Discrimination against Newcomers: Impacts of the German Emission Trading Regime on the Electricity Sector

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ABSTRACT: The EU Directive 2003/87/EC for the introduction of a European emission trading system has left the task of allocating the emission allowances mainly to the member states. In Germany the details of the allocation method are laid down in the Allocation Act (ZuG 2007). One central element of the Allocation Act is the so called transfer-rule, which is intended to provide incentives for the replacement of emission intensive installations and thus to achieve environmental benefits. This paper takes a closer look at the transfer-rule's ecological impacts and competitive effects in the field of electricity generation. The analysis suggests that the investment incentives provided by the transfer-rule are limited and uncertain, while at the same time the overall amount of emissions from participants of the trading scheme will not be reduced. Instead the transfer-rule causes windfall profits for incumbent generators and leads to a significant distortion of competition. This cannot be justified by environmental benefits as has been done by the German government and the European Commission.

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KEYWORDS: Emission Trading, Competition, Electricity

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1. INTRODUCTION

In October 2003 the EU Directive 2003/87/EG entered into force, introducing a European emissions trading scheme. One of the main reasons for the introduction of this instrument was that predefined emission targets can be realised cost-efficiently through a market-based mechanism.

For the introduction of an emissions trading scheme on installation level, numerous decisions have to be made with regard to its design. Apart from questions concerning the participants, covered gases or penalties in cases of misconduct or non-compliance, the rules for the allocation of emission allowances are of particular interest for the affected companies or installations.

In accordance with the principle of subsidiarity, the EU Directive has left the task of allocation mainly to the member states. It is important to notice in this context that for the first EU-trading period from 2005 to 2007 at least 95% of the emission allowances and for the second period from 2008 until 2012 at least 90% respectively have to be allocated free of charge. Further general criteria for the allocation are pointed out in Annex III of the Directive.

As the amount of emission allowances is scarce, they have a financial value. Consequently, the method chosen for the primary allocation of allowances can have a significant impact on the individual burdens of each participant and, as a matter of fact, his competitive position. It is evident that different allocation rules for competing entities can lead to distortions of competition.

Such distortions can either occur among existing installations or between existing installations and those that are newly entering the market.

This paper analyses the effects of a selected provision in the Zuteilungsgesetz 2007 (ZuG 2007), i.e. the German Allocation Act, namely which environmental effects will be triggered off and if there will be distortions of competition in the power generation sector.

2. IMPLEMENTATION OF THE EU-DIRECTIVE IN GERMANY

The EU-Directive for emissions trading was implemented in Germany through

- the Greenhouse Gas Emissions Trading Act (TEHG) and
- the Allocation Act (ZuG 2007).

While the former sets the general framework for emissions trading in Germany, the latter regulates the allocation of allowances.[5] According to the Allocation Act, overall emissions in the economic sectors “Energy and Industry” should not exceed an annual volume of 503 Mt CO_2 in the first EU-period. Between 2008 and 2012 the emission budget is fixed at a level of 495 Mt CO_2 per year.

The allocation of emission allowances to the affected installations, among those large combustion plants with a thermal output higher than 20 MW, is in principle based on the average emissions of the period between January 2000 and December 2002. The multiplication of the determined base emissions with a so-called compliance factor gives the amount of the allowances to be allocated.[6] Apart from this there exist numerous special rules such as, for example, the approval of early emission reductions or the provisions for combined heat and power generation installations.

With respect to the question about the possible preferential treatment or discrimination of individual installations, clause 10 (the so-called transfer-rule) is of particular importance.

The transfer-rule, which deals with the allocation of emission allowances for replacement-installations, states the following: if an operator replaces an old installation with a new one within three months after decommissioning, he will - for a period of four years after replacement has occurred - receive the same quantity of emission allowances as he got for his old installation. In addition, the allowances for the newly built installation will not be reduced by a compliance-factor for 14 years.

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5 The national allocation plan was accepted by the EU Commission in March 2005.

6 The actual compliance factor, which is defined in clause 5 of the Allocation Act, is set to 0.97. This is to say that an installation usually receives 97 percent of its average emissions caused in the period between 2000 to 2002.

Since these provisions do not apply for genuine new plants, the transfer-rule leads to a different treatment of existing installations and new entrants. The political motivation for this preferential treatment of replaced entities can be seen through the strengthening of incentives to substitute old, emission intensive capacity through new plants. The intention is to achieve a better environmental impact. This argument by the German government has been accepted by the Commission, which "...considers that in the period of the current allocation plan, the information provided by the Member State on the transfer rule demonstrates that for this period no advantage going beyond what is justified by the environmental benefit of the measure is granted to replacement installations compared to similar investments by other new entrants. For the following period, no difference exists between installations subject to the transfer rule and those to be covered by the reserve for new entrants." (EU Com. 2004, p. 4)[7]

Before the impact of the transfer-rule is analysed in detail, the following section gives a short description of how emissions trading works. A basic understanding of this instrument is a prerequisite for the comprehension of the forthcoming analysis.

3. PRICE FORMATION AND EMISSIONS REDUCTIONS IN EMISSIONS TRADING

Whilst state regulators usually depend on precise command and control measures for successfully ensuring environmental protection, in cases of precaution, other instruments are also suitable. This applies especially to accumulative damages like climate change, which is caused by excessive greenhouse gas emissions. The central problem here is that for a single emitter, the causal connection between his emissions and the resulting phenomenon at macro-level cannot be proven. Therefore, in this case, a restriction on the total quantity of emissions gains much more importance. Once the preferred quantity is determined, from an economic point of view, this target should be met at minimum cost.

Market based instruments like emissions trading enable such a cost efficient realisation of a given target.[8] Here the legislator only provides the participants with an initial allocation.

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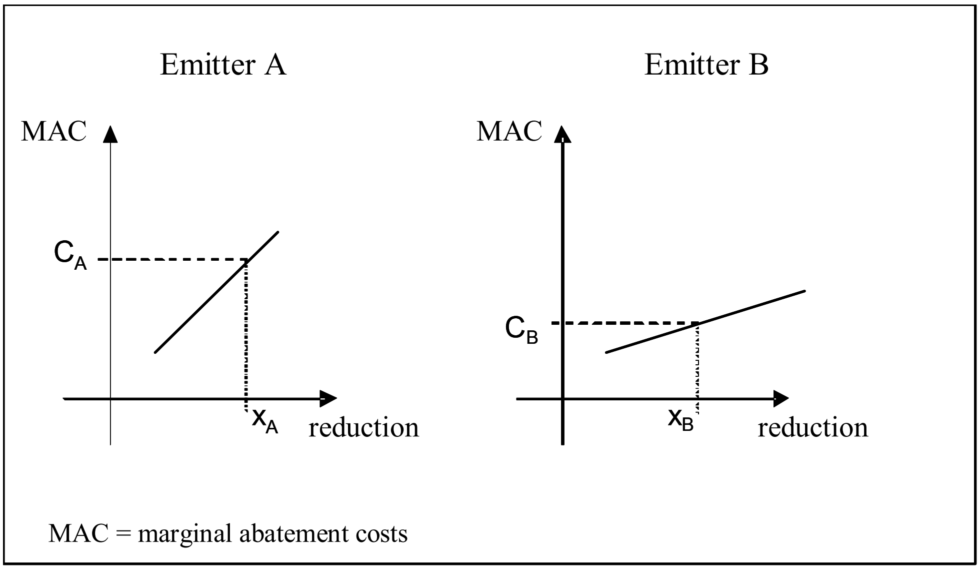
[7] Apart from environmental effects one may also think offsetting a price signal, which is generated through the transfer rule. As new installations receive almost as much allowances as they need (clause 11), there is only little incentive to consider the emission intensity of a new plant. See also the arguments presented below.

[8] For a detailed description see e.g. Tietenberg (1985).

Afterwards the participants are free to choose how to reallocate the allowances and finally achieve the target; either through the implementation of inhouse reduction measures or by purchasing allowances on the market. In the final equilibrium, the marginal abatement costs of all emitters are identical.

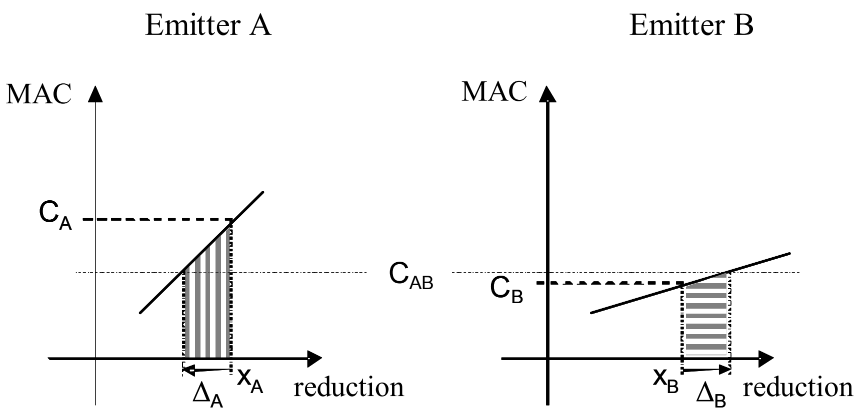
The process is illustrated in more detail in figures 3.1 and 3.2. If two participants A and B are given a precise reduction target X (in a command and control sense), the resulting marginal abatement costs are C_A and C_B respectively. The reduction targets X_A and X_B correspond to an initial allocation under a trading scheme. In the case where the marginal abatement cost amongst the participants differ, the reduction activities change as a result of the interaction between supply and demand. Due to his lower marginal abatement costs, emitter B reduces more emissions than technically needed. This "over-reduction" amounts to Δ_B (see figure 3.2). This in turn is exactly the quantity of emissions that emitter A does not reduce (Δ_A). Instead he buys B's surplus emission allowances. In doing so, the total quantity of emission reductions remains constant and in equilibrium both participants have the same marginal abatement costs C_{AB}. In addition, the total costs for achieving the target are reduced to a minimum. Interventions that lead to a deviation of this equilibrium always result in higher costs as far as the achievement of the overall target is concerned.

