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Emissions Trading: Impact on Electricity Prices and Energy-Intensive Industries

Under the EU-wide Emission Trading Scheme (ETS), CO_2 allowances have thus far been allocated largely free of charge. This paper presents a didactic synthesis on the impact of the ETS and argues that such a cost-free allocation will lead to an increase in electricity prices even when strong competition prevails in electricity markets. Electricity prices are also likely to increase as a consequence of the environmentally desirable fuel switch from coal to natural gas in the power sector when certificates are entirely auctioned in the power sector as of 2013. This tendency may be attenuated, but not outweighed, by the price decrease of CO_2 allowances over the long term.

The European Union's CO_2 emission target, stipulated in the Kyoto Protocol, aims at an emission reduction of 8% relative to 1990 between 2008 and 2012. The EU-wide emissions trading scheme (ETS), established in 2005, is a key pillar of the European Commission's strategy to achieve this target. As documented in the environmental economics literature[1], emissions trading schemes are an economically efficient means to achieve exogenously set emission reduction targets. Although the alternative of CO_2 taxation would be an equally cost-effective measure, its associated emissions reductions emerge endogenously as the market adjusts to higher CO_2 costs. Thus, a CO_2 tax does not ultimately ensure the achievement of a given reduction target.

After the introduction of the ETS, European electricity prices increased along with those of the emission certificates, alternatively called allowances or permits. This correlation instigated an intense debate concerning the distributive and welfare implications of the ETS, particularly in Germany. Confusion reigned among consumers as to why they faced an increase in prices and, ultimately, in electricity bills despite the cost-free allocation of CO_2 certificates in the majority of EU countries. Fuelled by the media and political posturing, it was commonly suspected that electricity suppliers used the introduction of this climate policy instrument as a pretext for increasing electricity prices, and hence, their profits. It was further alleged that this outcome could be prevented if electricity markets were more competitive.[2]

While providing for a didactic synthesis on the impacts of the ETS, this paper sets out to demonstrate why both of these conclusions are mistaken. Rational economic behaviour by power producers was bound to lead to an increase in electricity prices, in spite of the cost-free allocation of CO_2 certificates based on historical emissions, commonly called grandfathering[3], and irrespective of whether strong or weak competition prevails on electricity markets. Indeed, price increases for electricity are even desirable from an economic and environmental perspective, as this induces consumers to reduce their demand for electricity. Just such a price increase was predicted by economists prior to the introduction of the ETS.[4] In essence, the grandfathering of certificates represents a transfer of assets. The certificates could be used as an input in electricity generation, thereby increasing the cost of production, or power producers could reduce their production and sell the certificates at their market price. To demand that electricity producers disregard this op-

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1 E.g. T. Tietenberg: The Tradable-Permits Approach to Protecting the Commons: Lessons for Climate Change, in: Oxford Review of Economic Policy, Vol. 19, No. 3, 2003, pp. 400-419.

2 Ecologic: Strompreiseffekte des Emissionshandels. Bewertung und Lösungsansätze aus ökonomischer Sicht, Ecologic – Institut für Internationale und Europäische Umweltpolitik, Berlin 2005, p. 31.

3 T. Tietenberg, op. cit., p. 410.

4 D. Burtraw, K. Palmer, R. Bharvirkar, A. Paul: The effect on asset values of the allocation of carbon dioxide emission allowances, in: Electricity Journal, Vol. 15, No. 5, 2002, pp. 51-62; J. Reinaud: Emissions Trading and Possible Impacts on Investment Decisions in the Power Sector, IEA Information Paper, Paris 2003.

portunity cost in price setting would be completely ignorant of the functioning of a market economy.

If certificates are grandfathered, rather than auctioned, the ETS-induced price increases of outputs such as electricity lead to considerably higher revenues at no additional cost – that is, to windfall profits. Our estimations for Germany's power sector indicate that these windfall profits may be substantial, a conclusion that is substantiated by Sijm et al.[5] for the case of the Netherlands' power sector, as well as by Chen et al.[6] for northwest Europe. With a CO_2 tax, by contrast, it would be the government, rather than private firms, that would receive the increased payments by consumers. It therefore may well be justified for governments to extract some of these windfall profits via certificate auctioning, as stipulated by the European Commission for the third trading period (2013-2020). As of 2013, all certificates required by the European electricity producers will be auctioned.

It is commonly argued, however, that the abrupt transition to auctioning may endanger the competitive position of energy-intensive industries in Europe by imposing the CO_2 cost upon them, even though these industries already suffer from the indirect cost originating from the ETS-induced electricity price increases. This is all the more important as it is probable that long-term electricity prices will increase due to the power sector's environmentally desirable fuel switch to natural gas, which will be triggered when the certificates are auctioned. This likely increase in electricity prices due to the forced retirement of coal-fired power plants and investments in new gas-fired power plants may be attenuated, but not outweighed, by the long-term price decrease of CO_2 allowances following the emissions reductions in the electricity sector.

