The Danish CO_2 Emissions Trading System

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Introduction.

This article gives a background to and describes the functioning of the Danish carbon dioxide (CO_2) emissions trading system for the period 2000-2003 that was adopted by the Danish Parliament (Folketing) in 1999. The system sets total quotas for CO_2 emissions from electricity production, introduces emission allowances for the individual power companies and allows for emissions trading and banking. The implications for international emissions trading as well as the notification procedure in the European Commission are discussed.

Danish greenhouse gas reduction targets.

Through a number of national and international agreements Denmark has committed itself to reducing the emission of CO_2 and other greenhouse gases (GHGs). Following the European Community's commitment to stabilize its GHG emissions at 1990 levels in the year 2000 under the United Nations Framework Convention on Climate Change (UNFCCC), Denmark committed to the EU that it would reduce GHG emissions by 5% within this same period. Furthermore by a number of Folketing decisions during the years 1990-1997 and the two Governmental energy action plans, Energy 2000 and Energy 21, Denmark has set a national target of reducing the CO_2 emissions by 20% in 2005 compared to 1988.

The Kyoto protocol, adopted in December 1997 under the UNFCCC, commits the industrialized countries to a reduction of, on average, 5% of their emissions of a 'basket' of six GHGs in the period 2008-2012 compared to 1990 emissions. Among the 6 GHGs, CO_2 is by far the most important. The EU, as Party to the UNFCCC, undertook an 8% reduction commitment for the EU as a whole in 2008-2012 compared to its 1990 emissions. In the internal EU burden-sharing agreement that followed, Denmark committed itself to a 21% GHG reduction[1].

Denmark has made considerable progress in the energy area with respect to reducing CO_2 emissions through energy savings, increased use of combined heat and power (CHP) and renewable energy, as well as fuel switching and increased efficiency of the power plants. This enabled Denmark to accept a high proportion of the EU GHG reductions. However, this effort was more or less offset by extra CO_2 emissions in the period 1994-97 caused by a significant increase in electricity export from Denmark. This electricity export was to a large extent generated on old and environmentally outdated coal-fired power plants. The main cause of the increased export was the low rainfall level in Sweden and Norway, who are both, to a large extent, dependent on hydropower for their electricity generation. This highlighted the problem of CO_2 regulation in an open electricity market.

[1] EU Environment Council Conclusions of 16 and 17 June 1998. Denmark presupposes that the 21 % GHG reduction is to be calculated in relation to import-adjusted 1990 emissions. Furthermore, Denmark has declared that the 21 % reduction presupposes the application of policies and measures adopted at EU level.

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Introduction of market forces in electricity supply.

From 1976 to 1999, the Danish electricity supply legislation enabled the Government to regulate the use of fuel in individual plants through licences and plant approvals. Furthermore it was possible to implement various Government energy policy programmes by agreements with or instructions to the power producers. Even though extra costs were involved in some of these programs, they could be implemented without threatening the market share of the power producers, due to their monopoly position in the Danish electricity market. To some extent, the power companies have even regarded the programs with enthusiasm, since they led to technological development and new jobs. Examples of such programmes are:

- A 450 MW small-scale CHP programme (1986).
- A 100 MW wind power programme (1985).
- A new 100 MW wind power programme (1990).
- A new small-scale CHP programme (1990).
- A biomass-for-power programme (1993).
- A 200 MW wind power programme (1996).
- A 750 MW off-shore wind power programme (1998).

A number of countries have liberalized their electricity markets in recent years, and Denmark is no exception. The EU Electricity Market Directive from 1996[2] lays down the EU rules for the liberalization of the electricity sector in its Member States.

The EU Electricity Market Directive required Denmark to make fundamental changes in its national legislation. One of these fundamental changes was the requirement to provide for objective, non-discriminatory criteria for approval of new power plants. As a consequence of the changes, which subject power companies to competition, their enthusiasm for the national energy policy has disappeared.

