

Allocation, incentives and distortions: the impact of EU ETS emissions allowance allocations to the electricity sector

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Abstract

The allowance allocation under the European emission trading schemes differs fundamentally from earlier cap-and-trade programmes, such as SO₂ and NO_x in the USA. Because of the sequential nature of negotiations of the overall budget, the allocation also has to follow a sequential process. If power generators anticipate that their current behaviour will affect future allowance allocation, then this can distort today's decisions. Furthermore, the national allocation plans (NAPs) contain multiple provisions dealing with existing installations, what happens to their allocation when they close, and allocations to new entrants. We provide a framework to assess the economic incentives and distortions that provisions in NAPs can have on market prices, operation and investment decisions. To this end, we use both analytic models to illustrate the effects of the incentives, and results from numerical simulation runs that estimate the magnitude of impacts from different allocation rules.

Keywords: Allowance allocation; Emission trading; Power sector; Economic incentives

1. Introduction

The 25 national allocation plans (NAPs) established autonomously by the EU Member States (MSs) are central to the EU emissions trading scheme (ETS). According to Articles 9–11 and Annex III of the ETS Directive (2003/87/EC), NAPs must state how the total quantity of emissions allowances will be distributed to installations within their jurisdiction for each trading phase. The process of deciding the second phase allocation is currently under way. Each MS must submit their NAPs for 2008–2012 to the EU Commission by 30 June 2006. Over the subsequent 3-month period, these will be assessed by the Commission according to criteria outlined in the Directive.

How to initially allocate allowances has long been a central issue in the debate on market-based instrument design. Since Montgomery put forward some 30 years ago that market efficiency would be independent of the initial allocation 'modes' used to distribute tradable permits (Montgomery, 1972), considerable advances have been made to further understanding of the implications of

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allocation to the functioning of an allowance market. Recent literature, primarily discussing allocation in the context of the USA's SO₂ and NO_x programmes, evaluates different allocation modes using analytical, empirical and comparative approaches (e.g. Ellerman et al., 2000). This literature gives support for the argument that allocation indeed matters: the choice of allocation mode has distributional effects, but also consequences for efficiency and hence the overall costs of emissions abatement (Burtraw et al., 2001, 2002).

However, the EU ETS is a unique undertaking compared with the US programmes on several grounds. Addressing these differences is crucial when applying insights from the existing literature to allocation issues in the EU ETS. Three key differences in particular increase the complexity with the EU ETS. Firstly, the EU emissions trading scheme is by far the largest of its sort. Distributional considerations carry significant weight when giving away assets of such value to private sector agents. At CO₂ prices of €20/tCO₂, the annual value of emissions allowances reaches approximately €44 billion.¹ By law, the level of auctioning is likely to remain low.² Certain modes of free allowance allocation can create incentives of some significance for rational firms in a competitive market to adjust decisions on operation, investment and closure in order to influence future allocations.

Secondly, in most US programmes, allowances have been allocated at the beginning of the programme, with a clear understanding that no subsequent allocation will take place. In sharp contrast to this 'one-off' allocation, the EU ETS adopts a sequential approach. Allocation plans are decided for one commitment period at a time, with repeated negotiations about the allocation for the following period. Although consistent with the iterative nature of international emission reduction negotiations, this allocation approach can have significant implications for the efficiency of the market compared with a one-off allocation. For example, it creates perverse incentives for CO₂-intensive plants to remain in operation in order to receive free allocations, even if closure or replacement is socially more efficient. In addition, firms might invest in and operate more carbon-intensive technologies if they anticipate that future allocations of allowances will be proportional to today's emissions, output or fuel choice. This implies higher overall abatement costs to meet the cap.

Thirdly, further complications are introduced due to the decentralization of allocation (Åhman et al., 2005). Under the current system, where some discretion over NAPs is retained by each MS, we expect that allocation rules will reflect national interests. For example, where the actions of a single MS is expected to have a small impact on the European CO₂ price, national policies may be pursued with the objective of reducing impacts on domestic electricity prices. Pursuing the national objective can, however, have an adverse impact on CO₂ emissions. If many countries set out to minimize electricity prices, increased demand for allowances pushes up prices in the EU ETS, increasing the overall costs of abatement for Europe. High CO₂ prices, moreover, are likely to trigger some emission reductions among other market participants and increase the use of international mechanisms (e.g. CDMs and JI).

The potential complexity of allocation plans has thus reached new heights with the EU ETS. The objective of this article is to draw a clear set of messages to guide future allocations from our detailed analysis of the financial incentives resulting from the allocation process for power generators in liberalized electricity markets. The electricity sector plays a key role in determining the CO₂ price and ultimately in the success of the overall scheme (electricity represents around 60% of overall emissions regulated under the EU ETS). Insights from this sectoral study also have a useful bearing on other carbon-intensive sectors covered by the scheme.

In this study, we use both analytic models to illustrate the effects of incentives, and results from numerical simulation runs that estimate the magnitude and the relative impacts of different allocation rules. We do not assess strategic behaviour of generators in the electricity, gas or CO₂ market (e.g. Newbery, 2005) but assume a competitive market. First, power dispatch simulations of Great Britain (England, Wales and Scotland) and all of Europe are solved for the reference baseline – using one-off grandfathering and auctioning allocation methods.³ The base-case results are compared with results from simulations of alternative allocation scenarios, to demonstrate numerically the extent to which allocation can distort operation, investment, electricity prices and CO₂ emissions.

We do advise caution, because there is some debate as to whether dominant generation companies in some European countries are restrained not by the competition from existing companies or new entrants, but by the threat of triggering regulatory intervention. Such companies can develop prices that mimic the prices of competitive markets. However, the threat of windfall profit taxes, the anticipation of the impact of their current behaviour on the ongoing negotiations about allowance allocation for future periods, or the link to developments in other sectors of energy policy might induce such companies to refrain from adding the opportunity costs of CO₂ prices to the wholesale price level of electricity.

The remainder of this article is structured as follows. In Section 2 we describe the reference case, which mimics the results of an efficient cap-and-trade programme, and then discuss the distortions that result due to allocation to existing power stations. Section 3 deals with new entrants. Section 4 sets out some conclusions.

2. Allocation to incumbents

For the phase I trading period, incumbent firms received allowances based on their historic emissions. Most Member States took some average over a 3–5-year period between 1990 and 2002. For future trading periods, the Member States have to again define NAPs for the ETS.⁴ The Commission and various Member States initially announced that current behaviour will not be the basis for future allocations. It is, however, difficult for governments to commit to not redefining allocation methods and base periods in future. It is likely that the base period will be adjusted over time to reflect changes in the distribution of plants over time. It is, for example, difficult to envisage that in phase II a government will decide to allocate allowances to a power plant that closed down in phase I. This suggests that some element of ‘updating’ of allocation plans cannot be avoided if such plans are made sequentially.

