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synthesis article

Personal carbon trading in the context of the EU Emissions Trading Scheme

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Although several personal carbon trading (PCT) scheme designs have been mapped, the practical challenges in the context of existing EU climate policies have not been addressed in detail. The implementation and administration of the EU Emissions Trading Scheme (EU ETS) are compared with the current PCT proposals to reveal the intricacies of the implementation and administration of a new emissions trading scheme as well as issues of compatibility between schemes. Several issues need to be resolved. For example, problems of double regulation and double counting could be created by the parallel existence of the EU ETS. In addition, a clear definition of 'personal' is needed in order to prevent carbon leakage to 'non-personal' areas. Furthermore, monitoring (international) mobility emissions is a challenge without a practical and politically acceptable solution. Monitoring of emissions and trading of allowances in real time through the use of a carbon swipe card is likely to increase the costs and reduce the political acceptability of a PCT scheme. Finally, the assumption that equal per capita allocation would be fairer than other allocation methods is far from being accepted, therefore weakening some of the benefits of a PCT scheme.

Keywords: emissions trading; GHG emissions reduction; governance; personal carbon trading; policy barriers; policy instruments

Bien que plusieurs formes de systèmes d'échange de carbone individuel « Personal Carbon Trading (PCT) » aient été dressées, les défis liés à leur application concrète dans le contexte des politiques climatiques communautaires existantes n'ont pas été abordés en détail. La mise en place et l'administration du système communautaire d'échange de quotas d'émissions (SCEQE) sont examinées par rapport aux propositions courantes de PCT de manière à mettre en relief la complexité liée à la mise en place et à l'administration d'un nouveau système d'échange d'émissions, ainsi que la question de compatibilité entre les différents systèmes. Plusieurs questions doivent être résolues. Par exemple, des problèmes de double réglementation et double comptage pourraient être occasionnées par l'existence parallèle du SCEQE. De plus, une définition claire d' « individuel » est requise de manière à éviter les fuites de carbone hors du « secteur » individuel. En outre, l'évaluation des émissions liées à la mobilité (internationale) est un problème dépourvu d'une solution qui soit acceptable au niveau pratique comme politique. L'évaluation des émissions et l'échange de quotas en temps réel par carte magnétique carbone risque de faire augmenter les coûts et de réduire l'acceptabilité politique d'un système de PCT. Finalement, l'hypothèse selon laquelle une allocation repartie également entre individus soit plus juste que d'autres méthodes d'allocation est loin d'être reconnue, diminuant ainsi certains des avantages d'un système de PCT.

Mots clés: échange de carbone individuel; échange de quotas d'émissions; gouvernance; instruments de formulation de politiques; obstacles à la formulation de politiques; réduction des émissions de GES

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1. A new climate mitigation policy idea for empowering citizens

Personal carbon trading (PCT) is a market-based policy option developed in the UK for monitoring and curbing carbon dioxide emissions from households. The scheme would be a mandatory cap-and-trade emissions trading system where allowances would be allocated directly to individuals on an equal per capita basis. The originality of PCT resides in the fact that market participants would be individuals or households rather than organizations or States.

The original proposal was called tradable energy quotas (TEQs), in which carbon emissions resulting from the entire economy are capped, with allowances distributed freely to individuals and auctioned to businesses (Fleming, 1997). More recently, variants have been developed and are generally known under the broad heading of personal carbon trading (PCT) (Hillman and Fawcett, 2004; Fawcett et al., 2007). In these new proposals, the cap is restricted to energy use under the direct control of individuals, i.e. household energy and personal transport, assuming that other (existing) schemes will cover GHG emissions from organizations.[1] In general, these proposals have been designed by eco-innovators or researchers working in isolation from the policy process. In principle, any allocation system could be used, although the only option currently considered in any detail has been equal per capita allowances, because of its apparent equity and simplicity.

The intention is that this economic instrument will rely upon the capability of markets to aggregate information and thereby help people make better decisions, for instance, in investing in energy efficiency measures. Most of the research on this particular policy instrument does not come from economists –who tend to prefer upstream schemes because of their lower transactions costs – but from researchers in the environmental and energy domain, who argue that some kind of individual rationing is necessary given the rising trend in household CO_2 emissions. As they describe it, PCT

> is much more than an economic instrument; it also has important moral and social aspects. It makes clear the responsibility each of us bears for reducing emissions from our consumption patterns, and sets this individual responsibility within a strong social context of a shared national goal (Fawcett et al., 2007).

More precisely, in comparison with traditional economic instruments such as a carbon tax, the benefits of PCT are mainly associated with energy savings due to the effects of feedback. For instance, Darby (2006, 2008) found that providing direct energy consumption feedback with an in-house display resulted in reductions in household energy consumption of between 5% and 15%.