The instruments to regulate the CO_2 emission of the electricity sector therefore needed revitalization. For a number of years the emissions of sulphur dioxide (SO_2) and oxiedes of nitrogen (NO_x) from the Danish power plants have been regulated through (non-tradable) emission allowances[3]. This scheme has been successful in the sense that it gave the power companies flexibility to choose technology, location and timing of new flue gas cleaning plants. A number of other quota regulations had proven their effectiveness in real life, including, in particular, the SO_2 emission trading scheme under the US Acid Rain Programme[4]. Emissions trading appears to be an effective instrument if the total emissions of a sector are to be regulated on a non-discriminatory basis. Emissions trading is also the underlying rationale of the 'Kyoto Mechanisms'[5].

[2] Directive 96/92/EC of 19 December 1996 concerning common rules for the internal market in electricity (1997) OJ L27/20.

[3] By Executive Order no. 885 of 18 December 1991 on limitation of emission of sulphur dioxide and nitrogen oxides from power plants as amended by Executive Order no. 321 of 4 June 1998.

[4] See <http://www.epa.gov/acidrain/ardhome.html>

[5] International emissions trading (IET) (Article 17 of the Kyoto Protocol), Joint Implementation (JI) (Article 6 of the Kyoto Protocol) and Clean Development Mechanism (CDM) (Article 12 of the Kyoto Protocol).

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More recently, the Commission of the European Union has opened the debate on emissions trading in the EU by issuing a green paper on emissions trading in the EU[6].

The electricity reform.

A political majority in the Folketing agreed on an Electricity Reform in March 1999. The Reform implements the EU electricity market Directive and seeks to combine the introduction of market forces in electricity production with sustainable electricity production. The Reform has the following main elements:

- a stepwise, complete market opening for all electricity consumers by 2003;
- de-linking of production, transmission and distribution;
- a new price regulation for distribution and transmission companies;
- securing of consumer influence in electric utilities;
- a new arrangement of subsidies for renewable electricity production;
- introduction of a 'green' electricity market covering renewable electricity; green electricity is to be traded through green certificates;
- introduction of tradable CO_2 emission allowances for other electricity production for the period 2000-2003.

Legislation on the Danish CO_2 quotas (the CO_2 Quota Act) was passed by the Folketing in June 1999 together with a totally new Electricity Supply Act[7]. The new legislation was notified under the state aid rules to the European Commission in July 1999. When it became apparent that the Commission would need some time to finalize the approval of the total package, Denmark asked in November 1999 for a separate decision on the CO_2 Quota Act. The Commission raised a number of questions in late December 1999, the effect being that the Quota Act could not become operational in 2000. The Commission formally approved the CO_2 Quota Act in April 2000; the Act entered into force in January 2001.

The Electricity Reform is politically binding until the end of 2003. Before the end of 2001 the parties are to negotiate the electricity sector contribution for the period after 2003. According to the Reform this will take place against the background of experience gained as well as developments regarding the rest of the energy production. Furthermore, the negotiations will take place in the light of the results from the Sixth Conference of Parties to the UNFCCC (COP-6).

Total quotas.

The CO_2 Quota Act lays down a total CO_2 quota for electricity production of 23 million tonnes in 2000. This is reduced by 1 million tonnes per year, to reach a quota of 20 million tonnes in 2003.

[6] European Commision Green Paper on greenhouse gas emissions trading within the European Union, COM(2000)87 of 8 March 2000. Responses to the paper are now available from the Commission's website.

[7] Bill 235 on CO2 Quotas for Electricity Production. An unofficial English translation is available at: <http://www.ens.dk/uk/energy_reform/index.htm>

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Figure 1 shows the historical CO_2 emissions and the quota. For comparison, the total Danish CO_2 emission is around 60 million tonnes.

