Impacts on Dutch industry from sharpening the EU CO_2 target from -20 to -30%

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Contents

Executive summary

This study presents an analysis into the consequences of the costs for industry in the Netherlands of moving within the EU from a CO_2 reduction target of -20 to -30%. Most likely, a discussion on the desirability of stronger EU wide CO_2 targets will be part of the negotiations during the Copenhagen summit. The aim of the present research is to estimate the cost price increase for Dutch industry from an increase in CO_2 emissions reductions to -30%. This research uses the same data and methodology that have been used earlier in the research about competitiveness impacts for Dutch industry from Phase III in EU ETS that was finished in the summer of 2008.

Three scenarios have been formulated with respect to the target and the eventual price developments. In these scenarios the impacts of the financial crisis have been taken into account. The key parameters of these scenarios are given in the following table:

Scenario	EU target	ETS target NL 2020	EUA price €/ton CO_2	CDM price €/ton CO_2	Maximum EUAs to be covered by CDM
Base Case	-20%	- 21%	18	16.2	50% * 21%
Alternative 1a	-30%	- 31%	34	29.6	50% * 31%
Alternative 1b	-30%	- 31%	42	37.8	50% * 21%

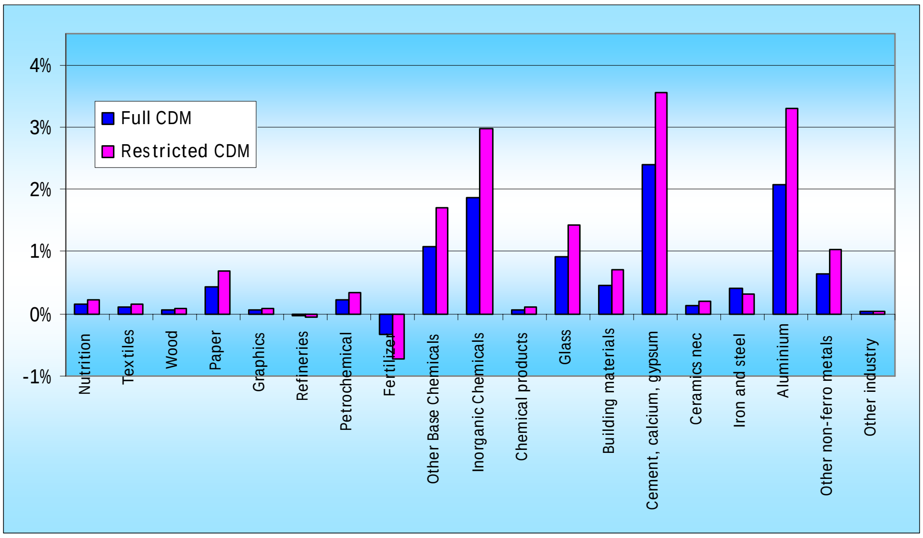
The base case is the present proposal for Phase III of the EU ETS. This will result in an estimated price of € 18/t CO_2 in 2020 and a CDM price that is 10% lower. Using an electricity model we estimate that € 10/MWh will be the EU ETS costs that are passed on into the prices. As electricity does already pass on the costs of their freely obtained allowances in the prices, these costs should be equal to the present costs of electricity.

Two alternatives have been formulated that each assumes a 30% EU overall target. The two scenarios differ with respect to the expected amount of CDM that can be used. In the first alternative there will be no restriction on the use of CDM: e.g. the additional reduction can also be covered using CDM projects. In the second alternative the use of CDM is limited to the present total amount. The additional reduction can only be realised through projects within the EU. This leads logically to a higher price of EUAs. In both cases industry will be confronted with additional price increases of electricity of respectively € 5 and € 8/MWh compared to the base case.

These three scenarios have been analyzed with respect to the potential costs for industry of complying with EU ETS. We distinguished both the direct costs of complying with EU ETS and the costs of increased electricity-inputs. The figure below gives the outcome for both scenarios where the additional costs of meeting the more stringent target have been expressed as a percentage of the total costs for industry.

It appears that the highest additional cost increases occur for the cement industry, the aluminium industry and the inorganic chemicals. These sectors have little opportunities to reduce emissions or electricity demand. The aluminium and inorganic chemical industry mainly suffer from the higher electricity prices, while the cement sector will be a net buyer of allowances. Some sectors, e.g. refineries and fertilizer, may profit from the more strict emission regime as they have opportunities to reduce their emissions at lower costs and become net sellers of emission credits.

Average cost price increase of a -30% reduction target in 2020 compared to a -20% reduction target, expressed as percentage of the total costs



Note: Costs in this figure resent gross costs not net costs.

The costs presented here are gross cost price increases. However, part of these costs will be passed on to the consumers. The net cost price increases will, ultimately, depend on the possibility of firms to pass through the higher costs. It was not investigated here to what extent the possibility to pass through the costs will be altered under a -30% target. Earlier research at CE Delft estimated that under a -20% target about half of the costs for complying with EU ETS may be passed onto the consumers. If more countries will commit themselves to binding CO_2 reduction targets, the amount of costs that can be passed through will be even higher as CO_2 will obtain a price in the most important trading partners of the EU.

Finally, an estimation was made of the total costs to comply with EU ETS and additional policies for smaller installations. These costs consist of the costs of investments, electricity price increases and the purchase or sale of emission allowances. While these costs were estimated at 0.4 billion annually in 2020 under the -20% target (less than 0.1% of GDP), the costs will increase to 0.9 billion annually for a target of -30% and no additional use of CDM. If the higher reduction target can also be reached by using CDM credits, the costs will lowered to 0.7 billion annually.

1 Introduction

1.1 Motivation

Within the EU a discussion is whether the current target of -20% should be sharpened to -30%. The decision to sharpen the target is made dependent on the outcome of the Copenhagen negotiations. The ministry of Economic Affairs in the Netherlands has asked CE Delft to make an analysis of the costs for Dutch industry for meeting this more strict climate target of -30%.

1.2 Aim and delineation

The aim of this research is to estimate the cost price increase for Dutch industry from changes in the amount of CO_2 reduced through EU ETS.

This research draws on methodology and data that have been used earlier in research about the competitiveness impacts for Dutch industry from Phase III in EU ETS (CE, 2008).

The data and approach have largely been unchanged. This implies (amongst others):
- A partial equilibrium approach is taken in which an exogenous CO_2 price is analyzed for it's consequences on the costs for companies. There is hence no feedback loop from emission reductions towards a lowering price, etc.
- An analysis of the cost price increase for specific sectors (e.g. steel sector) only. The sectoral cost price increase is lower than the cost price increase for individual firms or products. The aluminium sector in the Netherlands contains, for example, 60 companies of which only 2 are affected by EU ETS.
- The assumption that the whole sector will face climate change policies similar to EU ETS. In reality small installations within the sector will not fall under EU ETS. However, assuming that they will have to meet similar climate policies resulting in similar costs, the sectoral level is correct.
- As a point of departure the industrial structure and cost price structure in 2005 is taken. We do not estimate how industrial output and the cost-structure of industrial output are going to develop until 2020. Instead we show the impacts on the costs and industrial structure of 2005. We take here a ceteris-paribus analysis in which all elements are considered to remain unaltered except the reduction in CO_2 emissions.
- The analysis is only undertaken for the manufacturing industry. Impacts for oil and gas mining, electricity generation and aviation are not included here. Impacts of higher electricity prices on industrial costs are taken into account, however.