This new policy idea attracted political attention and received media coverage in the British press between 2005 and 2008.[2] It was discussed by key actors in the UK government, notably David Miliband, former Secretary of State for Environment, Food and Rural Affairs. Colin Challen MP introduced a Private Member's Bill in the UK House of Commons entitled 'Domestic tradable quotas (carbon emissions)' (Hansard, 2004), which was not adopted. In 2008 several detailed studies were commissioned (Accenture, 2008; CSE, 2008; Defra, 2008; Enviros, 2008) which led to the conclusion that a PCT system is technically feasible, but expensive to construct and maintain.

Current proposals are focused on the UK, but given the role of the EU in regulating the energy sectors and in defining climate change targets, it is likely that any attempt by a Member State to develop such a scheme would involve the EU Commission.

The implementation of a national scheme within the EU is, however, technically feasible. For instance, the Commission approved the UK ETS prior to the EU ETS because of the excellent learning opportunity it represented. The UK ETS was the world's first large-scale GHG emissions trading scheme. The primary aims of the scheme were to secure cost-effective GHG emissions reductions,

to give UK companies early experience of emissions trading and to encourage the establishment of emissions trading centres in London. With the establishment of the EU ETS, there was no longer a case for a UK-based scheme to address industrial-sector CO_2 emissions, but a similar mechanism is being revived in the UK to cover large emitters outside the scope of the EU scheme and is known as the CRC Energy Efficiency Scheme.

2. Comparison of the EU ETS and PCT

2.1. Introduction

The implementation, administration and enforcement of the EU ETS will be compared with current proposals for a PCT scheme. The EU ETS is the first mandatory international trading system for CO_2 emissions in the world. As such, it provides an excellent point of comparison for any policy-makers aiming to develop a new cap-and-trade scheme.

In order to establish a cap-and-trade emissions trading scheme, a legislator must agree on several parameters. In particular, five essential elements must be thought through in order for a scheme to be environmentally, economically and socially effective (Brohé et al., 2009). These elements include:

- defining a scope (a cap and a commitment period)
- allocating allowances
- managing the price volatility
- monitoring, reporting and tracking allowances in a registry
- reconciling emissions with allowances and setting penalties for non-compliance.

The definition of the scope is based on several parameters including geographical coverage, temporal range, and gases covered. Demand for allowances will depend on the severity of the cap but also on the level of actual emissions from involved agents. If the reduction target is small, the demand for emissions rights will be weak. Similarly, if the involved agents are able to significantly reduce their emissions, thus remaining within their cap, then demand for permits on the ETS will also be weak and prices will remain low to moderate. This can occur either because of the use of mitigation technologies or due to a fall in consumption.

The commitment period is the temporal aspect of the cap. It sets out the time period for obtaining emissions reductions. If the full benefits of emissions trading are to be realized, the rules of the system must balance predictability with flexibility to take advantage of changing circumstances. A long commitment period, with banking and borrowing of emissions credits between periods, can provide greater certainty and reduce policy risk (Helm et al., 2005).

The creation of a new emission market requires property rights to be identified and allocated, where previously there were none. There are two main allocation approaches: either selling these rights or giving them away. There is a vigorous debate around this allocation process and at its core lies an assumption about who initially should own the property right to the environment – the polluter, or the public at large (i.e. the taxpayer and the government).

Free allocation involves distributing pollution rights free of charge under some predefined rule such as ‘grandfathering’ or ‘equal per capita’. Through grandfathering, allowances are allocated on the basis of prior use. This allocation method is usually strongly advocated by polluters, as it recognizes their implicit right to use the environment as they always have, albeit now under the constraint of a cap. Per capita allocation is an alternative method which has been proposed from

at least as far back as 1988 (Carley et al., 1991). With this allocation method, the quantity of emissions rights allocated to a nation in a given year is calculated by dividing the total rights agreed upon globally for that year by the global population in that year (or an agreed base year) and then multiplying the quotient by the nation's population in that year (or the agreed base year). In a free allocation process, the allocation is political and is therefore influenced by various forms of lobbying, which can make the process laborious (as illustrated by the sulphur dioxide cap-and-trade programme; see Joskow and Schmalensee, 1998). This also often results in over-allocation (as illustrated by the EU ETS, see below).

Alternatively, if the government elects to sell permits, it assumes that polluters had no prior right to the environment and that the atmosphere is a commons effectively owned by all. Under this approach, agents covered by the scheme face the upfront cost of participation, as they have to bid for the right to use the atmosphere. In practice, governments sometimes develop a hybrid allocation method with a mix of free allocation and auctioning (see below, with the EU ETS).

