COGEN EUROPE POSITION STATEMENT

**POSITION STATEMENT**

# EU Emissions Trading and Combined Heat and Power

## Complementary mechanisms are necessary to prevent negative consequences for cogeneration

13 November 2002

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## 1. INTRODUCTION

In 2001 the European Commission issued a proposal for a European Directive to establish a EU-wide cap-and-trade scheme for Greenhouse Gas (GHG) emissions, notably carbon dioxide ($CO_2$). This scheme is one of several measures taken at EU-level to prevent or minimise the effects of climate change. It aims to push operators of certain installations to reduce $CO_2$ emissions to a desired level whilst making sure this happens at lowest possible overall costs. Combined Heat and Power (CHP, also known as cogeneration) is considered one of the key measures to reduce $CO_2$ emissions in a cost-efficient way. The Emissions Trading Scheme should therefore, in principle, encourage CHP. Yet, its potential implications on CHP have not been explored in detail. This paper considers possible problems that could emerge during the 2005-08 pilot period of the scheme, and suggests ways of overcoming them.

## 2. THE PROPOSED EMISSIONS TRADING SCHEME

According to the current proposal (European Commission 2001a), the Emissions Trading Scheme would be first launched for a three-year pilot phase between 2005-08. During this initial period, the scheme would be limited to $CO_2$ emissions[1] from certain activities including

- mineral oil refineries and coke ovens
- ferrous metals, cement clinkers, glass, glass fibre, ceramics, pulp, paper and board industries with a certain capacity
- combustion installations with a rated thermal input of more than 20 MW[2].

It is estimated that these sites – their total number in the EU territory is 4-5000 – will emit approximately 46% of the predicted EU $CO_2$ emissions in 2010.

Under the proposed Directive, they would require a "greenhouse gas emission permit" allowing them continued operation subject to the requirements set in the emissions trading regime.

Each site would then be given a certain amount of emission allowances for a specified period, whereby one allowance gives the concession to emit one tonne of $CO_2$ equivalent. Holding 50,000 allowances thus gives the right to emit 50,000 tonnes of $CO_2$. Allowances would be allocated to

[1] According to the proposal the greenhouse gases $CH_4$, $N_2O$, HFCs, PFCs and $SF_6$ would be included at a later stage. The European Parliament recommended in October 2002 to keep the option of their earlier inclusion into the scheme. To date, no final agreement has been reached on this issue.

[2] The European Parliament favours the mandatory participation of more activities, including the chemical and aluminium industries.


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activities carried out within one installation or several installations on the same site, the capacities of which would be added together. Importantly, it is proposed that during the pilot period 2005-08 allocation should be at no cost[3] and based on the historical emission record of the sites ("grandfathering").

For each tonne of $CO_2$ emitted from a site, the operator would need to submit an allowance. If the site emits less $CO_2$ than allowances held, then these may be banked from one year to the next, or they may be sold to another company that does not meet its $CO_2$ target and therefore needs additional allowances. Operators which emit $CO_2$ without submitting the necessary allowances, would during the pilot period face a penalty of € 50 per tonne $CO_2$ in excess (€ 100 after 2008).

Because allowances would be recognised across the EU without further negotiation the Directive would create a European market for allowances. In some sectors the potential for cheaper cost-reduction schemes is greater than in others. With an EU scheme, the price of allowances would be similar wherever the plant is located. On the basis of this common price, emissions trading plant managers can decide whether or not to reduce emissions themselves, or buy additional allowances from others who can reduce theirs at lower cost.

Fixing the total amount of allowances to distribute amongst the installations covered by the Directive would be essentially left to Member States. Yet, it should take into account the amount of $CO_2$ which the Member State is allowed to emit pursuant to the Kyoto Protocol in combination with the EU Burden Sharing Agreement; and the proportion of overall national emissions which the installations covered by the Directive generate. National allocation plans would have to be drawn up stating the total amount of allowances and the method to allocate them, based on objective and transparent criteria. Based on the experiences made, the method of allocation in the period 2008-2012 would then be determined.

## 3. $CO_2$ SAVINGS FROM COMBINED HEAT AND POWER

An important measure to reduce $CO_2$ emissions is the installation or upgrade of a CHP scheme. Schemes covered by the Directive would include:

- any CHP installation, regardless of its capacity, on an industrial site subject to mandatory participation in the Emissions Trading Scheme (e.g. refineries, large metal industries, paper producers etc.)
- any CHP plant with a rated fuel input of more than 20 MW

This includes two different types of CHP applications:

- industrial CHP, which often supplies heat at a high temperature level, where the site usually consumes all heat and a large part of the CHP electricity produced, and which often has a very long annual operation time in excess of 6000 hours.
- District Heating, which supplies heat at a lower temperature level and exports both its entire electricity and heat output. Because a major part of the heat load depends on the need for space heating due to climatic conditions, it may run during the summer period in non-CHP mode (i.e. as condensing power plant).