Figure 3.1: Reduction activities without emissions trading



The efficiency gains compared to the approach without the adjustment of the marginal abatement costs obviously results from the difference of A's avoided costs (shaded area in Figure 3.2 left) and B's additionally taken over costs (shaded area in Figure 3.2 right).

Figure 3.2: Reduction activities with emissions trading



MAC = marginal abatement costs

Before the effects of the transfer-rule will be scrutinised, it is essential to know relevant characteristics of power plants as well as typical timeframes for planning, licensing procedure and construction that operators in this industry are exposed to when investing in new installations.

4. LICENSING AND TECHNOLOGY FRAMEWORK FOR POWER PLANTS

The technological development and the framework of licensing and construction play a major role with regard to investments in new power stations. In addition, the German Allocation Act determines a trading period, therefore it is important to know whether an operator‘s reaction can follow the legislator’s intentions concerning developments in this period. This will subsequently be investigated. Further, an overview about the development of technical efficiency will be given, providing a basis for later discussions.

4.1 Timeframe for planning and building

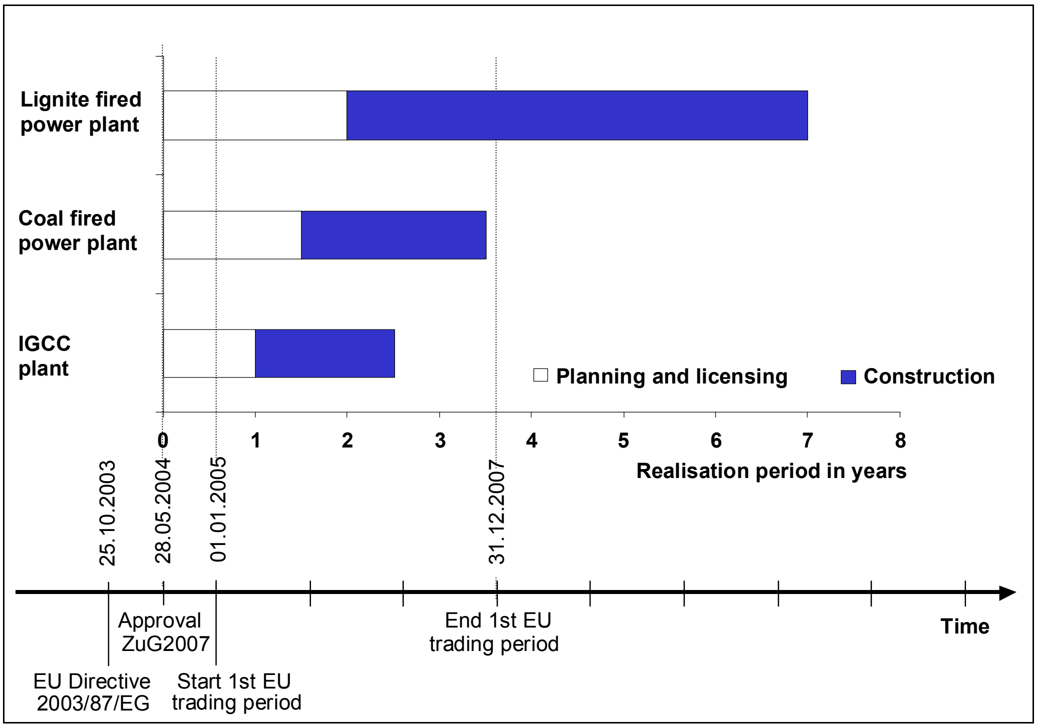
In recent years, power station providers made considerable efforts to shorten the timespan between an investor’s decision to build a new thermal power station and its commissioning. Nevertheless, the time needed for planning, licensing procedure and construction are still measured in years.

4.2 Consequences of the response time and the development of the degree of efficiency

Compatibility of managerial reaction and trading period

The average time periods for planning, licensing and construction of bigger power stations based on fossil fuels are given in figure 4.1. It shows that there are several years between the decision to build a power station and its commissioning. This does not take into account the preparation time within the company that proceeds the actual decision to start planning a new power station. The time required for this is also quite lengthy. Thereafter, it still takes, as experience shows, from at least 2 1/2 years (for a gas and steam cogeneration plant) up to 7 years (for a lignite fired power station), until the installation can be put into operation. According to this, an investor who decided to build a new lignite fired power station in 2004 can count on having the installation finished in 2011 at the earliest.

Figure 4.1: Comparing the realisation period of big thermal power stations with the timeframe of the German Allocation Act



In order to have a direct comparison the time axis at the bottom of figure 4.1 marks the most important data of emissions trading in Germany. The adoption of the Allocation Act through the German parliament on May 28th 2004 provided legal certainty for the first trading period. This period started on January 1st 2005 and ends three years later on December 31st 2007. Counting from the adoption of the law, a potential investor wanting to construct a power station can rely on legal certainty for a little more than three and a half years.

Figure 4.1 directly shows that the transfer-rule (clause 10, Allocation Act), with the intention to make operators of existing installations replace their power plants earlier,

- does not unfold this intention for lignite fired power plants,
- only has this impact theoretically for coal fired power plants and
- may realise its intention for gas and steam co-generation plants depending on technology and licensing due to the necessary response times.

In theory, an operator of a lignite fired power station could replace this installation by a gas and steam co-generation plant. In practice, this is not likely to happen as the operator will not carry out a fuel switch as long as he is still able to mine cheap lignite.

It should be noted that the realisation periods considered here are referring to authorised locations. For new locations, the licensing procedure lasts, from experience, substantially longer.

4.3 Degree of efficiency in cases of newly built power stations

The power efficiency of power plants has continuously increased in the past years (see figure 4.2). It is obvious that there exists already, even without any additional incentives, a steady progress towards a more efficient fuel use. In principle, when building a new power station, the operators aim for the highest possible degree of efficiency. This is mainly due to the subsequent decreasing fuel costs over the long lifetime of the installation.

Compared with today's construction of power stations, it will be possible to reach an increase in the degree of efficiency by several percentage points in the future:

- with lignite fired power stations by fine grain drying. This technology is only available since a short time. Its use in newly built power stations (e.g. in Neurath) has already been announced independently from the implementation of the Allocation Act ,
- with all fossil fuels by the use of higher steam temperatures (700°C). For this, it is necessary to employ new materials that are heat resistant. Standardised overcritical power stations that are ready for the market are not expected earlier than in the middle of the forthcoming decade.

Figure 4.2: Development of the efficiency of power plants in Germany

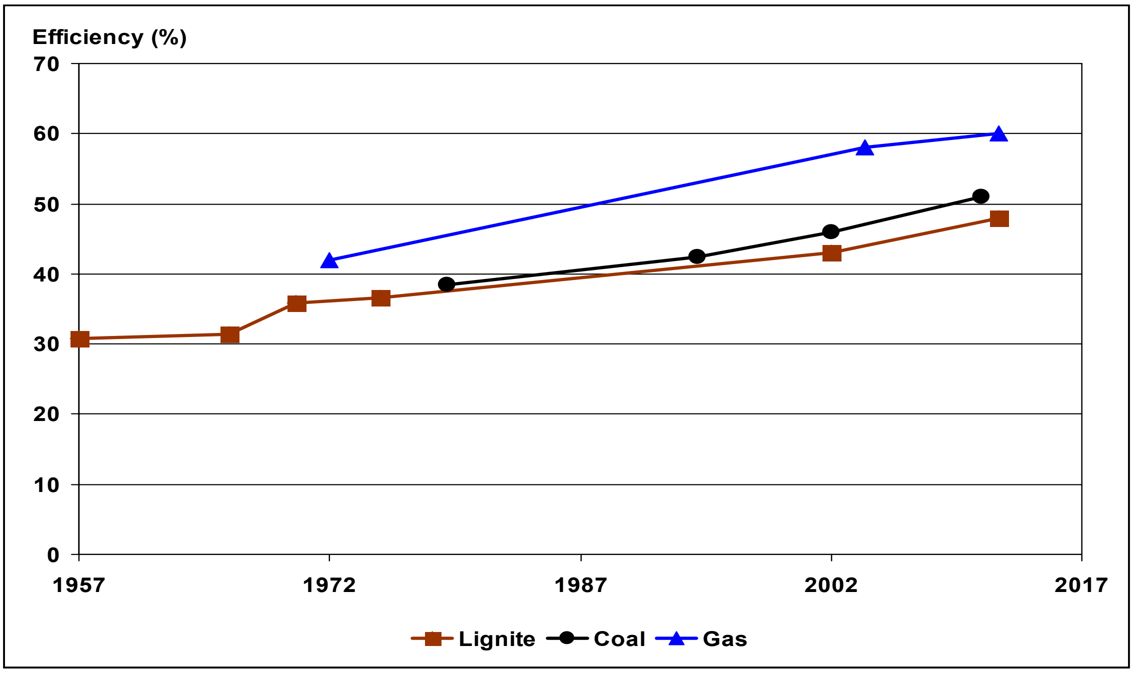


Figure 4.1: Time for planning, licensing and construction of power plants in Germany