Contrary to the analysis in 2008, we will pay here explicit attention to the role of CDM for lowering the additional costs of industry in complying with EU ETS. In addition we can now precisely determine the rules of allocation in EU ETS as these have been revealed by the Commission meanwhile (EC, 2009a).

1.3 Content

Chapter 2 identifies the scenarios used in this research and discusses the approach for calculating the cost price increases. Chapter 3 presents the results. Chapter 4 draws conclusions. In the Annexes further information can be found on the modelling efforts underlying the current calculations. As the current research uses data that were collected in an earlier study, we refer to the Annexes of that study (Annex A of CE, 2008) for a detailed description of the data.

2 Methodology

2.1 Introduction

Aim of this chapter is to outline the methodological choices that have been made for determining the additional cost price increases. First, in paragraph 2.2, we will construct the scenarios that have been used for analyzing the influence on the costs for industry of sharpening the EU target. In paragraph 2.3 the justification for the chosen parameters in each scenario is highlighted. Paragraph 2.4 identifies some conceptual classifications underlying the calculations.

2.2 Scenarios

Three scenarios have been developed in this study. The **base case** scenario is where the current amendment of the EU Directive (2009/29/EC) is put into place and the EU is aiming at an overall emission reduction target of -20% compared to 1990. In order to investigate the costs for industry of EU adopting a sharper target of -30%, we develop two **alternative scenarios** which primarily differ in the amount of CDM that is allowed on the market. The two scenarios are:

1. An EU wide target of -30% *with* additional use of CDM to comply with this target.
2. An EU wide target of -30% *without additional* use of CDM compared to the target of -20%.

Table 1 gives the input variables for these three scenarios that have been used in the cost price calculations.

Table 1 Overview on the assumptions in the three scenarios

Scenario	EU Target	EU ETS target NL 2020/2005	Maximum use of CDM	EUA price €/ton CO_2	CDM price €/ton CO_2
Base Case	- 20%	- 21%	50% * 21%	18	16.2
Alternative 1a	- 30%	- 31%	50% * 31%	34	29.6
Alternative 1b	- 30%	- 31%	50% * 21%	42	37.8

The EU wide target of -20% is translated to an EU ETS target of -21%. We simply assumed – without further calculations - that a target of -30% would be translated to an EU ETS of -31%. As a matter of fact these targets can be higher if the costs of meeting the higher emission reductions would be cheaper in the EU ETS sectors than in the non-EU ETS sectors.[1]

Contrary to CE Delft (2008), the present analysis takes into account that companies are allowed to make use of CDM credits. The amount of the emissions that is allowed to be covered by CDM credits however is restricted. In the base case scenario, the maximum amount is assumed to be equal to 50% of the emissions that have to be reduced (-21%) conform the Amending

[1] Cost equalisation between EU ETS and non-EU ETS sectors has been an important criterion to determine the relative contribution of EU ETS in the total reduction.

Directive. In the scenario with a higher emission target we differentiate between a higher and a lower amount of CDM credits that can be used: 50% of 31% of the 2005 emissions and alternatively 50% of 21% of the 2005 emissions. Notice that in the latter case the additional emission reductions to apply to the stricter targets can not be realised through CDM.

For an European emission target of -20% an EUA price of € 18/ton CO_2 is used in the analysis based on preliminary modelling results (see Annex A). For the stricter target of -30% two alternative prices, namely € 34/ton CO_2 and € 42/ton CO_2 are used, depending on the amount of CDM that is allowed to. The lower price refers to the case that use of CDM will be increased while the higher price refers to the case that the use of CDM will in absolute quantities be similar to the reduction target of -20%.

The CDM price is taken to be 10% less than the EUA price in the respective scenario, for reasons outlined in Annex A.

2.3 Approach taken in the calculations

2.3.1 Emission Trading Scheme and allocation

We assume here the emission trading scheme for the year 2020. This implies:
- A reduction of 21% of emissions compared to 2005 in the base scenario and a reduction of 31% of emissions compared to 2005 in the alternative scenarios. This -31% is an estimation of a probably goal for EU ETS that will be in line with an overall EU reduction goal of -30%.
- Allocation of the rights according to the current state of the comitology process. In this comitology process it is, amongst others, decided which sectors receive emission rights for free (because they would classify as showing risks of carbon leakage according to the criteria outlined by the Commission in the amendment of the EU ETS Directive (2009/29/EC). We took the status of this comitology process as it was on November 1st 2009. This implies that over 90% of industrial emissions in the Netherlands will be granted for free but that all emissions from the power sector will be auctioned.[2]
- Since we assume that all installations (whether or not part of EU ETS) will fall under similar targets as the EU ETS sectors, we do not need to take into account different definition of installations under Phase III of the EU ETS compared to Phase II.

2.3.2 Price formation on the electricity market

We assume in line with the present EU ETS Directive that the allowances used for the emissions stemming from electricity production will always be auctioned off. It can be expected that the power sector is able to pass through all of these extra costs and that hence industry is being faced with higher costs of electricity inputs. We take here into account only higher costs due to EU ETS; eventual higher costs from the -20% target for renewable energy has *not* been taken into account.

Using the CAFÉ model, we estimated that the marginal cost price increase of electricity will be € 10/MWh in the base scenario (EUA € 18/tCO_2, target -21%) compared to the situation when there will be no more EU ETS. This price

[2] Auctioning of industrial emissions will only take place in some parts of the sectors Nutrition, Paper, and Glass. This approach contrasts with CE Delft (2008) where all the allowances were taken to be either auctioned off or issued for free.

increase should be somehow similar to the present 2009 price of electricity as electricity producers do pass on the costs of their freely obtained allowances and the EUA price is currently close to € 18/ton CO_2. In case of the higher emission target and the relative abundant use of CDM the price is expected to rise by € 15/MWh and in the restricted use of CDM by € 18/MWh (see Annex A).[3]

Table 2 Overview on electricity price increase compared to 1/1/2005 in the three scenarios

Scenario	EU ETS Reduction 2020/2005	Electricity price rise compared to situation of non-EU ETS
Base Case	- 21%	€ 10/MWh
Alternative 1a	- 31%	€ 15/MWh
Alternative 1b	- 31%	€ 18/MWh

2.3.3 Cost concepts and cost types

Results in Chapter 3 are presented here using two cost-concepts:

1. Average costs. These costs represent an estimate of the real costs a sector will face when complying with EU ETS. These costs contain costs of taking reduction measures, costs of buying EU allowances, costs of higher electricity inputs due to EU ETS, etc.
2. Marginal costs. These costs represent an estimate of the 'opportunity' costs of companies when complying with EU ETS. The concept of opportunity costs implies that assets are valued against their market price. So a company that can reduce emissions at prices lower than the EUA price will still value this at the EUA-price as these reductions can be sold on the EU ETS market.

Due to the data collection (see CE, 2008, Annex A), the marginal cost rise is more accurately determined than the average cost rise. The average cost rise contains information on the costs to abate emissions in 2020 and these costs tend to be more uncertain. However, the average costs give an indication for the total direct tangible welfare costs of complying with EU ETS.