[3] A small percentage of allowances (about 15%) might be auctioned as a result of a proposed Parliament amendment.

CHP saves $CO_2$ due to two reasons (see Figure 1):

- First, CHP electricity displaces centrally produced electricity from power plants which are always less efficient and therefore more $CO_2$-intensive[4]. An important feature of CHP is that it entails higher *direct* fuel consumption and higher *direct* $CO_2$ emissions compared with a site without CHP. Yet, by replacing centrally produced electricity it reduces even more the *indirect* fuel input and $CO_2$ emissions for generating a specific amount of electricity, thus leading to the overall saving.
- Second, most CHP is decentralised generation, where the electricity produced is either consumed on-site or in the immediate neighbourhood. CHP therefore avoids electricity losses from centralised production that occur during electricity transport and transformation. These losses typically range between 5 and 15%[5].

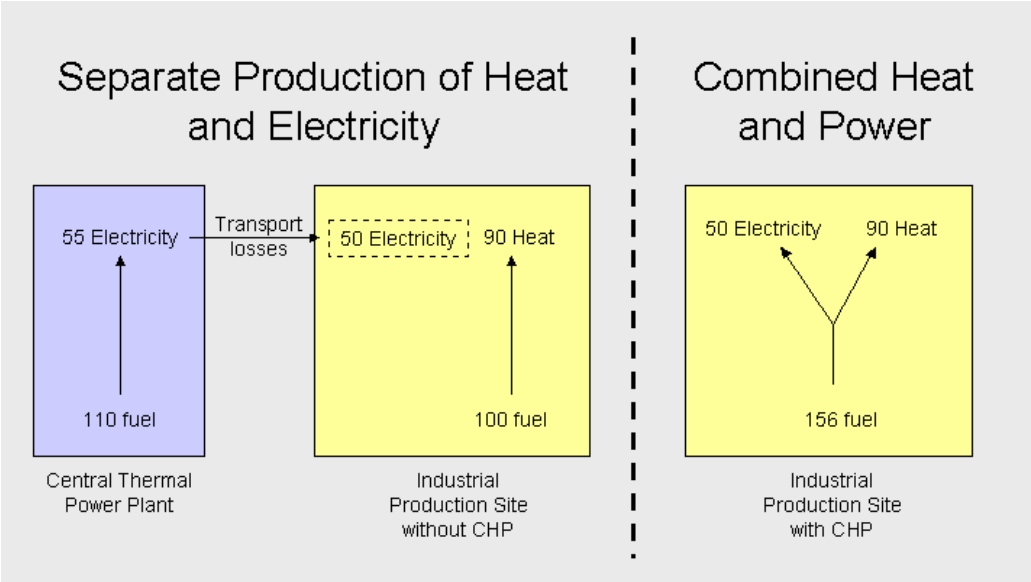


**Figure 1: Comparison of a highly efficient CHP installation with the separate production of heat and power using latest technology. The site with CHP has a bigger *direct* fuel input and $CO_2$ emissions. Yet, it reduces total $CO_2$ emissions by 26% by replacing *indirect* emissions from the central power plant, and by avoiding transport losses[6].**

It has been estimated that, depending upon the reference scenario used, increasing the share of cogenerated electricity to 18% in the European Union could result in additional $CO_2$ savings in the range between 65 and 194 Million tonnes per year compared to the 1997 situation (Euroheat & Power 2001, European Commission 2001b, future cogen 2001). The most realistic scenario might

[4] In practice, CHP is principally likely to replace neither electricity from base load power plants (nuclear and lignite fuelled) nor power from regenerative energy sources (photovoltaics, wind, hydro), but from middle load power plants with a fuel mix of coal, oil or gas (Gailfuß 2002). In Germany, depending on what electricity CHP replaces, it typically realises $CO_2$ savings between 20 and 80% (Gailfuß 2002, Tolle 2002, Traube & Schulz 2000). In order to be fuel neutral, the draft European CHP Directive suggests an approach whereby new CHP is compared with separate production based on the same fuel.

[5] In Germany, transmission losses amounted to about 4.7% in the Western part of the country, and 9% in the East in 1995. In 1999, total transmission losses in the entire country were 5.5%. The Western level is considered to be close to the technically achievable optimum (VDEW (1997 and 2000). In France, grid losses of 2.5% in the high-voltage network, 4% for medium-voltage, and 7% at low-voltage level are taken into account when calculating the benefits of decentralised generation (Club cogénération 2002).

[6] It is assumed that the same fuel type is used in both cases.

be between these extremes, i.e. in the order of 120-130 million tonnes $CO_2$. This represents 36-39% of the EU's total Kyoto commitment for the 2008-12 period (336 million tonnes $CO_2$ less than in 1990).