	Location	Capacity MW_{el}	*Start of planning*	Permit application	Start of construction	Commissio-ning
Gas	Köln-Niehl II	400	2000 (tender)	n.a.	Apr 03	Nov 04
	Duisburg-Wanheim	240	n.a.	n.a.	Nov 02	Oct 04
	München-Süd	450	Mar 02	July 02	Feb 03	Oct 04
	Hamm-Uentrop	800	Aug 04 (formation operating company)	n.a.	Sept 05	Sept 07
	Lubmin	1.200	April 98 (offer to buy space)	Nov 98	Mar 05	n.a.
Coal	Rostock	500	1991	n.a.	Nov 92	Sept 94
Lignite	Schkopau	900	n.a.	n.a.	Nov 92	July 96
	Schwarze Pumpe	800	n.a.	n.a.	Oct 93	Dec 97
	Boxberg IV	900	n.a.	n.a.	Aug 94	Oct 00
	Niederaußem BoA	965	94	Mar 97	Dec 97	Sept 02
	Neurath BoA	1.050	04	May 04	06	earliest 10
	Boxberg V	600 bis 700	04	n.a.	06	11

Based upon press releases published by the operators: GEW RheinEnergieAG, Stadtwerke Duisburg AG, Stadtwerke München Versor-gungs-GmbH, Trianel European Energy Trading GmbH, Concord Power GmbH & Co. Lubmin KG, Stadtwerke Rostock AG, Veba Kraftwerke Ruhr AG (VKR), Vereinigten Energiewerke AG (VEAG), RWE Power AG, Vattenfall Europe AG

5. ENVIRONMENTAL IMPACT OF THE TRANSFER-RULE

Concerning the environmental impact of the German Allocation Act on installation level it will be investigated whether and to which extent the transfer-rule leads to additional emission reductions compared to the “business-as-usual” case (scenario without transfer-rule).[9] The answer to this questions is not only interesting from an environmental perspective but also in view of competition between different suppliers and state aids.

The analysis can be subdivided into three steps:

- Managerial decision on replacement investments in the absence of climate policy instruments,
- Managerial decision on replacement investments with emissions trading without the transfer-rule,
- Managerial decision on replacement investments with both emissions trading and the transfer-rule.

5.1 Managerial decision on replacement investments in the absence of climate policy instruments

In contrast to the general assumption that the life-span of power stations is technically determined and can therefore be specified by a fixed number of years in operation, the decision about possible decommissioning and subsequent investment in a replacement installation cannot be defined precisely upfront from an economic point of view. The decision maker has to address the issue of the economic viability of the existing installation’s further operation. To this end, the expected revenue has to be compared with the relevant costs. As long as the costs are lower than the revenues, the economic life-span has not yet ended and further operation of the installation is viable.

In competitive markets, the revenue results from the price in equilibrium and the quantity produced. The price is fixed and cannot be influenced by the individual market participants.

[9] Remember that additional environmental benefits have been put forward as the main justification for implementing the transfer rule.

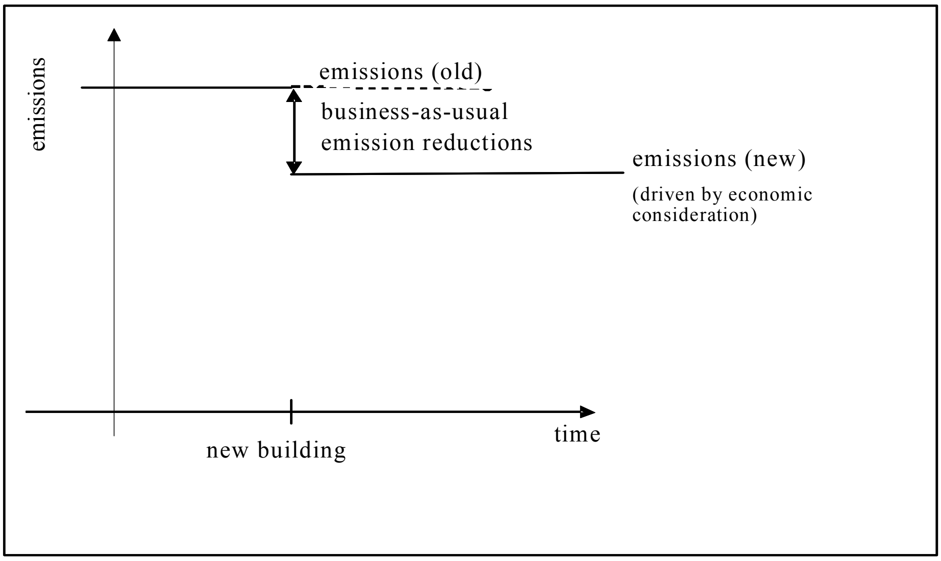
The aforementioned decisions can change when, as an alternative to the decommissioning, there is a possibility to invest in a new installation (in terms of the Allocation Act in a replacement-installation). Under these conditions, it might by all means be viable to decommission the installation before the end of its economic life-span, provided that the expected revenues from the new installation are higher than those obtained by the ongoing operation of the old installation.

In both cases, the decision for or against the further operation of the existing installation is solely driven by the consideration of the economic efficiency.

As a rule, the age of the installation is a decisive factor for its profitability. As elaborated on before, the degree of efficiency of new installations that are entering the market is rising. Due to the higher degree of efficiency, the marginal costs of the new installations are lower than of those existing installations. Hence, the existing installations will be put out of business.

As a result of the described market mechanism, the progress in technology leads to an autonomous increase in efficiency – or, in other words, to autonomous or "business-as-usual" emission reductions (see figure 5.1).

Figure 5.1: Stand-alone emission reductions



5.2 Managerial decision on replacement investments in the case of emissions trading without the transfer-rule

In theory, the implementation of an emissions trading system like the one according to the EU Directive 2003/87/EG, brings along additional costs for the emissions of carbon dioxide. The extent of these costs depends on the effective emissions occurring per energy unit generated (emission intensity) within the installation and the market price of the emission allowances. In this context, it does not make any difference whether the allowances are allocated with costs or free of charge. In the latter case, opportunity costs of the use of emissions allowances have to be taken into consideration: if the operator does not produce (and hence does not have to surrender emission allowances), he will be able to sell these allowances on the market.[10]

Assuming a competitive market for emission allowances, the price of carbon dioxide is equal for all participants of the trading system. Thus it becomes apparent that the emission intensity of the own installation is of crucial importance for an individual operator's decision behaviour. The installation's emission intensity depends on the employed fuel and the plant's efficiency. Old and inefficient installations that involve elevated costs anyway are thereby facing disproportionately higher costs.

The likelihood that these installations will be decommissioned and replaced by new ones increases considerably compared to the scenario without any climate policy instruments (see Figure 5.2). The fact that old, inefficient power stations leave the market is politically desired. According to clause 7 (7) of the Allowance Act for example, a lower compliance factor is imposed on condensing power stations that do not fulfill a determined minimum degree of efficiency and thereby cause higher compliance costs for the operators.[11]

The implementation of an emissions trading system does not change the decision mechanism described under 5.1 for a replacement installation. The operator will decide in favour of or against the further operation of the installation under the general conditions of the commodity market and the market for emission allowances. The investment decisions will also be made in accordance with these general conditions. The decision on a new investment

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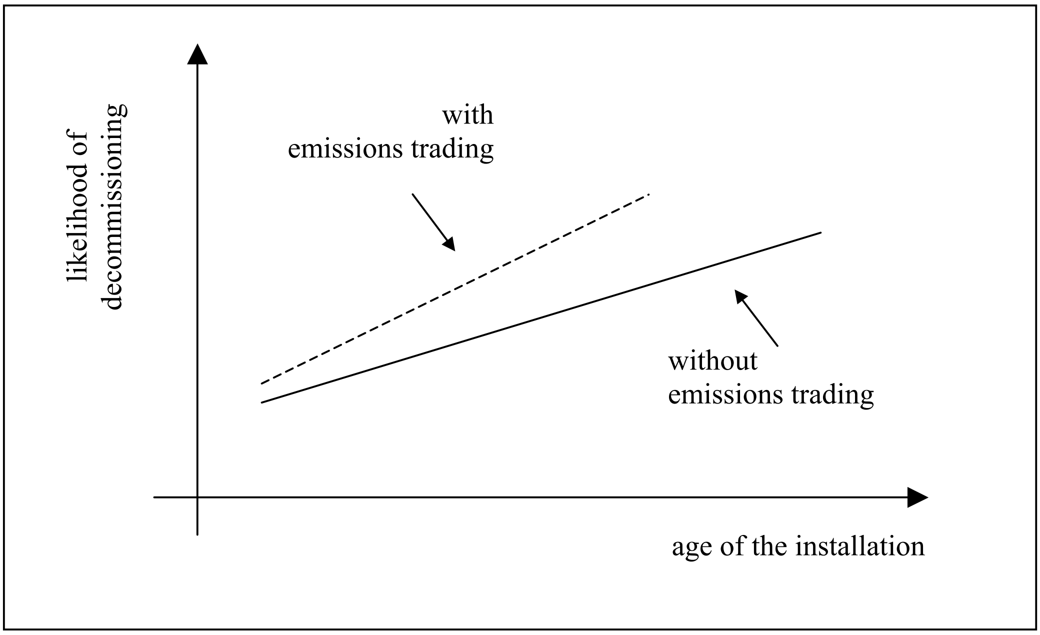
[10] A detailed description for the power sector is given by Bode (2004).

normally implies an emission reduction (see figure 5.1). The investment may be in a new installation that employs the same combustible (e.g. coal - coal) or an installation that is fired with a different combustible (e.g. coal - gas).

Figure 5.2: Likelihood of decommissioning of an installation with and without emissions trading



For the subsequent discussion it is assumed that the investment is made in a new installation which corresponds to the *best available technology* (BAT)[12].

5.3 Managerial decision on replacement investments with both emissions trading and transfer-rule

Operators that replace an old installation by a comparable new one receive emission allowances according to clause 7 for a period of four years. Annex 2 of the Allocation Act, category 1, states that installations for power generation (including combined heat and power plants) that are subject to Annex 1 numbers I to III Greenhouse Gas Emissions Trading Act are "comparable" installations.

