Combining cap-and-trade with offsets: lessons from the EU-ETS

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Linking a cap-and-trade with an offset mechanism has many theoretical advantages: it reduces compliance costs, extends the price signal outside the cap-and-trade, and triggers technology transfer. However, it is feared that such linking will induce outsourcing of emissions reduction at a low price and undermine the price incentive in the cap-and-trade. The EU Emissions Trading Scheme (EU ETS) is the first full-scale example of a cap-and-trade system linked to project-based mechanisms such that offsets have effectively been used by industrial installations. This article is an ex post analysis of EU ETS data for the years 2008 and 2009, and the characteristics of the link and its efficiency are evaluated. Although offsets have been much used, their use is concentrated and not very intense or frequent, which allays the fear that offsets will flood the market. Although the majority of surrendered CERs effectively come from the largest and oldest projects, the credits surrendered are similar to those available on the market. Possible factors that contribute towards inefficiency are the rules for using offsets, transaction costs affecting the participation of small installations, awareness and openness to market-based instruments, and uncertainties regarding CERs offer and demand from other markets. However, the impact on EUA equilibrium price still needs to be quantified.

Keywords: cap-and-trade; Clean Development Mechanism (CDM); EU Emissions Trading Scheme; flexible mechanism; linking

En théorie le fait de lier le plafonnement-echanges avec un mécanisme de compensation présente de nombreux avantages: réduire le coût de conformité, étendre le signal prix à l'extérieur du périmètre de plafonnement-echanges, et déclencher le transfert de technologies. Cependant il est à craindre qu'un tel lien entraînera une délocalisation des réductions d'émissions à moindre coût et sapera l'incitation par les prix dans le système de plafonnement-echanges. Le SCEQE est le premier exemple généralisé d'un système de plafonnement-echanges lié aux mécanismes de projets par lequel les compensations sont effectivement utilisées par les installations industrielles. Cet article est une analyse ex-post de données du SCEQE pour les années 2008 et 2009, et les caractéristiques de ce lien et de son efficacité sont évaluées. Alors qu'il y a eu une utilisation importante des compensations, celle-ci est concentrée et ni très intense ni fréquente, ce qui permet d'apaiser la crainte d'un marché inondé par les compensations. Bien qu'une majorité des URCE délivrées proviennent effectivement des projets les plus larges et les plus anciens, les crédits délivrés sont similaires à ceux qui sont disponibles sur le marché. Parmi les facteurs possibles contribuant aux inefficacités, on compte les règles d'utilisation des compensations, les coûts de transaction affectant la participation des petites installations, la sensibilisation et l'ouverture aux mécanismes de marché, et les incertitudes liées à l'offre et la demande en URCE provenant d'autres marchés. Cependant, l'impact sur l'équilibre du prix du quota européen (« EUA ») doit encore être quantifié.

Mots clés : plafonnement-echange; mécanisme de développement propre (MDP); système communautaire d'échange de quotas d'émissions (SCEQE); mécanisme de flexibilité; lier

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1. Introduction

The EU Emissions Trading Scheme (EU ETS) is the first large-scale CO₂ emissions trading system in the world. It covers more than 10,000 industrial installations in 30 countries (EU-27, plus Norway, Liechtenstein and Iceland), which account for approximately 40% of EU GHG emissions. The aim of the EU ETS is to help Member States reach their Kyoto target (from 2008 to 2012) and (with the 20-20-20 targets, also known as the ‘climate and energy package’, becoming law in December 2008) to help meet the European target of a 20% GHG emissions reduction in 2020 relative to 1990 levels (see EC, 2003; European Parliament and the Council of the EU, 2009a, 2009b). The EU ETS has three phases: 2005–2007 (Phase I), 2008–2012 (Phase II, which coincides with the commitment period of the Kyoto Protocol) and 2013–2020 (Phase III). Each period sets a total cap on EU ETS emissions, which determines an emissions target, materialized as tradable permits. In Phases I and II, the permits are allocated every year to stationary sources, mainly free of charge, on the basis of historical emissions corrected by an effort factor. The covered installations must surrender as many permits each year as they have verified emissions. Installations can keep unused permits to use at a later date (known as ‘banking’) with the exception that unused Phase I permits cannot be used in Phase II. They are also implicitly allowed to borrow allowances from the next year, up to the amount of next year’s free allocation (with the exception that allowances from Phase III cannot be borrowed in Phase II).

In Phase II, EU allowances (EUAs; the CO₂ permits associated with the EU ETS) are conversions of Assigned Amount Units (AAUs), which are the permits allocated to Annex B Parties of the Kyoto Protocol. Annex B Parties can use emissions credits from project mechanisms in the emissions trading system associated with the Kyoto Protocol. Since the introduction of the ‘Linking Directive’ (2004/101/EC) in 2004 (European Parliament and the Council of the EU, 2004), industrial installations covered by the EU ETS are similarly allowed, with some qualitative and quantitative restrictions, to meet part of their emissions reduction targets with Kyoto offsets, such as the Certified Emissions Reductions (CERs) of the Clean Development Mechanism (CDM) and Emissions Reductions Units (ERUs) of Joint Implementation (JI) (see Articles 6 and 12 of the Kyoto Protocol, UN, 1998; European Parliament and the Council of the EU, 2004). The advantages and disadvantages in establishing a link between cap-and-trade and project-based mechanisms (e.g. Flachsland et al., 2009) are cautiously examined by policy designers (e.g. Ramseur, 2008). From a global design point of view, this link extends the price signal of the cap-and-trade to other sectors and other regions of the world and is intended to trigger transfers of low-carbon technologies and good practices outside the cap-and-trade boundaries for as long as the reductions obtained are less expensive than the EUAs themselves.

