Danish Domestic CO_2 Cap & Trade Scheme

Experiences from Emissions Trading 2001-2004

15 August 2006

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Introduction.
As a step towards the Danish compliance with the 21% greenhouse gas reduction target[1] under the Kyoto Protocol, the 1999 Electricity Reform – in parallel with new rules for electricity competition and market opening - launched a domestic CO_2 emissions cap&trade scheme to control the CO_2 emissions from the power producers in Denmark. Total caps were set at 22 mill. tonnes in 2001, decreasing to 20 mill. tonnes in 2003 and 2004.

The Danish CO_2 cap&trade system was restricted to the electricity sector. The main reason was that the electricity production sector after introduction of competition would have been the only ”unregulated” energy sector in Denmark. Emissions trading was considered to be a suitable instrument in a competitive electricity market, as it uses the market forces to locate the cheapest CO_2 reductions.

The CO_2 cap&trade scheme was passed in the Danish Parliament in June 1999. It was approved by the EU under the state aid rules in April 2000 and entered into force in July 2000. The legal text can be found at [xxxx]. The trading scheme was extended to 2004 and then cancelled from January 2005 – when the European emissions trading directive came into force.

The paper describes the functioning of the Danish CO_2 cap&trade system as well as the experience gained. More information can be found at: [xxxx].

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

The CO_2 allowances were allocated per company and not per plant or plant unit[2]. A minimum threshold of 100.000 tonnes of CO_2[3] per year per company was set, reducing the number of companies under the scheme from several hundred to only 8, still covering more than 90% of the CO_2 emissions from electricity production.

[1] The 21% target for Denmark was set as a result of the ”burden sharing agreement” in the EU. The EU obligation is an 8% greenhouse gas reduction.
[2] This is different from the EU scheme which operates with ”installations”.
[3] This is different from the EU scheme which operates with a threshold of 20 MW thermal.

Grandfathering implies that the emission allowances are allocated to existing electricity producers[4] on the basis of historical emissions. Grandfathering introduces minimal distortion of the initial competitiveness of electricity companies and was therefore considered more acceptable to the electricity industry than other allocation methods in a situation without international emissions trading.

However, in applying the grandfathering principle, special provisions were made for Combined Heat and Power (CHP) plants. A high proportion (about 50%) of Danish electricity is produced as CHP, already contributing to substantial CO_2 reductions, hence CHP constitutes a substantial amount of "early action[5]". Therefore, a two-step grandfathering approach was chosen in which emission allowances for CHP electricity are allocated first, and the remaining emission allowances are then allocated as a fraction of historical emissions from condensing electricity production.

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. The precise allocation method and banking provisions can be described as follows:

Using the following definitions:

- E_i = Historical emission 1994-98 (installation i);
- B_i = Emission from CHP (backpressure) less CO_2 from heat production[6] (installation i);
- ΣB_i = Sum of B for all installations;
- C_i = Condensing emissions (= E_i-B_i) (installation i);
- ΣC_i = Sum of C for all installations;
- Q = Total cap (22 mill. tonnes in 2001),

the allowance and banking limit[7] can be calculated as:

- Allowance = $B_i+C_i/\Sigma C_i \cdot (Q-\Sigma B_i)$ (installation i; company allowance is sum of inst. allowances);
- Banking limit = Allowance$*$20/Q.

Based on the principles described above, the CO_2 allowances for 2001, 2002 and 2003 have been allocated to the 8 power producers above the threshold. The allocations are given in the form of a letter from the Danish Energy Agency to the individual electricity producers. Serial numbers were not used to identify each individual tonne of CO_2 allowance. Table 1 below shows the final allocations, before trading.

[4] One plant under construction (a ~500 MW power station approved under the old legislation) was included under 'existing producers'. For this plant, projected emissions were used in stead of historical emissions

[5] CO_2 reductions made "early", i.e. before CO_2 caps were imposed.

[6] CO_2 from heat production on a CHP plant is derived from fuel for heat production, which in turn is defined as heat production divided by 200%. This definition ensures continued incentive for CHP production.

[7] For political reasons, a technical limitation on banking in 2001 and 2002 was introduced. Banking is only allowed if emissions are below a certain "banking limit".

Producer	2001	2002	2003	2004
Energi E2 A/S	8.221	7.577	7.135	7.135
Elsam A/S	10.533	9.873	9.420	9.420
EON/PreussenElektra	0.965	0.838	0.751	0.751
I/S Avedøreværket 2	0.094	0.527	0.510	0.510
Østkraft Produktion A/S	0.062	0.060	0.058	0.058
Energi Randers Prod. A/S	0.198	0.198	0.198	0.198
Dansk Shell A/S	0.102	0.102	0.102	0.102
NRGI Amba (Anholt)	0.001	0.001	0.001	0.001
Without allowances	1.825	1.825	1.825	1.825
Total cap	**22.000**	**21.000**	**20.000**	**20.000**

Table 1. Final allocation of CO_2 emission allowances to power producers in Denmark. Unit: mill. tonnes of CO_2

Due to power company mergers in the wake of the electricity reform, the CO_2 allowance market is dominated by the two main power companies, Elsam and Energi E2.