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[11] For a more detailed description and classification of mitigation costs and compliance costs see Bode (2003).

[12] The term *best available technology* is not defined uniformly. The definition according to EG-Directive on integrated pollution prevention and control of 30th October 1996 is given in the annex.

Thus, it becomes apparent that the "business-as-usual" emission reductions resulting from the described market mechanism are provided for with additional allowances (windfall gain).

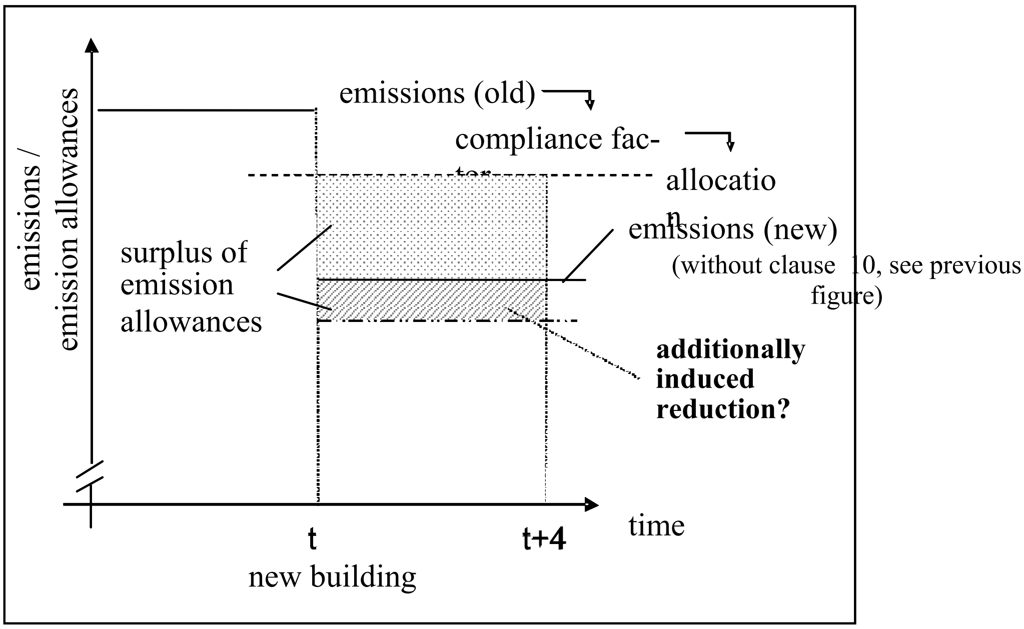
This rule makes sense only if emission reductions go beyond the extent of the stand-alone emission reductions. One can think of additional or brought forward reductions.

5.3.1 Additionally induced emission reductions through clause 10 Allocation Act

For a better understanding of the following section it must be realised that the analysis of possible additionally induced emission reductions does not take temporal elements into consideration. The potential bringing forward of the decommissioning of an installation will be analysed in part 5.3.2.

An additionally induced emission reduction is caused if a decision-maker chooses to invest in an installation whose efficiency exceeds the best currently available technique. In other words, it is caused if he decides to invest in a more efficient installation than the one that he would have considered optimal with regard to the economic efficiency without the transfer-rule (see part 5.2). The investor has an incentive to do so if the expected value of the additionally received emission allowances in the four year period is higher than the costs of excess BAT (see shaded area in figure 5.3).

Figure 5.3: Stand-alone and through clause 10 induced emission reductions



For the legislator it is impossible to prove whether such an incentive works due to existing information deficiencies. Only the decision-makers within the companies are familiar with the actual reasons for a determined investment decision. Against the background of the development of the newly built power stations presented in chapter 4, it can be assumed that an increase in efficiency beyond the already realised and economically motivated extent is limited due to technical reasons and, because of the disproportionately high costs, only sometimes economically viable.

It is not expected that the transfer-rule triggers off substantial additional emission reductions in cases of replacement-investments with the same combustible. A fuel-switch might bring different results. But if such a swap to another combustible is really driven by the transfer-rule and not induced by competition it can hardly be proven. In principle, windfall profits can also occur in this case, too (for economic implications see part 5.5).

5.3.2 Inducement to bring forward emission reductions through clause 10 Allocation Act

Besides an analysis of the possibility of induced additional emission reductions resulting from § 10, it is important to check if the transfer-rule results in early emission reductions due to the prior decommissioning of an installation. Therefore, two different designs of the transfer-rule can be thought of in theory:

- an indefinite validity period,
- a limited validity period

Indefinite validity period of the transfer-rule

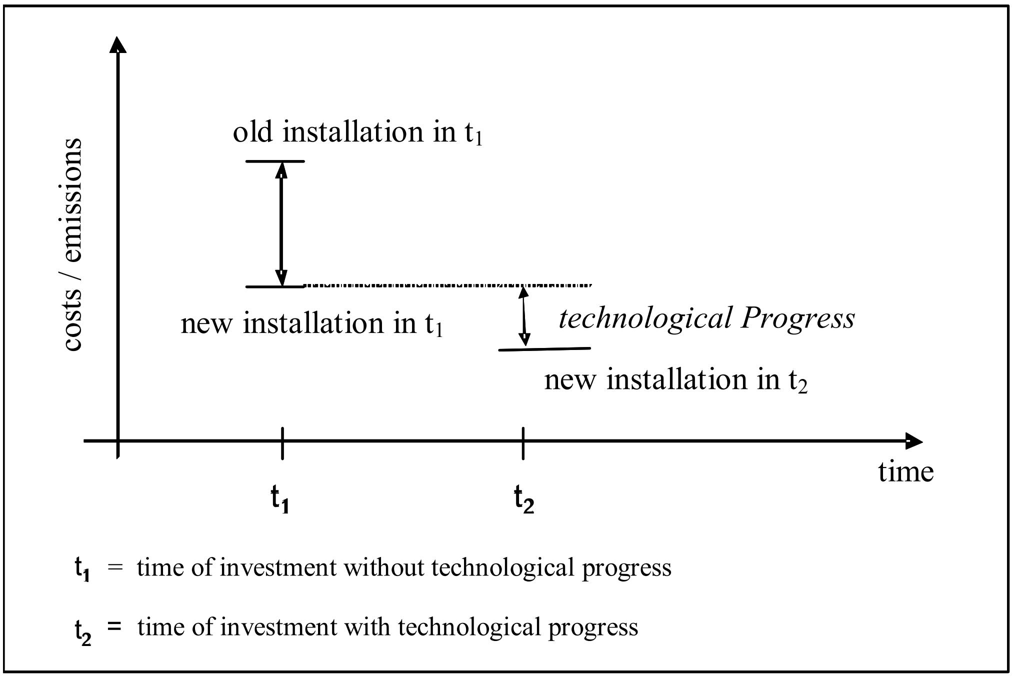
With an indefinite validity of the transfer-rule, the decision-maker initially has no incentive to decommission an installation at a determined point of time.

An incentive for an earlier commissioning of a replacement installation could be induced through the earlier reception of the emission allowances. This results in a financial advantage. On the other hand, this is opposed by the technological progress (see figure 4.2). If progress in technology is expected and an early investment is realised, the decision-maker would be bound to an inefficient installation for its life-span (see figure 5.4). This again would lead to higher production costs and consequently to a reduced quantity of surplus emission allowances.

The intention of the transfer-rule to bring forward replacements can be misleading in cases with a high rate of technological progress. That would create an incentive to defer investments in replacement installations in order to receive more surplus emission allowances later.

Keeping this in mind, in the case of a transfer-rule with an indefinite validity period it is unlikely that substantially earlier emission reductions are brought forward.

Figure 5.4: Specific costs and emissions of a new installation dependent on the rate of technological progress



Limited validity period of the transfer-rule

In case the validity of the transfer-rule is restricted, it can be economically viable to bring forward the decommissioning of an installation (whose expected end of life-span lies beyond the validity period of the transfer-rule) into this period in order to yield surplus emission allowances.

From an economic perspective, such a decision is viable as soon as the expected return of the surplus allowances (see shaded area in Figure 5.3) is higher than the additional costs arising from the early commissioning. Presumably, these costs are low and fulfill the aforementioned provision if and only if the considered installation is old and inefficient and hence the remaining economic life-span is small. Consequently, it can be expected that distinguished effects of prior replacements compared to the “business-as-usual” scenario (without clause 10) are unlikely. The considered installations would have been replaced within a short time anyway.

With regard to the expected quantity of emission reductions brought forward, it has to be stressed that the effect sets in only once – at the end of the validity period of the transfer-rule. Installations, whose economic life-span already ends before the expiry of the transfer-rule, make use of the rule without realising earlier emission reductions (windfall profits). In addition, it is possible that the aforementioned incentive to delay replacement-investments due to a high rate of technological progress might also occur here. Thus, emission reductions would not be expected in this case either.

5.4 Summary of the impacts on entity-level

Due to higher operation costs of old inefficient installations, “business-as-usual” increases in efficiency and thus emission reductions will occur in the course of time. The implementation of an emissions trading scheme further downgrades the competitiveness of old installations so that the likelihood of decommissioning and, if necessary, new building increases. Investments in replacement-installations that are driven by this market-mechanism can yield further emission allowances through clause 10 of the Allocation Act, even without realising additional emission reductions (windfall profits).

Additional reductions induced by the transfer-rule are possible, but not likely. Likewise, an indefinite validity period of the transfer-rule will not bring forward emission reductions.

With respect to a limited validity period of the transfer-rule, a one-time only effect of bringing forward the adoption of emission reductions through replacement investments might happen. It is to be expected that mainly old installations, that would have been replaced anyway shortly after that will be decommissioned earlier. The impact of the transfer-rule is therefore limited. One has to bear in mind too that the longer the rule's validity, the bigger the number of participants that can realise windfall profits.

