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Carbon trading: Current schemes and future developments

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ABSTRACT

This paper looks at the greenhouse gas (GHG) emissions trading schemes and examines the prospects of carbon trading. The first part of the paper gives an overview of several mandatory GHG trading schemes around the world. The second part focuses on the future trends in carbon trading. It argues that the emergence of new schemes, a gradual enlargement of the current ones, and willingness to link existing and planned schemes seem to point towards geographical, temporal and sectoral expansion of emissions trading. However, such expansion would need to overcome some considerable technical and non-technical obstacles. Linking of the current and emerging trading schemes requires not only considerable technical fixes and harmonisation of different trading systems, but also necessitates clear regulatory and policy signals, continuing political support and a more stable economic environment. Currently, the latter factors are missing. The global economic turmoil and its repercussions for the carbon market, a lack of the international deal on climate change defining the Post-Kyoto commitments, and unfavourable policy shifts in some countries, cast serious doubts on the expansion of emissions trading and indicate that carbon trading enters an uncertain period.

0. Introduction

Carbon trading, which refers to the trading of emissions of six major greenhouse gases – carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6) – is a market-based instrument aimed at mitigating climate change.

Currently there are several emissions trading schemes (ETSs) operating across the world. They differ in size, scopes and designs. Some of the schemes are linked with the Kyoto commitments (UNFCC, 1998), while others are operating in countries which have not ratified the Kyoto Protocol (e.g. the USA). Some schemes are voluntary, others are mandatory. The schemes vary in sectoral and temporal coverage and have different emissions targets. They all, however, share a common premise: emission reductions should take place where the cost of reduction is the lowest, thus lowering the overall cost of combating climate change.

This paper reviews the existing emissions trading systems and discusses possible futures of such schemes. The first part of the paper gives an overview of the schemes currently operating in the world. The overview is limited to mandatory schemes; several voluntary schemes are acknowledged but not examined in detail. The second part discusses future trends of emissions trading and examines whether existing pitfalls, controversies and political uncertainty surrounding current and planned schemes will hinder its prospects.

1. Emissions trading schemes currently in operation

Many ETSs have been proposed, but the only mandatory systems already operating are: The European Union Emissions Trading System (EU ETS) (EC, 2003, 2004, 2008a, 2009), the Regional Greenhouse Gas Initiative (USA) (RGGI, 2005a, b, c, 2010), New Zealand Emissions Trading Scheme (NZ Ministry for the Environment, 2002, 2008), Tokyo metropolitan trading scheme (Tokyo Metropolitan Government, 2008, 2009, 2010), and the New South Wales Greenhouse Gas Abatement Scheme (Australia) (NSW Government, 2002a, b). There are also several voluntary emissions trading schemes operating in a number of countries such as Japan (Japan Ministry of the Environment, 2008), the USA (CCX, 2010), Switzerland (FOEN, 2010), etc. A few more emissions trading schemes are being proposed in several regions and countries, including Western Climate Initiative (USA and Canada) (WCI, 2010), California's Cap-and-Trade programme (ARB, 2010), and mandatory national emissions trading schemes in the USA (APA, 2010), Australia (DCC, 2008), Canada (Environment Canada, 2010), Japan (METI, 2010) and South Korea (UNEP, 2010).

The following sections describe the main features of the existing mandatory schemes. A comparison of the ETSs' design aspects is given in Table 1.

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Table 1
Comparison of emissions trading systems.

	EU ETS	RGGI	GGAS	NZ ETS	Tokyo-ETS
Participating countries and regions	27 EU Member States+Iceland, Liechtenstein and Norway	10 US states: Connecticut, Delaware, New Jersey, New York, Maine, Maryland, Massachusetts, New Hampshire, Rhode Island, Vermont	New South Wales	New Zealand	Tokyo Metropolitan Area
Regulated sectors	*Phase* 1: Electricity, refining, iron and steel, cement, glass, ceramics, pulp and paper *Phase* 2: Phase 1 sectors+nitric acid *Phase* 3: Phases 1 and 2 sectors+petrochemicals, ammonia, aluminium and aviation	Electricity generating facilities $\geq$25 MW primarily fired by fossil fuels (coal, natural gas, oil), feeding more than 10% of their generated electricity into the grid	Electricity sellers, retailers and generators in New South Wales	*Phase* 1: Forestry *Phase* 2: Liquid fossil fuels *Phase* 3: Stationary energy, industrial processes *Phase* 4: Agriculture, waste	All large installations such as office buildings and factories in Tokyo that use energy equivalent to 1500 kl of oil a year
Regulated emissions	CO_2; N_2O from production of nitric, adipic and glyoxylic acids; PFCs from the aluminium sector	CO_2	CO_2, CH_4, N_2O, HFCs, PFCs and SF6	CO_2, CH_4, N_2O, HFCs, PFCs and SF6	CO_2
Time scales	*Phase 1*: 2005–2007 *Phase 2*: 2008–2012 *Phase 3*: 2013–2020	2009–2018	Initially 2003–2012, extended to 2020	*Phase 1*: 2008–2009 *Phase 2*: 2009–2010 *Phase 3*: 2010–2012 *Phase 4*: 2013–2020	*Phase 1*: 2010–2014 *Phase 2*: 2015–2019
Reduction goals	• 8% below 1990 levels in 2008–2012 period • 20% (or 30%) below 1990 levels by 2020 • 60–80% below 1990 levels by 2050	• 2009 cap: 5% above 2005 levels will remain until 2015 • 10% reduction below this cap by 2019	5% below 1990 levels	Carbon neutrality: electricity by 2025; stationary energy by 2030; transport by 2040	25% below 2000 levels by 2020
ETS cap	*Phase* 1 (2005–2007): Cap was set below the full range of "business as usual" estimates, with the objective of establishing the infrastructure for trading, not to achieve significant reductions. The cap reflected a 4.3% reduction by the European Commission in the quantity of allowances that had been proposed by member states *Phase* 2 (2008–2012): Annual cap 11.8% below the number of allowances in Phase 1, 6.5% below 2005 verified emissions. The cap reflects a 10% reduction by the European Commission in the quantity of allowances that had been proposed by member states	Target for initial five-year period is stabilisation of emissions for 2009–2014. Individual state emissions budgets and the overall cap are based on historical (2000–2002) average emissions and negotiation. State emissions budgets will then reduce 2.5% per year over 2015–2018, giving a 10% reduction on 2009 levels by 2018	No cap. State-wide annual greenhouse gas "benchmark" set (the "baseline") and apportioned to individual participants. The "benchmark" expressed in tonnes of CO_2 eq. per capita. Initial benchmark 8.65 t on CO_2 eq., dropped to 7.27 in 2007; remains at that level until 2012	No explicit cap or domestic target for emissions reductions. The scheme is fully linked to the international Kyoto Protocol market: New Zealand companies can emit as much as they wish as long as allowances are purchased to cover these emissions. The government will issue free allowances to the agricultural sector, energy-intensive industries and post-1990 forest owners who have opted in corresponding to forest growth. Participants without sufficient free allocation can purchase allowances from foresters or from the international Kyoto market to meet their obligations.	*Phase* 1 (2010–2015): 6% on base levels for factories and buildings receiving energy from district heat and cooling; 8% for other buildings *Phase* 2 (2015–2020): reductions around 17% envisaged. Facilities that have made outstanding progress can have compliance factor reduced to one-half or three-quarters

Table 1 (*continued*)

	EU ETS	RGGI	GGAS	NZ ETS	Tokyo-ETS
	Phase 3 (2013–2020): Cap to decline linearly to 21% below 2005 verified levels by 2020. This is intended to deliver a large part of Europe's reduction of 20% on 1990 levels by 2020. If Europe adopts an overall 30% by 2020 target, the EU ETS cap will be reduced to 34% below 2005 levels by 2020				
Allocation method	Grandfathering; benchmarking; max. 10% auctioning followed by a progressive move towards full auctioning of allowances. From 2013 at least 50% of allowances will have to be bought at auction and the aim is to reach full auctioning by 2020 for power sector, and by 2027 for all sectors	Auctioning minimum 25%; decision over remaining 75% left to individual states; approximately 90% of allowances auctioned	An annual State-wide GHG benchmark for the electricity sector—the "benchmark". Benchmark participants are allocated the mandatory GHG benchmark based on their share of NSW electricity demand. To be compliant, benchmark participants must surrender abatement certificates created from project-based emission reduction activities	*Phase* 1: Free allocation *Phase* 2: Auctioning *Phase* 3: Some free allocation for industrial processes *Phase* 4: 90% free allocation for agriculture	Free allocation; grandfathering. Allowances: base year emission × compliance factor × compliance period (5 years)
Unit	1 metric tonne CO_2 eq.	1 short ton CO_2 eq. (0.9 metric tonnes)	1 metric tonne CO_2 eq.	1 metric tonne CO_2 eq.	1 metric tonne CO_2 eq.
Compliance period	1 year	3 years	1 year	1 year (*Phase 1*: initially 2 years)	5 years
Penalty system	Delivery of the non-delivered allowances in the next period + €100 penalty per tonne (2008–2012)	Three times of the non-delivered certificates to be delivered at next compliance date	AUD11.50 per tonne; 10% shortfall allowed without penalty, provided the shortfall is made up the following year	Delivery of the non-delivered allowances (can be extended to two times of the non-delivered allowances) + NZ$30–60 penalty per tonne	Fines (up to ¥500,000), publication of the breach and a type of surcharge collected in proportion to the failure to fulfil the obligation
Banking	Yes—unlimited	Yes—unlimited	Yes—unlimited	Yes—unlimited	Yes—unlimited
Borrowing	No	No	Yes—up to 10% of the subsequent year's target is allowed	No	No
Offsets	Kyoto Protocol JI and CDM allowances within limits. Assigned Amount Units or Removal Units (forestry) not allowed	Credits are accepted from programmes in RGGI states or any other US state or jurisdiction	Unlimited use of domestic, project-based offsets	Unlimited use of Kyoto Protocol CERs (CDM credits), RMUs (forestry credits), ERUs (JI credits) and "approved" AAUs (Assigned Amount Units)	Participants may use unlimited offset credits related to reduction of emissions by SMEs within Tokyo. Unlimited use of renewable energy certificates for compliance. Offsets may also be generated from installations outside Tokyo—they are treated as if covered by the scheme and reductions beyond their "target" can count as offsets. Use limited to one-third of base year emissions