Figure 1 shows a time series of actual and adjusted CO_2 emissions from power production as well as the caps. There is a clear downward tend in emissions. This is a result of CHP, increased efficiency and increased use of natural gas and biomass in the Danish electricity sector.

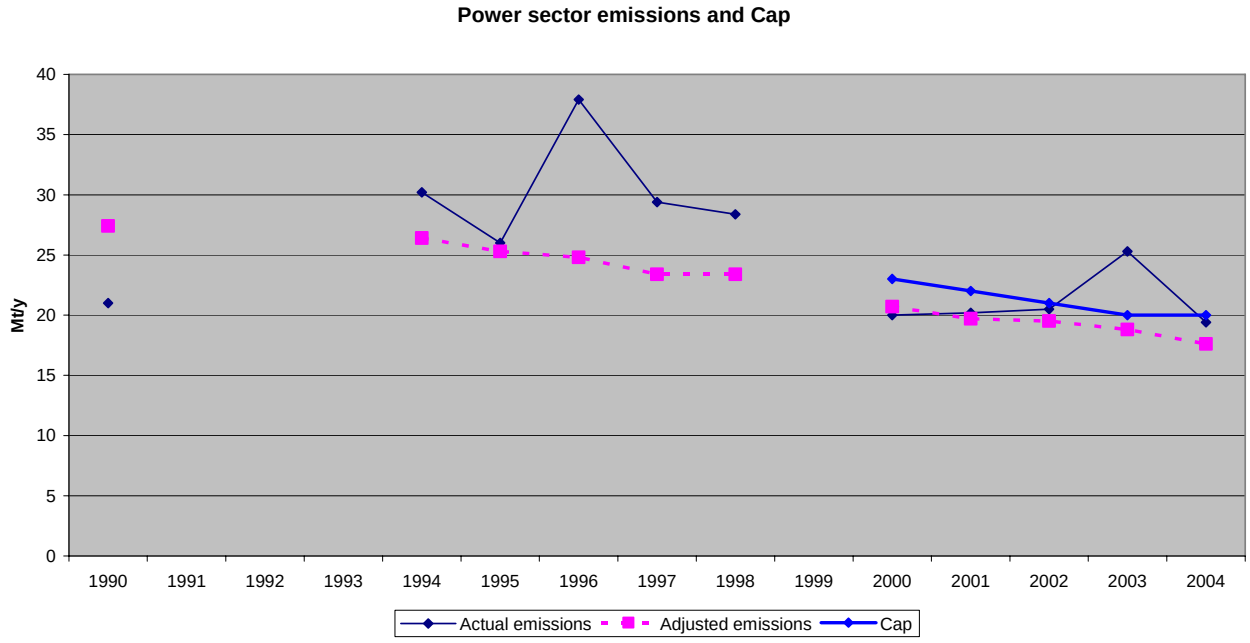

Figure 1. Actual and adjusted[8] CO_2 emissions and the caps[9].

[8] Due mainly to variation in rainfall in Norway and Sweden, the amount of electricity imports and exports undergoes large variations from one year to another. "Adjusted" emissions are emissions if there had been zero net electricity imports/exports.

[9] The cap for 2000 was not applied as the EU approval of the scheme came late.

Trading of Danish CO_2 allowances.
The volume of the Danish CO_2 allowance market was too small to sustain a carbon exchange, hence trading has relied entirely on bilateral agreements. There have been two types of trade: clean trades (trades of Danish CO_2 allowances for money) and swaps (exchanges of Danish CO_2-allowances for some number of "Verified Emission Reductions"[10]). The total volumes are shown in table 2.

Year	Number of trades	Volume (Mt)
2001	9+5	0.263+0.204
2002	13+1	0.408+0.010
2003	5+0	1.122+0
2004	0+0	0+0

Table 2. Number of trades and trading volumes ("clean trades" + "swaps").

Trades were reported to the Danish Energy Authority by buyer and seller no later than 4 weeks after any trade of CO_2 allowances[11]. Prices were also reported but not published. The average price of allowances has been somewhat lower than 40 DKK/tonne (the non-compliance penalty tax), which is perhaps not very surprising. The "exchange rate" between Danish 2001 allowances and VER's has been different from one-to-one.

The CO_2 cap&trade scheme was open in principle to emission credits generated from JI or CDM projects[12]. This required specific guidlines under the Act on CO_2 Quota for Electricity Production, in an executive order issued by the Minister. Such guidelines have not been issued due to lack of demand.

The swaps of Danish CO_2 allowances with various project credits listed above were carried through and entered into the registry, even though it was unclear to the companies if, when and to what extent these project credits could be used as compliance tools in connection with the domestic CO_2 caps or international obligations. Thus, the swaps were quite experimental in nature.