Using the empirical example of electricity production, we demonstrate in the subsequent section that passing through the value of grandfathered certificates to output prices is in perfect accord with rational economic behaviour and, hence, is no indication of a lack of competition. Then, we appraise the magnitude of the windfall profits accruing to Germany's power sector before shifting attention to other energy-intensive sectors. While empirical evidence on the impacts of the ETS is scant, the findings reviewed here cast doubt on the efficacy of the ETS as an instrument to reduce global emissions as long as the other major industrial and transition countries reject integration into a comprehensive global emissions trading system.[7]

CO_2 Certificates, Electricity Prices and Market Power

Electricity markets follow the same economic laws as other markets but with some important particularities. Two key properties of electricity are that, first, it cannot be stored at low cost in large quantities and, second, its demand is highly price inelastic in the short term but subject to substantial temporal fluctuations. These properties imply a high degree of volatility in electricity prices. In the public debate, these substantial fluctuations are frequently misinterpreted as a sign of weak competition among electricity producers. In a similar vein, public scepticism was also aroused by the ETS-induced increase in electricity prices following the largely cost-free allocation of CO_2 emission allowances.

Neither phenomenon, however, can be taken as an indicator for the presence of market power.[8] Rather, the electricity price-raising impact of certificates would also arise under perfect competition. Regardless of whether certificates are distributed at no cost or are purchased, they have a value that can be observed on a daily basis at exchanges such as the Leipzig Power Exchange. Because of the possibility to sell certificates at their market price, a rational electricity supplier will only produce a megawatt hour (MWh) of electricity if the profit from electricity generation is at least as high as the revenue that would be garnered from selling the otherwise required certificates in the market. The electricity price that a rational supplier therefore requests should cover both production and opportunity costs, where in this case the opportunity cost originates from the value of the certificates.

Although opportunity costs are not incurred in the same sense as the actual costs associated with inputs to electricity production, such as natural gas, this kind of cost is nevertheless equally price relevant: Irrespective of whether an emission allowance has been obtained via grandfathering or through an auction, the electricity producer always has the option of selling it at the exchange rather than actually using it in the production process. Indeed, as illustrated in the following, the fact that electricity pric-

5 J. Sijm, K. Neuhoff, Y. Chen: CO_2 cost pass through and windfall profits in the power sector, in: Climate Policy, Vol. 6, No. 1, 2006, pp. 49-72, here p. 49.

6 Y. Chen, J. Sijm, B.F. Hobbs, W. Lise: Implications of CO_2 emissions trading for short-run electricity market outcomes in northwest Europe, in: Journal of Regulatory Economics, Vol. 34, No. 3, 2008, pp. 251-281.

7 See e.g. C. Böhringer, C. Fischer, K.E. Rosendahl: The Global Effects of Subglobal Climate Policies. Symposium Distributional Aspects of Energy and Climate Policy, in: The B.E. Journal of Economic Analysis & Policy, Vol. 10, No. 2, 2010, Article 13, pp. 1-33.

8 Market power is defined as the ability of a producer to raise the price above the level that would prevail under full competition. In the ideal situation of full competition, all market participants are "price takers" and have no ability whatsoever to influence the price. In this theoretic ideal, prices equal the marginal costs of production.

es reflect this option is independent of whether individual suppliers can exercise market power[9] and of the allocation mechanism in place, whether this is grandfathering, auctioning or some mixture of the two.

It is a fallacy to attribute the pass-through of allowance prices to market power because the extent of this pass-through is a function of the supply and demand elasticities, even in the case of perfect competition. According to economic theory, the degree to which firms' higher production costs are passed on to consumers depends on the relative price elasticities of supply and demand. Given the notoriously price-inelastic demand for electricity[10], it is reasonable to surmise that CO_2 prices would largely be passed on to consumers, even if perfect competition prevailed in the electricity production sector.

That the intensity of competition plays a secondary role in the pass-through of CO_2 prices is demonstrated by a simulation exercise for Belgium, France, Germany and the Netherlands.[11] The decisive factor is instead seen in the distinct mix of fuels used for electricity production, which differs substantially across these countries (see Table 1). According to the simulation results, a plausible CO_2 price of €20/tonne would have a particularly strong effect in raising electricity prices only in Germany, where the price increase of electricity would lie between €13 and €19/MWh.

Table 1

Electricity Mixes of Germany, France, Belgium and the Netherlands in 2009

in per cent

	Germany	France	Belgium	Netherlands
Nuclear Power	22.6	75.6	52.0	3.7
Hydro Power	3.9	11.4	2.0	0.1
Wind Power	6.3	1.4	1.1	4.1
Coal	44.3	5.1	6.7	23.4
Oil	2.1	1.1	0.8	1.2
Gas	12.9	4.1	31.9	60.4
Others	7.8	1.2	5.6	7.0

Source: International Energy Agency: Electricity Information 2010, Paris 2011.