# 4. PRINCIPAL QUESTIONS AND POTENTIAL PROBLEMS FOR CHP

An Emissions Trading Scheme should, in principle, fully reflect the $CO_2$ savings from CHP thereby rewarding the operator of the installation for his investment. Yet, the proposed European Emissions Trading Scheme gives rise to the following open questions and problems.

## 4.1 Installation of new CHP or upgrade increases direct $CO_2$ emissions

As explained in section 3, if the operator of a site installs a new CHP unit where there has not been previously CHP, or if an existing CHP installation is being upgraded to bigger capacity or higher-efficiency CHP, this will normally increase direct fuel consumption and $CO_2$ emissions from the site[7]. If the operator of the installation has received his allowances based on the previous, lower emission from the site, he would then have to buy additional allowances on the market to cover the increase in $CO_2$ emissions. The potential costs of this have been calculated for two examples which are detailed in the Annex of this paper. Based on an assumed average price of allowances of € 20, they show that the Emissions Trading Scheme could imply additional costs of € 560,000 per year or more for the installation of a gas-fired industrial CHP scheme with a capacity of about 15 $MW_e$ or € 554,400 for a 20 $MW_e$ coal-fired District Heating plant (see Annex)

In turn, the central power generator whose electricity had been replaced by the CHP plant is likely to have to bear far less additional costs. Due to the free[8] allocation of allowances under the grandfathering principle, and the limited technical potential of thermal power plants to reduce $CO_2$ emissions, operators of these plants are likely to largely obtain the allowances to cover their $CO_2$ emissions during the 2005-08 pilot period. The pressure to invest into emission abatement measures would be limited and they could continue with "business as usual" for some time. Because some of their electricity production has been substituted by the CHP plant they even would have freed up allowances from the avoided $CO_2$ emissions worth € 844,019 for the industrial example and € 1,012,331 in the District Heating example per year which they would sell on the market (see Annex).

These amounts correspond to the value of the $CO_2$ savings realised by the CHP installations and would constitute the total financial penalty for having installed the CHP plants in the examples calculated in the Annex. They would increase the costs of producing electricity from CHP by €c 0.77/kWh in the industry example and €c 1.65/kWh in the District Heating example (see Annex). This would reduce even more the competitiveness of CHP, which already suffers from current distortions on the electricity market, and have a disastrous impact on new projects.

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[7] The replacement of heat-only applications with CHP, or the upgrade of existing CHP plants, is important not only for the existing EU territory but also for the candidate countries. In some EU Member States more than 65% of DH systems are equipped with CHP (for instance Austria, Denmark, Finland, Germany, according to figures from Euroheat & Power). Yet, this share is probably much smaller in Poland (around 48%) and in Romania (around 58%). The large share of non-CHP industrial and District Heating schemes in these countries offers significant potential to convert them into CHP. Also, there is much scope for modernising outdated, less efficient schemes with CHP to a higher efficiency and thus $CO_2$-saving performance (future cogen 2001).

[8] The proposed auctioning of 15% of the allowances would have only minor effects.

### 4.2 CHP could raise fuel input above 20 MW

For combustion installations in industry and District Heating, the upgrade to CHP may increase their thermal input above the threshold of 20 MW and the installations would then become a "new entrant" to the emissions trading regime. Because an operator may not wish to change status and be a player in the scheme – especially under the conditions outlined in the previous section - he may therefore decide not to install CHP. Similar situations could occur when a completely new site with CHP on it is built. This may be related to financial disadvantages which he would have under the scheme. But it could also be just a result of uncertainty, if the national allocation plan does not make it clear how CHP in such cases would be treated. Operators could therefore not make a cost-benefit calculation and assess financial risks, which might dissuade them from installing a CHP plant or in the worst case convince them to install all-electric factories.

### 4.3 Possibility of closure or reduced output from CHP installations

For existing CHP installations that are already struggling under current (not necessarily fair and ecologically sound) market conditions, operators might have an additional incentive to switch back from CHP to heat-only and purchase electricity externally. By externalising its electricity supply, the site would reduce its direct fuel consumption and therefore emit less $CO_2$. This would free up allowances worth € 560,000 for the industry example and € 554,000 for the District Heating case which could then be sold on the market (see Annex).

It is envisaged to prevent operators from selling unused allowances resulting from a plant shutdown. Instead, they would have to surrender these to the responsible authority. But it remains unclear whether switching from CHP to external electricity, or perhaps only reducing the CHP output, could be considered a closure of operation. CHP operators might therefore have an incentive to switch back to heat-only.

Whether this occurs in practice will depend on many interdependent factors, including the power to heat ratio of the CHP plant, the market price of allowances, the price for electricity supply, the profitability of the CHP plant etc. The probability of it is therefore difficult to predict. Yet, the financial disadvantage which CHP operators potentially suffer under the Emissions Trading Scheme could make it more likely.