A consistent methodology of allocating allowances is therefore likely to make allocation contingent on the past activities of a plant. We show that such contingent allocation has detrimental impacts on the efficiency of emissions trading, which vary with the specific allocation methodology. The incentives that the allocation methodology creates for the separation of power plants has been extensively discussed (Bernard et al., 2001; Palmer and Burtraw, 2003, 2004; Entec and NERA, 2005; Keats and Neuhoff, 2005). This section extends this discussion by addressing issues specific to the EU ETS.

2.1. The ‘updating dilemma’

We begin by presenting a theoretical framework for evaluating the impact of updating before moving on to quantify its impacts. To illustrate the effect of updating, consider a generation system with various technologies. In our auction base case, as the CO₂ price increases, the generation

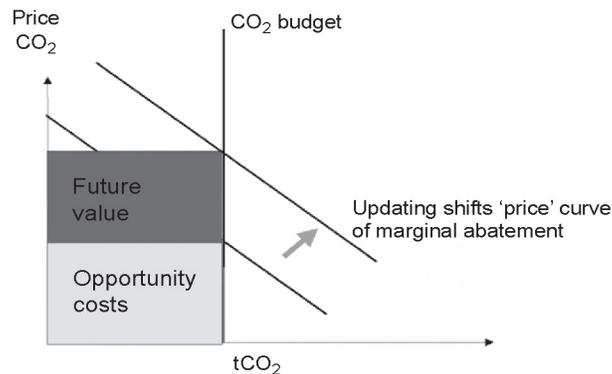


Figure 1. Impact of updating on marginal abatement cost curve.

portfolio will shift towards less carbon-intensive power generation. The track of the relationship between CO₂ price and resulting CO₂ emissions is referred to as the marginal abatement cost curve (MACC), as shown in Figure 1. With updating, the emitter receives some future allowances with today's emissions. The value of this future allocation will drive a wedge (indicated by the area labelled 'future value') between the market price of CO₂ allowances and the polluter's internal opportunity cost. This can be represented as an upward shift of the MACC. The CO₂ market price must therefore rise to ensure that the CO₂ budget is not violated (see Boeringer and Lange, 2005).

From the perspective of one country, using policies that promise updating is a tempting option. Emissions from the country will have little effect on the ETS price. Yet, by adding future value, updating essentially provides an output subsidy that reduces the variable cost of the economic activity. Thus national efforts to reduce economic activity, and hence CO₂ emissions, are reduced. Updating can therefore have adverse effects on emission levels, for example, by biasing investments in carbon-intensive technologies (e.g. coal). Moreover, if the demand for electricity is price-elastic, any resulting drop in electricity prices (Harrison and Radov, 2002) could trigger higher electricity consumption that induces additional production, with additional CO₂ emissions.

This approach will also have consequences on neighbouring jurisdictions. Figure 2 illustrates a case with two countries. Each country is characterized by a marginal abatement cost curve and emission budget. The right-hand side of Figure 2 illustrates that with international trade the individual marginal abatement cost curves and the budgets are added, and obviously the same equilibrium price X results.

If one country, say Country B, employs updating, then a wedge is created between CO₂ price and opportunity costs of CO₂ emissions. As companies' opportunity costs of reducing CO₂ emissions are not affected, the MACC has to shift upwards. When we allow trading of allowances between the two countries, the joint MACC also shifts upwards. The market now clears at the new equilibrium Y with higher CO₂ prices. How this joint equilibrium is reflected in national output choices can be seen by moving along the dashed line from point Y to the left. The resulting CO₂ price in Country A is higher and the country will implement additional CO₂ emission reductions equal to $E_A^1 - E_A^2$. The CO₂ prices will also be higher in Country B, but as the MACC has been shifted up even further, the country increases its emissions of CO₂ by $E_B^2 - E_B^1$. The global budget ensures that the

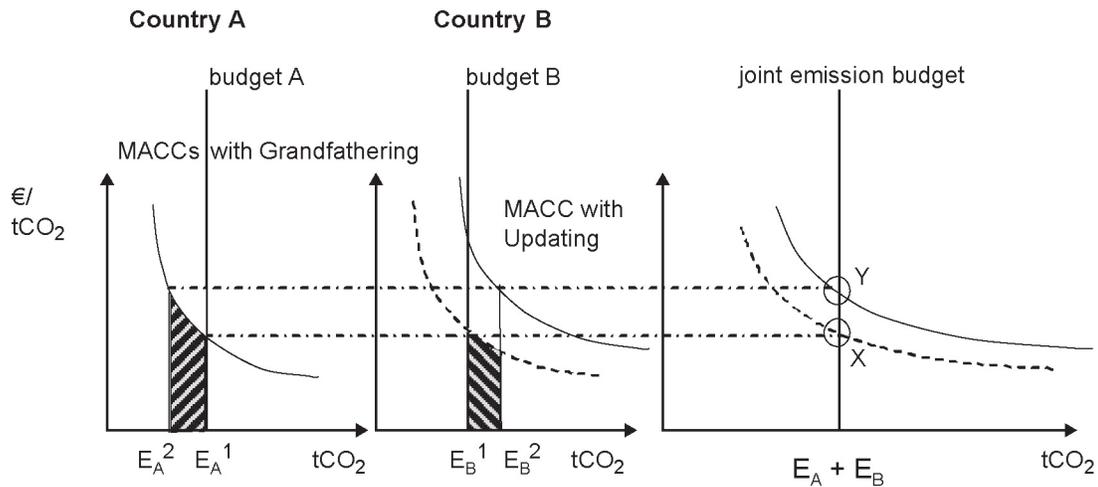


Figure 2. Impact of updating in a two-country emission trading system.

total emission reductions are not affected. Comparing the shaded areas under the MACCs, it is clear that savings made in Country B are outweighed by the additional abatement costs incurred by Country A.

One might argue that Country B or its companies ‘pay’ for these additional abatement efforts of Country A. However, in the process, Country B introduces a wedge, reducing the marginal opportunity costs for its industry and consumers at the expense of a higher ‘international’ CO₂ price and thus higher marginal opportunity costs for industry and consumers in other countries covered by the ETS. This might be referred to as ‘free-riding’ on others’ emissions reductions.

Åhman et al. (2005) recognize that individual Member States’ decisions on NAPs affect the overall efficiency of the system, and also that a strong EU approval process of NAPs is required to limit distortions from heterogeneity of NAPs. In addition, the application of updating is not limited to cross-border distortions. Similar arguments can be made about allocation procedures that differ across sectors (see Keats Martinez and Neuhoff, 2005).

Acknowledging the problems associated with defining future allocations as a function of output levels in the past, some governments have declared that they will not allow the use of updating. Such an announcement’s credibility can be enhanced if accompanied by a clear outline of the allocations approach in future trading periods.