The corresponding price increase in France is considerably lower, ranging between €1 and €5/MWh, while it lies in an intermediate range between €9 and €11/MWh for the Netherlands, depending on whether the market structure is assumed to be oligopolistic, monopolistic or fully competitive and on whether the calculation specifies demand which is completely inelastic or moderately elastic.

Given that the various generation technologies imply different CO_2 emissions per MWh and therefore distinct opportunity costs, these results are not surprising in light of the fuel mix in the electricity production of these countries. While France relies on CO_2-free nuclear power for roughly 75% of its electricity generation,[12] gas-fired plants with comparably low CO_2 emissions are dominant in the Netherlands, owing to the country's gas deposits. In Germany, by contrast, electricity prices are largely determined by coal-fired plants. Accordingly, the EU-wide prices for CO_2 allowances increase electricity prices more in Germany than in countries with less carbon-intensive electricity production, an effect that will be exacerbated by Germany's nuclear phase-out by 2022. EU-wide uniform CO_2 prices will continue to have disparate effects on the electricity prices in the individual countries until there is a sufficiently integrated electricity market in Europe. This, however, is unlikely to be achieved in the foreseeable future, given inadequate cross-country network capacities.

The Magnitude of Windfall Profits

Given the observed electricity price increases in the aftermath of the ETS introduction, it is of interest to provide a crude estimate of the magnitude of associated windfall profits. Although the data required for precise calculations

9 The suggestions by politicians, consumers and cartel offices that electricity producers not include the value of grandfathered certificates in electricity prices are fundamentally at odds with free market principles. Were the electricity sector forced to do so, rational electricity producers would reduce production, thereby driving up electricity prices to the point that the sale of certificates would become the unattractive alternative relative to production. As a result, market laws ensure the inclusion of the certificates' value in the electricity price even in the presence of command and control measures. In short, the widely held view that the inclusion of allowance values in electricity prices can be regarded as an indication of the absence of competition among utilities is misplaced.

10 E.R. Branch: Short Run Income Elasticity of Demand for Residential Electricity Using Consumer Expenditure Survey Data, in: Energy Journal, Vol. 14, No. 4, 1993, pp. 111-121, here 111, for example, estimates the electricity price elasticity in the USA to be -0.2. Accordingly, a price increase of 10% would be accompanied by a decrease in electricity consumption of 2%. In a review of the literature from E.R. Branch, op. cit. p. 118), the electricity price elasticity in the USA ranges from -0.11 to -0.55. In contrast to electricity, individual mobility demand seems to be much more elastic. An international survey of empirical studies by P. Goodwin, J. Dargay, M. Hanly: Elasticities of Road Traffic and Fuel Consumption with Respect to Price and Income: A Review, in: Transport Reviews, Vol. 24, No. 3, 2004, pp. 275-292, cites fuel price elasticities varying between -0.89 and -0.04. For Germany, specifically, M. Frondel, N. Ritter, C.M. Schmidt: Germany's solar cell promotion: Dark clouds on the horizon, in: Energy Policy, Vol. 36, No. 11, 2008, pp. 4198-4204 and M. Frondel, C. Vance: Do High Oil Prices Matter? Evidence on the Mobility Behavior of German Households, in: Environmental and Resource Economics, Vol. 43, No. 1 2009, pp. 81-94 find fairly high elasticities ranging between -0.6 and -0.4.

11 J. Sijm et al., op. cit., p. 61.

12 International Energy Agency: Electricity Information, Paris 2006.

Table 2
Gross Electricity Production in 2006 in Germany

	million MWh	Shares	t CO_2/MWh
Nuclear Power	167.4	26.3%	0.000
Brown Coal	152.0	23.9%	1.003
Hard Coal	136.0	21.4%	0.924
Natural Gas	73.5	11.6%	0.470
Hydro Power	27.9	4.4%	0.000
Wind Power	30.5	4.8%	0.000
Biomass, etc.	38.0	6.0%	0.000
Others	10.5	1.7%	-
Total	635.8	100.0%	-

Note: CO_2 emissions factors are taken from M. Klobasa, M. Ragwitz: Gutachten zur CO_2-Minderung im Stromsektor durch den Einsatz erneuerbarer Energien, Fraunhofer Institut für System- und Innovationsforschung, Karlsruhe 2005, p. 20.