5.5 Environmental impact of clause 10 of the Allocation Act at a on national level

As shown, emissions trading is a market-based instrument. The legislator decides on the total quantity of emission allowances, and the price for these allowances is determined by the market. As a basic principle, the sum of allowances is therefore constant and neither dependent on the initial allocation when starting the system nor on the distribution amongst participants at the end of a trading period.

The total amount of emission allowances for the participating entities in Germany until 2012 is fixed in the ZuG 2007. Even if in some cases there might occur additional or prior reductions through the transfer-rule, an environmental impact on the macroeconomic level is not to be expected. The surplus emission allowances can be sold on the market and another emitter can use them for his carbon dioxide emissions.

The fact that there are no emission reductions on a macroeconomic level as a result of the transfer-rule leads to the following economic implication: As long as the transfer-rule sets incentives to deviate from the behaviour under the "business-as-usual" case, there is a chance that inefficient emission reduction options will be realised. The mentioned incentives would change the equilibrium compared to an emissions trading market without the transfer-rule.

If the legislator wants to promote earlier or additional emission reductions, he can realise this by changing the total budget allocated to all participants. Emissions trading is a cost efficient way to reach such a goal. Rules that interfere with this mechanism and reduce economic efficiency will not lead to additional reductions on the macroeconomic level.

6. COMPETITIVE EFFECTS OF THE TRANSFER-RULE

6.1 Motivation and structure of the competition analysis

The following section refers to the impacts of the transfer-rule of the German Allocation Act on the competition in the electricity market. The analysis will be carried out in two steps:

- Identification of distortions of competition that are caused by the allocation act, i.e. changes of investment and price setting capabilities of competing firms are to be quantified.
- Evaluation of distorting effects with respect to the actual market situation in the electricity sector.

The relevant legal framework for competitive issues concerning the German electricity market is mainly given by the European competition law. Since Germany's electricity supply industry is embedded in the European single market, it directly falls under the EC's competition rules. In addition to that competitive effects resulting from the allocation of emission allowances are also regulated by the EU directive 2003/97/EC, which provides the general, comprehensive set of rules for the emission trading system.

The directive in article 9 lays down that national allocation acts of individual member states have to fulfil special criteria, which are pointed out in more detail in the directive's appendix. As far as competitive issues are concerned, rule No. 5 of annex III seems to be especially crucial. It explicitly prescribes that individual allocation acts "*shall not discriminate between companies or sectors in such a way as to unduly favour certain undertakings or activities in accordance with the requirements of the treaty, in particular articles 87 and 88 thereof*".

Thus it appears that the EU legislator accepts on the one hand that the initiation of an emission trading system will inevitably affect the competitive position of individual producers. On the other hand it is underlined that such distorting effects can only be accepted, if they are based on convincing reasons. Thereby the directive refers specifically to the EU's rules on state aids.

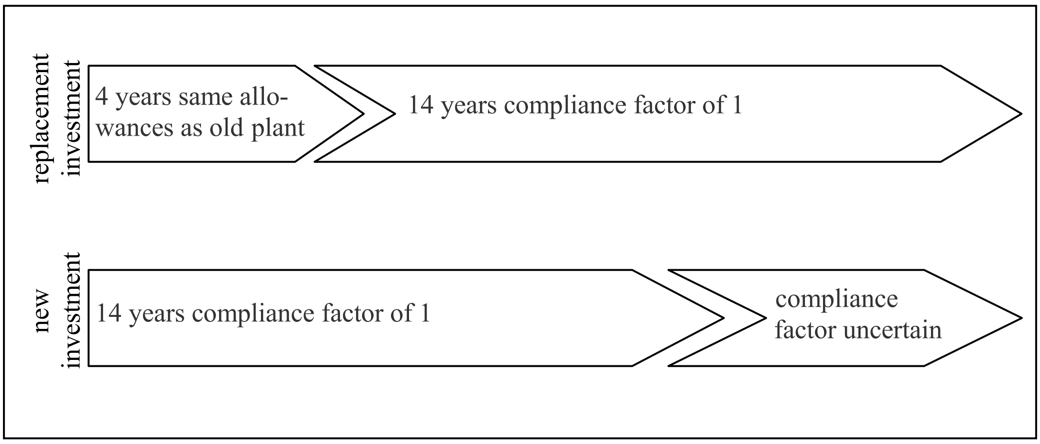
Absolute and relative levels of individual producer's burdens resulting from emissions trading, depend crucially on the chosen allocation method (Bode/Butzengeiger 2003; Bode 2004). Therefore the European legislator points out in clause 11.III of the directive that decisions about the allocation of emission allowances "*shall be in accordance with the requirements of the treaty, in particular the articles 87 and 88 thereof*".

The danger of competitive distortions generally occurs, if comparable issues are treated in a different manner. This may lead to an unequal outcome for individual producers. Now it seems to be the case that the actual German allocation act contains such a distorting element.

The allocation act makes a distinction between allocation decisions concerning new plants on the one hand and replacement investments on the other hand. While the allocation of allowances to "genuine" new plants depends on reference values given by the "best available technology" (clause 11 of the Allocation Act), the allocation to replacement capacity is based upon a so called *transfer-rule* (clause 10 of the Allocation Act). According to this, a reinvesting plant owner receives, for a period of four years, the same amount of allowances that he would have obtained for his old plant. Thus the transfer-rule leads to a higher amount of allowances for owners of replacement capacity than for newcomers who invest in a technologically identical plant (see ch. 5).

Additionally both types of plant operators are treated with a compliance factor of 1 for a period of 14 years, though the transfer-rule causes a delayed initiation for owners of replaced plants (cf. figure 6.1). Thus, they realise another advantage as it is almost certain that the compliance factor will decrease – at least if further emission reductions on the national level are to be achieved.

Figure 6.1: Competitive distortions caused by different allocation rules for replacement and new investments



The next section will at first provide a brief overview of the actual market situation in the German electricity supply industry. Afterwards the impacts of the transfer-rule on competition between plant operators in the electricity market will be analysed. Finally the main implications for anti-trust policy will be explained. Bearing in mind the results of the ecological analysis, this includes a discussion of the question whether the transfer-rule of the German Allocation Act represents an unallowed state aid.

6.2 Actual state of competition in the German electricity market

Presently, competition in the German electricity market is dominated by four generation companies: RWE, E.On, EnBW and Vattenfall Europe. This relatively tight oligopoly emerged after market liberalisation in 1998 and has since then strengthened its position. Shortly after liberalisation of the wholesale market, a broad process of consolidation between the previously monopolistic suppliers was set into progress. The most important developments are reflected in table 6.1. It can be seen that within the first three years after market opening the number of competitors decreased from eight to four. Three of the four existing generation companies were involved in the consolidation.

Table 6.1: Market shares in German electricity generation

1998	Since 2000/01	Market share 1998	Market share since 2000/01*)
VEBA	E.On	18.8	28.8
VIAG		10.0	
RWE	RWE	28.9	37.2
VEW		8.3	
EnBW	EnBW	8.6	8.6
HEW	Vattenfall Europe	2.6	15.0
BEWAG		2.1	
VEAG		10.3	
Other		10.4	10.4
Total		100.0	100.0

*) Note: These are estimated numbers. Since market liberalisation, production data is not collected centrally.
Source: Brunekreeft/Twelemann (2005), p. 103.

Very important for the market development were the mergers between RWE and VEW and between VEBA and VIAG respectively. They have led to the currently dominating companies RWE and E.On, which control about 66 percent of the power generation market. The approval of these mergers by the German Cartel Office involved a requirement for the companies to sell their shares in VEAG, which had been the central supplier in the eastern part of Germany. The VEAG shares were taken over by Vattenfall Europe. Shortly after this, Vattenfall Europe merged with the municipal suppliers of Hamburg and Berlin, HEW and BEWAG.

Although these numbers only give a rough description of the market situation, the share of other, independent generators has indeed hardly changed since the beginning of liberalisation (see Brunekreeft/Twelemann, 2005). This group consists of small municipal suppliers and industrial co-producers on the one hand and new, independent generators on the other hand. Therefore the almost unchanged market share for “others” reflects the fact that since market opening no conventional power plant has been built by a new, independent generation company (see OECD, 2004).

In many liberalised electricity markets new entry by independent power producers occurred on the basis of combined-cycle gas turbines (CCGT). Key reasons for this are the relatively low investment costs and the short timeframes for planning and approval (see IEA, 2004). Until today only two independent CCGT projects have been planned in Germany – Fortum and Dynergy. Both projects were abandoned in 2001. The critical point seemed to be uncertainty about gas procurement from the regional supplier (OECD, 2004). Another reason for the absence of market entry can be seen in the development of German wholesale prices – after market opening prices decreased substantially, they stayed below a cost recovering level for many generators for a long time (see Brunekreeft/Twelemann, 2004).

Nevertheless some new plants were built by incumbent suppliers. This fact indicates existing barriers to entry for newcomers. The market position of the four incumbents is especially strengthened by their ability to control the transmission system and system operations within their individual supply area. Besides, the incumbent generation companies increased their share in regional supply companies, who also control the distribution network. Thus, in contrast to new entries, the vertically integrated incumbents do not only depend on the generation segment, but can also benefit from the transport of electricity.

The competitive advantage of incumbent firms that results from their control over the monopolisitc transmission function was until now reinforced by the existing regulatory framework of the German electricity market. Germany has installed a system of negotiated third party access, which offers grid operators significant freedom in setting their network charges. Control over the level of network charges was until now executed *ex post* by the German Cartel Office. At present the installation of a specific regulator for the electricity sector is under way. Nevertheless the details of the forthcoming regulatory system still remain unclear.