Monitoring and reporting of emissions.
The monitoring of CO_2 emissions was based on a slightly adjusted version of a statistical reporting format that has been used since 1994. The producers report – for each individual power plant or CHP plant – fuel consumption, type of fuel, electricity production, useful heat production and CO_2 emissions. This reporting is based on the existing continuous monitoring of fuel consumption and a number of standardised fuel-to-CO_2 conversion factors (see table 3). The monitoring did not require the producers to have continuous in-stack on-line monitoring of CO_2. The emissions reports were checked by the Danish Energy Authorities but not by independent verifiers.

[10] Project credits derived from activities such as carbon storage in enhanced oil recovery projects, wind power projects abroad or reforestation.
[11] The information must include volume, vintage and price.
[12] Joint Implementation and Clean Development Mechanism.

The reporting forms covering actual emissions were sent to the power producers early February to be returned by 31 March. The Danish Energy Authority processed the information, taking into account trading, so that a final decision could be made by 1 July on actual emissions, compliance with caps, banking and non-compliance penalty tax for each participating company.

Fuel	CO_2 (kg/GigaJoule)
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 3. Standard emission factors for different fuels (referring to lower heat value).

Parallel to the 2001 reporting, the DEA asked a consulting firm (ref. 2) to investigate the monitoring procedures and the level of accuracy of the CO_2 emissions reported by the two largest producers. The firm estimated that the total uncertainty on CO_2 emissions was in the range of 1-3%, given the CO_2 conversion factors in table 3. However, an additional uncertainty arises from the use of standard conversion factors because the actual emission per energy unit from a given fuel has a variation around the standard factors. This is especially the case for coal. Thus, the total uncertainty on the reported CO_2 emissions could go up to 8% for a single coal-fired plant.

However, the consulting firm concluded that the companies' reporting gave a good estimate of the CO_2 emissions under the given technical and legal constraints.

Registry.
The registry under the Danish domestic emissions trading scheme was a simple password-protected spredsheet. Trades were reported by fax or email and then entered manually into the registry by one of the three persons with access to the registry.

The cost of the registry was therefore very low.

Compliance.
In case of non-compliance, there was a penalty tax of 40 DKK (€ 5.3) per tonne of excess CO_2 emissions. The revenue from the penalties were used for energy savings.

The size of the penalty was settled as the result of a political compromise in the Electricity Reform and must be considered as fairly low. Thus it did not necessarily secure compliance under all market conditions, contrary to the penalty under the US SO_2

allowance system or the penalty under the EU scheme[13]. The reason for the fairly low penalty was the competitive situation between the electricity sectors in Denmark and neighbouring countries (where emissions trading was absent until 2005).

The final decision on whether or not a producer must a pay penalty tax or can bank some allowances to the next year is based on the following math:

Using the following definitions:
- E = Emissions from company;
- A = Allowances allocated to company;
- P = Purchased allowances;
- S = Sold allowances,

then:
- Surplus of allowances = A - E + P – S;
- If surplus < 0, a penalty tax is paid (40 DKK/tonne of excess emissions);
- If surplus > 0, the minimum of Surplus and (Banking limit – E) is banked.

Table 4 shows the total non-comliance and payment of penalty tax. For the electricity sector in total, there was non-compliance in 2003 only. This was due to low rainfalls in Norway and Sweden that year.

However, in 2002 and 2004 some companies were in non-compliance even though the total number of allowances was sufficient to cover all emissions. Thus, trading was unable to re-allocate allowances in all cases, which must be ascribed to the immature nature of the Danish CO_2 market at the time.

Year	Total excess emissions (Mt)	Penalties (M€)
2001	0	0
2002	0	1.0
2003	4.47	23.8
2004	0	0.03

Table 4. Compliance and penalty tax in the Danish domestic CO_2 cap & trade scheme.

Administration.
The administration of the CO_2 cap&trade scheme and the operation of the registry of CO_2 allowances was handled by the Danish Energy Authority. The electricity producers paid an administration fee of 0.079 DKK (€ 0.011) per tonne of allocated free CO_2 allowances to the DEA. The fee covered the administration costs (verification of CO_2 emissions, control, allocation of allowances, operating the registry, monitoring of trading, development of the scheme etc.). The administration was managed with total costs less that 200,000 € per year.

An Energy Complaints Board handled complaints under the CO_2 cap&trade Act. No complaints were recorded.

[13] 40-100 EUR per tonne of CO_2 equivalent.

Conclusion.

The main experiences with the domestic Danish CO_2 cap & trade system 2001-2004 were:

- It was possible to create an adminstratively simple, low-cost system that was easily understood by the power industry.
- The number of companies and/or the volume of trade under the scheme was too low to sustain an efficient market with exchanges, brokers et.
- The low non-compliance penalty did not secure compliance in all cases.
- Though to some extent experimental in nature, the scheme allowed the Danish power sector to gradually prepare for the full-scale European emissions trading.
- The Danish scheme has attracted some international interest and is likely to have influenced the emergence and modalities of the EU ETS to some extent (together with the other “front runner”, the UK domestic ETS).

References.

1. Act on CO_2 quotas for electricity production (Act no. 376 of June 2,1999).
2. Kontrol af indberetning af CO_2-udledning fra elproducenter i 2001. Carl Bro 20 June 2002.