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Impacts on Competitiveness from EU ETS

An analysis of the Dutch industry

Report

Delft, June 2008

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Publication Data

Bibliographical data:
Sander de Bruyn, Dagmar Nelissen, Marisa Korteland, Marc Davidson, Jasper Faber, Gerdien van de Vreede
Impacts on Competitiveness from EU ETS, An analysis of the Dutch Industry
Delft, CE, 2008

Emissions / Tradable permits / EC / Policy / Competitiveness / Effects / Industry / Analysis

Publication number: 08.7592.31

CE-publications are available from www.ce.nl

Commissioned by: PRET (Projectgroep Review EU Emissiehandelssysteem):
Ministeries van Financiën, Economische Zaken, VROM, Buitenlandse Zaken.

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Preface

This research has been enhanced with contributions from Martijn Blom, Harry Croezen and Lonneke Wielders who also work at CE Delft.

We especially would like to express our gratitude to the advisory board, consisting of Herman Vollebergh (MNP), Harmen Verbruggen (Vrije Universiteit Amsterdam), Remco van der Molen, Ewout Visser and Rein ter Horst (Ministry of Finance), Jip Lenstra and Frans Duinhouwer (Ministry of the Environment), Maurits Blanson Henkelmans and Paul van Slobbe (Ministry of Economic Affairs) and Paul Koutstaal (Central Planning Bureau). Any remaining errors are, of course, our responsibility.

Nederlandse management samenvatting

Het Europese emissiehandelssysteem (ETS) is in 2005 gelanceerd om de CO_2-emissies van grote industriële installaties te maximeren. De Commissie stelt momenteel het EU ETS post-2012 systeem vast, zoals in COM(2008)16 (EC, 2008) in grote lijnen is geschetst. Nieuw in dit systeem is dat een groter deel van de rechten zal worden geveild. Het veilen van emissierechten waarborgt in zijn algemeenheid een grotere mate van efficiency dan (bepaalde vormen van) vrije allocatie, vermindert de administratieve kosten en voorkomt eventuele oneigenlijke winstvorming (*windfall profits*).

Het veilen van rechten kan echter ook leiden tot een potentieel verlies aan concurrentievermogen voor de industrie. Zeker als er geen mondiaal klimaatakkoord tot stand komt zijn bedrijven niet altijd in staat om hogere kosten aan hun klanten door te berekenen en kan er sprake zijn van een verlies aan rendement en de dreiging van importsubstitutie. Een verplaatsing van de productie naar landen die geen CO_2-doelen kennen resulteert in een wereldwijde toename van de CO_2-emissies. Dit fenomeen wordt wel een koolstoflek (*carbon leakage*) genoemd. Om een koolstoflek te voorkomen, heeft de Commissie voorgesteld kwetsbare sectoren vrij te stellen van de veilingplicht en hun op basis van een benchmark vrijelijk rechten toe te wijzen. Het belangrijkste criterium hierbij is een aanzienlijk verlies aan concurrentievermogen, op grond waarvan wordt besloten of bepaalde sectoren veilingplichtig zijn of in aanmerking komen voor vrije allocatie.

In deze studie is onderzocht welke sectoren binnen de Nederlandse economie bij een veilingsysteem mogelijk te maken krijgen met een verlies aan concurrentievermogen. Het concurrentievermogen wordt beïnvloed door de combinatie van aanzienlijke potentiële kostprijsstijgingen en wezenlijke import- en exportstromen van en naar landen zonder vergelijkbaar klimaatregime. Het lijkt erop dat vooral in de sectoren aluminium, kunstmest, ijzer en staal, anorganische en andere basischemicaliën, relatief hoge prijsstijgingen te verwachten zijn, die mogelijk niet volledig aan de klanten kunnen worden doorberekend. Het rendement in deze sectoren kan afnemen en de kans op koolstoflekken neemt toe.

Wat betreft de impact op de nationale economie (d.w.z. het BNP) zijn de gevolgen echter waarschijnlijk gering. De directe kosten van het voldoen aan EU ETS bedragen 0,2% van het BBP bij een CO2-prijs van € 20/ton. De industrie zal deze kosten gemiddeld voor ongeveer de helft kunnen doorberekenen aan de afnemers. Verslechtering van de marktpositie kan optreden in sectoren met hoge kosten en weinig mogelijkheden tot doorberekening, maar deze sectoren zijn - met uitzondering van de ijzer- en staalindustrie - relatief klein (in totaal circa 1,15% van het BNP). Daarnaast zullen, indien het internationale klimaatbeleid tot het jaar 2020 ertoe leidt dat meer landen instemmen met bindende reductietargets, de gevolgen voor het concurrentievermogen kleiner zijn dan die welke hier zijn geanalyseerd.

Het veilen van emissierechten waarborgt een grotere mate van efficiency en voorkomt windfall profits. Uit deze studie is gebleken dat het veilen van emissierechten naar verwachting het concurrentievermogen in een beperkt aantal sectoren kan verminderen hetgeen gevolgen kan hebben voor de kans op koolstoflekken. Er zijn in deze studie diverse opties geanalyseerd om de negatieve effecten voor het concurrentievermogen te compenseren. Indien de regering de gevolgen voor energie-intensieve sectoren wil matigen, kan worden gedacht aan een instrument voor Border Tax Adjustments en aan hergebruik van de opbrengsten voor energiebesparende investeringen, naast de vrije toewijzing van rechten.

Nederlandse uitgebreide samenvatting

Achtergrondinformatie

Het Europese emissiehandelssysteem werd in 2005 gelanceerd om de CO_2-emissies van grote industriële installaties te maximeren. Met een dekking van bijna de helft van alle CO_2-emissies in de EU, vormt het de kern van het Europese beleid betreffende het klimaatbeleid. EU ETS is waardevol voor de reductie van CO_2-emissies en heeft een markt tot stand gebracht met een vermogenswaarde van tientallen miljarden euro's per jaar.

De Commissie is momenteel doende het EU ETS post-2012 op te stellen, zoals in COM(2008)16 (EC, 2008) in grote lijnen is geschetst. Nieuw in dit systeem is dat een groter deel van de rechten zullen worden geveild. Het veilen van emissierechten waarborgt in zijn algemeenheid een grotere mate van efficiency dan (bepaalde vormen van) vrije allocatie, vermindert de administratieve kosten en voorkomt eventuele windfall profits.

Het veilen van emissierechten kan echter ook een potentieel verlies aan concurrentievermogen voor de industrie tot gevolg hebben, aangezien de kosten voor de industrie hoger zijn bij veiling van de emissierechten dan bij vrije allocatie ervan. Bedrijven in de EU krijgen te maken met hogere kosten als er geen mondiaal klimaatakkoord wordt bereikt die ook andere landen dwingt hun emissies te beteugelen. De hogere kosten kunnen hun exportpositie aantasten en leiden tot importsubstitutie uit niet-EU-landen waar kooldioxide geen prijs heeft. Een verplaatsing van productie naar landen zonder klimaatbeleid resulteert simpelweg in een wereldwijde toename van CO_2-emissies. Dit fenomeen wordt 'koolstoflek' (*carbon leakage*) genoemd. Om een koolstoflek te voorkomen, heeft de Commissie voorgesteld kwetsbare sectoren vrij te stellen van de veilingplicht en hen op basis van een benchmark gratis rechten toe te wijzen. Het belangrijkste criterium hierbij is een aanzienlijk verlies aan concurrentie-vermogen, op grond waarvan wordt besloten of bepaalde sectoren veilingplichtig zijn of in aanmerking komen voor vrije allocatie.

De term concurrentievermogen is helaas een slecht gedefinieerd begrip in de economische wetenschap en er bestaat geen algemene methode voor het analyseren van de effecten van hogere kosten door milieuwetgeving. De wisselwerking tussen een grotere mate van efficiency van een veilingsysteem en het risico van koolstoflekken kan het best beschouwd worden aan de hand van economische modellen. De meeste modellen zijn echter niet genoeg gedetailleerd wat betreft de specifieke economische activiteiten en er kleeft eveneens een aantal andere bezwaren aan het gebruik van modellen. Om die reden is een partiële micro-economische analyse van de gevolgen van hogere CO_2-prijzen overheersend geworden in het debat over het toekomstige ontwerp van EU ETS.

Deze studie borduurt voort op deze onderzoekstraditie met een partiële micro-economische analyse van de kosten van het toekomstige EU ETS-ontwerp. Het voordeel ervan is dat er een gerichter detailniveau kan worden bereikt dan met economische modellen. Het nadeel van deze benadering is dat uitsluitend wordt gekeken naar de directe kosten van EU ETS en dat bepaalde voordelen of indirecte kosten voor de samenleving buiten beschouwing blijven.

Doelstelling van deze studie

Doelstelling van deze studie is een analyse van de effecten van EU ETS op het concurrentievermogen. Daarnaast beoogd de studie om de economische activiteiten te identificeren waarvoor de gevolgen waarschijnlijk groot zijn en om diverse maatregelen (compensatiemechanismen) te bespreken die de gevolgen op het concurrentievermogen beperkt kunnen houden. Deze gevolgen zullen worden geanalyseerd aan de hand van een partiële micro-economische analyse met verschillende CO_2-prijzen en verschillende allocatiemechanismen. De wenselijkheid van een eventuele compensatie van energie-intensieve sectoren is niet geanalyseerd in deze studie.

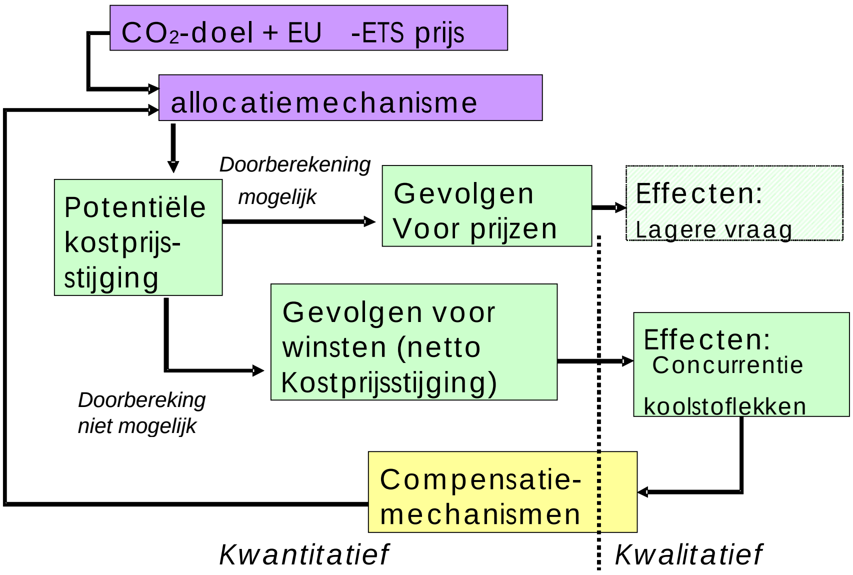
Studieontwerp

Wij hebben de effecten onderzocht aan de hand van twee allocatiescenario's:

a Volledige toepassing van het veilingsysteem waarbij alle rechten zullen worden geveild.
b Gedeeltelijke vrijstelling waarbij alle emissies afkomstig uit de productie van elektriciteit zullen worden geveild en alle overige rechten gratis worden uitgedeeld.

We zijn uitgegaan van een exogeen bepaalde emissiehandelsprijs van € 20/ton CO_2 (de effecten van een hogere prijs van € 50/ton worden eveneens in deze studie geanalyseerd) en een reductiedoelstelling van -20% in 2020. De doelstelling en de emissieprijzen resulteren in **potentiële kostenstijgingen** voor de industrie. Indien een bedrijf haar prijzen kan doorberekenen naar de klanten en tegelijk haar marktaandeel kan behouden, zullen de productprijzen door EU ETS stijgen maar blijven winstmarges in stand. De impliciete afname van de vraag (door de hogere prijzen) kan worden beschouwd als een *beoogde* doelstelling van EU ETS en is om die reden niet in deze studie geanalyseerd. Indien bedrijven *niet* in staat zijn hun prijzen bij te stellen door concurrentie uit landen waar geen klimaatbeleid wordt gevoerd, zal EU ETS gevolgen hebben voor bedrijfsrendement. Dit zal uiteindelijk een remmende werking hebben op investeringsbeslissingen en resulteren in koolstoflekken.

Figuur 1 Overzicht van de in deze studie gekozen benadering, waarbij kostenconcepten en effecten zijn geïdentificeerd



Opmerking: De paarse blokken zijn exogeen bepaald in deze studie, de groene blokken zijn de in deze studie berekende (of besproken) effecten, het gele blok geeft bepaalde compensatiemechanismen weer die in deze studie zijn onderzocht en in de witte box staan de effecten die in deze studie buiten beschouwing zijn gebleven want behorend tot de beoogde effecten.

Het concurrentievermogen wordt in deze studie geïnterpreteerd als de extra kosten voor bedrijven bij invoering van EU ETS die niet door hogere productprijzen kunnen worden gedekt. Deze kosten, de zogenaamde ***netto kostprijsstijging***, vormen een verlies voor de onderneming en kunnen het concurrentievermogen van het bedrijf aantasten. Indien de kosten niet aan de klant kunnen worden doorberekend, zijn de netto kostprijsstijging en de potentiële kostprijsstijging per defintie aan elkaar gelijk. Wij gebruiken in deze studie beide kostenconcepten omdat de potentiële kostprijsstijgingen eenvoudiger kunnen worden bepaald dan de netto kostprijsstijgingen. Dit wordt veroorzaakt door het feit dat het inschatten van de mogelijkheid voor bedrijven om de hogere kosten van EU ETS door te berekenen ambigu is.

Ten slotte kunnen door de potentiële en netto kostprijsstijgingen compensatiemaatregelen wenselijk zijn. Wij hebben in deze studie diverse maatregelen geïdentificeerd die – op z'n minst in theorie – de gevolgen voor energie-intensieve sectoren kunnen verzachten. Het effect van een aantal van deze maatregelen is kwantitatief becijferd.