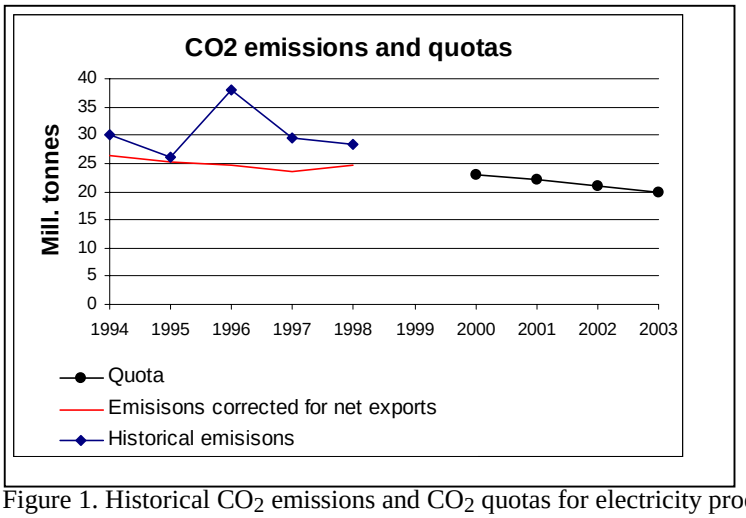

Figure 1. Historical CO_2 emissions and CO_2 quotas for electricity production.

One observation is that the required reductions are fairly substantial. In 2000, the quota is 76% of the 1994-98 emissions, and in 2003 it is only 66% of the historical level. In its approval of the regime the Commission has paid some attention to the required reductions in connection with the grandfathering principle, which is discussed further below.

A technical complication had to be solved due to the strong link in Denmark between electricity and heat production through extensive use of CHP. It is a well established fact that CHP reduces fuel consumption and therefore CO_2 emissions compared to separate production of electricity and heat. The CO_2 Quota Act provides for the sharing of this CO_2 reduction between the electricity and heat producers, thus keeping the incentive to further expansion of CHP. If a power plant produces X units of heat as district heating or process heating, then 0.5 times X units of fuel is subtracted from electricity production and allocated to the heat production.

Will the power companies be able to comply with the quotas?

There are a number of CO_2 reduction measures available in the electricity production sector:

- increased use of CHP;
- fuel switching from coal to biomass, natural gas or oil products;
- increased use of wind power;
- reduced electricity exports.

A number of energy planning exercises[8] have ascertained that the CO_2 reductions laid down in the Act are in fact possible at moderate cost (0-30 US$/tonne). One of the cheapest CO_2 reduction measures is the reduction of electricity exports, since the export – at current market prices - is

[8] Energy 21: The Danish Government's Action Plan for Energy (1996) and Energy 2000: A Plan of Action for Sustainable Development (1990).

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produced with only a marginal profit. On average, electricity exports were responsible for 5.4 million tonnes of extra CO_2 being emitted annually in the period 1994-98.

What is covered by the system?

The legal entities to receive emission allowances are the power companies. The allowances are issued per company, not per unit or per plant. The system covers all electricity producers operating in Denmark, except producers relying entirely on renewable energy. The two foreign-based production companies operating on the Danish market, the German PreussenElektra and the Swedish Vattenfall are also provided with emission allowances. Small producers are exempted. The cut-off level for exemption from the regime is a historical CO_2 emission of less than 100,000 tonnes of CO_2 - but only if electricity is produced as CHP. The exemption reduces the transaction costs for a number of small producers who have already – through establishment of an eficient CHP plant – have contributed to the CO_2 reduction and therefore have limited scope for further CO_2 reductions. cut off, leaving around 15 producers to receive emission allowances. These small CHP producers do not receive an emission allowance and they do not have to pay the penalty in case of non-compliance. The CO_2 contribution from the small producers (1.9 million tonnes) is taken into account in the determination of the total amount of allowances to be distributed to the entities participating in the allowance system to ensure that the sum of emission allowances plus the contribution from the exempted small producers does not exceed the total quota.

The cut-off threshold of 100,000 tonnes of CO_2 from electricity production per year still means that more than 90% of the total CO_2 quota for electricity production will be issued as emission allowances. On the other hand, only around 8 of about 500 electricity producers will be covered by the CO_2 emission allowances regime.

Trading and banking.

The emission allowances under the CO_2 Quota Act are tradable. The trading is done by the electricity producers without Government interference. The number of players on the market is fairly low (8), and the volume of traded CO_2 is also expected to be fairly low, at least in the initial phases. So far, no trading has been recorded (March 2001). For this reason, it was chosen to let trading rely on bilateral agreements rather than setting up an independent market place to handle the trade. Whenever an emission allowance is traded, the Danish Energy Agency must be notified as to the volume of CO_2, the year(s) affected by trading and the price of allowances. Thus, the traded commodity is simply a right to emit X tonnes of CO_2 in a given year.