1.1. The EU emissions trading system (EU ETS)

The EU ETS is by far the largest and most ambitious carbon trading scheme currently in operation. The scheme has been hailed as the EU's flagship climate change policy and identified as the primary mechanism for achieving compliance with the EU's commitments under the Kyoto Protocol.[1]

The EU ETS was formally established by the Emissions Trading Directive in 2003 "in order to promote reductions of greenhouse gas emissions in a cost-effective and economically efficient manner" (EC, 2003). The Emissions Trading Directive was followed by the "Linking Directive" (EC, 2004), which came into force in November 2004 and connects the EU ETS to the Kyoto Protocol's flexibility mechanisms. The Linking Directive is an important complement to the Emissions Trading Directive as it allows installations participating in the EU ETS to use a specified proportion of emission reduction credits generated by the Kyoto Protocol's emission reduction projects (the Joint Implementation (JI) and Clean Development Mechanisms (CDM)) in order to fulfil their surrendering obligations under the EU ETS.

The EU ETS is devised as a classic "cap and trade" system. The scheme operates by the allocation and trading of greenhouse gas emissions allowances. One allowance gives the right to emit one tonne of CO_2 equivalent. An absolute quantity limit (or cap) on CO_2 emissions has been placed on some 11,000 installations covered by the scheme. There was no initially determined overall limit (cap) set by the EU, instead it was the sum of 27 separate decisions concerning the total number of European Union Allowances (EUAs) that each member state could distribute to affected installations within its jurisdiction. Each member state, through their respective National Allocation Plans (NAPs) proposed a quantity of EUAs, but that quantity was subject to review and approval by the European Commission according to procedures and criteria specified in the EU Emissions Trading Directive.

The allowances are then distributed to the installation in the scheme in an amount equal to the cap. So far, most allowances have been allocated to installations free of charge (rather than being sold at auction) and are primarily based on historical emissions. Though only businesses covered by the EU ETS are given allowances, anyone else – individuals, institutions, non-governmental organisations, etc. – is free to buy and sell in the market in the same way as companies (EC, 2008a).

At the end of each year, the companies operating these installations (referred to under the EU ETS as "*operators*") are required to ensure they have enough allowances to cover their installation's emissions. Operators of installations have the flexibility to purchase additional allowances (on top of their free allocation) from the market, or to sell any surplus allowances generated from reducing their emissions.

Companies that keep their emissions below the level of their allowances can sell their excess allowances at a price determined by supply and demand at that time. Those facing difficulties in remaining within their allowance limit have a choice between several options. They can take measures to reduce their emissions (such as investing in more efficient technology or using a less carbon-intensive energy source); they can buy extra allowances on the market; or they can use a combination of the two. This flexibility ensures that emissions are reduced in the most cost-effective way (EC, 2008a).

In addition to EUAs, the EU ETS allows credits from JI and CDM projects to be traded under the scheme. JI and the CDM enable developed countries that have binding emissions reduction or limitation targets under the Kyoto Protocol to undertake emission-saving investments in third countries and credit these savings towards their own emissions target. JI applies to projects in countries that have agreed to an emission target – other industrialised countries and countries with economies in transition – and yields credits known as 'emission reduction units', or ERUs. The CDM covers projects in countries without an emission target under the Kyoto Protocol, i.e. developing nations. Reductions since 2000 are potentially eligible to receive credits called 'certified emission reductions', or CERs.

The EU ETS recognises most of these credits as equivalent to emission allowances (1 EUA=1 CER=1 ERU) and allows them to be traded under the scheme. However, credits from nuclear facilities and land use, land-use change and forestry activities are not accepted. In line with the supplementarity criterion of the Kyoto Protocol (which aims at ensuring that a significant proportion of the expected reduction of emissions occurs within each country), the EU ETS limits the use of CERs and ERUs for meeting compliance requirements to a percentage of the allocation to an installation for most member states. The specific limit is given in each member state's NAP and it varies among member states and, in some cases, even by sectors within a member state. For instance, in its Phase II NAP, the UK Government set a limit on the use of project credits from JI and CDM of 8% of each installation's free allocation (DEFRA, 2007).

Participation in the EU ETS is mandatory for businesses in the sectors covered by the scheme. After each calendar year, installations must surrender a number of allowances equivalent to their verified CO_2 emissions in that year. These allowances are then cancelled so they cannot be used again. Those installations with allowances left over can sell them or save them for future use.

Installations that do not surrender enough allowances to cover their emissions in the previous year are penalised. They have to pay a dissuasive fine for each excess tonne of carbon equivalent emitted. In the initial phase the penalty was €40 per tonne, but from 2008 it is €100 per tonne. This compares to €14 per tonne of CO_2 traded (as of December 2010). Operators also have to obtain allowances to make up the shortfall in the following year, and are 'named and shamed' by having their names published. On top of this, some EU member states have also laid down additional dissuasive sanctions for any infringements of the ETS rules at national level. Member states are also subject to reporting obligations and have to submit a report to the European Commission evidencing compliance with the EU ETS Directive on an annual basis.

The EU ETS became operational on 1 January 2005 and is being implemented in three distinct phases or "trading periods". The first "pilot" phase ran from 1 January 2005 to 31 December 2007. Its primary goal was to develop the infrastructure and provide the experience for the later more serious engagement. During this initial phase, the scope of the ETS was intentionally limited while experience of emissions trading is being built up. Consequently, the first trading period covered only CO_2 emissions from large emitters in the power and heat generation industry and in selected energy-intensive industrial sectors: combustion plants, oil refineries, coke ovens, iron and steel plants and factories making cement, glass, lime, bricks, ceramics, pulp and paper. A size threshold based on production capacity or output determined which plants in these sectors were included in the scheme. Even with this limited scope, some 11,000 installations in the 25 EU member states were covered, accounting for almost half of the total European CO_2 emissions or about 30% of its overall greenhouse gas emissions (Hepburn, 2007).

[1] Under the Kyoto Protocol, the EU-15 (the group of 15 countries that were EU Member States before 2004) are committed to reducing their collective greenhouse gas emissions to 8% below 1990 levels during 2008–2012. This target is shared among the 15 Member States under a legally binding burden-sharing agreement. The 12 Member States that joined the EU in 2004 and 2007 have their own binding national targets under the Kyoto Protocol with the exception of Cyprus and Malta which have no targets. The EU ETS is one of the key policies introduced across the EU to help it meet these targets.

Phase 2 began on 1 January 2008 and will run until 31 December 2012 which coincides with the "first commitment period" of the Kyoto Protocol—the 5-year period during which the EU and its member states must comply with their emission targets under the Protocol. In this (current) phase, the European Commission has cut the volume of emission allowances to 6.5% below the 2005 level, thus hoping that real emission reductions will take place. This was done on the basis of the verified emissions reported during Phase 1. The scope of the scheme remains unchanged, with the exception of emissions of nitrous oxide from the production of nitric acid which are now also included. In addition, the geographical coverage of the EU ETS has been extended beyond the 27 EU Member States to include Iceland, Liechtenstein and Norway.

Phase 3 will run for 8 years, from 1 January 2013 to 31 December 2020. The EU expects that this longer trading period will contribute to the greater predictability necessary for encouraging long-term investment in emission reduction (EC, 2008a). The scheme itself will be substantially strengthened and extended from 2013, enabling it to play a central role in the achievement of the EU's climate and energy targets for 2020. As the latest amendments to the Emissions Trading Directive indicate, in Phase 3 we will see broadening of the scheme to incorporate more industrial sectors and greenhouse gases, gradually phasing out the free allocation of allowances that took place in Phases 1 and 2 as well as more challenging emission reduction targets for participating installations (EC, 2009). In a separate but related development, the aviation industry, which is not currently affected by the EU ETS, will be included in the EU ETS from 1 January 2012 following the adoption of the Aviation Directive (EC, 2008b).

