions were implemented through "no regrets" investments. In fact, it is difficult to relate the high price of traded CO_2 inside BP's system with the net USD 650 million savings. The latter suggest a very low – negative? – marginal cost of emission reductions.

Shell tradeable emission permit system

In 2000, Royal Dutch/Shell group launched a voluntary internal emissions trading system targeting a 10% reduction in greenhouse gas emissions by 2002 relative to 1990 volumes.[104] The Shell tradeable emission permit system (STEPS) included businesses that represented 30% of the group's annual total emissions of 103 $MtCO_2e$.

A cap-and-trade system, STEPS, grandfathered permits to participants based on 98% of their CO_2e emissions in 1998. Participants committed to a 2% reduction, or 500,000 tCO_2e over the period 2000 to 2002. Shell group's European energy trading unit acted as broker, transaction register, and market maker. The system witnessed the trade of around 4.5 $MtCO_2e$ at average prices of between USD 2 and USD 4 per tonne.

Within Shell's assessment, STEPS publicised emissions trading within the company but had not otherwise been "a major success in terms of developing an active internal market for the delivery of emissions reductions at lowest cost".[105] Cited weaknesses included the small scope and voluntary nature of participation and resulting low market liquidity; the absence of investment incentives as fiscal reasons prevented exchanging money between businesses in different countries; the brevity of the pilot period; and over-ambitious reductions target, revision of which during the scheme produced marked uncertainty among market actors.

104. http://www.shell.com/static/royal-en/downloads/steps.pdf
105. http://www.shell.com/static/royal-en/downloads/steps_learning.pdf

Table 7:

Design features of emerging trading systems

	Canada	Norway	Switzerland	Australian States	RGGI	CCX	Korea
Type of target	Baseline-and-credit; sectoral targets by activity on an emissions intensity basis (45Mt)	Cap-and-trade delivering 500,000 to 1m tonnes of GHG savings p.a. or 10% of Kyoto target	Cap-and-trade; negotiated agreements in exchange for CO_2 tax exemption	Cap-and-trade, with cap to be determined	Cap-and-trade, with cap to be determined	Cap-and-trade; reductions of 4% below 1998-2001 baseline by 2006	Cap-and-trade
Coverage (sectors; gases)	Mandatory for large final emitters (700 entities); GHG coverage to be determined	Mandatory for 51 energy production and process installations; covers 4 GHG	Voluntary coverage of 40% of industry emissions; GHG coverage to be determined	Mandatory for stationary energy sector (electricity gas, and coal) representing around 50% of national emissions; covers 6 GHG	Mandatory with participants TBD (power plant or boiler level i.e. >25MW); covers CO_2 during Phase 1, with other gases to be considered for future phases	Voluntary, 50 private and public sector firms; covers 6 GHG	Voluntary, with government incentives to participate; starting with CO_2
Compliance period	Initially 2008-2012	2005-2007	To be determined (likely to be 2008-2012)	To be determined	To be determined (likely to be 2009-2020, with a review in 2015)	2003-2006	To be determined

	Canada	Norway	Switzerland	Australian States	RGGI	CCX	Korea
Allocation method	Grandfathered. Process emissions enjoy 0% reduction; other emissions face a 15% reduction target	Fully grandfathered	To be determined	Mix of grandfathering and auctioning	Likely to be mainly grandfathered	Small number of allowances auctioned	To be determined
Penalty	To be determined; permit price capped at CAD 15/tCO_2	EUR 40/tCO_2	Value of CO_2 tax (35 Swiss Francs) tax plus interest for period of non compliance	To be determined	To be determined	To be determined	To be determined
Offsets (external credits)	Yes	Yes	Yes	Yes	Yes	Yes	To be determined
New entrants/ closures	New entrant allocation identical to LFEs'. Closures given an allocation for the final year of operation	New entrant allocation based on potential to reduce emissions	Entry based on voluntary negotiated agreement	To be determined	To be determined	Voluntary entry and exit to scheme	To be determined
Banking/ borrowing	No	Banking during, but not across, periods	To be determined	Both considered, to be determined	Unrestricted banking; limited borrowing	Banking allowed. No borrowing.	To be determined
Monitoring/ reporting	To be determined	Norwegian Emissions Trading Registry	Energy agency for the economy	To be determined	To be determined	Self-regulatory	To be determined

Linking Systems: Issues and Opportunities

The systems presented in the above show a great variety in design. This raises concerns about the difficulty of establishing an emissions trading system of broad coverage, best able to deliver least-cost compliance to emission sources and sinks. The economic case for linking is clear. Linking various systems and emissions targets under a single emissions trading umbrella would help deliver a common environmental goal at least-cost, as each participant would now have access to a broader range of mitigation options. The economic literature provides a wide range of economic estimates illustrating the gains from broadening a trading regime.[106]

This section examines issues and opportunities in linking different emissions trading systems. Some governments outside the EU are actively studying the possibility to link their emissions trading systems to the EU ETS. Linking is not a question of practical relevance for these countries alone, but also for others that may be encouraged by developments in emissions trading and wonder how they may benefit from the allowances market.

Linking raises some practical challenges. The following issues come to mind:

- Are allowances in country X equivalent as those traded in country Y?
- What if prices are different prior to linking two or more different trading systems?
- What are the competitiveness impacts of linking when entities in one system were previously subject to auctioning while others received gratis allowances?

106. See in particular Hourcade and Shukla, 2001; Aldy et al, 2004

- Targets are set per unit of output in country X while similar activities face an absolute cap in country Y: will production in country Y not relocate in country X?
- A price cap has been introduced in country X but not in country Y. Can entities still trade freely if the price cap is reached in country X?
- Banking and borrowing of allowances are allowed in country X but not in country Y. What are the implications?
- Country X relies essentially on baseline-and-crediting or project-based mechanisms while country Y operates under a cap-and-trade system. Are they compatible?
- Countries X and Y have adopted targets that seem to require significantly different levels of effort? Would linking benefit both?

These questions can only be answered with precise knowledge of systems involved, not a straightforward matter for this analysis, as most systems are still evolving. Rather, this section identifies minimum requirements to allow linking, and covers some critical technical questions.[107]

Prerequisites

There are many different options for emission trading scheme designs, but some key principles are pre-requisites if trading schemes are to achieve environmental goals. These principles can broadly be divided into two groups; the first relates to the legitimacy of the tradable units within the scheme, and the second relates to the boundaries of the scheme.[108] It is useful to keep these principles in mind when considering the potential effects of linking two schemes with different designs to ensure that the combined scheme would also satisfy the principles.

107. This section draws extensively on the following sources: Haites and Mullins, 2001; Baron and Bygrave, 2002; Bygrave and Bosi, 2004; Blyth and Bosi, 2004; Philibert 2005a.

108. DEFRA, 2003.

Legitimacy of tradable units

In any sound trading system, the commodity to be traded must either have an inherent value of its own (e.g. steel, oil, etc.), or the units being traded must have legitimacy conferred on them by some other means. For example, national currencies are considered legitimate as they are backed up by government's record on management of the national wealth. In an emissions trading scheme, the units in themselves have no inherent value; they only have value in the context that they can be credited against a target for which non-compliance carries some form of penalty. The legitimacy of the emissions trading units typically requires a number of conditions to be met:

- Ideally, the units should represent the same quantity throughout the trading system (i.e. 1 tonne CO_2e = 1 tonne CO_2e whatever its source).[109]
- The rules of the scheme should be sufficiently stable to establish confidence in the value of the units, and ideally allow the creation of a forward price curve to allow sound decision making and risk management.
- The liability against which the units can be redeemed should be well defined. This requires a well-defined compliance regime.
- Emissions levels need to be verifiable, using consistent and transparent methodologies for measurement and reporting. Participants that are liable for compliance with emission objectives may worry if acquired allowances are perceived to be generated by a system with, say, inaccurate inventories.

109. Although the monetary value of the units may vary (for example if there is a gateway between absolute target sectors and relative target sectors, units may be priced differently on each side), the quantity of environmental improvement represented by the unit should remain the same. Alternatively, a system could work with a fixed exchange rate between units from different schemes, as a means to address concerns about the relative stringency of the targets in the two schemes. Such an approach would transfer the negotiation from the stringency of the target to a negotiation on the exchange rate. For example, this may be politically practical if countries have already negotiated targets domestically. Such an approach would have implications in accounting for other units entering the system (e.g. JI and CDM credits), and how governments manage their compliance.

- The process for issuing units should be clear and predictable, and the registry and systems for tracking transactions should be secure and designed to prevent fraud.

An agreement between countries to harmonise domestic systems on the above criteria would be critical to make linking a success.

Well-defined boundaries

Generally, the more sectors and gases that are covered in an emissions trading scheme, the greater the potential for liquidity and market efficiency, and the lower the total cost of compliance – this is the main rationale for linking different schemes. Nevertheless, the boundary of trading systems needs to be well defined for these benefits to be realised.

As described above, the value of the units in an emissions trading scheme is tied to the ability to use those units to satisfy an emissions target, in the context of some compliance regime. For countries that are bound by a target under the Kyoto Protocol, the obvious boundary for a domestic emissions trading scheme would be the national boundary so as to ensure that emission reductions from the scheme contribute towards the Kyoto target. Alternative approaches can be conceived. One example is the Chicago Climate Exchange, whose membership is self-selecting, and is not limited to the USA. Another alternative to schemes with national boundaries would be a scheme based on transnational sector-wide targets, where all companies carrying out a particular activity could be included wherever they were located physically.

In isolation, a trading scheme may be able to operate without well-defined boundaries. However, the boundary definitions become very important when considering linking different schemes together. There are three issues for consideration:

- Within the scope of the scheme, coverage of companies or sectors should be complete (subject to possible size thresholds). If companies are allowed to choose particular installations to be included in the scheme, they are likely to only choose those where relatively easy emissions reductions can be made, whilst allowing emissions from their non-covered installations to continue to expand. Such 'cherry-picking' opportunities undermine the environmental effectiveness of the trading scheme.

- Companies or installations should only be allowed to count emissions reductions once. Particularly in the context of linking two schemes, double-counting of emissions reductions would undermine the legitimacy of traded allowances. Trade of products with greenhouse gas implications for installations covered in both the exporting and importing countries' schemes (e.g. energy) would need to be handled with careful accounting measures. Linking national-based schemes to other types of scheme (e.g. sectoral schemes) on the other hand could cause problems of double-counting.
- Emissions trading is meant to impose a cost on emissions which, in turn, could encourage sources to move their production outside the system. The wider the coverage of the system globally, the lower the incentive to relocate. However, political problems could arise if activities were to relocate, inside the system, in countries with a more favourable treatment of new entrants, for instance.

Coverage of schemes

Differences in coverage of greenhouse gases and sectors change the cost of abatement between schemes, and will affect carbon prices, but should not be a barrier to linking. For example, there may be some comparative advantage for the companies in the scheme with the wider coverage, since their access to the lower cost options might increase their ability to sell allowances on the wider scheme. But these comparative advantages would occur anyway, irrespective of whether the schemes were linked or not. Therefore as long as tradeable units are verifiable (i.e. legitimacy is maintained) there is no technical reason why schemes with different coverage should not be linked.

It will, however, be important to avoid double-counting that might arise from linking schemes with different coverage since it devalues genuine reductions by lowering allowance prices and it reduces environmental effectiveness as it leads to some "paper allowances" – not representing reductions – in the market. Double counting can be avoided by clearly defining the boundaries of the schemes being linked and ensuring that proper accounting procedures for emissions are in place.

Various approaches of emissions coverage may create emissions accounting problems, whether trading systems are linked or not:

- Under an upstream trading regime, fossil fuel producers and importers are liable for emissions embedded in their products. In this case, fuel exports should not be counted as they will release CO_2 emissions outside the country.[110]
- Under a system of indirect emissions coverage, users of certain commodities like electricity would be liable for the emissions embedded in their electricity consumption – the UK emissions trading scheme has adopted such an approach. This can be done by applying a simple CO_2 emission coefficient to overall electricity consumption and asking consumers to surrender allowances to match corresponding emissions. Presumably, electricity exports would need to be treated carefully, as no domestic end-user would report consumption. The importer, if it is covered by a direct system – i.e., it is responsible for its own emissions only – would not be liable for embedded emissions. This would leave a portion of the exporting country's emissions unaccounted for.[111]

Measures could be also introduced to ensure that different provisions for excluding, or opening access to, certain sources are not a barrier to linking schemes. For example, entities that opt-out could be covered by

110. See Hargrave, 2000, for a full examination of issues related to the combination of upstream and downstream regimes.

111. Baron and Bygrave (2002) cover the full implications of the co-existence of trading systems with different coverage features, whether or not their respective governments decide to link systems.

some other measures so as not to compromise the environmental integrity of the overall system, hence facilitating linking with a country with a more comprehensive coverage of sources.

Mutual recognition of trading units

Any trading scheme must have clarity on what units are included or excluded from the scheme. Even if there are restrictions on the use of certain types of unit within one of the domestic schemes (e.g. certain units are restricted from entering into an emissions registry), the supply of this type of unit into the other domestic scheme will affect the overall level of supply in the combined scheme once they are linked. Rules on the eligibility of different units are critical for the functioning of GHG trading schemes and must be agreed jointly if two schemes are to be linked together; otherwise, the total amount of emissions units in the combined scheme could be greater than if the domestic schemes functioned independently (depending on the relative cost to generate different units).

The recognition of units is ultimately a political issue, as it depends on the credibility – actual or perceived – and preferences for different units. There are no obvious technical fixes available to link schemes with different recognition of units. The Kyoto Protocol does provide a framework for the recognition of common trading units in the international emissions trading context, although parties are free to decide on the definition of their trading units in their domestic trading schemes (e.g. for domestic policy reasons).

For countries that would not operate under the Kyoto Protocol system and may therefore generate trading units on a different basis – e.g., with a broader definition of sinks, different coefficients for the GHG equivalent of aviation emissions, etc. – counterparts would need to agree on whether linking would be acceptable on that basis. This relates essentially to each party's perception that others in the system have established a reliable and environmentally effective framework.

Concerns could otherwise arise that one partner in the system encourages activities that are not recognised as environmentally sound, or that it provides its entities with an unduly cheap supply of reductions, granting them an artificial competitive advantage within the linked emissions trading system.

Absolute and indexed targets

In a scheme with indexed targets, emissions would typically be more or less linked to a sector's growth – value added or physical output could be used to index emission commitments. Linking systems with indexed and absolute targets could increase the allowed emissions in the combined scheme, whereas the country with absolute caps has rejected this possibility *a priori.* If properly enforced, the risk in linking systems with absolute and indexed targets is not one of non-compliance. In fact, entities in the absolute system may have access to cheaper sources of reductions in the indexed system – although, as we have mentioned, a indexed system may be made more stringent and lead to a higher price than a system based on an absolute, yet relatively lax, overall cap on emissions.[112] The issue would rather be that higher emissions would now be allowed by granting access to a pool of allowances that could grow with industrial output.

In the context of the Kyoto Protocol, where, say, a country linking to the EU-ETS has an overall national emissions target and backs up its GHG trading units with Kyoto allowances or equivalent, there should not be any environmental compromise associated with linking absolute and indexed schemes. In fact, any GHG increase will be offset elsewhere in the economy, or through purchase of Kyoto units.

The problems related to linking absolute-cap and indexed-target systems together have emerged in an entirely domestic context, that of the UK ETS. The concern was that a flow of allowances from the indexed sectors

112. In fact, for an identical environmental outcome, economic analysis shows that allowance prices would be higher under relative targets than under absolute targets (Gielen et al, 2002).

would inflate emissions in the absolute sectors. The solution to this problem has been to only allow an equal flow of allowances in both directions. In other words, entities subject to an indexed target could only transfer allowances to entities with absolute caps if allowances had been transferred earlier in the other direction. While indexed sectors could freely trade among themselves, and in some cases, trade with absolute sectors, a welcome option from a market liquidity standpoint, indexed sectors could not be net sellers to the absolute sectors.

The issue may be of lesser concern at international level: once there is agreement and recognition by governments and regulatory authorities on the respective levels of efforts of their trading scheme, they should be comfortable with their entities having access to a broader and cheaper pool of allowances.

Would linking in this case raise a problem of distortions of competition? Probably not. Without linking, two systems would co-exist. An entity with an absolute cap may have an incentive to relocate anywhere – if it is economically sound – as a result of high mitigation costs. It could, for instance, relocate in the country with the indexed target, where meeting the standard for emissions per unit of output would grant it access at no direct carbon cost. The possibility to relocate to this country would be identical with or without linking. The only difference would be the price of allowances if systems were linked. Without looking at a specific case (e.g. with a high price in the absolute target system and a low price in the indexed target one or vice versa), it is impossible to predict the incentive for more or less relocation. The price of carbon plays less of a role in the investment decision under a indexed target, since allowances are granted for free provided the producer meets the set standard on tonnes of CO_2 per unit of output.

Allocation rules

Differences in the initial allocation methodology (grandfathering and auctioning) between two schemes should not cause a difficulty in linking since, beyond an initial transfer of wealth, the method of allocation will not further affect the profitability of companies in the overall scheme. In addition, distortions in incentives due different treatment of new entrants would arise from operation of the different schemes, irrespective of whether they are linked or not, and may be short-lived if allocation in subsequent trading periods is based on an updated base-year (since then new entrants will only by 'new' for a limited period).