Unused emission allowances can be banked and used in the following years. Thus the producers are not only provided with an emission allowance but also a saving limit, which – except for a minor difference in 2001 and 2002, introduced for political reasons – is identical to the emission allowance. Banked CO_2 can also be traded.

CO_2 allowances saved in the period 2000-2003 can, in principle, not be used after 2003, since the Act does not fix the total quota after 2003. However, experience from the United States has shown

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that trading might take place even though there are no legally binding allowances[9]. The Danish CO_2 Quota Act does not prevent CO_2 allowances from being carried forward after 2003; in fact the Electricity Reform assumes that to be possible.

Monitoring and compliance.

Monitoring of CO_2 emissions is based on continuous monitoring of the fuel consumption on each electricity and heat producing plant in Denmark. To obtain the CO_2 emissions, fuel consumption is multiplied with a standard value for CO_2 content, see table 1 below. If a power producer can substantiate that the actual CO_2 factor for the fuel used by this particular producer is different, this CO_2 factor will be used.

The CO_2 emissions are annually reported to the Danish Energy Agency. A continuous and online reporting system, like the system under the US Acid Rain Programme, is thus not required.

Fuel	CO_2 (kg/GJ)
Coal	95.0
LPG and LVN	65.0
Motor and aviation gasoline	73.0
Kerosene type Jet Fuel and other kerosene	72.0
Gas/diesel oil	74.0
Fuel oil, waste oil	78.0
Orimulsion	80.0
Petroleum coke	102.0
Natural gas, town gas, refinery gas	56.9
Coke	105.0
Lignite briquettes	97.0
Straw, wood, biogas, fish oil, waste	0.0

Table 1. Standard emission factors for different fuels (referring to lower heat value).

If an electricity producer exceeds the CO_2 emission allowance, taking into account traded CO_2 emission allowances and banked CO_2, he must pay a penalty to the state. The penalty is fixed at DKK 40 (about 5 US$) per tonne of CO_2 emitted in excess of the allowance. The revenue from the penalties is to be used for investments in energy savings. The size of the penalty was settled as the result of a political compromise in the Electricity Reform. Unlike the penalty under the US SO_2 allowance system, the Danish CO_2 penalty is fairly low. Still, it is estimated that compliance is assured under low to moderate electricity prices. At high electricity prices on the market, the probability of non-compliance is high. The reason for the fairly low penalty is the lack of symmetry in regulation of the electricity sectors in neighbouring countries. As other countries introduce CO_2 trading, the penalty can be adjusted upwards to assure compliance and still maintain efficient competition on the international electricity market.

[9] An example of this is given in ”Greenhouse Gas Emissions and Reduction Activities – A Voluntary Company Report in Support of the U.S. Department of Energy Climate Challenge Program.” by Niagara Mohawk Power Corporation (NMPC), November 1999. NMPC traded CO_2 ”futures” for SO_2 allowances.

The functioning of the system.

For year X, the system works as follows:

In year X-1:
- A hearing procedure is carried out among the affected electricity producers, providing the producers with a draft allocation of emission allowances for the following year (X).
- After receiving comments to the draft allocation, each producer receives a final, legally binding allowance (A) for year X, taking into account trading that took place during year X-1, relating to year X.
- Each producer also receives a saving limit (S). If emissions are below S, banking is allowed.

In year X:
- The fuel consumption and actual CO_2 emission (E) of each producer is monitored.
- Trading takes place and is reported to the Danish Energy Agency.

In year X+1:
- The fuel consumption and the actual CO_2 emission (E) of each producer for year X is reported to the Danish Energy Agency, broken down to plant unit level.
- If E > A, a penalty of (E – A) * 40 DKK is paid to the state through normal taxation procedures.
- If A > E > S nothing happens (no penalty, no banking of CO_2).
- If E < S the amount (S – E) is banked and can be used in later years.

In figure 2, the consequences of the CO_2 Quota Act is simulated for the first 7 years of operation, assuming that the 2003 quota of 20 mill. tonnes is extended to the period after 2003[10]. The simulation was carried out on the Danish Energy Agency electricity market model and must only be seen as an illustration of how the power companies might react to emissions trading under a number of assumptions. The most important assumption is the electricity price. This is assumed to be low (0.12 DKK/kWh) in 2000, increasing to a higher level (0.20 DKK/kWh) in 2006.