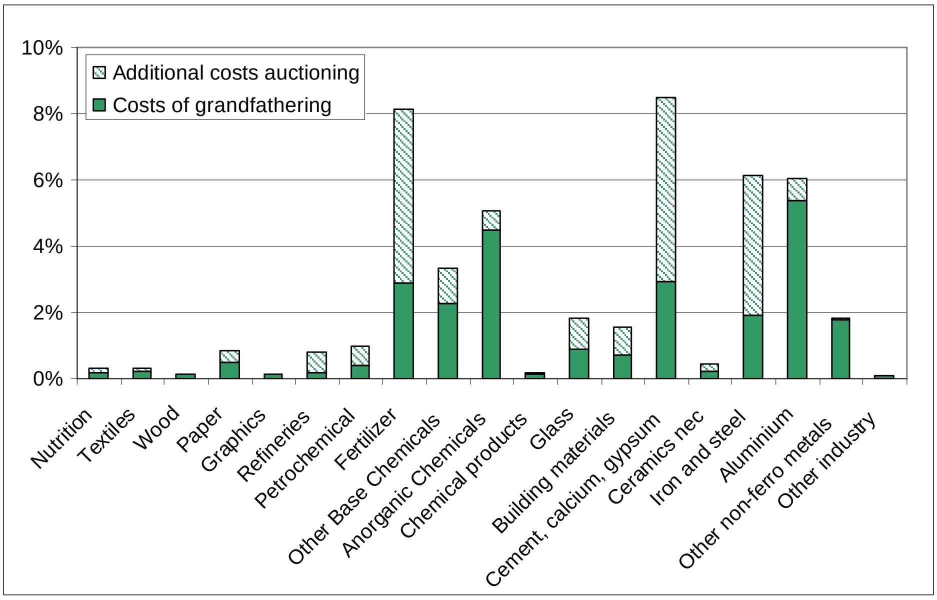
Resultaten: potentiële kostprijsstijgingen

De potentiële kostprijsstijgingen bestaan uit indirecte en directe kosten. Indirecte kosten zijn kosten die worden veroorzaakt door hogere elektriciteitsprijzen. Deze kosten zijn in deze studie berekend aan de hand van een kasstroommodel voor investeringen in nieuwe elektriciteitscentrales. Voor lange termijncontracten – die vooral bij industriële leveringen gebruikelijk zijn – wordt verondersteld dat de additionele kosten van nieuwe capaciteit de in de prijzen door te berekenen marginale productiekosten weergeeft. De directe kosten zijn de kosten die verband houden met de kosten van het aankopen van rechten.

Bij een emissiedoelstelling van 20% reductie en een emissieprijs van € 20 per ton CO_2, krijgen diverse sectoren te maken met grote potentiële kostprijsstijgingen, indien zou worden gekozen voor veiling van de emissierechten. De kunstmest- en cementindustrie krijgen te maken met een kostenstijging van meer dan 8%. De kostenstijgingen voor ijzer en staal en aluminium zouden circa 6% bedragen. Andere sectoren met relatief grote kostenstijgingen zijn de anorganische chemicaliën en de 'overige basischemicaliën'. Voor de overige Nederlandse industriesectoren zouden de kostprijsstijgingen minder dan 2% bedragen. De gemiddelde kostenstijging voor de Nederlandse industrie zou 0,6% bedragen.

Indien een gedeeltelijke vrijstelling van de veilingplicht zou worden toegepast, zouden de kosten voor de kunstmest-, cement- en ijzer- en staalsectoren met circa tweederde worden gereduceerd. Alleen voor de aluminium- en de anorganische chemicaliënsectoren zouden de potentiële kostenstijgingen door vrije allocatie nauwelijks worden gereduceerd omdat de kostenstijgingen van deze sectoren vooral worden bepaald door de hogere elektriciteitsprijzen. Figuur 2 weerspiegelt de potentiële kostenstijgingen voor alle sectoren, indien wordt overgegaan tot veiling van de emissierechten met een gedeeltelijke vrijstelling.

Figuur 2 Extra kosten wanneer alle rechten worden geveild, afgezet tegen gedeeltelijke vrijstelling, € 20/ton



Noot: Additional costs auctioning = additionele kosten veiling, costs of grandfathering = kosten van het gedeeltelijk gratis weggeven van de rechten. Sectoren zijn in volgorde: Voeding, Textiel, Hout, Papier, Drukwerk, Raffinaderijen, Petrochemie, Kunstmest, Overige basischemicaliën, Chemische producten, Anorganisch, Glas, Bouwmaterialen, Cement, calcium en gips, Keramiek, IJzer en staal, Aluminium, Overige non-ferro, Overige industrie.

De potentiële kostprijsstijgingen zullen iets afnemen, indien deze worden gecorrigeerd door technische maatregelen die sectoren kunnen nemen om emissies te reduceren. In geval sectoren technische maatregelen nemen, zouden de totale directe kosten van EU ETS 0,2% van het BNP bedragen bij een emissieprijs van € 20 per ton CO_2. Indien de emissieprijzen verdubbelen tot € 50, zouden de totale effecten 0,4% van het BNP bedragen. In zijn algemeenheid kan worden gesteld dat de sectoren die te maken krijgen met de grootste potentiële kostenstijgingen, de sectoren zijn met de minste toegevoegde waarde voor de Nederlandse economie, uitgezonderd de ijzer- en staalindustrie. Dit zou vanuit een macro-economisch perspectief inhouden dat het veilen van emissierechten waarschijnlijk geringe gevolgen heeft in vergelijking met gedeeltelijke vrijstelling.

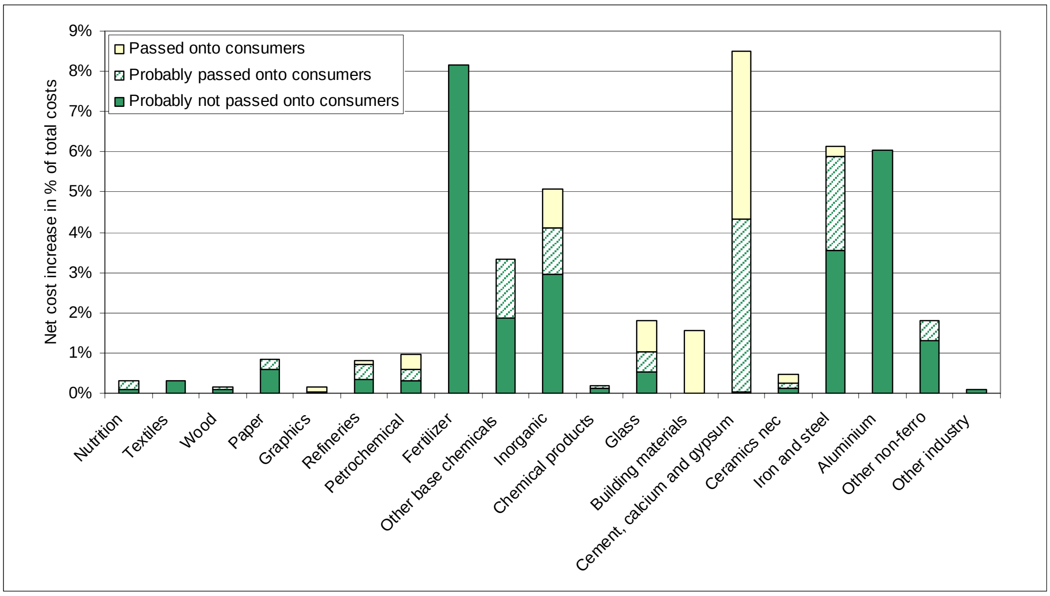
Resultaten: Netto kostprijsstijgingen

Een aantal van de potentiële kostprijsstijgingen kan mogelijk aan de consument worden doorberekend. De mogelijkheid om de kosten aan de consument door te berekenen hangt specifiek af van de dreiging vanuit de internationale handel van leveranciers die niet te maken hebben met een klimaatveranderingsbeleid en van de marktkracht van Nederlandse industriesectoren. Het grootste deel van de export van de Nederlandse industrie gaat naar de EU, waar installaties ook moeten betalen voor hun CO_2 uitstoot. Alleen de ‘chemische productensector’ heeft een relatief groot aandeel in de export naar landen die niet tot de EU behoren. Op de nationale markt is de import vanuit landen die niet tot de EU horen relatief groot wat betreft textiel, raffinaderijproducten en aluminium.

Het is bijna onmogelijk om ex-ante exact de mogelijkheden van sectoren te bepalen voor het doorberekenen van de kosten. De voor deze studie gekozen benadering was om hiervoor gebruik te maken van de literatuur over kostprijsdoorberekeningen die op EU niveau zijn gedaan. Het merendeel van de studies gaan uit van een ex ante perspectief of gebruiken bedrijfstakmodellen zonder passende documentatie voor de aannames die aan dergelijke modellen ten grondslag liggen. Uit de literatuur blijkt dat de sectoren die goed gedetailleerd zijn onderzocht, zoals de ijzer- en staalsectoren, een grote variëteit aan resultaten laten zien. Ook merken we op dat in de literatuur nergens rekening wordt gehouden met de Porter-hypothese waarin wordt gesteld dat milieuwetgeving tot innovatie kan aanzetten, hetgeen vervolgens zou leiden tot vermindering van de bedrijfskosten en tot verhoging van het concurrentie-vermogen. Om die reden zouden naar ons oordeel de resultaten uit de (empirische) literatuur als overdreven pessimistisch kunnen worden bestempeld ten aanzien van de doorberekening van de kosten. Feitelijk bestaat er echter geen manier om de waarheid hieromtrent boven water te krijgen.

Eén ding dat uit ons onderzoek duidelijk is geworden, is dat er bepaalde handelsbarrières bestaan voor verscheidene energie-intensieve producten. Met name in de sectoren cement, anorganische chemicaliën en ijzer en staal werken transportkosten als een handelsbarrière. Indien wij de bevindingen uit de bestaande literatuur over doorberekening van kosten toepassen op individuele sectoren, schatten wij in dat circa de helft van de potentiële kostprijsstijgingen aan de consument kan worden doorberekend indien besloten wordt tot veiling van de emissierechten. Echter, bij toepassing van de meest pessimistische resultaten uit diverse studies, zou niet meer dan een zevende deel van de extra kosten aan de consument kunnen worden doorberekend. Figuur 3 laat de resultaten zien van de kostenbedragen die kunnen worden doorberekend, indien alle rechten zouden worden geveild.

Figuur 3 Een schatting van de netto kostprijsstijging in % van de totale kosten bij veiling van rechten, emissieprijs € 20/ton CO_2



Noot: Passed onto consumers = kunnen worden doorberekend aan consument. Sectoren zijn: Voeding, Textiel, Hout, Papier, Drukwerk, Raffinaderijen, Petrochemie, Kunstmest, Andere basischemicaliën, Chemische producten, Anorganisch, Glas, Bouwmaterialen, Cement, calcium en gips, Keramiek, IJZer en staal, Aluminium, Andere non-ferro, Andere industrie.

Het blijkt dat met uitzondering van de cementproductiesector, de sectoren met een hoge potentiële kostprijsstijging over het algemeen niet veel mogelijkheden hebben om deze kosten door te berekenen. Dit is in het bijzonder het geval voor aluminium en kunstmest. Voor ijzer en staal, anorganische chemicaliën, raffinaderijen en papier is de situatie ingewikkelder. De cementindustrie zou haar kosten kunnen doorberekenen, indien de koolstofprijzen door de bank genomen circa € 20/ton zouden bedragen. Echter, indien de huidige concurrentiesituatie van de Nederlandse cementindustrie slechter is dan gemiddeld in de EU het geval is (hetgeen wij verwachten), zouden de extra kosten van EU ETS wellicht niet kunnen worden doorberekend en zou een en ander resulteren in een verlies aan concurrentievermogen.

Resultaten: Compensatiemaatregelen

Ter compensatie van de ongunstige effecten op het concurrentievermogen kan de regering een keuze maken uit diverse compensatiemaatregelen. De eerste optie is de rechten kosteloos aan de industrie toe te wijzen aan de hand van een vaste benchmark, zoals thans in de voorstellen van de Commissie is vervat. In deze voorstellen zullen de rechten bij het opwekken van elektriciteit echter nog steeds geveild worden en dit zal hogere prijzen voor de industrie tot gevolg hebben. Daarnaast moet de industrie nog steeds betalen voor de reductie van 20% in 2020.

Desondanks kan vrije allocatie op basis van een vaste benchmark een oplossing bieden voor het verlies aan concurrentievermogen van de ijzer- en staalindustrie, cement- en de kunstmestindustrie. Voor de aluminiumproductie en anorganische chemicaliën levert een gedeeltelijke vrijstelling nauwelijks enige kostenreductie op, omdat die in hoge mate bepaald worden door de stijging in elektriciteitsprijzen. Deze sectoren zouden in theorie kunnen worden gecompenseerd door het verstrekken van extra gratis rechten op basis van hun elektriciteitverbruik, maar dat is in deze studie niet geanalyseerd.

De precieze effecten op de efficiency van een systeem waarin de rechten (gedeeltelijk) gratis worden verstrekt hangt af van de details van zo'n systeem. De Commissie heeft voorgesteld eventuele gratis rechten toe te wijzen op basis van een vaste benchmark (vast te stellen in 2012) en een uittredingsregel toe te passen op grond waarvan bedrijven die hun activiteiten staken hun vrijelijk toegewezen rechten dienen af te staan. Een dergelijk allocatieplan werkt efficiënter dan het huidige systeem waarin de benchmarks periodiek opnieuw worden vastgesteld. Een nadeel is dat het ingewikkeld is om in elke sector te komen tot een uniforme benchmark en dat er bij elke benchmark sprake zal zijn van wisselwerkingen tussen efficiency en billijkheid (bijvoorbeeld bij het belonen van bedrijven die hun productiestandaards vóór EU ETS hebben verbeterd). Het zal bovendien erg moeilijk zijn te beslissen aan welke sectoren gratis rechten worden toebedeeld en welke sectoren onder de veilingregel zouden vallen. Slechte beslissingen kunnen grote gevolgen hebben: *windfall profits* indien een sector gratis rechten krijgt maar die wel kan doorberekenen aan de consument en een verlies aan concurrentievermogen indien de sector de rechten op een veiling moet kopen maar de kosten niet kan doorberekenen aan de consument.

Terugsluizen van de opbrengsten van de veiling naar de industrie kan een alternatieve manier zijn om de impact op het concurrentievermogen te verminderen. Onze analyse heeft aangetoond dat een terugsluis door verlaging van de vennootschapsbelasting of door verlaging van de door de werkgever betaalde sociale lasten nauwelijks compenserende waarde heeft omdat de energie-intensieve sector relatief weinig werknemers in dienst heeft en slechts een klein deel van de vennootschapsbelasting voor haar rekening komt. Het op deze wijze terugsluizen kan echter wél een stimulans betekenen voor andere economische sectoren die arbeidsintensiever zijn, een groter deel van de vennootschapsbelasting voor hun rekening nemen en – over het algemeen – minder vervuilend zijn.