It seems plausible that the loose regulation concept of a negotiated third party access has led to the relatively high network charges in Germany, by which vertically integrated companies can compensate low margins in their generation segment (see Brunekreeft, 2004). Collectively, the vertically integrated incumbents seem to have incentives and scope to use their control over the network in order to raise entry barriers for new, independent generation companies.

To sum up, it has to be pointed out that since liberalisation, conditions for market entry of new, independent generators have remained quite unfavourable. Both of the two CCGT projects that were planned by newcomers had to be abandoned. Instead, incumbent firms were able to increase their market share in power generation via different forms of co-operation. The expected impact of the allocation act, especially its' transfer-rule on the competition between generation companies, has to be assessed regarding this background.

6.3 Competitive Effects of the transfer-rule

As mentioned above, state-run policy measures always cause competitive distortions if their economic consequences for individual suppliers or groups of suppliers are unequal. From this point of view, the German Allocation Act will possibly affect competition in all participating sectors, especially in the electricity supply industry.

The German allocation act prescribes a different allocation of allowances to owners of new plants, depending on whether they replace old capacity or build genuine new plants. Operators, who substitute an existing plant, can make use of the transfer-rule of clause 10, according to which they receive for a time of four years the same amount of allowances that they would have obtained for their old plant. Since new replacement capacities are generally more efficient than their predecessors, substituting operators gain a surplus of allowances that can be sold at the market. Thereby substituting operators receive additional revenues, which enhance their scope in investment and price setting decisions.

Alternatively, operators of genuine new plants fall under clause 11 of the Allocation Act. Accordingly they receive an amount of allowances that is predefined by capacities using the *best available technology*.[13] Because of the obvious difficulties to out-perform this benchmark, it seems unlikely that operators of genuine new plants will gain an allowance surplus and corresponding revenues that are similar to the benefits of their substituting competitors.

These considerations lead to the central hypothesis that the transfer-rule will cause significant competitive distortions, which mainly come at the expense of potential new entrants from both at home and abroad.

[13] Power generators receive at least 365 g CO2 / kWh and a maximum of 750 gCO_2/ kWh.

Of course the magnitude of distorting effects depends largely on the future price development for emission allowances. An indication for the approximate price level is given by the futures market for allowances. Since October 2004 future prices at the European Energy Exchange have increased from almost 8.75 Euro/tCO_2 to around 20.00 Euro/tCO_2 in May 2005 (see EEX, May 2005). It seems likely that these prices still reflect uncertainty about the market development. Therefore the following analysis is based on the assumption of an allowance price of 10 Euro/tCO_2. It should be noted that the precision of the assumed allowance price is not necessary for identifying competitive distortions. The underlying price level affects only the degree of distorting effects.[14]

Now the expected impact of the transfer-rule on the competition between electricity generators can be examined more closely. It is clear that the possible advantages of individual plant owners depend on the specific investment situation. As far as electricity generation is concerned, conditions for investment and production vary strongly between base-load and peak-load capacities. In the following, the different conventional thermal plant types – lignite, coal and gas – will be analysed with regard to the amount of allowances that their operators can receive under the allocation act.[15] For all plant types the allocation results for genuine new capacities and replacement capacities will be compared. The focus will be on the allowance allocation in the first four years after installation of the plants, because in this period the transfer-rule makes a difference between incumbents and new operators. Possible effects of the uncertainty about compliance factors mentioned above will be neglected here. At least it should be noted that newcomers have to face uncertain compliance factors four years earlier than their incumbent competitors.

With regard to replacement investments the following scenarios will be examined: In the base-load segment an old lignite plant will be substituted by a new lignite facility. As far as peak-load is concerned it is also assumed that operators always reinvest in the same fuel source. Actually this seems to be the most probable scenario, because at current price levels of fuel and CO_2, a change within the merit order cannot be expected (cf. Tauchmann, 2004 and Peek et al., 2004). But the possibility of such a fuel switch cannot totally be refused. Therefore the following calculation also includes the replacement of a coal-fired plant by a

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[14] In order to show the influence of the allowance price, two additional scenarios with CO_2-prices of 7 Euro and 15 Euro respectively, have been calculated. The results are presented in the appendix.

new gas-fired facility. Table 6.2 gives an overview of the four scenarios considered and the production data for each case.

Table 6.2: Scenarios for the replacement of generation capacity

Plant Type	**L – L*)**	**C – C**	**G – G**	**C – G**
Capacity (MW)	1.000	600	400	600 – 800**)
Production hours per year***)	6.500 – 7.500	4.500	3.500	4.500
Annual production (MWh)	6.500.000 – 7.500.000	2.700.000	1.400.000	2.700.000 – 3.600.000
Efficiency (old)	0.31	0.33	0.40****)	0.33
Efficiency (new)	0.43	0.45	0.57	0.57

*) L = Lignite, C = Coal, G = Gas
**) Since old lignite facilities face higher costs than new plants, they are replaced downward in the merit order. Therefore, for old lignite plants an annual production time of 6.500 hours is assumed.
***) Since cost data are only available for 800 MW gas-fired plants, a capacity enlargement has to be assumed. Note that the transfer-rule applies only to the share of new plants that correspond to replaced capacity.
***) Combined installation.
Sources: Pfaffenberger/Hille (2004), own assumptions.

Considering the assumed efficiency improvements for the different plant types one can calculate the expected emission reduction (per unit of output produced) that can be achieved after a replacement has been completed. By taking into account the annual production of the different plants, one can now determine the emission reductions achieved per year.

Bearing in mind how the transfer-rule works it becomes clear that a reinvesting operator gains an annual surplus of allowances that corresponds exactly to the emission reductions realised after replacement. Based on this the operator's total surplus of allowances and the additional revenues he can achieve by selling this allowance surplus at the market can be calculated. The results are given in table 6.3. It can be seen that with the assumed allowance price of 10 Euro/tCO_2, reinvesting operators can realise significant increases in revenues in all scenarios considered.

[15] The role of nuclear power and capacities based on renewable resources is neglected here, since costs and profitability of these non-CO_2 emitting plants are not directly affected by emissions trading.

In the case of lignite, potential for emission reduction and additional revenues are especially high. In this case the transfer-rule can lead to extra revenues of about 94 Million Euro for a single plant. This substantial effect can be explained by the high emission intensity of lignite and the high load factors of these base-load capacities. In the replacement scenarios for coal- and gas-fired plants incumbent operators can expect additional revenues of 29 Million Euro and 16.8 Million Euro respectively. If an operator decides to make a fuel switch from coal to gas, his allowance surplus will be worth about 71.4 Million Euro. Once again it should be emphasised that "real" newcomers, who build a new plant in the first place, do not fall under the transfer-rule and cannot realise these benefits.

Table 6.3: Emission reductions and revenues of incumbents realised by the transfer-rule (allowance price: 10 Euro)

Plant Type	L – L	C – C	G – G	C – G
Emission reduction (1 year), (Million t CO_2)	2.34	0.73	0.21	1.78
Emission reduction (4 years), (Million t CO_2)	9.36	2.92	0.84	7.14
Additional revenues (4 years), (Million Euro)	93.6	29.2	8.4	71.4

Source: Own calculations.

Now it has to be questioned, how these absolute revenue streams will affect the competitive position of reinvesting incumbents compared with potential new entrants. For this purpose operational and financial characteristics of the different types of plants have to be taken into account (cf. Table 6.4). This makes it possible to determine the financial and cost-related advantages of incumbent generators.

Table 6.4: Operational and financial characteristics of different plant types

Plant Type	L	C	G
Acquisition costs (Million Euro)	1.000	540	160
Depreciation range (years)	40	40	35
Weighted average cost of capital (in %)	7.1	7.1	7.1

Source: Pfaffenberger/Hille (2004), UBS (2003), own assumptions.

A first indication for the scope of discriminatory effects can be seen by a comparison between the additional revenues of reinvesting incumbents and the acquisition costs of the different plants considered (cf. Table 6.5). If it is assumed that an incumbent uses the extra revenues he gets from the sale of his allowance surplus in order to directly finance his reinvestment project, the financial structure of his project will obviously improve. The windfall profits he yields lead to lower costs of capital, since less capital from equity and debt is needed. The transfer-rule therefore clearly has the character of a subsidy.

In the case of lignite, additional revenues stemming from the transfer-rule account for almost 9 percent of the acquisition costs of a new plant. As far as coal and gas are concerned, about 5 percent of new investments can be financed through the sale of the allowance surplus. If a fuel switch from coal to gas takes place, extra revenues cover (even) 22 percent of the acquisition costs for a new gas-fired plant.