In 2000 and 2001, the model simulation predicts that the CO_2 emission – because of low electricity prices - is below the quota, sufficient to enable banking of 3.4 mill. tonnes of CO_2 . In 2002, the CO_2 emissions exceed the quota, but no penalty is paid because the bank is emptied. In 2003 and 2004, the bank is empty, and emissions are close to the quota because electricity prices are still fairly moderate. In 2005 and 2006, emissions exceed the quota because of high electricity prices, and the penalty is paid on the excess emissions.

The simulation indicates that the system should work as intended. It also confirms that compliance is not assured under high electricity prices.

[10] No decision has been made regarding the quota after 2003.

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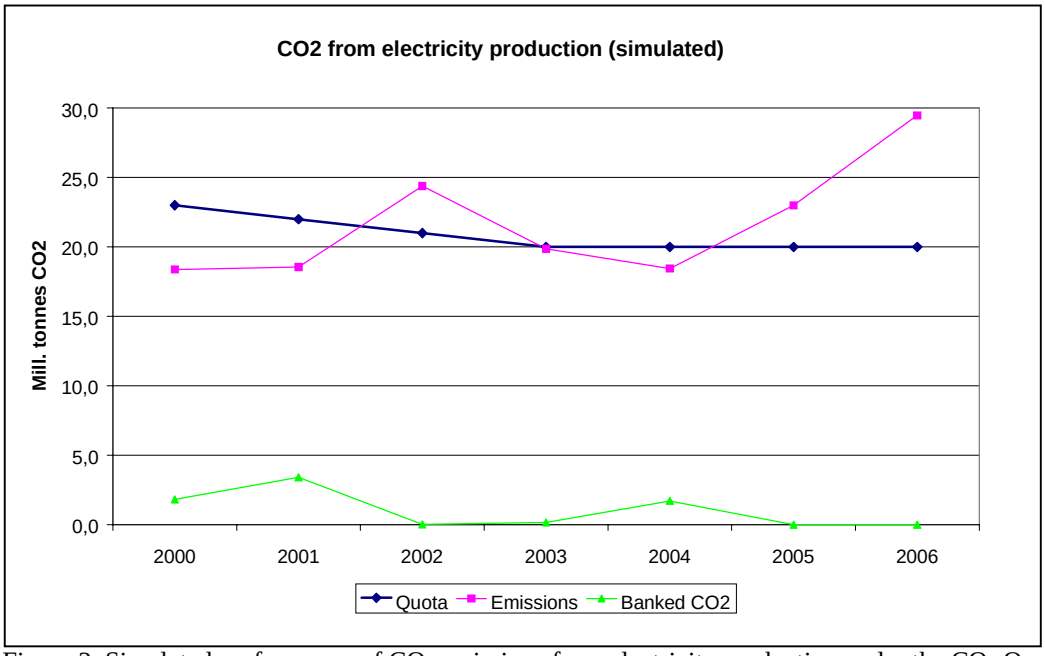

Figure 2. Simulated performance of CO_2 emissions from electricity production under the CO_2 Quota Act.

Initial allocation of emission allowances.

One of the core issues in the design of the regime has been the initial allocation of allowances. As guiding principle, 'grandfathering' on the basis of the historical period 1994-1998 was chosen.

Grandfathering implies that the emission allowances are allocated to existing electricity producers[11] on the basis of historical emissions. This was based on the reasoning that the existing electricity producers have made their power plant investments under the old legal regime without anticipation of CO_2 quotas. Some of these investments might not have been made under the CO_2 Quota scheme, and the producers are therefore to some extent burdened with sunk cost in plants that are not competitive under the new scheme. Thus it was deemed reasonable that the emission allowances should be allocated to the existing electricity producers. Furthermore, grandfathering introduces only a small distortion of the initial competitiveness of electricity companies and is therefore more acceptable to the industry.