Het terugsluizen van de opbrengsten voor subsidiëring van investeringen in energiebesparingen is, op het eerste gezicht, veelbelovender. Uit onze analyse blijkt dat er in diverse energie-intensieve sectoren sprake zou zijn van een aanzienlijke reductie van de netto EU ETS-kosten. Toepassing ervan op EU-niveau zou kunnen leiden tot lagere emissieprijzen en daarmee een reductie van de impact op het concurrentievermogen. Er zou echter sprake zijn van minder efficiency van het totale systeem dan in het geval van een veilingplicht, aangezien technische maatregelen voor emissiereductie te prefereren zijn boven reductie van de uitstoot. Daarnaast moet de basis van dergelijke subsidies van een investeringsaftrek worden gewijzigd in een directe subsidie voor de niet-winstgevende top van de energie-investeringen.

Vanuit het perspectief van een verzachting van de gevolgen voor energie-intensieve bedrijven, zou in theorie een instrument van B*order Tax Adjustments* en exportsubsidies ter compensatie van de hogere EU ETS-kosten de beste optie zijn. De effectiviteit en de kosten van een dergelijk instrument zouden echter in hoge mate afhankelijk zijn van de precisie waarmee deze belastingen kunnen worden bepaald en de acties die andere landen zouden kunnen ondernemen wanneer zij te maken krijgen met invoerbeperkingen en exportsubsidies van EU-lidstaten. Indien andere landen compensatiemechanismen in hun handels-tarieven zouden inbouwen (represailles), zouden de gevolgen uiteindelijk zelfs nog slechter kunnen zijn.

Tabel 1 vat de voors en tegens samen van de diverse compensatieopties ter verzachting van de ongunstige gevolgen van EU ETS.

Tabel 1 Voors en tegens van diverse compensatiemechanismen

Compensatiemechanisme	Voors	Tegens
Vrije allocatie van rechten (op basis van vaste benchmarks) aan kwetsbare sectoren. Bedrijven die hun productie stopzetten dienen hun rechten in te leveren.	Eenvoudig te implementeren, rechtstreeks bedoeld voor energie-intensieve industrieën.	Hogere prijzen voor EUA [verhandelbaar Europees emissierecht] door het feit dat productie impliciet wordt gesubsidieerd, hetgeen een netto geldverplaatsing teweegbrengt van niet-kwetsbare naar kwetsbare sectoren. Moeilijkheden bij bepalen welke sectoren gratis rechten zouden krijgen en bij het vaststellen van een benchmark die efficiënt en rechtvaardig is.
Border tax adjustments en exportsubsidies.	In theorie geen gevolgen voor concurrentievermogen en minimalisering van de netto kosten van EU ETS.	Gevaar van tegenmaatregelen in andere landen wanneer deze te maken krijgen met EU-exportsubsidies en invoertarieven die uiteindelijk de handel zullen beperken en het concurrentievermogen zullen aantasten. Moeilijkheden bij het vaststellen van de juiste tarieven.
Hergebruik opbrengsten via loonheffingen of vennootschaps-belasting.	Eenvoudig te implementeren, lage administratiekosten. Minimaliseert potentiële kosten van EU ETS en kan een prikkel zijn voor een minder energie-intensieve industriële structuur.	Nauwelijks enig effect op het concurrentievermogen van de energie-intensieve kwetsbare sectoren.
Hergebruik opbrengsten via subsidies voor energiebesparende maatregelen.	Richt zich op energie-intensieve industrieën en verlaagt de prijs van CO_2-rechten.	Vermindert de efficiency van het systeem (hogere uitstoot) in vergelijking met het veilingsysteem.

Aanvullende voorbehouden

Wij willen benadrukken dat de resultaten van deze studie uitsluitend opgaan voor het type analyse dat is verricht: een partiële micro-economische analyse van de extra kosten voor sectoren. Dit houdt in dat alleen de directe kosten van EU ETS zijn bepaald. Eventuele voordelen door minder energieverbruik, verbetering van de luchtkwaliteit en innovatieverbetering (d.w.z. de hypothese van Porter) zijn in de analyse niet meegewogen. Extra indirecte kosten, zoals het verlies van banen en koolstoflekken, zijn evenmin bij deze benadering worden betrokken. De uitkomsten vormen daarom louter een indicatie van de gevolgen die EU ETS zou kunnen hebben voor het risico op koolstoflekken; we hebben echter geen kwantitatieve schatting in die richting verricht. Dit zou idealiter moeten gebeuren met een algemeen evenwichtsmodel op wereldschaal.

Om een scenarioanalyse van de kosten en uitstoot van de Nederlandse industrie te vermijden, hebben we bovendien de gevolgen in 2020 geschat op basis van uitstoot in 2005. Voordeel hiervan is dat de resultaten eenvoudig zijn te interpreteren en kunnen worden vergeleken met de situatie waarin de industrie zich op dit moment bevindt. Het nadeel is dat autonome ontwikkelingen, zoals het eventueel verdwijnen van een aantal sectoren uit de Nederlandse economie door andere factoren, buiten beschouwing zijn gebleven. Ook de autonome groei in industriële productie is buiten beschouwing gelaten.

Voorts is er een aantal andere voorbehouden van toepassing op deze uitkomsten. In de eerste plaats hebben wij in deze studie sectoren als analyse-eenheden gekozen. Zelfs indien wij concluderen dat een sector gemiddeld genomen geen effecten laat zien, kunnen toch diverse producten of bedrijven binnen een sector tamelijk aanzienlijke effecten vertonen, omdat de verhouding tussen CO_2-emissies en kosten niet altijd evenredig over een sector is verdeeld. Deze aanname zal eventueel bij toekomstig onderzoek meer in detail moeten worden bestudeerd. Vooral binnen de voedings- en papiersectoren zijn er aanwijzingen dat het in deze studie verkregen detailniveau te grof is. En voor diverse individuele producten, zoals aluminium, ijzer en staal, zink en cement geeft de sectorale benadering een onderschatting van de impact op productniveau. In de tweede plaats zijn uitsluitend indirecte kostprijsstijgingen door elektriciteit geanalyseerd. Indien echter de helft van de kosten aan de consument kan worden doorberekend, zou er sprake kunnen zijn van een aantal andere indirecte gevolgen voor industriële sectoren die producten verbruiken die afkomstig zijn van de energie-intensieve sectoren. Deze zijn in deze studie niet onderzocht. Ten slotte veronderstellen de uitkomsten van deze analyse dat het internationale klimaatbeleid zal falen en dat landen als China, India en de Verenigde Staten geen enkele doelstelling voor GHG-reductie zullen hebben. Indien er wel een internationaal klimaatbeleid van de grond komt, zullen de kostprijsverschillen minder groot zijn.

Interpretatie van de uitkomsten

Allocatie van de emissierechten is in wezen een verdelingskwestie. Hoewel het veilen van emissierechten in zijn algemeenheid efficiencyverhogend kan werken, bestaat er een gevaar van koolstoflekken. Deze studie heeft aangetoond dat vooral in de sectoren aluminium, kunstmest, ijzer en staal, anorganische en andere basischemicaliën, relatief hoge prijsstijgingen te verwachten zijn, die mogelijk niet volledig aan de klanten kunnen worden doorberekend. Het rendement in deze sectoren kan afnemen en de kans op koolstoflekken neemt toe.

De gevolgen voor de nationale economie (d.w.z. het BNP) zijn echter waarschijnlijk klein. In de eerste plaats zijn de sectoren die te maken krijgen met de grootste kostenstijgingen over het algemeen de kleinere sectoren van de Nederlandse economie (0,5% van BNP), met uitzondering van de ijzer- en staalindustrie (0,65% van BNP). In de tweede plaats kan een gedeelte van de kosten aan de consument worden doorberekend - hoewel de mate waarin op dit moment onzeker is. In de derde plaats kunnen sectoren reductietechnologieën toepassen waardoor de kosten van naleving lager worden. Tot slot zullen, indien het internationale klimaatbeleid tot het jaar 2020 ertoe leidt dat meer landen instemmen met bindende reductietargets, de gevolgen voor het concurrentievermogen kleiner zijn dan die welke hier zijn geanalyseerd.

Niettemin is te verwachten dat het veilen van emissierechten gevolgen zal hebben voor het concurrentievermogen van een beperkt aantal sectoren waar de kans op koolstoflekken groter wordt. Indien de regering de gevolgen voor energie-intensieve sectoren wil verzachten, kan worden gedacht aan een instrument voor *Border Tax Adjustments* en aan hergebruik van de opbrengsten voor energiebesparende investeringen, naast de vrije toewijzing van rechten.

Executive Summary

The EU emissions trading scheme (ETS) was launched in 2005 to cap CO_2 emissions from large industrial facilities and electricity producers. The European Commission is currently designing the post 2012 EU ETS, as outlined in COM(2008)16. Novel to this system is that a greater part of the rights will be auctioned. Auctioning in general assures a greater deal of efficiency compared to (certain types of) free allocation, lowers the administrative costs and prevents eventual windfall profits.

However, auctioning also implies a potential loss of competitiveness for industry. If no international agreement on future climate policies is reached, firms may not be able to pass on the higher costs to their customers and may be faced with a loss in profitability and the threat of import substitution. In any emission trading scheme with an absolute cap, a relocation of production that is not covered by CO_2 targets implies an increase in global CO_2 emissions. This phenomenon has been labelled as 'carbon leakage'. To prevent carbon leakage, the Commission has proposed to exempt exposed sectors from auctioning and allocating them rights freely on the basis of a benchmark. A severe loss of competitiveness is here the main criterion against which it is decided whether sectors will be subject to auctioning or free allocation.

This study has investigated which industrial sectors of the Dutch economy possibly face a loss of competitiveness from auctioning. The competitive position is determined by the combination of significant potential cost price increases and substantial imports and export flows to countries that have no comparable climate change policy. It appears that especially in the aluminium, fertilizer, iron and steel , inorganic and other base chemicals sectors relatively high cost price increases can be expected which may not be fully passed on to their customers. Profitability in these sectors may be reduced and the risk of carbon leakage increased.

However, in terms of impacts on the national economy (i.e. GDP) the effects are probably small. The direct costs of EU ETS are 0,2% of GDP (for an emission price of €20/ton CO_2) of which about half can be passed on to the customers. Impacts on the competitive position may occur in the vulnerable sectors but these sectors are in general the smaller sectors of the Dutch economy - with the exception of the iron and steel industry (in total 1,1% of GDP). In addition, if international climate policy until the year 2020 will result in more countries agreeing on binding reduction targets, impacts on competitiveness will be smaller than analyzed here.

Auctioning assures a higher degree of efficiency and prevents windfall profits to occur. This study showed that some impacts from auctioning the rights on the industrial structure in the Netherlands can be expected which increase the risk of carbon leakage. Several options to compensate for the adverse effects on competitiveness have been investigated in this study. If the government wants to alleviate the impacts for energy intensive sectors thought may be given to a system of border tax adjustments and the recycling of revenues to energy saving investments next to the free allocation of rights.

Summary

Background

The EU emissions trading scheme was launched in 2005 to cap CO_2 emissions from large industrial facilities and electricity producers. Covering almost half of all EU CO_2 emissions, it forms the centrepiece of European policy on climate change. EU ETS gives value to reducing CO_2 emissions and has formed a market with an asset value worth tens of billions of Euros annually.

The European Commission is currently designing the post 2012 EU ETS, as outlined in COM(2008)16 (EC, 2008). Novel to this system is that a greater part of the rights will be auctioned. Auctioning in general assures a greater deal of efficiency compared to (certain types of) free allocation, lowers the administrative costs and prevents eventual windfall profits.

However, auctioning also implies a potential loss of competitiveness for industry as the costs for industry are higher under auctioning than under free allocation of the rights. Especially if no international agreement on future climate policies is reached, firms in the EU are being faced with higher costs which may harm their export position and foster import substitution from non-EU countries where carbon has no price. In any emission trading scheme with an absolute cap, a relocation of production that is not covered by CO_2 targets implies an increase in global CO_2 emissions. This phenomenon has been labelled as 'carbon leakage'. To prevent carbon leakage, the Commission has proposed to exempt exposed sectors from auctioning and allocating them rights on the basis of a benchmark. A severe loss of competitiveness is here the main criterion against which it is decided whether sectors will be subject to auctioning or free allocation.

Unfortunately, competitiveness is an ill-defined concept in economics and there is no common methodology for analyzing the effects of higher costs due to environmental regulation. The trade-off between a higher degree of efficiency due to auctioning versus the risk on carbon leakage is most thoughtful addressed with economic modelling. However, most models lack enough detail of the economic activities that might be at stake and have a number of other drawbacks as well. Therefore, partial microeconomic analysis into the effects of higher CO_2 prices has become dominant in the debate on the future design of EU ETS.

The present study builds on this research tradition by offering a partial microeconomic analysis of the costs of future EU ETS. The advantage is a more targeted level of detail than could be arrived with economic modelling. The disadvantage is that the approach focuses on the direct costs of EU ETS only and neglects some benefits or indirect costs to society.

Aim of this study
The aim of this study is to analyze the effects from EU ETS on industrial competitiveness in the Netherlands, to identify economic activities where substantial impacts are likely to occur and to discuss several remedies (compensation mechanisms) that can reduce the impacts on competiveness. These impacts will be analyzed using different CO_2 prices and different allocation mechanisms using partial microeconomic analysis. We did not conduct here an analysis into the desirability of compensating energy intensive sectors.

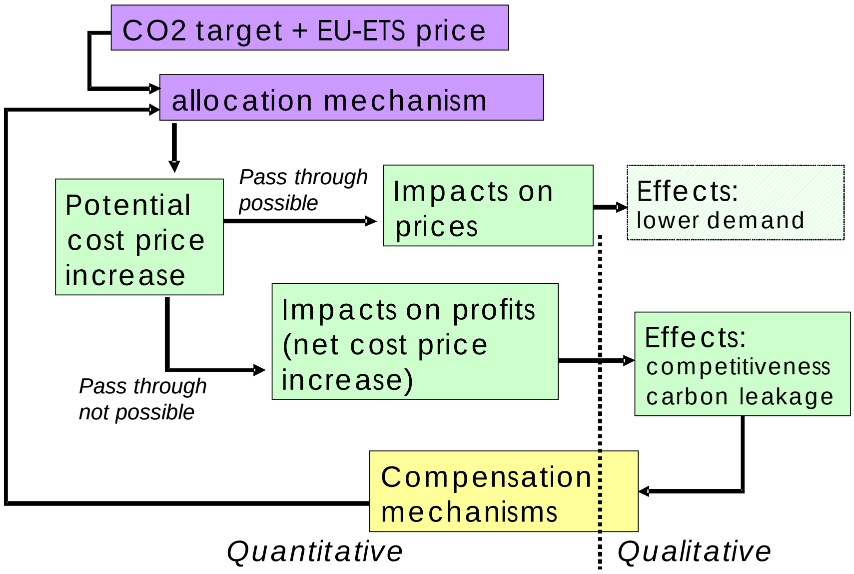
Design of the study
We have investigated the effects according to two allocation scenarios:

a Full auctioning in which all the rights will be auctioned.

b Partial grandfathering in which the rights for emissions due to electricity production will be auctioned and the other rights will be freely allocated. In total this implies that about half of the rights will be auctioned.