Since its inception in 2005, the EU ETS has become the largest carbon market in the world by a substantial margin, both by value and by volume. In the first year of operation (2005) at least 362 million allowances (tonnes of CO_2) were traded with the value of around €7.2 billion. According to Point Carbon, a consultancy which tracks and analyses the carbon markets, trading volume rose to 1 billion allowances in 2006, 1.6 billion in 2007, almost 3.1 billion in 2008, and 5.6 billion in 2009 (Point Carbon, 2010a).

At a more fundamental level than trading, the EU ETS needs to be evaluated according to how well it delivers emission reductions. According to a recent World Bank report on emissions trading, the EU ETS has so far succeeded in its main goal of reducing overall carbon emissions. The report claims that available data point to a 2–5% decline in emissions (40–100 Mt CO_2 eq. annually) attributable to the ETS during the trial period of 2005–2007 (Kossoy and Ambrosi, 2010). According to the report, the electric utility sector accounted for the bulk of emission reductions through increased use of clean generation technologies, but anecdotal data also suggest improvements in energy efficiency. A latest survey by Point Carbon also suggests that the EU ETS has been successful in reducing emissions: an outright majority of respondents in this survey said the EU ETS has caused emission reductions in the companies they represent (Point Carbon, 2010b).

The fact that companies have achieved true emission reductions regardless of trade volumes and in the presence of sophisticated financial instruments is critical to the political viability of the EU ETS and its future.

1.2. The US Regional Greenhouse Gas Initiative (RGGI)[2]

The Regional Greenhouse Gas Initiative (RGGI) is the first mandatory greenhouse gas emissions trading programme in the United States (RGGI, 2010). RRGI was officially established in 2005 and became operational in 2009. Similar to the EU ETS, RGGI is also a cap-and-trade programme but it covers only the power sector. Ten Northeastern and Mid-Atlantic states participate in the RRGI: Connecticut, Delaware, Maine, New Hampshire, New Jersey, New York, Vermont, Massachusetts, Maryland and Rhode Island. They have established a regional cap on CO_2 emissions from fossil-fuel power plants (25 MW or more) which are required to possess a tradable CO_2 allowance for each tonne of CO_2 they emit. In total, 209 power plants are covered by the scheme. The cap was initially set at 188 million (short) tonnes of CO_2 emissions (the 2009 levels) for the 2009–2014 period. Beginning in 2015, the cap will be decreasing by 2.5% annually for a total reduction of 10% by 2018.

RGGI is composed of individual CO_2 Budget Trading Programmes in each of the ten participating states. Through independent regulations, based on the RGGI Model Rule, each state's CO_2 Budget Trading Programme limits emissions of CO_2 from electric power plants, issues CO_2 allowances and establishes participation in regional CO_2 allowance auctions.

The power generators ("regulated sources") are required to hold allowances equal to their CO_2 emissions over a 3-year control period. CO_2 allowances are issued by each state according to their respective CO_2 Budget Trading Programmes. Regulated power plants can use a CO_2 allowance issued by any of the ten participating states to demonstrate compliance with an individual state programme. In this manner, the ten state programmes, in aggregate, function as a single regional compliance market for CO_2 emissions.

Emission allowances are distributed through auctions. Overall, the RGGI states have chosen to sell approximately 90% of CO_2 allowances through quarterly, regional auctions. Proceeds from the RGGI CO_2 allowance auctions are invested in programmes to improve end-use energy efficiency and to accelerate the deployment of renewable energy technologies (currently around 70% of auction proceeds are invested in this way).

RGGI compliance occurs in 3-year control periods. At the end of each control period, each regulated power plant must submit one CO_2 allowance for each tonne of CO_2 emitted over the preceding 3 years. The first control period began on 1 January, 2009, and extends through 31 December, 2011.

Regulated power plants have a variety of options to comply with RGGI. For instance, they can reduce their emissions through efficiency measures, switching fuels, or using new technologies, and then sell their excess allowances. Or, they can simply purchase allowances sufficient to cover their emissions, if they emit more CO_2 than their initial allocation of allowances would permit.

Aside from trading emission allowances, RGGI allows various flexibility mechanisms to enable successful compliance with the cap. Emission "offsets" are one such mechanism. In the case of RGGI, an *offset* represents project-based greenhouse gas emissions reductions or carbon sequestration achieved outside of the capped electricity sector.

RGGI limits the award of offset allowances to five project categories, each of which is designed to reduce or sequester emissions of three GHGs: carbon dioxide (CO_2), methane (CH_4), and sulphur hexafluoride (SF_6). Currently, RGGI's five eligible offset project categories include projects that:

- capture or destroy CH_4 from landfills;
- reduce emissions of SF_6 from electricity transmission and distribution equipment;
- sequester CO_2 through afforestation;
- reduce emissions of CO_2 through non-electric end-use energy efficiency in buildings; and

[2] This section draws on the RGGI official information available at: http://www.rggi.org/rggi.

– avoid CH_4 emissions through agricultural manure management operations.

All offset projects must be located within one of the RGGI participating states. Other eligible offset types may be added in the future.

RGGI participating states currently allow regulated power plants to use qualifying offsets to meet up to 3.3% of their CO_2 compliance obligation. This amount may be expanded to 5% and 10% if CO_2 allowance prices reach thresholds of $7 and $10 per allowance, respectively.

RGGI has grown into the most prominent carbon market in North America with 805 Mt CO_2 eq. traded for an overall value of almost US$2.2 billion in 2009, its first full year of operations. This represented a 10-fold increase over (pre-market) activity in 2008 in terms of both volume and value. RGGI allowances traded at an average of US$3.3 per tCO_2 eq. during 2009 (or significantly less than EUAs) in an over allocated market—a situation that could continue for many years unless the caps are revised (Kossoy and Ambrosi, 2010). The growth of RGGI activity has been attributed to the expectation of the US federal carbon regulation: it now appears unlikely that such regulation will emerge any time soon (more about this later in the paper).

1.3. The New South Wales Greenhouse Gas Reduction Scheme (GGAS)[3]

The Greenhouse Gas Reduction Scheme (GGAS) in Australia's state of New South Wales (NSW) was one of the first mandatory greenhouse gas emissions trading schemes in the world to become fully operational (GGAS, 2010a). GGAS was established in 2002 through amendments to the NSW *Electricity Supply Act 1995* (the Act) and the *Electricity Supply* (*General*) *Regulation 2001* (the Regulation) (NSW Government (2002a, b). The scheme commenced operation on 1 January 2003.

GGAS covers electricity sellers, retailers and generators in New South Wales (NSW) for which the participation is mandatory (GGAS, 2008). Large electricity users (>100 GWh per year) may also participate in the scheme but their participation is voluntary. GGAS objectives are to reduce greenhouse gas emissions associated with the production and use of electricity and to develop and encourage activities to offset the production of greenhouse gas emissions (GGAS, 2010a). The scheme covers emissions of six greenhouse gases covered by the Kyoto Protocol (UNFCC, 1998).

Unlike the EU ETS and GGRI which are both classic *cap-and-trade* approaches, GGAS is a "*baseline and credit*" (rate-based) form of emissions trading. GGAS establishes annual State-wide GHG reduction targets for the electricity sector – the "benchmark" – expressed in tonnes of CO_2 eq. per capita (GGAS, 2010b). The initial level was set at the commencement of GGAS in 2003 at 8.65 tonnes. The benchmark dropped to 7.27 tonnes in 2007 which represented a reduction of 5% below the Kyoto Protocol baseline year of 1989–1990. The per capita amount continues at this level until 2021.

NSW electricity retailers and certain other parties, collectively referred to as 'benchmark participants', are allocated the mandatory GHG benchmark based on their share of NSW electricity demand (GGAS, 2010b). To be compliant, benchmark participants must surrender abatement certificates created from project-based emission reduction activities by accredited abatement certificate providers.

To understand how GGAS works, it helps think of the benchmark participants as creating the demand for certificates, and accredited abatement certificate providers as providing the supply of certificates to meet demand (GGAS, 2010a).

The tradable commodity used in the scheme is called an NSW Greenhouse Abatement Certificate or NGAC. One NGAC represents the abatement of one tonne of CO_2 eq. associated with the consumption of electricity in NSW. NGACs are transferable certificates that may only be created by accredited abatement certificate providers. NGACs can be created by accredited providers who have engaged in the following activities (GGAS, 2010c):

– low-emission generation of electricity or improved generator efficiency (*Generation*);
– activities that result in reduced consumption of electricity or on-site generation of electricity (*Demand Side Abatement*); and
– the capture of carbon from the atmosphere in forests (*Carbon Sequestration*).