2.2. Quantifying impacts

2.2.1. Base case: auctioning or one-off grandfathering

Various studies have modelled the impact of CO₂ allowances on the European power sector (see, for example, Sijm et al., this issue). To quantify the impact of CO₂ allowances on both the GB and the EU power sector, we use ICF International’s Integrated Planning Model® (IPM). This is a linear programming model that selects generating and investment options to meet overall electricity demand today and on an ongoing and forward looking basis over the chosen planning horizon at minimum cost. For the GB simulations, England, Wales and Scotland are treated as an island with no electrical interconnection to its neighbours. In the European simulations, IPM is designed to

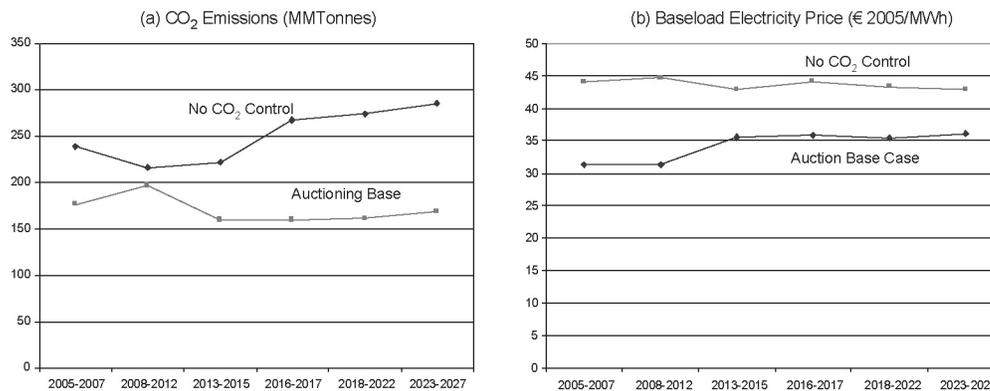


Figure 3. CO₂ emissions and baseload price with auctioning base case (GB only). Note: CO₂ prices fixed at €20/tCO₂.

replicate the operations of the interconnected European power system, using an accurate engineering representation of power plants, transmission links and fuel supply options.

In order to calculate the distortions induced by the NAPs, we have to define a reference or base case. In our base case we assume that all allowances are auctioned. This base case creates the same investment, operation and closure decisions as a one-off allocation of free allowances.⁵ The ‘only’ difference between auctioning and one-off allocation allowances are the rents transferred from government to historic emitters. In this article we do not discuss the mix of auctioning and free allocation required to compensate power companies for the effect of the CO₂ emission trading scheme (see Keats Martinez and Neuhoff, 2005). This does not apply to companies in regulated market environments or in situations where companies are exposed to regulatory threats, e.g. windfall profit taxes. In the extreme case of pure auctions, companies will face the full costs and can pass these on. With complete free allocation there is little impact on their average costs and thus on prices (Burtraw et al., 2005). Results for the auctioning case and the no-CO₂ case are shown in Figure 3.

2.2.2. Updating with an output-based uniform benchmark

To update allocation, governments may consider using benchmarks. How does the choice of benchmark impact electricity prices and CO₂ emissions? We start by quantifying the impacts of the simplest form of updating: using an output-based uniform benchmark (OB UB). In this case, the allocation in the following compliance period is equal to the product of the benchmark and electricity production in the preceding compliance period (Palmer and Burtraw, 2004). To avoid distortions between any sources of power generation, the uniform benchmark also envisages the allocation of CO₂ allowances to low-carbon technologies such as wind, hydro, solar or nuclear.

The simulation results for GB presented in this section assume that all power stations receive, for free, an allowance of 0.35 tCO₂ per MWh electricity produced in the preceding compliance period. This benchmark is phased out linearly so that by 2023 no further allocation is received. In the model it is also assumed that GB is small relative to the European market, such that even with changing GB emissions, the CO₂ price stays at €20/tCO₂. The simulation results in Figure 4 show that the electricity price increases, but by far less than in the auction case.

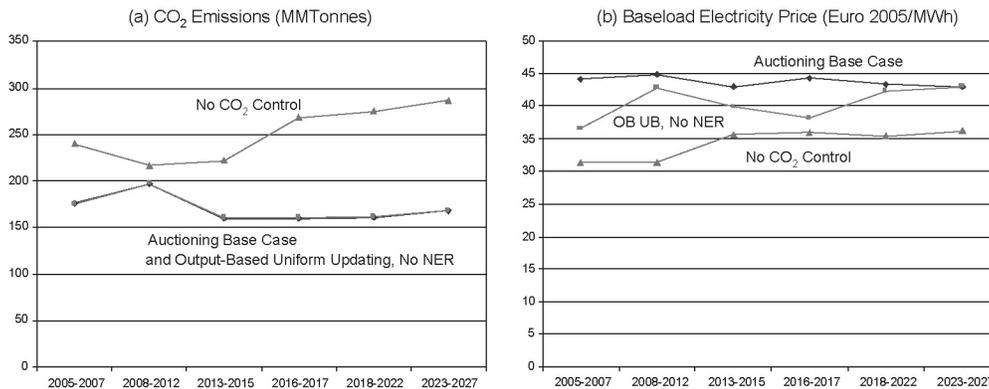


Figure 4. CO₂ emissions and baseload price with updating using an output-based uniform benchmark (GB only, €20/tCO₂).

Figure 4 also shows that the impact on CO₂ emissions was very small when compared to the auction case. While lowering electricity prices, updating using an output-based uniform benchmark does not result in any significant increase in CO₂ emissions. The benefits of future allocation reduced the production costs of operation, resulting in a reduction in prices without affecting the dispatch order. Output-based updating therefore acts as a production subsidy (Fisher, 2001).

This, however, may not be the whole story. For modelling purposes we assumed that demand is exogenous. In reality electricity demand is price-elastic in the mid- and long term, when higher prices induce more energy-efficient investment. Hence we expect electricity demand to increase with the output-based updating. To meet this additional demand, more generation is required, resulting in higher CO₂ emissions.

For modelling purposes we also assumed that a fixed CO₂ price does not constrain CO₂ emissions. However, if updating increases CO₂ emissions on a European scale, then allowance prices will appreciate, and this in turn will compensate for (some) of the previous electricity price reductions.

2.2.3. Updating with an output-based fuel-specific benchmark

As basing phase II allocation on activities in phase I was discouraged by the EU Directive, some Member States update allocations using output-based fuel-specific benchmarks (FSB), where the benchmark is set higher for coal-fired plants than for gas-fired plants. Here, we assess the impact of this alternative updating method and compare with the output-based uniform benchmark approach.