We have assumed an exogenously given emission trading price of € 20/ton CO_2 (the effects of a higher price of € 50/ton are analyzed in this study as well) and a reduction target of -20% in 2020. The target and emission prices results in **potential cost increases** for industry. If the firm can adjust its prices while maintaining market shares, EU ETS will raise product prices but leave profit margins unchanged. The associated demand reduction (due to higher prices) can be perceived as an *intended* effect of EU ETS and has therefore not been analyzed in this study. If firms are *not* able to adjust their prices due to competition from countries where no climate policies are in place, EU ETS will impact on the profitability of the firms or in the market shares if they would still raise prices. This will in the end hamper investment decisions and result in carbon leakage.

Figure 1 Summary overview of approach chosen in this study, identified cost concepts and effects



Note: Boxes in purple are exogenous to this project, boxes in green are the calculated (or discussed) effects in this study, the yellow box indicates certain compensations mechanisms that have been investigated in this study and the white box are effects that are not taken into account in this study.

Competitiveness is interpreted in this study as the additional costs firms face under EU ETS that cannot be covered by higher product prices. These costs, labelled as the ***net cost price increase***, present a loss to the company and may impact on firm's competitiveness negatively. If none of the costs can be passed onto the consumers, the net cost price increases and potential cost price increases are the same. We use both cost concepts in this study as the potential cost price increases can be determined more easily and precisely than the net cost price increases. This is due to the fact that estimation of the possibility of firms to pass on the higher costs of EU ETS is an ambiguous task.

Finally, the cost price increases may result in a call for compensating measures. We have identified in this study several measures that could, in theory at least, alleviate the impacts on competitiveness for energy intensive sectors. The effect of some of these measures has been estimated quantitatively.

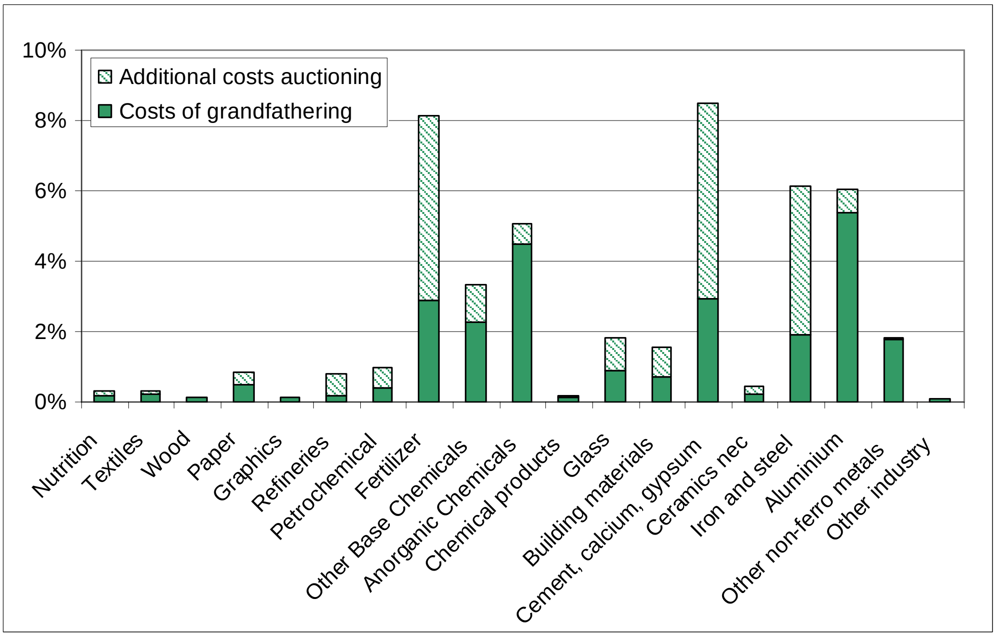
Results: potential cost price increases

The potential cost price increases consist of indirect and direct costs. Indirect costs are costs due to higher electricity prices. In this study these costs have been estimated using a cash flow model for new energy plant investments. For long-term contracts, prevailing in industry, the new generation capacity is believed to represent the marginal cost of production to be passed on in the prices. The direct costs are the costs associated with buying allowances.

Under an emission target of 20% reduction and an emission price of € 20 per ton of CO_2, various sectors face high potential cost price increases if the rights would be auctioned. Fertilizer and cement production would be faced with a cost increase of above the 8%. Cost increases for iron and steel and aluminium would be around the 6%. Other sectors with relatively high cost increases are the inorganic chemicals and the 'other base chemicals' which mainly produce industrial gasses. For the rest of the Dutch industrial sectors, potential cost price increases would be less than 2%. The average cost price increase for Dutch industry as a whole would be 0,6%.

If the rights would be partially grandfathered, the costs for the fertilizer, cement and iron and steel sectors would be reduced by about 2/3. Only for the aluminium sectors and the inorganic chemicals free allocation would not reduce their potential cost increases as these sectors' cost increases are determined through the higher electricity prices. Figure 2 gives the potential cost increases for all sectors under auctioning and partial grandfathering.

Figure 2 Additional costs of full auctioning compared to partial grandfathering, € 20/ton



The potential cost price increases tend to be somewhat lower if corrected for the technical measures that sectors can take to reduce emissions. If sectors would apply technical measures, the total direct costs of EU ETS would be 0,2% of GDP for an emission price of € 20 per ton CO_2. If emission prices would double to € 50, the total effects would be 0,4% of GDP. In general one could say that the sectors facing the highest potential cost price increases are the sectors with the lowest value added to the Dutch economy - except for the iron and steel industries. This would imply that, from a macroeconomic perspective, auctioning probably has a small impact compared to grandfathering.

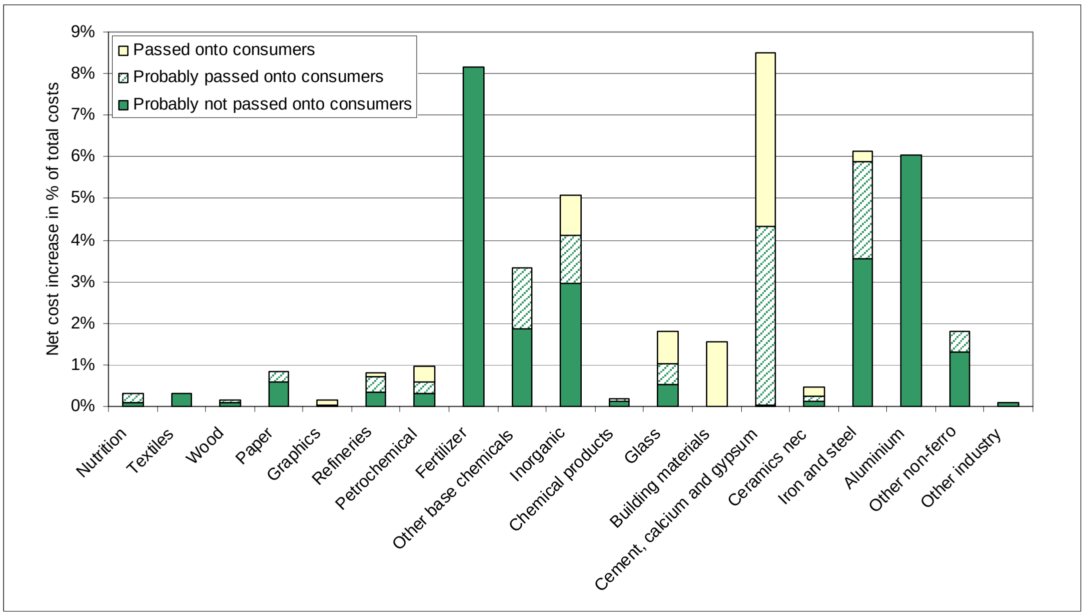
Results: Net cost price increases

Some of the potential cost price increases may be passed onto consumers. The possibility to pass on the costs to consumers typically depends on the exposure to international trade from suppliers that are not being faced with climate change policies and the market power of Dutch industrial sectors. Most of the exports of Dutch industry go to the EU where carbon will have a uniform price. Only the ‘chemical products’ sector has a relatively large share of exports to non-EU countries. On the domestic market, imports from non-EU countries are relatively large for textiles, products from refineries and aluminium.

It is very difficult to exactly determine the possibilities of sectors to pass through the costs. The approach chosen in this study was to examine this from the literature at the level of EU industries. However, there exists almost no (ex-post) econometric evidence on the possibilities to pass on the costs. Most studies take an ex-ante perspective or use sectoral models without proper documentation on the assumptions underlying such models. Sectors that have been investigated in great detail, such as the iron and steel industries, show a great variety on results from the literature. None of the literature takes the possibility of the Porter hypothesis in account that has stated that environmental regulation may foster innovation that in turn would reduce costs for firms and enhance competitiveness. Hence we would suggest that the results from the literature on cost pass through might be overly pessimistic on the situation to pass on the costs. However, there is virtually no way to reveal the truth in this respect.

One thing that has become clear from our investigation is that certain trade barriers exist for several energy intensive products. Especially in the cement, inorganic chemicals and iron and steel industries transport costs act like a trade barrier. If we do apply the existing literature findings on cost pass through for individual sectors we arrive at an estimate that about half of the potential cost price increases under auctioning can be passed on to the consumers. However, if we apply the most pessimistic results from various studies, only $1/7^{th}$ of the additional costs could be passed on to consumers. Figure 3 gives the results of the amount of costs that can be passed through if all rights would be auctioned.

Figure 3 An estimation of the net cost price increase under auctioning, emission price of € 20/ton CO_2



It appears that, with the exception of cement manufacturing, sectors with a high potential cost price increase have, in general, not so much possibilities to pass on these costs. This especially applies to aluminium and fertilizer. For iron and steel, inorganic chemicals, refineries and paper, the situation is more mixed. The cement industry should be able to pass on its costs if carbon prices are around € 20/ton in general. However, if the current competitive situation of the Dutch cement industry is worse than average in the EU (which we expect), the additional costs of EU ETS might not be passed on and result in a loss in competitiveness.

Results: Compensation measures

In order to compensate for the adverse effects on competitiveness, the government may choose various compensation options. First option is to allocate the rights for free to industry on the basis of a fixed benchmark, as indicated in the proposals of the Commission. In these proposals, however, electricity generation will still be under auctioning and result in higher prices for industry. Industry also needs to pay for the reduction by 20% in 2020. Nevertheless, free allocation on the basis of a fixed benchmark may solve some competitiveness issues for the iron and steel industry, fertilizer and cement industries. For aluminium production and inorganic chemicals grandfathering does hardly reduce costs as these depend heavily on electricity consumption. They could in theory be compensated by giving them free allowances on the basis of their electricity consumption, but this has not been analyzed in the present study.

The precise effects on efficiency of a system of free allocation greatly depend on the details with respect to the basis of allocation and entry/exit conditions. The Commission has proposed to allocate rights on the basis of a fixed benchmark (to be determined in 2012) and apply a closure rule in which companies that quit operations must hand over their freely allocated rights. Such an allocation scheme fares better with respect to allocative efficiency than a system where e.g.

benchmarks are periodically updated. A disadvantage is that it may be very difficult to agree upon a common benchmark in every sector and that almost in every benchmark there will be trade-offs between efficiency and equity (e.g. rewarding companies that have improved their production standards prior to EU ETS). Moreover, it will be very difficult to decide which sectors would be granted with free allocation and which sectors would fall under auctioning. Poor decisions may have large consequences: windfall profits if the sector would wrongly receive the rights for free and a loss in competitiveness if the sector would wrongly be under auctioning.

Full auctioning of all the rights can be an alternative, if the revenues of the auction could be recycled to industry as a compensation measure for the impacts on competitiveness. Our analysis showed that recycling is possible through lowering corporate tax or reducing social security contributions paid by the employer. The energy intensive sectors, however, hardly profit from this recycling scheme as they employ relatively few people and pay a minority of the corporate taxes. However, recycling of revenues in this way may provide a stimulus for other sectors in the economy that have a higher labour intensity, pay a large share of corporate taxes and are - in general - less polluting.

Recycling of revenues to subsidy schemes for investments in energy savings is, at first sight, more promising in mitigating the effects for energy intensive industries. Our analysis showed that several sectors would be faced with a considerable reduction in costs due to EU ETS. When applied at the EU level this may lower emission prices and have mitigating effects for all sectors that fall under EU ETS. However, efficiency of the whole system would be lower than in the case of auctioning as technical measures to reduce emissions are favoured over reductions in output. In addition the basis of these subsidies has to be altered from a rebate in corporate taxes to a direct subsidy for the unprofitable top of the energy investments.

In theory, the best option, from the perspective of mitigating the effects for energy-intensive industries - would be to set up a system of border tax adjustments and export subsidies to compensate for the higher costs of EU ETS. The effectiveness and costs of such a system would, however, highly depend on the accuracy with which these taxes can be determined and the effects that other countries might undertake when being faced with import restrictions and export subsidies of EU member states. If other countries would take compensating mechanisms in their trade tariffs (retaliation), the effects could, in the end, be even worse.

Table 1 summarizes the pros and cons of various compensation options to mitigate the adverse effects of EU ETS.

Table 1 Pros and cons of various compensation mechanisms

Compensation mechanism	Pros	Cons
Free allocation of rights (on the basis of fixed benchmarks) to exposed sectors. Companies that reduce output must hand in their rights.	Easy to implement, directly targeted at energy intensive industries.	Higher prices of EUA due to the fact that production is implicitly subsidized, which implies a net transfer of money from non-exposed sectors to exposed sectors. Difficulties in determining which sectors would be gifted with free allowances and in arriving at a benchmark that is efficient and fair.
Border tax adjustments and export subsidies.	In theory no impacts on competitiveness and minimization of net costs of EU ETS.	Risk of compensating measures in other countries when being faced with EU export subsidies and import tariffs, which, in the end, will limit trade and harm competitiveness. Difficulties in setting up the correct tariffs.
Recycling revenues through labour taxes or corporate tax.	Easy to implement, low administrative costs. Minimizes potential costs of EU ETS and can form an impetus for a less energy intensive industrial structure	Almost no effect on the competitiveness of the energy intensive exposed sectors.
Recycling revenues through large scale subsidies on energy saving measures.	Targeted at energy intensive industries and lowering the price of CO_2 rights.	Lowering the efficiency of the system (higher output) compared to auctioning.