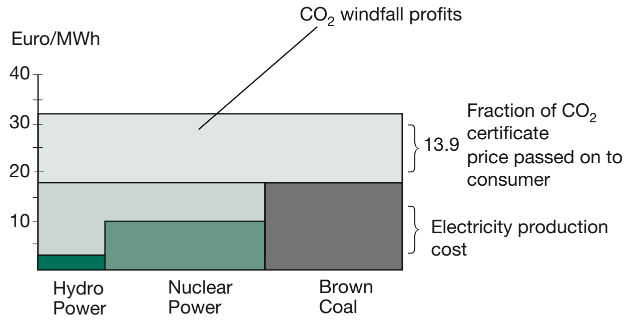
Source: H.-W. Schiffer: Deutscher Energiemarkt 2006, in: Energiewirtschaftliche Tagesfragen, Vol. 57, No. 3, 2007, pp. 32-42, here p. 38.

is largely proprietary, an approximation can be undertaken using publicly available figures for German electricity production (Table 2). The following estimation for 2006 assumes that 80% of the certificate price is passed on to electricity consumers. This share lies in the middle of the 60-100% range that Sijm et al.[13] identify for the CO_2 cost pass-through rates for Germany's wholesale markets. In 2006, CO_2 prices averaged €17.4/tonne at the Leipzig Power Exchange, so an 80% pass-through implies that consumers would bear a CO_2 cost of €13.9/tonne. For electricity production from brown coal, for instance, the 80% pass-through would increase the electricity price by €13.9/MWh, given a CO_2 emission factor for brown coal of around one tonne CO_2/MWh.

While nuclear, hydro and brown coal power plants are typically employed to satisfy base-load demand, the higher cost of production in brown coal power plants usually determines the electricity price in base-load times.[14] Hence, under the ETS regime it is the additional CO_2 cost of electricity production from brown coal that increases base-load prices, irrespective of whether electricity is produced from brown coal, nuclear or hydro power.

While benefitting from these ETS-induced price increases, electricity sources with lower CO_2 emissions than brown coal also incur less additional cost from any CO_2 penalty.

Figure 1
Stylised Example of the Variable Cost of Base-Load Electricity Production Including CO_2 Opportunity Cost Under Grandfathering



Nuclear power, in particular, does not cause any CO_2 emissions and, hence, does not suffer at all from penalising CO_2. It is therefore reasonable to surmise that a large share of windfall profits can be ascribed to CO_2-free nuclear power generation. This is in line with Sijm et al.[15], who conclude that given their high share of nuclear power in total generation, Électricité de France (EdF) and Germany's E.ON may benefit most from emissions trading, even if electricity producers have to buy all their allowances. Note that even without ETS, both nuclear and hydro power benefit from their lower variable unit production costs relative to coal (see Figure 1).

Using the electricity production data for Germany presented in Table 2, the windfall profits attributed to nuclear-based electricity production in 2006 were on the order of €2.3 billion. This estimate is obtained by multiplying 167.5 million MWh of nuclear power by the price increase of €13.9/MWh, which results from the assumed 80% pass-through of CO_2 costs for brown coal-based electricity production. Additional windfall profits accrue to electricity production from hydro power, which also incurs no CO_2 costs. In 2006, 27.9 million MWh of electricity were produced from hydro power. If it is again assumed that the CO_2 opportunity cost is €13.9/MWh, the estimated windfall profits associated with hydro power amount to another €0.4 billion. In short, the CO_2-free electricity production from nuclear and hydro power alone may have accounted for some €2.7 billion of the windfall profits realised by German electricity producers in 2006, illustrating the enormous economic significance of the ETS.

In addition to nuclear and hydro power plants, the CO_2-free electricity production by wind power and other renewable energy technologies – generously supported by Ger-

13 J. Sijm et al., op. cit, p. 67.
14 IEA: Impact of Carbon Emission Trading on Electricity Generation Costs, by J. Reinaud: Energy Prices and Taxes, Second Quarter 2005, pp. xi-xviii, here p. xiv, International Energy Agency, Paris 2005.
15 J. Sijm et al., op. cit, p. 63.

man electricity consumers on the basis of the Renewable Energy Sources Act[16] – also leads to windfall profits for conventional electricity producers.

Not least, even the CO_2-intensive electricity production from brown and hard coal profits from the cost-free allocation of certificates. Assuming for the sake of simplicity that the producers of brown coal-based electricity were to have received all required emission permits without any charge, the windfall profits resulting from the production of 152.0 million MWh of electricity produced from brown coal in 2006 would have hypothetically added up to €2.1 billion, again assuming the extra CO_2 cost to be €13.9/MWh. Of course, the €2.1 billion figure overestimates the true windfall profits of coal-based electricity production, as there were some moderate CO_2 abatement obligations in the first trading period (2005-2007).[17]