A cap-and-trade system can create significant price variability. Such volatility potentially poses a significant threat to economies in a carbon-constrained world. There are, however, various mechanisms to control volatility. The first option is to allow banking of allowances for future use. This allows governments to encourage companies to further reduce their emissions now by allowing them to establish a reserve of allowances for the future, and can limit price volatility between trading periods and can also smooth out prices (Amundsen et al., 2006). Setting price floors and/or ceilings is another method that could be used. These would aim to provide a mechanism of 'safety valves' to reduce the volatility (Jacoby and Ellerman, 2004). The price floor would prevent the collapse of the emissions market due to either an over-allocation of permits or a fall in the demand for permits. The price ceiling would insure the covered entities against extremely high costs of abatement. However, this would need to be weighed against the loss in environmental integrity induced by the addition of permits to the system. A third method used to limit price volatility is to link cap-and-trade schemes to external baseline and credit projects which are outside the capped system. With a baseline and credits project, an investor can generate additional emissions credits by investing in emissions reductions in other sectors or areas. These credits can then be used for compliance purposes in a cap-and-trade scheme. For instance, a British company can reduce its emissions abroad in countries where the marginal abatement cost of carbon might be lower (e.g. China). Another option in order to avoid fluctuations in a market is to link a system to another scheme. In practice, however, linking emissions markets is complex because of varying definitions. Some countries may have more severe monitoring and reporting guidelines, higher penalties for non-compliance, and so on. Linking with a less reliable system could harm the effectiveness and credibility of a scheme and actually increase volatility, so it should be considered with caution.

Emissions are fungible; hence it is important that the measurement methods are reliable and consistent so that a tonne of CO_2 means the same thing between different agents, across different sectors and different countries. The monitoring and reporting of emissions is therefore the next critical element. The definition of clear rules and the development of standardized methods for calculating emissions are a prerequisite for the credibility of any emissions trading system.

Reliable registries are also needed to ensure that emissions and corresponding emissions rights (allowances) can be traced. Registries ensure the booking of transactions of emissions rights. Their function is to ensure traceability of the allowances, thereby guaranteeing the environmental integrity of the system. At the end of the accounting period, reconciliation between actual emissions and emissions rights held by the participants is performed using the data booked in the registry.

Finally, in order to ensure environmental integrity of the system regarding the cap, the regulator must set enforcement rules. A system of fines encourages polluting entities not to emit more than the number of allowances they hold. However, fines alone are not always enough to ensure environmental integrity. Take, for example, the case where there is a substantial over-demand for permits due to an unusually cold and long winter which means more energy and GHG emissions to heat homes than the regulators might have expected when they set the cap. The price of emissions permits in these circumstances may rise so high that the polluter may choose to pay the fine, rather than attempt to buy emissions permits. To avoid this pitfall, governments may declare that the payment of a penalty does not release the agent from the obligation to reduce emissions. The entity in default must therefore also redeem the rights missing during periods of subsequent compliance.

2.2. Defining a cap and a commitment period (scope)

2.2.1. Scope of the EU ETS

The EU ETS was launched on 1 January 2005. The first trading period lasted 3 years until the end of 2007. This period was presented by the EU Commission as a 'learning-by-doing' phase designed to prepare for the second trading period. Beginning on 1 January 2008, the second phase is scheduled for 5 years until the end of 2012. An essential characteristic of this second trading period is that it coincides with the first commitment period of the Kyoto Protocol, during which the EU Member States and other industrialized countries must meet GHG emissions targets. Because the EU is a Party to the Kyoto Protocol, the cap imposed by the EU ETS does not strengthen the climate target of the EU nor does it directly create additional reductions. By setting a limit on its industry, the EU has an influence on the effort-sharing between categories of GHG emitters in Europe (covered industrial installations versus services, small industrial sites and individuals). Technically, the participation of the EU in a wider scheme (International Emissions Trading under Kyoto) means that every EU allowance (EUA) allocated to the industry is backed up by an assigned amount unit (AAU) under the Kyoto Protocol. EUAs are in fact tagged AAUs, which are tracked on two different registries (see below).

In the EU ETS, the ceiling for emissions is set individually for each installation within the scope of the Directive in the relevant national allocation plan. The total volume of the cap is therefore the sum of allowances allocated on a case-by-case basis at each installation.

The ETS covers installations performing specific activities. From the beginning, it has covered (above certain capacity thresholds) power plants and other combustion plants, oil refineries, coke ovens, iron and steel plants, and factories producing cement, glass, lime, bricks, ceramics, pulp, paper and paperboard. New sectors (including aviation) and gases will be included in the future.