The surrender of NGACs to the Compliance Regulator (Independent Pricing and Regulatory Tribunal of NSW, IPART) is the main way that benchmark participants can abate their greenhouse gas emissions and reach their individual greenhouse gas benchmark levels. If they fail to meet their benchmarks then a penalty is assigned; for 2010, the penalty was AU$ 14.00 per tonne of CO_2 eq. A 10% shortfall is allowed without penalty, provided the shortfall is made up the following year.

Monitoring the performance of benchmark participants is undertaken by the IPART in its role as Compliance Regulator (GGAS, 2010d). Assessing abatement projects, accrediting parties to undertake eligible projects and then create certificates, and monitoring compliance with GGAS is the responsibility of the Scheme Administrator, currently IPART. The Scheme Administrator also manages the Greenhouse Registry which records the registration and transfer of certificates created from abatement projects (GGAS, 2010e).

GGAS has reduced or offset over 90 million tonnes of GHG emissions since it began in 2003 (GGAS, 2010f).

In recent years, the NSW Government has been preparing to transition GGAS to a national scheme. However, the proposed Australian national emissions trading scheme has been postponed and will be re-examined by the end of 2012 (Kelly, 2010). In the context of ongoing uncertainty around the timing, form and scope of national emissions trading scheme, the NSW Government has commenced a review of GGAS. The review stated that the NSW Government recognises "the importance for GGAS participants of a smooth transition to any national carbon pricing mechanism that may be implemented in the future and will take into account national policy developments in reviewing GGAS", and that the Scheme Administrator IPART is examining options to "strengthen the integrity of GGAS in light of its operation to date and for increasing its greenhouse gas abatement potential" (GGAS, 2010f).

1.4. New Zealand Emissions Trading Scheme (NZ ETS)[4]

The NZ ETS is the first mandatory, economy-wide scheme outside Europe.

Legislation to enact the NZ ETS was adopted in September 2008. The NZ ETS covers GHG emissions from forestry, transport fuels, electricity production, industrial processes, synthetic gases,

[3] This section draws on the GGAS official information available at: http://www.greenhousegas.nsw.gov.au/.

[4] This section draws predominantly on the NZ ETS official information available at: http://www.climatechange.govt.nz/emissions-trading-scheme/about/.

agriculture and waste, making it the broadest sectoral scheme amongst the current emissions trading scheme.

The NZ ETS is currently in a "transition phase" which started in July 2010 and will last until 31 December 2012 (NZ Government, 2010). During this period, only forestry, transport fuels, electricity production, and industrial processes have full obligations and are subjected to mandatory GHG reporting. For synthetic gases and waste sectors, the scheme will become compulsory in January 2013, while the entry date for agriculture has been deferred until 1 January 2015.

During the transition period, there will be no cap on emissions since there will be an unlimited supply of allowances. Entities will, however, be accountable for their emissions and will need to purchase allowances when emissions exceed their free allocation. As there is no cap and therefore no certainty as to the volume of emissions with which the national economy must operate, the NZ ETS does not fit a classic cap-and-trade system (Bertram and Simon, 2010).

The primary unit of trade in the NZ ETS is a New Zealand unit (NZU) issued by the Government. Effectively, one NZU is the right to emit one tonne of carbon dioxide, or the equivalent amount of other greenhouse gases.

Participants are required to surrender NZUs to the Government to meet their obligations under the scheme. During the transition phase one NZU will be required to cover every two metric tonnes of GHG emissions in a calendar year. After this, one emission unit will be equal to one tonne of emissions. Participants can also surrender a range of 'Kyoto units' (issued by the UNFCCC Secretariat under the rules of the Kyoto Protocol) which they can buy overseas.

The government allocates NZUs into the market by giving them to eligible individuals or firms in specific sectors, awarding them to individuals or firms conducting approved removal activities, or by selling them. NZUs can be traded within New Zealand. During the transition phase, only the forestry sector will be able to convert the NZUs freely allocated to them to Kyoto units to be traded overseas.

Free allocation of the NZUs varies by sector. Tradable emission units will be issued by free allocation to emitters, with no auctions in the short term. The fishing sector will receive free units on a historic basis, at the level of 90% of their 2005 emissions. Pre-1990 forests will receive a fixed free allocation of 60 emissions units per hectare. Allocation to emissions-intensive industry and agriculture will be provided on an output-intensity basis, which will be based on the industry average emissions per unit of output and will be uncapped.

During the transition phase, participants will also be able to buy emission units from the Government for NZ$25 each. After the transition phase, the price of an NZU will be determined in the trading market and will tend to match the international price of emission units. Participants can sell NZUs internationally by exchanging them for Kyoto units, within the limits on international sales set by the Kyoto Protocol.

Businesses participate in the emissions trading scheme in different ways:

- some have a legal obligation to acquire and surrender emission units to cover their direct GHG emissions or the emissions associated with their products. These participants are generally 'upstream' operators, for example transport fuel producers or importers bringing in products to New Zealand;
- some have the choice to apply to opt in to the scheme if they carry out a relevant activity;
- some receive free emission units that can be used to meet their own obligations or to sell to other firms, for example landowners with forests planted before 1990; and
- some do not have to take part in the emissions trading scheme, but trade emission units in the same way that stockbrokers or real estate agents trade in their respective markets. These are secondary market traders.

The Ministry of Economic Development manages the day-to-day running of the ETS. It is the main compliance and enforcement agency, responsible for verifying that participants are complying with the scheme. It also runs the New Zealand Emission Unit Register.

The Ministry for the Environment administers the Climate Change Response Act, which established the emissions trading scheme. It is also responsible for developing emission unit allocation plans and regulations under the Act, except for those relating to the forestry sector, which are managed by the Ministry of Agriculture and Forestry.

The NZ ETS is still an incipient market with uncertainty in terms of demand and choice of compliance options, so it is far too early to assess its effectiveness. The Scheme is considered by some, particularly by green groups, as too soft on big polluters (Greenpeace New Zealand, 2010), and as such unlikely to produce the required emissions reductions. The New Zealand Government has recently announced that the ETS will be reviewed in 2011, "to ensure it is meeting its purpose of reducing emissions at least possible cost and that New Zealand is appropriately pacing itself on climate change relative to its key trading partners" (Smith, 2010). Key areas for the review will be how to change the scheme's design to match any possible new global deal to fight climate change, and whether to ramp up the scheme and to include new sectors (Smith, 2010; Fogarty, 2010).

1.5. Tokyo's carbon trading system (Tokyo-ETS)

The Tokyo's carbon trading system (Tokyo-ETS), launched in April 2010, is the first mandatory GHG emissions scheme in Asia. The scheme's objective is to cut GHG emissions in Tokyo's metropolitan area by 25% by 2020, against a 2000 baseline (Tokyo Metropolitan Government, 2008, 2009, 2010).

Tokyo-ETS is a cap-and-trade scheme. Currently, the cap is placed only on CO_2 emissions resulting from fuel consumption and the use of electricity and heat, but it is planned to expand the types of greenhouse gases to be capped in the future (Tokyo Metropolitan Government, 2010).

The Tokyo Metropolitan Government sets legally binding emissions targets for the city's most energy and carbon intensive organisations. The cap for the first compliance period (2010–2014) has been set at a level of 6% below the base year emissions. The cap for the second compliance period (2015–2019) will be set at a level of approximately 17% below base year emission (Tokyo Metropolitan Government, 2009).

All large installations such as office buildings and factories in Tokyo that use energy equivalent to 1500 kilolitres of oil a year must participate or face fines of 500,000 yen (~US$6000) per facility. Some 1400 factories, offices and commercial buildings which, together, are responsible for 20% of the city's emissions, are covered by the scheme. During the initial compliance phase participating organisations are obliged to cut their carbon emissions by 6% (factories) to 8% (office buildings), compared with their highest 3-year average from 2002 to 2007. In the second phase of the scheme (from 2015 to 2019), commercial buildings and factories will be required to cut emissions by 17% from base-year levels.

To comply with the emissions targets, participating organisations can implement their own energy-saving measures or, under a cap-and-trade system, buy emissions credits from other entities that have reduced emissions beyond obligatory levels. This is similar to the way the EU ETS operates (Section 1.1). They can also purchase renewable energy certificates issued by power

generators and/or buy credits earned through reduction efforts by small and medium-sized companies in Tokyo. Offsets backed by domestic projects that reduce emissions are eligible under the Tokyo-ETS system; however, under the rules of the scheme, credits issued outside of Tokyo cannot exceed a third of the emission cuts required of participating organisations. Offset credits from foreign projects, including UN Certified Emissions Reduction credits, are not eligible under the scheme.

Those organisations that fail to comply with the scheme's rules will face fines and could also be 'named and shamed' by the government. Non-compliant firms will also be ordered to cut emissions by 1.3 times the amount they failed to reduce during the first phase of the scheme.