In applying the grandfathering principle, special provisions were made for CHP plants. An important feature of the Danish electricity system is the high proportion (about 50%) of electricity produced as CHP, which has already contributed to substantial CO_2 reductions. If 'blind' grandfathering were applied, the CHP production would come under pressure as the quotas are gradually reduced, hence the quota system would prove counterproductive. Therefore a two-step grandfathering approach was chosen in which emission allowances for CHP electricity are allocated first, and emission allowances for condensing electricity are allocated next. Thus, electricity producers who have already contributed to CO_2 savings through CHP production - and therefore

[11] One plant under construction (unit 2 of Avedøreværket, approved under the old legislation) was included under 'existing producers').

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have limited scope for improvement - are not met with the same strict CO_2 reduction requirements as electricity producers who have not produced by means of CHP.

Detailed provisions are laid down in the legal text of the CO_2 Quota Act to remove as many ambiguities as possible in the allocation of emission allowances. This serves the purpose of reducing fruitless discussions with the producers on technical details to a minimum. Furthermore, since non-compliance with emission allowances leads to a penalty on the excess CO_2 emissions, equivalent to a tax, it was necessary with respect to the Danish Constitution to lay down precise and objective rules. The availability of a thorough and consolidated database for all electricity producing plants in Denmark has made it possible to implement the grandfathering principle with great precision.

Grandfathering and state aid.

In the notification procedure under the state aid rules, it became apparent that the Commission considers grandfathering of emission allowances to be state aid. Since this is a core issue of emissions trading, it is of interest to review some of the questions that have been discussed between the Danish Government and the Commission.

In short, the Commission's view is that grandfathering is state aid. The Commission's reasoning is that grandfathering impedes the freedom of establishment, i.e. that a new producer in Denmark (who has no emission allowances and will have to buy them on the market) will be discriminated compared to existing producers (who have received free emission allowances due to the grandfathering principle). As a consequence, the Commission approval of the Danish Quota Act, given in April 2000, presupposes that the Danish Government announces that it will provide new producers with emission allowances according to objective and non-discriminatory conditions, if such producers should come on stream before the end of 2003[12].

Will this decision on new producers have any effect in practical terms?

As far as the Danish Quota Act is concerned, the answer to this question depends on the answer to another question: Will there be any new power stations commissioned in Denmark within the period 2000-2003 where the Act lays down explicit total quotas?

The first part of the answer concerns profitability. Since the current electricity prices on the Nordic electricity market (Nordpool) are only at about half the level required for a new plant to be profitable, there are no power plants in the pipeline. The low electricity prices can in part be attributed to the fact that most countries in Europe have established some degree of over-capacity in electricity production during the monopoly period.

The second part of the answer concerns plant lead times. The most recent power plant project – unit 2 of Avedøreværket – is to be commissioned in late 2001. The application for this plant was submitted to the Danish Energy Agency in late 1994. Thus the plant lead time was 7 years. Of this, 4½ years is the construction time itself. The time spent on political debate and formal treatment of the project in the DEA will be shortened after the introduction of objective and non-discriminatory

[12] Letter from CEU to the Danish Government dated 12-04-2000 on state aid case no. N653/99 – CO_2 quotas.

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criteria for new plants. But power plant projects will still be subject to treatment under the Physical Planning Act and the Environmental Protection Act, requiring at least one year. So even if plant construction time could be shortened somewhat by choosing another plant design, is seems impossible for a new plant to be commissioned before the end of 2003.

The concept of a new producer.

The discussion with the Commission on new producers is therefore purely theoretical as far as the Danish CO_2 Quota Act is concerned. But it has important implications for future amendments to the Act and for legislation on emission trading in other EU member states. Therefore it is of interest to discuss the CEU position on new producers further.

So, what happens if a new producer enters the market? This raises another question: What is a 'new producer', and how many allowances must be given to the 'new producer'? This question - which is crucial to the functioning of emissions trading - has not been explicitly addressed by the Commission.