2.2.2. Scope of the PCT

The target is rarely explicitly mentioned in the PCT literature, but in the UK most authors refer to the Climate Change Act which aims is to ensure that the net UK carbon account for all six Kyoto greenhouse gases for the year 2050 is at least 80% lower than the 1990 baseline. All reports written on PCT acknowledge the need for intermediary targets, for instance annually, but claim that a clear long-term signal is needed in order for individuals and corporations to adapt in a sustainable way.

In a similar vein to the EU ETS, it is worth mentioning that, while the UK/EU is part of a wider international emission trading scheme, unilaterally adopting a more stringent target would not

have a global environmental effect.[3] Adopting a stringent target on individuals will leave more room for emitters in non-covered sectors. In the EU this would mostly benefit small businesses, the commercial and service sectors, and other activities which would not fall either under the EU ETS or a PCT scheme.

There is no consensus between PCT researchers on the extent of the scope, with some considering that the scheme should only cover delivered energy use (heating, indirect emissions from electricity use, personal transport) and others arguing that aviation and other public transport should be included as well. While Bottrill (2006) argues that public transportation should be excluded for practical reasons, due to the high number of transactions and because effective public transport is an efficient way to reduce carbon dioxide emissions, recent work performed by the Carbon Limited project at the RSA has considered the inclusion of public transportation. Eventually a third argument could be advanced for the exclusion of public transport: the consumers are often not responsible for the level of emissions of the transportation company they use. For instance a passenger in the Paris metro is (indirectly) responsible for the release of $4gCO_2$/km (RATP, 2006). With the London underground this figure rises to $55gCO_2$/km (TfL, 2006). Since the energy efficiency of the underground engines is similar, the difference is mainly explained by the fuel mix of the electricity supplier (mostly fossil fuel in the UK versus nuclear power in France). The behaviours and climate change awareness of Londoners and Parisians have no influence in changing this pattern. For public transport, policies on transport companies and electricity suppliers are likely to be more successful than demand reduction measures. To a certain extent, the same argument could be use for every type of indirect emissions, and in particular for electricity and aviation. However, here the competition between different actors, associated with GHG emissions disclosure, could allow the consumers to choose the least carbon emitting option.

Depending on the scope considered (activities included and countries considered), the scheme will cover between one-third and one-half of CO_2 emissions (i.e. between 25% and 40% of GHG emissions).

As most proposals include electricity, it is important to recall that electricity is primarily an energy carrier with a relative rate of indirect (or embodied) GHG emissions. Consumers of electricity are not directly responsible for their level of emissions. We could hardly argue that the French or Swedish people are more environmentally minded or care more about energy efficiency than German or British people. However their per capita emissions from electricity use are up to six times lower due to their low-carbon-emitting power plants (nuclear in France, hydro and nuclear in Sweden). The implementation of an equal per capita scheme at the EU level would be likely to result in a transfer of allowances/wealth from countries with a carbon-intensive electricity grid (e.g. Poland, the UK, Germany) to countries with a less carbon-intensive electricity grid (e.g. France, Sweden, Belgium). Moreover, because electricity is already covered by the EU ETS, it is important to first understand how this system impacts on the choice of technologies, on the price of electricity, and on the profitability of the sector before including indirect emissions from electricity consumption in another cap-and-trade scheme. Note that a similar observation could soon be made with regard to aviation, since flights departing from or arriving to the EU will be covered under the EU ETS as of 2012. If certain aeroplanes are more efficient than others, a traveller can hardly choose based on this criterion due to the absence of easily available public information and lack of competition on some airline routes.

Finally it is worth mentioning that the scope of a PCT scheme does not offer the traceability that is inherently available from stationary installations. Some of the implications of this key difference are discussed in the Conclusion.

2.3. Allocating allowances

2.3.1. The EU ETS allocation method

For Phase I and II of the EU ETS, Member States draw up national allocation plans (NAPs), setting their total level of emissions under the scheme and the number of allowances allocated to each installation falling into the scope of the Directive located on their territory.

The environmental benefits of the first trading period were limited due to excessive allocation. In May 2006, when the publication of verified emissions data for 2005 highlighted this over-allocation, the market reacted by lowering the market price of allowances (Ellerman and Buchner, 2007). The price of the EUA during the first period never recovered and ended at 3 eurocents, resulting in the scheme being unable to influence the short-term strategic decisions of European operators in 2007.

The EU over-allocation average amounted to 2.5% of the total cap. Faced with criticism of the distortions in competition created by the 27 NAPs, the 27 national caps will be replaced by an EU-wide cap. This cap would be lowered in a linear manner from 2013. This means that NAPs will not be needed any more, as the Commission will allocate allowances on the basis of harmonized rules. A significantly higher share of allowances will be auctioned instead of allocated free of charge.[4]

2.3.2. The PCT allocation method

Allocation of emissions rights to citizens, while placing them under an obligation to share the responsibility of emissions reduction, would mark a major shift in the political economy of the environment (Brohé et al., 2009).