The first carbon credits in Tokyo's system were sold in August 2010 on an online marketplace operated by Japan Climate Exchange. It is expected that Japan Climate Exchange will handle 800,000 tonnes of CO_2 emissions by 2015 and 1.3 million tonnes by 2020 (Biggs and Nakayama, 2010).

2. The future of carbon trading

In 2009 the carbon market endured its most challenging year to date, and in the midst of a global economic crisis, emissions trading looked "clouded by uncertainty" (Kahya, 2009). However, even as global GDP declined by 0.6% in 2009, and at a more perilous rate of 3.2% in industrialised economies, the carbon market demonstrated resilience. The total value of the market grew 6% to US$144 billion (€103 billion) by year's end with 8.7 billion tonnes of CO_2 eq. traded (Kossoy and Ambrosi, 2010). Therefore, most players remain confident that "emissions trading is here to stay" (EC, 2009), and expect the market to mature and grow in size and scope.

At the same time, there are notable intentions within the current schemes to expand geographically and temporary and include more sectors and greenhouse gases. Furthermore, new schemes are being planned around the world too and there are indications that some of them would be linked or merged with the current emission trading mechanisms. This raises a possibility of the emergence of a global carbon market. However, there are significant technical and non-technical (policy and political) obstacles to a possible expansion. Linking of the current and emerging trading schemes requires not only considerable technical fixes and harmonisation of different trading systems, but also necessitates clear regulatory and policy signals, continuing political support and a more stable economic environment. The latter factors appear to be currently missing, which may seriously impede carbon trading prospects. The following sections explore these issues in more detail.

2.1. Geographical expansion

Some of the emissions trading schemes described in the previous section have expanded their respective geographical coverage 'organically'. For instance, the geographical scope of the EU ETS has grown as the EU itself has enlarged to 27 member countries, and it has since expanded beyond the EU boundaries by including three neighbouring countries: Iceland, Liechtenstein and Norway. Similar natural geographical expansion has happened to RGGI in 2007 when Massachusetts, Rhode Island and Maryland joined the other seven states that initiated the scheme in 2005.

It is expected that more regions in Japan will join the Tokyo ETS, suggesting that the metropolitan scheme may soon become the national scheme. The adjoining prefectures of Saitama, Chiba and Kanagawa, as well as cities around the capital including Kawasaki, are discussing how to participate in Tokyo's carbon market, suggesting nationwide trade will develop (Biggs and Nakayama, 2010). If those prefectures and cities join, the Tokyo system would cover the world's largest urban area with more than 31 million people. Those involved in the Tokyo programme are confident about further expansion of carbon trading in their part of the world and anticipate "the creation of an Asian and American (carbon) market to match Europe" (Biggs and Nakayama, 2010).

However, the real prospect of geographical expansion of carbon trading lies in potential linking of various trading schemes. The EC has declared that EU ETS is open to "linking with other compatible mandatory cap-and-trade systems that would not undermine its environmental integrity" (EC, 2009). The EC has also stated that "a global carbon market can and should be built by linking comparable domestic emissions trading systems" (EC, 2009). One of the first steps in this EU's vision of a global carbon market is to create an emissions market among member countries of the Organisation for Economic Co-operation and Development (OECD) by 2015 and then to expand this to include the big emerging economies from around 2020. In November 2010, the European Commission proposed opening negotiations on linking the EU ETS with Switzerland's domestic trading system which initiated the first formal process to link the EU ETS with the emissions trading system of a third country (EC, 2010).

In the USA, the RGGI has been collaborating with the two planned schemes – the Western Climate Initiative (WCI), and the Midwest Greenhouse Gas Reduction Accord (MGGRA) – on options for linking their regional cap-and-trade programmes. Together, these three schemes cover 23 US States and four Canadian Provinces and account for approximately one-half of the US population, over one-third of US GHG emissions and over three-quarters of the Canadian population and one-half of Canadian GHG emissions. With the uncertain fate of the US federal climate change legislation and the national cap-and-trade scheme in Canada, this co-operation of the three large regional schemes has shown a promise of further expansion of carbon trading in North America. However, as we will see later in the paper, the most recent developments in US state and regional trading programmes and proposals cast some doubts on this particular expansion.

The NZ ETS is also open to linkage with other schemes such as the EU ETS, but no decision has been made on whether to accept bilaterally the compliance units. The New Zealand's Government has also been working with Australia on harmonising its emissions trading scheme with the Australia's proposed Carbon Pollution Reduction Scheme (DCC, 2008). However, these efforts have yet to produce any results as Australia has decided to postpone its emissions trading scheme (BBC News, 2010; Kelly, 2010). The New South Wales Government has already announced that it would transition its Greenhouse Gas Abatement Scheme into an Australian emissions trading scheme if one were introduced, given the direct overlap in objectives, design and participants (NSW Government, 2010).

In addition, in 2007, countries and regions that have implemented or are actively pursuing the implementation of carbon markets through mandatory cap and trade systems have formed the International Carbon Action Partnership (ICAP) with the mission "to contribute to the establishment of a well-functioning global cap and trade carbon market (ICAP, 2010)".

2.2. Linking and ETS design

As the above examples indicate, there is willingness to link different schemes which could facilitate the transition from the current rather limited and fragmented emissions trading towards a global carbon market. Linking current and emerging carbon

markets at a global level would have distinctive advantages. Some of the advantages would be the establishment of a level playing field for the covered sectors and a consistent regulatory framework across national borders (ICAP, 2010). Linking schemes would also aid international co-operation on emissions reductions, reduce price volatility, help address competitiveness concerns, and reduce costs by increasing access to low cost abatement opportunities (Lazarowicz, 2009).

However, linking carbon trading schemes would need to overcome some serious practical obstacles. Currently, the ETS designs differ in some important aspects that may generate economic and/or political obstacles to linking. If linking is to be successful, major design features of current ETSs will need to be coordinated, including: the level of ambition, monitoring, reporting, verification, compliance and enforcement standards, treatment of offsets, allocation methods, and rules on banking and borrowing and price control mechanisms.

First, linking will only be possible between the schemes that share similar levels of ambition with respect to environmental objectives. In other words, for the linking of different ETSs to work, the level of ambition embodied in the caps had to be compatible. As capping emissions is the most important feature of an ETS, it is of crucial importance for linking of different systems that schemes that do not have a binding absolute cap are not allowed to corrupt those schemes that do have binding caps.

In order to be effectively linked, different emissions trading schemes need also to have a similar timeline of commitment period and comparable units (Baron and Bygrave, 2002). How targets are expressed (e.g. fixed or indexed) is also of critical importance. Although most emissions trading schemes (planned or currently in operation) have fixed limits, some, for example the NSW GGAS, express indexed/intensity emissions limit targets for their participants. As Ellis and Tirpak (2006) show, while it is possible to link emissions trading schemes with fixed and intensity targets, such linking could result in the linked systems emitting more than the individual non-linked systems (e.g. if a generous indexed target encourages increased production in that country, which then sells its surplus units to the country with a fixed target). Similarly, emissions could increase by linking systems that have a weak (but fixed) target with a stringent, indexed (intensity-based) target (Ellis and Tirpak, 2006).

Also, monitoring, reporting, verification, compliance and enforcement standards need to be comparably robust and trusted so that systems do not compromise each other's environmental integrity through linking. If these standards are lax and environmental integrity is compromised in one ETS, then authorities in another ETS are unlikely to link so as not to compromise the credibility of their own system. For instance, non-compliance provisions can affect the environmental effectiveness of a particular scheme by encouraging (or not) its targets to be met. Participants in a scheme with rigorous non-compliance provisions may be reluctant to link to a scheme with less stringent provisions, and thus a lower perceived environmental effectiveness.

Another area where coordination across ETSs is needed is the treatment of offset credits. As illustrated in the previous sections, the schemes differ significantly in the way they use offsets credits. Some schemes allow the use of credits from international projects while some limit offsets exclusively to national and/or regional projects. Both the EU ETS and the NZ ETS, for instance, allow offsets from international projects originating in Kyoto Protocol Parties, while RGGI stipulates that all offset projects must be located within one of the RGGI participating states. Tokyo-ETS and the NSW GGAS also limit offsets to domestic projects and do not allow credits from foreign projects.

Some ETSs have made policy decisions to include or exclude credits from particular project types. For example, all credits from CDM and JI projects, except those from nuclear facilities and from land use, land-use change and forestry activities, are currently accepted in the EU ETS. The NSW GGAS and the NZ ETS, on the other hand, accept offsets from forestry projects. RGGI, for its part, has a limited number of projects eligible to generate offsets.

This diversity in the use of offset credits presents a significant obstacle to linking. Take, for instance, a possible linking between the NZ ETS and the EU ETS. Currently, their respective rules regarding the use of offset credits would make such linking problematic. For instance, the NZ ETS allows the use of Assigned Amount Units (AAUs) for compliance while the EU ETS prohibits their use to preclude the inflow of low-cost "hot air" AAUs that could lead to a collapse of EUA prices. However, in a linked system, AAUs would became available in the EU ETS indirectly, as the New Zealand trading participants could sell NZUs to the EU ETS and purchase AAUs for domestic compliance instead.