### 4.4 Competitive disadvantage for District Heating on the heat market

With regard to District Heating schemes, the majority of schemes with CHP meet the 20 MW fuel input threshold and will therefore be subject to the Emissions Trading Scheme. These schemes may have to compete on the heat market with small domestic gas- and oil-fired heat-only boilers, which will not be covered by the Directive. If the Emissions Trading Scheme increased the price of production of District Heating, this could imply a competitive disadvantage vis-à-vis the smaller boilers. This disadvantage may prevent both the conversion from heat-only to CHP District Heating, and the construction of new heat networks.

# 5. POTENTIAL SOLUTIONS AND MECHANISMS

It has been shown that, without additional mechanisms, the proposed Emissions Trading Scheme risks during its pilot phase 2005-08, creating a paradoxical situation where the investor into CHP faces a hefty financial "penalty" although he reduces $CO_2$ emissions, whilst a financial "reward" makes it at least more bearable for the power plant operator to lose a client. This is a consequence of the schemes focus on *direct* emissions from specific sites, combined with the initial free allocation of allowances based on historical emission records. In fact, the pilot phase will not put a price on *all* direct emissions, which would remove the distortion, but only those which exceed the free initial allocation.

It is therefore essential to amend the Emissions Trading Scheme and create complementary mechanisms which make the scheme fully reflect carbon savings from CHP instead of penalising them between 2005-08. These should be fair, i.e. reflecting the actual savings achieved; take particularities of different CHP installations into account; be as simple as possible in order to avoid unnecessary red tape; and be harmonised across the EU to avoid emissions market distortions and unequal treatment of CHP in different Member States.

Two mechanisms which, in principle, could have corrected the scheme distortions identified, can practically be ruled out in view of the advanced stage of decision-making on the emissions trading Directive:

1. Inclusion of direct *and* indirect $CO_2$ emissions from a specific site in the Emissions Trading Scheme. Designing the scheme that way was initially discussed but was then not taken further. Also, the technical and economical feasibility of such a scheme is unclear.
2. Auctioning of all allowances from the beginning. This would put a price on *all* emissions from existing and new installations covered by the Directive. Due to its higher efficiency CHP would produce more useful output at the same costs compared to separate production and thus have a competitive advantage. Yet, it is unlikely that more than a marginal share of allowances – 15% according to the latest proposal of the European Parliament - will be allocated by auctioning during the 2005-08 period. This leaves much of the problem unsolved.

This leaves the choice of complementary mechanisms to the following:

## 5.1 Treat CHP as new entrant

The proposed Directive requires Member States to consider in allocation plans how new entrants to the Emissions Trading Scheme will be treated. This could include considering new CHP capacity, modernisation of CHP, or upgrade to CHP as "new capacity". In each case the allowances used to cover the increase in emissions from CHP could be allocated for free. Member States could establish a sort of "allowances reserve" to be able to provide new CHP entrants with the allowances required. Such a measure would at least be cost-neutral and prevent CHP from being penalised for the increase in direct emissions which it implies. But the CHP operator could not realise a profit from the $CO_2$ savings which his installation actually realises. In the examples in the Annex this profit would amount to €c 0.26 per kWh electrical output in the industry example, and €c 0.75 in the District Heating example (see Annex).

## 5.2 Allocation of allowances to useful heat and/or power output

The proposed Directive does possibly not prohibit Member States undertaking the initial allocation of allowances based on the useful energy output. This approach, which has been suggested in previous occasions (Euroheat & Power 2002), would imply that the operator of an electricity generating installation would obtain no free allowances to cover $CO_2$ emissions from the losses on his system. Specifically, the operator of a power plant with an annual conversion efficiency of 40% would need to purchase allowances for 60% of his $CO_2$ emissions, corresponding to the energy conversion loss of 60% on his system. In the case of a CHP installation this would be only 15% if its total efficiency were 85%.

This initial allocation model would thus immediately reward carbon savings from existing CHP installations and thus respond to the need to treat "early action" in a distinctive manner. For instance, the cost advantage of CHP against the heat and power production in the examples in the Annex to this paper would be in the order of €c 0.24 per kWh cogenerated electrical output in the industry example, and €c 0.71 in the District Heating example (see Annex).

This allocation mechanism would, however, not capture the difference in $CO_2$ emissions due to different fuels. For instance, the $CO_2$ savings gas-fuelled CHP would be even bigger if its electricity replaced power from a coal-fired power plant.