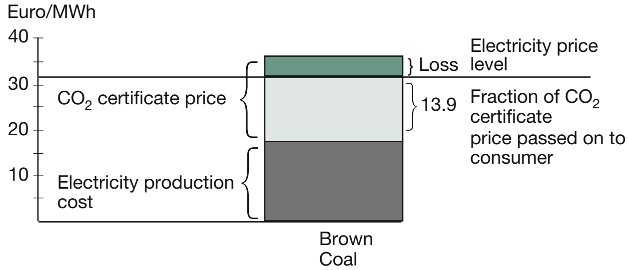
Impacts on Energy-Intensive Industries

By certificate auctioning, such windfall profits could be diminished. This possibility is one of the primary reasons why in the second trading period (2008-2012) German electricity producers must purchase almost 9% of the certificates that are allocated to the sectors participating in the ETS.[18] This is close to the auctioning limit of 10% that is stipulated by the European Commission for the second trading period. For the third trading period (2013-2020), the Commission decided to expand the extent of the auction to cover 100% of all certificates required by European electricity producers.

This may adversely affect the electricity-producing sector, as well as many other industry sectors, as further electricity price increases can be expected to accompany a full auctioning. This consequence appears to be likely given the current CO_2 cost pass-through rates of less than 100%.[19] The incapability of producers of brown coal-based electricity to pass through the entire CO_2 cost to electricity prices would lead to losses under a complete auctioning. This is illustrated by Figure 2, which shows that with an imperfect pass-through of the CO_2 cost, the total cost of brown coal-based electricity production is not completely covered by the prevailing electricity price level. A study of the UK electricity sector initiated by the Carbon Trust[20] confirms this potential auction outcome: without free allowance allocation, the sector incurs losses under a scenario that presumes CO_2 prices of €25/tonne. This level appears to be realistic given the price range of up to €30/tonne that has been observed thus far for ETS emissions certificates. To avoid losses, it may well be expected that producers would seek to push electricity prices higher by reducing supply.

Figure 2

Variable Cost of Brown Coal-Based Electricity Production Including CO_2 Prices Under a Complete Auctioning Regime



Without a doubt, emission-intensive plants, such as those producing electricity from brown and hard coal, incur large CO_2 costs from complete auctioning, thereby triggering the environmentally desirable conversion from high to low-emission technologies. In the short run, European electricity producers involved in the ETS would increase their utilisation of existing gas power plants in place of coal power plants. Over the long term, a complete auctioning would most likely accelerate the retirement of coal power plants and the installation of new gas-fired plants. According to the Carbon Trust[21], this is the main abatement option for the EU electricity sector. The investment cost and higher operating costs of the new gas-fired power plants will put upward pressure on electricity prices. A February 2008 paper by the Swiss bank UBS predicts that 43% of Europe's coal-fired power generation will be converted to gas.[22] *Ceteris paribus*, that is, without an additional reduction of the emission caps stipulated by the European Commission for 2020, this demand shift will decrease CO_2

16 M. Frondel et al., op. cit.; M. Frondel, N. Ritter, C.M. Schmidt, C. Vance: Economic impacts from the promotion of renewable energy technologies: The German experience, in: Energy Policy, Vol. 38, 2010, pp. 4048-4056.

17 According to Germany's National Allocation Plan (NAP1), in the first trading period (2005-2007) existing plants were forced to undertake a CO_2 reduction of 2.91% relative to the historical emission level, resulting in a need to purchase additional allowances.

18 In fact, the purchase of 9% of the total number of allowances that are allocated to the German sectors participating in the ETS covers 40 million tonnes of the annual CO_2 emission volume of 453.1 million tonnes allowed by the European Commission for the second trading period (NAP2 2007, p. 20), with the German electricity sector responsible for about 70% of the overall CO_2 volume emitted by the German industries involved in the ETS.

19 J. Sijm et al., op. cit, p. 67.

20 Carbon Trust: The European Emissions Trading Scheme: Implications for Industrial Competitiveness, The Carbon Trust, UK 2004, p. 11.

21 Carbon Trust, op. cit., p. 12.

22 Economist: A changed climate, The Economist, 2008, http://www.economist.com/world/europe/displaystory.cfm?story_id=12341574.

prices over the long term but will increase long-term gas demand and, hence, the prices of gas[23] and electricity in general. This would result in further pressure on European industries, which already face relatively high electricity prices compared with North America and non-EU European countries such as Norway and Switzerland (Table 3).