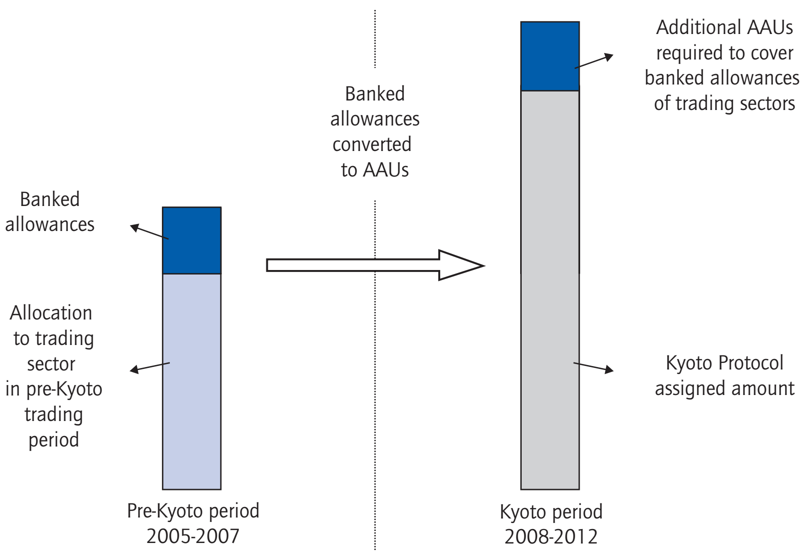
There could, however, be some additional gaming opportunities created by linking two schemes that have different rules on subsequent allocations. For instance, subsequent allocations can take account of emissions in the preceding trading period (i.e. updating). Different rules (e.g. treatment of new entrants and plant closures) can also lead to different incentives for behaviour during the earlier period. For example, if allowances in the second period are allocated on the basis of emissions in the first period, there is an incentive to forego emission reductions in the first period. This would be profitable if the expected allowance price in the second period were higher than allowance prices in the first period. Since differences in the basis for updating of allocations for subsequent commitment periods could lead to more lasting impacts, it is advisable to identify the scale of potential distortions, and address them if they are found to be significant.

Banking

If a country prohibits banking from one commitment period to the next and another country in a linked regime allows it, companies in countries without banking will effectively be able to bank via swaps with companies in countries that do allow banking. They will simply need to sell unused allowances to their counterparts in countries with banking, and buy them back in the next commitment period. A difference in banking has been an issue in the context of the pre-Kyoto commitment period of the EU ETS, during which member states can take different approaches. Specifically, the concern is that if a country concentrates a large number of banked units, because it allows this option while other countries do not, it would need to draw more AAUs from its Kyoto assigned amount to be distributed back to its entities than they actually need in the 2008-2012 period (see figure 8). In fact, some of the allocated AAUs would be immediately transferred back to entities in systems without banking. As a result, countries allowing banking would need to find more reductions outside the domestic trading system to make up for such over-allocation.

FIGURE 8

Banking allowances into the 2008-2012 commitment period



Source: Blyth and Bosi, 2004.

Note: If banking is allowed into the Kyoto period, the banked allowances will need to be covered by additional AAUs. If it is not allowed by all countries, banking could concentrate in those countries that do allow it. Restrictions on banking may then be needed to prevent excessive amounts of AAUs being required by those countries.

Harmonisation of banking rules, or some limitations on banking would therefore be advisable in order to reduce concentration of banking in a few countries, if such differences in the treatment of banking were to remain in the future. Suitable fixes can be implemented which would allow this problem to be solved without too many detrimental effects on the efficiency of the market. For example, companies may only be allowed to bank on the basis of their own overachievements, i.e., the difference between their initial allocation and their actual emissions over the period.

Borrowing

Linking schemes with and without borrowing would enable a company in a non-borrowing scheme to buy allowances from a company that can borrow them from its future allocation. If the country without borrowing had rejected that option on environmental grounds (i.e. the risk of perpetual non-compliance if sources keep on borrowing) linking could be perceived as a problem as its sources would now have access to "borrowed" allowances, albeit from another country's sources. Nonetheless, a restriction on the total amount that can be borrowed may be enough to address concerns raised by linking systems with and without borrowing.

Monitoring, reporting and verification

Monitoring of emissions, accurate reporting and verification of inventories (MRV) is fundamental to ensure confidence in the traded units and to underpin their value. In theory, national-level guidance such as that provided by IPCC guidelines and good practice guidance provides a common basis for the development of entity-level reporting schemes, and should act to limit the extent to which MRV schemes at the entity level differ from country to country – although differences could still occur in practice. Differences in MRV process or even to some extent accuracy may not matter as long as these differences do not undermine the legitimacy of the currency in the trading system and market confidence in the value of the units.

Penalty regime and price caps

In the case of the EU ETS, a penalty is applied to emissions above companies' holdings of allowances. This fixed penalty rate does not release the installation from the need to cover its full emissions each year with allowances. There is therefore no direct link between the level of the penalty and the price of allowances on the market. However, linking to a scheme with a fixed penalty with emissions restoration regime should not be a problem, even if the level of the penalty is different, as it does not affect the market price.

Other arrangements include a price cap, mentioned for country targets in chapter 5, or the price assurance mechanism (PAM) of the Canadian domestic trading system, currently in discussion. Such mechanisms allow emitters to pay a fixed price to release them from any further liability for emissions above the level of allowances This would create a cap on the price of allowance prices for these entities.

It may not be straight-forward to combine the compliance regime of the EU ETS (fixed penalty and restoration) with a scheme that has a price cap. Linking would create the risk that EU entities face a higher price and then decide to acquire allowances from entities whose prices are capped. These would acquire allowances at capped prices from their government for the purpose of selling them, at a profit, to entities outside this regime. If the government made up for the difference between the international price and the domestic cap, it would in fact, be reducing the compliance cost of foreign companies by the provision of relatively cheap allowances, at the expense of its taxpayers.

Such situations could be mitigated by granting allowances at price-cap for the difference between an entity's holding of allowances allocation and its actual emissions, provided that it holds at least as many allowances as it were distributed originally. An entity that had sold allowances beyond its means early in the period would therefore be obliged to buy allowances back from the market – at an uncertain price – to restore its initial allowance level. Only then would it be eligible to acquire allowances at the price cap. The quantity of allowances to be issued at the price cap would only be known after having gathered inventories from sources and compared them with their initial allocation.[113]

The Canadian DET sets conditions for the use of the PAM allowances. The sale of PAM allowances would be restricted to annual forward contracts, which can only be applied to the difference between a firm's emissions and the allocation for that year (plus any eligible banked allowances).[114] In addition, PAM allowances would not be re-sellable in the open market.

Linking: a mere technical question?

The above presentation of linking issues may leave the reader with the impression that for each potential problem arising from differences in system designs or countries' emission objectives, a technical "fix" can be found, albeit involving increased administrative costs. Indeed, none of these problems are insuperable. On the other hand, markets can be rather unpredictable and great care should be taken before introducing "bells and whistles" at the interface of various domestic systems and national registries to accommodate for different designs. The alternative would be to work out a transition towards systems of a more homogeneous nature, for the satisfaction of all trading partners.

For this to happen there has to be a mutual recognition that linking is desirable. Could we envision situations in which countries would decide that systems are essentially incompatible? Some countries have, in the past, expressed strong preferences for project-based reductions that do not include the use of certain technologies (e.g., forestry activities, nuclear, large dams). Broader coverage may make these concerns less prominent, especially if a country takes a nation-wide commitment,

113. Blyth and Bosi, 2004 propose to halt all transfers from the system operating under the price cap as soon as the price hits that level. The downside of this option is that an entity with a surplus for sale, at a price above the price cap on the international market, would no longer have access to it.

114. See http://www.nrcan-rncan.gc.ca/lfegggef/English/papers_en.html with the freedom to achieve emission reductions through the most practical and cost-effective means available to it. For instance, it is a fact that a country that cannot register a nuclear facility under JI or the CDM would benefit from this technology's contribution to its GHG inventory and could trade any surplus that it generated, since allowances such as AAUs can hardly be linked to specific activities, except when they have been allocated to specific industrial players.

What if, now, systems develop in parallel over a number of years, based on market fundamentals that would lead to radically different trading prices? For an extreme illustration, let us consider the EU ETS and the Chicago Climate Exchange: the EU ETS is currently generating trading of EUAs at more than EUR 25/tCO_2, whereas the CCX records trades at EUR 1.5/tCO_2 for vintage 2005 instruments. If such striking differences remain, leading investors in both regimes to radically different mitigation choices and future price expectations, will this not create a political barrier to linking? Economists may dismiss such arguments as running against all players' economic interests. Yet this is already a reality in the context of industry-based systems that are not automatically favourable to bringing sectors with significantly higher mitigation costs – e.g. transport and aviation – on the basis that it runs the risk of increasing allowance prices and further damaging their competitiveness. This problem may be of a transitional nature if one assumes that competitiveness concerns can be addressed through a progressive broadening of the geographic scope, e.g. with sectoral agreements, transnational or not.

There will be winners and losers in each system. The buyers in the high price system and sellers in the low price system would gain from linkage. The sellers in the high price system and the buyers in the low price system would lose. Put differently, actors in the high-cost system may feel that they are financing emissions reductions – including, in some cases, industrial modernisation – in the low-cost system. While society as a whole would have the possibility to spend less to bring emissions down, a positive outcome, individual players will first need to be convinced that others' targets are fair. These considerations will play a role in making linking a reality.

In summary, governments considering the possibility of linking emissions trading schemes would need to assess the advantages and disadvantages of such a policy decision, as well as the design and administrative implications. The clear economic benefits and lack of technical barriers to linking should typically drive systems towards harmonisation. In their search for economic efficiency in this matter, policy makers must also recognise that economic systems have evolved with radically different input prices, the most striking of which being labour. The possibility of separate GHG trading regimes, however unfortunate this may be from a cost savings standpoint, cannot be ruled out entirely, nor should it, provided that the international community continues to make progress towards global GHG reductions.

Conclusion

The international consensus producing the Kyoto Protocol in 1997 established emissions trading at the forefront of climate policy. Within and beyond the Protocol's Annex B countries, policy makers of various levels are busy conceiving and managing emissions trading schemes. Emissions trading has begun to shift market preference to carbon-lean energy, especially in Europe's industry, where installations must manage their CO_2 emissions under the EU ETS. Since the commencement of the EU ETS, the magnitude of GHG trading has shot up.

In the absence of hindsight, our assessment can be only cursory. The real benefits, i.e., the cost savings, of emissions trading systems are more likely to emerge as carbon-constrained entities adapt to the carbon price. The details of implementation matter a great deal in determining a proper incentive for cost-effective emissions reduction. This dynamic is all the more important when considering emissions trading potential effect on industrial competition and the conflict between the long term signal that it should provide and its potential to curb industrial growth. On paper, some features of the EU ETS's national allocation plans hamper decisions to close older, less efficient plans, and open new ones.

Creating markets for greenhouse gas emission reductions is not a trivial task. Initial allowance allocation and rules for new entrants and plant closures merit careful negotiation. Harmonisation of these still volatile matters will enable governments to provide certainty, necessary when considering the relative irreversibility of energy investments.

Concerns over emissions trading effect on industrial competition plague the implementation of existing systems and the design of future schemes. The competitive presence of unconstrained sectors exacerbates these concerns. While multilateral environmental agreements generally compromise between broad coverage and stringent requirements, the dynamics of industrial competition subject to emissions constraint favours the opposite tact: broadening the coverage of the carbon constraint may be requisite to its deepening. The risk of emissions leakage could otherwise block more ambitious commitments. Chapter 5 considers various options to incorporate developing countries in emissions trading and expand participation within industrialised countries to circumvent this political dilemma.

Diverse emissions trading systems are emerging within and beyond the framework of the Kyoto Protocol. Linking these various systems would prove cost-effective and enable policymakers to set more ambitious targets: eventually, the growth in global GHG emissions needs to slow, stop and reverse. Barriers to linking systems are not insuperable but linking will require policy makers dedication as all systems involved will need adjusting.

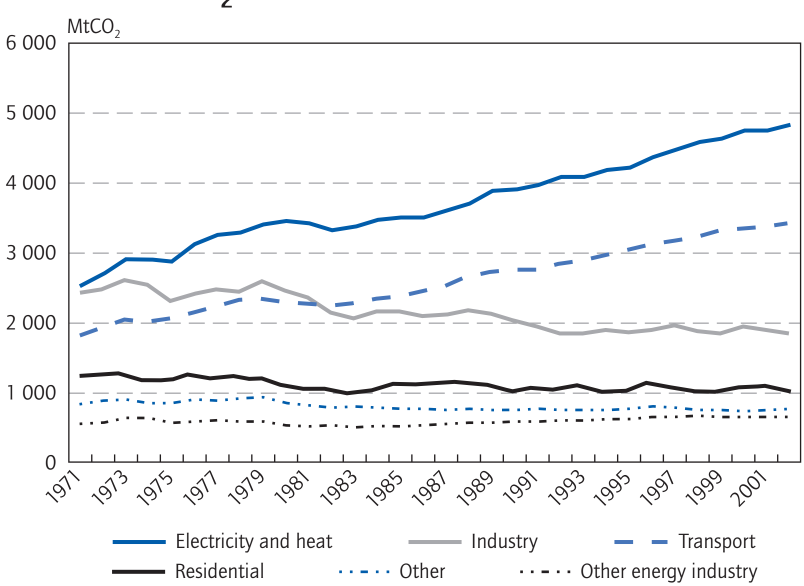
BEYOND INDUSTRIAL ACTIVITIES

Established trading schemes have targeted power generators and heavy industry, both energy-intensive consumers. These industries' relatively large contribution to total emissions, their easily-monitored structure, and the variety of industrial reduction opportunities all explain this choice. More importantly, these actors are more likely to choose energy of lowest cost than households and smaller businesses of limited energy expenditures. The latter are often caught in a "landlord-tenant" dynamic whereby the final energy user does not control its energy-using equipment and cannot respond to changing energy prices.

If countries are to stabilise and reduce their GHG emissions in the long term, they must address other sectors' emissions. Emissions trading may be considered as a complement or a substitute to existing government regulation of these emissions.

FIGURE 9

Sectoral CO_2 emission trends in OECD countries



Source: IEA statistics

Extending Coverage through Upstream Allocations

Several analysts have envisioned the establishment of upstream systems covering all fossil fuel uses in a country. An upstream system distributes allowances and thus liability to firms supplying an economy's carbon-based fuels. The sources of emissions are not accountable to any emissions cap. An upstream allocation covers a significant share of a country's emissions with a single policy implicating a relatively small number of actors, namely importers and producers of oil, gas and coal. Upstream allocation incorporates small sources into the trading system without allocating allowances to a multitude of agents, nor monitoring their emissions.[115] Covering the same volume of emissions as an allocation to each individual user of fossil fuels, upstream allocation follows a much simpler, straightforward structure. However, an upstream system does not address process related emissions of CO_2 (cement, aluminium) and non-CO_2 emissions.

Upstream allocation is not the perfect design. First, fossil fuel producers and importers can only influence the consumption of their products through pricing.[116] A significant shift in behaviour and technology preferences among small businesses and vehicle owners would require steep price increases. For example, the short-term price elasticity of fuel demand in transport is relatively low, implying that near-term objectives would require fairly high price increases, entailing high CO_2 prices. Long-term elasticity is higher, accounting for shifts to more efficient vehicles. This dynamic also governs heating systems and appliances. As such, suppliers of energy-using equipment receive only a secondary signal to produce energy-saving hardware. Only dramatic consumer preference for efficient equipment would drive suppliers' shifts.

115. See Hargrave, 1998; KPMG, 2002; Niizawa et al. 2003.

116. Alternatively, refiners could lower the net CO_2 emissions from the combustion of their fuels by adding biofuels, provided these are compatible with the car fleet.

Because an upstream system would cover fewer entities than a downstream system, two types of risk arise. Within a system involving hundreds of liable entities, market liquidity may be more limited than under a system of thousands. Large allowance holders could also collude to fix prices. The practice of an upstream system may require a large number of relatively small market players to diffuse risks of collusion. While an exclusively upstream allocation would fit the 2 000 point sources in the United States, regulation of the 104 refinery plants in Europe may require a different design.[117]

Ultimately, energy producing and importing companies would collect a new "tax" on fossil fuels. This additional revenue, resulting from environmental policy, resembles power generators' expected windfall profits as a result of gratis allocation in the EU ETS. In theory, energy producers should pass the marginal cost of compliance to consumers, without having entirely paid to acquire allowances. Allocation by auction rather than by gratis distribution would justify recipients in raising their prices to reflect the purchase of emissions allowances; refunding a small portion of the revenues from auction back to energy producers could sufficiently offset the revenue losses triggered by higher prices and lower demand.[118] Another option is to tax windfall profits as they appear.

Hybrid systems

We also mentioned the merits of grandfathered allocations for industries competing with un-carbon-constrained producers. It may be possible to elaborate hybrid systems of downstream allocation to energy-intensive industries and upstream for other energy users. Upstream and downstream allowances would be fully fungible.

A more macro-economic evaluation reveals also some risks of systematically constraining GHG with energy prices.[119] A general equilibrium analysis of international CO_2 trading among EU nations

117. Hargrave, 1998; Julia Reinaud, personal communication.

118. Bovenberg and Goulder. 2001.

119. Babiker et al., 2002.

indicates the potential downside of participation in emissions trade. Some economies may fare better in refraining from emissions trade. In responding to the international carbon prices, nations introduce the risk of price distortion on energy that is often heavily taxed. The incentives to control emissions autonomously become especially apparent when considering transport fuel.

While emissions trading would benefit its participants, it may not benefit the national economy as a whole – a country that is a net seller may suffer on its terms of trade, having raised its energy prices more than needed to comply with its emission goal. A net buying country with existing high energy taxes would indeed gain from trading relative to compliance through raising energy prices. Of course, revenues from an auction-based upstream system, or from energy producers' windfall profits, could be used to relieve the consumers' financial burden. Kopp et al. (1999) propose a solution to the negative distributive impacts potential to an upstream regime. The bulk of a nation's auction revenues would be directly re-funded, in equal sums to each of the nation's legal residents. The remaining revenue would mitigate local hardship. A "check in the mail" may rally public support for upstream allocation.

Climate policy does not operate in a vacuum. Existing energy and fiscal policies may interfere with emissions trading systems as governments seek to minimise the cost of GHG abatement.

Emissions Trading in Road Transport

Overview of experience

Myriad elements of road transport drive emissions: from mobility needs, vehicle types, on-board technology, fuels, to the provision of alternatives. Provided that incentives find their way to the appropriate agents, from car users to town planners, a proper price signal on CO_2 emissions would affect each of these aspects to a different degree. While a single trading mechanism may not prove all-encompassing, it could reduce the cost of CO_2 abatement for some of the agents involved.

The transport sector is not entirely foreign to the use of market instruments to limit pollution or vehicle use. The following paragraphs summarise the trading schemes used to reduce air pollutants and transport's other negative externalities, and how such schemes may be adapted to control GHG emissions from transport.