In our model, gas-fired plants receive 0.35 tCO₂ and the coal-fired power stations receive 0.75 tCO₂ per MWh generated in the preceding compliance period.⁶ The results for our GB simulation are shown in Figure 5. The fuel-specific updating scenario leads to higher CO₂ emissions, and electricity prices are lower because of the output subsidy, but CO₂ emissions are significantly above the auctioning case.

2.2.4. Updating in an international context

To test the net impact that updating can have on the efficiency of the EU ETS as a whole, we simulate four scenarios for all countries in Europe. The IPM treats the electricity dispatch system

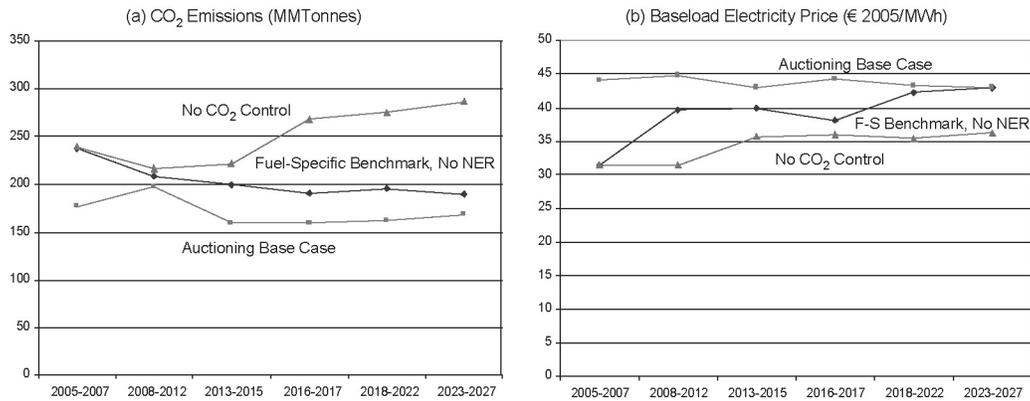


Figure 5. CO₂ emissions and baseload price with updating using an output-based fuel-specific benchmark (GB only, 20€/tCO₂).

as a system of integrated and interconnected markets. It assumes that the competitive market allows for the optimal operation decisions of power stations across multiple jurisdictions. The first scenario defines the business-as-usual case (‘No-CO₂ control’), and the second simulates a situation where all European countries use allocation by auctioning and a price of €20/tCO₂. For the final two cases, we apply different allocation methodologies to the UK, Germany and The Netherlands: first an output-based uniform benchmark, and then a fuel-specific benchmark. All other European countries continue to auction allowances. The impact of updating in these three countries on CO₂ emissions is reported for 2008–2012 in Figure 6.

On an overall European scale, the results show that updating using an output-based uniform benchmark in the UK, Germany and The Netherlands has a smaller impact on emissions than

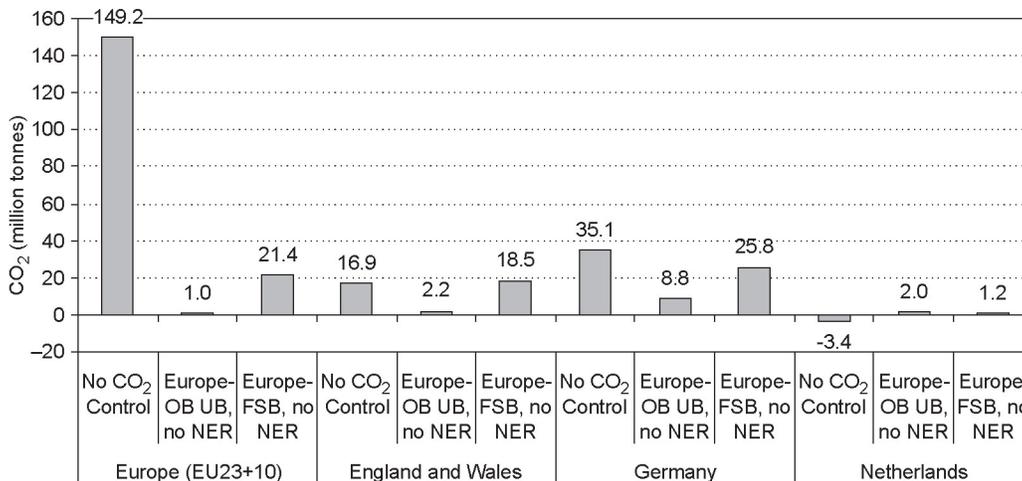


Figure 6. CO₂ Emissions with base case, updating using output-based uniform benchmark and output-based fuel-specific benchmark for Europe (EU23+10), England and Wales, Germany and The Netherlands (20€/tCO₂, 2008–2012 only).

using an output-based fuel-specific benchmark in the same three countries. The No-CO₂ control case results in the highest emissions. Emissions were lowest with all countries adopting the auctioning approach.

Comparing the impact of different allocation procedures for the three individual countries, we observe a similar behaviour in Germany and England & Wales. Distortions in the allocation process mean that CO₂ emissions increase from the auction to the output-based uniform benchmark case and then again to the output-based fuel-specific benchmark case. Emissions are highest in the No-CO₂ control case. The Netherlands proved a special case, with emissions in the BAU case lying below the auction case. Two explanations underlie these results: first, the large proportion of gas-fired plants makes The Netherlands a preferred country for electricity generation under emissions trading; second, the high level of interconnection with neighbouring countries allows trade to utilize this opportunity.

These numerical simulations provide a useful insight into the magnitude of distortions induced by allocation to the power sector. Since the CO₂ emissions cap for Europe is fixed, high CO₂ emissions projections imply increased scarcity and allowance prices. This could induce an increased flow of allowances through the flexible mechanisms of the Kyoto Protocol, including the clean development mechanism (CDM) and joint implementation (JI). The extent to which CO₂ prices would have to adjust to achieve the same level of European-wide emissions is a question requiring further research.

2.3. Closure rules: the impact of 'contingent allocation'

With a one-off allocation, the ownership of the allowances remains unaffected by closure of the power station. If the continued operation of a plant is no longer profitable, then owners can sell the allowances and close the plant.

Closure decisions are distorted if the allocation of allowances is contingent on the activity level of a plant. Plant owners will retain plants on the system and continue operation at minimum-run conditions in order to receive allowances in the next trading period.⁷

In addition, most countries, with the exception of Sweden and The Netherlands, explicitly include closure rules within their NAPs. For example, in Germany, entities that close down operations (defined as emitting less than 10% of its average annual baseline emissions) will not receive allowances from the following year. Such formal closure rules further discourage the closure of inefficient plants within a trading period, as allocation essentially becomes a subsidy for continued production (Åhman et al., 2005).

These closure rules have two consequences for the power system. First, with more plants staying on the system, there is more electricity supply and therefore prices can initially be reduced. Secondly, as inefficient old plants are artificially retained on the system, investment in more efficient new plants is delayed. This increases power prices and CO₂ emissions.