To put it in more general terms, once systems are linked any differences in treatment of offset credits disappear de facto and credits may enter the market through the national system with the most permissive rules, where they can be swapped into freely tradable allowances (Fankhauser and Hepburn, 2009).

That is one of the reasons why the European Commission has expressed the view that when linking with other schemes, it would be important to take a common approach to external credits (House of Lords, 2008). As an EU official put it, "if one of you has taken a decision not to accept a certain type of credit, then you cannot link with somebody who allows that type of credit without tacitly allowing it to affect your systems" (House of Lords, 2008). In other words, the types of credits accepted in each scheme would need to be standardised or very near standardised for full linking to occur.

Lazarowicz (2009), however, argues that credit regulations do not need to be harmonised precisely to link systems, but in order to avoid this potential barrier to linking ETS authorities should ensure that credit import rules are coordinated to levels that are acceptable by both authorities before linking. This includes the types of credits that are allowed and limits that are placed on the use of credits for compliance. As the decision on the acceptance and import limits for offset credits critically influences the price level of an ETS and thus that amount of domestic emissions reductions, this particular ETS design feature requires special attention.

The method of allocation is a key feature of any cap and trade systems and bears significant implications for its environmental and distributive effects (Grubb and Neuhoff, 2006). As such, different allocation methods in current ETSs are bound to have significant implications for linking. Whether emission permits are allocated free of charge or auctioned could have competitive implications thereby affecting the political acceptability of linking different national systems (Ellis and Tirpak, 2006).

As the previous section illustrates, several allocation modes currently co-exist in countries and regions where carbon trading systems are in place or planned. Emission permits can be allocated free of charge, auctioned, or be a combination of the two. How emission permits are allocated to existing and new installations can vary within an ETS, as well as between different ETSs.

A trend is emerging towards increasing use of auctioning, both in the more recent proposed schemes and in further phases of existing ETS. Under the EU ETS, for example, so far almost all of allowances have been allocated for free. The trading Directive (EC, 2003) did allow up to 5% of allowances to be auctioned in Phase 1 but most EU states ignored that possibility and opted for 100% free allocation. Only four EU Member States (Denmark, Ireland, Hungary and Lithuania) used the possibility to auction some allowances within the 5% limit in the first trading period. In the second trading period (2008–2012), the level of auctioning is increased to a maximum of 10% of allowances, with several

member states making use of this option (e.g. Germany (< 9%), UK (7%), Netherlands (> 4%), Ireland, Hungary, Lithuania, Austria and Belgium). The third trading period, however, will mark a progressive move towards full auctioning of allowances in place of the current system of cost-free allocation. From 2013 at least 50% of allowances will have to be bought at auction and the aim is to reach full auctioning by 2020 for power sector, and by 2027 for all sectors. Exceptions can be made for specific energy intensive industries where it is judged that having to buy all allowances would damage their international competitiveness (EC, 2009).

The EU ETS will also change the way the cap is set. Under the revision of the EU ETS that will take effect in 2013, a single EU wide cap on emission allowances will replace the current system of 27 national caps implemented through national allocation plans (NAPs) (EC, 2009).

Amongst the other schemes currently operating, at the one end of the allocation spectrum is Tokyo-ETS where participating organisations are allocated free emission allowances. On the other end of the spectrum are the RGGI states. Massachusetts, for instance, has committed to auction 100% of its allowances, while the State of New York has also recently proposed to auction 100% of its state-wide allowance allocation under the programme (RGGI, 2010). Overall, the RGGI states have chosen to sell approximately 90% of allowances through regional auctions.

However, most systems combine free allocation and auctioning to a certain degree. Four EU Member States (Denmark, Ireland, Hungary and Lithuania) used the possibility to auction some allowances within the 5% limit in the first trading period. The remainder of the allocation was mainly based on 'grandfathering' (i.e. allocated for free according to historical emissions).

In the New Zealand ETS, the government currently allocates allowances into the market by giving them for free to eligible individuals or firms in specific sectors, awarding them to individuals or firms conducting approved GHG removal activities, or by selling them. Free allocation, however, will be phased out in favour of auctioning, with a linear rate of decline from 2013 to 2025 (NZ Ministry for the Environment, 2009a, b).

It is often argued that that auctioning is a more efficient method of permit distribution than free allocation (Reinaud and Philibert, 2007). Nonetheless, as auctioning could potentially affect some sectors 'profitability and/or competitiveness in relation to unconstrained competitors, grandfathering allowances is often proposed at least in an initial transition phase. The grandfathering practice is likely to continue despite the fact that this allocation method requires sound data on historical emissions, which experience shows are not always readily available (Reinaud and Philibert, 2007).

As to the implications of different allocation methods for linking – mutual compatibility of allocation methodologies is certainly desirable as it would prevent unwanted distributional effects. For instance, if an ETS applies grandfathering or benchmarking, there will be winners and losers across companies: net sellers in the high price ETS and net buyers in the low price ETS will lose, while net buyers in the high price and net sellers in the low price ETS will win due to the change of the price level (Haites and Mullins, 2001). In case of updating (allocations based on emissions in a previous period), there may be an intensified incentive for companies to increase their emissions in order to benefit from larger allocations in subsequent periods (Jaffe and Stavins, 2007). If an ETS applies auctioning, there will be distributive effects among the authorities that receive the revenue from the auction: the authority in the ETS with a lower pre-linking price will receive more revenue, while the authority in the high price region will receive less (Flachsland et al., 2008).

These are some of the reasons why consistency in allowance allocation across systems is important if linking is to work without distorting the carbon market. In isolated markets (and in the early stages of a system) allowances tend to be issued for free, particularly to installations that are subject to international competition. However, as Fankhauser and Hepburn (2009) show, in a linked system free allocation becomes a form of state aid that gives its recipients a competitive advantage over rivals that have to purchase their allowances. Thus, to avoid market distortions, an alignment in allocation rules is crucial for linking up ETSs.

Different rules on banking and borrowing and the presence of price control mechanisms such as price caps are further design features that may create barriers to the linking of systems if they underpin diverging views about the appropriate level of ambition (and hence prices) (Fankhauser and Hepburn, 2009).

Although differences in banking and borrowing provisions do not preclude links between systems, if systems featured very different approaches then a linked system could face significant challenges. For instance, systems with borrowing risk their environmental effectiveness if an operator borrows allowances and goes bankrupt before these are repaid. Also, if operators under a scheme with borrowing borrow heavily this will lead to considerable reduction burdens in future periods. In face of such costly obligations for companies there will be pressure on governments to relax caps in order to reduce economic impacts on companies. Therefore, inter-period borrowing could comprise the environmental integrity of an ETS (Flachsland et al., 2008).

In a linked scheme, borrowing provisions in a partner scheme would be unacceptable for an ETS if it is perceived to carry the potential for weakening the environmental effectiveness of the scheme. Also, linking one system with banking to another system without banking effectively creates a banking option for the system without banking (Fankhauser and Hepburn, 2009). However, there are limited differences in banking and/or borrowing rules in existing and proposed ETS so this particular design feature should not form a major challenge in practice.

To sum up, geographical expansion of carbon trading by the linking of different trading systems appears a real prospect. However, there are some considerable practical obstacles and several technical and non-technical (i.e. policy/political) issues that could affect the speed at which systems are linked.

This section has discussed some of the design features that may generate political or economic obstacles to linking. They include: differences of ambition embodied in the caps, treatment of offsets, price management policies, rules on banking and borrowing, different allocation methodologies, etc. While design differences along these dimensions do not necessarily prevent linking, they contribute to increased economic issues, design problems or political concerns about financial flows from one system to the other.

There are no conceptual reasons why links between emissions trading systems and markets cannot be expanded. As a UK official put it: "As long as we are based on the same basic principles of environmental integrity and a tonne of CO_2 is a tonne of CO_2 come what may, then most schemes should be able to link" (House of Lords, 2008). However, it appears that the linking will only be possible between trading systems that share similar levels of ambition with respect to environmental objectives, quality-control of credits, verification and enforcement mechanisms (House of Lords, 2008).

Although geographical expansion of carbon trading by formally linking various emissions trading systems looks likely, it will require some time to achieve it. Jill Duggan, Head of International Emissions Trading at the UK Department of Energy and Climate Change (DECC), for instance, thinks that the EU's proposal for an OECD-wide set of linked cap and trade systems by 2015 is "probably optimistic and ambitious", and stresses that, overall, the UK is envisaging that a global carbon market would take 40 years to be built (Environmental Audit Committee, 2010).

Mike O'Brien, former UK Minister of State at the Department of Energy and Climate Change, has also suggested that developing a global market in this way by linking up various emissions trading schemes that have been created could take decades to complete and conceded that the development process is not going to be easy (Environmental Audit Committee, 2010).