The first and maybe best-studied trading scheme covering transport required the reduction of lead in gasoline in the United States. Established by the US environmental protection agency in 1979, the scheme capped the lead content per gallon of gasoline sold. Refiners and importers complied not with a standard for each gallon, but with the average lead content of the total of fuel sold over a three month period. In 1983, trading was introduced to allow those refineries and importers producing an average lead content below the targeted standard to sell lead credits to those unable to meet the standards. Allowing the banking of credits between 1985 and 1987 triggered a sharp decrease in lead concentration. Refineries scrambled to reduce their fuel lead by 1984 to bank compliance credits to use over the following years of even more austere limits.[120] The refineries' familiarity with trading additive rights may explain the success of the lead-in-gasoline trading scheme.[121]

The design of this American scheme cannot apply intact to CO_2 emission control, since the CO_2 content of transport fuel cannot be separated from the fuel itself. However, such a scheme could be used to require refineries to favour biofuels among their products. In such a rate-based system, the trade of certificates representing the biofuel content above the standard would reduce overall compliance cost.

Shifting liability slightly downstream but not entirely to drivers themselves, in 1998 the environmental protection agency established

120. Nussbaum (1992).
121. Raux (2002).

a trading scheme between automotive producers. The mobile source averaging, banking and trading (ABT) programme sets emission standards for engines and applies them to various groups of manufacturers. To comply, automotive producers can average emissions over engine families in the same model year, bank credits to offset future emissions, and trade credits between firms. The programme now covers producers of heavy-duty trucks, automobiles and light-duty trucks, non-road diesel engines in construction work and agriculture, locomotives, marine engines, and small engines such as lawn mowers.

For heavy-duty truck engines, the pollutants open for trade are NO_x and hydrocarbons. Emissions averaged over a manufacturer's annual sales of one engine type must meet the engine type's set limit. The averaging mechanism allows some vehicles to be more polluting if other low-emission vehicles in the fleet offset their excess. Banking is possible over an indefinite time but credits can only be used within the same engine family and are discounted by 10% if the manufacturer does not meet higher, voluntary emission standards. The credit discount applies also to the trading mechanism, which is the least used of the three instruments. Trade's high transaction costs and the risk of revealing sensitive information to competitors explain its reluctant use.[122] We discuss below the possibility of applying a similar system to cars and CO_2.

Like the ABT, California's zero emission vehicle (ZEV) programme targets automotive manufacturers. However, the California programme aims to promote the sales of vehicles without direct emissions, namely those powered by fuel-cells or electricity. As manufacturers defaulted, the programme changed several times before introducing credits trading. Credits represented the sale of low- and zero-emission vehicles.[123]

122. Ellerman et al. (2003); electronic code of federal legislations (May 9th, 2005): title 40, protection of environment; chapter 1, environmental protection agency; subchapter C, air programs; part 86.1 to 86.544-90 control of emissions from new and in-use highway vehicles and engines:

123. California air resources board, 10 May 2005: http://www.arb.ca.gov/homepage.htm

While ZEV regulated HC, CO, and NO_x, such a system could technically include CO_2 emissions. In theory, selling vehicles with CO_2 emission levels lower than target would also generate credits for sale. In spite of its flexibility, the ZEV scheme highlighted the need to introduce technologies following market demand. Weak demand for these cleaner yet costly vehicles proved fatal to the first ZEV scheme.

A system of transitional points can also control transport related emissions. As illustrated by the Austrian example, freighters transiting Austria must surrender "ecopoints" corresponding to their NO_x emission class. The transitional point system falls outside a narrow definition of emissions trading.[124] To reduce 2003 NO_x emissions by 60% relative to 1991 while reducing noise from road transport, the system prohibited traffic to exceed 108% of 1991 levels. Units onboard each truck collect ecopoints electronically. Credits are not tradable and must be surrendered to a reserve when a member country does not exhaust its entire ecopoint allocation. From the reserve, the credits are reissued to those countries that need them. The system did reduce NO_x emissions but proved less effective for noise. The 108% clause was eventually suspended by the European Commission because it proved impossible to enforce.

The Austrian transitional points system targets freighters but could also be expanded to private vehicles. In the context of CO_2 emission reductions, the number of credits deducted would represent the CO_2 emission class of the vehicle and the distance driven. Distance could be measured with an on-board unit based on GPS.[125] The expansion of such a system to car users would involve significant costs to monitor travel distances among other possible technical barriers to implementation. A better proxy for CO_2 emissions may be fuel use, as targeted by an upstream system or a tax.

124. Raux (2002) and European Parliament (2003).

125. Germany tracks transport freight by GPS for road tax purposes.

Singapore's vehicle quota system requires prospective car owners to obtain a certificate of entitlement before buying. A restricted number of certificates is auctioned twice a month. As car ownership cannot be easily translated into travel distances and corresponding CO_2 emissions, this measure may not be suitable to control CO_2 emissions, even if constraining the number of cars does indirectly cap fuel use. As Singapore does not host a car industry, the government can restrict car sales without damaging domestic production.

The EU's voluntary agreement with car manufacturers ranks among the most comprehensive policies to reduce CO_2 emissions from private automobiles (box 7). The system uses an averaging mechanism resembling that of the ABT but does not allow for trading.

Trading mechanisms applied to transport pollution target a broad range of actors in the transport sector. The US lead-in-gasoline programme assigned liability to refiners for removing lead emissions (upstream), and proved particularly effective. The ABT and ZEV programmes target automotive producers (midstream) with mixed results. Singapore's vehicle quota system and Austria's ecopoints seek to affect end-users (downstream) but only target externalities indirectly. Lessons from these examples may guide the construction a trading scheme for transport CO_2 emissions.

Transport CO_2 emissions trade

Following review of upstream emissions trading, one should consider the design of a downstream allocation in which vehicle drivers are liable for their emissions. As initial allocation would now target individuals, the design must enable their buying and selling of allowances. Clearly, this option would widely distribute the carbon rent relative to a system of oil supplies liability and would heighten of transport's role in climate change.

The principal flaw of a downstream design is the administration required by allocation and monitoring, anticipated to be far more

Box 7

Voluntary agreements with car manufacturers

In 1998, the European Commission negotiated an agreement with the European, Korean and Japanese car manufacturers associations (ACEA, JAMA, KAMA) to reduce average emissions from new cars to 140 gCO_2/km by 2008-2009. In return, the Commission will not impose additional charges on the manufacturers.[126] While manufacturers had been on track earlier, recent data indicate their imminent shortfall. Emissions were reduced by only 1.8% last year clearly short of the average of 3.3% necessary.[127]

However, these official figures do not account for the differences between real driving conditions and the test driving cycle in which air conditioning for instance is not included, thus neglecting emissions from air-conditioning and other variables.

The Canadian government signed a memorandum of understanding with the representatives of its domestic automotive industry in April 2005, requiring a reduction of GHG emissions from cars and light-duty trucks by 5.3 $MtCO_2e$ by 2010. Advanced emission technologies, advanced diesel technology, alternative fuel vehicles, hybrids, and high fuel efficiency vehicles will generate the majority of the reductions. In signing, the automotive manufacturers also pledge research and development in lightweight materials, alternative fuels, and hydrogen fuel cells. Interim reduction goals have been set to 2.4 $MtCO_2e$ in 2007, 3.0 $MtCO_2e$ in 2008 and 3.9 $MtCO_2e$ in 2009. While the reductions are initially non-binding, the prospect of regulation looms if firms fall short of the 2010 target.[128]

126. ACEA (2002): ACEA's CO2 commitment – A 35 million tonnes CO2 Kyoto contribution to date.
127. European Commission (2004) and Financial Times 11/05/2005; http://news.ft.com/cms/s/500532f8-c1ba-11d9-943f-00000e2511c8.html
128. Government of Canada, 2005.

expensive than for options covering fewer entities. In a downstream design, vehicles could be equipped with a fuel counter, to be checked annually during the technical inspection of the vehicle. To comply, drivers would transfer to the regulator certificates corresponding to their annual fuel consumption. Car-users could also be required to surrender allowances when refuelling; the incentive structure would then be similar to an upstream system.

Energy economists continue to debate the extent to which a price increase or tax can reduce emissions. Some economists insist on a low, short-term elasticity as drivers have little choice but to drive more slowly or, when possible, choose different means of transportation. Others insist on a high longer-term elasticity as fuel costs influence consumers' vehicle choice and car manufacturers and local authorities respond to these shifting preferences with vehicles of higher fuel economy, and more extensive public transit. Most agree that the demand may differ relative to any existing cost and fuel taxes. The same carbon cost incorporated into prices would represent a higher increase in the USA than in Europe or Japan. Most economists also doubt that the transport infrastructure would swiftly and deeply respond to mere fuel price signals. These considerations, combined with the political difficulties of setting up this price signal without infuriating professional freighters and other road users, may deflect policy makers' attention to alternatives, especially as gas prices appear on the rise.

One alternative is to hold local authorities liable for transport-related CO_2 emissions in their jurisdiction. This requires that these authorities have opportunities to reduce CO_2 through interventions in road infrastructure, tolls, and public transport. These measures may be financial, such as investing in sustainable transport networks and establishing incentives for more fuel-economic transport. They may also be educational: targeting drivers' behaviour or encouraging the use of public transport. Monitoring the baseline emission levels and policies' effect may be quite complex, as such measures would cover regions or towns.

Another system could assign liability to large transport services, including public transport providers and freight companies. Such a system would encourage less carbon-intensive modes of transport and increase the fuel economy of the companies' fleets. Emissions for public transport providers should be calculated per vehicle-km or seat to allow for the expansion of the transport network. Emissions of road-freight companies would be calculated per tonne-km and thus compel freighters to reduce empty travels.[129] Austria's transitional points system provides an example of such calculations. A system assigning liability to freighters may advantage large fleets, better equipped to improve fuel economy and rationalise freight routes than independent truck owners.

In the following section, we detail the implications of capping the emissions one level above vehicle users by assigning liability to vehicle manufacturers.

Making vehicle manufacturers liable under a CO_2 cap-and-trade system

Both the ABT and ZEV programmes implemented in the United States illustrate the feasibility of allocating the burden of emissions reductions to vehicle manufacturers. Such allocation requires one of two systems: in a baseline-and-credit scheme, vehicle manufacturers earn emission allowances by improving the fuel economy of their fleet below the baseline. The alternative, a cap-and-trade system, requires public authorities to cap the total volume of emissions before allocating emission allowances to vehicle manufacturers. These manufacturers are then encouraged to reduce the average CO_2 emissions per km of their fleet sales. Emission reduction units represent the product of the CO_2 emissions of models sold by manufacturers in a particular year and the average distance driven over the lifetime of these vehicles. Both systems enable the trade of CO_2 allowances, including trade with other sectors.

129. Raux and Fricker (2001).

To reduce CO_2 emissions per vehicle-km, manufacturers would equip new vehicles with more fuel-efficient technology. However, the fuel test driving cycle biases the measurement of actual efficiency improvements as today's test cycles do not cover all standard equipment, such as air conditioning. Consequently, vehicle manufacturers have overlooked some potential emission reductions that would otherwise benefit consumers.[130] Secondly, measurement of actual CO_2 emissions would also require the verification of vehicle mileage relative to an assumed driving behaviour.

Could such a system deliver reductions, and at what cost? What technical options are available to car manufacturers to bring down the CO_2 content of car travel? Is such a system practical and how will cost be shared between car manufacturers and car users? Definitive answers to these questions remain beyond the scope of this book, given the variety of car manufacturers, regional markets, fuel availability, driving behaviour and other conditions of the demand for mobility. For the sake of illustration, we explore the design of such a system in the context of technical information on engineering cost of various automotive technologies provided by the California air resources Board.[131] Liable under such an emissions trading scheme, car manufacturers would employ these technologies, on the basis of the relative cost of their deployment and the carbon price. Such deployment would probably occur less rapidly if CO_2 prices were to affect fuel prices, rather than car manufacturers.

CARB's data on the US vehicle market was revised following the tenets of ECMT/IEA (2005) to more accurately project the effects of these technologies on manufacturers and consumers. Additionally, two

130. ECMT/IEA (2005) cites vehicle technology which can reduce this "shortfall", that is, the gap between fuel consumption during the standardised driving test cycle and real-world fuel consumption. The technologies assessed do not face technical barriers for commercialisation, but have not been introduced widely because the resulting performance improvement would not be fully taken into account by the official test cycle. Examples for such technologies are electrically driven oil and water pumps, efficient alternators and air conditioners, fast warm-up technologies, the use of fuel-efficient oils, aids to improve driving habits, idle-off and 42V electrical systems, adaptive cruise control and efficient heat pumps.

131. CARB, 2004.

scenarios of European driving variables have been included to illustrate how fuel price and distances travelled affect CO_2 emissions and the financial costs and returns of fuel-efficient vehicles. It was assumed that US carbon reduction technologies bolster fuel economy by the same percentage in European vehicles. As such, the data stated for European driving variables are only estimates.

The technical options described in CARB provide the basis for the cost estimates below. When implementing a technology that would not be otherwise used, car manufacturers incur its direct cost. The cost of reduced CO_2 emissions is simply the ratio of the cost of these new technologies over the volume of avoided CO_2 over the lifetime of the car. Cost to the vehicle buyer can be estimated by comparing the new car's payback period[132] or its net present value (NPV) in comparison with the baseline model. The NPV is calculated over ten years and assumes car prices that fully reflect the technology cost. Fuel savings are computed with each region's average fuel price including taxes and mileage (box 8). Fuel prices include taxes and are discounted at 10% per annum.[133]

In the accounting of car manufacturers, where they reap no financial benefits from fuel savings, the lowest cost per tCO_2 abated in the "large car" vehicle category is EUR 18/tCO_2 under US driving assumptions. This figure assumes a standard package of equipment as indicated in the first line of table 8. CO_2 abatement costs rise when assuming European driving standards as the Europeans' lower annual mileage entails a smaller window for fuel and CO_2 savings.

One important technology option seems missing from CARB's inventory, however, perhaps on the grounds that it would have a behavioural dimension in modifying some (rarely used) performances of the vehicles. This is the limitation of maximum speed. It can produce

132. Incremental retail technology cost divided by the annual fuel savings. Despite its wide use, this criterion is often misleading as it takes no account of financial flows beyond the pay back time.

133. With such discounting, EUR 10 saved in 10 years is equivalent to EUR 3.86 today.

Box 8:

Assumptions on car mileage and transport fuel prices in the US and Europe

The data provided by CARB covers five light duty vehicle classes. The US emissions baselines were set at 181 gCO_2/km for small cars, 214 for large cars, 246 for minivans, 276 for small trucks and 318 for large trucks.

The baselines for the European driving assumptions were calculated from the fuel economy data derived from ECMT/IEA (2005): 175 gCO_2/km for gasoline and 156 for diesel. When applied to EU baselines, the percentage reduction in CO_2 emissions under US driving conditions as noted in the CARB report indicates the CO_2 reduction potential for fuel economic technology in Europe.

Assumptions	US Gasoline	Europe Gasoline	Europe Diesel
Average annual distance driven (km)	19 200	15 000	18 000
Average fuel economy (l/km)	8.7	7.5	5.6
2004 Fuel prices (EUR /l)	0.44	1.03	0.87

The CARB report presented 37 single technologies, grouped into packages for each vehicle class and divided into near-term (2009-2012), mid-term (2013-2015) and long-term categories.

Technology cost projections assume a competitive environment of three suppliers with plants each producing 500,000 annual units, using flexible manufacturing able to produce a variety of models in one plant. Cost calculations required a detailed examination of all aspects of technology deployment in baseline vehicles, relative to the new technologies' influence on other vehicle systems. CARB factored additional cost reductions for some emerging technologies that account for additional innovation and production volumes.

important gains, not so much in effectively limiting the real maximum speed but much more in limiting maximum engine power. This provides for important fuel economy gains at all actual speeds and traffic conditions. Moreover, it has no real cost.

Evaluating consumer preference, we assume that car price tags fully reflect technology cost. These improvements save fuel, benefiting the drivers' finance, as quantified in table 8's listings of the pay-back periods and the NPVs of each technology package as compared with the baseline. Automotive industry standards establish a payback period shorter than three years when attracting consumers to new technology.[134] NPVs under US gasoline prices and driving assumptions are lower than in Europe and sometimes negative.

Table 8 assumes no change in driving behaviour resulting from improved fuel economy. As fuel cost per km travelled decreases, drivers are inclined to increase travel, or shift driving behaviour, choosing more aggressive driving. According to Greening et al. (2000), who reviewed twenty two published studies on the rebound effect, the increase in mileage may cancel 10 to 30% of improved fuel economy's initial gains. The rebound effect would obviously increase the cost of achieved CO_2 emission reductions.

To minimise the rebound effect's distortion of expected CO_2 reductions, scheme managers must forecast targets using actual driving behaviour rather than ideals. To eradicate the effect altogether, policy makers could add another variable cost to car use, possibly in the form of a fuel tax. Note that an upstream or hybrid trading regime would need no additional measure to combat the rebound effect.

Constructing a functional trading system with theoretical tools of this analysis must account for the technical aspects of existing domestic and international trading systems. For instance, this report credits

134. ECMT/IEA (2005).

Table 8

Comparative data on CO_2 abatement costs and benefits for large cars

Driving Assumption			US Gasoline				Europe Gasoline / Diesel			
	Retail cost incremental (EUR 2004)	CO_2 reduction from baseline	tCO_2 reduced lifetime	EUR/CO_2 (car manufacturer)	Payback period (years)	NPV (2004 EUR)	tCO_2 reduced lifetime	EUR/tCO_2 (car manufacturer)	Payback period (years)	NPV (2004 EUR)
Technology										
GDI-S, DCP, Turbo, AMT, EPS, ImpAlt	370	27%	17	18	1	566	11	28	1	1 160
DCP, Turbo, A6, EPS, ImpAlt	214	19%	12	18	1	391	7	29	1	807
CVAeh, AMT, EPS, ImpAlt	748	27%	17	44	4	125	11	69	2	725
VVL, DCP, AMT, EPS, ImpAlt	703	23%	14	49	4	32	9	77	3	536
Moderate HEV - Gasoline	1 413	45%	28	50	4	31	18	79	3	1 024
DCP, DeAct, A6	532	17%	10	51	4	8	7	80	3	380
gHCCI, AMT, ISG, EPS, eACC - Diesel	1 739	28%	n.a.	n.a.	n.a.	n.a.	12	145	7	- 35
Moderate HEV – Diesel	1 413	45%	n.a.	n.a.	n.a.	n.a.	19	74	4	1 320
CVAeh, GDI-S, AMT, EPS, ImpAlt	956	30%	18	52	4	- 9	12	82	2	1450

Driving Assumption	US Gasoline						Europe Gasoline / Diesel			
	Retail cost incremental (EUR 2004)	CO_2 reduction from baseline	tCO_2 reduced lifetime	EUR/CO_2 (car manufacturer)	Payback period (years)	NPV (2004 EUR)	tCO_2 reduced lifetime	EUR/tCO_2 (car manufacturer)	Payback period (years)	NPV (2004 EUR)
DCP, A6	385	12%	7	53	4	- 11	5	83	3	560
GDI-S, DeAct, DCP, AMT, EPS, ImpAlt	748	23%	14	53	4	- 14	9	82	3	1 101
gHCCI, DVVL, ICP, AMT, EPS, ImpAlt	708	21%	13	54	4	- 38	8	86	4	1 030

Source: CARB (2004), authors' calculation.