## 5.3 Determine and deduct CO2 savings from CHP

The forthcoming European CHP Directive (European Commission 2002) will most probably establish a EU-wide methodological framework to determine the primary energy savings of CHP compared to a reference system of separate heat and power production. This Directive is likely to enter into force in 2003 and will be transposed in EU Member States around 2005, in parallel to the Emissions Trading Scheme. This provides an opportunity to use the methodology proposed also for purposes of the emissions trading Directive. Notably, it could provide the basis for calculating $CO_2$ savings from CHP in order to credit these to the CHP operator[9] and determine the number of allowances to be submitted. The number of allowances would then correspond to the total direct $CO_2$ emissions from the site minus the $CO_2$ savings from CHP. A graphical representation of this approach, combined with the figures from the industry example in the Annex, is shown in Figure 2 on the next page.

This approach appears to be fair and transparent, reflect the particulars of different CHP installations, and has the chance to be harmonised across the EU with the likely approval of a CHP Directive. This would avoid distortions in the market for allowances and unequal treatment of CHP in different Member States. In the examples in the Annex to this paper it would reward the $CO_2$ reduction from CHP with €c 0.26 per kWh electrical output in the industry example and €c 0.75 in the District Heating example (see Annex).

[9] Linking the two Directives in this way is actually recommendable for many more reasons highlighted in a recent COGEN Europe Position Paper (COGEN Europe 2002)

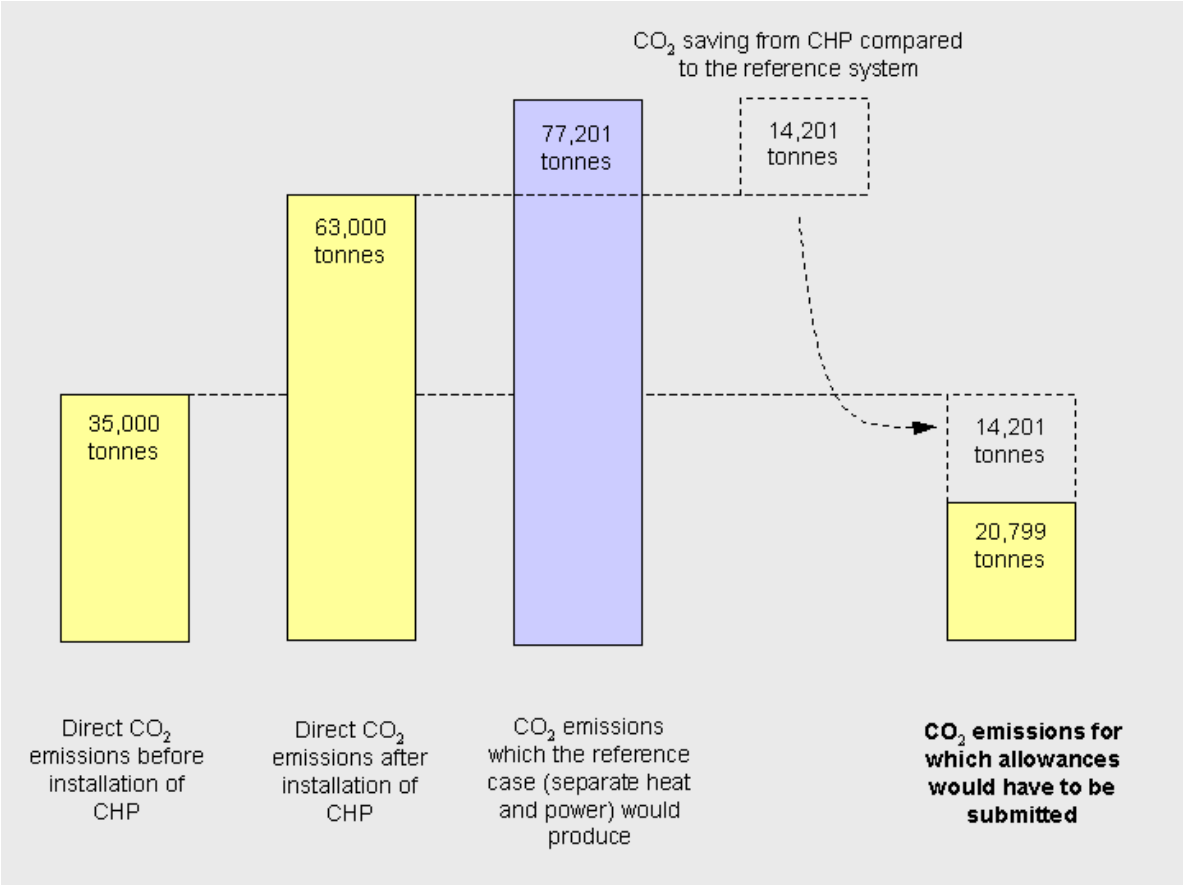


**Figure 2: Proposed method to determine the number of allowances which CHP operators would have to submit based on the $CO_2$ savings of their installations. The figures used are taken from the industry example in the Annex of this paper.**

## 5.4 Exemptions for heat from CHP District Heating

Planning provisions which enforce mandatory connection to District Heating, known for example from Denmark or Germany, can compensate its potential competitive disadvantage on the heat market compared to small boilers. Yet, such regulatory measures do not exist in all countries.