2.3. Broadening sectoral and GHG coverage

Another notable trend in carbon trading is a gradual broadening of its sectoral and GHG coverage. Earlier carbon trading schemes focused on "downstream" CO_2 reductions from the power sector and energy-intensive industries. However, new phases of the established schemes such as the EU ETS as well as more recent announced or proposed programmes tend to combine downstream allocation for these large stationary point sources with upstream allocation to fossil fuel producers and importers. Other gases and sectors are considered for inclusion or addressed through provisions for offsets, notably aviation, agriculture and forestry, and waste. This is discussed below.

Current carbon trading schemes have either already expanded or plan to expand their sectoral and GHG coverage. For instance, in the first trading period (2005–2007) the EU ETS covered CO_2 emissions from high-emitting installations in the power and heat generation industry and in selected energy-intensive industrial sectors: combustion plants, oil refineries, coke ovens, iron and steel plants and factories making cement, glass, lime, bricks, ceramics, pulp and paper. In the second trading period (2008–2012) the scheme essentially covers the same industries, with the exception of emissions of nitrous oxide from the production of nitric acid which are also included. However, the scope of EU ETS will be extended in Phase 3 (2013–2020) to include new sectors and gases covering:

- carbon dioxide emissions arising from petrochemicals, ammonia, and aluminium sectors;
- nitrous oxide emissions from the production of nitric, adipic and glyoxylic acid, and perfluorocarbons emissions from the aluminium sector; and
- capture, transport and geological storage of carbon dioxide emissions.

These changes in scope are expected to bring into the system net additional emissions equivalent to 120–130 million tonnes of CO_2 per year from 2013 extending the coverage of the EU ETS from around 40% to 43% of total EU GHG emissions.

Importantly, on 1 January 2012, the aviation sector will join the EU ETS which will cover all flights arriving at or departing from any EU airport from 2012 onwards and will apply to carbon dioxide emissions only. This first year of participation will serve as preparation for Phase 3 starting the following year.

The New Zealand's ETS is even more ambitious in its sectoral and GHG expansion as it intends to include all sectors of the economy and all greenhouse gases by 2015.

A trend to expand emissions trading to more sectors and gases is evident in emerging schemes too. Various announced or proposed systems, starting with Australia and the USA, would combine an upstream regime for small sources, and a downstream regime for large sources. For example, the proposed US ETS (APA, 2010) would cover power plants and industrial facilities emitting more than 10,000 t on CO_2 eq. a year, facilities producing or importing petroleum- or coal-based transportation fuel, the use of which will emit the same annual amount, and facilities producing or importing non-fuel chemicals that will emit again the same amount. The proposed US ETS also integrates all the Kyoto greenhouse gases (CH_4, N_2O, SF_6, PFCs, HFCs) at the outset—a feature often neglected by other systems or considered for some undefined future expansion.

Clearly, there is a trend of expanding emissions trading to cover more sectors and gases in the future. An important argument for broadening the scope of emissions trading is that this gives carbon a price on a larger scale, which can then be taken into account in economic decisions (Reinaud and Philibert, 2007). Further, generally speaking, the more sectors and gases that are covered in an emissions trading scheme, the greater the potential for liquidity and market efficiency (Baron and Bygrave, 2002).

Other options for broadening the scope of emissions trading have been suggested in the literature, aimed at targeting other elements in the chain that lead to emissions, such as carmakers, which would be liable for the emissions of the cars they sell, based on some estimate of mileage (IEA, 2005).

Perhaps more intriguing is the idea of personal carbon trading, i.e. giving to everyone a limited allowance to emit carbon dioxide and allowing those who want to emit more to buy from those who emit less (Reinaud and Philibert, 2007). Although a study commissioned by UK's Department of Food and Rural Affairs (Roberts and Thumin, 2006) shows that personal carbon trading may be much easier to implement than one might expect, there are still no signs that the scope of carbon trading will be expanded in this way any time soon. In fact, following its pre-feasibility study into personal carbon trading, the UK Government has decided to wind down its work in this area on the grounds of high implementation costs and public resistance to the concept (Environmental Audit Committee, 2008).

2.4. Temporal expansion

Some of the current ETS are designed to be used for compliance with emission commitments under the Kyoto Protocol, while others are planned or in use in non-Kyoto Parties. The EU ETS and the NZ ETS, for instance, are linked with the Kyoto targets and their temporal coverage follows the Kyoto commitments period. However, both schemes are clearly designed to continue beyond the end of 2012 when the Kyoto Protocol expires.

The other operating schemes have also officially announced plans to continue beyond the current phases. For instance, Tokyo-ETS and RGGI have both set the reduction targets beyond initial trading periods which end in 2014.

Emission trading is expected to constitute a building block of any post-2012 climate policy, hence temporal expansions of the ETSs are likely to happen. However, the uncertainty surrounding the further evolution of international climate policy and the future architecture of carbon markets make any specific plans for such temporal expansions tentative.

2.5. Changing political environments and policy and regulatory uncertainty

The carbon market keeps developing. In December 2010, California approved an extensive carbon-trading plan aimed at cutting greenhouse emissions (ARB, 2010). New emissions trading schemes are being planned around the world, for instance the USA, Canada, Japan, South Korea and Australia have all announced plans to introduce national emissions trading schemes.

However, there is considerable uncertainty when, how or whether these plans will be executed. According to the latest survey by Point Carbon, expectations for the introduction of cap-and-trade around the world have been shrinking since 2009, with notable exceptions such as Japan and South Korea (Point Carbon, 2010a). However, since the publication of the report the carbon trading expectations have cooled down significantly even in Japan and South Korea (Maeda, 2010; Reuters, 2011).

More recent developments certainly indicate that not all is well on the carbon trading front. The Japan government, for instance, has approved legislation outlining details for a mandatory trading scheme, but the Climate Bill (METI, 2010) was vague on how the scheme would set limits on GHG emissions. While an early draft of the Bill by the Environment Ministry proposed a "cap-and-trade" scheme that sets absolute caps on emissions, the bill was watered down after complaints from businesses that volume caps would stifle growth. The vagueness of the Climate Bill, along with continuing pressure from industry groups in protest at volume caps, has led to a drawn-out process in designing the trading scheme. More importantly, in late December 2010 the government of Japan announced that it was postponing its plans for a national emissions trading scheme. Japan's National Strategy Minister, Koichiro Gemba, who was appointed to review the government's core green policy steps, said the trading scheme needed further careful study, indicating that it had effectively been shelved (Maeda, 2010). Neighbouring South Korea has also delayed the introduction of its emissions trading laws into parliament until February because of business concerns (Maeda, 2010).

The future of another well-publicised scheme, namely the Australian Carbon Pollution Reduction Scheme (CPRS), looks tentative too. In April 2010, the Australian government put plans for a flagship emissions trading scheme on hold until 2013 at the earliest (BBC News, 2010; Kelly, 2010). Although incumbent Australian Prime Minister Julia Gillard has suggested that under her Government Australia will still be moving towards an ETS (Guardian, 2010), it is far from certain when and if the scheme will be implemented.

More troublesome news for carbon trading, however, are the most recent announcements with regard to the US cap-and-trade programme. After the US mid-term elections in November 2010, President Barack Obama announced that the USA would not be pursuing an emissions trading scheme. In a press conference the day after the election, President Obama distanced himself from the cap-and-trade programme he once backed as the best tool to limit global warming: "Cap-and-trade was just one way of skinning the cat…It was a means, not an end," he said. "I'm going to be looking for other means to address this problem" (Chipman and Lomax, 2010). Obama's statement marked a clear shift in the US official stance on emission trading. In 2009, the legislation on cap-and-trade had passed in the US House of Representatives, but had not been taken up in the Senate. With the balance of power in the House of Representatives shifting decisively to the Republicans, prospects for a US carbon market are now more remote because the vast majority of Republicans have opposed cap-and-trade proposals to date.

The most recent developments in US state and regional trading programmes and proposals additionally indicate that carbon trading in the US is entering a difficult period. In the early 2011, the Midwestern governors formally abandoned a pact to create a carbon market (the proposed Midwest Greenhouse Gas Reduction Accord); the lower house of the New Hampshire passed a bill that would remove New Hampshire from RGGI; New Jersey announced that it would withdraw from RGGI by the end of the year, and California's top climate change regulator announced that the state planned to delay the start of a market for greenhouse gases by one year until 2013 (Point Carbon, 2011a, b, c, d).

These developments in the US, in particular the failure of the Obama administration to land a federal US cap-and-trade programme, will have serious repercussions for other proposed national schemes, and consequently, for the prospect of a global carbon market. Most governments fear that their companies would be at a disadvantage if restrictions were placed on them that are not placed on their US competitors. This is most obvious in Canada where the Conservative government has largely followed the USA lead on climate change. It is now reasonable to expect that the proposed Canadian cap-and-trade scheme will also be put on hold. The US decision could also have an impact on the New Zealand ETS. The New Zealand government has recently announced that full implementation of its ETS could be delayed if adequate progress is not made in establishing similar regulations in other developed countries (New Zealand Parliament, 2011).