We quantify the impact of the implicit closure rules for the Great Britain electricity system: if a power plant closes, it does not receive any allocation in the following compliance period. Table 1 lists the initial annual allocation of allowances to the different technologies. We assume that this is the allowance allocation for the period 2005–2008 and will be linearly phased out until 2028. We again fix the CO₂ price at €20/tCO₂.

Comparing results for the cases where allocation of allowances is contingent on plant existence during the 3–5-year allocation period with the base case (auction or one-off grandfathering), the

Table 1. Assumed initial allocation to incumbents for period 2005–2007

	Initial allocation (tCO ₂ /MW/year)
CCGT (combined-cycle gas turbine)	1893
OCGT (open-cycle gas turbine)	473
Hydro (pumped storage or pondage hydro)	0
Diesel generator	947
Nuclear	0
Renewables	0
Conventional coal boiler	2840
Conventional steam turbine (burning fossil fuel other than coal)	1420

number of retirements of plants falls. With no CO₂ constraint, only 0.4 GW of capacity was retired for economic reasons. In the auction case, 7.1 GW of capacity is retired by 2015 and 14.2 GW by 2022. In contrast, free allocation to existing plants reduces cumulative retirements to 2.5 GW and 7.2 GW over the same periods. This reduces the investment in new lower-carbon plant. For our parameter choice, we did not observe strong effects of contingent allocation on CO₂ emissions. Power prices are slightly lower in the contingent allocation case. As the scenario analysis for new entrant allocation in Section 3 illustrates, such results can drastically change with small changes to the choices of parameter.

2.5. Summary of allocation to existing facilities

The allocation procedures applied by NAPs combine various aspects discussed in this section. Table 2 illustrates and summarizes the transition from an efficient allocation based on auction (or one-off grandfathering) to the various dimensions of distortions that are created by the iterative grandfathering approach using a moving baseline in current NAPs.

The economically efficient allocation methods are auctions or a one-off free allocation of allowances. The first set of impacts will result if allowances are only allocated in the future, if the power stations are operational today. The value of future allocations delays closure of plants beyond their socially efficient lifespan. This effect is reinforced if the amount of allocation increases with the CO₂ intensity of the technology. With such technology-specific allocation, more CO₂-intensive technologies receive additional encouragement to stay operational, further delaying the shift towards less CO₂-intensive power stations.

The second set of impacts follows, if the amount of future allocations is related to current electricity production. A uniform benchmark would not create distortions between the operation of different technologies. In our model, the output-based uniform updating resulted in lower electricity prices. We did not look at the impact on electricity demand and implied changes in CO₂ emissions. Output-based updating also implements a closure condition – only power stations that produce will receive allowances in the future. Thus it creates some distortions as discussed above. Many of the discussions about output-based benchmarks assumed that these benchmarks are fuel- or technology-specific. Updating based on such benchmarks does create strong distortions in the operation and can create significant increases in CO₂ emissions.

Reality can offer even more distortions. The allocation of CO₂ allowances in phase I of the EU ETS was based on baseline CO₂ emissions, and the current discussions surrounding phase II

Table 2. Effect of allocation methods to power sector incumbents

Allowance allocation method	Impacts	More expenditure on extending plant life relative to new build		Increase plant operation		Less energy efficiency investments
	Distortions	Discourage plant closure	Distortion biased towards higher emitting plant	Shields output (and consumption) from average carbon cost	Distortion biased towards higher emitting plant	Reduce incentives for energy efficiency investments
Auction						
Benchmarking	capacity only	X				
	capacity by fuel/plant type*	X	X			
Updating from previous periods'	output only	Y		X		
	output by fuel/plant type*	X	X	X	X	
	emissions	X	X	X	X	X

Note: X indicates a direct distortion arising from the allocation rule. Y indicates indirect distortions if allocation is not purely proportional to output/emissions.

* Differentiating by plant type adds additional distortions compared to purely fuel-based distinctions.

indicate that this will remain the dominant metric. Among our model runs, the output-based fuel-specific benchmark using a moving baseline best reflects the distortions created by the emission-based NAPs, assuming that they also use a moving baseline. The emission-based updating creates additional distortions not captured by our model run. First, it reduces the incentive to operate the more efficient power stations of the same fuel type. This may not be a large problem, as generators typically prefer to run more fuel-efficient power stations. Second, the emission-based allocation reduces the incentives to invest in efficiency improvements of existing and new power stations.

As the European budget for CO₂ emissions is capped, if many Member States implement this allocation methodology, increases in national emissions are likely to push up the European price of CO₂ allowances. They, in turn, increase the electricity prices across all states, and thus the subsidy-effect of free allocation that lowers electricity prices is partly offset.

3. Allocation to new entrants

We assess the economic incentives and their impacts resulting from allocation to new projects of power generators. All Member States have made provisions that guarantee a certain volume of free allowances to new entrants for a defined period. Section 3.1 uses a simple analytic model to illustrate the impact of a uniform allocation of CO₂ allowances to all new projects, Section 3.2

discusses how increased allocation to coal affects the equilibrium. In Section 3.3 we then use a numerical model to calculate the impacts of different allocation schemes in the UK and European system, taking into consideration the existing assets and investment pathways. Finally, Section 3.4 summarizes the results of all model runs.

NE provisions are often viewed as a ‘general’ or ‘synthetic’ compensation mechanism in the EU ETS. For example, by encouraging firms to establish new sources rather than to expand the operation of existing facilities, it aims in part to compensate for distortions created by closure conditions, including delaying the shift towards new efficient investment. Also it is sometimes argued that NE provisions create ‘fairness’ among incumbents and new entities; if existing facilities receive allowances, so should new facilities. Barriers to entry for new firms due to inadequate liquidity in the market may be a more appropriate, but also more difficult, justification for NE allocations (Baron and Bygrave, 2002). Free NE allocations compensate for the direct additional costs incurred by new entrants to the market. By improving their access to capital, free allowances can facilitate entry by new firms; hence NE reserves address the wider issues of market power (Åhman et al., 2005) and thus increase competition within rather concentrated national European electricity markets (Åhman and Zetterberg, 2003; Pedersen, 2002, cited in Baron and Bygrave, 2002). As most new projects are initiated by existing utilities, the expression ‘new entrant allocation’ seems a bit misleading and could perhaps be replaced by ‘new project allocation’ in future discussions.

Most phase I NAPs provide for NE allocations based on a general emission rate and predicted activity level. For example in The Netherlands (NL), new entrants are allocated allowances based on projected output or fixed cap factor multiplied by uniform emission rate in line with that of a combined-cycle gas turbine (CCGT). In France, Germany and Poland, CO₂-intensive power generators, such as coal-fired installations, receive the highest number of allowances per kW installed. The literature highlights the risk that NE provisions can create distortions (Harrison and Radov, 2002). In order to illustrate how these rules can impact electricity prices and CO₂ emissions in our GB simulations, we focus on two approaches: one based on a uniform benchmark and one based on a fuel-specific benchmark. In both cases the forecast capacity factor of new entrants is fixed at 60%.