Both the average as the marginal costs can be divided into two categories of costs:

1. The direct costs, which constitute of the costs that companies must make in order to comply with the regulations of EU ETS. This includes costs of measures to reduce emissions, costs of purchasing allowances and costs of auctioned emission allowances for companies that fall under auctioning.
2. The indirect costs, which constitute of the costs of inputs (electricity, other energy, resources) that increase due to EU ETS. We take here into account only the electricity cost price increase, as this is the single largest source of indirect cost price increases.

Other types of costs, such as administrative costs, have not been taking into account.

When we combine the cost concepts with the cost categories we obtain the following types of costs that have been included in this study:

[3] The electricity price is assumed to rise in CE Delft (2008) by € 14/MWh (€ 34/MWh) under an EUA price of € 20/ton CO_2 (€ 50/ton CO_2).

Table 3 **Additional costs of complying to EU ETS**

	Direct costs	Indirect costs
Average costs	Costs to meet EU ETS goals (= costs of abatement + EUA price for non-abated emissions)	Price of purchased electricity (= costs of own CHP to comply with EU ETS + costs of higher electricity prices).
Marginal costs	EUA price multiplied by the reduction	Electricity price increase multiplied by electricity consumed.

Annex B in more detail explains how the various cost concepts have been used in this study.

Finally, one may distinguish between gross and net costs. Gross costs are the expenses to industry from complying with EU ETS. However, as part of these costs may be passed onto the consumers, the net costs to industry will be lower. The results given in this study are always in terms of gross costs.

2.3.4 Sector classification

Dutch industry is relatively small and due to issues of confidentiality many data sources are not available. The chosen level of sector disaggregation used in this study is as follows:

Table 4 **Sector classification used in this study**

Name	SBI
Nutrition	15, 16
Textiles	17, 18, 19
Wood	20
Paper	21
Graphics	22
Refineries	23, excl. 231
Petrochemical	2414, 2416, 2417
Fertilizer	2415
Inorganic chemicals	2413
Other Base Chemicals	2411, 241
Chemical products	242-247
Glass	261
Building materials (tiles, bricks)	264
Cement, calcium and gypsum	265
Ceramics nec (*not else classified*)	262, 263, 266, 267, 268
Iron and steel (incl. casting and cokes)	271-273, 231, 2751 and 2752
Aluminium	2742
Other non-ferro	2741, 2743 and further, 2753 and further
Other industry	25 and 28 and further
Total industry	

Although this division might give a reasonable subdivision for the base chemical, building materials and base metal sectors, the subdivision for the paper industry is too rough. However, it proved not possible to further subdivide the paper industry.

3 Results

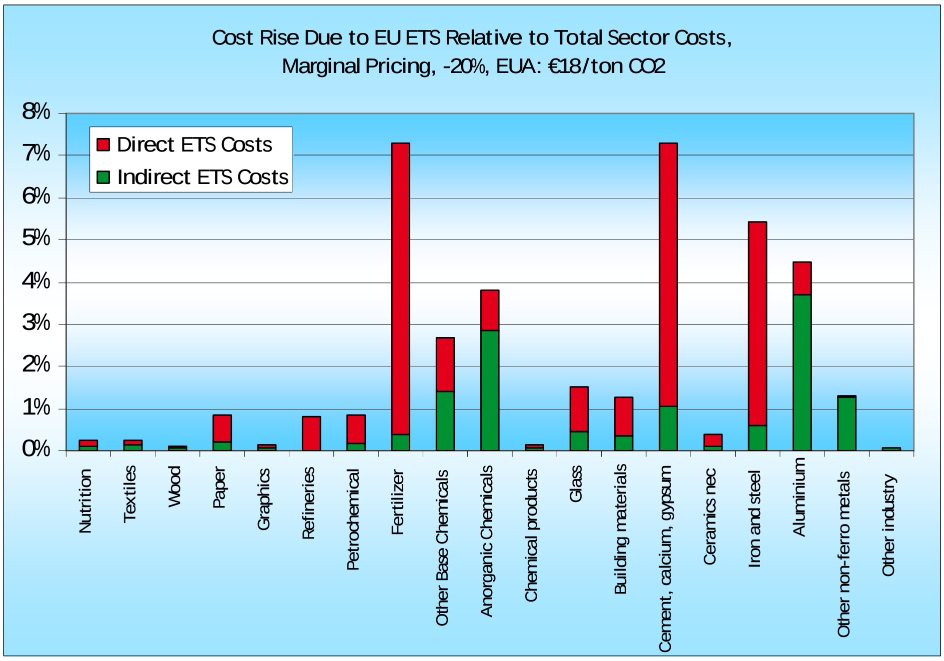
3.1 Introduction

This chapter presents results on the development of the costs for industry if the target is to be raised from -20 to -30%. First in paragraph 3.2 the results for the base scenario is given where emission reductions stay at -20%, and then subsequently in paragraph 3.3.

3.2 Base scenario

For a European emission target of -20% and an EUA price of € 18/ton CO_2 the gross marginal cost rise of the different industrial sectors is illustrated in Figure 1.

Figure 1 Gross marginal cost rise (-20%, € 18/ton CO_2)

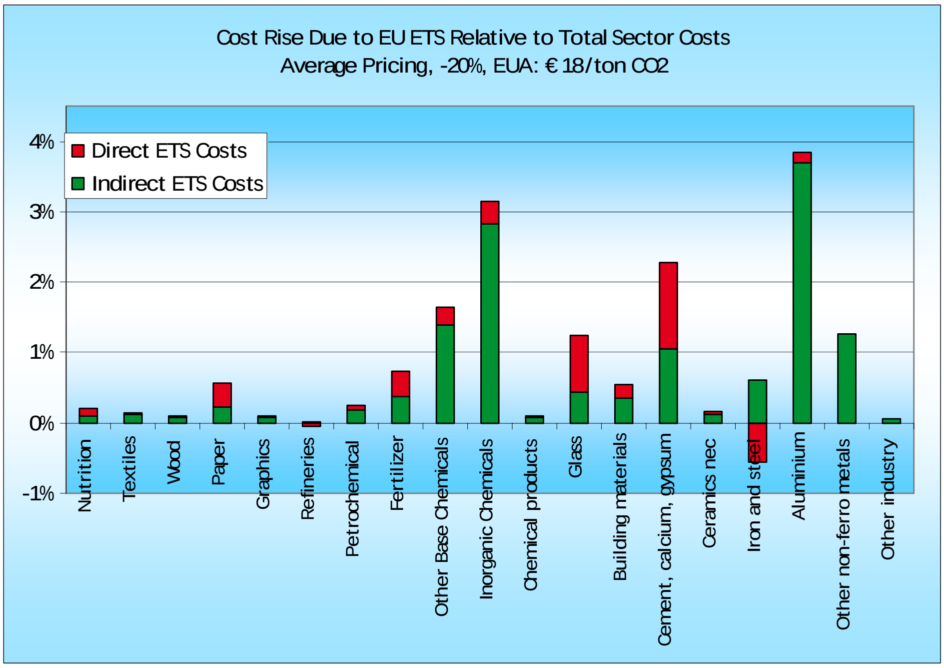


For most of the sectors it holds that the potential cost rise is lower than 1%. For the sectors Glass, Other Non-Ferro Metals and Building Materials it is between one and two percent. The six most affected sectors are, in ascending order, Other Base Chemicals, Inorganic Chemicals, Aluminium, Iron and Steel, Cement, calcium and gypsum, and finally Fertilizer with the highest relative potential cost rise of more than 7%.