Notes: A6: 6-speed automatic transmission; AMT: Automated Manual Transmission; CCP: Coupled cam phasing; CVVL: Continuous variable valve lift; CVT: Continuously variable transmission; DCP: Dual cam phasing; DeAct: Cylinder deactivation; dHCCI Diesel homogeneous charge compression ignition; eACC: Improved electric accessories; EAT: Electronically assisted turbocharging; EGR: Exhaust gas recirculation; ehCVA: Electrohydraulic camless valve actuation; emCVA: Electromagnetic camless valve actuation; EHPS: Electrohydraulic power steering; EPS: Electric power steering; EWP: Electric water pump; FDC: Fixed displacement compressor; GDI-S: Stoichiometric gasoline direct injection; gHCCI Gasoline homogeneous charge compression ignition; HEV: Hybrid-electric vehicle; ICP: Intake cam phaser; ImpAlt: Improved efficiency alternator; ISG: Integrated starter-generator system; Turbo: Turbocharging.

Exchange rate: 1.244 EUR/USD.

Fuel price assumptions: EUR 1.03/l gasoline, EUR 0.87/l diesel, USD 2 per gallon of gasoline in the USA.

emission reduction allowances to the automotive manufacturers for the full 15-year lifetime of the vehicle. This is an unusually long crediting period relative to those of already established emissions trading schemes. If the crediting period were truncated to coordinate with existing systems, the marginal cost of avoided CO_2 would rise accordingly. Without shortening these crediting periods, system designers seeking inter-scheme coherence could allocate vintaged allowances to manufacturers. Those allowances of future vintage could not be used for compliance beforehand.

A comparison of today's carbon prices indicates a marginal cost of abatement in the transport sector several times that of industrial sources. As calculated using CARB data, the range of costs per tonne of CO_2 for car manufacturers, EUR 18 to EUR 145 per tCO_2, is generally higher than current prices of EU allowances of about EUR 20.[135] The extent to which car manufacturers pass improved technology costs to car prices will determine their cost per tonne as car buyers then absorb the cost of new technology. Given complete coverage of new car fleets, all cars would now bear some cost of higher efficiency.

In conclusion, an emissions trading scheme among automotive manufacturers could initially benefit consumers and manufacturers. Automotive manufacturers would benefit from relaying much of the cost of fuel economic equipment; if unable to devolve these costs, manufacturers would limit their abatement costs to those stated above. They would receive a permanent incentive to engineer carbon-lean models. Drivers would benefit from the improved fuel economy of new vehicles as fuel savings over the vehicles' lifetime could produce a net gain from the additional investment. The stringency of the allocation to car manufacturers and any rebound effect would both determine final emission reductions. However, allocating emission allowances in a cap-and-trade system on the basis of real, ex-post mileage assessment and by constant recalibration of the driving cycles would mitigate the uncertain influence of a rebound effect.

Box 9

CO_2 allocation to a car company

Our theoretical car manufacturer sells 1.6 million vehicles per year in North America and 230 000 in Europe. Multiplying sales numbers by the average CO_2 emissions for the manufacturer's fleet and the annual mileage typical of the respective region, we assume that the manufacturer's vehicles sold in North America emit 6.6 $MtCO_2$ per year while European sales represent 0.7 $MtCO_2$ annually. Accounting for the vehicles' fifteen-year viability, the manufacturer's annual CO_2 rent would be 15 times 7.3 $MtCO_2$, or 110 $MtCO_2$.[136] At EUR 20 per tonne, this would represent assets of EUR 2.2 billion.

Let us now assume further that a manufacturer deploys a package of fuel conservation technologies.[137] For this year's fleet, this would reduce emissions by 15%: 13.3 $MtCO_2$ in North America and 1.1 $MtCO_2$ in Europe. With a 30% rebound effect, annual emission reductions would be 10.1 $MtCO_2$. These reductions must be considered in the context of their annual incremental cost to the manufacturer, depending on the degree to which carbon consumers would assume the cost of new technology. In this example, the manufacturer would incur no more than EUR 726 million in annual cost over both regions.

A comparison of these figures suggests a non trivial trading incentive for car manufacturers facing a sufficiently high carbon price. If nothing else, their own finances should compel manufacturers to active trading and implementation of efficiency technologies. Clearly, car manufacturers reaping the benefits of emissions reductions are more likely to quickly deploy more efficient technologies.

135. *Some technology, especially biofuels, could result in much higher cost per tonne of CO_2, as indicated by the Sustainable Mobility Project. In this case, cost would be borne by consumers and manufacturers through technology changes and higher fuel prices (WBCSD, 2004).*

136. *For comparison, the total CO_2 emissions from the transport sector in 2002 amounted to 4 914 $MtCO_2$.*

137. *The package is identified as DCP, A6 in table 8.*

A system limited to automotive manufacturers carries the risk of limited trading between parties. As in the ABT programme, those manufacturers with surplus allowances would prefer to keep them and force competitors to engage in mitigation measures of higher cost. Linking the above system to broader schemes such as the EU ETS would diffuse this risk, as car manufacturers could acquire allowances from a myriad of other sources.

Environmental integrity, economic efficiency and cost of administration determine the viability of an emissions trading scheme.[138] A comprehensive cost analysis must account for externalities. The total costs of driving a vehicle exceed the cost of vehicle ownership and operation to include costs of parking, traffic congestion, noise pollution, social costs of car accidents, roadway costs, and traffic services. Increased mileage would amplify the effects of these negative externalities. Increased fuel economy may hence not be the best method to reduce CO_2.[139] On the other hand, reduced fuel consumption entails its own external benefits, among them reduced local air pollution and dependency on imported oil.

The trading system illustrated above could reduce the CO_2 intensity of car use, though it would not reduce travel, itself an important driver of rising CO_2 emissions. Increases in fuel economy, compelled by an emissions trading system among car manufacturers, form only part of the solution to transport's rising CO_2 emissions. Policies to reduce mobility needs and encourage more efficient transportation must complement technology-driven fuel efficiency, central to emissions trading between manufacturers.

138. OECD, 1997.
139. Litman, 2005.

Including International Aviation and Marine Bunker Fuels

Emissions from international aviation and maritime transportation (known as international bunker fuel emissions) are not subject to the limitation commitments of Annex I Parties under the UNFCCC and the Kyoto Protocol. These emissions are however measured and reported in the Parties' calculated GHG inventories.

Still, these emissions are growing quickly and could threaten the Convention's stabilisation objective if left unabated. Between now and 2050, global air passenger travel is projected to grow by about 5% per year and aviation fuel use would see a three-fold increase in CO_2 emissions by 2050. At that time, aviation alone would be responsible for 5 to 13 parts per million of atmospheric CO_2 concentration. Moreover, the overall impact on the greenhouse effect of aviation's other emissions, including water vapour, is two to four times higher than that of CO_2 alone.[140]

While parties to the Convention, the international civil aviation organisation (ICAO) and the international marine organisation (IMO) all struggle to fairly assign emissions to countries, the debate continues as to the appropriate instruments to control aviation emissions and, to a lesser extent, marine sector emissions. Current debate revolves around three potential instruments: voluntary agreements with industry, taxes or charges, and emissions trading. The ICAO Assembly recommended further work on emissions trading to focus on two approaches:

- A voluntary trading system initiated by states and international organisations.
- Incorporation of emissions from international aviation into states' emissions trading systems in a manner consistent with the UNFCCC.

140. IPCC, 1999.

While total CO_2 emissions fell by 3% between 1990 and 2002 within the EU, the region's aviation emissions rose by 60%. Forecasts suggest that by 2030, aviation emissions could amount to no less than a quarter of UK's current emissions. This startling potential growth has compelled the UK to champion the EU ETS's incorporation of aviation emissions by 2008. Concurrent with the UK's 2005 presidency of the EU, the European Commission has authorised a study on the feasibility, and the environmental and economic effects of aviations' incorporation in the scheme (see box 10).[141]

The environmental benefits of aviation emissions trade vary according to emissions trading designs and the market's carbon price. Among enumerable mitigation policies, Wit et al. (2005) have studied three in which the EU ETS's incorporation of aviation emissions reduces them by 19 to 27 $MtCO_2$ by 2012. The bulk of these reductions would be bought from non-aviation sectors. Reduced demand for air transport would account for most short-term reductions from 0.2% to 3% against a growing baseline. In the longer run, technical and operational measures would account for half of these reductions.

The competitive position of EU carriers is not likely to suffer from emissions trade. Regardless of nationality, carriers operating on the same routes will be subject to the same carbon constraints. Although changes in prices may influence the choice of tourists' destinations, transportation preferences remain determined by geography.

The distinction between Annex I and non-Annex I countries blurs when considering aviation and marine transportation: both sectors foster fierce competition between companies of similar design regardless of location.[142] As such, sector-wide commitments suit aviation and marine emissions attributable to non-Annex I countries. Both the approaches championed by the ICAO could address these emissions on a global scale.

141. In the meantime, the Commission and various EU member states have supported the introduction of a tax on aviation fuel in the EU, albeit to fund development assistance. This latter objective does not necessarily exclude the former of reducing aviation emissions.

142. Sassi, 2003.

Relative to the spotlight on aviation emissions, emissions from marine bunkers attract much less attention from those involved in climate policy. This is somewhat surprising as marine bunkers exceed aviation bunkers both in emission volume (463 vs. 354 MtCO_2 in 2002) and recent growth rate (27.6% versus 23.9% between 1990 and 2002). Greater demand elasticity of aviation, notably for tourism, may explain this divergence in popular assessment. Moreover, while energy efficient high-speed trains could substitute for air transport, the more carbon-intensive road freight would assume the role of some marine bunkers transport.[143] Maritime transport's idiosyncratic tinkering and offshore refuelling may undermine any non-global policy. On the other hand, in comparison with the aviation sector, maritime transport exhibits much greater potential for energy efficiency improvements, in particular from the generalisation of electric propulsion chains, which a carbon price would likely foster.

Box 10

Aviation in the EU ETS

The prime variables of policy design include the geographic scope of covered emissions, the liable entities, the various allocation issues, and the possible means to capture the full effects of emissions. Regarding the coverage of aviation's atmospheric impacts, Wit et al. (2005) distinguish three options to fully assess aviation's emission reduction policy:

1. A CO_2 multiplier *to account for other climate impacts, with no specific incentives for the reduction of non-CO_2 gases.*
2. A CO_2 plus effect-by-effect approach *to gauge the influence of other variables. Wit et al. (2005) shy from this approach as the involved uncertainties appear too large.*

143. Sassi, 2003.

3. A CO_2 only approach, *with flanking instruments to address non-CO_2 effects. This approach should account for potential NO_x landing charges at all EU airports and possibly a NO_x en-route charge.*

In the geographical context, Wit et al. consider six flight scenarios covering between 2.4% to 7.7% of the emission volume of the EU ETS in its first period:

1. Intra EU (52 MtCO_2 – 2.4%)

2. Intra EU + 50% routes to/from EU (135 MtCO_2 – 6.1%)

3. Departing from EU (135 MtCO_2 – 6.1%)

4. Emissions in EU airspace (121 MtCO_2 – 5.5%)

5. Departing from EU + EU airspace (170 MtCO_2 – 7.7%)

6. Intra-EU and routes to/from other KP states (72.5 MtCO_2 – 3.3%)

The authors offer no specific recommendation for the seamless extension of the EU ETS to aviation emissions. However, the most practical coverage design may be the most inclusive, that involving all emissions in the EU airspace and those from flights departing from the EU. There seems to be no legal obstacle to this scenario (nor to others), as current aviation law does not address emissions trading. This coverage would extend to all aircraft, irrespective of ownership. In a communication at the end of September, 2005, the Commission expressed a preference for such scheme.

Aircraft operators appear to be the most suitable entities of whom to require compliance with the EU ETS. Despite the precedent of member state level allocation set by the first NAPs, *two arguments favour a single supra-national allocation to the aviation sector at the EU level, imposing common regulation on all aviation entities: first, international aviation's exemption from the EU burden-sharing agreement; and second the absence of competitive distortions and administrative costs.*

However, the inclusion of aviation in the EU ETS creates unit accounting difficulties, as those generated by international aviation are not assigned under the Kyoto Protocol. This is particularly true if there is a net flow of tradable units from the aviation sector to sectors producing both EUAs and AAUs under the Kyoto Protocol. Solutions to this problem are not forthcoming. Imposing quantitative obligations on aviation seems implausible before 2012. Aviation firms may be reluctant to buy allowances from other sectors. It may be more acceptable that the obligation to surrender allowances is limited to emissions above some baseline, but it creates no incentive to ever go below. If, as many believe, the aviation sector carries comparably high marginal abatement costs, allocation of a just quantity of allowances to entities enabled to buy from other operators but not to sell, in semi-open trading (or to sell only those allowances previously bought on the market, through a gateway) could provide a solution. This qualified selling creates an incentive for operators to emit less than their initial allocation.

Regarding methods of allocation, Wit et al. suggest auctioning as the option best suited to reduce emissions at least cost, followed by benchmarking. Auctioning's egalitarian treatment of all companies proves its greatest advantage over allocation by grandfathering. As current international regulation already obliges airlines to register the amount of fuel used on each flight, monitoring would be best conducted by aircraft operators.

Emissions from international aviation and marine bunkers are of particular interest as they remain outside any GHG mitigation agreement. Market actors, including through ICAO, have expressed their preference for emissions trading over any other instrument.[144] Policy makers should exploit such an opportunity.

Conclusion

Emissions trading can extend beyond heavy industry and the power and heat sector. All sources of energy-related CO_2, however small, can be covered by an upstream regime, allocating CO_2 to fossil-fuel producers and importers, or a combination of upstream and downstream allocation. In the absence of end-of-pipe technology, fuel consumption serves as an accurate proxy for CO_2 emissions. Upstream systems provide a price signal to all energy consumers to reduce CO_2 emissions. Governments must address other GHG emissions sources and sinks either through a downstream allocation or other measures.

The successful implementation of such schemes may hinge on their credible public distribution of the carbon rent, without dimming the CO_2 price signal sent to energy users. Schemes less ambitious in scope may prove more practical, as noted in the illustrated scheme requiring the compliance of car manufacturers and encouraging production of more efficient vehicles. However, policy makers should try to introduce a clear signal to fossil fuel users that related CO_2 emissions carry a cost, without which the incentive structure to reduce emissions at least cost is not complete.

Energy analysts cite empirical evidence that economic agents rarely behave as theory predicts. Numerous market imperfections distort the appropriate response to a price signal. In crafting an effective mitigation strategy, policy makers should carefully consider the specific

144. See, e.g., Joppart, 2005, and the European Aviation Industry Joint Position Paper on Emissions Contrainment Policy dated 7 July, 2005 (http://www.aea.be) drivers of fossil fuel consumption in various sectors, as well as prevailing market conditions and its potential imperfections. Only after considering price signal distortions can they proceed with effective mitigation, potentially using emissions trading as one among many instruments. Emissions trading alone will not solve all market imperfections. The transport sector illustrates this point vividly. The sector's high cost of CO_2 emission reductions may reflect its market fundamentals. The transport sector should become a net buyer from other sources in a global emissions trading system. On the other hand, such high cost may reflect the lack of investment in alternatives such as public transport, telecommuting, or modal shift in the case of freight. Effective reductions in transport would then require a more diverse policy toolkit than emissions trading can offer.

BROADENING AND DEEPENING

When examining the many proposals to broaden the scope of greenhouse gas emissions trading, policy makers must consider whether a single type of target best serves goals of common mitigation of Parties of highly variable circumstances. Can the application of multiple compliance targets deliver environmentally-sound reductions at least cost within a system of international emissions trade? Clearly, emissions trade benefits from a comprehensive scope; the broader the sectoral and geographic coverage of a single carbon price, the more meaningful and effective its signal. However, differences in energy prices and income levels may deter the realisation of such a principle. Analysis of the cost and benefits of emissions commitments in the context of emissions trading must account for local conditions. In theory, a single international carbon price would imply much steeper energy price increases in a developing country than in an industrialised country. While a developing country may become a net seller of carbon units, application of the international carbon price on its domestic energy consumption could gravely affect household income. The difficulty arises when applying the theoretical idea without regard for local conditions. This indiscriminate, compulsory compliance would discourage widespread participation, especially among developing economies.

This section will review several of the quantitative emission objectives discussed in international fora and examine their compatibility with emissions trading. Options to be reviewed include: absolute emissions goals; dynamic, index-based targets; non-binding targets; binding targets with GHG price caps; and sector commitments of regional and multinational scope.

Climate change is global by nature and its mitigation requires global action. Stabilisation of atmospheric CO_2 concentrations will some day require global net emissions of almost zero. Starting now, the timing of global emission reductions will determine the level of GHG concentration and the impacts on climate. Despite this, developing countries have been reluctant to adopt mandatory emissions targets which they perceive as a threat to their economic development. At the same time their energy production and consumption patterns offer great opportunity for energy-efficient systems and CO_2 reductions. As these economies develop, quickly and hastily constructing a long-lived energy infrastructure, they may be starting down the path of CO_2 intensive energy, endangering the local environment, energy security and the economy over the long term. Waiting for developing countries to attain a certain development stage before requiring their participation in climate mitigation alarms some in countries whose ambitious mitigation policies target internationally-exposed industry. This raises the risk of emissions leakage as carbon-intensive activities would relocate in countries without such constraints.