Additional caveats

We want to emphasize that the results of this study only hold for the type of analysis that has been conducted: a partial microeconomic analysis on the additional costs of sectors. The partial microeconomic analysis conducted here implies that only the direct costs of EU ETS are estimated. Eventual benefits through lower energy consumption, improvements in air quality and improvements in innovation (i.e. the Porter hypothesis) have not been included in this analysis. Additional indirect costs, such as a loss in jobs and - indeed - carbon leakage also cannot be estimated using this approach. The results hence only give an indication of the impact EU ETS could have on carbon leakage but we have not conducted any quantitative estimation in that direction. Ideally, such an exercise should be undertaken using a general equilibrium model.

Moreover, in order to abstain from scenario analysis into the costs and output of Dutch industry, we have estimated the effects in 2020 on the basis of the emissions of 2005. This has the advantage that the results are easy to interpret and can be compared to the situation industry faces at present. The disadvantage is that autonomous developments, such as an eventual disappearance of some sectors of the Dutch economy due to other factors, are not taken into account. Also a growth in industrial output resulting in a larger share of absolute costs is not taken into account in this study.

Furthermore, a number of other caveats apply to these results. Firstly, we have chosen here sectors as entities of analysis. Even if we conclude that a sector, on average, shows no effects, still various products or firms within a sector may show rather significant effects as the ratio between CO_2 emissions and costs may not be evenly spread within a sector. This assumption may need to be scrutinized in more detail in future research. Especially within the food and paper sectors there is some evidence that the level of detail obtained in this study is too rough. For various products, such as aluminium, iron and steel, cement and zinc, this approach may underestimate the costs at the product level. Secondly, only indirect cost price increases due to electricity are analyzed in this study. However, if half of the costs can be passed through to the customers, some other indirect effects might exist for industrial sectors consuming products from the energy intensive sectors. These have not been included here. Finally, the results from this analysis assume in essence that international climate policy will fail and countries like China, India and the United States will not have any targets on reducing GHG. If an international climate policy will be in place in 2020, the costs will be lower than estimated here.

Interpretation of the results

Allocation of the emission rights is in essence a distributional question. While overall efficiency may be enhanced if emission rights are being auctioned, there exists a risk on carbon leakage. It appears that especially in the aluminium, fertilizer, iron and steel , inorganic and other base chemicals sectors relatively high cost price increases can be expected which may not be fully passed on to their customers. Profitability in these sectors may be reduced and the risk of carbon leakage increased.

However, in terms of impacts on the national economy (i.e. GDP) the effects are probably small. First, the sectors that face the highest cost increases are in general the smaller sectors of the Dutch economy (0,5% of GDP) with the exception of the iron and steel industry (0,65% of GDP). Second, some of the costs may be passed on to the customers although the extent is rather uncertain at present. Third, sectors may apply abatement technologies which lower their costs of compliance. Finally, if international climate policy until the year 2020 will result in more countries agreeing on binding reduction targets, impacts on competitiveness will be smaller than analyzed here.

However, if no agreement is reached on international climate policy auctioning may impact on the industrial structure in the Netherlands and may increase the risk of carbon leakage in the aluminium a few energy-intensive sectors. If the government wants to alleviate the impacts for energy intensive sectors thought may be given to a system of border tax adjustments and the recycling of revenues to energy saving investments next to the free allocation of rights.

1 Introduction

1.1 Background

The EU emissions trading scheme was launched in 2005 to cap CO_2 emissions from large industrial facilities. Covering almost half of all EU CO_2 emissions, it forms the centrepiece of European policy on climate change. EU ETS gives value to reducing CO_2 emissions and has formed a market with an asset value worth tens of billions of Euros annually (Grubb and Neuhoff, 2006).

On 23 January 2008, the Commission adopted a proposal designed to amend the current EU ETS Directive (Directive 2003/87/EC) (EC, 2003). The Commission proposes to auction allowances as the principle mechanism for initial allocation instead of allocating them for free. However, in the current situation where many non-EU countries do not have emission reduction targets, auctioning may come at a price. Installations in the EU may lose competitiveness relative to their competitors in non-EU countries, as the former see their marginal costs rise whereas the others do not.

A reduction of CO_2 emissions achieved through a relocation of industrial production to countries with less stringent CO_2 policy goals has adverse effects for the economy while the global emissions of CO_2 remain almost unchanged[1]. This phenomenon has been labeled ‘carbon leakage’ and is a serious threat to the feasibility of climate change policies. Therefore, the Commission has proposed to exempt *exposed economic activities* from auctioning by giving them allowances for free.

One important question is now which economic sectors can be considered as exposed and what are the consequences from a broader use of auctioning as allocation mechanism? Information on the additional costs of EU ETS and possibilities for cost-pass through for products is a first requirement to gain insight into the possibilities of carbon leakage. Several recent studies have taken this orientation: McKinsey (2006) has analyzed the situation for the EU, while Climate Strategies (2007) has analyzed the situation for the UK. The present study aims to assess the effects from EU ETS on industrial competitiveness in the Netherlands. Do the results from EU-wide studies hold for the Netherlands as well, or is the Dutch situation different from that in the EU? And what can be the effects of inclusion in EU ETS on the profitability of firms?

[1] The precise effects depend on the state of technology of the relocated facilities.

1.2 Aim and content of this study

1.2.1 Aim

The aim of this study is to analyze the effects from EU ETS on industrial competitiveness, to identify economic activities where substantial impacts are likely to occur and to discuss several remedies (compensation mechanisms) that can reduce the impacts on competiveness. These impacts will be analyzed using different CO_2 prices and different allocation mechanisms.

The impacts will be analyzed using a partial (static) microeconomic analysis (see paragraph 1.4 for an explanation). Hence only direct impacts will be taken into account.

1.2.2 Content of this study

In the remaining parts of Chapter 1 we will place the research on competitiveness from EU ETS for the Dutch industry in a wider framework of existing literature. In Chapter 2 we will sketch the methodological framework of this study. Chapter 3 contains results of the cost price increases for sectors of Dutch industry. Chapter 4 will elaborate on the possibility to pass through part of the costs and discusses the likelihood of 'carbon leakage'. Chapter 5 will give an analysis into the various compensation mechanisms that exist to mitigate the consequences for Dutch industry. Conclusions of this study are finally presented in Chapter 6.

The annexes contain technical background information used in this study.

1.3 Competitiveness

The debate about competitiveness issues from EU ETS is based in a wider body of literature addressing the effects of environmental policies in one (group of) countries on the economy and the environment in other countries. These effects are called 'spillover effects' and can broadly be summarized as the unwanted and undesirable side effects of environmental policies through the trade mechanism that links countries worldwide. Competitiveness is one of the major areas of concern here (though other effects exist).

1.3.1 Defining competitiveness

One may define competitiveness as the ability of an economic agent to maintain its operations in a given market. This definition immediately raises the question what can be considered as 'an economic agent' and what does one mean by 'its operations'. One may consider 'a firm' here as a relevant 'economic agent' and all firm activities as 'operations'. However, firms are often partially vertically integrated. EU ETS may not affect all activities from the firm equally. If some economic activities of the firm would be affected, it does not need to close down its operations entirely. Instead, a rational firm would relocate the unprofitable parts of production elsewhere. Therefore, a firm is not a good starting point for the analysis of competitiveness. It is the economic activities that are at stake, not the firms themselves.

This has consequences for the type of research conducted. If economic activities are of concern here, one should investigate the effects on competitiveness from the perspective of economic sectors. Virtually all studies dealing with competitiveness indeed have investigated the issue from the perspective of economic sectors.

1.3.2 Measuring competitiveness

Competitiveness is hence the ability of firms to maintain their level of economic activities in certain markets. Of course, this ability is difficult to measure. A myriad of indicators have been developed in the empirical literature. Most of these measures give a hint on the impact of environmental regulation on, especially, profit margins (OECD, 1993).

The advantage of comparing the additional costs of new environmental regulation to the profits is that it *predicts*, to a certain extent, the behaviour of the firm. If the additional costs of environmental regulation can be passed on to the customers, profitability is hardly affected and no effect on competitiveness can be expected. If the firms are *unable* to pass on the additional costs to their customers, two situations may occur:

1 If additional costs of environmental regulation ‘eats out’ the profits, firms will simply close.
2 If the additional costs of environmental regulation make profits fall, capital will flow to other, more profitable, investments and the future of the production facility may be at stake. This all will strongly depend on the cost structure of the firm and the amount of ‘sunk’ costs at the facilities.

In more practical terms, however, ‘profits’ as a measure of competitiveness may be limited by the availability of data. As noted in Climate Strategies (2007), profits are very volatile and change rapidly from year to year, sometimes becoming negative. In addition companies do have an impetus to lower their profits before taxes in order to lower the bill of the corporate tax.

Therefore, most studies have put the cost increases central. These cost increases can subsequently be perceived as a proxy of the impacts on profits. The translation of the cost price increases into an indicator of competitiveness is described in paragraph 2.3.

1.3.3 Critique on the concept of competitiveness

Economists have, in general, been very critical to the concept of competitiveness, especially when applied on a macroeconomic scale. For example, Krugman (1994) argues that:

'The doctrine of 'competitiveness' is flatly wrong. The world's leading nations are not, to any important degree, in economic competition with each other'.

As Krugman notes, national economic welfare is determined primarily by productivity in both traded and non-traded sectors of the economy and not by the amount of competitiveness of its economic sectors. This boils down to a central fact in macro-economics: if all production factors are utilized to a certain degree, productivity gains are the driving force of economic growth, not increasing output. And, as Krugman notices, there is no difference between policies stimulating productivity in a closed autarkic economy and policies in an open economy. This leads Krugman to conclude that policy recommendations for stimulating competitiveness often result in a misallocation of resources.

Bringing this discussion back to the EU ETS system, it implies that at the macroeconomic level the orientation should not be on the impact from environmental regulation on competitiveness, but on the impact from environmental regulation on productivity growth; i.e. the growth in national income or, even better, welfare[2].

In addition to effects on income, politicians may be interested in the effects on employment. Here again, we must notice an important caveat. One must bear in mind that effects on employment always need to refer to a certain date or time. In the short run, employment may decline due to environmental regulation. In the long run, however, the lower level of employment will put a downward pressure on wages which will result in a stimulus to overall employment. Hence a loss of employment in one sector is, after a certain transition period, often translated in a gain in employment in other sectors and the effects on national income tend to be negligible[3]. Also from the perspective of national income (or welfare), the employment effects are normally negligible[4]. Only if there is large scale unemployment (and the wages are inflexible due to institutional constraints) one may conclude that employment effects may be permanent and have consequences on the national income as well.

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2 Income is a smaller concept than welfare. Many categories that are valuable to humans are not included in the income statistics but do matter for welfare. One can think of household labour or a clean environment. The welfare effects of a policy measure are normally the focus of Societal Cost-Benefit Analysis, not the effects on income.

3 Costs associated with applying carbon abatement technologies will also result in an increase in jobs in sectors producing these technologies.

4 Even if the macroeconomic costs are considered to be negligible, some sectors may be particularly worse off. Politics is not only about efficiency: considerations about fairness and equity may result in certain adaptations of policy plans.

1.4 Study approaches

Empirical studies have taken different routes to analyze the effects of environmental regulation on competitiveness:

a Modelling.
b Econometric analysis.
c Statistical or numerical data analysis.

Here we will very briefly outline each approach, without any claim of being exhaustive or complete. Good literature overviews on the issue of competitiveness can be found in MNP (2004) or MNP (2007).

1.4.1 Modelling

Modelling has been used especially to address issues relating to 'carbon leakage', mainly because carbon leakage can only be estimated using modelling. A second application of modelling is the estimation of the sum of all direct and indirect effects on income levels. Modelling is normally done using *computable general equilibrium* (CGE) models[5].

IPCC (2001) has investigated a number of CGE models that have estimated the effects resulting from uniform CO_2 taxes. Such models do estimate large employment effects in the short run and high leakage rates of about 5-20% for the period up to 2020 (see also Climate Strategies, 2007). In the Netherlands, WorldScan has been used to determine the effects from Kyoto (CPB, 2002) in the Netherlands. The CPB study showed that the costs of a carbon tax of $ 27 per ton CO_2 are modest (0,2% of GDP), but some distributional effects exist as the energy intensive sectors would lose 0,4% of employment.

Although CGE models have provided useful insights in the discussion on the effects on competitiveness, they are faced by several problems and limitations with regard to practical policy decision-making, including problems such as model pre-selection, parameter specification, statistical testing or empirical validation (MNP, 2005). Moreover, there is little consensus on the key parameters influencing *carbon leakage.* As a result, there is much debate and controversy on most of the key parameters in CGE models on carbon leakage and on the relationship between these parameters[6].

5 CGE models are also called applied general equilibrium (AGE) models.

6 Technology, for example, tends to be exogenously determined. In addition one may point at the fact that most economic models assume a greater amount of mobility of capital than observed in reality. MNP (2005, p14) point at the fact that '*a large amount of controversy exists on the potential impact of international reallocation of production factors - particularly capital - on carbon leakage. While some modellers assume that the contribution of capital mobility will be very limited (and mainly restricted to capital flows among the more advanced Annex-I countries), others stress the importance of international capital mobility in this respect, especially in the longer term'.*

1.4.2 Econometric analysis

Econometric analysis offers an alternative to modelling in which a more flexible approach towards model specification can be followed. Econometric analysis tries, in essence, to analyze differences in trade patterns between countries or over time due to price differentials of commodities due to environmental policies. Although this has formed the starting point of many 'trade and the environment' studies (cf. Jaffe et al., 1995), it probably is not very useful for analyzing the effects of EU ETS. By definition econometric analysis can only reveal relationships ex-post and the sheer size and impacts of EU ETS make it hard to compare to any similar activity in the past.

Econometric analysis has been used, however, in order to determine whether sectors have obtained windfall profits from EU ETS. Sijm *et al*. (2006) have used econometric analysis to show that the electricity sector most likely passed part of their freely obtained EU ETS allowances on to the consumers thereby generating windfall profits. This is a useful approach for other sectors for which daily spot prices are available as well (i.e. refineries, steel, aluminium), but such studies have, to our knowledge, not been conducted yet.

1.4.3 Partial microeconomic analysis

A third strand of literature aims to analyze the effects of EU ETS based on statistical information and performs a partial static microeconomic (or meso-economic) analysis to these figures. This type of analysis is more common in business economics and has often been applied to the effects of EU ETS on competiveness. Various recent reports at the level of the EU have used this approach (e.g. see McKinsey, 2006 and Climate Strategies, 2007).