The existing proposals consider that allowances should be allocated on a per capita basis, i.e. each individual would receive an equal right to release carbon dioxide in the atmosphere. However, there is still a debate about whether children should receive a full allowance, no allowance, or a partial allowance depending on their age.

These allowances would have to be surrendered when individuals buy fossil fuel products (heating, personal travel) or any other activities included in the scheme. The choice of this (free) allocation method is mainly explained by the fact that most authors on PCT consider the '*contraction and convergence*' framework as the fairest and/or most promising way to reach a global agreement on climate change (Fawcett, 2005: 23).[5] These assumptions are, however, probably premature. A recent article by Starkey (2008) proposes an ethical discussion of the equal per capita allocation and concludes, based on extensive literature review and in-depth analysis of political philosophy works, that equality is not fairness. In particular, such a scheme would create conflicts between different groups of the population with different GHG emission profiles (urban vs rural, young vs old, parents vs non-parents). Clearly, someone living in an isolated house in Scotland would need more energy to heat their home and to travel than someone living in a flat in central London, in which case an equal per capita allocation might be unfair. The questioning of this major feature clearly weakens some of the presupposed social benefits of a PCT scheme.

2.4. Managing price volatility

2.4.1. Managing price volatility under the EU ETS

The management of price volatility has not been very successful during the first years of the EU ETS (Figure 1). Between January 2005 (launch of the scheme) and April 2006, when consolidated results of the first audit reports were released, the allowance price had been rising in a

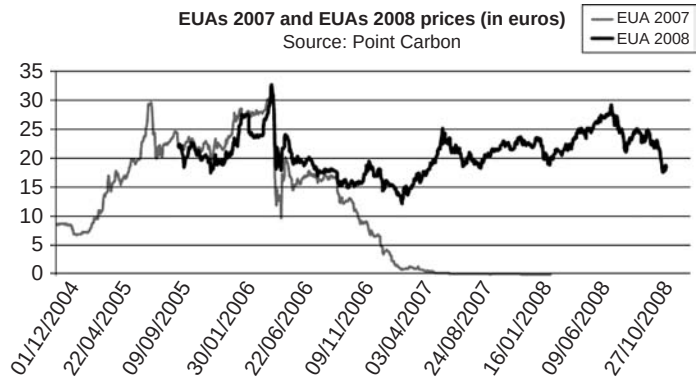

FIGURE 1 Managing price volatility under a PCT scheme.

quasi-continuous manner, essentially due to risk-averse behaviours from installations likely to have excess allowances, and speculative behaviours by brokerage firms or banks. The sharp increase in June 2005 was mainly due to the inactivity of hydropower in Spain and fears of a cold winter that had significantly increased the forward price of natural gas. The only significant decrease in 2005 (30%) was recorded in July 2005, when natural gas prices fell back, making gas more competitive than coal. This fall was amplified by the first rumours of over-allocation in the new Member States. The dramatic fall in prices, down to 3 eurocents at the end of 2007, was due to a problem of over-allocation. During the second period, the scheme was completed, with two measures to avoid such a scenario: allowing banking of Phase II allowances, and linking to the baseline and credit schemes implemented by the UNFCCC (CDM and JI).

With a PCT scheme, the carbon price could in theory rise without limit. However, the possibility of high allowance prices creates a number of social issues. For instance, high prices would exacerbate the impact on fuel poverty (Defra, 2008).

High prices for allowances would also cause disapproval, particularly if individuals are paying more for their allowances than businesses are through other trading schemes such as the EU ETS or the CRC energy efficiency scheme. High prices would also cause more absolute volatility and hence more uncertainty and risk for individuals. By setting a hard cap, the government would effectively transfer the risk and the cost of meeting their targets to individual households.

For these reasons, it is unlikely that a PCT scheme could be introduced with a hard cap, without a 'safety-valve' or buy-out mechanism. An option would be to link PCT with the EU ETS, thereby avoiding differing carbon prices. Alternatively the government could issue unlimited personal carbon trading allowances at the ceiling price.

2.5. Monitoring, reporting and tracking on a registry

2.5.1. Monitoring, reporting and tracking under the EU ETS

For monitoring of emissions, installations can choose between a method based on calculations and a method based on continuous measurement. In choosing the latter method, the operator must demonstrate the reliability of the method and have its choice approved by the competent authority, which means that in practice most installations in Europe calculate rather than measure their CO_2 emissions.

Monitoring and reporting of GHG emissions was already a common practice in the EU. Since 2001 almost 10,000 European facilities have had to monitor and report their pollutants emissions (including CO_2) on a European pollutant emission register (EPER).