These marginal costs represent the opportunity costs of complying with EU ETS but should not be considered as equivalent to the actual costs companies face. Actual costs are lower for three reasons:
1. Most industrial sectors receive their allowances for free.
2. Most industrial sectors can apply abatement technologies resulting in even lower prices to comply with the EU ETS regulations.
3. Most industrial sectors have their own power generation in CHP units that face lower cost increases than the purchase of electricity on the market.

The average cost price increase is given in Figure 2.

Figure 2 Gross average cost rise (-20%, € 18/ton CO_2)



The average cost rise of most sectors is lower than 1%. Three sectors (Aluminium, Inorganic Chemicals, and Cement, calcium and gypsum) experience a higher cost rise than 2% with the maximum cost rise being 3.9% for Aluminium.

Comparing the marginal with the average cost price increase shows that iron and steel and fertilizers may have very cost-effective opportunities to abate emissions in the year 2020. [4] On the contrary, the average cost rise of the sectors Aluminium and Inorganic Chemicals is still relatively high because of the high indirect costs and there exist few opportunities to cut down electricity use in these sectors. Because Cement, calcium and gypsum disposes

[4] Data for abatement costs have been obtained from ECN. The fertilizer and iron and steel industries themselves claim that these cost-effective opportunities in 2020 may not be realised as these techniques are still in experimental stages. For Fertilizers CO_2 sequestration in the ammonia production enables the sector to reduce 1.9 Mt of CO_2 according to ECN. In the Iron and Steel sector the use of a Cyclone Converter Furnace (CCF) accounts for 3.46 Mt of CO_2 reduction. The high abatement potential of CCF is due to the fact that this furnace is more efficient than a conventional furnace. The development of this technology started in the 1980s but had been stopped in the 1990s. In the Optiedocument (ECN en MNP, 2006) it is being estimated that if the development is further pursued CCF will become available between 2015 and 2020. Since within the European project Ulcos (Ultra low CO_2 Steelmaking) the development is being continued, we assume that the technology is available in 2020.

over little cost-efficient emission abatement measures, the average cost rise for this sector is also still relatively high.

At the level of the national economy, the total costs of complying with EU ETS are equivalent to € 0.4 billion. This is less than 0.1% of GDP. These costs consist of the costs of investments, electricity price increases and the purchase or sale of emission allowances. Not included are here eventual indirect effects, such as the relocation of industry due to cost differentials between EU and non-EU market. The literature assumes that these impacts are very small (see CPB, 2008). Moreover, using a literature review, CE Delft (2008) assumed that on average half of the opportunity costs that companies face may be passed on to the consumers under low emission prices (below the € 30/tCO_2).

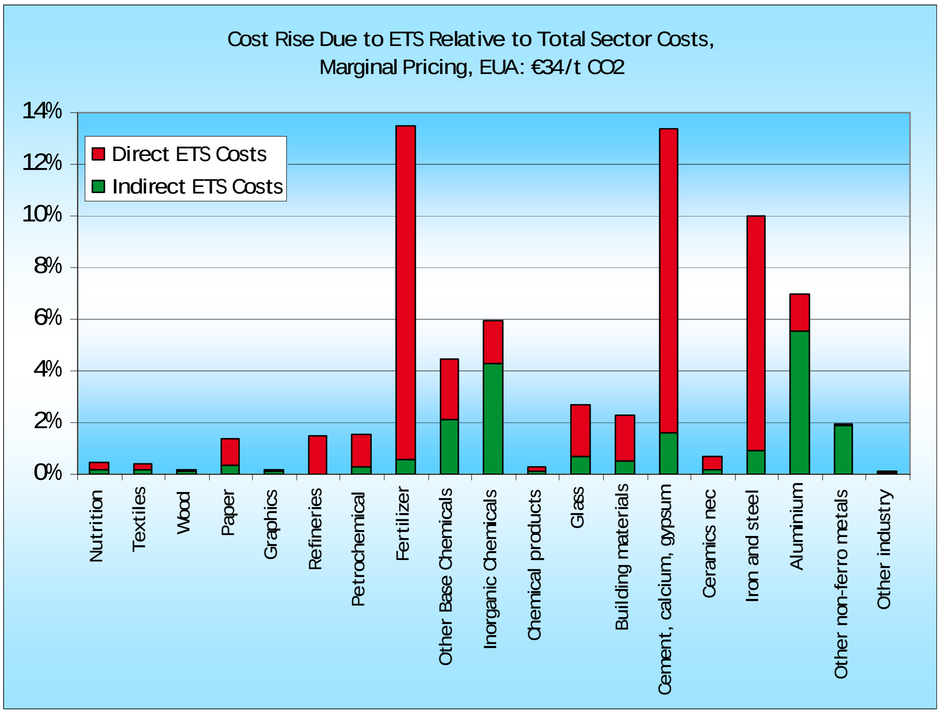
3.3 Impacts from sharpened reduction targets

If the EU increases the level of ambition from -20 to -30%, costs for industry will rise. As companies need to abate more emissions, costs will be higher. However, as other countries most likely also will adhere to binding GHG reductions, the competitive situation of companies might improve compared to the unilateral -20% goal.

3.3.1 Marginal cost price increases

Figure 3 gives the marginal cost price increase in case CDM is not restricted if the EU lifts the overall target to -30%. The consequence of a higher target is that the EUA price almost doubles (from € 18 to € 34) and that the CDM price will follow accordingly. This will have especially an impact on the sectors that have a large share of direct emissions. Electricity prices, however, will increase less as the marginal electricity unit will become a gas fired power station with lower CO_2 emissions.

Figure 3 Gross marginal cost price increase without restrictions on CDM (-30%, € 34/ton CO_2)



If CDM is going to be restricted, the marginal cost price increase will even be higher. The six sectors with the highest cost price increase under the base case scenario are also the most affected sectors in the two scenarios with the stricter emission reduction target. Table 5 gives an overview on the relative potential marginal cost rise of these sectors for the three scenarios.

Table 5 Marginal cost price increase of the six most affected sectors under different scenarios

Sector	Base scenario -20%, € 18/ton CO_2	Full CDM scenario -30%, € 34/ton CO_2	Restricted CDM scenario -30%, € 42/ton CO_2
Fertilizer	7.3%	13.5%	16.6%
Cement, calcium and gypsum	7.3%	13.4%	16.4%
Iron and Steel	5.4%	10%	12.3%
Aluminium	4.5%	7%	8.4%
Inorganic Chemicals	3.8%	6%	7.2%
Other Base Chemicals	2.7%	4.5%	5.4%

These marginal costs are important to explain eventual carbon leakage as these marginal costs can be perceived as a proxy for the opportunity costs. It should be borne in mind that the marginal costs are not the actual costs that companies face to comply with EU ETS.

3.3.2 Average cost price increase

Figure 4 gives the increase in costs companies will face in average costs if CDM is not going to be restricted.