This approach has the advantage that the methodology is clear also to non-professionals and that it can be based on verifiable statistical data. Also the level of detail (with respect to sectors or design of the emission trading mechanism) is higher than in economic modelling. However, the effects that can be quantified using this methodology are limited. Especially all the indirect effects (including carbon leakage) can hardly be determined quantitatively using this approach. Ideally this approach is accompanied by an exercise that uses modelling for the various indirect effects that exist.

1.4.4 Approach chosen in this study and delineation

This study has taken the approach of a partial microeconomic analysis. This decision has not been based on the believe that such is the best approach for an analysis of all effects of EU ETS, but because it can form a good informative starting point on the discussion of the impacts of EU ETS on competitiveness.

However, this approach has some consequences for the interpretation of the results. The partial approach makes –by definition- the analysis conducted here in comprehensive. First, the present analysis focuses only on the costs. Eventual (co-) benefits from EU ETS, such as a better air quality, job creation in sectors that supply abatement technologies or an acceleration of innovations are not included in this analysis. Second, the present analysis only focuses on direct costs. Any indirect costs, such as a loss of jobs in energy intensive sectors and carbon leakage cannot be estimated properly using this approach and are therefore not included.

The results from this study do, however, give a quantification of the direct impacts on the profitability of firms due to EU ETS and improves insight into the costs society and industry faces when complying with EU ETS. It should be borne in mind, however, that such is a partial analysis only and that the welfare impacts of EU ETS have not been addressed in this study.

1.5 Recent findings

The two most cited studies that have recently investigated the effects of EU ETS on competitiveness are McKinsey (2006) and Climate Strategies (2007). Both studies used a statistical/numerical approach and developed various indicators to express the effects of EU ETS on the competitiveness of EU industry.

1.5.1 Climate Strategies (2007)

Climate Strategies (2007) concludes that the position of the aluminium sector stands out these of other sectors: they have a high trade intensity (indicating that aluminium is mainly imported from and exported to non-EU countries) and also have a relatively high cost impact - even in the case of free allocation of rights. If the rights were to be auctioned, the cement sector would face the highest cost increases up to almost 25% of its value added. However, the cement sector is barely exposed to the international market and therefore might pass through a large part of the costs. This situation is probably different for iron and steel which face high cost increases and are amongst the most open sector of the EU economy.

The potential cost increases are subsequently analysed in both modelling and more qualitative analysis. The results show that cement and electricity generation may, in general have benefits from EU ETS in terms of profitability (if the rights are to be allocated freely) while the aluminium sector will be unable to maintain its profitability. The analysis goes into great level of detail of the position of various subsectors. This analysis shows that within every sector some production parts have both a high amount of cost increases and are relatively prone to international competition: within the chemical sector, for example, the production of *other inorganic chemicals* may result in much higher cost increases than the sector's average.

1.5.2 McKinsey (2006)

In McKinsey (2006) a change of the international competitiveness is taken as a change in operating margin approximated by the procentual cost increases. Assuming a competitive power market with a full pass through of CO_2 costs into electricity prices and assuming that 95% of the required allowances are grandfathered, it is being concluded that in the short and medium term the overall average impact on industry margins is limited, except for primary aluminium and integrated pulp & paper production based on mechanical or thermo mechanical pulp.

If firms applied marginal cost pricing or rights would be auctioned, the pressure to shift production might be significant for some industries in international competition. The short and mid term results for the various sectors are as follows:

- The power sector is likely to benefit, whereby the benefits highly depend on the level of free allowances.
- For the steel sector, the integrated production route (BOF) is expected to be affected such that relocation to other areas is conceivable, whereas the minimill route (EAF) is expected to be affected only to a small extent.
- Pulp and paper is compensated only to a small extent by free allowances. The remaining cost increase varies highly depending on the process under consideration. Most affected is, as mentioned above, pulp & paper production based on mechanical or thermo-mechanical pulp.
- The impact on the cement industry highly depends on the potential to pass through costs. The sectors profitability highly depends on the level of allowances grandfathered.
- Impact on refining sector is expected to be neutral.
- Primary aluminium will be under high pressure due to the high increase in electricity costs, which might accelerate migration, whereas the impact on secondary aluminium is expected to be rather marginal.

2 Analytical framework

2.1 Introduction

This chapter will sketch the framework of the current research and highlight the approaches chosen and assumptions made. As stated in the previous chapter, this study uses a microeconomic framework for analyzing the effects of EU ETS. In this chapter we outline this framework, discuss the consequences for the conclusions and indicate under which circumstances we have chosen not to follow the traditional microeconomic analysis but have opted for other insights. First in paragraph 2.2 the microeconomic theoretical framework will be sketched. Then in paragraph 2.3 the translation of the insights from the micro-economical framework into an empirical analysis will be sketched.

2.2 Theoretical framework

In this paragraph first the functioning of an emission trading scheme will be outlined, allocation principles discussed and the pricing strategies of firms will be elaborated from a theoretical point of view. Then, in paragraph 2.3 the translation of this theoretical framework into an empirical framework will be highlighted.

2.2.1 EU ETS and allocation mechanisms

In theory, systems of tradable emission allowances belong to the most efficient and effective policy options to achieve emission standards. They are based upon two principles. First, that the costs per ton of emission reduction differ from measure to measure, from company to company, and from economic sector to sector. Second, that governments lack the information as well as the manpower to prescribe only the cheapest options from all possible measures with which the environmental targets can be achieved. A system of tradable emission allowances solves the latter problem by using the power of the market. In the market, every participant makes optimal use of the information about the possibilities within the own company to achieve profits. By giving a financial value to emissions, emission reductions are achieved - as by an ‘invisible hand’ - against lowest costs.

However, there is a considerable debate related to the allocation of the allowances and the recycling of revenues eventually stemming from a system of tradable rights since not all options lead to an equally efficient system. By efficiency we mean the degree to which the design achieves minimization of the costs of emission reduction. The two design options that give the most efficient incentive for all possible measures to reduce emissions are pure auctioning and pure grandfathering. We shall discuss these first, before turning to other design options.

Pure auctioning

In this case, the government holds yearly auctions for emission allowances, i.e. the allowances to emit one ton of CO_2[7]. The government recycles revenues for purposes which are unrelated to the origin of the returns, for example by lowering its national debt or by *lump sum* lowering existing taxes. If the returns are earmarked for purposes specifically intended to benefit the companies which produced the returns, the system moves in the direction of a performance based system and loses efficiency. The recycling of the revenues bears the risk of introducing 'government failures' that hamper the efficiency of the system of auctioning.

Pure grandfathering

In the case of pure grandfathering, the government puts a cap to emission space, but freely allocates the emission space to those companies who were already 'occupying' this space before the start of the system. These companies, the 'grandfathers', receive free 'grandfathered rights'. A grandfathered right gives the owner the (perpetual) right to receive *each year* one emission allowance[8]. The grandfathered rights are fully tradable and their value or price is equal to the discounted stream of allowances, i.e. the price of a single allowance divided by the interest rate. Such grandfathered rights are comparable to land property, which either can be fully sold or be rented to others for specific periods of time. Similar grandfathered rights also exist in the case of fish catching ('fish quota'), milk production, pig farming or SO_2 trading in the United States.

Since the grandfathered rights are allocated once and for all at the start of the system, newcomers either have to 'rent' these grandfathered rights by yearly buying emission allowances or have to buy grandfathered rights from the grandfather companies that shut down, scale down or become more efficient.

Pure grandfathering is just as perfectly efficient as pure auctioning, since both design options basically have the same economic working. The only main difference is that in the case of pure grandfathering the grandfather companies receive a one off capital gift at the start of the system, which affects the capital position of the company or the shareholders. However, this one off capital gift does not influence the marginal production costs in comparison to pure auctioning. Although the emission allowances are obtained for free, they still represent an opportunity cost.

Adaptations to the pure grandfathering system

Adaptations of the pure grandfathering system are possible, such as the system where the historical reference period is periodically updated. In this case, the efficient working of the ETS is (partly) undone (see e.g. Grub and Neuhoff, 2006). After all, while emissions require the use of emission allowances, to which opportunity costs are connected, the same emissions also offer the opportunity to receive free allowances in next periods. Hence, there exists an opportunity benefit

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[7] A theoretical possibility is that the government auctions 'grandfathered rights' once and for all at the start of the system. This option has been rarely proposed, however, and is to our knowledge nowhere installed.

[8] Or a certain share (percentage) of the total cap.

in production *growth* under this system. This implies that grandfathering with updated allocation rules is less efficient than auctioning.

Other adaptations deal with entry and exit conditions. In a pure grandfathering system companies that close operations can sell the rights on the market, and newcomers must fully buy the rights on the market. Adaptations to these entry and exit conditions make the system less efficient compared to the pure grandfathering system. Take for example the compulsory acquisition of the grandfathered rights by the government in the case of closure. Such an adaptation makes the system less efficient as the decision to reduce output or close an installation is not longer made on the opportunity costs (Åhman et al., 2006). Hence, output will be larger than under a system of pure grandfathering. Present and future ETS, as proposed by the Commission, contain this specific closure rule. This implies that grandfathering including the closure rule is less efficient than auctioning as maintaining inefficient production is implicitly subsidized (by giving the rights for free).

Approach chosen in this study

In this study we follow the proposal of the Commission, COM(2008)16 (EC, 2008). Hence we take that:

- All emission allowances for electricity production will be auctioned, irrespective of whether emissions are generated within the power sector or within industry.
- Some of the remaining emissions will be auctioned if sectors are not exposed to international competition.
- Some of the remaining emissions will be allocated free of charge to sectors that are exposed to international competition. Free allocation of rights will take place on a fixed benchmark (or fixed historical emissions) to be determined at the beginning of the new trading period (i.e. 2012) and which will not be updated in order to minimize inefficiency[9]. However, the closure rule still applies and firms must offer their rights for free to the commission in case of closure.

In paragraph 2.3 the 'allocation scenarios' used in this study will be sketched.

2.2.2 Impact on prices and profits

How does EU ETS affect profits and competitive power? In a neoclassical perfect competitive market, the market price is determined by the point where the marginal social benefits of a product equal the marginal production costs of all companies combined. In such a competitive market, all companies are price takers, unable to set prices. Therefore, each company produces up to the point where its marginal production costs equal the market price. If either less or more would be produced, the companies profit would be reduced.

[9] Although this is in line with the proposal by the Commission one may question the likeliness of such an allocation rule. Industry may lobby to adjust the allocation basis if technological progress takes place. Allocation under a historical benchmark may be perceived as outdated by the stakeholders (and politicians). In order to maintain efficiency, the benchmark should never be updated, also not after 2020. If the benchmark will be updated in 2020, an implicit subsidy on production still exists.

Whether the company does in fact make profit depends upon the companies *average* production costs. The profit is equal to the market price minus the average production costs times the production. Therefore, only companies enter the market that are able to produce against average production costs which are lower than the market price. The so-called marginal company is that company for which the average production costs equal the marginal production costs (which equal the market price). This company makes no profit or losses.

EU ETS implies that marginal production costs will rise and hence have an ***impact on prices***. This is obvious in the case of auctioning but less clear in the case of free allocation. From economic theory one would state that the rights, even given for free, represent an opportunity cost for companies that use them in production. After all, they could decide to quit production and sell the rights. Hence, economic theory tells us that companies will raise prices so to cover the opportunity costs. However, under the *closure rule*, where companies have to hand in their allowances to the government for free in case of closure, things work out differently. Although the company uses the rights in production, they are worthless if production ceases. Hence the opportunity costs of these rights are zero in the long run. Therefore we believe that under the closure rule grandfathering does not result in an increase in marginal costs and hence does not influence the product prices.[10] The exact effects, in the end, depend on the efficiency of the closure rule. An efficient closure rule would imply that also firms that reduce output have to hand in their rights. Only in that case there is truly no opportunity costs associated with production. If output reduction does not result in fewer rights, opportunity costs of production will, however, still be reflected in the prices. If the rights are allocated for free and firms are able to pass on the opportunity costs into the prices, *windfall profits* can be made.

Auctioning, on the other hand, surely has an impact on prices. The impact will depend largely upon the fact whether the affected companies are *sheltered* from or *exposed* to competition with companies that do not participate in the EU ETS. In the case of sheltered economic sectors, a new equilibrium market price will come about where the new marginal production costs equal the marginal private benefits of production. Depending on the price elasticities of demand and supply for the specific good, the new market price will be somewhere between the old price and the old price plus the full marginal cost increase. The profit of the companies will be somewhat lower as demand is reduced but the profit margin is not affected. However, the marginal producer will be driven out of business as he is unable to produce at the new price level.

In the case of exposed economic sectors, however, the market price will to a large extent be exogenous, i.e. remain the same. In that case, the profit margin (profit per unit production) will decrease by the additional marginal costs due to the ETS. If marginal producers exist in the EU, they will be driven out of business. In that case, the price will remain the same and demand will not be lowered, so

[10] Price increases will however occur if companies need to reduce their emissions, as in EU-ETS, due to the fact that the costs of reducing the emissions will be reflected in the prices.

production is just moved to installations in non-EU countries that are able to produce now at lower costs.

The additional costs of EU ETS that cannot be passed onto the consumers will reduce profits of companies. The exact distribution of the effects from EU ETS can also be viewed from the perspective of 'tax incidence' (see e.g. Musgrave and Musgrave, 1984). The theory tells us that if supply is inelastic or demand is very elastic, producers will pay the burden of EU ETS. However, if supply is very elastic (sensitive to price increases) or demand highly inelastic, consumers pay the additional costs of EU ETS as producers are able to pass on the costs in these situations. Elasticity of supply of Dutch industry depends of course on the amount of competition from suppliers that are not faced with higher costs due to climate change policies. If this competition is high, measured through high import shares, supply is inelastic. But also for industries with large sunk costs supply may be rather inelastic, implying that even for some non-exposed sectors limitations may exist in the ability to pass on the costs. However, this largely depends on the elasticity of demand in this case. Inelastic demand may form a reason for passing on a larger share of the costs to the consumers.

The costs that cannot be passed on to the consumers will result in an ***impact on profits*****.** This impact depends, next to the elasticities of demand and supply, on the allocation mechanism as auctioning simply implies higher costs than grandfathering[11]. Hence, for exposed sectors that cannot pass on the costs, grandfathering will reduce the impacts on profits. For non-exposed sectors, however, grandfathering will be neutral as long as companies do not try to raise prices. If the closure rule only applies for firms that quit operations, there are still opportunity costs associated with the emission rights which might result in windfall profits. If the closure rule corrects for changes in output, no windfall profits can be expected.