In order to track exchanges of EUAs and meet the requirements of the Kyoto Protocol, it is mandatory for each Member State to have a national registry. These registries ensure accurate accounting for all units under the Kyoto Protocol plus accurate accounting for allowances under the EU ETS. Not only companies, but also individuals, may open an account anywhere in an EC registry. The Community Independent Transaction Log (CITL) records the issuance, transfer, cancellation and banking of allowances that take place in the registries (Halleux, 2006). The CITL currently manages the transfer of EU allowances, and since 2008 has been complemented by the International Transaction Log (ITL), which tracks the exchange of AAUs and other Kyoto units. For instance, from 2008, when a French company sells EUAs to a German company, an equivalent amount of AAUs is transferred from the French registry to the German one. The purchase of certified emission reductions (CERs) or emission reduction units (ERUs) by an installation covered by the EU ETS increases the amount of allowances available for the country in which the installation is located.

2.5.2. Monitoring, reporting and tracking under a PCT scheme

Even if monitoring and verification are the cornerstones of a viable and credible emissions trading scheme, very little research or analysis has been carried out on these issues in the PCT literature. A detailed analysis of the most complete reports on PCT (Starkey and Anderson, 2005; Roberts and Thumim, 2006; Redgrove and Roberts, 2007; RSA, 2007; Defra, 2008) reveals that none of them analyse monitoring in depth. It is foolish to believe that the market would automatically adjust to the desirable level of emissions without controls. A Californian household GHG cap-and-trade proposal (Niemeier et al., 2008) foresees that households would be informed of their actual emissions and remaining allowances through their monthly utility bill, while the annual verification and reconciliation between emissions and allowances would be managed by the State and utility companies on a yearly basis. If the amounts of emissions and collected allowances do not balance, then appropriate actions and fines would be issued to the utility service provider. This system appears more realistic and has lower set-up and operational costs than other PCT proposals. However, the scheme here is limited to emissions from the residential sector (gas and electricity).

In the PCT literature, a mandatory swipe card is often considered to be a suitable way to register all transactions. However, this is not necessarily the best option. A mandatory carbon swipe card is certainly not as evident and straightforward as a loyalty card, to which it has sometimes been compared, or an electronic ID card, to which it is less often compared by proponents of PCT, given the fierce debate on the introduction of ID cards in the UK.

Swipe cards are often considered as necessary because of a common (mis)interpretation that considers carbon credits as a new currency. A speech from David Miliband, former Secretary of State for the Environment, has resulted in this interpretation being widely encountered.

> Imagine a country where carbon becomes a currency. We carry bank cards that store both pounds and carbon points. When we buy electricity, gas and fuel, we use our carbon points, as well as pounds. To help reduce carbon emissions, the government would set limits on the amount of carbon that could be used (Miliband, 2006).

In practice 'carbon points' (allowances) are more a 'right' (that you have to pay or that you may sell according to your needs and wants, akin to property rights) than a currency. Unlike other units of exchange, the purpose of carbon allowances is not to facilitate the transfer of goods and/or services, and therefore the comparison with a currency is maybe not as insightful as it might first appear. Carbon allowances are permits which represent a right to emit. Currencies are used to facilitate the transfer of these rights but these rights in themselves cannot be described as a currency as their level is not linked to the creation of wealth by a nation (or a monetary union). Because of these misinterpretations, many researchers have considered that allowances should be redeemed by individuals at the point of sale of energy or transportation services. In practice, the experience of other existing emissions trading schemes predict only an annual reconciliation of emission and allowances, thereby significantly reducing the operating costs and the IT infrastructure.

Monitoring, reporting and verification are in fact key issues, given the high associated costs when numerous actors are involved. During the design process for the CRC energy efficiency scheme, a report by NERA (2006) concluded that administration and transaction costs would overcome the benefits of the policy if universal coverage of businesses was attempted. The report stated

> If all half-hourly metered sites were covered by the scheme without any exemptions for relatively small energy users, the administrative and transaction costs would be significant and would outweigh the energy-savings delivered by the scheme under most plausible scenarios (NERA, 2006).

A minimum electricity use of 6,000 MWh a year has been adopted for the CRC on the basis that administrative and transaction costs would be too large for smaller businesses in comparison with the anticipated energy savings that would be achieved. The question arises as to why this would not be the case for individuals, who use even less energy (most households consume less than 6 MWh annually).

2.6. Enforcement

2.6.1. Enforcement rules under the EU ETS

If an actor fails to meet its obligation and does not surrender a number of EU allowances equivalent to its emissions, it would be charged a penalty of €100 (€40 in Phase I). Note that this fine is a penalty for lateness of surrender and not a price ceiling, since it does not exempt the company in default from redeeming the missing allowances the following year.