3.1. New entrant allocation with a uniform benchmark

To illustrate the impact of new entrant allocation, we calculate the long-term investment equilibrium for a competitive electricity market. Section 3.3 will subsequently assess the impact in real electricity markets, where existing generation assets do affect the generation and price structure.

In our simplified model we assume that the highest prices are set by demand side response or open cycle gas turbines, followed by combined-cycle gas turbines with high variable and low fixed costs, and coal-fired power stations with low variable and high fixed costs. We compare two cases. First, the system is small relative to the EU emission-trading scheme and the EU CO₂ price is not affected by changes in national emissions of CO₂. Second, the model represents the entire EU ETS, and we set a fixed CO₂ budget and endogenously determined CO₂ price.

The results with uniform NE allocation are shown in Figure 7. With a fixed allowance price, as the value of the NE allocations increases, additional gas power stations replace peaking generation, usually provided by open-cycle gas turbines, or demand side response as the value of the allocation increases. The electricity price falls and CO₂ emissions fall. Nevertheless, at a certain value of total NE allowances (between €40 and €50/KWh), the option for CCGT to replace peakers is exhausted and it becomes viable to invest in new coal-fired power stations. From this point onwards,

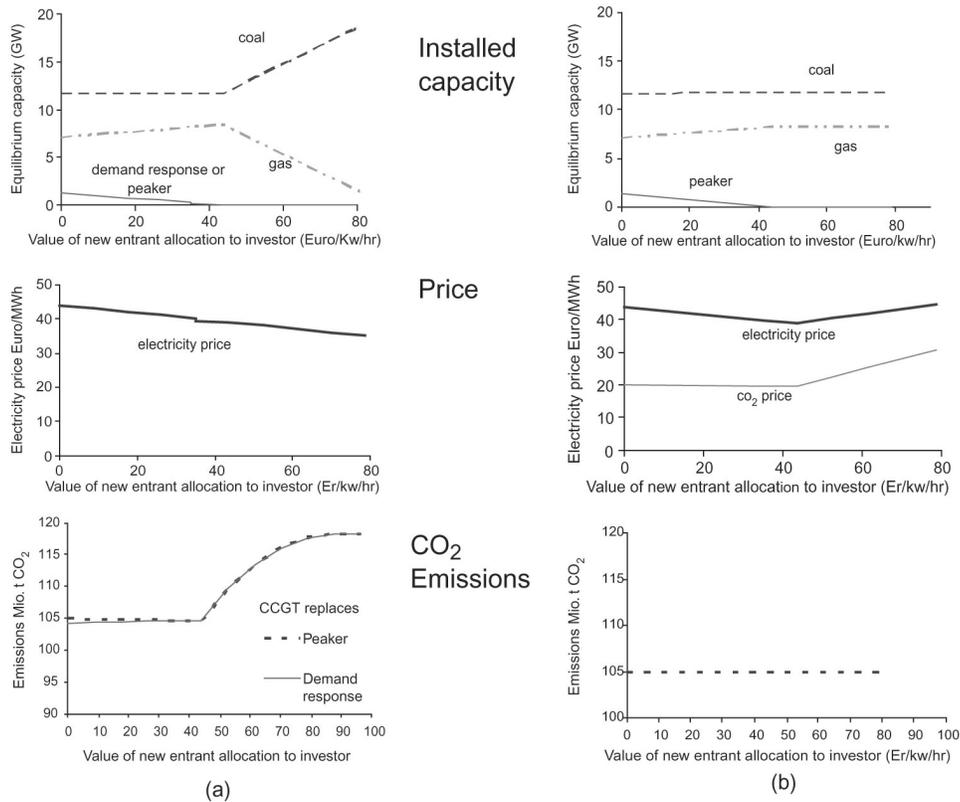


Figure 7. Long-term equilibrium effect of increasing levels of uniform new entrant allocation.

coal-fired power stations are built in preference to CCGT. This results in significant increases in CO₂ emissions, even as electricity prices continue to fall.

The right-hand side of Figure 7 shows what happens if same uniform new entrant allocation provision is applied at the European level, i.e. when the CO₂ budget is fixed. When the value of the new entrant allocation is sufficiently high that construction of new coal-fired power stations is made viable, with a fixed CO₂ cap, however, the equilibrium price of CO₂ will increase and the higher exposure of coal power stations to CO₂ prices reduces the expected benefit of operating the coal power station. This prevents the additional construction of coal-powered stations. Higher CO₂ prices, however, feed through to higher electricity prices.

3.2. New entrant allocation with a fuel-specific benchmark

Figure 8 illustrates the effect of a fuel-specific new entrant allocation in the long-run equilibrium. With a fixed CO₂ price, the additional support for coal-powered stations implies that even small values of new entrant allocation result in incentives to build additional coal-powered stations. This increases national CO₂ emissions and lowers electricity prices. With a fixed CO₂ budget, the cap on total emissions implies that CO₂ prices must rise. The higher CO₂ prices again feed through to higher electricity prices.