Flexible future commitments could mollify developing countries' concerns over the carbon constraint's threat to their economic development. The first option is a dynamic emission target, whereby assigned amounts grow or shrink as economic growth deviates from expectations. Dynamic targets will reduce but not eliminate those economic risks posed by uncertainties on the allocation's constraint on economic growth, as well as the risks of over-allocation.

Another option is a non-binding target, establishing an emissions objective and a CO_2 market mechanism favourable to developing countries. Should a country's emissions fall below the target, the regime authorises its sales of excess allowances, without requiring the country to buy if emissions exceed its target. Non binding targets thus eliminate economic risks driven by uncertainty on economic development, and on the evolution of energy prices and carbon-lean technologies. A non-binding target, if set on or close to business-as-usual emission trends, imposes no net cost on developing countries. Indeed, given the potential benefits of participation in trade, developing economies should account for the international price of carbon when crafting energy and agriculture policy. As such, a non-binding target would be best used as a pragmatic transition to mandatory compliance.

A comprehensive examination of emissions trading expansion must address the domestic implications of a nation's participation in an international regime. Does participation in an international scheme require a nation's establishment of a domestic emissions trading system? With 1.5 billion people not having access to electricity and 2.5 billion reliant on traditional biomass as fuels for heating and cooking, the specifics of energy use in many developing countries suggest that a sweeping market instrument like emissions trading may enjoy limited application in developing countries.

Given these economic realities, country-wide targets, even if indexed or non-binding, may be less suitable for developing countries than sector-wide targets. With coverage between existing project-based mechanisms and nation-wide targets, these tools may preface standard compliance mechanisms. Of course, developing countries may ultimately prefer mitigation approaches independent of international trade, but discussion of such strategies remains beyond the scope of this book.

The Advantages of a Global Emissions Trading Regime

Emissions trading presents two grand advantages over other economic instruments to address climate change. The first is the flexibility with which governments can choose their own most appropriate mitigation policies, including the option, if domestic trading is feasible, to allocate quotas for free or sell them at an auction. The second theoretical advantage of emissions trade is that its cost-effectiveness does not hinge on the initial allocation of quotas. This enables negotiators to focus on acceptable allocations.

Macro-economic modelling indicates how a global emissions trading regime would reduce the overall costs of emissions reduction. Few have shown how the cost reductions of global trade compel a more ambitious environmental objective. The OECD's 1999 *Action Against Climate Change* compares three different scenarios for global participation, each determining a different GHG concentration by 2200:

- "Kyoto forever": Annex I parties limit their emissions to the levels specified in the Kyoto Protocol; other countries are not constrained. This scenario would not stabilise atmospheric concentrations.
- "740 parts per million in volume (ppmv)", a doubling from current concentration.
- "550 ppmv", roughly twice the concentration of pre-industrial times.

A comparison of the global economic cost over the 2010-2050 period proves striking. The costs for Annex I under a "Kyoto forever" scenario without trading are not lower than the total cost of stabilising concentrations at 550 ppmv in the presence of global emission trading. In further contrast, most of the scenarios that involve trade deliver net economic benefits to non-Annex I regions, whereas "Kyoto forever" entirely ignores developing countries. These results – among others – demonstrate the potential for large cost savings and for more ambitious targets of a global regime with emissions trading.

As mentioned in chapter 2, the CDM (its present form beset by transaction costs) cannot claim to trigger sector-wide changes in developing countries. In addition, the CDM cannot prevent emissions leakage and may, in fact, promote investment in plants defined as efficient only in relation to their host country's baseline. According to this pessimistic theory, incentives from the CDM may allow or even encourage a carbon-constrained nation to close a moderately efficient plant and replace it by a less efficient plant in a developing country.

International emissions trading is a model of cost effective environmental regulation as the mechanism providing the broadest range of mitigation options to all participants. A scheme covering a wide range of countries and industries would also reduce emissions leakage. Again, this dynamic remains independent of the initial allocation: while some countries may enjoy an excess of allocated allowances, GHG emissions would carry the same opportunity cost everywhere. Any additional emission in such over-endowed countries would represent a lost opportunity to sell. This loss entails the same cost as buying allowances to cover emissions in a constrained country.

However, competing industries operating in different countries would not automatically face the same opportunity cost for their emissions. For this to happen, governments must somehow devolve commitments to their industries. This would allow these sources to pursue their own least-cost compliance strategy. Yet governments may not follow the economist's viewpoint, in developing and developed countries alike.

Designed to encourage sustainable economic growth, an international emissions trading regime would provide developing countries various benefits beyond the clear aim of GHG abatement. Emissions trade could drive the transfer of technology and finance. It could also offer ancillary benefits, reducing emissions of local pollutants, and forge new strategic relationships in the realms of government and private business. Characterised by low labour cost and the initial growth in infrastructure, the economies of developing countries could generate a significant share of emission reductions, given business-as-usual emissions trends.

Barriers to a Global Regime

The UNFCCC requires developed countries to take the lead given their responsibility for atmospheric GHG accumulation. However, emissions trading would benefit developing and industrialised nations alike, especially as lower mitigation costs encourage more ambitious climate policy. Clearly, this argument alone has not convinced developing countries to enter a regime delivering such benefits. Instead, the perception that a cap on emissions implies a cap on economic development remains widespread – eradication of poverty and improving living standards are the primary and legitimate goals of developing countries. This scepticism is slow to erode although success in the CDM would quicken the pace.

The clean development mechanism, although derived from a Brazilian proposal, has incurred the criticism of some experts of developing countries. Principal among the complaints is the dilemma of "low-hanging fruit": the CDM enables industrialised nations to now pick the cheapest abatement opportunities in the developing nations, leaving only more costly and complex potential abatement. When no longer exempted from binding emission reductions, the developing country would have no choice but to assume the heavy cost of these less attractive options. This theoretical fear may prove wrong, however: cheap opportunities presented by the construction of a new infrastructure disappear if not realised – low-hanging fruits rot if not picked on time. Of prime concern now is that CDM projects may not arise in a quantity large enough to benefit all developing countries.

The expectations sparked by the CDM may enable a productive discussion of emissions trading between developed and developing nations. Nevertheless, concerns over the economic implications of binding quantified objectives require a careful consideration and the possible negotiation of initial emission targets sensitive to economic growth.

Some proposals compensate the potential burden on developing nations with a generous emission allocation, either as a simple strategy to obtain developing countries' support for the regime or in a realisation of a global equity principle borrowed from social justice.[145] The likely consequence of such allocation is a massive transfer of financial resources from developed to developing countries through the global GHG trade. Most of the money spent by industrialised countries

145. *A famous such proposal is "contraction and convergence" developed by Aubrey Meyer. For a presentation of a broader set of options for allocation, as well as other options for future international cooperation to mitigate climate change, see Philibert, 2005b.*

would not finance emissions reductions and industrialised countries may thus be deterred from adopting ambitious reduction goals.

Such transfers have already proven unpopular in the context of the Kyoto Protocol, as some economies in transition have obtained assigned amounts well above their projected emissions. Proposals by Russia and other EITs to create green investment schemes whereby revenues from trade would fund GHG-mitigation projects indicate market player's reluctance to acquire AAUs that have not been generated by policy, but rather inherited from international negotiation. Targets based on business as usual (BAU) emissions may prove most popular among developing nations. BAU may, however, incorporate reductions from autonomous improvements in energy efficiency. BAU can also account for policies generating emission reductions at no net cost and possible ancillary benefits, such as improvements in local air quality.[146] These various options appear compatible with what Edmonds et al. (1995) termed "no-harm" rule: the international climate policy must assign no positive cost to developing nations. As predicting growth in GHG remains an imprecise science, commitments to reducing emissions will always carry some risk on actual efforts and costs involved.[147]

This uncertainty has proven a powerful deterrent to developing countries' fixed and binding quantitative commitments. These concerns of developing countries confront fears that they may negotiate a fixed target to cover economic growth matching their highest expectations, leading to "tropical hot air" as such growth will not materialise. Other target options may engage developing countries in GHG mitigation without compromising environmental integrity.

These new commitment options differ from the fixed and binding targets adopted under the Kyoto Protocol. Proponents of a standard "cap-and-trade" approach question the logic of further flexibility, as the

146. Viguier (2004) suggests that the targets could be set at a level ensuring that total abatement costs match total revenues that may arise from emissions trading, leaving no benefit.

147. See Lecocq and Crassous (2003) for a quantitative illustration of this point.

system already offers a wide selection of mitigation options to all participants. But the specifics of climate change as an environmental problem justify extending flexibility (see box 11).

We now discuss the design options to add flexibility to international emissions trading systems.

Dynamic Targets

Dynamic targets are indexed to an agreed variable like actual economic growth. Assigned amounts would be established in advance and based on predicted GDP growth at the country level or another metric of output at the entity level. Assigned amounts representing abatement efforts would be recalibrated as growth exceeds or is lower than expectations.[148] This would reduce the cost risk stemming from uncertain emission trends and could encourage more ambitious commitments.[149] Dynamic targets, however, cannot address cost uncertainty surrounding the future availability of abatement options and technologies.

Dynamic targets could promote full differentiation – either through varying assigned amounts or multiple indices. So-called "intensity targets" (defined as a ratio of greenhouse gas emissions to GDP) represent a particular form of dynamic target. Assigned amounts could also be indexed to population, exports, or energy consumption. Dynamic targets can also account for the prevalence of certain sectors in a country's economy, as in Argentina's recognition of agricultural non-CO_2 emissions in its 1998 target proposal.

148. See Frankel, 1999; Baumert et al. (1999).

149. Pizer (2005) and Kolstad (2005) have suggested another argument for indexed targets: dynamic targets would better "accommodate growth". However, if growth were fully certain, dynamic and fixed targets would be equivalent – they would only be defined differently. It is not clear to what extent this cosmetic difference would help in negotiating targets. The issue of comparing intensities between countries would certainly be raised in this context – and with it all the complexities that may arise in comparing GDPs.

Box 11

Uncertainty and the choice of economic instruments

Because the accumulation of emissions rather than those of any one day or year drives the greenhouse effect, climate change mitigation does not require compliance with precise emission targets on a specific date. Targets requiring such precise timing may create unnecessarily high cost of compliance if abatement costs are uncertain.

Sound investment decisions must be driven by expected costs and benefits, i.e. the average of all possible cost and benefit outcomes, weighted by their probability of occurrence.[150] *In context of climate change, marginal abatement costs are likely to grow more quickly than marginal benefits – not over time but with the quantity of abatement undertaken at any moment. Putting a cap on the price of carbon thus reduces the expected costs associated with a given target much more than it reduces the expected benefits. Consequently, the expected net benefits (i.e. benefits minus costs) of a hybrid policy associating a target and a price cap exceed those of identical fixed targets.*[151]

The possibility of an abrupt climatic change would modify these results if science could predict with certainty at which GHG concentration level such change would happen. Even if we were certain what temperature change would trigger a catastrophe, a strict cap-and-trade policy would hold only minor advantage over a price policy. In any case, the uncertain relationship between greenhouse gas emissions and temperature change would require strict control of emissions.[152]

150. See Baumol and Oates, 1971, Weitzman 1974, Roberts and Spence, 1976.
151. See Pizer, 2002; Newell and Pizer, 2003.
152. Pizer, 2003a.

One may wonder how a policy of uncertain environmental outcome may promote a long-term concentration goal. In fact, the ultimate objective of the UNFCCC to stabilise greenhouse gas concentrations in the atmosphere has not yet assumed quantitative form. The level "that would prevent dangerous anthropogenic interference with the climate system" *remains to be determined. The period within which stabilisation of concentration should occur,* "sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner" *also remains to be defined.*

Indeed abatement costs must be part of any decision on these levels, and the discussion on what may be "dangerous levels" *cannot be disconnected from the abatement cost issue. Assuming otherwise would imply that the world should simply decide to return without delay to pre-industrial levels, since there is no guarantee that even current levels are not "dangerous". Climate change is already occurring and already detrimental for some species and human communities. But returning to pre-industrial concentration levels, assuming this is feasible, is unlikely to* "enable economic development to proceed in a sustainable manner".

Intensity targets raise a number of concerns, some regarding the risks of compounding unexpected economic recessions or authorising flagrant emissions in times of economic growth. Predictions of future intensity levels may prove no more precise than those of future trends in emissions.[153] Comparing annual emissions and annual intensity levels for six industrialised nations over the years 1981 to 2001, Pizer (2003b) found that both fluctuated randomly by about 5%. Based on

153. On these various concerns, see Müller et al., 2002, Moor, 2002, and Dudek and Golub, 2003.

this result, Dudek and Golub (2003) claimed that *"setting an intensity target does not really reduce uncertainty about future costs – we might be just as far off on an intensity prediction as on an emission prediction".*

However, the analysis concerns annual emission and intensity fluctuations that would flatten over a multi-year commitment period of dynamic as well as fixed targets. More relevant to long-term climate policy are the trends in emissions over a long period of time, such as the Kyoto Protocol's 15 year span between the adoption of targets and the end of the commitment period.

Some observers worry that trading in the context of intensity targets may be more difficult than in a market exclusive to units generated under fixed caps. In response, promoters of dynamic targets insist that they reduce the uncertainty of net abated volumes more easily than pure intensity targets.

Well-designed dynamic targets could alleviate some of these concerns. Ellerman and Wing (2003) suggest a simple and general formula for "growth-indexed emission limits" that combine a fixed target and an intensity target. The degree of indexing (which is the relative weights of each target type) can take any value between zero (fixed targets) and one (pure intensity targets). A "less-than-proportional" dynamic target gauges very well the emergence of myriad no-cost options as capital stock rotation, particularly that of the energy sector, accelerates during times of rapid economic growth. If, on the contrary, economic growth is lower than anticipated, basic energy needs may be insulated relative to other market-related energy needs, justifying a reduction in a country's assigned amount less than proportionate to the GDP decrease calculated from initial expectations.[154]

Recent work at the IEA further examines the difficulties in emissions forecasting.[155] "Past projections" of economic growth and emissions for

154. IEA (2002a).
155. Philibert, 2005a.

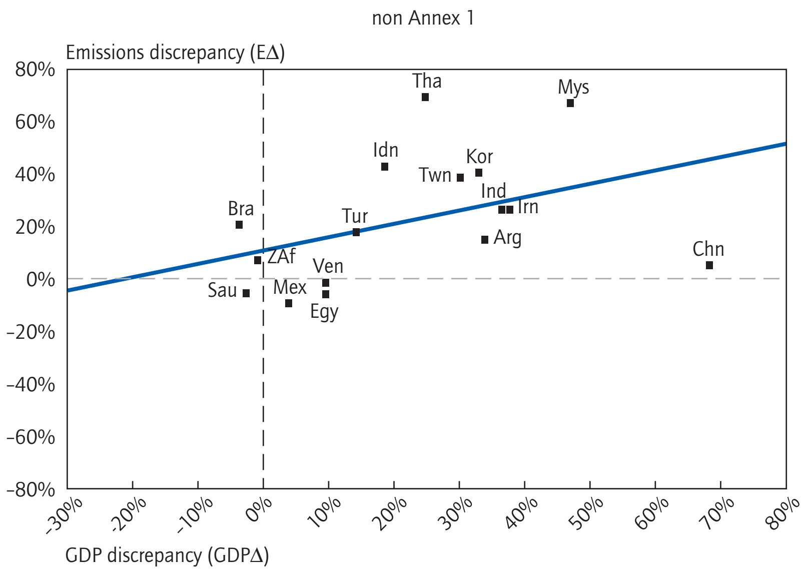
a series of developing economies were derived from a simple extrapolation of 1971 to 1991 trends to the years 1997 to 2001. These projections were then compared with actual GDP growth and emissions, estimating the errors in these forecasts. The results are plotted in figure 10. The errors in forecasting GDP and emissions are represented in the horizontal and vertical axes, respectively. The regression line illustrates the dynamic between deviation in GDP forecasting and deviation in emissions forecasting. Its coefficient of determination is equal to 0.174, indicating that only 17.4% of the variability in emissions can be explained by the variability in economic development.

For a majority of economies, intensity targets would have lightened the burden of compliance with a fixed target during a period of more rapid economic growth than anticipated. Intensity targets would also have proven their worth in the opposite case of sluggish growth. Had they been implemented in Saudi Arabia, intensity targets would have reduced the surplus quotas theoretically generated by a fixed target in the context of low economic growth. However, fixed targets would have done a better job for a few economies where deviations in GDP and emissions forecasts follow opposite trends. For Egypt, Mexico and Venezuela, intensity targets would have inflated the volume of hot air. For Brazil and South Africa, intensity targets would have exacerbated difficulties in target compliance. These countries for which fixed targets prove superior to intensity targets cluster at the centre of figure 10.

Only in hindsight can the advantages of fixed targets be discerned for developing economies. Before the resolution of uncertainties, dynamic targets still appear more appropriate for these countries, as the analysis reveals a general correlation between deviations from economic and emissions forecasts.

Figure 10

Variations in emission forecasts with respect to variations in GDP forecasts



Notes: 0% on each axis indicates that observations match forecasts.
Arg: Argentina; Bra: Brasil, Chn: China; Egy: Egypt; Idn: Indonesia; Ind: India; Irn: Iran; Kor: South Korea; Mex: Mexico; Mys: Malaysia; Sau: Saudi Arabia; Tha: Thailand; Tur: Turkey; Twn: Taiwan; Ven: Venezuela; ZAf: South Africa.

However, the low correlation coefficient of 17.4% suggests that intensity targets cannot eliminate concerns regarding uncertainties in emission forecasts. Dynamic targets adjusted to each country' circumstances could further reduce uncertainty on emission levels despite uncertain economic growth. From figure 10, it appears that a "more-than-proportionate" indexation would be more effective in reducing discrepancies between expectations and actual emissions and GDP trends.[156]

Critics charge that the stabilisation of GHG concentrations at acceptable levels would require impossibly quick improvements in

156. The authors are indebted to John Newman for the methodology, data gathering and computing.

carbon intensity. This implies an even more implausible scenario, that countries could adopt sufficiently stringent fixed targets, accepting a potential impediment to economic growth. On the contrary, countries are more likely to adopt ambitious targets if their economic development is shielded by a mechanism to control abatement costs.

The modelling work of Jotzo and Pezzey (2005) provides a theoretical analysis of greenhouse emissions trading with general, continuously-revised dynamic targets accounting for uncertainties in GDP. They apply this frame to an empirical model of a global climate agreement, divided in 18 countries and regions to simulate developments in international climate policy. The target level for each country is determined by maximising the global, expected, risk-adjusted payoffs for all countries joining a climate treaty, subject to the equity criterion that all countries enjoy the same expected payoffs per capita.