2.6.2. Enforcement rules under a PCT scheme

Enforcement rules have not been described in great detail in any PCA proposal. Some authors have even argued that because the likely market value of allowances will be rather lower than many existing benefits and tax allowances, at least initially, the level of fraud-proofing would also be rather lower than expected (Roberts and Thumim, 2006).

3. Discussion and conclusions

Through the comparative analysis of different features carried out in the previous section (summarized in Table 1) we can now investigate some of the pitfalls which may arise during the implementation and running of a new emissions trading scheme so as to better understand the

TABLE 1 Comparative overview of the EU ETS versus PCT

	EU ETS	PCT
Scope	Limited number of sources. These sources are either stationary or traceable: +10,000 industrial sites (+ airline companies as of 2011) Emissions under EU ETS are already covered under Kyoto (EUAs are tagged AAUs)	Large number of sources. These sources are mobile (individuals) The definition of 'personal' needs to be refined Pending question regarding the inclusion of public transport Emissions under a PCT scheme are already covered under Kyoto. Emissions from electricity are also covered by the EU ETS (and emissions from aviation as of 2011) Double counting/pricing issue
Allocating allowances	Mostly allocated for free through grandfathering Political gaming and over-allocation Share of auctioning will increase during next periods	Allocation for free Pending questions regarding the allocation of allowances to children
Managing the price volatility	Banking not allowed between phase 1 and 2 → high volatility between trading periods Linked with baseline and credit schemes	No mechanism is defined to manage volatility. However, it is likely that a price cap would be needed to avoid perverse social effects (e.g. if the prices were too high to allow people to heat their homes)
Monitoring, reporting and tracking on a registry	High transactions costs (mostly verification) Annual reporting and verification	High transaction costs (mostly set-up costs) Real-time reconciliation
Reconciling and setting penalties for non-compliance	Financial penalties + obligation to surrender a number of allowances equivalent to the number of missing allowances before the next verification	Not defined yet

compatibility of both schemes. It is indeed important to keep institutional and political considerations in mind when evaluating policy instruments as, in practice, different policies will be more or less effective depending on the context in which they are applied. This analysis should clarify some misunderstandings on benefits and problems created by any ETS and the challenges posed by a scheme dedicated to individuals.

Going back to the scope, it is important to recall that with all EU Member States engaged in international emissions trading, the stringency of a cap on household emissions will not lead to additional emission reductions. It will mainly require a larger share of the reduction to take place

in the household sector (or ease the tasks of other sectors). This is why, in practice, it is unlikely that PCT will deliver an additional environmental benefit. It will only deliver a financial benefit where it delivers additional abatement that costs less than the cost of international abatement. Indeed the overall level of emissions across the EU is established by the European cap. Domestic abatement in the UK or another country adopting a PCT scheme will not affect the overall environmental outcome globally unless the EU cancels its excess of allowances.

With the EU ETS already implemented, EU countries which decide to implement a PCT scheme would face problems of:

- *Double regulation*: all electricity consumers could face two sets of carbon prices for the electricity they consume. After the inclusion of aviation within the EU ETS, the same would apply to this sector as well.
- *Double counting*: a single abatement action could lead to two separate carbon allowances being sold – one in each scheme (Sorrell and Sijm, 2003).

Partially overlapping trading schemes could also create inconsistent carbon prices across different fuel types and activities, hence creating stronger signals to reduce emissions from some fuel types rather than others. Overall this will result in inefficient abatement choices being made by individuals, and the cost of achieving its abatement targets will be higher for a country adopting a PCT scheme. Consider the case where electricity is counted in both the EU ETS and in the PCT scheme, whereas gas is only included in the PCT scheme. The EU ETS establishes a carbon price, most of which is passed onto consumers. As a result, there is a carbon cost included in the price of electricity. For gas, which is not covered within the EU ETS, there is no such effect. The PCT also sets a carbon price which will cover both gas and electricity. Therefore the overlap of the two trading schemes will establish a higher carbon price for electricity than for gas.

An important and probably more fundamental issue when discussing the scope of a PCT scheme comes from the meaning given to the adjective 'personal'. So far, various authors have given various definitions of what it means in practice (see the discussions on the inclusion of public transport). This loose definition poses a potential threat as an unclear classification between 'personal' and 'non-personal' (or 'professional') emissions could create significant carbon leakages from one category to another and threaten the effectiveness and fairness of the scheme. Indeed, with a non-negligible proportion of the population driving company cars or buying flights from business-to-business travel agencies, 'professional' emissions are likely to represent an important share among some people in high-income brackets. To some extent this could even challenge the assumption that the scheme is progressive. An unclear definition of 'personal emissions' could also provide leakage opportunities, where some individuals would avoid the costs of buying extra allowances by externalizing some of their emissions to non-personal areas which are also outside the EU ETS or CRC energy efficiency scheme. Taking a taxi, staying in a hotel, and flying with a corporate business jet are three activities which release carbon emissions but would remain outside the current proposals for a PCT scheme.