These long-term effects of a complete auctioning on power prices and on the competitive position of European industry have received scant attention in both empirical studies and theory.[24] Despite the substantial economic repercussions to be expected from the ETS, there are few empirical analyses that explore the effects of the higher electricity prices from emissions trading on the energy-intensive industries in Europe. A particularly conspicuous research lacuna concerns the effects of a complete auctioning, though a major reason for this is that to date no complete auctioning system has been put into practice. In the USA, for example, one of the first countries to use an emissions trading system, certificates have been almost exclusively grandfathered on the basis of historical emissions.[25]

Besides the Carbon Trust[26] study on the implications of the ETS for the competitiveness of European industrial sectors, one of the few relevant studies is the "Report on International Competitiveness"[27], which was commissioned by the Directorate-General for the Environment of the European Commission and carried out by Ecofys and McKinsey. Because both studies do not consider future developments of Europe's power sector, their results reflect the short-term effects of the ETS. With a complete auctioning of certificates, however, it is most likely that the fuel mix of European power generation would change significantly, with substantially higher demand for natural gas and increasing gas and electricity prices as potential consequences. There is apparently no empirical study that addresses these long-term issues, and the report from Ecofys and McKinsey[28] is no exception. Nevertheless, this study shows that even under the assumptions of small-scale auctioning accompanied by a grandfathering of 95% of allowances and a CO_2 price of €20, the impact of CO_2 penalties on electricity prices could be substantial for energy-intensive industry sectors.

Table 3

Electricity Prices for Industries (2002-2009)

in US cents per kWh

	2002	2004	2006	2009
Italy	11.03	16.1	21.0	27.6
Germany	4.9	7.7	9.4	13.5
UK	5.2	6.7	11.7	13.4
France	3.7	5.0	5.1	10.7
Switzerland	7.0	8.4	8.0	9.4
USA	4.8	5.3	6.2	6.8
Norway	3.1	4.3	5.5	5.9
Canada	3.9	4.9	5.9	5.9
Japan	11.5	12.7	11.7	15.8

Source: International Energy Agency: Electricity Information 2010, Paris 2011.

Among the most greatly affected would be the highly electricity-intensive aluminium producers[29], despite the fact that they have not been involved in the ETS so far. Although not directly affected by CO_2 cost, this sector is indirectly impacted by the ETS-induced electricity price increases. Its migration to countries with low electricity prices, such as the Gulf States of the Middle East or Iceland, would clearly be accelerated by an auctioning system. Small et al.[30], for instance, reach this conclusion for Great Britain as well as for Europe in general. Their study shows that aluminium production on the island would already be completely abandoned at a CO_2 price of €15/tonne even if all allowances were grandfathered. Similar consequences could be expected for other electricity-intensive industries, such as copper production.

For this reason, Ecofys and McKinsey[31] conclude that for energy-intensive industry sectors – and only these sectors are involved in the ETS – the "possibility of production shifts and CO_2 leakage is real". In other words, the ETS-induced burden placed on energy-intensive European industries leads to a transfer of emissions to other countries that have no such climate protection costs. The emissions reduction within the EU would then be offset by emissions increases outside the EU, a phenomenon commonly referred

23 D. Helm: European Energy Policy: Meeting the Security of Supply and Climate Change Challenges, in: European Investment Bank Papers, Vol. 12, 2007, pp. 30-48, here p. 37.

24 An exception is the simulation study by Sijm et al., op. cit., p. 63. These results indicate, for instance, that utilities with an unbalanced production portfolio mix, such as Germany's exclusively hard coal-based STEAG, would experience profit losses under a regime of complete auctioning.

25 P. Graichen, T. Requate: Der steinige Weg von der Theorie in die Praxis des Emissionshandels: Die EU-Richtlinie zum CO_2-Emissionshandel und ihre nationale Umsetzung, in: Perspektiven der Wirtschaftspolitik, Vol. 6, No. 1, pp. 41-56, 2005, here p. 52.

26 Carbon Trust, op. cit.

27 Ecofys, McKinsey: EU ETS REVIEW, Report on International Competitiveness, December 2006, European Commission, Directorate General for Environment, McKinsey & Company, Ecofys 2006.

28 Ibid.

29 Carbon Trust, op. cit., p. 3.

30 R. Small, M. Hartley, C. Hepburn, J. Ward, M. Grubb: The Impact of CO_2 Emissions Trading on Firm Profits and Market Prices, in: Climate Policy, Vol. 6, 2006, pp. 29-46, here p. 40.

31 Ecofys, McKinsey, op. cit., p. 37.

to as carbon leakage,[32] which is conventionally defined as the change in foreign emissions as a share of domestic emissions reduction. Of particular concern is leakage to emerging countries that lack comparable environmental regulation.[33]

Three drivers account for carbon leakage. First, high-polluting industries may relocate outside the EU. Second, imports of pollution-intensive goods may diminish production within Europe. Third, a substantial reduction of the energy demand in countries with strongly curbed emissions could lead to lower energy prices worldwide, which would in turn increase demand for fossil fuels in the remaining countries. While sceptics argue against overestimating the carbon leakage effect, given that environmental regulations are but one of many factors determining firm location, the possibility of resettlement must nevertheless be acknowledged.[34]

The possibility that the importation of pollution-intensive goods could curb European production and not decrease global emissions accordingly appears to be of high relevance. For example, using a trade model for homogeneous goods with high transportation costs and under the assumptions of 90% grandfathering of allowances and a CO_2 price of €20/tonne, Demailly and Quirion[35] find leakage effects of 50% in the cement industry, a sector that accounts for around 5% of global anthropogenic CO_2 emissions. In other words, roughly half of the emission-savings would be offset by cement imports from non-EU countries, with a corresponding decrease in cement production within the EU as a result.[36] This decreased production would not imply a reduction in profits, however, because the EU cement industry could sell its unused allowances, 90% of which were obtained for free. But if these certificates were auctioned at a rate of 50% or higher, the study finds that the cement industry would have to contend with substantial cuts in profits.