The work demonstrates how dynamic targets allow for more ambitious objectives while maximising payoffs, up to 20% of global abatement. This effect is more important for developing nations than for industrialised nations. Simple intensity targets (or “standard intensity targets”) are less effective than nuanced dynamic targets (or “optimal intensity targets”), in which the ratio of the assigned amounts to GDP is based on the share of emissions linked to GDP as well as the relative stringency of the target. These “optimal intensity targets”, include for some countries “more-than-proportionate” indexation, already mentioned above.

Monitoring and market compatibility issues

Countries with dynamic targets would need to report emissions as well as other data relevant to establish the level of their commitment such as GDP. Because their allowances would be adjusted accordingly, their registry would need to hold a specific account for adjustments corresponding to annual variations in GDP, in this example.

Accurately measuring GDP, growth rates, and other variables of indexed targets pose problems to the implementation of dynamic targets.

Particularly in developing countries, such measurement is often difficult and sometimes controversial. Some economists argue that the unit used, between exchange rates, purchasing power parities or local currency, is irrelevant to targets based on domestic variables rather than their international comparison. Others counter that variations in GDP over time may differ depending on measurement techniques.[157]

In case large variations in GDP were recorded from one year to the next, the country's assigned amount would follow a similar path, although possible increases in emissions triggered by higher GDP would offset part, or all, the visible increase in the country's assigned amount. It is difficult to predict how an international trading regime may react to such variations. We should keep in mind that dynamic targets are designed to smooth variations in countries' needs or provisions of allowances. Further, a country's target does not impose that its entities – industry, power generation or other sectors – adopt targets of a similar nature. For instance, some sectors may be subject to an absolute cap, be allocated allowances that will remain fixed in the country's registry – with full account taken of their transactions, of course – and trade on that basis. They may, also, be allocated dynamic targets, although there is no need a priori to use an identical index to establish companies' targets. Companies or sectors' value added – the sum of which, for all activities, equals the country's GDP – may not be the best suited index for industrial activities. Physical output may be more appropriate, although it has its own problems when setting emission objectives.

Non-binding Targets

Non-binding, negotiated, targets authorise countries to sell allowances only if actual emissions are below the target, but do not require them to buy allowances in the opposite case.[158] Non-binding targets thus

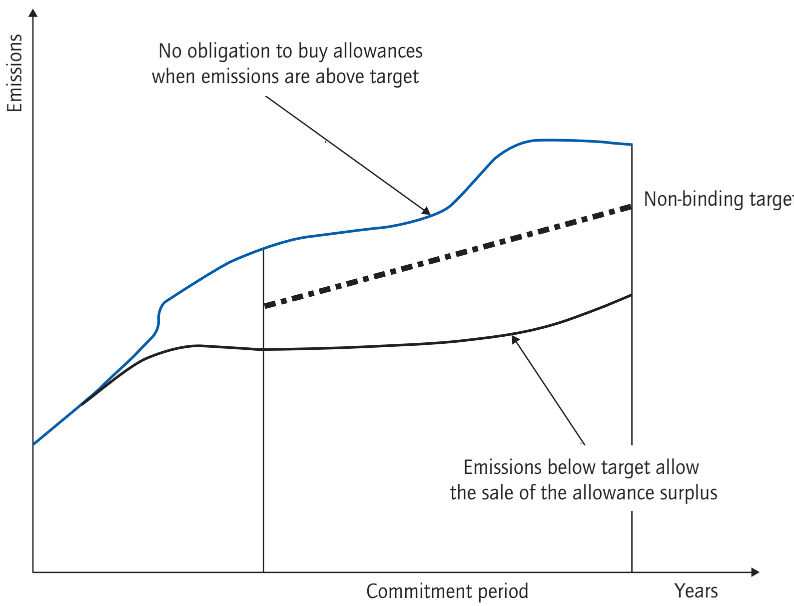
157. See Müller and Müller-Fürstenberger, 2003.

158. This type of target – first termed "emissions budgets"– is also known as "no-lose", "one-way" or "positively binding" targets.

present another way to reduce cost uncertainty and guarantee a net economic benefit as no reductions occur unless domestic costs are lower than the international market price. This design continues to attract interest for experts representing both industrialised countries and developing economies such as India or China.[159]

FIGURE 11

Non-binding targets



Developing countries are unlikely to accept a binding target that would not provide enough allowances for their economic development. This creates a risk of introducing large amounts of excess allowances in the international trading regime. The combination of a non-binding target below which selling may occur, combined with a higher, binding target above which buying is compulsory, may represent a compromise

159. See Philibert, 2000; Bodansky, 2004; Grubb, 2004; Höhne et al., 2005. Also Philibert et al. 2003, Chan-Woo 2002, Dasgupta and Kelkar 2003, Chen 2003.

between contradictory demands for environmental efficacy and economic certainty.

The primary shortcoming of non-binding targets is the limited certainty that they provide on the global environmental outcome. Non-binding targets poorly address the risk of ample deviations from expected GDP growth. Not uncommon in developing economies, these dramatic fluctuations create large amounts of surplus allowances or deep deficits. Trade in surplus allowances constricts the environmental integrity of the market mechanism. Large deficits would render participation unlikely if not impossible. These risks must be weighed against the extent to which developing countries would adopt non-binding targets, while they would oppose fixed and binding targets, unless the latter imply an allocation generous enough to prevent any obligation to buy. The downside of such generous allocation is, of course, its impact on the environmental integrity of the market mechanisms. As noted above, a well-designed dynamic target would minimise these risks. Sectors may also use non-binding targets to enable a single sector's participation in international emission trade, in the absence of a national cap.

The structure of emissions trading with non-binding targets would resemble that of the clean development mechanism. The CDM is also non-binding: if a project releases more emissions than the agreed baseline (rather than less), neither the host country nor the project developer must compensate the global regime for this increase. While the certified emissions reductions in the CDM must be calculated relative to an objective baseline, BAU emissions trends may prove a useful starting point for negotiating non-binding targets.[160]

What could be the market effect of a large country becoming a seller? Its decision to participate in trading would lead to a GHG price reduction. Such situation would probably not come as a total surprise: countries' GHG inventories are public information. Buyers would

160. Philibert and Pershing, 2001; Viguier 2004.

welcome the impact on prices. The prospective seller would however refrain from "swamping" the market with its allowances, in an effort to maximise sales revenue. In the end, a well-functioning market with proper expectations should allow for a smooth transition when new sellers come in the international market.

Market compatibility

Several mechanisms could ensure that countries sell only emission allowances representing reductions beyond their non-binding target. One option would be to start trading only at the end of the commitment period. This would not provide the upfront financing to develop carbon lean investments. Forward contracts may provide for this when the "country risk" does not appear too important. Trading after the commitment period would hamper market liquidity and efficiency by introducing part of the supply only after emissions have occurred.

A second option would make the target mandatory after a country enters trade. This option may deter countries from engaging in trading until they are sure that it does not put them at risk. As such it may be the least acceptable to developing countries

A third option would hold a country responsible for its original assigned amount if its emissions are above target. Any sold allowances would need to be purchased back from the market. A country's liability would be limited to allowances sold.

The commitment period reserve that applies to emissions trading under article 17 of the Kyoto Protocol may prove useful to trigger participation by countries with non-binding targets: their latest annual GHG inventory could be given as an indication of their emissions in the near future. If in fact lower than the agreed target, the inventory could define the total quantity available to a country, plus or minus year to year variations, and allow it to transfer no more than this quantity.

For developing countries under non-binding targets, allowing domestic sources to enter international emissions trading long before the end of the commitment period would be possible, but not without risks. If the country's emissions end up exceeding the target, government can hardly ask domestic sellers to buy back allowances needed to cover their sales, as they would have complied with the domestic rules. Thus the government would be liable for the overall emissions, at least to the exact extent of the companies' sales. Although the balance of trade would end up at zero for emissions, there may be a net cost as there is no guarantee that allowances can be bought at a price that is not higher than the transfer price. Arguably, however, this financial liability remains limited as overall emissions in these countries would remain unconstrained.

The entry of developing countries on international markets may be delayed up to the point where governments are almost sure of their ability to sell. On the positive side, it may provide an incentive to limit the emissions of the sectors not covered by emissions trading; and to not over-allocate allowances to companies.

Other Target Types

Among those instruments of climate change abatement compatible with emissions trading, sector-wide targets and crediting mechanisms most merit consideration (see *Sector-wide targets* below). Other options briefly described here include "action targets", "allowances and endowments" and "long-term permits".

An action target commits its agent to reduce GHG emissions by an agreed percentage relative to an observable baseline: actual emissions during the commitment period.[161] It could be adopted at any institutional level: firm, industry, municipal, state or national. In the context of large fluctuations in economic growth and emission levels,

161. Goldberg and Baumert, 2004. For a discussion, see Philibert 2005a.

these targets, as a percentage of actual emissions, moderate required abatement fluctuations relative to that of fixed or GDP-indexed targets.

In practice, however, countries would demonstrate domestic reductions, proving that emissions would have been higher by the agreed percentage in the absence of the target. This would require constructing a baseline of emission trends in the absence of the country's actions. As with the calculation of baselines and additionality under project-based mechanisms, this demonstration may encounter technical and political difficulty. Worse, the uncertainty on the delivery of any surplus allowances will be resolved only after the commitment period. This makes this option probably less market-friendly than others.

Under a regime of allowances and endowments,[162] each participating country would:

- Require domestic energy producers to hold an annual emission allowance for each tonne of carbon embodied in their energy production, sales or imports.
- Issue perpetual emissions "endowments" of annual emission rights equal to a fraction of emissions during a base period.
- Potentially provide additional annual allowances to firms within its borders at a stipulated price (set at USD 2.7/tCO_2).
- Create domestic markets for perpetual endowments and annual allowances. These would involve no international trade, but the common price for annual allowances would guarantee short run economic efficiency.

Designed for both developed and developing nations, this regime calculates endowments volume specific to each. Developed countries would receive emissions endowments based on their Kyoto targets. Developing countries would receive emissions endowments equal to their current emissions plus an agreed percentage. Therefore, in the

162. McKibbin and Wilcoxen, 2002.

short run, the price of annual allowances would be zero in developing countries. The allowance price will equalise over time, as developing countries' ability to pay rises. The distinction between annual allowances and long-term endowments should set a long term price signal without excessive short-term cost.

Long-term permits[163] could be used to cover emissions at any time during a long commitment period, perhaps from 2010 to 2070. This extended period should allow agents to identify the most efficient timing of emission abatement. Authorised borrowing between successive shorter periods would provide the same time flexibility.

Box 11 on page 112 illustrates why time flexibility may not be detrimental to the environmental integrity of a greenhouse gas trading regime. Banking has proven an effective tool to smooth price variations and avoid risk of non-compliance. Its absence in the RECLAIM NO_x trading programme exacerbated allowance price increases. Lower expected costs due to time flexibility may facilitate the adoption of more ambitious targets at the onset.

International emissions trading under the Kyoto Protocol allows for limited time flexibility in two forms: the five-year commitment period, to smooth year-to-year climate or economic variability; and the possibility to bank unused allowances.[164] Complete time flexibility, however, would require both borrowing and banking to allow optimally timed investment in abatement. A mechanism familiar to controversy, borrowing presents the obvious risk that sources will indefinitely defer investment. As with long-term targets, this risk increases in the absence of strong enforcement mechanisms. This default is perhaps most likely in the international arena where regime participants are sovereign nations. In the end, the market may provide the same service as borrowing – a source buys allowances to meet its current deficit and sells its surplus future allowances under a forward contract. This leaves

163. Peck and Teisberg, 2003.
164. Article 3.13 of the Kyoto Protocol.

the compliance risk with the source, where it belongs, while borrowing transfers the consequences of non-compliance form the source to the environment or the government.

It is not certain that the above options would fare better than dynamic, non-binding, and sector-wide targets to encourage participation of developing countries in international emissions trading.

Developing Economies' Circumstances

Institutional capabilities

A global regime must engage developing nations. Beforehand, system architects should assess the institutional capacity of developing economies to participate in international emissions trading and the risks arising from insufficient capacity, were they to participate. We addressed in the above the risk on economic development and solutions to it. Other risks are likely to remain.

If transparency, accurate monitoring, a functional legal system, and realistic incentives to trade are scarce in countries with economies in transition, *"the problems run much deeper in the developing world"*.[165] In developing nations, one finds few people with the necessary skills and experience to implement and monitor sophisticated policies; skilled labour is concentrated in cities rather than field posts; monitoring equipment is in short supply; even baseline data are unreliable; and informal and even institutionalised corruption runs rampant. Greenspan Bell suggests that it may be impossible *"to expect that countries only beginning the process of environmental protection can start with the most difficult environmental instruments."*

As Baumert et al. (2003) also note, the success of trading systems *"requires competitive markets and other conditions that, in reality, may*

165. Greenspan Bell, 2003.

prove elusive, especially within the confines of international treaty law where participation and compliance cannot be assured." Further, *"if cross-border financial flows from trading turn out to be significant, then it does not necessarily follow that revenues would be used domestically for socially beneficial purposes, such as poverty alleviation or helping countries adapt to adverse climate impacts."*

There are no easy answers to such questions. The need for a working legal system to back emissions trading seems obvious. Countries or entities now holding valuable allowances could be tempted to sell without delivering corresponding reductions, unless strong enforcement measures are in place. On the other hand, the cost-effectiveness of emissions trading would exert a lower pressure on the compliance regime of any environmental policy and lower the probability of non-compliance by offering cheap compliance options.

According to Willems and Baumert (2003), the form of future targets may dictate institutional needs of emissions trading: *"Fixed, legally-binding, comprehensive targets certainly put the strongest pressure on the domestic policy setting to create the institutional conditions to meet them. Dynamic targets or targets with price caps somewhat reduce these capacity needs by reducing a source of uncertainty inherent in achieving a fixed target. Yet, they have new features which may create additional institutional capacity requirements. Sectoral targets and non-binding targets unequivocally reduce some of the institutional needs, by, respectively, reducing the scope of the target and limiting capacities needed to make sure the target is met".*

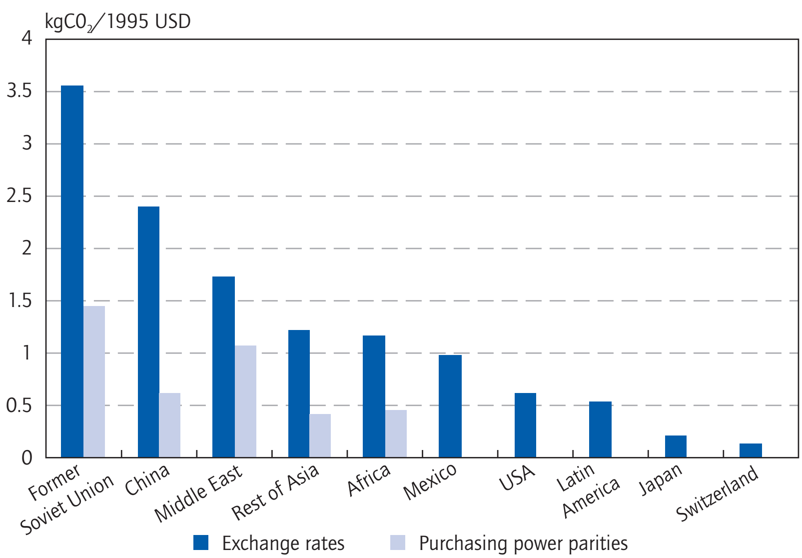
To participate efficiently in carbon markets and mitigate GHG emissions, economies in transition and developing countries must build institutional capacity in environmental policy. As energy statistics could be the basis on which countries define their trading opportunities and needs, energy authorities may have an important role to play. At the activity level, the capacity limitations suggest focusing on sectors with relatively sophisticated management such as the electricity generators and petroleum producers/distributors.

Energy use in developing countries

Developing countries' rapid construction of new infrastructure and high energy and economies of high energy and carbon intensities (see figure 12 below) drive the common expectation of their massive supply of cheap emission reductions. However, structural differences between economies and various economic efficiencies cannot be solely attributed to energy conservation. A comparison of intensities on the basis of purchasing power parities (PPP), instead of exchange rates, illustrates this point (same figure).

FIGURE 12

CO_2 intensities of GDP for selected countries and regions

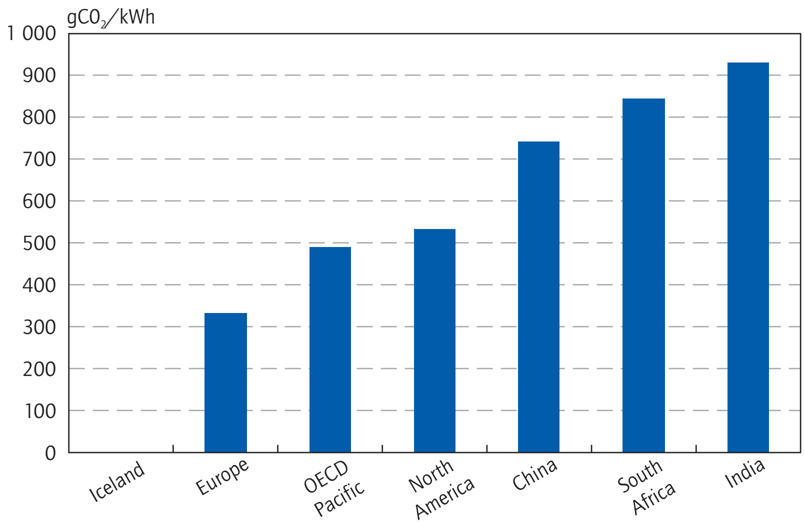


Source: IEA statistics.

Identifiying the most appropriate indicator of carbon intensities per unit of physical output in goods or services proves complex. Purchasing power parities (PPP) may be more appropriate with respect to local consumption while exchange rates figures may prove more accurate in the context of internationally traded goods. The carbon intensity of electricity production shown on figure 13 gauges both the efficiency of generation plants and the carbon content of countries' fuel mixes.