If the 'new producer' were a new company buying a share of an existing company's power plants (which is in fact the most likely way to enter into power production in Denmark in the short term), it would not make sense to allocate new emission allowances to the 'new producer' since no new production facilities are coming on stream. If a new company constructs a new power plant, the Commission position requires new emission allowances to be given to the new producer. This raises a number of delicate questions, includingwhether the allowance to the new producer should reflect the choice of fuel. If this were to be the case, the question is whether this would encourage the use of more GHG-emitting fuels. If not, then it could lead to the provision of an important loophole by, for instance, allowing a renewable electricity producer to claim the right to receive allowances by simply adding 1 gram of oil to his fuel. If an existing power company (already in possession of emission allowances) were to construct a new power plant, it would be necessary to provide it with new emission allowances in order not to discriminate against new companies, compare above. Otherwise, the result would be fruitless speculation in company structure. If an existing power company were to reconstruct an existing power plant, e.g. by boosting a coal-fired plant with a gas turbine or additional boiler, it is unclear whether that would be a 'new producer' and what the role of the capacity of the gas turbine (1 MW or 100 MW?) would play in this determination.

Thus it appears that there are a number of unsolved legal and technical complications implied by the Commission's position that grandfathering is a discriminatory allocation method.

Competition issues for new versus existing producers in emission trading.

The Commission has taken the view that 'pure' grandfathering is discriminatory towards new producers. However, it appears that this need not necessarily be the conclusion when the actual competitive position of a new producer in case of a new power plant project is considered.

When a producer wants to construct a new power plant, some CO_2 emission allowances must be obtained. This applies to new as well as existing producers. Thus, both new and existing electricity producers will have to purchase emission allowances corresponding to the new electricity production (or pay the penalty). Existing electricity producers will have the additional option of

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shutting down or reducing electricity production on existing plants, releasing emission allowances to be used for the new plant. However, this will reduce the earnings of the electricity producers from these existing plants and will therefore lead to financial loss in the same manner as if they had to purchase emission allowances.

For a new power plant to be competitive, the market price for electricity would have to be substantially higher than today. Existing plants have higher short-term marginal costs than new plants but the capital costs can in day-to-day operation be considered as 'sunk cost'. Consequently, the financial loss by reducing electricity production on some existing plants could be quite substantial. Therefore, it is by no means obvious that the additional option of reducing production on existing plants gives the existing producer (with allowances) a better position on the market than a new producer (without allowances).

Thus it may not be entirely obvious that grandfathering is really discriminatory, at least not if the total number of emission allowances are sufficiently limited, which is the case for the Danish regime as demonstrated earlier.[13]

One suggestion that the Commission made was to prevent existing producers from selling emission allowances from older plants that are to be decommissioned. But this would remove any incentive the producers may have to shut down the old plants – and could therefore prove counterproductive from an environmental point of view.

Competition issues for Danish versus foreign producers.

One of the questions raised by the Commission was whether the CO_2 Quota Act would involve state aid being given to Danish exporters of electricity. The answer is clearly no, since electricity producers situated outside Danish borders who do not have CO_2 emission allowances (and therefore no CO_2 restrictions at all) will – other things being equal – be able to produce electricity cheaper than an electricity producer inside Danish territory, who has used his emission allowance. Thus, the emission allowances do not represent state aid but really the opposite: they pose a restriction on producers in Denmark, that producers outside Denmark do not have. With the trading scheme in place, the Danish producers can never gain competitiveness compared to producers outside Denmark. They will possibly lose competitiveness due to the tightness of the emission ceiling.

One could also argue that producers outside Denmark have unlimited (free) emission allowances, representing an unlimited value, whereas producers in Denmark only have limited allowances, thus representing a limited value. Of course this line of reasoning is only valid on the assumption that the producers outside Denmark do not have CO_2 quotas.

[13] This line of reasoning is supported by Center for Clean Air Policy (CCAP) in their report to the CEU: Design of a Practical Approach to Greenhouse Gas Emissions Trading Combined with Policies and Measures in the EU, November 1999 (page 8). The CCAP seem to suggest less stringent guidelines for the initial allocation of emission allowances than the Commission. Even the Commission Green Paper COM(00)87 of 08-03-2000 on emissions trading to some extent supports this line of reasoning.

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Alternatives to grandfathering.

Other models for allocation of emission allowances were considered as alternatives to grandfathering.