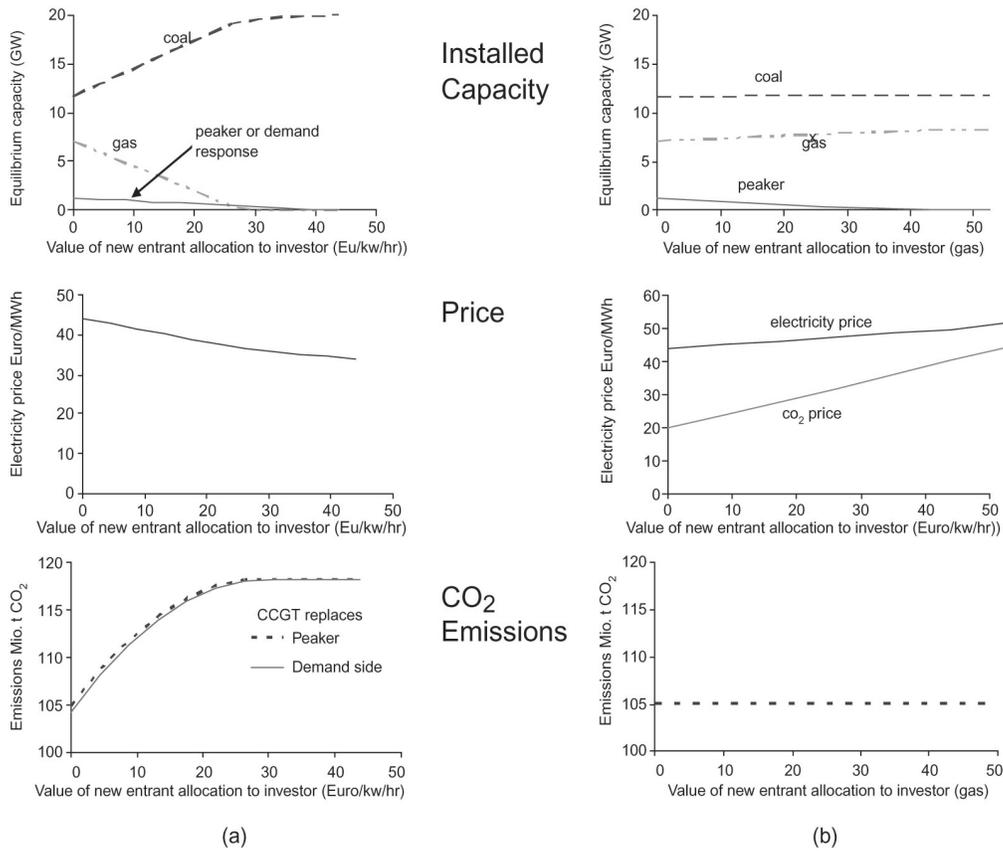


Figure 8. Long-term equilibrium effect of increasing levels of fuel-specific new entrant allocation.

This analysis highlights the dangers of a fuel-specific new entrant allocation at the European level. In equilibrium, fuel-specific benchmarking increases the social costs of complying with the CO₂ cap.

3.3. Aggregate impact on CO₂ emission and electricity prices for Europe

We also used the IPM to assess how updating and new entrant allocation can affect the evolution of the power system in England and Wales for a series of cases with a fixed CO₂ price. For 2005–2007, NE allocation based on a uniform benchmark assumes a benchmark rate of 0.35 tCO₂ per MWh for all power plants together with an annual load factor of 60% for both technologies. The fuel-specific NE allocation assumes 0.75 tCO₂ per MWh for new coal-fired plants. The allocation drops linearly over time so that by 2028 NE would have to purchase all their allowances from the market. Figure 9 summarizes the results, which are taken from our European simulation. In these, Germany, The Netherlands and the UK were subject to the alternative allocation method, whilst all other countries applied auctioning or one-off grandfathering.

Starting with a base case assuming no updating or NE allocation, CO₂ emissions decrease when a NE allocation is used. The allocation results in accelerated construction and operation of combined-

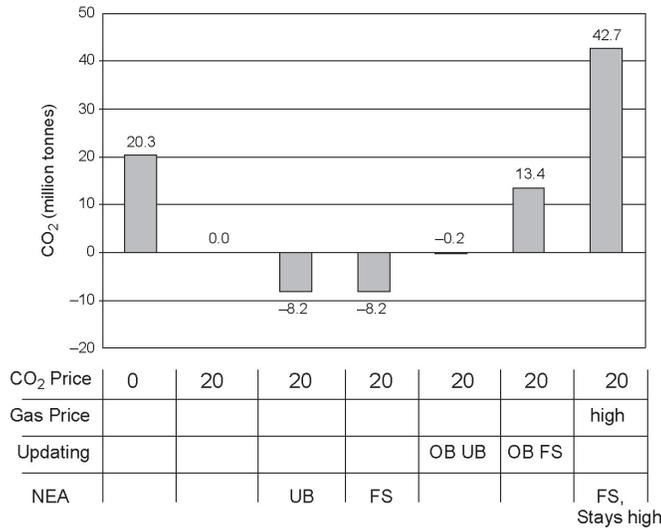


Figure 9. Effect of various allocation methods on England & Wales CO₂ emissions in period 2008–2012 (assuming fixed CO₂ price on CO₂ emissions). NEA = new entrant allocation, UB = uniform benchmark, FS = fuel-specific benchmark, OB = output-based.

cycle gas turbines and thus lower CO₂ emissions. For our given set of input parameters, the results for uniform-benchmark or fuel-specific benchmark were the same. This result was caused because, with the first set of parameters, the subsidy to coal was not large enough to justify any construction of new coal power stations. The resulting reduction in CO₂ emissions, however, could be dramatically reversed. When we increased the price of natural gas above €4.9/MMBTu and assumed that there would be no fall in the allocation over time, coal became the preferred new-build option. Emissions of CO₂ increase above the No-CO₂ and fuel-specific updating cases. The implementation of uniform updating did not affect emissions. If, however, updating is fuel-specific (e.g. producers with coal power stations expect higher future allocations than producers with gas power stations), then dispatch decisions are distorted and emissions increase.

Figure 10 illustrates the impact on electricity prices of the different allocation methods for the same England & Wales cases. The simulations are run on the assumption that European CO₂ prices are not affected by the changes of CO₂ emissions in the UK. If various EU countries implement allocation plans that would increase national CO₂ emissions, then this assumption is no longer valid, and CO₂ prices will rise and feed through to higher electricity prices.

3.4. Summary of the numerical results

Table 3 summarizes the impact of different allocation methods examined for our GB simulation which are based on the assumption that the UK emission pattern will have limited impact on the European allowance price, which is therefore set as fixed.

Uniform allocation of allowances creates the fewest distortions for both incumbents and new entrants. For a fixed CO₂ price, the uniform benchmarks for allocation to existing and new facilities resulted in a reduction in electricity prices, with limited impact on CO₂ emissions. We caution that

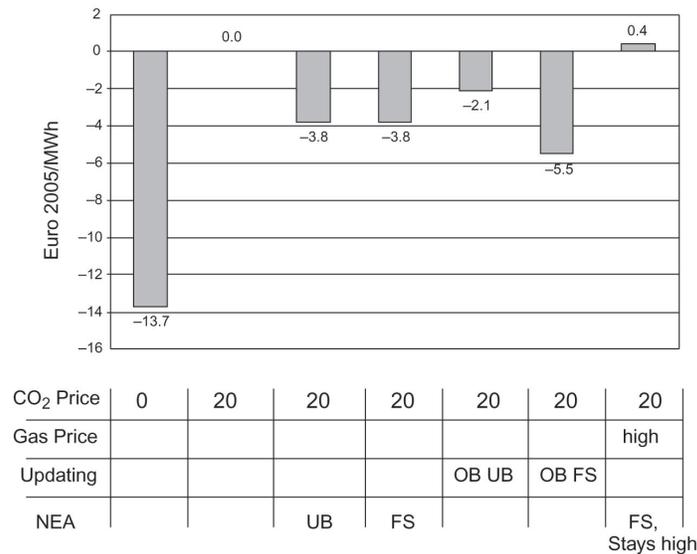


Figure 10. Effect of various allocation methods on England & Wales prices in period 2008–2012 on electricity price (assuming fixed CO₂ price).

this ‘optimistic’ result is based on price-independent electricity demand and our assumptions on available technologies and fuel prices. Furthermore, as we assume forward-looking investors, we did not model the time delay of 3–5 years between the implementation of new entrant allocation rules and new investment decisions that affect electricity prices. Finally, the reduction in electricity prices is typically far lower than the value of the free allowances, as investors and operators discount CO₂ price and regulatory uncertainty. Thus uniform allocation of allowances can be interpreted as an inefficient capacity payment scheme.