However, the main advantage of linking cap-and-trade with offset mechanisms is that it lowers the compliance cost of installations inside the cap-and-trade. Although this direct effect on compliance cost only benefits those installations that use offsets, it induces an additional cost-saving effect for all installations because it lowers the demand for cap-and-trade allowances and thus their price.

The main argument for establishing a link between the EU ETS and the Kyoto Protocol’s project-based mechanisms, which was clearly stated prior to the Linking Directive in the European Commission’s impact assessment (EC, 2003), is that it reduces cost.

It is also feared that linking cap-and-trade with an offset mechanism will induce negative effects. There are at least four problems associated with the incorporation of offsets into a cap-and-trade system (Olander and Murray, 2008): (i) damage to the integrity of the cap (e.g. when offsets are not real, that is, are not additional emissions reductions), (ii) money flows to foreign countries, (iii) negative co-effects in host countries, and (iv) the outsourcing of emissions reductions (e.g. because emissions reductions first occur where they are least expensive, the cap could be met without any reduction in participants’ domestic emissions).
The first three problems are not discussed here. The fourth problem, the outsourcing of emissions reductions, was clearly a concern when both the Kyoto market and the EU ETS were designed. In both cases it was declared that the majority of the emissions reduction effort must be reached domestically. To satisfy this requirement, the establishment of a limit on the authorized use of offsets for Annex B Parties and EU ETS installations was agreed, so that cap-and-trade participants could partially benefit from the cost reduction effect of offsets without preventing the implementation of domestic actions. (Emissions trading was agreed to be ‘supplemental’ to domestic action, see Article 17, UN, 1998.)

This agreement is of interest, because the underlying assumption is that offsets would naturally be much less expensive than allowances and would be used on a very large scale. In the case of the EU ETS, the assumption implies that the limit on the use of offsets would be reached due to its cheaper price. This raises the question of whether there is in fact any evidence that offsets will flood the market and undermine the price-related incentive for domestic emissions reduction.

The EU ETS has been in operation since 2005 and was actively developed in Phase I (Ellerman et al., 2010). However, CERs were not used in Phase I of the EU ETS because of surplus allowances, which made the EUA price drop progressively to zero after May 2006. ERUs were not created until 2008 and so were not available during Phase I. Indeed, although the possibility of using offsets has been available since 2005, they were not first used until the beginning of Phase II.

Data for the years 2008 and 2009 have been used in this article. During this period, the EU ETS was linked to the CDM and JI, and credits were used by industrial installations (a little above 80 Mt or 4% of emissions in the EU ETS each year). The data for 2010 were disclosed during the writing of this article and are therefore not included here. Nevertheless, the first two years of data constitute a base for comparison with later years, mainly because they are free of any effect related to the decision of the European Commission to restrict the use of certain offsets from 2013 onwards.

The main aim here is to quantify the \textit{ex post} effects of the Linking Directive, and to evaluate whether offsets have been effectively used both on a large scale, up to the authorized limit, and by all installations, in a frequent and intensive way. To date, this kind of analysis has been very rare (an important exception is the work done by Sandbag, an NGO; Elsworth and Worthington, 2010). In order to be concise and because their use in the EU ETS has been relatively small (48,000 t in 2008, 3.5 Mt in 2009), ERU offsets from the JI were excluded from the analysis. This is a notable limitation of the present study, because larger volumes of ERUs will become available before the end of the commitment period of the Kyoto Protocol in 2012.

In Section 2 the regulatory framework for using offsets in the EU ETS in terms of quantity, quality and timing (factors that can directly impact the nature of the demand for offsets) is explained, and the main characteristics of the offset offer originating from CDM projects are described. In Section 3, an overview of the use of CERs in the EU ETS, based on surrendered units data, is provided. The main characteristics of such units in the EU ETS, and how they compare to the CERs that were available at the time, are presented, and the direct savings realized by installations are estimated. In Section 4, the use of CERs at the installation level in terms of intensity, frequency and concentration, by sector, size and position (deficit or surplus of allowances) is analysed. It is concluded in Section 5 that although there has so far been a significant use of offsets, this is concentrated but not very intense or frequent, which allays the fear that they will flood the market. Four factors that contribute towards inefficiency are identified, and further relevant issues are discussed.

2. The frame for using offsets

The rules for using offsets in the EU ETS are stated in the ‘Linking Directive’ of 2004 (European Parliament and the Council of the EU, 2004). The process is decentralized. The percentage of offsets allowed
is expressed as a share of each installation’s allocation, and is determined separately by each Member State at the beginning of the relevant phase. This percentage must be compatible with the relevant Member State’s Kyoto Protocol commitments if it is to be accepted by the European Commission.

Installations covered by the EU ETS must follow a compliance process. At the beginning of the year, each installation receives a free allocation consisting of EUAs. Emissions over the year must be monitored and verified. The following year (before the end of April), installations must surrender as many allowances as there are verified emissions in the previous year. It is at this stage that CERs and ERUs can be used instead of EUAs to match verified emissions.

2.1. Qualitative limits on the use of offsets
In Phase II of the EU ETS, most types of offsets are accepted, with the exception of CERs and ERUs generated from nuclear facilities and temporary offsets resulting from land use, land-use change and forestry activities (European Parliament and the Council of the EU, 2004). (Note that there are also some restrictions on large hydro projects.) These project types represent a very small share of the offers potentially available for the EU ETS in Phase II. However, the recent restrictions on industrial gas credits, which are to apply only to Phase III, may have consequences (to be discussed in Section 2.4) for the use of offsets in Phase II.