Another issue arises from the fact that people are by definition mobile, while an industrial site is stationary. How would a PCT scheme account for carbon emissions from non-EU (or non-British if the scheme were to be implemented in the UK only) citizens living in the EU (UK)? Conversely how would a scheme monitor carbon emissions from a British citizen who flies between Zurich and Washington? Clearly only a 'Big Brother'-like scheme linked to a GPS could track

carbon emissions from an individual. In the event that only emissions from planes departing from or arriving in the UK were accounted for in the scheme, this would be likely to boost international airports easily accessible from London (Dublin with a short-haul flight, Paris or Brussels by train) but would not necessarily reduce international travel by British people. Not addressing this monitoring issue satisfactorily would increase the risk of fraud or cheating behaviour. In the event that the price of carbon becomes so high that some households are unable to purchase fuel products through official channels, one can also fear the development of a black market, where people would illegally import fuels from areas where carbon emissions from individuals are not subject to the same level of pricing.

Linked to this traceability issue, the swipe card/real-time tracking of emissions/allowances would probably create more problems than it would solve. To date, no single emissions trading scheme has monitored/calculated emissions in real time, as the reconciliation of emissions with allowances occurs on an annual basis in most schemes. Clearly, the introduction of a swipe card would significantly increase the costs in comparison with an EU ETS-like approach of verification, while reducing the political acceptability of any PCT proposal. One must, however, note that a more widespread use of smart energy meters could resolve this issue for emissions from homes.

The question of whether PCT is a desirable climate policy is probably premature before a clear definition of 'personal' is agreed upon and solutions are found to prevent PCT avoidance through fiscal engineering. The presented analysis of current PCT proposals in light of other carbon trading schemes has led to the conclusion that including diffused and international emissions would be too complex and costly for a short- to medium-term implementation. Perhaps a good compromise would be to develop a scheme which focuses on residential emissions and where the credit transfers and reconciliation would be largely managed by utilities (see the Californian proposal in Niemeier et al., 2008). With such a scheme, households would directly make a link between energy saving measures, energy bills and carbon emissions, which would certainly increase the level of awareness and carbon literacy in general.

Finally, a better understanding how existing schemes work and can be improved can provide helpful lessons to policy-makers. Perhaps future research on PCT schemes should pay more attention to alternatives and existing policies. Policies are always the result of trade-offs and compromises between pressure groups and stakeholders; therefore analysing the interactions of PCT with other existing policies is probably needed in order to promote this idea as a practical and viable policy to solve the climate crisis.

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Notes

1. This is particularly the case in the UK where, next to the EU ETS a Carbon Reduction Commitment (CRC ENERGY EFFICIENCY SCHEME) scheme is being implemented for organizations that do not fall into the sectors covered by the EU ETS but who are sufficiently large to be significant energy users.
2. See Clover, C. 'Energy ration cards for everyone planned', *The Telegraph*, 3 July 2005; Black, R. 'CO_2: This time it's personal', *BBC News*, 29 November 2005; Adam, D. and Batty, D. 'Miliband unveils carbon swipe-card plan', *The Guardian*, 19 July 2006; McCarthy, M. 'Blair: Who says I'm not green?', *The Independent*, 18 November 2006;

Wintour, P. 'Miliband plans carbon trading 'credit cards' for everyone', *The Guardian*, 11 December 2006; Toynbee, P. 'This electric radicalism marries green politics with social justice', *The Guardian*, 15 December 2006; Shrubsole, G. 'This time it's personal', *The Guardian*, 8 August 2007.

3. This fact is likely to hold true in the coming decade, since both the UK and the EU, as signatories of the Kyoto Protocol, have agreed on reduction targets at the EU level until 2020 regardless of the outcome of COP-15 in Copenhagen.
4. Only 0.12% of the EUAs available in the first phase were auctioned (Brohé et al., 2009).
5. 'Contraction and convergence' represents a major shift from the Kyoto Protocol approach, where emissions rights are grandfathered, i.e. allocated proportionally to historical emissions (Meyer, 2000). This approach begins with the assumption that the atmosphere is a global common to which all are equally entitled, and focuses on sharing the use of the atmosphere (resource sharing). 'More specifically, the approach defines and allocates emission rights on the basis of a convergence of per capita emissions under a contracting global emission profile' (den Elzen et al., 2005).

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