$CO_2$ emissions from heat produced in District Heating systems should therefore be partly or entirely exempted from the need to hold allowances. Alternatively, allowances to emissions corresponding to the production of this heat could be allocated for free (ZEW/Öko-Institut (2002) and Ministerium für Umwelt, Natur und Forsten des Landes Schleswig-Holstein (2002)). This measure should help District Heating stay competitive vis-à-vis individual heating systems. The incentive to convert from heat-only systems to CHP would not be lost, because this conversion would lead to additional income from the sales of the generated electricity and of freed allowances.

# 6. POTENTIAL REGULATORY MECHANISMS

There are two levels where the mechanisms discussed above should be established:

1. The proposed European emissions trading Directive should possibly be amended with requirements for the treatment of CHP during the Emissions Trading Schemes' pilot phase.
2. Member States should devise regulations and procedures in those areas which the Directive leaves to their discretion.

Major changes to the emissions trading Directive are unlikely given the advanced stage of decision-making. Yet, it would offer the chance of a coherent approach and could ensure that negative impacts on CHP at Member State level are avoided. The European Parliament's proposed amendment that Member States should "ensure that indirect mechanisms to reduce $CO_2$, such as combined heat and power generation, receive consideration in national allocation plans" goes in the same direction.

Taking the right measures at national level, within individual Member States, is likely to be the most important way to make sure the emissions trading treats CHP fairly during the pilot period. National governments and CHP stakeholders, such as national associations for cogeneration, will have a key responsibility in taking the right steps.

## 6.1 Regulatory mechanisms at European level

### *6.1.1 Amendments to the Emissions Trading Directive*

- Amendment 97 of Parliament introduces a new paragraph 1a into Article 4 of the Directive stating that "using the European Guidance on the Carbon Equivalence, which shall be prepared by the Commission prior to the scheme's entry into force, Member States shall take account of the corresponding carbon value of savings achieved through combined heat and power generation investments (…) to operators". This amendment seems to reflect ideas suggested in section 5.3, i.e. a method to determine and take into account $CO_2$ savings from CHP. It could be complemented with a requirement that the carbon value of savings from CHP should be calculated on the basis of the methodology to determine the efficiency of CHP installations in the Cogeneration Directive.
- Annex III of the proposed Directive, setting the criteria for national allocation plans, could be amended in a number of ways, including
  - a requirement that greenhouse gas emissions savings from CHP installations, compared with the separate production of heat and electricity, should be taken into account when determining emissions from a specific site.
  - The explicit opportunity that, in order to encourage cogeneration, the plan may restrict the allocation of allowances to the useful output of heat and/or electricity generating installations.
  - An opportunity to exempt heat output of existing or new District Heating installations from the need to hold greenhouse gas emissions allowances.

### *6.1.2 Amendments to the proposed Cogeneration Directive*

- The Preamble could be amended with a new recital stating that a coherent approach to determine the efficiency of CHP is required for the Directives on cogeneration and emissions trading. This point could equally be made in the existing Recital 11.
- Article 5 ("Efficiency Criteria") could be amended by a paragraph stating that the methodology to determine the efficiency gain from CHP should be used to calculate the carbon savings from CHP under the provisions set out in the Emissions Trading Directive

### *6.1.3 CHP as part of a Project-based Mechanism*

- The creation of a flexible project-based mechanism to complement the Emissions Trading Scheme is currently under consideration. Similar to the UN's flexible mechanisms it could allow those subject to the emissions trading regime to realise their $CO_2$ reductions through third-party projects. If such a mechanism is established, CHP should become part of it. This could broaden the scope of potential investors into a variety of CHP projects. For instance, electricity companies could have more incentives to become energy service companies (ESCOs) realising small-scale and micro-CHP projects in households and SMEs. Again, this would require creating a methodology to determine the $CO_2$ savings which such CHP projects realise.

## 6.2 Regulatory mechanisms at Member State level

At this level it will be crucial to design national allocation plans in a way which takes $CO_2$ savings from CHP fully in account. As discussed, this includes the following possibilities:

- Member States should preferably establish systems to determine $CO_2$ savings from CHP installations and take these into account when calculating how many allowances have to be submitted (section 5.3 on page 8)
- If this is not possible, the initial allocation of allowances based on the useful heat and/or power output should be envisaged (section 5.2 on page 8).
- As a last resort, new CHP capacity may be considered as a new entrant and exempted from the need to hold allowances or provided with free allowances (section 5.1 on page 7);
- In any case, Member States should consider avoiding discrimination of heat from District Heating with CHP, for instance by exempting it from the need to hold allowances. (section 5.4 on page 9).