Auctioning implies a loss of profits for exposed sectors as they will not be able to pass on the costs of the auction. For non-exposed sectors, auctioning has no impact on the profit margins if they can successfully pass on the costs to their customers. Table 2 summarizes the results.

Table 2 Stylized impacts on profits from allocation rules for different types of industries according to economic theory

	Auctioning	**Grandfathering**
Exposed sectors	Loss in profitability	No impacts
Non-exposed sectors	No impacts	Windfall profits[12]

Note: The exact impacts depend largely on the elasticities of demand and supply (see text above).

[11] Even if grandfathering was applied without the closure rule, the allowances would still imply an asset value which should translate itself into lower prices of renting capital. Hence also under pure grandfathering impacts on the profitability of firms can be expected.

[12] If the closure rule does not correct for changes in output.

Hence we conclude, from an economic perspective, that chances on windfall profits only apply in one particular case. However, the chances on windfall profits in the end depend on the possibility that the benchmark will be periodically updated (for example in 2020 at the end of the trading period). In that case the emission allowances would represent an opportunity costs, but there are also opportunity benefits connected to production. If a company produces a certain product today, the company knows it will be rewarded according to the benchmark with a certain number of free emission allowances during the next period. This subsidy (partly) compensates the cost increase due to the emission allowances required for present production. Hence, in that case, a company that applies marginal pricing will set lower prices than in the case of pure grandfathering and windfall profits are likely to be reduced. However, also the efficiency of ETS will be reduced resulting in higher prices.

2.2.3 Effects from a change in profitability

Due to EU ETS profits of companies may be reduced. The lower profits have an impact on future flows of capital. In macro-economic theories the rent on production factors is what drives economic growth. Auctioning*, if the revenues are not recycled to industry*, has the effect of lowering the rent on capital by reducing profits. This will make investments in energy intensive activities less attractive than under a scenario of grandfathering.

However, recycling of revenues is key here. If the revenues were to be recycled to the economy lump-sum, some economic activities would profit and investments into these activities may become more attractive. The total effects on welfare depend on a number of factors which are normally addressed by economic modelling - a route we will not follow in the present study. However, we notice here that against the loss in profitability of some sectors will stand a reduction in costs (and thus profitability) in other economic activities and that the costs for energy intensive sectors are - to some extent - mitigated by benefits in other sectors.

Finally we want to emphasize here that the choice between auctioning and grandfathering is mainly (and often viewed as) a distributional issue determining the transfers of welfare from industry to society and vice versa without affecting the total level of welfare. However, as discussed in paragraph 2.2.1, there are small effects on efficiency (i.e. total welfare) as well. Auctioning leads to a more efficient trading system as companies are being stimulated to use both output reduction and abatement technologies as means to reduce emissions. Grandfathering with the closure rule results in a larger amount of output as the opportunity benefits of closure are zero. Hence auctioning results in a higher degree of efficiency and therefore in lower prices than grandfathering. On the other hand, the total effects on efficiency will highly depend on the possibilities of the government to recycle the revenues lump-sum, for example through lowering the national debt. If governments are tempted to use the revenues of the auctioning for other purposes *governmental failure* may be introduced that negatively impacts on welfare.

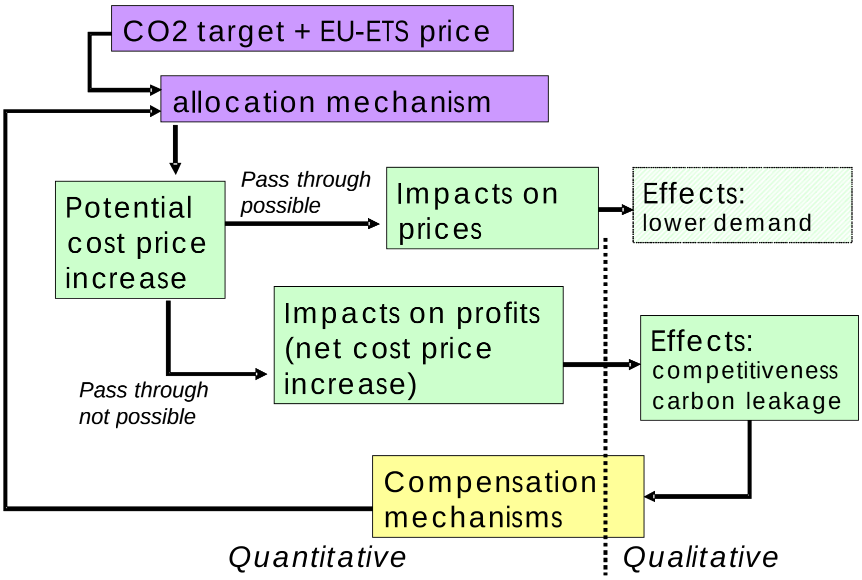
2.3 Empirical framework

This study is not a theoretical investigation into the effects of cost price increases due to EU ETS but a purely empirical analysis. In this paragraph we outline some of the concepts and calculations from which the results will be presented in Chapter 3. First we will present an overview of the used approach in this study.

2.3.1 Summary overview

Figure 4 gives a summary overview of how the issue of competitiveness is addressed in this study empirically.

Figure 4 Summary overview of approach chosen in this study, identified cost concepts and effects



Note: Boxes in purple are exogenous to this project, boxes in green are the calculated (or discussed) effects in this study, the yellow box indicates certain compensations mechanisms that have been investigated in this study and the white box are effects that are not taken into account in this study.

We assume in this analysis that the CO_2 targets, the associated EU ETS price and allocation mechanisms are given exogenously to our analysis (colour purple in case you have a colour print)[13]. EU ETS implies additional costs to firms as they have to buy allowances or invest in technologies to curb emissions downwards. These costs have been labeled in this study as the 'potential cost price increase'. Firms will try to pass on these costs to their customers. However, if they are unable to do so they have to accept a loss in profits and bear the costs of EU ETS themselves. As outlined in paragraph 2.2, the ability to pass on the costs is largely determined by the question if the market price is given exogenous to the firms (in case of exposed sectors) or if they can influence the price (in the case of non-exposed sectors).

[13] Of course, this is not the case in reality, but using various CO_2 prices and allocation mechanisms, one can gain insight into the potential effects that may occur (see also paragraph 2.3).

If firms are able to pass on the costs to their customers, higher prices will induce lower demand. This will affect profitability as well. Such effects have not been taken into account in the present study, largely because these are *intended effects* from any climate change policy. After all, EU ETS must finally be translated into higher prices for consumers of carbon intensive products. However, if firms cannot pass on the costs to their customers, they will have to lower their profit margins which will have *unintended* side effects labeled as a loss in 'competitiveness'. These effects include 'carbon leakage' and losses in employment.

In order to derive an indicator of the effect on profit margins we use here the concept 'net cost price increase' which is equivalent to the potential cost price increase minus the additional turnover by passing on (some of) the costs in the product prices. For companies that can pass all of their costs into higher prices the net cost price increase is zero.

Considerable net cost price increases may result in 'carbon leakage' and losses in employment. These effects will only be estimated qualitatively in this study as they step beyond the microeconomic framework applied in this study. However, by referring to the existing body of literature investigating these effects we hope to be able to shed some light on the question how severe these effects can be and what kind of implications they should have for policy.

The effects of EU ETS may be mitigated by several compensation mechanisms. In this study we solely focus on mitigating the effects from *auctioning*. One of the compensation mechanisms, considered by the Commission, is to give the allowances for free. However, many other options exist, including the recycling of revenues of auctioning to, for example, corporate taxes, or the installation of a system of border tax adjustments and export subsidies in order to correct for the loss of competitiveness of industry. Such compensation mechanisms will be considered in Chapter 5 in this study.

2.3.2 Definition and typology of costs, competitiveness and carbon leakage

As can be seen from Figure 4, the potential cost price increase forms the starting point in our empirical analysis. The **potential cost price increase** is the increase that can be expected in the operational costs per unit of product[14]. Hence the potential cost price increase gives an indication of the additional costs sectors face for complying to EU ETS. These costs correspond to the costs of buying allowances for their emissions. However, we also investigate the possibility when firms have a choice between buying allowances and investing in abatement technologies. Rational behaviour from the firm implies that only investment in abatement technologies will take place if the costs are lower than the price of an allowance. Hence, the actual cost price increases will be lower than the potential cost price increases. Mathematical formulae for the potential cost increases (both maximum and actual) are given in Annex D.

[14] The costs in this study are all average costs for the sector, unless stated differently.

The potential cost price increases may be (partially) shifted to the consumers through higher product prices. In this study we reserve the term **net cost increase** for the additional costs the sectors face when correcting the costs for the portion of potential cost increases that can be passed through to consumers. The net cost increase can be seen as the amount of money that will directly impact on the profits of the companies and is hence an important indicator for the effects on competitiveness[15].

Table 3 makes clear what costs are included in the three cost categories.

Table 3 Cost concepts and various cost categories used in this study

Cost concepts / **Categories**	Potential cost price increase (maximum)	Potential cost price increase (actual)	Net cost increase
Direct costs of buying EU allowances			
Indirect costs of electricity inputs			
Correction for costs of measures to abate CO_2 emissions or reduce electricity demand			
Correction for amount of costs that can be passed through			

One should notice that we distinguish in this table also **direct from indirect costs**. Direct costs are the costs of buying allowances or applying abatement technologies, indirect costs are cost price increases through price increases of their inputs. Especially electricity price increases can be important here - these have been taken into account in the present study. Other cost price increases, such as an eventual higher price of steel, have not been taken into account in the present study[16].

Competitiveness is in this study hence indicated as the net cost price increase, the amount of costs that cannot be passed on to the consumers. This is a relative concept. No impact on competitiveness implies that market shares and profit margins remain unaltered due to EU-ETS. Impacts on competitiveness imply that market shares or profit margins will be reduced due to EU ETS.

However, as EU ETS will in the end imply higher prices for carbon intensive products and services, demand will be reduced. This will reduce total turnover and profits even if no effects on competitiveness could be detected. However, since this reduction is similar for every seller of products and services in the EU market, it does not imply a loss of competitiveness.

15 Due to issues relating to data availability we are not able here to directly estimate the impacts on profits and profit margins.

16 We notice here that such effects have not been used in McKinsey (2006) and Climate Strategies (2007) neither.

Carbon leakage refers to the situation where activities that are currently under EU ETS are transferred to areas where they do not fall under climate change policies. In this way, global emissions will be higher than in the situation without carbon leakage. It is not necessary that the new installations will be less efficient. If, for example, steel manufacturing will be relocated from the Netherlands to India, this will always result in higher emissions worldwide, as the emission target for the Netherlands is still equivalent to -20% whereas the emission of India will now increase irrespective the efficiency of the new installation.[17]

2.3.3 Indicator issues

One important question is now how the additional costs due to EU ETS can be captured in an indicator. Costs can be expressed in absolute terms, but the impacts from cost price increases are often better expressed in relative terms. A cost price increase of 4% has a meaning to everyone, while a statement that costs increased by € 10 million is relatively meaningless in a debate about competitiveness. Hence, an indicator for the potential cost price increase should be a ratio.

The two most often used indicators are:

1 Percentage potential cost increase: a ratio in which the additional costs of environmental regulation are put against the operational costs. McKinsey (2006) uses this as their prime indicator although it should be notice that McKinsey uses marginal costs throughout their report.
2 Value at stake in which the additional costs of environmental regulation are divided by the value added of sectors. Climate Strategies (2007) uses this as their prime indicator.

Both indicators have put the cost increases in their numerator but the denominator differs. The question is which indicator provides a better picture for competitiveness. If one accepts the proposition that the main concern of competitiveness is profitability of the firm, the percentage cost increase probably gives a better indication of the impacts on profits. Profits are the sales minus the costs and the sales price is often determined as a fixed percentage over the costs. Hence the percentage potential cost increase gives an indication how profitability of economic activities will be affected. We consider the closer relationship to profitability an important advantage of the percentage cost increase as an indicator.

The advantage of the value at stake is, however, that it makes more sense from a macroeconomic perspective: it indicates the contribution of the sector to the national economy. Climate Strategies (2007) also claim that the value added is a more stable parameter, something that is in general true for labour intensive sectors but couldn't be further from the truth for labour extensive sectors

[17] Notice that the Commission in their proposals has stated hat carbon leakage only refers to the situation where the new installations are less efficient. This is not the approach followed in this study where we refer to carbon leakage the additional CO_2 emissions of any relocation irrespective of the efficiency of the new installations.

(see e.g. Entec, 2003). We notice here that most energy intensive sectors are often quite labour extensive.

In practical terms data availability may often be a more important criterion for selecting an indicator. In the Netherlands, data on value added is only available at the 2-digit level, while data on total costs is available at the 3, and sometimes 4-digit level. This forms another argument to focus in this study on the additional cost increases relative to total costs. However, we will discuss in Chapter 3 the interpretation of our findings in terms of value at stake as well.

2.3.4 Allocation scenarios

In this study we consider two allocation scenarios.

1. **Full auctioning:** 100% auctioning for all sectors including electricity generation.
2. **Partial grandfathering** where only rights will be auctioned meant for electricity generation (irrespective of whether this happens in the energy sector or through CHP installations in industry) and the rights for all other installations will be allocated for free (also for heat production from CHP).

The partial grandfathering scenario is similar to the proposals from the Commission where all sectors are considered as being *exposed* and exempted from auctioning. In total this implies that about half of all the rights will be auctioned and the other half will be grandfathered. The scenario “full auctioning” is similar to the proposals from the Commission where all sectors are considered as being non-exposed. In reality, allocation mechanism in the future will most likely not follow these two extremes, but consist of a more subtle mix of auctioning and free allocation depending on the question how vulnerable a sector is to competition from countries where carbon has no price.

Grandfathering will most likely be based on a fixed benchmark. For the analysis of this study benchmarks have not been analyzed. However, free allocation based on fixed benchmarks will give, at the level of sectors, the same average cost price increase as free allocation based on fixed historical emissions.

Finally, it is assumed in our analysis that the closure rule applies which forces companies to hand in their emission rights in the case of closures.

2.3.5 Unit of analysis and coverage of EU ETS

The unit of analysis is in this study sectors. As outlined in Section 1.3, we believe that sectors form a better starting point of analysis than firms as sectors are a better approximation of the economic activities that are at stake than firms which are often vertically integrated in more than one market.

We investigate in this study only sectors in industry. Mining and electricity generation, although included in EU ETS, will not be part of the present analysis.

However, the indirect effects for industry through higher electricity prices is taken into account in this study (see paragraph 2.3.2).