Figure 4 Gross average cost price increase without restrictions on CDM (-30%, € 34/ton CO_2)

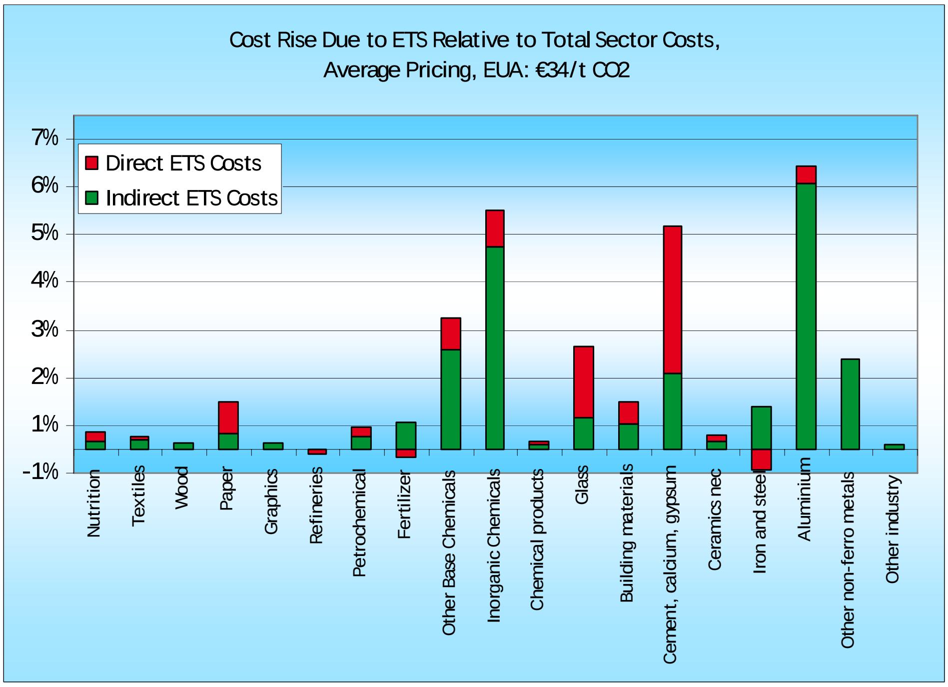


Table 6 gives information on the gross average cost development of the most affected sectors for both alternatives.

Table 6 Gross average cost rise of the six most affected sectors

Sector	Base scenario -20%, € 18/ton CO_2	Full CDM scenario -30%, € 34/ton CO_2	Restricted CDM scenario -30%, € 42/ton CO_2
Aluminium	3.9%	5.9%	7.1%
Inorganic Chemicals	3.1%	5.0%	6.1%
Cement, calcium, and gypsum	2.3%	4.7%	5.8%
Other Base Chemicals	1.7%	2.7%	3.4%
Other Non-Ferro Metals	1.3%	1.9%	2.3%
Glass	1.2%	2.2%	2.6%

Setting a higher emission reduction target leads to a higher cost rise for all sectors. Aluminium and inorganic chemicals are the most affected sectors with respect to average cost price increases. However, setting the target higher impact, in relative terms, the glass and other base chemicals the most as their cost price increase under the restricted CDM scenario more than doubles.

For two sectors, Refineries and Fertilizers, it appears that a higher target actually may result in some benefits. The reason is reflected in the fact that when the emission reduction target is tightened the industry as a whole has to reduce more emissions, leading to higher total abatement costs. A higher CDM price also makes emission reduction more expensive. With the emission price being higher, more emission abatement measures are cost efficient. The sectors Fertilizers and Refineries for example will abate much more in this case. They could already sell some of their allowances in case of the lower emission target but now they can sell even more allowances. The profit from the sale of excess allowances makes that their total costs decrease.

The total costs for the Dutch economy are presented in Table 7.

Table 7 Total costs of complying with EU ETS according to three scenarios

	Base scenario -20%, € 18/ton CO_2	Full CDM scenario -30%, € 34/ton CO_2	Restricted CDM scenario -30%, € 42/ton CO_2
Total costs (billion €)	0.4	0.7	0.9
As % of GDP	0.1%	0.1%	0.2%

Table 7 shows that the total costs for Dutch industry doubles if the target is to be raised from -20 to -30% and access to CDM is not enlarged in absolute amount. If the use of CDM is not going to restricted, costs can be lower. In terms of impacts on GDP, these effects are small. Moreover, these are costs that are not necessarily paid by industry themselves since part of these costs will be passed onto the consumers. The more countries accept binding CO_2 reductions, the lower the chances of import substitution will be and the more of these costs will be passed onto the consumers.

4 Conclusion

In this study we have determined the potential cost increase of the Dutch industrial sectors as a result of EU ETS. Three different scenarios have been analysed. The scenarios differ with respect to the emission reduction target, the price of the emission allowances and CDM credits, as well as with the scope to which it is allowed to use CDM credits.

Table 8 Main specification of the three scenarios

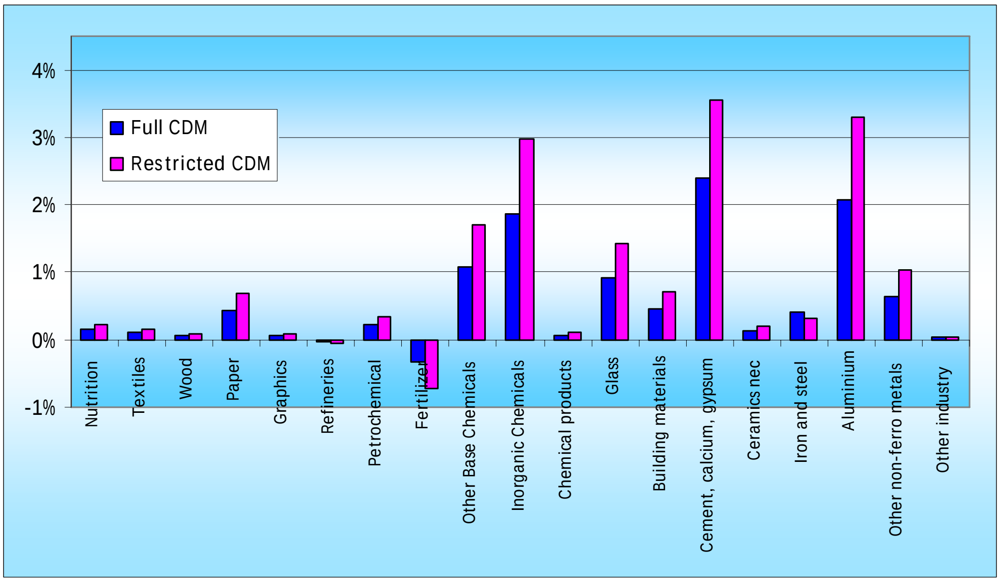
Scenario	EU target	ETS target NL 2020	EUA price €/ton CO_2	CDM price €/ton CO_2	Maximum EUAs to be covered by CDM	Electricity price rise
Base Case	-20%	- 21%	18	16.2	50% * 21%	€ 10/MWh
Alternative 1a	-30%	- 31%	34	29.6	50% * 31%	€ 15/MWh
Alternative 1b	-30%	- 31%	42	37.8	50% * 21%	€ 18/MWh

In first instance the maximum cost rise of the sectors was determined, assuming that the sectors dispose of no or only relative expensive abatement measures and that they additionally bring the opportunity costs into account. In every scenario the sectors Fertilizers, Cement, calcium and gypsum and Iron and Steel then turn out to be affected the most. The relative marginal cost rise of the first two sectors ranges from roughly 7 to 16% over the scenarios, whereas for Iron and Steel roughly from about 5 to 12%.