# 7. CONCLUSIONS AND OUTLOOK

There is no doubt that the EU Emissions Trading Scheme will become a key mechanism to reduce $CO_2$ emissions and bring the EU closer to meeting its Kyoto commitments in a cost-efficient manner. CHP should play an important role given its potential for low-cost emissions reduction. Yet, it has been shown that, unless complementary measures are taken, emissions trading could actually seriously undermine the competitiveness of CHP during the emission trading scheme's 2005-08 pilot phase. This would make the situation of CHP even worse than it is already now. All efforts should be undertaken to prevent such a scenario and give CHP the position it merits within the Emissions Trading Scheme.

## 7.1 Bibliography


Club cogénération (2002) Observations sur le projet de Directive Cogénération. Unpublished.

COGEN Europe (2002) Towards a EU-wide coherent approach to determining primary energy/greenhouse gas savings from CHP

Euroheat & Power (2001) CO2 reductions by Combined Heat and Power in the European Union

Euroheat & Power (2002) Position Paper on the Directive proposal on greenhouse gas emission trading presented by the Commission on 23 October 2001 – COM(2001)581

European Commission (2001a) Proposal for a framework Directive for greenhouse gas emissions trading within the European Community. COM (2001) 581

European Commission (2001b) Communication on the implementation of the first phase of the European Climate Change Programme

European Commission (2002) Proposal for a Directive of the European Parliament and of the Council on the promotion of cogeneration based on a useful heat demand in the internal energy market. COM(2002)415 final

future cogen (ed) (2001) The Future of CHP in the European Market – The European Cogeneration Study. Final Publishable Report.

Gailfuß, M. '$CO_2$ Minderung durch Blockheizkraftwerke'. (http://www.bhkw-infozentrum.de/erlaeuter/co2_minderung.html), accessed on 26/08/2002

Ministerium für Umwelt, Natur und Forsten des Landes Schleswig-Holstein (2002) Emissionshandel. Position der schleswig-holsteinischen Landesregierung. p. 6

Traube, K. and Schulz, W. (2000) Ökologische und ökonomische Wirkung eines mittelfristigen Ausbaus der Kraft-Wärme-Kopplung zur Nah-/Fernwärmeversorgung in Deutschland

VDEW (1997 and 2002) Press Information on http://www.vdew.de

ZEW/Öko-Institut (2002) Final Report for the preparation of an opinion on the proposed Directive on the Implementation of EU-wide Emissions Trading COM(2001)581. Mannheim/Berlin. pp. 30-31




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# Annex
# $CO_2$ savings from CHP and their value, and potential penalty under the pilot Emissions Trading Scheme

| | | Industry Example | | District Heating Example | |
|---|---|---|---|---|---|
| | Unit | Before CHP | After installation of CHP | Before CHP | After installation of CHP |
| **Part 1: Increase of direct $CO_2$ emissions after installation of CHP** | | | | | |
| **Fuel type** | | Natural Gas | Natural Gas | Coal | Coal |
| **Electrical Efficiency** | [%] | 0% | 35% | 0% | 30% |
| **Thermal Efficiency** | [%] | 90% | 50% | 85% | 50% |
| **Rated Thermal input** | [kW] | 25,000 | 45,000 | 40,000 | 68,000 |
| **Heat Capacity** | [kW] | 22,500 | 22,500 | 34,000 | 34,000 |
| **Electrical Capacity** | [kW] | 0 | 15,750 | 0 | 20,400 |
| **Fuel Input** | [kWh/year] | 175,000,000 | 315,000,000 | 120,000,000 | 204,000,000 |
| **Electrical Output** | [kWh/year] | 0 | 110,250,000 | 0 | 61,200,000 |
| **Useful Heat Output** | [kWh/year] | 157,500,000 | 157,500,000 | 102,000,000 | 102,000,000 |
| **Annual Operation Time** | [h/year] | 7,000 | 7,000 | 3,000 | 3,000 |
| **Marginal Electrical Efficiency** | [%] | n/a | 78.8% | n/a | 72.9% |
| **Fuel Emission Factor** | [kg $CO_2$/kWh] | 0.20 | 0.20 | 0.33 | 0.33 |
| **Direct $CO_2$ Emissions** | [t/year] | 35,000 | 63,000 | 39,600 | 67,320 |
| **Part 2: Potential "penalty" from increased direct CO2 emissions after installation of CHP** | | | | | |
| **Cost per Emissions Allowance** | [€/allowance] | | 20 | | 20 |
| **Additional Allowances needed** | [n] | | 28,000 | | 27,720 |
| **Total Cost of additional Allowances** | [€/year] | | 560,000 | | 554,400 |
| **Cost of additional Allowances per kWh** | [€c/kWh$_{el}$] | | 0.51 | | 0.91 |
| **Part 3: Actual CO2 savings from CHP and their potential value (Comparison with reference case according to proposed European CHP Directive)** | | | | | |
| **Efficiency of Reference Power Plant** | [%] | | 55% | | 42% |
| **Network Loss** | [%] | | 5% | | 5% |
| **Fuel Input Reference Power Plant** | [kWh/year] | | 211,004,785 | | 153,383,459 |
| **$CO_2$ Emissions Reference Power Plant** | [t/year] | | 42,201 | | 50,617 |
| **Efficiency of Reference Boiler** | [%] | | 90% | | 85% |
| **Fuel Input Reference Boiler** | [kWh/year] | | 175,000,000 | | 120,000,000 |
| **$CO_2$ Emissions Reference Boiler** | [t/year] | | 35,000 | | 39,600 |
| **Total $CO_2$ Emissions Reference Case** | [t/year] | | 77,201 | | 90,217 |
| **$CO_2$ Saving of CHP** | [t/year] | | 14,201 | | 22,897 |
| **$CO_2$ Saving of CHP** | [%] | | 18.4 | | 25.4 |
| **Submission of Allowances with CHP** | [n] | | 20,799 | | 16,703 |
| **Value of $CO_2$ Savings of CHP** | [€/year] | | 284,019 | | 457,931 |
| **Value of $CO_2$ Savings of CHP** | [€c/kWh$_{el}$] | | 0.26 | | 0.75 |
| **Part 4: Total potential "penalty" for having installed CHP** | | | | | |
| **Potential "Penalty" for CHP** | [€/year] | | 844,019 | | 1,012,331 |
| **Potential "Penalty" for CHP** | [€c/kWh$_{el}$] | | 0.77 | | 1.65 |