The variety of leakage rates resulting from various studies using CGE (computable general equilibrium) models is considerable, ranging from 10-30% on the low end[37] to rates above 100% for oligopolistic market structures.[38] For individual sectors, calculated leakage rates can be much higher than the average rates.[39] In response to carbon leakage concerns, several OECD countries are proposing trade-related measures, such as border carbon adjustments (BCAs), to complement their climate policies. BCAs require importers to purchase emissions allowances in proportion to the emissions embodied in the foreign production of goods, whereas on the other side they would give rebates to exported goods, depending on a benchmark of their emissions intensity. These rebates keep domestic goods competitive on world markets. The EU has so far used preferential allocation of grandfathered allowances to allay concerns about losing profits to foreign competitors, whereas the USA, Australia and New Zealand propose output-based rebating as another form of free allocation to offset most of the carbon cost increases to their energy-intensive, trade-exposed industry sectors.

Such measures, however, are controversial. Some analysts believe that they may harm industries in developing countries while minimally mitigating total carbon emissions. Others argue that these trade policy measures are disguised restrictions to trade, intended primarily to protect the competitiveness of domestic industries in OECD countries.[40] Missing from much of the debate on trade-related measures, though, is a broader understanding of the effects of climate policies that are implemented unilaterally or sub-globally.

Using a CGE modelling framework, Böhringer, Fischer and Rosendahl[41] investigate how unilateral and sub-global climate policies implemented in either the EU or the USA, or in both regions, affect the global distribution of economic and environmental outcomes and how these outcomes may be altered by complementary anti-leakage policies. With a leakage rate of up to 28%[42], carbon leakage is highest if only the EU countries reduce their emissions, whereas

32 J. Oliveira-Martins, H.M. Burniaux, J.P. Martin: Trade and the Effectiveness of Unilateral CO_2-Abatement Policies: Evidence from GREEN, OECD Economic Studies 19, Paris 1992.

33 C. Böhringer et al., op. cit., p. 1.

34 S. Hentrich, P. Matschoss: Emissionshandel in Deutschland – Klimaschutz im Schatten von Lobbyismus und Industriepolitik, in: Energiewirtschaftliche Tagesfragen, Vol. 56, No. 10, 2006, pp. 50-53, here p. 51.

35 D. Demailly, P. Quirion: CO_2-Abatement, Competitiveness, and Leakage in the European Cement Industry under the EU ETS: Grandfathering versus Output-based Allocation, in: Climate Policy, Vol. 6, 2006, pp. 93-113, here 109.

36 According to M. Grubb, K. Neuhoff: Allocation and Competitiveness in the EU Emissions Trading Scheme: Policy Overview, in: Climate Policy, Vol. 6, 2006, pp. 7-30, here p. 12, this high leakage rate can be explained by the large output price increases due to ETS-induced CO_2 costs that tend to “overcome the barriers that have traditionally kept foreign imports out”.

37 M.H. Babiker, T.F. Rutherford: The Economic Effects of Border Measures in Subglobal Climate Agreements, in: The Energy Journal, Vol. 26, No. 4, 2005, pp. 99-126.

38 M.H. Babiker: Climate Change Policy, Market Structure, and Carbon Leakage, in: Journal of International Economics, Vol. 65, No. 2, 2005, pp. 421-445.

39 S. Paltsev: The Kyoto Protocol: Regional and Sectoral Contributions to the Carbon Leakage, in: The Energy Journal, Vol. 22, No. 4, 2001, pp. 3-79; C. Fischer, A.K. Fox: Combining Rebates with Carbon Taxes: Optimal Strategies for Coping with Emissions Leakage and Tax Interactions, Discussion Paper dp-09-12, Resources for the Future, 2009.