2.2. Quantitative limits on the use of offsets
The majority of emissions reductions induced by the Kyoto Protocol and the EU ETS must be realized domestically. To satisfy this requirement, the amount of offsets that can be used by operators is limited to a certain percentage of the conventional allocations. On average, installations can surrender offsets from the project mechanisms of the Kyoto Protocol up to 13.5% of allocations, which represents around 1450 Mt in the period 2008–2012. The limits are specified in the different National Allocation Plans for Phase II and vary from 0% (in Estonia) to 20% (Germany, Spain, Norway and Lithuania) of allocated allowances (EC, 2006). Owing to the fact that the limit of use is expressed as a share of allocations, the quantity of offsets allowed is larger in the major emitting Member States. For example, installations from Germany are permitted to use a total of 450 million offsets over Phase II, more than a quarter of the total volume of offsets allowed in Europe itself. Seven EU Member States (Germany, Spain, Italy, France, Poland, the UK and the Czech Republic) account for more than 75% of the total limit of use (see Table 1).

2.3. Variability of the authorized use of offsets over time
Although the limit of 1450 Mt of emissions is set over the relevant phase, Member States can decide to establish annual limits of use. Limits can also differ across sectors for each country. For example, although the limit in the UK is set annually, UK installations may bank any unused limit for the next year; moreover, the percentage allowed for large electricity producers is slightly higher than other sectors (DEFRA, 2007).

The rules differ significantly between countries. Consequently, there is a great amount of spatial and temporal variability in the potential demand for offsets in the EU ETS. Three factors have an impact on determining the maximum quantity of offsets for each country that can be used every year: (i) how industries are treated, (ii) how much banking of the unused annual limit occurred, and (iii) how much borrowing of next year’s annual limit occurred. In 16 countries, representing 160 Mt (56%) of the average annual potential offset use, installations have full flexibility, that is, one limit for the relevant phase as a whole (Table 1).
This lack of harmonization in the rules may lead to imperfect information for market actors as it is very difficult for anybody to determine exactly the level of offsets used by other actors. This makes the interpretation of data at the installation level more complicated.

### 2.4. Limits for Phase III and implications in Phase II

In order to give installations more flexibility, the revised Directive for Phase III enables them to engage in banking, that is, use any unused portion of their Phase II limit in Phase III. This surplus is to be added to any additional Phase III limit, which is decided by Member States of the EU and the

| Country          | Authorized use (in % of allocation) | Corresponding amount over the phase (Mt) | Banking the limit | Borrowing the limit |
|------------------|------------------------------------|------------------------------------------|-------------------|---------------------|
| Austria          | 10.0                               | 15.4                                     | Yes               | Yes                 |
| Belgium          | 9.1                                | 24.6                                     | –                 | –                   |
| Bulgaria         | 12.5                               | 26.5                                     | –                 | –                   |
| Cyprus           | 10.0                               | 2.7                                      | Yes               | Yes                 |
| Czech Republic   | 10.0                               | 43.4                                     | Yes               | Yes                 |
| Denmark          | 17.0                               | 20.8                                     | Yes               | Yes                 |
| Estonia          | 0                                  | 0                                        | –                 | –                   |
| Finland          | 10.0                               | 18.8                                     | Yes               | Yes                 |
| France           | 13.5                               | 89.6                                     | Yes               | Yes                 |
| Germany          | 20.0                               | 453.1                                    | Yes               | Yes                 |
| Greece           | 9.0                                | 31.1                                     | Yes               | Yes                 |
| Hungary          | 10.0                               | 13.5                                     | No                | No                  |
| Iceland          | –                                  | –                                        | –                 | –                   |
| Ireland          | 10.0                               | 11.1                                     | Yes               | Yes                 |
| Italy            | 15.0                               | 151.2                                    | Yes               | No                  |
| Latvia           | 10.0                               | 1.7                                      | No                | No                  |
| Liechtenstein    | –                                  | –                                        | –                 | –                   |
| Lithuania        | 20.0                               | 8.8                                      | No                | No                  |
| Luxembourg       | 10.0                               | 1.3                                      | Yes               | Yes                 |
| Malta            | 10.0                               | 1.1                                      | –                 | –                   |
| Netherlands      | 10.0                               | 42.9                                     | Yes               | Yes                 |
| Norway           | 20.0                               | 15                                       | Yes               | No                  |
| Poland           | 10.0                               | 104.2                                    | Yes               | No                  |
| Portugal         | 10.0                               | 17.4                                     | Yes               | Yes                 |
| Romania          | 10.0                               | 38                                       | Yes               | Yes                 |
| Slovakia         | 7.0                                | 11.4                                     | Yes               | Yes                 |
| Slovenia         | 15.8                               | 6.6                                      | Yes               | Yes                 |
| Spain            | 20.6                               | 156.8                                    | Yes               | No                  |
| Sweden           | 10.0                               | 11.4                                     | Yes               | Yes                 |
| UK               | 8.0                                | 98.5                                     | Yes               | No                  |

Source: Compiled from European Commission and National Allocation Plans for Phase II (2008–2012).
European Commission, with regards to international negotiations and to the level of the European economy-wide reduction target for 2020. Installations of the EU ETS are thus free to spread the use of their Phase II limit as they like over the period 2008–2020. However, as stated above, they are not allowed to borrow allowances from Phase III for use in Phase II. The quantity of offsets accepted in Phase III will thus be around 1450 Mt minus the limits used in Phase II plus any new limit accepted by its end.

In 2011, the European Commission also added qualitative restrictions to the use of offsets in Phase III (EC, 2011). From 2013 onwards, offsets that correspond to emissions reductions from HFC-23, and N₂O from adipic production, will no longer be authorized for use in the EU ETS. One immediate consequence is that it provides an incentive to use these offsets (which represent more than 70% of credits so far issued) in Phase II, while they are still valid.