Table 6.5: Additional revenues of incumbents compared with investment costs

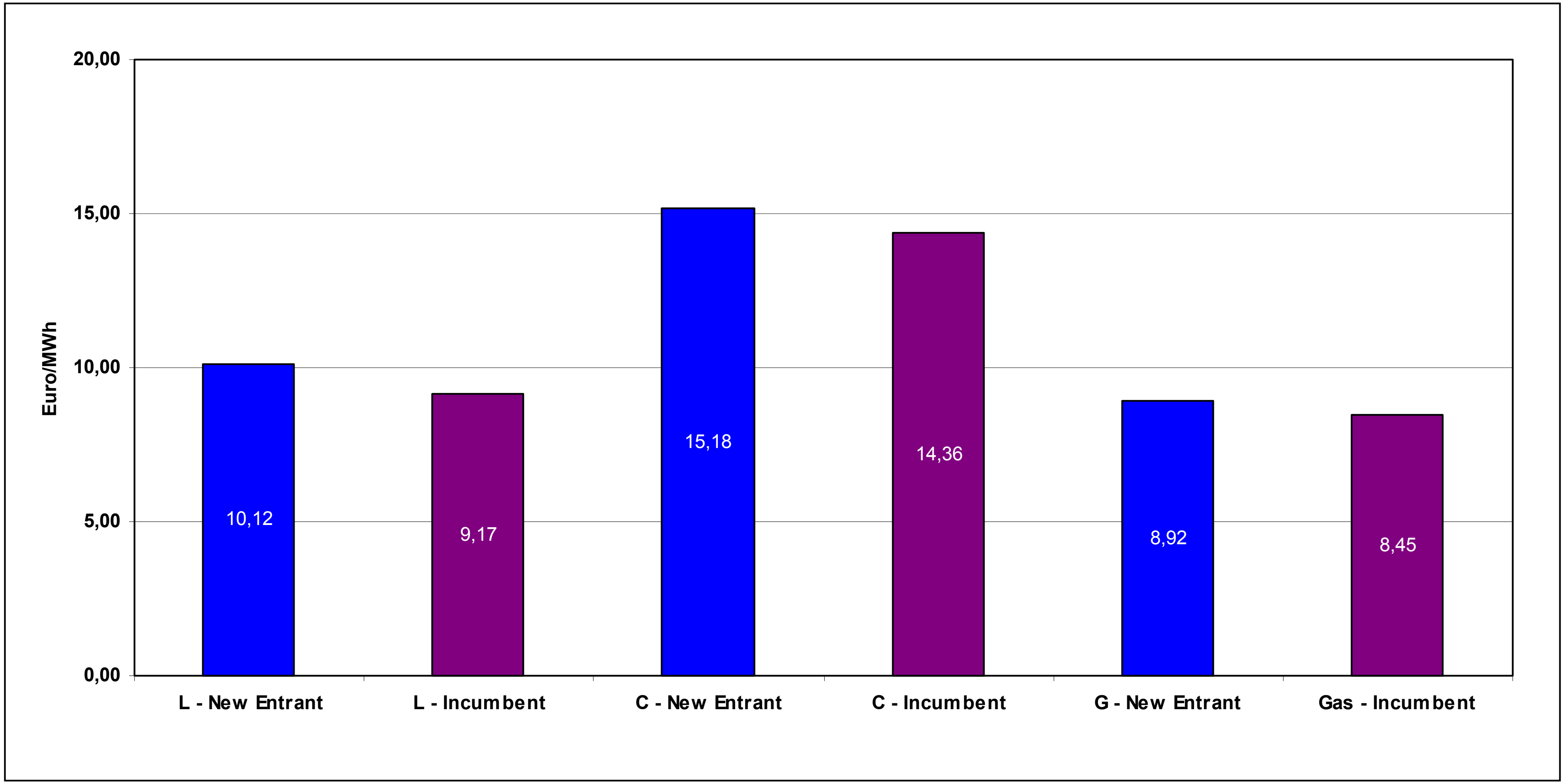
Plant Type	**L – L**	**C – C**	**G – G**	**C – G**
Acquisition costs (Million Euro)	1.000	540	160	320
Additional revenues (4 years)				
- in Million Euro	93.6	29.2	8.4	71.4
- as % of acquisition costs	9	5	5	22

Source: Own calculations.

The extra revenues generated by the sale of allowances also have an effect on the ongoing costs of capital. Since an incumbent does not have to pay any interest or amortisation for this disposable capital, his capital costs per unit produced are lower than the equivalent costs of a real newcomer. Through this finance effect, the temporary “investment aid” provided by the transfer-rule makes an impact on the whole economic life of a reinvested plant. The costs of capital for reinvesting incumbents and new entrants are shown in figures 6.3 and 6.4.

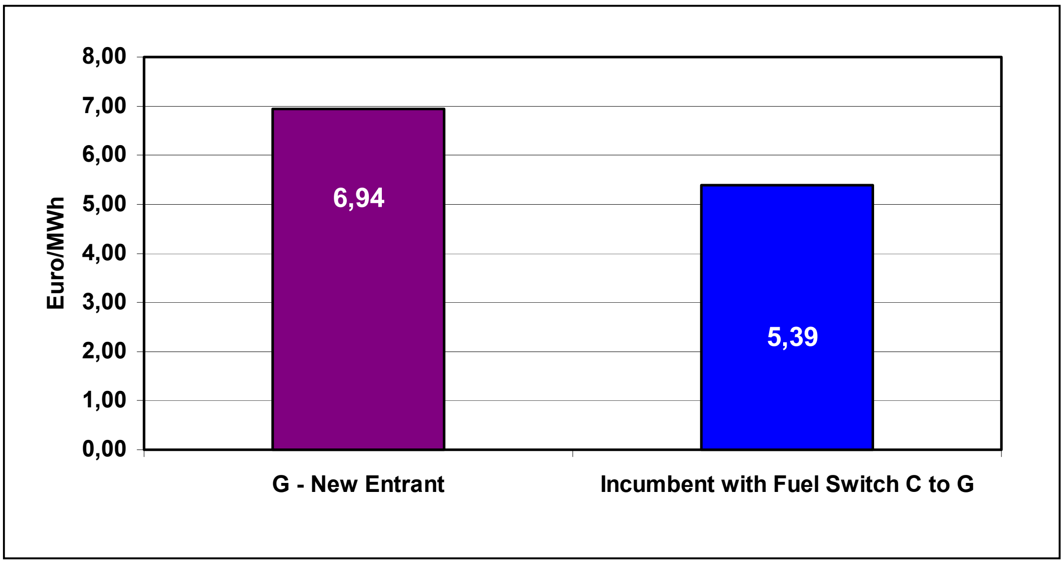
A striking cost differential between both groups of producers occurs in the case of lignite. While newcomers face capital costs of about 10.12 Euro/MWh, incumbent suppliers can produce a MWh with capital costs of 9.17 Euro. In the investment scenarios for coal and gas the capital cost differential is also significant. Calculating the assumed fuel switch of an incumbent from coal to new gas, the incumbent's costs of capital have to be compared with the equivalent costs of a newcomer, who runs an identical gas-fired facility with the same annual utilisation (4.500 hours/year). Thereby extra revenues achieved have to be attributed to the total annual production of the new, larger gas-fired plant (3.6 Million MWh). Note that here a capacity enlargement is assumed. If the capacities of the substituted coal-plant and the new gas-fired plant were equal, the difference in capital costs per MWh would be even higher. The results are shown in figure 6.4.

Figure 6.3: Costs of capital for incumbents and new entrants



Source: Own calculations.

Figure 6.4: Costs of capital for incumbents and new entrants – incumbent's fuel switch from coal to gas

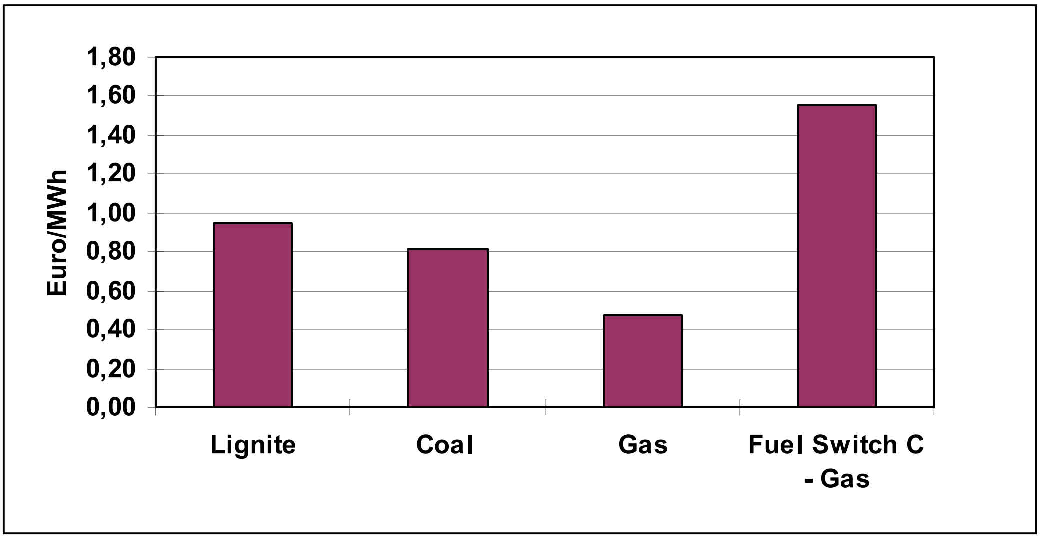


Source: Own calculations.

The resulting cost advantages of incumbent plant operators are shown in figure 6.5. The capital costs for each MWh in a reinvested lignite plant are about 0.95 Euro lower than in an identical new lignite facility. Given the average annual production of about 7.5 Million MWh, this leads to a cost advantage of more than 7 Million Euro per year. In the case of coal and gas plants, cost advantages per unit amount to 0.80 and 0.50 Euro/MWh respectively. This corresponds to an annual advantage of 2.2 Million Euro for coal and 1.4 Million Euro for gas. In the final scenario of a coal-gas fuel switch, incumbent operators realise a cost advantage of 1.55 Euro/MWh. As a result the annual cost advantage would be 5.6 Million Euro.