The US change in policy regarding emissions trading is bound to have some adverse impacts on the largest and most important emissions trading scheme in operation—the EU ETS. As the most recent World Bank report (Kossoy and Ambrosi, 2010) points out, Europe's political resolve may waver if other regions of the world fail to participate with their own carbon reduction schemes. Although it is unlikely that the EU will abandon the market mechanism in which it has invested so much time and political capital constructing, the question remains as to how long the EU will continue to make a real effort to control its emissions while those of other regions grow unchecked.

In addition to the impacts of a changed political landscape in the USA, the uncertainty surrounding the future direction of global climate policy may also have negative implications for the future of carbon trading. In December 2009, the fifteenth conference of the parties (COP-15) to the UN Framework Convention on Climate Change (UNFCCC) was held in Copenhagen. At the meeting, heads of government clashed over the future direction of global climate policy while many questions important to the carbon market were deferred. The following COP-16 in Cancun in December 2010 failed to clear uncertainty over a global climate framework beyond 2012. Before the Cancun conference, several key players, including UN secretary-general, Ban Ki-moon; the EU commissioner for climate action, Connie Hedegaard; and executive secretary of the UNFCCC, Christiana Figueres (Tregaskis, 2010), had gone on record saying they did not expect a binding deal any time soon. The UN and European Union officials and others were cautioning that the Cancun conference probably would yield only a first answer on curbing greenhouse gases, and that a legally binding climate change treaty was not likely until 2011 at the earliest (Watts, 2010; Carrington et al., 2010). Although some progress was made in Cancun, the overall impression was that in the overriding desire to get any deal, as one commentator put it, "gaping loopholes and ambiguities were left in, dates were left out and major issues about the final legal form and the emission cuts all countries will need to make were pushed back another year" (Vidal, 2010).

Ultimately, governments may need to address divisions over the question of extending the Kyoto Protocol if no new treaty is reached by its 2012 expiry date. If a new treaty and an extension of Kyoto fail to materialise, it is quite possible there will be a period without any global commitment to cut emissions. As things stand, the Copenhagen and Cancun climate conferences' inconclusive outcomes and the publically expressed pessimism that international policymakers will be able to reach a legally binding agreement any time soon, have deepened the sense of uncertainty over the future of the global emission reductions effort.

It is reasonable to expect that these developments in the USA and international climate policy will have detrimental effects on prospects of carbon trading. It appears very difficult to imagine how carbon trading would prosper in an environment with unresolved questions over both international and US carbon trading frameworks.

The current economic turmoil is another factor that must be taken into consideration when discussing the future of carbon trading. The global economic crisis, which started in late 2008 and intensified in early 2009, negatively impacted both the demand and supply sides of the carbon market. As industrial output

plummeted, the demand for carbon assets fell. On the supply side the financial crisis spurred financial institutions and private investors to deleverage and redirect their positions away from risky investments and towards safer assets and markets. Capital inflow to developing countries fell dramatically, while already internalised resources flowed out. As a result, many project developers found it impossible to lock in finance and project origination effectively ground to a halt (Kossoy and Ambrosi, 2010). Although the carbon market demonstrated resilience (as shown in its total value growth of 6% at the end of 2009), it is difficult to predict what impacts the global economic turmoil will ultimately have on carbon trading.

In addition to the present lack of global policy signals and political and economic uncertainties, there are also serious doubts about some of the design features and effectiveness of current schemes which could also impede prospects of carbon trading. It has been pointed out that the schemes have not been entirely successful in reducing GHG emissions and have demonstrated serious flaws (Gilbertson and Reyes, 2009; Sandbag, 2010a, b; Greenpeace New Zealand, 2010). The issues of over-allocation, and windfall profits in particular have been highlighted as significant concerns (Ellerman and Joskow, 2008).

The EU ETS, for instance, has been criticised for "over-allocation" of emissions allowances (Sandbag, 2010b). Critics of the EU ETS have pointed out that the member states created too many allowances during the trial period which led to an emissions cap that was not sufficiently constraining or at least not demanding enough. The fact that emissions allowances were (still are) distributed almost exclusively for free (based on past emissions), could also lead to perverse dynamic effects where firms have an incentive to emit more now in order to receive a larger free allocation in the future. Furthermore, as Hepburn (2007) points out, allocating EUAs for free inevitably results in rent-seeking behaviour by firms as they invest valuable resources in lobbying to obtain a higher allocation.

Critics also point to windfall profits as another deficiency of the EU ETS that resulted from the free allocation of allowances (Sandbag, 2010a). It has been alleged that the market value of freely allocated allowances, instead of their zero cost, was "improperly" included into power supply bids, thereby causing higher wholesale power prices and significantly higher profits for some generators.

There are, however, those who dismiss this critique as reflecting "either a misunderstanding of how cap-and-trade systems work in a market economy or fundamental disagreement with basic provisions of the EU ETS" (Ellerman and Joskow, 2008).

Other schemes have also been criticised on similar grounds. It is claimed, for instance, that the allocation of carbon credits to industrial processes in the New Zealand ETS is extremely generous (Greenpeace New Zealand, 2009), and, by giving free credits to heavily carbon emitting industry, the ETS removes the incentive to invest in low carbon-intensive technologies (Parliamentary Commissioner for the Environment, 2009).

Critics of carbon trading not only point out the serious flaws in the current systems, but also continue to question the very essence of carbon trading. It should be noted that sustained opposition against the fundamental concept of emissions trading can still be found among academics (see, e.g., Driesen, 2007; Bachram, 2004) and a number of civil society organisations (see, e.g., Durban Group, 2004). Detractors have argued that carbon trading is ethically dubious as it represents an indefensible kind of 'commodification' or 'pricing what should not be priced' (ECI, 2007). Some conceptualise the emerging carbon markets as neoliberal "accumulation by decarbonisation" (Bumpus and Liverman, 2007), while others reject carbon trading on the grounds that it "reduces the political space available for education, movement building and planning around the needed fair transition away from fossil fuels" (Lohmann, 2006a). A number of critics have argued that the current pattern of emissions trading schemes fails to distribute the burdens of mitigation fairly (handing out large benefits to energy companies), cannot meet the energy needs of the poor, and has an unconvincing record in lowering emissions (e.g. Caney, 2010).

Some of these ethical arguments, such as equity issues and the ETS record in reducing emissions, highlight some serious concerns about the current practice of emissions trading. They do not, however, entail that emissions trading should necessarily be abandoned. Rather, they highlight the need to improve the design of emissions trading schemes in order to overcome these flaws and address the raised concerns. Others, such as those who raise the issue of carbon commodification, go beyond equity issues and the shortcomings in practical implementation of carbon trading and question the very legitimacy of carbon trading (Lohmann, 2006b). However, it is difficult to estimate whether (and if so to what degree) this fundamental critique of carbon trading erodes its appeal, and what would be repercussions of this continuing legitimacy question for the prospects of carbon trading.

3. Concluding remarks

Climate change has been called "a greatest market failure" (Stern et al., 2006). Emissions trading was created as one of the key measures to address this failure. This paper has reviewed the mandatory emissions trading schemes currently in operation and discussed their prospects.

As to the future of these schemes, it transpires that each of the reviewed schemes intends to expand its respective coverage and is open to future linking with other schemes. Together with announcements of new schemes being planned around the world, this seems to have indicated that the future of carbon trading lies in a further expansion and the creation of a global carbon market. While there are no conceptual reasons why links between emissions trading systems and markets cannot be established, there are, however, some considerable practical obstacles and several technical and non-technical issues that could hinder this development.

The paper has discussed some of the ETS design features that may generate barriers to linking, such as differences of ambition embodied in the caps, treatment of offsets, price management policies, rules on banking and borrowing, different allocation methodologies, etc. It has argued that, while some design differences along these dimensions do not necessarily prevent linking of ETSs, they contribute to increased economic issues, technical problems or political concerns that need to be addressed before any formal linking occurs.

The paper has also argued that an expansion of current emissions trading schemes and their possible linking depends not only on technical fixes and harmonisation of different trading systems, but also on clear policy signals, continuing political support and a more stable economic environment. Currently, these latter factors are missing. The global economic turmoil and its repercussions for the carbon market and a lack of international deal on climate change that would define global commitments to emissions reductions, cast serious doubts on expansion of emissions trading schemes.

In the light of considerable uncertainties surrounding the further evolution of international climate policy and the future architecture of carbon markets, the planned expansions of current emissions trading schemes around the world are likely to be put on hold. Significant concerns about practical implementation and effectiveness of the current schemes, the most recent failure of the world largest emitters of GHG, the USA to establish a national

cap-and-trade programme and a tentative status of some of the planned schemes, all indicate that carbon trading enters an uncertain period.

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