In a second step the average cost price increase was determined taking the actual emission abatement measures of the sectors into account and not considering the sectors opportunity costs. Freely obtained allowances are then really obtained at no costs to the sectors. It turned out that the potential relative average cost rise of the sectors is much lower. The sectors Aluminium, Inorganic Chemicals and Cement, calcium and gypsum are then the most affected ones, with a relative cost rise of roughly 4-7%, 3-6% and 2-6%, respectively, depending on the scenario. The sectors such as Iron and Steel, Fertilizers and Refineries, which dispose of a high cost-effective emission reduction potential, are less affected than those with a low cost-effective reduction potential such as Cement, calcium and gypsum. The sectors that are electricity intensive, as for example Aluminium or Inorganic Chemicals, are stronger affected than the other sectors.

The average cost increase allows us to determine the real costs to the sectors of each scenario from complying with EU ETS. Figure 5 gives the outcome for both scenarios where the additional costs of meeting the more stringent target have been expressed as a percentage of the total costs for industry.

Figure 5 **Average cost price increase of a -30% reduction target in 2020 compared to a -20% reduction target, expressed as percentage of the total costs**



Note: Costs in this figure present gross cost not net costs.

It appears that the highest additional cost increases occur for the cement industry, the aluminium industry and the inorganic chemicals. These sectors have little opportunities to reduce emissions or electricity demand. The aluminium and inorganic chemical industry mainly suffer from the higher electricity prices, while the cement sector will be a net buyer of allowances. Some sectors, e.g. Refineries and the Fertilizer sector, may profit from the more strict emission regime as they have opportunities to reduce their emissions at lower costs and become net sellers of emission credits.

The costs presented here are potential cost price increases. The net cost price increases will, ultimately, depend on the possibility of firms to pass through the higher costs. It was not investigated here to what extent the possibility to pass through the costs will be enlarged under a -30% target. Earlier research at CE Delft estimated that under a -20% target about half of the costs for complying with EU ETS may be passed onto the consumers. If more countries will commit themselves to binding CO_2 reduction targets, the amount of costs that can be passed through will increase as CO_2 will obtain a price the most important trading partners of the EU.

Finally, an estimation of the total costs to comply with EU ETS shows that these increase under higher emission targets. While these costs were estimated at 0.4 billion annually in 2020 under the -20% target (less than 0.1% of GDP), the costs will increase to 0.9 billion annually for a target of -30% and no additional use of CDM. If the higher reduction target can also be reached by using CDM credits, the costs will lower to 0.7 billion annually.

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Annex A Market Analysis

(Annex A.1 and A.2 are in Dutch only)

A.1 EUA-prijzen

EUA-prijs

Er bestaat een uitgebreide literatuur met schattingen over toekomstige emissiehandelsprijzen. Zo wordt in de Europese impact assessment van het klimaat- en energiepakket voor 2020 een prijsverwachting van € 39/ton CO_2 genoemd (EC, 2008). Andere voorspellingen[5] variëren van € 35 tot € 70/ton CO_2, waarbij meestal wordt uitgegaan van een 20% reductie-doelstelling in fase III. Wanneer wordt uitgegaan van een internationale klimaatakkoord met bijbehorende hogere reductiedoelen zal, ceteris paribus, een hogere prijsverwachting tot stand komen[6].

Om een aantal redenen kunnen deze prijzen aan de hoge kant liggen:
- Invloed van de huidige economische recessie.
- De huidige economische recessie en de daarmee samenhangende terugloop in industriële productie en emissies is veelal niet in de berekeningen meegenomen. Deze crisis heeft een lagere EUA-prijs tot gevolg. Momenteel worden een aantal bestaande prijsverwachtingen naar beneden bijgesteld (zie ook Box 1)[7].
- Duurzame energie-doelstelling.
- Een andere reden voor een (te) hoge prijsinschatting is dat men (nog) geen rekening houdt met de Europese doelstelling voor het aandeel duurzame energie in 2020 (20%) of er vanuit gaat dat deze doelstelling niet wordt gehaald (zie bijvoorbeeld Carbon Finance, 2009; Climate Strategies, 2009). Hierdoor zouden duurdere technieken nodig zijn om de benodigde CO_2-reductie te realiseren en zal de prijs van emissierechten toenemen.

Om deze factoren wel mee te nemen hebben we aansluiting gezocht bij ECN waar op dit moment gewerkt wordt aan een model van de EU ETS-markten waar alle onderliggende variabelen in hun samenhang bestudeerd worden. Op basis van correspondentie met het ECN komen we tot de volgende (voorlopige) prijsschattingen die een rol spelen in ons onderzoek:
- Base scenario:
  Bij een reductiedoelstelling van 20% en CDM-inzet volgens de huidige EU ETS-Directive (2009/29/EC) bedraagt de EUA-prijs in 2020 naar verwachting € 18/ton CO_2.
- Alternative scenario 1A:
  Wanneer de reductiedoelstelling 30% wordt zal de prijs oplopen tot € 34/ton CO_2. Aanname hierbij is dat de inzet van CDM maximaal 50% van de 30% reductie-inspanning mag bedragen.

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[5] Het gaat hier om o.a. Point Carbon, Société Generale, Carbon Trust, New Carbon Finance, ICF International, Fortis en andere private sector-schattingen.

[6] Zo berekent ICF (2009) een prijs van € 70 per ton CO_2 en noemt ECN (2009) een gemiddelde prijs van € 52/ton bij een stabilization doel van 450 ppm CO_2-eq.

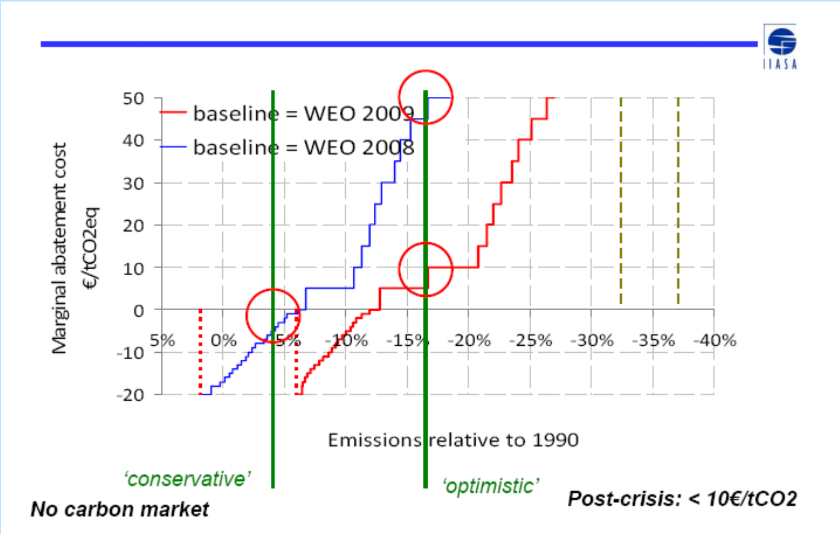
[7] New Carbon Finance (2009) heeft, bijvoorbeeld, de gemiddelde prijs bij een reductietarget van 20% verlaagt van € 55 per ton naar € 40 per ton CO_2.

– Alternative scenario 1B:
Wanneer de reductiedoelstelling aangescherpt wordt tot 30% maar het toegestane gebruik van CDM niet wordt verhoogd (blijft beperkt tot 50% van 20% emissiereductie), dan loopt de prijs op tot € 42/ton CO_2. Dit heeft te maken met het feit dat CDM over het algemeen een relatief goedkope manier van emissiereductie is. Wanneer deze optie ingeperkt wordt (ten opzichte van scenario B), moeten duurdere maatregelen worden aangesproken en zal de EUA-prijs hoger komen te liggen.