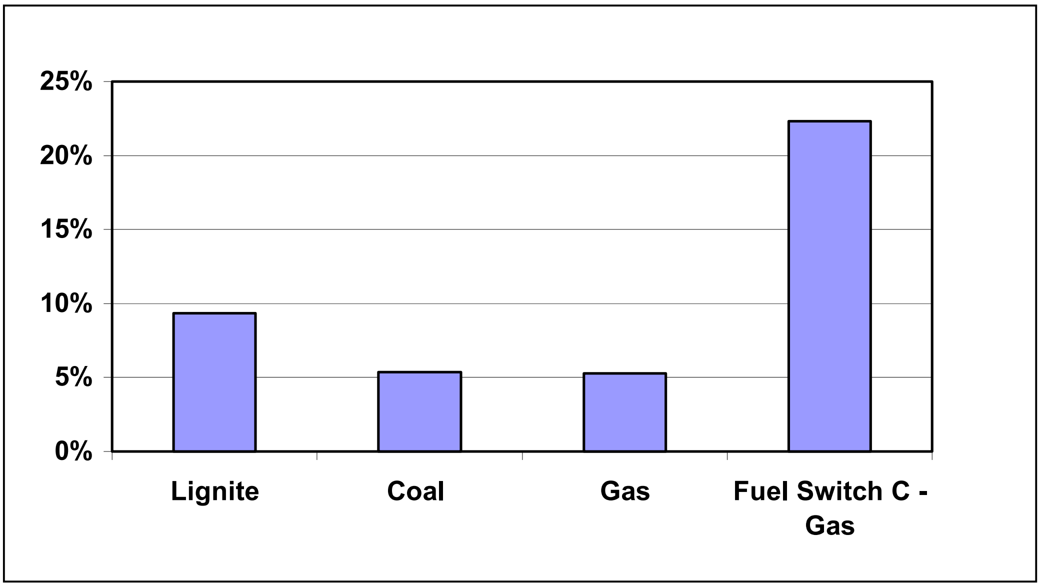
In addition to these absolute differences, figure 6.6 shows the relative cost advantages of incumbents. A reinvesting lignite generator has an advantage of about 9 percent in proportion to the total costs of capital. For coal- and gas-replacements the incumbent's cost of capital are about 5 percent lower than those of a new entrant. If a fuel switch from coal to gas takes place, the relative cost advantage would be even 22 percent.

Figure 6.5: Absolute capital cost advantages of incumbents



Source: Own calculations.

Figure 6.6: Relative capital cost advantages of incumbents



Source: Own calculations.

Finally it has to be mentioned that incumbents also benefit from the later application of the uncertain compliance factor (cf. figure 6.1).[16] Besides this, new entrants who generate on the basis of lignite face another disadvantage, because according to the relevant allocation rule of clause 11, a free allocation to new plants is generally adopted until the maximum emission

[16] Depending on assumptions about the possible compliance factor after 14 years, this additional cost difference can sum up to 50 Million Euro for a new lignite plant.

benchmark of 750 gCO_2/kWh. This target value cannot be reached for the time being even by a new lignite plant using the best available technology.

The described cost effects of the allocation act have to be evaluated carefully regarding the actual competitive situation in the German electricity market. With consideration to the fact that profit margins in the German generation segment are low and entry barriers for new, potential competitors already exist as a result of the loose regulation of network access, additional benefits for incumbent suppliers seem to be quite problematic. It can thus be expected that the transfer-rule will reinforce the given market structure.

After all, one can sum up that the transfer-rule of the German Allocation Act causes a clear distortion of competition that comes at the expense of new, potential suppliers.

6.4 The transfer-rule as an unallowed state aid?

Given the subsidising character and the distorting impact of the transfer-rule, it seems reasonable to examine whether this institutional measure violates the European Community's law on state aid. Following Art. 87.1 of the EC treaty, any forms of aid granted by Member States are prohibited in principle, although this general rule is constrained by some exceptions (cf. Mestmäcker/Schweitzer, 2004). According to the EC treaty state aids are allowed in cases, where positive effects for social and economic welfare can be expected.

First of all it has to be assessed whether the transfer-rule really qualifies as a state aid. Here it can be put forward that this allocation rule directly leads to a benefit for certain companies – in this case the group of incumbent plant operators. Besides it seems evident that this selective aid is granted by the state, because all issues related to the allocation of emission allowances are decided and implemented by public institutions. Moreover the resulting benefits cause a significant distortion of the *level playing field* between competing firms. Therefore central elements of a state aid seem to be fulfilled.

Now the essential question arises as to whether the transfer-rule has an enhancing effect on the overall welfare level, so that it might justify as an exception of the general prohibition of state aids.

Since the transfer-rule is aimed at the replacement of old, emission intensive power plants, welfare enhancements in the form of positive environmental effects could be supposed. This was also argued by the European Commission who declared in its judgement on the German allocation plan that the transfer-rule does not cause any advantages or disadvantages that go "*beyond what is justified by the environmental benefit of the measure*" (EU Commission, 2004).

Nevertheless the analysis about the ecological effectiveness of the transfer-rule as presented in this paper has shown that such an additional benefit for the environment cannot be expected. The rule's incentives and consequences at firm level are highly uncertain – both regarding possible emission reductions and the timing of investments. At macroeconomic level ecological effects clearly cannot be expected, since all individual surpluses of allowances are only redistributed via the trading mechanism. Thereby the overall volume of allowances as well as the corresponding emissions remain unchanged.

Considering the fact that the transfer-rule does not generate an ecological benefit, a justification for the distortions of competition that are created is lacking. As a matter of fact this specific state aid cannot be legitimated on economic grounds.[17]

7. CONCLUSIONS

Regarding the ecological and competitive effects of the transfer-rule as it is implemented in the German Allocation Act, the following findings have to be pointed out:

- The trading period of the German allowance act is not compatible with the licensing and technology framework for power plants.
- Assuming realistic time periods for managerial decisions, in the case of lignite plants, an intended investment shift caused by the transfer-rule is virtually impossible. In this case the rule will just lead to windfall profits. As far as coal- and gas-fired plants are

[17] The price signal generated through the transfer-rule may be seen as a benefit in terms of economic efficiency. However, it should be noted that there are other options that also provide a price signal without distort

concerned, a timely response is only possible, if all phases for planning, licensing and building go according to plan.

- In cases where a permission for a new plant location is needed, the timeframes are stretched significantly, so that responses within the trading period cannot be expected.
- Historical data about installed power plants show a continuous increase in efficiency. This suggests that even in the absence of climate policy instruments, power producers try to implement improved or even the best available technology. This seems reasonable, since the expected time-of-use of power generation facilities is high and every efficiency increase contributes to a lowering of production costs.
- Theoretical analyses of firm's investment behaviour confirm that even in the absence of climate policy the competitive mechanism will lead to autonomous efficiency increases.
- The introduction of an emission trading system causes an earlier replacement of old, emission intensive plants, because additional emissions costs elevate the total costs of these facilities disproportionately to the costs of new capacities.
- As a result of the transfer-rule operators of fossil-fueled plants, who replace their capacities anyway, receive additional emission allowances. The longer the validity period of the transfer-rule is, the higher these windfalls are.
- Substantial efficiency increases that are induced by the transfer-rule are possible, but not probable, because electricity generators already try to achieve a high technical potential. Thus the scope for additional efficiency gains is limited both technically and also economically, since the relevant investment costs increase disproportionately.
- A transfer-rule with an indefinite validity period should not lead to an earlier commissioning of replacement investments. Depending on the scale of technological progress even postponements are possible.
- If the validity of the transfer-rule is time-restricted, an earlier replacement of plants can occur, although this effect may set in only once. Moreover it can be expected that such a replacement mainly affects old, costly plants, which will be shut down soon anyway. Even with a restricted transfer-rule, investment delays are possible depending on the technological progress.
- At the macroeconomic level the transfer-rule does not have an environmental impact, because the overall amount of emission alowances is clearly defined in the Allocation

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competition in such a manner. The transfer rule may even trigger investments which would not be realised under an auction of allowances, which is perceived as efficient allocation option (Crampton/ Kerr, 2002).

Act (ZuG 2007). Even if emission reductions at entity-level take place, a resulting surplus of allowances will be only redistributed via the allowance market. Thereby emissions are relocated to other plant operators, but not reduced.

- The transfer-rule may lower the efficiency of the market-based emission trading system.
- The transfer-rule leads to cost and competitive advantages of incumbent generators, who replace their fossil-fuelled capacity. The incumbents receive a surplus of emission allowances. By selling these allowances, incumbent plant operators realise additional revenues, which enhance their investment and price setting capabilities. Conditions for the market entry of real newcomers, who cannot benefit from the transfer-rule, deteriorate accordingly.
- From an economic perspective the transfer-rule qualifies as a state aid, because the selective benefits for reinvesting incumbents stem from a political act by a Member State.
- The rule generates an additional price signal for the construction of new plants. However, the potential benefit is unlikely to outweigh the drawbacks from the distortion between new and incumbent installations. This state aid is economically unjustifiable, since there are no environmental impacts and corresponding welfare effects of the transfer-rule that could compensate for the resulting distortions of competition.

Finally it has to be underlined that the transfer-rule does not contribute to environmental effects at the macroeconomic level, but merely distorts the competition between established operators of fossil-based plants and new entrants. In this way the German allocation act raises new barriers for the development of a competitive electricity market.

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APPENDIX

Table A1: Incumbent's revenues realised by the transfer-rule (Million Euro)

CO_2-Price	L – L	C – C	G – G	C – G
7 Euro	65.5	20.3	5.9	49.8
10 Euro	93.6	29.2	8.4	71.4
15 Euro	140.3	43.5	12.6	107.1

Table A2: Incumbent's revenues compared with investment costs (% of acquisition costs)

CO_2-Price	L – L	C – C	G – G	C – G
7 Euro	7	4	4	16
10 Euro	9	5	5	22
15 Euro	14	8	8	33

Table A3: Absolute capital cost advantage of incumbents (Euro/MWh)

CO_2-Price	L – L	C – C	G – G	C – G
7 Euro	0.66	0.57	0.33	1.08
10 Euro	0.95	0.82	0.47	1.55
15 Euro	1.42	1.22	0.70	2.32

Table A4: Relative capital cost advantage of incumbents (Euro/MWh)

CO_2-Price	L – L	C – C	G – G	C – G
7 Euro	7	4	4	16
10 Euro	9	5	5	22
15 Euro	14	8	8	33