The first communication about this restriction was a statement in August 2010 by Connie Hedegaard, a member of the European Commission, 8 months before the compliance deadline (the end of April 2011) of EU ETS installations for the year 2010 (Hedegaard, 2010). The 2010 compliance data may thus show the effects of these restrictions in Phase II. Although these data are not included in the present article, the incentivizing effect of the restrictions has already been noted by Trotignon and Stephan (2011), who argue that the restrictions on HFC-23 and adipic N₂O credits from 2013 have generated a substantial increase in the use of offsets in 2010, due to both the aforementioned incentive and the perception of an increased risk linked to the rules that will govern the use of credits. The analysis of the 2008 and 2009 data presented in this article is free of this incentivizing effect and can therefore be used to compare with further research that includes 2010 data.

2.5. Price spread is an incentive to use as many offsets as possible

As long as the price of an offset is below the price of an EUA, all installations have an incentive to use as many offsets as possible over the time period, either as a cheaper alternative to buying EUAs or to free up EUAs, which can then be sold or banked. The gain in both cases is the difference (i.e. spread) between the EUA and offsets prices (see Mansanet-Bataller et al., 2011, regarding the determinants and evolution of this spread). Offsets can be bought on the market (secondary CERs) or indirectly by financing a CDM project (primary CER market). Offsets have been cheaper than EUAs since the inception of the secondary market for CERs, so all installations have had an incentive to surrender as many offsets as they are allowed. The price spread is not constant over time, so the incentive to use offsets for installations is variable. (As discussed in Section 1.2, most installations have the flexibility to decide when to use the option value of surrendering an offset during the phase.) An installation’s actual use of offsets depends on both the current and expected spreads between EUA and offset prices.

2.6. The offer of offsets: observed and forecasted CER issuance

There can be no use of offsets without offsets. The UN provides information on existing projects and offsets issuance every month, and a summary table is made available (UNEP Risoe, 2010). At the time of writing there are more than 6500 different projects, 802 of which are implemented and regularly issue offsets. Most offsets come from industrial gases activities and renewable energy projects (the reduction of hydrofluorocarbon (HFC) and N₂O represents 75% of the cumulated offsets issued in 2009 and 2010, while Wind and Hydro represent 10%). In terms of location, most CERs come from emerging countries: China (representing nearly 50%), India, South Korea and Brazil together account for 90% of the cumulated issued CERs in 2008 and 2009.

The amount of CERs issued does not directly indicate the number of CERs available for compliance in the EU ETS, because there are other sources of demand for offsets: the Kyoto Protocol’s international
market (for Annex B Parties), and the regional or voluntary markets. Real offset demand from the Kyoto international market is hard to estimate because CERs are substitutes for AAUs (which can be less expensive and are readily available due to the global surplus in the Kyoto international market). Demand from regional and voluntary systems is also very difficult to quantify.

Table 2 summarizes the quantities of CERs generated by CDM projects and those that are potentially available for EU ETS installations. It shows that the quantity of offsets available in 2008 and 2009 is low, and probably lower than the average annual limit if taking demand from other markets into account. The cumulative total offer of CERs at the end of the Phase II compliance period (in April 2013) is inferior to the authorized 1450 Mt limit. There is therefore a high probability that there will not be enough CERs to meet the maximum limit of use before 2012. However, ERUs could also be used to meet this cap; although their volumes were very small in 2008 and 2009, they have, since 2010, been more readily used and available (Trotignon and Stephan, 2011).

### 3. Overview of CER use in the EU ETS based on surrendered units data

#### 3.1. Presentation of the Community Independent Transaction Log (CITL) data

In the EU ETS, compliance is recorded in accounts associated with each emitting installation, which are maintained in registries. In the case of the CITL, which is the central registry for the EU ETS, these accounts record the annual allocation of allowances to installations, their emissions for the year, and the number of allowances surrendered for compliance (EC, 2010). In addition, the registry of origin for every surrendered allowance is reported. Regarding Kyoto offsets, the project identifier and country of origin (i.e. the project’s host country) of each surrendered offset is reported. These installation-level data can then be aggregated by ETS sector, country, size and so on.

#### 3.2. Main characteristics of CERs surrendered in the EU ETS

In 2008 and 2009, 170 million CERs were surrendered for compliance in the EU ETS (a little bit more in the former than in the latter), that is, approximately 4% of allocations or one-third of the average annual limit of use. The number of installations using at least one CER increased from 2008 to 2009, as did the number of projects of origin (see Table 3).

Are surrendered offsets similar to those issued (i.e. the potential offer)? It seems so – the subset of offsets used for compliance in the EU ETS reflects the offer in terms of project types and host countries (albeit with slightly more HFC and Indian projects and fewer Hydro and Wind projects). No preference in the treatment of operators towards certain offset types or host countries is therefore revealed.

The use of offsets also follows the evolution of the offer over time, as indicated by the registration and first issuance dates of projects from which surrendered offsets came. In both 2008 and 2009, the offsets came from projects registered, on average, 3 years before the surrender deadline, although in

### TABLE 2  CERs generated by CDM projects and potentially available for EU ETS installations

|                      | 2008 (until end-April 2009) | 2009 (until end-April 2010) | 2012 (projected until end-April 2013) |
|----------------------|-----------------------------|-----------------------------|--------------------------------------|
| Total CERs issued (cumulated) (Mt) | 280                         | 407                         | 1000–1200                            |
| Share of industrial gases offsets (%) | 76                          | 75                          | –                                    |
2009 more offsets came from younger projects. This shows that the offsets used in the EU ETS have matched the largest spectrum of CDM projects (from the earliest projects to the oldest). Moreover, the time between the issuance of an offset and its use in the EU ETS can be very short (less than 3 months in some cases), which suggests that operators can react quickly to changes in the issuance.