40 C. Böhringer et al., op. cit., p. 1

41 C. Böhringer et al., op. cit.

42 Ibid., pp. 18-19.

the leakage rates are lower than 10% if only the USA reduces emissions. An important reason for this discrepancy is that imports and exports in the USA constitute a smaller share of the economy than in the EU. Another reason for the higher leakage with a unilateral EU climate policy is that this region's energy-intensive industries are less carbon-intensive than those in the USA. While the net effect of anti-leakage policies on worldwide abatement costs is moderate, none of the countervailing policies reduce leakage rates very much.[43]

Summary and Conclusions

One of the key points emerging from our review of the EU's experience with emissions trading is the potential for adverse economic repercussions from unilateral climate policies. Based on the theory of finance, unilateral action may lead to not only a reduction of other countries' incentives to diminish greenhouse gas emissions[44], thereby compromising the EU's bargaining position in global climate negotiations[45], but also to large carbon leakage effects, whereby production is shifted to countries lacking stringent climate protection regimes.

These considerations may have been reason enough for the European Commission to avoid the abrupt transition from the current 10% auctioning to a 100% auctioning of certificates beginning in 2013. Instead, the share of permits that must be auctioned by the industry sectors other than electricity will be increased successively, from 20% in 2013 to 70% in 2020.[46] With a complete auctioning, after all, the competitive position of energy-intensive EU industries facing strong international competition would suffer relative to their counterparts in countries without comparable environmental costs, with detrimental effects on economic growth, income and employment.[47] In addition to ETS-induced electricity price increases, frequently called indirect CO_2 cost, the direct production cost increases resulting from auctioning may generate a heavy burden for energy-intensive industry sectors, such as the cement industry or copper and aluminium producers.

The Commission's decision on the exceptional 100% grandfathering of allowances for the most efficient 10% of firms in those industries that would suffer from carbon leakage[48] does not create additional incentives to reduce emissions beyond those already reflected in the ETS-induced higher electricity prices. Nevertheless, these non-electricity sectors should be completely exempted from the auctioning of certificates as long as all other major industrial and transition countries abstain from serious climate protection measures and reject integration into a comprehensive global emissions trading system.

It bears particular emphasis that the future obligation for European electricity producers to purchase all certificates beginning in 2013 may have serious long-term consequences, in that it may trigger a substantial increase in the EU's demand for natural gas. In the long run, this may ultimately lead to higher electricity prices via increasing gas prices, as well as greater reliance on gas imports, in particular from Russia.[49] Not only would a complete auctioning thus undermine the EU's endeavour to improve its energy security situation, it could also result in dramatic changes in countries such as Poland, whose electricity production largely rests on coal-fired plants. Coal-based production currently accounts for 93.1% of total Polish electricity generation.[50] Although there is the exceptional rule of an annually increasing auctioning share for the electricity sectors of several new Member States such as Poland, electricity is anticipated to become much more expensive in these EU countries when full auctioning is prescribed in 2020.

This is all the more relevant as it bears noting that after 2012, a substantial reduction in emissions will be required if compliance with the ambitious European climate protection goals set for 2020 is to be achieved. To reach the EU target of a 20% reduction relative to 1990 by 2020, the European Commission will uniformly reduce the overall emission cap for the ETS sectors by 1.74% per annum, beginning with the year 2010.[51] This would yield a CO_2 emission reduction in the ETS sectors of 21% relative to 2005, a drastic cut compared to the EU's Kyoto target of an 8% reduction relative to 1990 between 2008 and 2012. The most likely consequences would be higher certificate prices, thereby making electricity even more expensive.

43 C. Böhringer et al., p. 29.
44 H. Auerswald, K.A. Konrad, M. Thum: Unsichere Klimafolgen und rationale Klimapolitik, 2011, http://www.oekonomenstimme.org/artikel/2011/06/unsichere-klimafolgen-und-rationale-klimapolitik/.
45 L.P. Feld, K.A. Konrad, M. Thum: Umdenken in der Klimapolitik nach Cancún!, 2011, http://www.oekonomenstimme.org/artikel/2011/04/umdenken-in-der-klimapolitik-nach-cancun/.
46 BMU: ETS Background Paper, Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, Berlin 2008, http://www.bmu.de/files/pdfs/allgemein/application/pdf/hintergrund_ets_richtilinie.pdf.
47 J. Sijm: EU ETS allocation: Evaluation of the present system and options beyond 2012, in: Zeitschrift für Energiewirtschaft, Vol. 30, No. 4, 2006, pp. 285-292, here 291.
48 These are industries that would incur additional carbon cost of at least 5% of their value added and face a trade intensity of at least 10%. If either of these so-called carbon leakage risk criteria exceeds the threshold of 30%, this risk is regarded as permanent for such an industry, giving rise to an unconditional grandfathering of permits for such industries in the future (BMU, op. cit.). Yet, only those firms among the 10% of the most efficient in their sector receive 100% of the permits for free. As a consequence, very inefficient firms in sectors suffering from carbon leakage may need to auction a substantial share of permits, which may easily exceed the share of permits freely allocated to them.
49 D. Helm, op. cit., p. 37.
50 IEA: Electricity Information 2008, International Energy Agency, Paris 2008, III 465.
51 BMU, op. cit.