FIGURE 13

CO_2 intensity of electricity in selected countries

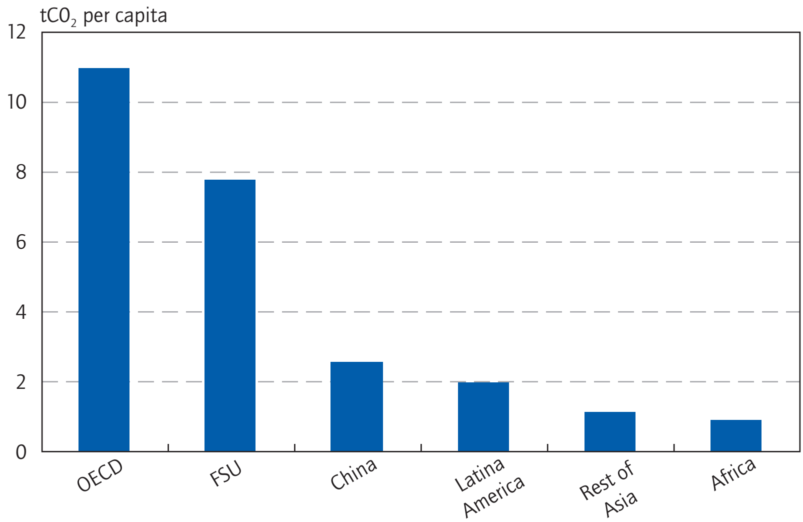


Source: IEA statistics.

Without discounting the potential for cheap emission reductions in developing countries, these numbers caution over its overestimation, especially as such potential varies widely between nations. To guide policy makers, these figures must be read in conjunction with per capita energy-related emissions of carbon dioxide.

FIGURE 14

Per capita emissions (energy-related CO_2)



Source: IEA statistics

More than anything else these numbers reveal industrialised nations' significant share of world emissions and the need to design domestic emissions trading systems suited to local circumstances. A just system must reflect the diversity of energy use within developing and industrialised countries.

Social aspects of energy use

In 2002, more than one quarter of the world's population lived without electricity in their homes: the majority of these 1.6 billion are in South Asia and sub-Saharan Africa. Almost 2.5 billion people rely on non-commercial biomass including charcoal, wood, straw, agricultural residues, and dung for cooking and heating. Poor people in rural areas, especially women and children, often spend hours each day in the search for firewood that gravely harms the local environment. Often inefficiently burnt, biomass is a major source of indoor pollution, which kills 1.6 million people each year.[166]

Biomass may be used efficiently to counter local and indoor pollution: from improved stoves to the gasification of biomass for the production of heat, electricity and cooking gas, projects ranging in sophistication have proven successful in industrialised and developing countries.

With respect to electricity, incremental improvements provide the greatest daily benefit first by powering lights, radio, television, and the conservation of vaccines and food. Providing access to minimal electricity – 50 kWh per person per year in rural areas, twice as much in urban areas – to those now living entirely without it would increase global energy related CO_2 emissions by 1.4%, with current fuel mix. Off-grid renewable electricity would account for little of the expansion.[167]

When incomes rise, households in developing countries typically switch to cleaner, more efficient energy, often from biomass to coal and kerosene, then to cleaner liquefied petroleum, gas and electricity. Moving up the "fuel ladder" from potentially renewable biomass to cleaner, though fossil, fuels provides immediate social benefits that far outweigh their marginal contribution to climate change. This dynamic must qualify the design of developing nations' GHG mitigation policies.

Subsidies to energy services usually prove ineffective, economically inefficient, and contrary to sound environmental practice. However, it could be justified to combat poverty if restricted to services provided through fixed networks: electricity, natural gas or district heating, less prone to misappropriation. Even in the context of fixed networks, subsidies may prove inefficient, downgrading service.[168] Subsidies for easily tradable goods, such as petroleum products, cannot precisely target poverty. However, this may not compel governments of developing countries to shift from energy subsidies to direct or indirect

166. Common Statement of the world health organisation and the United Nations development programme, 15 October 2004.

167. See IEA 2003: 408-413; 479-481, and IEA 2004b: 329-355.

168. See IEA, 2002b.

taxation of petroleum products. Employing a price signal to affect end-use consumers, an upstream emissions allocation may be unrealistic for developing countries at present. Removing fossil fuel subsidies may be an important first step.

Other practicalities may discourage developing countries' use of a full-fledged upstream system that affects all fossil energy prices. For the country as a whole the sale of allowances would cover abatement cost. But even a full refund of profits from trade would not compensate the higher price energy consumption, which could have drastic effects on household income.[169] Refunding windfall profits of fossil fuel importers or producers, or government's revenues from auction, may prove impossibly complex although we considered earlier the possibility of a simple "check in the mail" refund. Moreover, there is a risk that developing countries policy makers, often of the urban elite, craft regulation to maximise their country's revenues from emissions trading at the expense of poor citizens in need of modern energy services.

The premise of upstream allocation that high energy prices would encourage conservation and reduce emissions cannot justly apply to consumers already constrained in their energy choices. Instead, higher prices of oil and gas products would drive a reversion in consumption to those fuels of lower immediate price such as biomass, with negative effects for people's health and local environment.

Country-wide targets may yet serve developing nations. Their comprehensive coverage gives countries the option to undertake mitigation across sources and sinks, with the prospect to trade allowances at a profit. Participation in international emissions trading neither implies nor discourages the establishment of domestic trading schemes. Those developing countries agreeing to national targets may choose to establish domestic trading for some sectors, presumably large stationary sources, before attempting schemes of comprehensive coverage.

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169. See Ghersi et al. (2003) for an illustration of this point for various developing countries. They also point out the macro-economic effects of recycling trading revenues, which may bring additional benefits to capital-starved regions such as Africa, but may not be enough to compensate the otherwise detrimental effects of a high carbon price in India – assuming, again, that the carbon rent is not redistributed.

From Countries to Sectors

Sector-wide targets

Expectations for the CDM share of global mitigation may far outstrip the mechanism's contribution. To salvage the environmental productivity of the CDM, analysts suggest broadening the scope of the CDM from projects to sectors.[170] This could prove particularly appropriate for household, small commerce and industry, and transport sectors. Developing countries may also establish sectoral targets for industry. Sector-wide targets may be fixed or dynamic, binding or non-binding, and coherent with emissions trading.

To create sector-wide CDM projects, countries might codify the activities and credit-generating methods of the CDM in policy covering an entire sector. Effects of such a policy would be judged against a reference scenario; those generating quantifiable reductions below emissions in the policy's actions could be credited. As with other CDM projects, the presence of a crediting mechanism would not oblige sector-wide reductions.

Instead, the establishment of sector-wide domestic trading schemes in developing countries would entitle domestic firms to trade in the global market and circumvent the credit-generating process as described above. A government anxious that a sector-wide target may carry unexpectedly high costs could negotiate non-binding or dynamic targets, or set a price cap. A domestic scheme of non-binding sector-wide target would include no domestic trade as inter-scheme buyers would not exist. Exposure to foreign buyers constrained with binding caps would create demand.

Compared to narrowly-defined project-based mechanisms concerning a plant, not a sector, sector-wide approaches may:

- Lower transaction costs per tonne.

170. See, e.g., Philibert and Pershing 2001; Samaniego and Figueres 2002; Winkler et al. 2002; Chung 2003; Dasgupta and Kelkar 2003; Stewart and Wiener 2003; Schmidt, Lawson and Lee 2004; Yamagata 2004; Bosi and Ellis 2005.

- Alleviate concerns over competition and prevent leakage by providing an "opportunity cost" to all greenhouse gas emissions in covered sectors.
- In using average, sector-wide baselines, generate credits not representing actual reductions.[171]

Compared to country-wide quantified targets, sector-wide approaches may:

- Require lighter monitoring and enforcement.
- More effectively links economic agents in the covered sectors and international investors.
- Settle part of the abatement cost uncertainty inherent to uncertain economic growth.
- Reduce the scale of cost or benefit, if any, for the country.
- Limit emissions reduction choices.
- Create emissions leakage from sectors covered to those unconstrained.
- Complicate international negotiations with sector-specific technicalities.

Under a non-binding sector-wide target, firms would decide whether and when to sell on the international market. The smaller scale of a sector's emissions inventory relative to that of a country enables firms' quick decisions. In the end, sectors would assume the uncertainty previously borne by the country as a whole, allowing firms much more control of their participation in emissions trade.

Transnational sectoral agreements

Thus far, sector-wide commitments or mechanisms can be considered complementary to country-wide targets in industrialised countries. Transnational sector-wide targets would expand the trading market

171. Yamagata, 2004 suggested to offset this risk by halving the amount of credits.

with a nuance unknown to the country-level target even if linked. As they apply to these sectors, transnational obligations could trump the tenets of country-level trading systems. Future climate change regimes could also be considered in terms of sectoral units. Comprehensive commitments among sectors of global distribution could render country-level targets superfluous. GHG mitigation regimes could also require compliance at the level of multinational corporations, as illustrated in box 12.

Box 12

Caps for multinational corporations

Multinational corporations headquartered in industrialised countries account for a non-trivial share of global emissions. Sussman et al. (2004) explore the possibility that parent enterprises, within the border of nations participating in a specific agreement, report and reduce emissions of affiliated foreign enterprises. Caps on multinationals would grant them access to existing international emissions trading systems.

This option would focus on the existing international flows of investments. It could be implemented without involvement of developing country governments, beyond those interested volunteers. It would cover a portion of emissions in developing countries, addressing the perception of uncapped developing nations' unfair competitive advantage.

This option carries theoretical faults. Foreign-owned companies may be at a disadvantage relative to unaffiliated domestic companies, all the more so as the latter could be credited under the CDM while the foreign subsidiary would carry a carbon constraint. Multinationals could skirt the cap by selling assets in developing countries and pursue a contractual relationship with the previously affiliated enterprise.

Transnational sectoral agreements (TSA) may control emissions of energy-intensive industries while mitigating the risk of distorted competition and emissions leakage. To be effective, transnational agreements need to include compliance mechanisms ensuring that individual plants, companies, or industry associations do not free-ride on the system – a prerequisite for such agreements to be acceptable. Liability should also be clearly defined: would each entity be liable to the government of the country of its location, or to an international body representing the sector? If the latter is true, would this sector link to the rest of the trading market with its own registry, or would entities be trading through their host country's registry?

As mentioned in the previous chapter, transnational agreements could suit the aviation and maritime sectors, especially as they are not accounted for in the assigned amounts of the industrial Kyoto Parties. This brand of agreement may also be suitable for industries whose products compete on international markets. Aluminium, responsible for slightly less than one% of global GHG emissions, provides the best possible example. The light metal is heavily traded; its production industry is fairly concentrated in a few firms. Other internationally-traded products discussed in this context include iron and steel, cement, and light-duty vehicles.[172] Emissions trading would benefit all participants but may develop from sector-wide targets specific to country rather than transnational accords.

Transport and the production of heat and power, two sectors of essentially domestic scope exhibit the most rapid growth in emissions, already greater than those of any other sector. Transnational agreements may be inappropriate to cover these sectors as some drivers for emissions are very country specific and neither sector carries much risk of carbon leakage. Instead, both transnational and country-specific agreements would be served by targeting sub-sectors. For example, the global effects of an agreement covering the power sector of India and

172. See Watson et al. (2005) for a full presentation of these activities.

China, even limited to their coal-fired electricity, may be quite significant.

Transnational sectoral agreements were considered in some depth during the June 2005 meeting of the OECD's round table on sustainable development. Participants agreed that TSA must:

- Be compatible with existing institutions and mechanisms such as the Kyoto Protocol, emissions trading and CDM, and in no way prejudice the negotiating position of countries under the UNFCCC.
- Cohere a critical mass of companies.
- Cover many countries.
- Ensure that national policies do not distort the international agreement.
- Prove environmentally sound.
- Recognise the development goals.
- Promote R&D on clean technology in the involved sectors.

A preliminary evaluation

The most important dynamic of an emissions trading regime including sectoral targets is how they encourage the participation of individual sources. While a domestic emissions trading regime could cover heavy-industry and the power sector, targets of different form would suit transport and other sectors.

Setting sectoral targets, especially for industrial activities, should include a technical discussion of available mitigations options. Focusing on technology solutions may encourage participation, though this somewhat command and control approach may mandate a benchmark that violates cost-effectiveness of market mechanisms. This is especially true for dynamic targets likely to use various technology improvements. While the opportunity cost of allowances should provide an incentive to reduce emissions whenever possible, innovation may stagnate around this benchmark. On the other hand, there are examples of sectors gathering a critical mass of companies to undertake research and development that could trigger breakthroughs for the benefit of all, as in the case of ULCOS (ultra-low CO_2 steel), funded by the European iron and steel industry with some support from the European Commission. Transnational agreements could be a venue for such technology collaboration.

As concerns about distortions of competition and leakage could drive support for sectoral targets in energy-intensive industries, the treatment of new entrants and plant closures may prove as decisive as the nature of the targets – relative or absolute. These variables require international harmonisation. Sectoral targets, especially those of international scope, would also need to calibrate the variables of each participant: GHG intensities, access to technology, and fuel prices among them.

Industrial preference may also determine relative targets of sector compliance. As many industries claim, indexing targets would not only reduce expected costs, but also encourage the adoption of more stringent objectives – as would be the case at country level.

Demand side incentives

Consider a target for the heat and power sector. If the target is absolute, energy efficiency management at plant level, fuel switching, and demand side management enable compliance. Where the target for power generation is expressed in CO_2 per MWh, there appears no incentive for action among end-users. Under a relative target, the source is less inclined to pass the cost of mitigation to consumers, since the resulting reduction in output – and in emissions – would not automatically lead to a surplus of allowances available for sale. In this instance, relative targets resemble production subsidies, in comparison with absolute caps.

The reality may be more complex. In the case of China, for example, closing the oldest and less efficient plants may more profoundly influence short term emissions than incremental improvements in the efficiency of the modern plants under construction. However, the rapid growth of electricity demand renders this a moot point – cleaner plants join, rather than replace, the very inefficient existing capital stock to supply the power grid. In such a case, demand side management may be the only way to fulfil a sectoral target, even if one focused on installations.

Substitution between sectors

Sector-wide targets may trigger indirect effects – some negative, others positive. For example, an increase in the price of electricity driven by a sectoral agreement in electricity may hamper the substitution of more efficient electricity for fossil fuel use in various industries. An efficient outcome would require coverage of these end-uses.

The same concern surrounds energy-intensive products, some of which may be covered by sectoral agreements. If, say, steel were covered but aluminium were not, the former would be at a competitive disadvantage and risk emission leakage – depending on the emission rates of processing both materials.

The comprehensive accounting of the emissions involved in material substitution may further divide reality from its projected outcome. For example within the transport sector, targets covering aluminium but not steel would encourage steel's substitution for aluminium in the car industry. The greater weight of steel would raise overall emissions in the transport sector. On the contrary, the benefits of incorporating aluminium in sectoral targets could be felt in the building sector, as it would slow the progression of aluminium in roller shutters – the less performing insulation material among several others.

These remarks illustrate the possible inefficiencies or faults in sectoral targets, as they may not cover competing materials, and be implemented without policies to address end-use. Policy coherence and least-cost would of course require as comprehensive an approach as possible. However, imperfect solutions remain preferable to no solution at all, especially as they sometimes pave the way for more comprehensive emissions trading schemes of quantified objectives.

Options for Industrialised Countries

Despite their divergent situations of economy, energy use and emissions history, industrialised countries and developing countries share similar concerns regarding uncertainties of climate change mitigation. Before committing, countries seek precise estimates of the cost of compliance in financial and social terms. As such, some of the options considered for developing countries could guide industrialised countries in adopting more ambitious targets.

Dynamic targets

This mutual applicability is particularly true for dynamic or intensity targets. For some experts, such targets should only be offered to developing countries. They argue that dynamic targets may lead to an increase in emissions – although fixed targets as well allow increases in emissions, as is the case in the internal European burden-sharing. In fact, the fixed or dynamic nature of a target does not condition the "absolute" or "relative" nature of the reductions. More important is the fact that dynamic targets, as any other price capping mechanism, reduce expected costs and may thus facilitate the adoption of relatively more ambitious objectives – at the expense of the certainty of resulting emission levels.

Can non-binding targets suit all countries, including the industrialised world? A scheme of such design would not work without a buyer. Conceivably, this would be some international institution, financed by all countries, perhaps relative to their financial contributions to the United Nations.[173] In the absence of a designated buyer, some

173. Bradford, 2004.

countries must maintain binding targets for real reductions to occur. Presumably, they would be more advanced nations.

Price caps

Another option provides some insurance on the marginal cost of quantitative commitments in emissions trade. Safety-valve mechanisms of a maximum price on allowances could greatly reduce the economic damage of dramatic, if temporary, change in economic circumstances, or of faulty estimates of the cost of emission reductions. The safety valve, or price cap, could supplement the cap-and-trade system in which the authority offers to sell allowances in unlimited amount at a pre-set price. The cost of meeting the emissions target can be limited.

If costs exceed expectations, governments or some international entity would supply additional allowances. The unpredictable revenues thus produced could finance technical compensation for higher emissions or more research and development to reduce future abatement costs.

In international accords, the price cap may take two different forms: in the first, economic agents or countries buy these allowances from an international body, in an amount corresponding to excess emissions from sources not covered by domestic targets. In the second, economic agents within countries buy these allowances from their own governments, which would prove that the marginal abatement cost for those entities not included in trading is equal or above the price cap. This demonstration may prove challenging and controversial. Instead, a hybrid upstream-downstream system would establish the link with an international regime and provide a majority of GHG sources with the same cost for their emissions.

A single price cap for all industrialised countries would not prevent differentiation of assigned amounts and, thus, efforts. However, if international harmonisation of a price cap proves difficult, many price cap levels may co-exist, provided countries can only make use of the price cap if and when their registry accounts show as many allowances as in their initial assigned amount.[174] A net seller cannot thus benefit from the price cap. However, price caps of different levels raise the risk of efficiency losses and market turmoil, as different caps may trigger sequential withdrawal of segments of market demand as they are activated by countries.

A country with a price cap would not be obliged to use it, even if the cost of domestic reduction reaches its level. With several price caps, a country with a low price cap may fulfil its commitment at a marginal cost above this cap, to allow profitable allowance sales when the international carbon price reaches a higher level. Benefits from units traded could pay for the abatement that the country needs in order to be in compliance.