### 3.3. How much money has been saved?

Savings can be attributed to offsets. The major impact of using CERs is to lower the demand for EUAs, thus lowering the equilibrium price on the EUA market. These savings are theoretically spread across all installations (due to lower opportunity costs). The total cost saving that results from this effect is difficult to estimate and, although this question deserves attention, it is not the purpose of this article.

Another cost saving due to offsets is the benefit from the EUA–CER price spread when surrendering CERs instead of EUAs. This saving is more direct, but benefits a smaller number of installations. A back-of-the-envelope calculation of these savings consists in multiplying the volume of offsets used by the average EUA–CER spread over the period. Table 4 gives an average of €280 million saved over the first 2 years of Phase II. This method assumes that installations buy CERs on the secondary market (note that savings would probably be higher for installations whose offsets were gained from financing a project). In any case, the total benefit is somewhat small compared to the total value of allowances (around €30 billion annually).

### Table 3 General picture of CERs use in the EU ETS in 2008 and 2009

|                | Volume of CERs surrendered (Mt) | As % of allocation | Number of installations that surrendered CERs | Number of different projects of origin |
|----------------|----------------------------------|--------------------|---------------------------------------------|---------------------------------------|
| 2008           | 86.9                             | 4.4                | 1758                                        | 176                                   |
| 2009           | 83.5                             | 4.3                | 1855                                        | 405                                   |
| Total          | 170.4                            |                    |                                             |                                       |

Source: Calculated from EC (2010) and data for May 2009, May 2010 and November 2010, UNEP Risoe (2010).

### Table 4 Estimated direct EU ETS benefit from using CERs

|                              | 2008       | 2009       | Total  |
|------------------------------|------------|------------|--------|
| CERs used (Mt)               | 86.9       | 83.5       | 170    |
| Maximum EUA–CER spot prices spread (EU/t) | 4.09      | 2.28       |        |
| Minimum EUA–CER spot prices spread (EU/t)   | 0.35      | 0.83       |        |
| Average EUA–CER (arithmetic mean of daily spot spreads) | 1.96      | 1.35       |        |
| Estimated EU ETS benefit (EU€ millions)       |           |            |        |
| Maximum                                   | 355        | 190        | 546    |
| Minimum                                   | 30         | 69         | 100    |
| Average                                   | 170        | 113        | 283    |

Source: Calculated from BlueNext and EC (2010).
A complete utilization of the authorized amount of offsets would in theory induce a high frequency and intensity of use among installations. In this section, the use of CERs is analysed at the installation level by category of installation (e.g. sector, size and position) in terms of frequency, intensity and specific intensity. Tables 5–7 represent the frequency, specific intensity and intensity of CERs use by sector, size and position, respectively.

The ‘frequency’ of use of CERs is the number of installations in the category (sector, size or position) that surrendered at least one CERs unit for compliance divided by the total number of installations in that category. It represents the awareness of a category for project-based mechanisms and compliance cost minimization. The ‘specific intensity’ of the use of CERs is the sum of CERs surrendered by category (sector, size or position) divided by the sum of allowances (all types aggregated) surrendered by installations that surrendered at least one CER unit. It represents the average importance of CERs use for those installations that surrendered offsets. From the specific intensity and frequency indicators, the average ‘intensity’ of use for all installations (taking into account installations that

### TABLE 5 Frequency, specific intensity and intensity of CERs use by sector, 2008 and 2009 combined

| Sector              | Frequency (%) | Specific intensity (%) | Intensity (%) |
|---------------------|--------------|------------------------|--------------|
| Combustion          | 17           | 12                     | 4            |
| Refineries          | 26           | 11                     | 3            |
| Coke ovens          | 20           | 6                      | 5            |
| Metal ore           | 22           | 16                     | 1            |
| Iron and steel      | 14           | 19                     | 6            |
| Cement              | 29           | 13                     | 4            |
| Glass               | 10           | 27                     | 3            |
| Ceramics            | 22           | 25                     | 7            |
| Paper and board     | 21           | 19                     | 7            |
| Opted-in            | 4            | 11                     | 0            |
| Total               | 18           | 13                     | 4            |

Source: Calculated from EC (2010).

### TABLE 6 Frequency, specific intensity and intensity of CERs use by size, 2008 and 2009 combined

| Size (t/yr) | Frequency (%) | Specific intensity (%) | Intensity (%) |
|------------|--------------|------------------------|--------------|
| <25,000    | 13           | 29                     | 5            |
| <50,000    | 22           | 22                     | 5            |
| <100,000   | 29           | 16                     | 5            |
| >500,000   | 30           | 11                     | 4            |
| Total      | 18           | 13                     | 4            |

Source: Calculated from EC (2010).
surrender no offsets at all) is derived. This ‘intensity’ represents the average level of offset use among all installations (if offsets are a central piece for compliance, or just used as a little bonus).

### 4.1. Intensity and frequency of CERs use by category of installation

A little less than 20% of installations surrendered at least one CER unit for compliance in 2008 or 2009. The main results of this analysis allow us to characterize this use.

Table 5 shows that the use of CERs is quite frequent and stable in all sectors, and most frequent in the cement and refinery sectors. CER intensity is relatively small and constant across all sectors (4% on average), with the most intense use being in the paper, ceramics and iron and steel sectors. Despite the popular view that power companies are used to trading and market arbitrage, the combustion sector does not stand out. However, the combustion sector is by far the largest of those of the EU ETS (both in the number of installations and in the volumes of allocation) and includes a wide range of installations from small-scale externalized combustion for industries to large-scale electricity plants. (This may explain why figures for the combustion sector are close to the European average.)