Box 1: Impact van de economische crisis op de ETS-markt

Het International Institute for Applied Systems Analysis (IIASA) heeft inschattingen gemaakt van de gevolgen van de huidige politieke beleidslijnen van de Annex 1-landen. Eén analyse is uitgevoerd zonder rekening te houden met de huidige recessie (WEO, 2008). In de meest recente analyse zit de economie wel op een lager groeipad (WEO, 2009). Enkele resultaten staan vermeld in Figure 6. Wanneer wordt uitgegaan van zogenaamde 'conservatieve' beleidsinzet (voor de EU betekent dit -20%) is de verwachting dat er geen carbon market zal zijn. De prijs gaat immers naar nul wanneer er geen schaarste is op de markt. Onder het 'optimistische' beleidsscenario (-30% voor de EU) zou er na de economische crisis slechts een beperkte krapte ontstaan; de ETS-prijs blijft onder de 10 €/ton CO_2. Zonder recessie zou de inschatting op 50 €/ton CO_2 hebben gelegen.

Figure 6 Implicaties doelstellingen en economische crisis op EUA-prijs en ETS-markt



A.2 CDM-prijzen

Naast gewone emissierechten (EUAs) mogen bedrijven ook een gelimiteerd aantal Certified Emission Reduction Units (CERs) verkregen uit Clean Development Mechanism (CDM) projecten inzetten om hun EU ETS-doelstellingen te halen. Dit zijn emissiereducties die in het buitenland zijn gerealiseerd[8].

8 Sinds 2008 geldt dit ook voor Emission Reduction Units (ERU) verkregen via Joint Implementation (JI) projecten.

Historisch gezien bestaat er dan ook een sterke relatie tussen de prijs van CERs en de prijs van een EUA. De CER-prijs werd veelal geschat op zo'n 75-80% van de EUA-prijs (Carbon Finance, 2008; EEX-Eurex, 2008)[9], maar ligt momenteel op circa 90% van de EUA-prijs[10]. Figure 7 laat ook zien dat het verschil tussen beide prijzen (de spread) de afgelopen periodes is gedaald. Dit heeft o.a. te maken met het feit dat de aankoop van CERs door EU ETS-deelnemers sinds oktober 2008 vergemakkelijkt is, door de zogenaamde CITL-ITL link[11]. Daar CERs goedkoper zijn dan EUAs, is het aantrekkelijk emissierechten te verkopen en CERs aan te kopen (arbitrage). Dergelijke swaps reduceren het prijsverschil. De EUA-prijs zal vermoedelijk wel hoger blijven omdat het aanbod van EUAs op de markt beperkt wordt door het gereguleerde emissieplafond, terwijl dit voor CERs niet geldt. Overigens wordt wel verwacht dat er voor de periode 2008-2012 op de totale JI/CDM-markt een klein tekort aan emissiereducties ontstaat, wanneer projecten deze niet (tijdig) volgens contractering opleveren (World Bank, 2009). Daar staat tegenover dat de huidige economische recessie mogelijk tot een lagere Europese vraag lijdt dan verwacht en er juist credits over zouden kunnen blijven (Carbon Positive, 2009).

Figure 7 Ontwikkelingen in EUA-prijzen, CER-prijzen en spread

Bron: ECX, 2009a.

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9 Dit is de prijs van secundaire CERS, i.e. reeds gegenereerde en geregistreerde emissiereducties. Dit type credits is het minst risicovol en heeft de hoogste prijs. Op de primaire CDM-markt worden nog niet gegenereerde credits verhandeld, waarbij er geen eenduidige prijs is vast te stellen. Prijzen zijn afhankelijk van de projecteigenschappen, risico's en het type contract en worden vaak niet openbaar gemaakt.

10 Gemiddelde percentage over de periode maart- november 2009. Eigen berekening o.b.v. prijsdata uit EXC (2009b).

11 De European Community Independent Transaction Log (CITL) is gelinkt aan de International Transaction Log (IT) van de Verenigde Naties. De nationale registeren van EU-lidstaten zijn hierdoor rechtstreeks gelinkt aan de ITL (IDEAcarbon, 2008; EC, 2009b).
Verder is banking mogelijk van EUAs en mogen credits naar een volgende handelsperiode worden meegenomen.

Op de basis van deze analyse veronderstellen we dat de CDM-markt niet fundamenteel zal veranderen. We veronderstellen derhalve een CDM-prijs die 10% onder de EU ETS-marktprijs zal liggen voor het 20% reductiescenario.

Bij een 30% reductiescenario zou idealiter wel rekening gehouden worden met een veranderde CDM-markt omdat hierin wordt uitgegaan van een internationaal klimaatakkoord. Tot op heden is Europa de grootste afnemer van CDM credits (World Bank, 2009), maar Japan, Australië en de USA worden verwacht een significatie vraag naar CERs uit te oefenen in de periode 2012 tot 2020, vooral wanneer de internationale klimaatonderhandelingen in Kopenhagen succesvol verlopen (Mission Climat, 2009; CE Delft/ ICF International, 2008). Dit is een argument om uit te gaan van wereldwijde CER-prijzen (zie ook New Carbon Finance, 2009). Op dit moment hebben wij echter onvoldoende zich op de implicaties van een wereldwijd klimaatakkoord met daaraan verbonden regels en procedures, die zowel de vraag naar als het aanbod van CDM credits zullen beïnvloeden[12]. In deze studie zullen wij daarom toch de huidige CDM-markt en prijsontwikkeling aanhouden en ook voor de 30%-scenarios uitgaan van een CDM-prijs die 10% onder de EU ETS-markt zal liggen.

A.3 Electricity prices

Emissions from the power sector will be auctioned in Phase III. One important element to the quantitative analysis is how the power sector will pass on the costs of auctioning into the price of electricity. This is important for an estimation of the **indirect costs** for industrial sectors and households.

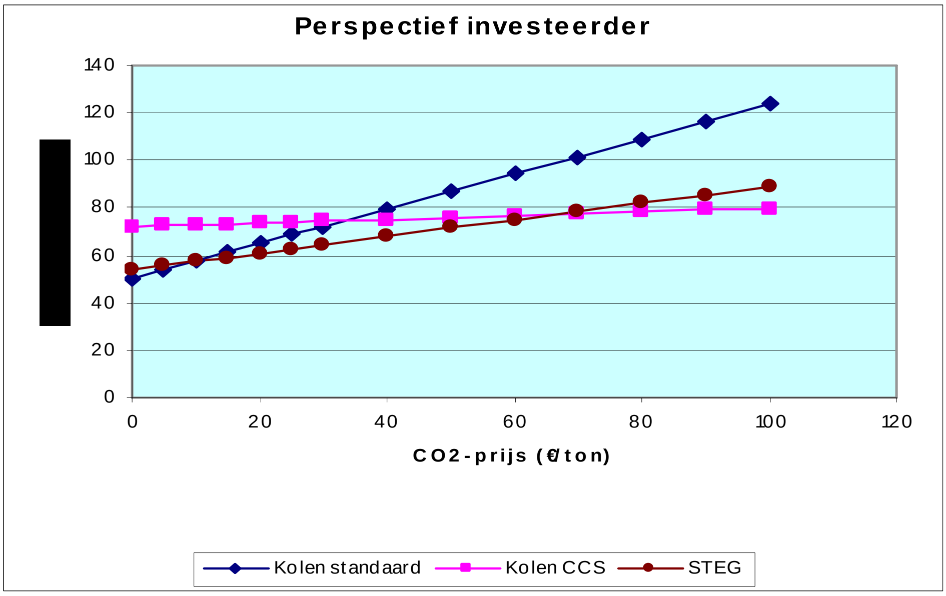
The Dutch electricity sector has some notable features: it has a large share of coal-fired power stations and a large fraction of gas-fired co-generation plants, with many of the latter being operated as joint ventures with industries. Compared to other countries in the EU, nuclear energy and renewable energy provide very little of the total primary energy supply in the Netherlands.