A price cap – but at what price? If it is to work as a precaution against higher prices than forecast, it should be set in the upper range of forecasted marginal costs. A price cap much below that level would act as a carbon tax, allow higher than expected emissions and therefore cancel the ambitious targets that a safety valve mechanism allows.

Given the different views on future abatement costs and negotiation's possible perversion of technical analysis in determining the price cap, a standard, "best guess" has yet to be established. In theory, this determination would proceed in three stages:

- Agreement of targets in the absence of a price cap.
- Setting price cap in the upper range of cost expectations for these targets.
- Tightening the initial targets; the initial price cap level may now appear in the lower, not higher, range of cost expectations.

174. Philibert, 2005a.

Addressing Uncertainties

Dynamic targets, non-binding targets and price caps, whether country or sector-wide, reduce uncertainties surrounding abatement cost and thus could encourage participants including developing countries to adopt quantitative commitments. With improved certainty on compliance cost, uncertainty shifts to the system's environmental contribution. Assuming full compliance, emissions volumes in a compliance regime of dynamic targets logically becomes less certain than those bound by a fixed cap. Is this acceptable? We present several elements of response.

First consider expected abatement costs – all possible cost outcomes weighted by the probability of occurrence. For a given target, the introduction of some flexibility, as in a price cap or an indexed target, may deeply discount these costs. This dynamic opens the possibility to set more ambitious targets at lower expected costs than under a fixed target.[175] Deviations from targets set in this context must best be compared not only to the targets themselves, but also to the proposed fixed and binding commitments.

The great difficulty in climate policy rests in our inability to determine an optimal course of action, weighing mitigation costs, global environmental benefits, and accommodating political and strategic realities. How to be sure to compel sufficient action if the objective itself remains undetermined? One possible solution is to set ambitious objectives but make their full achievement dependent on the availability of affordable reductions.[176] Price caps, non-binding and to some extent dynamic targets enable this:

- Short-term, ambitious, targets may be discarded if their full attainment proves too costly.
- In parallel, countries would set indicative long-term objectives, subject to periodic revisions.

175. In the case of a price cap, the reduction in expected costs actually drives the stringency, particularly in the absence of a floor price, as shown by Cournède and Gastaldo (2002).

176. IEA, 2002a.

- If entities in a scheme of price cap compliance fail to meet short-term targets, design revisions would either raise the long-term objective to account for higher abatement costs; or tighten the objective and raise the level of the price cap – depending on the scientific knowledge of climate impacts.

This optimal process can be conceived if a single decision-maker were in charge. Whether the international community could follow such a process remains to be seen. A price cap falling far below the level of forecasted costs would act as a carbon tax, entirely canceling any ambition in the targets.

In sum, a price cap, dynamic and non-binding targets for developing countries do not undermine progress toward a long-term objective that uncertainties on cost and benefit prevent from precisely defining. On the contrary, price caps may instead calibrate the level of action to actual abatement costs, following willingness-to-pay for climate change mitigation.

Box 13

A domino effect of various commitment options?

Egregious emissions deviations seem possible if various flexible compliance options coexist in a single international trading scheme. Conceivably, this could provoke a cascade or domino effect, harming the international regime. If, for example, a large developing country cannot fulfil its non-binding commitment, other countries would lose access to this country's cheap abatement potential. Buying elsewhere, these purchasing nations might drive the price carbon to the price cap. A deviation of emissions from a non-binding target could thus trigger deviation from all brands of targets for other countries.

Recent modelling work commissioned by the IEA illuminates this issue.[177] *Based on a global model of energy and climate policy, this scenario assumes a continuation of the US policy to reduce carbon intensity by 18% in ten years. Other industrialised nations would reduce emissions by 50% relative to 1990 levels by 2050. Developing countries would adopt non-binding targets set at 90% and 80% of business-as-usual emission levels in 2030 and 2050, respectively. Global emissions would stabilise in 2030 and fall below BAU by 25% in 2050. The international price of carbon would grow, from USD 19/t*CO_2 *in 2030 to USD 44 in 2050. Recognising uncertainty in this estimate, countries agree to set a price cap of USD 50/t*CO_2 *at the outset.*

The study considers the implication of China defaulting on its non-binding target, following a period of unexpectedly rapid economic growth. Global emissions could increase by up to 18% relative to levels of the full compliance scenario. However, rising international energy prices would moderate the increase in the price of CO_2 *within industrialised countries. Bullied by Chinese demand, increases in fossil fuel prices would trigger emissions reductions and reduce carbon market demand. Assuming a price cap of USD 50/t*CO_2*, a country's default on a non-binding target and subsequent reservation of its emissions quota from the market entails no domino effect. However, another model may give different results. In this illustration, USD 50/t*CO_2 *is in the upper range of cost expectations.*

Under the assumption that the price cap facilitates the adoption of relatively more ambitious objectives, targets for those industrialised countries ratifying Kyoto further contract from -50 to -75% of 1990 levels in 2050. The carbon price now reaches USD 58/tCO_2*, above the USD 50 price cap. This high cost then*

177. See Philibert, 2005a.

blocks full compliance with the tighter target. Emissions would exceed the target by only 1.5%. However, they would be 5% lower than with the original target before the price cap was factored in.

This illustrates that, under a price cap, emissions will be much above target only if marginal abatement costs greatly exceed expectations.

Conclusion

As the broadest coverage of emission sources enables the most efficient compliance with emissions objectives, we have presented a range of options for countries to engage in GHG emissions trading, as appropriate to their national circumstances. We have also examined the difficulties inherent to broad coverage especially of developing countries, and transitional compliance options such as non-binding targets and sector-based targets. Transnational sectoral agreements could alleviate concerns over competition distortions that loom large in the implementation of domestic trading systems.

Scientific and political uncertainties plague climate change mitigation. They should not preclude timely action, and instead compel the design of policy instruments receptive to new information, as it becomes available. One virtue of emissions trading is the precise display of the cost of reducing emissions, though the design's long-term indications remain partly speculative.

Flexibility on short term emission levels could encourage more comprehensive participation in emissions trading and more ambitious emission reduction goals. In particular, the financial incentives of emissions trading may encourage developing nations to more meaningful participation. Emissions trade cannot be perceived as inhibiting the economic development of developing countries that struggle to eradicate poverty and satisfy growing energy service needs.

ACT LOCALLY, TRADE GLOBALLY

When John H. Dales first conceived using tradable permit systems for environmental protection, climate change was a very remote issue only known by a handful of world scientists. This was 1968, and it would be more than twenty years before George Herbert Bush introduces legislation creating the first national emissions trading system addressing air pollutants.

If John H. Dales were still alive, he would be struck by the role emissions trading plays today. Companies sell and buy CO_2 allowances over-the-counter, futures are traded, consultants prepare GHG abatement projects, on-line CO_2 market reports are published daily, no week ends without the launch of a new carbon fund. Industry executives, environmentalists and bureaucrats gather somewhere monthly, ministers deliver speeches, heads of states and governments discuss options to address climate change. Emissions trading is part of these conversations.

And this may only be the beginning. As humankind tries to address the threat of climate change, our contemporaries need energy at home, at work, at leisure, and for moving frantically from one activity to the other. Coal mines, oil and gas fields provide the bulk of this energy. Curbing global greenhouse gas emissions and transforming the way we produce and use energy will be a considerable task. Efficient end-use, renewable, nuclear, carbon dioxide capture and storage technologies will need to be further developed and deployed.

Emissions trading promises to foster reductions at the lowest possible cost. It also helps get everyone on board through a fair, acceptable initial allocation of emission allowances. Alternatives would presumably need to establish side incentives. This is why emissions trading may play such an important role in climate change mitigation.

Or maybe not. In cap-and-trade many like the trade, fewer the cap. Many fear the uncertain costs or have rents to protect. Some doubt the benefits. Vested interests fear changes. While many need more energy to just cook their meal, others are already way above that subsistence level. Nevertheless, the climate system affects them all – and they all affect it.

For emissions trading to help mitigate climate change, its architects and policy makers must learn fast by doing well. They have to elaborate sound rules and find ways to expand the scope amongst as many countries as possible. Policy makers and stakeholders, on energy and environment sides alike, must come to understand the long term and stock nature of the greenhouse gases build-up, and the depth of the cost of changing almost everything in the energy sector. This does not imply delay – quite the opposite. The first way to reduce costs is to spread action over decades to benefit from natural capital stock rotation. But the precise level of emissions in one day, or in one year, is simply irrelevant. Precision in targets is useless. Ambition in strategies is not.

Prediction is difficult, especially about the future, as the saying goes. The exact Earth's climate sensitivity remains unknown, as the exact extent of oil reserves. But we know greenhouse gases keep it warm, and plentiful coal reserves are burning to get burnt. Reducing emissions in thirty years will have a cost – depending on energy efficiency improvements, economic growth, cleaner technology developments, relative energy price evolutions and the like. We need long term objectives but we don't know enough to set them – let alone justify short term targets with full cost-benefit analyses. Meanwhile we must engage as many sources of emissions in mitigation to achieve cost-effectiveness.

Emissions trading may be an important tool, provided the nature of the cap is re-thought to better fit the nature of the problem. This will help bring more countries into it, and avoid facing unnecessary uncertainties on mitigation costs – this will also help establish the long term price that investors need in order to make sound decisions. But there is no silver bullet that can bring institutional capacity and political will where they do not yet exist.

Countries would further reduce costs of achieving their targets if they were capable of equalising marginal abatement costs across sectors, i.e. avoid overspending here when money would deliver more reductions in greenhouse gases there. Extending domestic trading beyond industry and the power sector should be explored and if deemed effective, policymakers will have to convince their electors that the rent will be captured neither by them nor by the fossil fuel industry. And it seems very unlikely that ET will anytime soon be extended to all sectors in less developed countries.

Implementation of an ambitious policy tool, like emissions trading for so significant an environmental and economic issue as climate change mitigation, is not without problems. At the domestic level, regulators are careful in managing the transition from an uncapped environment to an economic environment where CO_2 carries a cost, because action is not yet global and competitiveness concerns loom large. There is a reluctance to set the cap and just leave matters entirely to markets. As a result, implementation runs the risk of creating incentives that fall short of their theoretical ideal – for instance, why take back allowances from companies that close plants? Companies should be able to use carbon allowances from old installations to open new and more efficient ones.

There may also be lingering misunderstandings about the way emissions trading is meant to deliver cost savings. Some observers are now complaining that end-users of electricity will end-up paying a higher price for electricity as a result of the EU emissions trading scheme. The purpose of the system is, in the end, to encourage consumers to consume less of the more CO_2-intensive products and services – and to do so through prices that reflect the new cost of carbon. There are certainly distributive implications of a rising price of energy and policy makers should not neglect them. Governments have been on a steep learning curve to introduce emissions trading at the domestic level, where command-and-control had been employed to date. More experience is probably needed before governments can be confident that, with proper framework conditions, emission sources will engage in the right choices and create a price signal that reflects the true cost of their carbon constraint.

Among possible improvements, we must stress the importance of longer-term allocations and a more harmonised treatment of new entrants to ensure that they can fully "internalise" the cost of the CO_2 "externality", rather than make investments in long-lived capital stocks committing to more CO_2 emissions than necessary. This said, competitiveness concerns cannot be ignored. Trading is well suited for heavy industry – basically large combustion plants – and this sector is one that competes with companies outside any carbon constraint at present. There may be trade-offs between carbon market efficiency and the risk of carbon leakage - the potential relocation of some industry and its emissions – but all stakeholders should be aware of the cost.

The long-term nature of the GHG mitigation problem raises a challenge for emissions trading. The cost-effectiveness brought in by emissions trading has two sides. On the bright side, in reducing costs it facilitates the adoption of more ambitious objectives in the future. On the dark side, it fails to deliver sufficiently high costs to allow innovative technologies now in their infancy to improve performance through learning-by-doing under market conditions. Governmental action to support technology development and deployment will be necessary.

While the above sounds like a resounding endorsement for emissions trading as a cure-all in GHG mitigation policy, numerous barriers stand in the way of proper economic responses to price signals. Covering all energy-related CO_2 emissions with a single emissions trading system is possible in theory and may appeal to policy makers in search for policy efficiency. However, market imperfections abound that hamper rational energy choices – why would a landlord insulate windows when the tenant gets the benefits? The price of carbon may not trigger the expected efficiency improvements and least-cost GHG savings. Other policies and measures will be needed to bring about more rational energy uses, without a loss of service. The IEA has already widely documented best practice in energy efficiency policies that can deliver CO_2 reductions at negative cost: these should be implemented first, before introducing a price signal that will otherwise not deliver reductions.

Emissions trading will not suffice. Billions of people are not just ready to embrace it. Other tools will need to be brought out of the toolkit. Technology programmes will prepare for the longer term. However, if mankind is to succeed in effectively mitigating climate change, emissions trading is likely to grow and expand. New options will enrich its portfolio. New market actors will be involved. Bridges will be built between systems, sectors, countries, and continents.

Climate change is a global issue, which depends on how we all heat or cool our homes and offices, how we travel, what technologies we develop, what industries we set up. It requires global action, as it requires the action of all. Emissions trading may become a bridge between local action and global results. In preparing the UN conference on the human environment in 1972, René Dubos spelled out this maxim: think globally, act locally. This is still good advice.

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GLOSSARY

AAU: Assigned amount unit, the tradeable unit under the Kyoto Protocol's emissions trading mechanism (article 17). Each unit allows the country to emit one tonne of CO_2 equivalent of any of the six greenhouse gases covered by the Protocol.

ABT: Averaging, banking and trading programme (USA).

Allowance: The right to emit one tonne of CO_2, or CO_2 equivalent of another greenhouse gas.

Assigned amount: Under the Kyoto Protocol, the quantity of allowed emissions of greenhouse gases over the period 2008-2012, for each country listed in Annex B of the Protocol. The assigned amount is equal to five times the country's emissions in a base year (generally 1990), multiplied by the country's percentage listed in Annex B.

Auctioning: Entities liable under an emissions trading system must acquire their allowances through an auction, as opposed to receiving them through a gratis allocation.

CARB: California air resources board.

CER: Certified emission reduction, the emission credit issued, once verified, for a clean development mechanism project undertaken in a developing country. A CER can be used for compliance by a country with an emissions commitment under the Kyoto Protocol. A CER represents one tonne of CO_2 equivalent.

CDM: The clean development mechanism. Under the Kyoto Protocol's article 12, the CDM allows a developing country to earn certified emission reductions (CERs) for a project that results in an emissions reduction or sinks enhancement.

CO: Carbon monoxide.

CO_2: Carbon dioxide, the most important man-made greenhouse gas.

CO_2e: A unit that represents the equivalent CO_2 mass of greenhouse gases, reflecting their various global warming potentials, usually compute over 100 years.

COP: Conference of the parties to the UNFCCC, comprising countries and regional economic integration organisations that have ratified or acceded to the convention.

COP/MOP: Conference of parties of the UNFCCC serving as the meeting of the parties to the Kyoto Protocol (COP/MOP). The MOP is the supreme body of the Kyoto Protocol, and comprises parties that have ratified the Kyoto Protocol.

Downstream: A downstream emissions trading system for CO_2 control allocates allowances to the point sources of emissions such as fossil fuel combustion installations.

Dynamic targets: Emissions objectives that are adjusted according to a pre-agreed metric such as gross domestic product for an economy, or production level for an industry; also known as relative, output-based, or indexed targets.

EB: The executive board of the clean development mechanism.

EUA: European Union allowances. Emission allowances distributed to installations by their respective governments, under the EU emissions trading scheme. Each allowance corresponds to one tonne of CO_2 that can be emitted during the scheme's commitment period.

EU burden-sharing: The agreement reached among the 15 EU member states to jointly fulfill their commitments, as allowed by article 4 of the Kyoto Protocol. The EU burden-sharing reallocated emission levels to each country, from the homogeneous 8% reduction of the Protocol's Annex B.

EU ETS: European Union emissions trading scheme. Under the EU ETS, some 11 500 installations in the 25 EU countries are allocated tradeable allowances for their CO_2 emissions in the period 2005-2007, to be followed by a second period, 2008-2012.

ERU: Emission reduction units. The emission reduction credit issued, once verified, for reductions achieved by a joint implementation (JI) project. An ERU represents one tonne of CO_2 equivalent.

GHG: Greenhouse gas. The Kyoto Protocol lists the following GHG: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur-hexafluoride (SF6).

GIS: Green investment scheme.

Grandfathering: A allocation mode whereby an existing source receives, for free, a quantity of allowances in proportion of its past emission levels.

HC: Hydrocarbon.

HFC: Hydrofluorocarbon, a familly of greenhouse gases.

Intensity target: A dynamic target expressed by the ratio of emissions over gross domestic product.

JI: Joint implementation. Under the Kyoto Protocol's article 6, JI allows an industrialised country with a commitment under Annex B to earn ERUs if it undertakes emissions reduction – or sink enhancement – projects. ERUs can be transferred to another party and used for compliance. An AAU must be cancelled for every issued ERU.

Kyoto Protocol: The protocol to the UNFCCC that commits most industrialised countries to greenhouse gas emission limits between 2008 and 2012, and establishes so-called flexibility mechanisms (joint implementation, the clean development mechanism, emissions trading).

Linking: Allowing sources under different emissions trading systems to trade their respective allowances.

NAP: National allocation plan. Under the EU ETS, each government must produce a national allocation plan detailing the implementation of the scheme at domestic level.

Non-binding target: A non-binding target allows a country to sell allowances if its emissions are below the target, but does not oblige it to buy allowances if emissions are above. Also known as no-lose, or one-way targets.

NOx: Nitrogen oxides.

Opportunity cost: The cost of an emissions allowance in terms of the most valuable foregone alternative to holding it, i.e., the revenues from its sale on the CO_2 market. The opportunity cost is generally equal to the CO_2 market price.

Price cap: A cap set on the price of traded emissions allowances. Sources have access to an unlimited supply of allowances at the price cap. Also known as safety valve.

UNFCCC: United Nations framework convention on climate change.

Upstream: An upstream emissions trading system for CO_2 control allocates allowances to fossil fuel producers and importers and makes them liable for the CO_2 emissions corresponding to the carbon content of their fuel sales inside the country.

ZEV: Zero-emission vehicle (California).

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IEA Publications, 9, rue de la Fédération, 75739 Paris Cedex 15
Printed in France by Actis
(61 2005 28 I PI) ISBN 92-64-10953-6 November 2005