The size of the installation matters in terms of frequency. Smaller installations are clearly using CERs less frequently than the others (see Table 6). One-third of installations representing more than 500,000 t/yr surrendered at least one CER, but only one-tenth of installations representing less than 25,000 t/yr did so. This difference can be explained by market awareness, the relative size of benefits that depend on the total volume of offsets surrendered, and the potential transaction costs associated. Even if the size of the installation does not seem to matter in terms of intensity, smaller installations tend to surrender a slightly larger share of offsets compared to big installations. This is striking in terms of specific intensity (see Table 6) as this confirms both (the claim made above) that smaller installations have an incentive to surrender as many offsets as possible to get a reasonable benefit (because the limit of use depends on allocation allowances and is thus very small in volume), and that small installations can face significant barriers when willing to participate in trading (Jaraite et al., 2010).

An installation’s position (emissions greater or less than allocation) has no clear effect, as shown by Table 7. This might be surprising given the asymmetry between long (emissions < allocation) and short (emissions > allocation) installations: short installations must find allowances or offsets if they are to be compliant, whereas long installations can, but are not required, to sell surplus permits. Indeed, long installations have surrendered more CERs in terms of intensity than short installations. Installations have not used offsets in order to be compliant but rather have used them as a way of minimizing the total cost of compliance. In theory, this was to be expected. Of those installations that surrendered CERs, almost two-thirds are long installations. This clearly shows that installations swapped out CERs in order to engage in banking (i.e. selling EUA surpluses), thus benefiting from the EUA–CER price spread.

|          | Frequency (%) | Specific intensity (%) | Intensity (%) |
|----------|---------------|------------------------|--------------|
| Long     | 16            | 16                     | 5            |
| Short    | 19            | 10                     | 3            |
| Total    | 17            | 12                     | 4            |

Source: Calculated from EC (2010).
Of the factors tested, the size of installations is by far the strongest driver for CERs use in the EU ETS, even though in terms of intensity their use is more or less equally spread, whichever factor is considered (i.e. sector, size or position).

4.2. Country-level use of CERs
As explained in Section 2, the limit on the use of offsets by each Member State is expressed as a percentage of an installation’s free allocation. The majority of the demand for offsets comes from the countries that have emitted the most and thus that have allowed a high percentage of offset use. For example, Germany is the highest emitter and has agreed a 20% use of offsets; it has by far the highest total demand for offsets (32% of the total), followed by Spain and Italy (both 11% of the total).

The way CERs have been used effectively reflects this situation. Installations in Germany surrendered 31% of the total offsets used over 2008–2009, followed by Spain (16%) and Italy (10%). In some countries, such as Spain or Portugal, the use of offsets is more intense (close to the average annual limit) than in others. This is particularly the case in many of the new EU Member States, such as Latvia, the Slovak Republic, Hungary and Poland. It should be noted, however, that comparing these results with the figures presented in Table 1 does not allow a conclusion to be drawn on the possible effects of the time-flexibility left to installations.

4.3. Concentration of CERs use
It is an important feature of observed CERs use in the EU ETS so far that the majority of it results from the behaviour of a small number of actors. The use of CERs has been more concentrated among installations than emissions. In total, 70% of CERs have been surrendered by only 10% of those installations that surrendered them (only 1.5% of all installations). The use of offsets was even more concentrated in 2009, when 80% of the CERs have been surrendered by 10% of installations that surrendered them.

What is the link between the 1800 installations that used offsets and the 400 projects of origin of these offsets? A large majority of installations (over 60%) surrendered offsets that came from a single project, and less than 3% of installations surrendered offsets that came from more than 20 different projects. The record is held by a power station in Berlin, which surrendered 1.25 million CERs in 2009, from a total of 135 different projects. This is not very surprising given that large installations have to diversify the sources of their offsets in order to gather the quantity needed. Because of the smaller volumes of CERs involved, smaller installations will reach their limit of use quicker.

Another way to look at the concentration of CER final flows is to consider the number of different installations that surrender offsets that come from the same projects: 5% of the projects of origin have had their offsets surrendered by more than 50 different installations.

The offer of offsets is also very concentrated. Table 8 details the top 10 projects of origin from which offsets were used in the EU ETS. These 10 projects represent more than 65% of CERs surrendered in the EU ETS. Three lessons for the EU ETS are suggested. First, the major sources of offsets to the EU ETS are projects that were registered long before the time offsets were required for compliance. Projects need time to generate large amounts of offsets. HFC and N₂O projects are large and were among the first and least expensive to be developed. Second, a large share of the offsets issued by these old and large projects have already been used in the EU ETS (55%, on average, for the top 10 projects). This implies that if the demand for offsets grows over the years, many smaller projects will be required to replace the disappearing stock of offsets from large and old projects. Third, large chunks of offsets were eventually found divided among a diverse number of installations, which indicates that the secondary market is useful for, and used by, EU ETS operators.
5. Conclusions

5.1. Global efficiency of CERs use

If the linking of the EU ETS with an offset mechanism were completely efficient, one would find evidence that offsets were used on a large scale; that is, significant volumes of offsets would be transferred from a large number of projects to a large number of installations, independently of their sector, size or position. Moreover, one would find that the limit to use offsets was fully exploited at the end of the phase. The ex post analysis of CERs use in the EU ETS presented here allows us to partially determine whether linking EU ETS with an offset mechanism is (i) completely efficient and (ii) fully exploited, and to draw four conclusions.

Offsets have been much used in the first two years of the EU ETS, with more than 40% of offsets issued before May 2010 surrendered in the EU ETS. A large share of the offsets’ final flows moves from the major sources of offsets to the countries with the higher limits of use. Despite the economic crisis and the consequent drop of demand in the EUA market, installations have used as many offsets in 2009 as in 2008. This confirms the economic theory, despite the asymmetry between the longs and the shorts, and reveals that EU ETS installations do indeed recognize opportunity costs: the evidence shows that long installations actively swapped CERs to bank or sell EUAs.