Reinaud (IEA, 2003) gives an extensive and thoughtful analysis of the pricing strategies of electricity producers. Reinaud argues that in case of tight available capacity, prices are expected to rise by the additional carbon cost to the marginal producer. The marginal producer for industry may not be similar as the marginal producer for the household market. In the household market, the marginal production unit is more likely based on the peak load which may imply a unit that can easily be switched off, such as a gas-fired STEG. For the energy-intensive industry, the marginal production unit is more likely based on the base load and hence a coal-fired power plant.

12 Bijvoorbeeld kwantitatieve en kwalitatieve limieten op de inzet van CDM binnen de (toekomstige) regionale emissiehandelssystemen en eisen m.b.t. het land van herkomst. Wanneer de CDM-markt zou omslaan van een aanbiedermarkt naar een vragersmarkt, zal de link met de EUA-prijs zelfs geheel kunnen verdwijnen.

In this study, we took the route where we based the marginal unit for industry on the costs of an additional unit of newly built electricity, a similar routine as undertaken in our previous report (CE, 2008). In order to determine the costs of the marginal unit for industry we rely on the CAFÉ-model, developed by CE Delft and CIEP for a Dutch think-tank on energy issues (*Bezinningsgroep Energie*)[13]. This model, based on ECN data, analyzes the marginal electricity production unit under different prices of CO_2 (and other pollutants as well). Figure 8 gives the average costs of production for the most used techniques under different CO_2 prices[14].

Figure 8 Outcomes of a model run using the CAFÉ model



From this model one may conclude that with an ETS price of € 34 and € 42, STEG units connected to the heat grid are the most economical option from the perspective of an electricity company. If no EU ETS would be in place, the price per MWh would be € 52 for a new coal fired power plant. If the EU ETS price would rise to € 30, the average costs per MWh would be € 67 for a gas-fired STEG. This results in a marginal price increase of € 15. For an emission price of € 42, the gas fired STEG results in additional costs of € 18/MWh. For an emission price of € 18/ton CO_2, the marginal cost price increase would be equivalent to € 10/MWh.

13 This is a cash-flow model that simulates the investment decision for an investor implementing new energy plants under various scenarios.

14 These results differ from the analysis in CE Delft (2008) because of adjustments of the price of construction of a coal fired power plant by ECN. Costs of construction of coal fired power plants have been increasing due to various reasons, among them the higher costs of steel in 2006 and higher costs of labour inputs. Moreover, the technique of a coal fired power plant connected to the heat grid has been abandoned as this technique is only in limited cases possible. For the calculations we took average price levels of 2006: coal prices of € 2,6/GJ, gas prices of € 5,7/GJ and an average electricity price of 4,6 Eurocent/kWh. All cash flows have been calculated using the net present value for a time span of 20 years. A sensitivity analysis with prices of 2007 showed no substantial differences in the price increases due to EU ETS.

Annex B Cost concepts

In this study we use two cost concepts and two cost price categories

B.1 Cost concepts

In this study we distinguish marginal from average costs. The marginal cost rise gives the maximum potential cost rise of a sector in the sense that, first, it is being assumed that the sector cannot take emission reduction measures or only disposes of very expensive reduction measures, second, that it cannot make use of CDM rights, and third that the sector does take the opportunity costs of the following activities into account:
- Use of free allowances.
- Use of self-produced electricity.

The marginal cost rise is therefore equivalent to the opportunity costs of complying to EU ETS.

On the contrary, the average cost rise is determined taking the sectors' cost-efficient emission abatement measures into account. Besides, the opportunity costs of free allowances and self-produced electricity are not accounted for. What should be borne in mind is that for both estimations the *potential* cost rise is determined; a possible cost pass through is not dealt with in this analysis.

B.2 Cost categories

The potential cost rise is calculated considering the following two cost entries:
1. Indirect costs. Power plants fall under EU ETS, leading to a cost rise in the electricity sector. When these costs are passed through, the electricity price rises, constituting indirect costs of EU ETS for the industrial sectors. Note that the price of inputs other than electricity might rise too, these effects however are not included in this analysis.
2. Direct costs. The direct costs are on the one hand the sectors' costs for complying with EU ETS. Compliance costs are costs for emitting and costs for emission abatement. On the other hand, and these costs are only considered in the marginal cost rise case, opportunity costs arise for using self-produced electricity.

In the following the two cost entries are described in greater detail.

Indirect Costs
Power plants fall under EU ETS, leading to a cost rise in the electricity sector. When these costs are passed through, the electricity price rises, constituting indirect costs of EU ETS for the industrial sectors. These indirect costs have to be accounted for in both cases, the marginal and the average cost rise.

Direct Costs - Emission Abatement Costs
For the calculation of the marginal cost rise individual emission abatement measures do not have to be specified since it is being assumed that the sectors either do not dispose of abatement options or do only dispose of very expensive options. In any case, under this assumptions the sectors will not make use of emission abatement.

On the contrary, the average cost rise is determined on the grounds of the actual emission abatement costs. To this end the Optiedocument (ECN and MNP, 2006) is used. Here the costs and reduction potentials of the emission abatement options of the different sectors are given.[15] Credits stemming from CDM projects are here also considered as emission abatement options.

Direct Costs – Emission Costs

The costs for each unit of the pollutant that is emitted in the marginal cost rise estimation is always equal to the EUA price: For allowances that were obtained free of charge, the sector assesses the opportunity costs, i.e. the EUA price. When allowances are bought on the allowance market the EUA price is of course the relevant unit. The same holds for allowances purchased by auction. In contrast, in case of the average cost rise, the costs associated with the actual emissions vary with the allocation mechanism. If allowances are auctioned off, again the EUA price reflects the costs per unit of emission, but if allowances are (partly) issued for free, sectors will only incur costs when they have to buy additional allowances on the market. They might even generate a profit when being able to sell spare free allowances.

Direct Costs – Opportunity Costs Self-Produced Electricity

In some industrial sectors there are firms that produce electricity themselves. When these firms also use this electricity themselves they, independent of the EU ETS system, incur opportunity costs since they could have sold the electricity alternatively. This opportunity cost is higher under EU ETS if the electricity price rises due to EU ETS. These costs are considered in the marginal cost rise calculation.

15 In the Optiedocument (ECN en MNP, 2006) the reduction potentials of the abatement options are given for the year 2020. In our analysis we abstract from an autonomous growth of the baseline emissions between 2005 and 2020 by taking the simplifying assumption that the 2020 emission target has to be met in 2005 immediately. For this reason we apply a correction factor to the abatement potentials as given in the Optiedocument. The factor used is about 0.86 which reflects the ratio of the 2005 and the 2020 emissions as given in the Optiedocument.