One of the alternatives considered was a model allowing for a certain amount of CO_2 to be emitted per MWh of electricity produced. This amount would be reduced according to the total CO_2 target each year. Producers with CO_2 emissions in excess of this amount would pay a penalty. This model would have basically the same incentives as the actual scheme, since electricity producers having CO_2 emission below the set amount would be able to sell allowances whereas electricity producers having CO_2 emissions above that amount would have to buy allowances. However, this model would not be compatible with a quantitative CO_2 target and was therefore rejected.

The auctioning of CO_2 emission allowances was also considered as an alternative allocation method. Some writers argue that this is the most efficient allocation method. [14] While this may be true theoretically if every Member State introduces emissions trading simultaneously, it involves great difficulties in case of a first-mover initiative as the Danish CO_2 Quota Act. The capital investment needed by the industry to purchase the allowances is in practice a tax[15] on the total electricity production (not only the marginal CO_2 emissions as in the actual scheme) and would therefore be devastating to the power industry as long as other Member States do not have similar arrangements. The devastating effect could be avoided by recycling the auction revenues back to the power industry. This might however raise new state aid issues.

Reactions from the electricity industry.

The industry has reacted in a moderately positive way to the CO_2 Quota Act, since emissions trading is an instrument that runs easily alongside competition. However, the industry would have preferred Denmark to wait until an international emissions trading scheme could be established. There have been discussions on the initial allocation of allowances, and some proposals from the industry have suggested different allocation methods, e.g. methods relating to installed capacity or potential CHP production.

The CO_2 Quota Act has led to questions from power producers and international organizations on the impact of the Danish emissions trading scheme on the general electricity market. Although the model simulation indicates that there will be an effect, it is too early to reach definite conclusions. But as long as the penalty remains moderate, so will the effect on electricity trade.

Emission allowances for 2001.

The emission allowances for 2001 were distributed on 15 December 2000 after a hearing procedure among the producers. The allocations are provided in the form of a letter from the Danish Energy

[14] Ibid.

[15] The tax level (i.e. the price of emission allowances) should in principle settle at the marginal cost of CO_2 reductions corresponding to the CO_2 emission ceiling.

Agency to the individual electricity producers. Table 2 below shows the final allocations for 2001 and preliminary allocations for 2002 and 2003.

Unit: million tonnes of CO_2	Final allocation	Preliminary allocation	Preliminary allocation
Producer	**2001**	**2002**	**2003**
Energi E2 A/S	8.221	7.577	7.135
Elsam A/S	10.533	9.873	9.420
PreussenElektra (EON)	0.965	0.838	0.751
I/S Avedøreværket 2	0.094	0.527	0.510
Østkraft Produktion A/S	0.062	0.060	0.058
Energi Randers Prod. A/S	0.198	0.198	0.198
Dansk Shell A/S	0.102	0.102	0.102
NRGI Amba (Anholt)	0.001	0.001	0.001
Without allowances	1.825	1.825	1.825
Total quota	**22.000**	**21.000**	**20.000**

Table 2. Allocation of emission allowances.

Future developments.

The CO_2 Quota Act makes provisions for initiatives under the Kyoto mechanisms. Thus the Minister for Environment and Energy can issue guidelines on the participation of Danish electricity producers in the transfer of CO_2 reductions between Denmark and another country with a GHG target (under joint implementation) and extra CO_2 emission allowances to be issued as a result of projects implemented in another country without a GHG target (under the clean development mechanism). Power producers have thus far not requested such guidelines. The guidelines activating the mechanisms under the Act can only be issued when international guidelines exist, the adoption of which should be the result of COP-6.

The Electricity Reform is to be renegotiated in 2001. During renegotiations it will be necessary to deal with the period after 2003. Some of the questions relating to the future development of the scheme are:

- How should allocation of emission allowances account for new producers?
- Is it necessary to develop a market place for emission allowances?
- Should more sectors or more players be included in the scheme? Since the industrial and heating sectors are regulated by other means, this was not considered under the current scheme.
- How should the penalty of 40 DKK/tonne of CO_2 be adjusted as other Member States introduce emissions trading?
- Should the time scale of the scheme be longer to remove some of the planning uncertainties for the power producers?

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The views presented in this paper are those of the author and do not necessarily reflect the views of the Danish Energy Agency.

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