The use of offsets is concentrated although not yet very intense or frequent: results vary across categories of installations. However, the combustion sector does not stand out (as one might have expected). The installation-level analysis shows that smaller installations have faced higher relative barriers (i.e. a less frequent but more intense use of offsets), whereas a few big installations have surrendered a large share of the total offsets (i.e. the use of offsets was more concentrated than the emissions). For the European limit to be reached, all installations should individually use the maximum amount of

### TABLE 8 Top 10 projects from which offsets used in the EU ETS originated (2008 and 2009 combined)

| ID  | Host country | Type | First issuance | Total CERs issued in May 2010 (Mt)$^b$ | Share of issued CERs surrendered in the EU ETS (%) | Share of the project in total CERs used in the EU ETS | Number of installations which surrendered at least one offset from this project |
|-----|--------------|------|----------------|----------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|
| 99  | S. Korea     | N₂O  | 24 Nov 06      | 38.7                                   | 52                                              | 12% (20.2 Mt)                                   | 593                                             |
| 1   | India        | HFC  | 10 Apr 06      | 25.4                                   | 67                                              | 10% (17.1 Mt)                                   | 445                                             |
| 232 | China        | HFC  | 1 Jun 07       | 24.1                                   | 70                                              | 10% (16.9 Mt)                                   | 261                                             |
| 115 | India        | HFC  | 16 Jan 06      | 16.5                                   | 65                                              | 6% (10.8 Mt)                                    | 355                                             |
| 306 | China        | HFC  | 12 Apr 07      | 28.0                                   | 37                                              | 6% (10.4 Mt)                                    | 306                                             |
| 116 | Brazil       | N₂O  | 5 Mar 07       | 21.3                                   | 45                                              | 6% (9.6 Mt)                                     | 283                                             |
| 11  | China        | HFC  | 3 May 07       | 23.9                                   | 38                                              | 5% (9.0 Mt)                                     | 381                                             |
| 1238| China        | N₂O  | 28 Jul 08      | 13.0                                   | 60                                              | 5% (7.8 Mt)                                     | 295                                             |
| 550 | China        | HFC  | 20 Aug 07      | 12.6                                   | 51                                              | 4% (6.5 Mt)                                     | 87                                              |
| 868 | China        | HFC  | 18 Jun 08      | 10.9                                   | 59                                              | 4% (6.4 Mt)                                     | 204                                             |

Notes: $^a$The first non-HFC/N₂O project in this list is the 13th, ID 350, an energy efficiency project in India registered in January 2007, which issued 4 Mt, 3.1 Mt of which have been surrendered in the EU ETS.

$^b$The amounts in the fifth column (‘Total CERs issued in May 2010’) are the total cumulative offer from the start of the project to May 2010 (which is approximately 4 years for old projects).

Source: EC (2010) and data for May 2009, May 2010 and November 2010, UNEP Risoe (2010).
offsets. Although this is currently far from the case, the time-flexibility given to installations leaves this possibility open.

Surrendered CERs are representative of the CERs available, the majority of which have come from the largest and oldest projects: 65% of the CERs surrendered in the EU ETS came from 10 large HFC or N₂O projects in emerging countries. On average, projects are registered 2–3 years before their offsets are found in the EU ETS. The present analysis shows that younger projects are becoming new sources of offsets for the EU ETS. The number of different projects of origin of surrendered offsets has nearly doubled between 2008 and 2009, which suggests a diversification of such sources. Once a project has made its first issuance, 2–3 months are enough to successfully export some offsets in the EU ETS. On average, the offsets used in the EU ETS reflect the nature of the offer in terms of project type and host country, and do not reveal any preference of treatment.

Finally, it seems that the secondary market for CERs has been useful for and used by installations: the number of projects of origin of surrendered offsets shows that the offsets surrendered are often amalgamations of offsets originating from a wide variety of projects.

5.2. Limiting factors to using offsets in the EU ETS
Although the use of offsets in the EU ETS could undoubtedly have been less, it is difficult to know whether the volumes of offsets used in the first 2 years could have been larger. In theory, larger volumes were possible (cumulated CERs issuance over the first 2 years of the EU ETS was higher than the actual use of offsets), but this did not happen for some reason. Five possible limiting factors to using offsets in the EU ETS were identified, on both the demand and offer sides:

- The rules. Differences in the rules governing each EU Member State makes the demand at the country level concentrated and the timing of potential offset use very unpredictable. In order for the European limit to be reached, all installations would have to use the maximum authorized amount over the time period. Complicated and decentralized rules lead to imperfect information among participants, which creates difficulties for them to ascertain exactly what amount of offset is used by other actors and who reached its limit of use. (These facts play a role in forecasting offer and demand on the EUA and CER market.)

- Transaction costs. Analysis at the installation level shows that size matters. Smaller installations tend to surrender offsets less frequently, but more intensively than larger installations. This suggests that transaction costs or some barriers exist when using offsets.

- Awareness and openness to market-based instruments. Some installations might not be aware of the existence of such mechanisms nor recognize their benefits, or they might just avoid using them.

- Uncertainty on CERs offer, and CERs demand from other markets. Cumulated CERs issuance until April 2013 is not expected to be above 1200 Mt, which is below the global limit of use in the EU ETS over Phase II. However, the offer could rise after 2013, and any unused demand for offsets would be carried over to Phase III. Demand from other markets, including Parties to the Kyoto Protocol, is not precisely known.