*(Explanation of the table see next page)*

**Explanations to the table in the Annex:**

The table calculates for two examples – a gas-fired industrial site and a coal-fuelled district-heating installation – the changes in $CO_2$ emissions and the potential economic implications of switching from heat-only production to CHP under the proposed Emissions Trading Scheme. The assumed total efficiency of the CHP schemes is 85% and 80% respectively. These efficiencies can be realistically expected from a well-designed scheme. The $CO_2$ emission factors of the fuels used are based on values proposed in the draft Emissions Trading Directive.

**Part 1:** The installation of CHP would increase the direct $CO_2$ emissions from 35,000 to 63,000 (39,600 to 67,320) tonnes per year, because together with the heat production, which remains unchanged (157,500/102,000 MWh/year), an additional amount of electricity (110,000/61,200 MWh/year) would be generated. This would raise the rated thermal input from 25 to 45 (40 to 68) MW and the annual fuel input from 175,000 to 315,000 (120,000 to 204,000) MWh. Yet, the marginal electrical efficiency of the CHP installation (i.e. the conversion efficiency of the fuel used for electricity generation) would be very high: 78.8% (72.9%) of the fuel's energy content would be converted into electricity.

**Part 2:** Without specific compensation mechanisms, the operator of the site which has been converted to CHP would need to buy additional allowances to cover the increase in direct $CO_2$ emissions. Based on a price of € 20 per allowance this would imply an additional annual cost of € 560,000 (554,400). This would translate into an additional cost of €c 0.51 (0.91) to produce each kWh of electricity.

**Part 3:** Because the decentralised CHP installation would replace condensing electricity centralised power plants, which is less efficient and therefore produces more $CO_2$ for the some output of useful energy (lower conversion efficiency and electricity transport losses). The reference figures for a power plant and boiler are based on the proposed European CHP Directive. For the industrial example, this reference could be criticised for being too optimistic about the efficiency of separate production (especially the assumed 55% efficiency of a modern gas-fired power plant), and for the unrealistic assumption that CHP electricity would currently replace electricity from such a power plant. But even under this scenario the CHP installation would reduce overall $CO_2$ emissions by 14,201 (22,897 in the District Heating example) tonnes per year – i.e. 18.4% (25.4%) less – by replacing electricity from the reference power plant. Based on the saving he achieved, the operator of the CHP installation should have to submit only 20,799 (16,703) allowances per year from his initial allocation, assumed to be 35,000 (39,600). Selling the remaining allowances on the market would allow him to realise a benefit of € 284,019 (457,931), and to reduce his specific electricity generation costs by €c 0.26 (0.75) per kWh.

**Part 4:** In the worst case, if the Emissions Trading Scheme did not include a mechanism to take indirect $CO_2$ savings from CHP into account, the financial disadvantage for having installed CHP would amount to € 844,019 (1,012,331) per year. This would include the cost of additional allowances needed to cover the increase in direct $CO_2$ emissions, and the benefit from the total $CO_2$ savings which the operators would not be allowed to realise. The emission trading scheme would thus increase electricity production costs for new CHP operators by €c 0.77 (1.65).


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