Table 3. Impact from allocations for period 2005–2017 (GB simulation only)

	Average CO ₂ emissions (million tCO ₂)	Average baseload prices (€/MWh)	Cumulative retirements (MW)	Average gas use (TBTU)	Average coal use (TBTU)
No closure rules, high FS NER, high gas price	241	45.26	12,977	359	1,623
No CO ₂ control	226	32.79	556	1,221	1,628
FS updating, no NER	215	37.01	5,118	1,325	1,440
Closure rules, no NER	187	43.28	3,318	1,694	946
Closure rules, uniform NER	180	41.86	3,678	1,766	829
Closure rules, FS NER	180	41.86	3,678	1,766	829
Uni updating, no NER	178	39.72	10,640	1,804	776
Auctioning base case	178	43.96	10,629	1,798	780
No closure rules, uniform NER	170	41.81	20,597	1,863	670
No closure rules, FS NER	170	41.81	20,597	1,863	670

Fuel-specific benchmarks applied to existing power stations create incentives to shift production towards more CO₂-intensive generators. Whether we refer to fuel-specific updating or NE allocation, for any given price of CO₂, these allocation methods will result in CO₂ emissions in excess of the auctioning case. If operators and investors expect that future NAPs are similar to current NAPs, then they anticipate receiving fuel-specific allocation in the future. If the CO₂ budget were fixed, this would imply that CO₂ prices, and hence electricity prices, would have to rise.

4. Conclusions

This article illustrates the set of distortions that can result from allocation of CO₂ allowances to existing facilities and new entrants in the form of *closure rules* where allocation is lost once the facility shuts down, *updating* where allocation in forthcoming compliance periods is a function of generation or emissions levels today, and *allocations to new entrants* based on different benchmarks.

We illustrated the set of distortions that can result from allocation of CO₂ allowances to existing facilities and new entrants.

The first set of distortions is introduced with uniform updating (e.g. based on past power output). From a national perspective, assuming fixed CO₂ prices, free allowances reduce the opportunity costs (updating) or scarcity prices (new entrant allocation) and thus feed through to somewhat lower electricity prices. The regulatory uncertainty involved in the future benefit might imply that the decrease in electricity prices might be far lower than the value of allowances handed out. The failure to internalize the CO₂ externality into the electricity prices limits investment in energy efficiency and results in higher electricity consumption. Thus electricity production and national CO₂ emissions increase. If all European countries implement such policies, the suggested higher CO₂ emissions would translate into higher CO₂ prices and feed through to higher electricity prices.

Overall, an allocation based on a purely uniform benchmark creates the fewest distortions for both incumbents and new entrants. A similar approach for both facilities would increase transparency and avoid difficulties in defining what a new entrant is, relative to an existing facility (Entec and NERA, 2005). However, this does not suggest that it is desirable from an equity perspective, as power generators might receive free allowances above the level they require to cover any additional costs from the emission trading scheme.

A justification for the free allocation of allowances is that they are used to compensate emitters for otherwise reduced profitability due to the introduction of ETS. This provides a rationale for output-based fuel- and technology-specific allocation, whereby CO₂-intensive generators receive more compensation than CO₂-efficient generators. Relative to the distortions created by uniform benchmarking, this has the following impacts. Fuel-specific benchmarks applied to existing power stations create incentives to shift production towards more CO₂-intensive generators. If applied on a European scale, the overall increase in CO₂ emissions inflate CO₂ prices. These feed through to higher electricity prices.

Fuel-specific allocation to new entrants creates additional incentives to invest in CO₂-intensive power stations. The fixed EU allowance budget prevents additional CO₂ emissions and would thus push up CO₂ prices to a level at which investment in CO₂ power stations is unprofitable. Thus fuel-specific new entrant allocation increases CO₂ emissions and electricity prices.

Allocation relative to past emissions is prevalent in current NAPs. If such direct updating continues, then the incentives that ETS could offer existing power stations to increase fuel and CO₂ efficiency are severely reduced. Any improvement will reduce the future allowance allocation.

We note that NAPs were designed in anticipation of some of these distortions. The NAPs aimed to counter some of these distortions, e.g. by transfer provisions between power stations. However, it seems impossible to comprehensively address the complex set of interactions of incentives from various provisions in NAPs. Any such assessment tends to be valid for only one scenario and not robust to changes of fuel and technology prices.

Nevertheless, despite the complex interactions, we have shown that it is possible with the aid of simulation tools to make an assessment of the distortionary impact of allocation procedures both at the national and international level. These tools provide useful insights to policy makers as they assess the impacts of forthcoming NAPs. Our numerical calculations for the UK assuming a fixed CO₂ price illustrate how quantitative results can invert with a change in the assumption of gas prices and investors' expectations. This suggests that it is rather tricky to micro-manage NAPs with the well-intended objective of correcting for inappropriate incentives following from individual provisions.

Acknowledgements

Financial support from the UK Research Council Project TSEC, and from the Carbon Trust and Climate Strategies is gratefully acknowledged.

Notes

- 1 2.2 billion tonnes of annual CO₂ emissions in phase I (EC, 2005).
- 2 A maximum of 5% and 10% of allowances may be auctioned in phases I and II, respectively, under Articles 9–11 and Annex III of the ETS Directive. This gradual incorporation of auctioning is inconsistent with the fact that private and equity ownership are considerably lower in the EU, and hence EU citizens are more likely than US citizens to object to free allocation.
- 3 In terms of their incentive effects, one-off grandfathering and auctioning are equivalent and efficient. Thus, both represent the zero-distortions reference case here.
- 4 Defined by the Kyoto process (e.g. 2005–2007, 2008–2012).
- 5 Most of the US cap-and-trade programmes for SO₂ and NO_x used such a one-off allocation. Given the larger value of CO₂ allowances, the novel experience with a CO₂ trading scheme and the iterative nature of the definition of national or regional targets, such a one-off allocation was not viable under the ETS.
- 6 Although technology-specific benchmarks may be intended as incentives for clean technologies, at the same time, they also provide channels to make 'concessions' for technologies and sites that cannot achieve lower emission targets (Entec and NERA, 2005).
- 7 To address such distortions, Åhman et al. (2005) propose 'the 10-year rule', which they argue can parallel the incentives of one-off grandfathering, hence eliminating the trade-off between updating and one-off allocation.

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