- Uncertainty about ERUs. This study focused on CERs, but ERUs generated by JI are also eligible as offsets in the EU ETS. In 2008 and 2009, available volumes were small, as were surrendered volumes in the EU ETS (48,000 t for 2008, 3.5 Mt for 2009), but in 2011, they have been both more available and used.
5.3. Further issues
This article has been a first step on the road to better understanding the consequences of linking cap-and-trade and offset mechanisms. Many issues remain to be resolved, in particular what the indirect impact is on the EUA price. Using offsets has already induced direct compliance savings for some installations, although global benefits obtained via the modification of the EUA equilibrium price are probably of more importance and benefit to a larger share of installations (while at the same time they are more difficult to capture). The potential impact of offsets on EUA prices will last as long as offsets are available (and are less expensive) and installations can use them. Extending this analysis would require a detailed investigation of the price formation of the European market, and an evaluation of EUA price elasticity with respect to the demand.

Another important issue is the link between ERU issuance and the potential differences in the use of ERUs and CERs. ERUs are important, because they are perfect substitutes for CERs. Their offer, as well as their use in the EU ETS, is growing over time. The expected issuance of ERUs and CERs combined could satisfy a significant share of EU ETS installations’ need for offsets before 2013.

The final issue that needs resolving is the general evolution of international negotiations and their impact on the rules for producing and using offsets post-2012. CDM and JI are mechanisms based on complicated UNFCCC and Kyoto Protocol rules, which themselves could not entirely survive if no agreement takes place post-2012. As far as EU ETS installations are concerned, this introduces uncertainty in terms of the timing, quantity and quality of usable offsets.

References
BlueNext, Closing Prices for EUA and CER Spot Contract [available at http://bluenext.eu/statistics/downloads.php].
DEFRA, 2007, EU Emissions Trading Scheme – Approved UK Phase II National Allocation Plan, Department for Environment, Food and Rural Affairs, UK Government, London.
EC, 2003, Extended Impact Assessment on the Directive of the European Parliament and of the Council Amending Directive 2003/87/EC Establishing a Scheme for GHG Emission Allowance Trading within the Community, in Respect of the Kyoto Protocol’s Project Based Mechanisms, (COM(2003)403 Final), Commission Staff Working Paper, European Commission.
EC, 2006, National Allocation Plans: Second Phase (2008–2012), European Commission [available at http://ec.europa.eu/clima/documentation/ets/allocation_2008_en.htm].
EC, 2010, Community Independent Transaction Log (CITL), European Commission [available at www.ec.europa.eu/environment/ets].
EC (European Commission), 2011, ‘Commission Regulation (EU) No 550/2011 of 7 June 2011 on determining, pursuant to Directive 2003/87/EC of the European Parliament and of the Council, certain restrictions applicable to the use of international credits from projects involving industrial gases’, Official Journal of the European Union L.149, 1–3.
Ellerman, A.D., Convery, F., De Perthuis, C. (eds), 2010, Pricing Carbon: the European Union Emission Trading Scheme, Cambridge University Press, Cambridge.
Elsworth, R., Worthington, B., 2010, International Offsets and the EU 2009, Sandbag, London.
European Parliament and the Council of the EU, 2004, ‘Directive 2004/101/EC of the European Parliament and of the Council of 27 October 2004 amending Directive 2003/87/EC establishing a scheme for greenhouse gas emission allowance trading within the Community, in respect of the Kyoto Protocol’s project mechanisms’, Official Journal of the European Union L338, 18–23.
European Parliament and the Council of the EU, 2009a, ‘Decision No 406/2009/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their GHG emissions to meet the Community’s GHG emission reduction commitments up to 2020’, Official Journal of the European Union L.140, 136–148.
European Parliament and the Council of the EU, 2009b, ‘Directive 2009/29/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 2003/87/EC establishing a scheme for greenhouse gas emission allowance trading within the Community’, *Official Journal of the European Union* I.140, 63–87.

Flachsland, C., Marschinski, R., Edenhofer, O., 2009, ‘To link or not to link: benefits and disadvantages of linking cap-and-trade systems’, *Climate Policy* 9(4), 358–372.

Hedegaard, C., 2010, Statement by Connie Hedegaard, European Commissioner for Climate Action, on the Commission’s Proposal for Quality Restrictions on the Use of Credits from Industrial Gas Projects, MEMO/10/614, Press Release, Europa, Brussels, 25 November 2010.

Jaraite, J., Convery, F., Di Maria, C., 2010, ‘Transaction costs for firms in the EU ETS: Lessons from Ireland’, *Climate Policy* 10(2), 190–215.

Mansanet-Bataller, M., Chevallier, J., Herve-Mignucci, M., Alberola, E., 2011, ‘EUA and sCER Phase II price drivers: unveiling the reasons for the existence of the EUA-sCER spread’, *Energy Policy* 39(3), 1056–1069.

Olander, L., Murray, B., 2008, Offsets: An Important Piece of the Climate Policy Puzzle, Policy Brief 08-01A, Nicholas Institute for Environmental Policy Solutions, Duke University, Durham, NC [available at http://nicholasinstitute.duke.edu/mitigationbeyondcap/offsetseries1].

Ramseur, J., 2008, ‘The Role of Offsets in a Greenhouse Gas Emissions Cap-and-Trade Program: Potential Benefits and Concerns’, RL34436, Report for Congress, Congressional Research Service, Washington, DC [available at www.nationalaglawcenter.org/assets/crs/RL34436.pdf].

Trotignon, R., Stephan, N., 2011, ‘2010 compliance: weak recovery and high credit use’, *Tendances Carbone* 59(June), CDC Climate Research [available at www.cdcclimat.com/Tendances-Carbone-no59-2010.html].

UN, 1998, *Kyoto Protocol to the United Nations Framework Convention on Climate Change*, United Nations, New York.

UNEP Risoe, 2010, *CDM and JI Pipeline Analysis and Database*, United Nations Environment Programme Risoe, Roskilde, Denmark [available at http://cdmpipeline.org/].