Another important aspect is the coverage of installations in EU ETS. At present there is a capacity threshold of 20MW in the system in order to lower administrative burdens for smaller installations. This is likely to continue in the future. However, we assume in this study that all of the emissions of a sector, irrespective of their capacity, will be subject to future climate change policies. This assumption is needed in order to match information on emissions with financial-economic information that is required for the analysis on cost structures. An analysis for only the installations above the capacity threshold of 20MW is not possible, as there is no financial information available at this level of detail.
However, this will not influence the results as the new proposals of the EU point at a dual scheme: EU ETS for larger installations and additional climate change policies for installations that do not fall under EU ETS. Targets for both groups of installations have been proposed based on the assumptions of equalizing marginal costs between both groups. Hence, the costs increases for installations that fall under EU ETS and installations that do not fall under EU ETS should be similar in the future. Therefore do the results from this study apply to non EU ETS installations even if this is not the explicit subject of the present study.

2.4 Concepts and Assumptions

In this paragraph we will outline the concepts and assumptions underlying the calculation performed in Chapter 3 and further.

2.4.1 Targets and prices

In this study we have calculated the effects of a target of -20% for Dutch industry by 2020. During our study, the Commission has proposed for the Netherlands a reduction of -21% for EU ETS and a reduction target somewhat lower for the sectors and installations currently not covered by EU ETS. Hence the overall target of -20% is reasonably close to what would be the effort requested from industry as a whole.

In this study, a price of € 20/ton CO_2 is assumed, which is similar to the price taken in both Climate Strategy (2007) and McKinsey (2006). According to McKinsey (2006) a price of € 20/ton is, ‘in the range of potential mid- and long-term CO_2 prices’. They furthermore point at the fact that the long-term view is most relevant to investment decisions in capital-intensive industries.

But what will happen if prices of CO_2 rise to much higher levels? We conduct in this chapter a sensitivity analysis for a price of € 50/ton CO_2. However, as will become clear, we consider a price of € 50/ton as unlikely given the underlying cost curves. However, only a modelling effort could reveal the long-term equilibrium prices on the EU ETS market.

Both prices are given exogenous to the calculations we perform.

2.4.2 Allocation mechanisms

As stated above two scenarios will be considered in this study with respect to the allocation of rights:

1 **Full auctioning:** 100% auctioning for all sectors including electricity generation.
2 **Partial grandfathering** where only rights will be auctioned meant for electricity generation (irrespective of whether this happens in the energy sector or through CHP installations in industry) and the rights for all other installations will be allocated for free (also for heat production from CHP).

For the second scenario, the amount of allowances that is being grandfathered is assumed to be equal to the emission goal, i.e. a sector gets an amount of allowances that equals 80% of its 2005 emission level[18]. Depending on the abatement costs of a sector it might either want to buy or sell EUA's. We assumed that the rights are allocated on the basis of a fixed reference point: on the basis of the emissions in 2005. This allocation principle does not alter if a benchmark is chosen as allocation mechanism as long as the sector's total emissions still have to meet the target of -20% of the emissions in 2005.

ETS will have an impact on the barriers of entry or stimuli to exit the market. Such effects are not included here. It is therefore assumed that in a system of grandfathering, the rights cannot be sold to the market but have to be given to the government (i.e. the closure rule applies). The government gives these rights to new entrants for free. These assumptions are similar to McKinsey (2006).

2.4.3 Sector classification

Much effort in his study has been devoted to guarantee a higher level of sectoral disaggregation than would normally be feasible from the statistical sources in the Netherlands. 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:

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18 As total emissions of the Netherlands were in 2005 equivalent to the total emissions of 1990 these goals assure that the Netherlands as a whole will comply with the future post-Kyoto targets that the EC might agree upon.

Table 4 Sector classification used in this study

	Name	SBI
1	Nutrition	15,16
2	Textiles	17,18,19
3	Wood	20
4	Paper	21
5	Graphics	22
6	Refineries	23, excl. 231
7	Petrochemical	2414,2416,2417
8	Fertilizer	2415
9	Inorganic chemicals	2413
10	Other Base Chemicals	2411,241
11	Chemical products	242-247
12	Glass	261
13	Building materials (tiles, bricks)	264
14	Cement, calcium and gypsum	265
15	Ceramics nec (*not else classified)*	262,263,266,267,268
16	Iron and steel (incl. casting and cokes)	271-273,231, 2751 and 2752
17	Aluminium	2742
18	Other non-ferro	2741, 2743 and further, 2753 and further
19	Other industry	25 and 28 and further
20	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 without making assumptions which were not acceptable to the opinion of the paper industry. In paragraph 3.3.5 we will briefly indicate the consequences if the paper industry would be subdivided in various product categories.

2.4.4 Data requirements

The data that we have used in this study deal with sectoral data on:

a CO_2 emissions of the sector.
b Electricity bought.
c Electricity produced in CHP in industry.
d Electricity delivered back to the grid.
e CO_2 emissions due to electricity production from CHP (calculated).
f Total operational costs.
g Total sales of production.
h Value of imports to country of origin.
i Value of exports to country of delivery.
j Costs of abatement measures.
k Value added (*estimated).*

Data rows (a), (c), (d) and (e) are used for estimating the direct potential cost increase of EU ETS. They have in essence two components:

1 CO_2 emissions not stemming from electricity production in CHP which will be auctioned or grandfathered according to the allocation scenarios.
2 CO_2 emissions from electricity production in CHP which will be auctioned. We investigate here only the electricity production which is consumed in the sector itself. Some sectors deliver part of the produced electricity back to the grid. We assume here that they will successfully pass through the EU ETS costs so that only the net energy consumption will impact on the potential and net cost price increases.

Data row (b) is used for determining the indirect cost price increases (see paragraph 3.2.1). Data rows (f) and (k) are used for constructing the indicators, as described above in paragraph 2.3.3. Data rows (g), (h) and (i) are used for constructing the trade intensity of the sectors (see Chapter 4). Data row (j) finally is used to estimate the actual potential cost price increases (see paragraph 2.3.2).
Annex B describes the data sources and estimations used in order to derive the chosen sector classification.

2.4.5 Assumptions related to the time dimension in this study

All the calculations that are performed in this study are for the EU ETS system in the year 2020. However, the final outcome will be highly dependent on two developments:

1 The structure and size of Dutch industry in the year 2020.
2 The development of international climate policy in 2020 and the years after.

The **structure and size** of Dutch industry in the year 2020 matters for the analysis conducted here. Some sectors of the Dutch industry might be relocated even without EU ETS as labour or energy costs are cheaper in other parts of the world. However, the future developments are uncertain and we felt that these will dominate any outcome on the analysis of EU ETS. Therefore, we decided to abstain from dynamic developments until the year 2020. The costs are hence derived for 2005 under the assumption that the industry has to meet a 20% CO_2 emission reduction in this very year. This has been done in order to abstain from the influence of scenario analysis onto the results of the study and make the results easier to interpret.

The **development of international climate policy** matters as the analysis in this study largely depends on the assumption that there will be no progress in international climate policy. Hence this study assumes that only in the EU and the developed countries that currently signed and ratified Kyoto climate policies will be in place. The rest of the world, including China, India and all the states in the United States, will face a situation where carbon will have no price at least until 2020 and also for the years after. Only under these circumstances price differentials between countries that adhere to climate change policy goals and countries that do not have any type of climate change policies are maximized and sustained. Therefore the results from this study typically are only valid if international climate policies will completely fail. This is of course a very pessimistic scenario and therefore the results from this study are typically to be interpreted as the ‘worst case scenario’.

Finally, the results from this study are also from another perspective a ‘worst case scenario’. In the current Commission proposal, the amount of auctioned rights in the non-electricity sector gradually increases from 2013 to 2020. However, in this study we only investigate the situation in 2020. In practice, the gradual introduction of auctioning will have a mitigating effect as firms are able to adapt slowly to the higher costs. If they can pass on (part of) the costs they could, in principle, make windfall profits in early years to mitigate the effects of auctioning compared to the results in this study for sectors with a high degree of

3 Analysis on the potential cost price increases

3.1 Outline

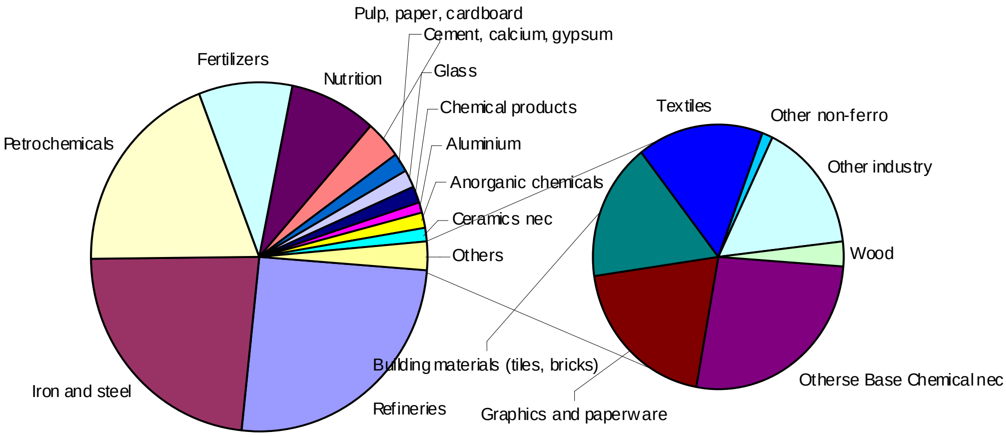
In this chapter the results of our empirical analysis on the potential cost increases will be presented. First, in paragraph 3.2 the indirect and total potential cost price increases will be derived for both allocation scenarios (full auctioning and partial grandfathering). Then, in paragraph 3.3., a sensitivity analysis will be conducted where we investigate the effects of higher emission prices, allowing companies to reduce their emissions with abatement technologies and different sector classifications. Conclusions will be presented in paragraph 3.4.

3.2 Potential cost price increases

3.2.1 Determining direct costs of CO_2 emissions

The Dutch industrial sector makes up about 15% of GDP in the Netherlands. Compared to other EU countries the industrial sector is relatively small but with a large share of energy intensive industries in the base metal, base chemical and refineries sectors. Total CO_2 emissions of the Dutch industrial sector equalled 49,2 Mton in 2005, 26% of total Dutch CO_2 emissions[19]. Figure 5 gives the division of CO_2 emissions of Dutch industry.

Figure 5 Division of CO_2 emissions of Dutch industry in 2005



[19] CBS gives here 44,9 Mton but we distribute part of the CO_2 emissions from the electricity production from coke oven gas to the iron and steel industry. Very small rounding errors exist (<1%) between our emission estimates and the totals from CBS. See Annex B for more information.

From Figure 5 it becomes clear that two third of the direct Dutch CO_2 emissions stem from three sectors: (i) iron and steel; (ii) petrochemicals, and (iii) refineries. These sectors together emit 33 Mton. Table 5 gives in more detail the CO_2 emissions used for these sectors in this study.

Table 5 CO_2 emissions of Dutch industry in 2005

SBI	Name	Mton
15,16	Nutrition	4,0
17,18,19	Textiles	0,2
20	Wood	0,04
21	Paper	1,5
22	Graphics	0,25
23 (excl. 231)	Refineries	12,3
2414,2416,2417	Petrochemical	9,4
2415	Fertilizer	4,6
2411,241	Other Base Chemicals	0,4
2413	Inorganic chemicals	0,6
242-247	Chemical products	0,7
261	Glass	0,8
264	Building materials	0,3
265	Cement, calcium, gypsum	0,8
262,267,268	Ceramics nec	0,5
271-273, 2751-2752	Iron and steel*	11,2
2742	Aluminium	0,6
2743	Other non-ferro	0,02
25, 263, 266, 28 and further	Other industry	0,9
	Total	49,2

Source: CBS, own calculations (see Annex B).'* Emissions from the Iron and Steel industry include emissions from coke oven gas delivered to electricity producers additional to the normal emissions if the electricity would be generated with fossil fuels. This amount equals the amount of emission rights Corus passes on to the electricity producers (i.e. 4,5 Mton) for compensating for the higher emissions from coke oven gas.

Emissions have been based on CBS and not NEA as NEA does not fit to the sectoral classification followed by CBS (which we need for the other data in this study). The division between the various subsectors of the chemical industry, building materials industries and base metal industry is provisionary and partly based on LCA data, as outlined in Annex B and D.

By multiplying the CO_2 emissions with the emission price one arrives at the costs that companies would face under full auctioning. In the scenario of partial grandfathering the sectoral CO_2 emissions need to be disaggregated in a part attributed to CHP and a part for the other installations and processes. The CHP part is subsequently split in emissions due to electricity production and emissions due to heat generation. Only the electricity part will be auctioned, the other emissions will be grandfathered up to the desired level of reduction (i.e. 80% of the emissions from 2005).

3.2.2 Determining the indirect cost price increase

The indirect cost price increase is dependent on the costs that electricity producers will pass on to their customers. Electricity producers will fall under auctioning for both allocation scenarios that have been used in this study. It is generally expected that they will be able to pass on the full costs to their customers. The price rise is largely dependent on the additional CO_2 costs for the marginal unit of electricity production, as this unit is determining the price on the electricity market.

Reinaud (IEA, 2003) has given a thorough analysis on the potential cost price rises for the electricity market and she arrived at a cost price increase of €10/MWh for an emission price of € 20/ton CO_2. This figure has become 'a stylized fact' and is used in both McKinsey (2006) and Climate Strategies (2007) for calculating the impacts on competitiveness for industry. Although the way Reinaud has arrived at this figure is too complicated to outline here, the marginal cost increase she foresees is largely determined by the additional costs gas fired installations will face if carbon costs € 20/ton CO_2. Industry, however, has pointed at the fact that they feel that this situation is not applicable to them as they typically have long-term contracts with 24hrs of electricity use. They state that their electricity prices are typically determined by the price of coal[20].

In order to test whether the price of € 10/MWh is a good approximation of the costs for industry, we have conducted here an analysis with the CAFÉ model developed at CE Delft for investments in new energy plants. In some ways, the costs for new energy capacity may be perceived as the marginal unit for long-term contracts. Our analysis (see Annex A) shows that with an emission price of € 20, a coal fired unit remains favourable for investors in new capacity. The additional CO_2 costs for a new coal fired unit would mount to € 14/MWh for an emission price of € 20/ton CO_2. If prices would rise to € 50/MWh the additional CO_2 costs to be passed on in the prices would raise to € 34/MWh. Within this project we have decided to use these higher figures for calculating the costs. They may be representative in the long-run for the additional costs to be passed on in long-term contracts. However, they may give an overestimation of the additional costs for electricity use that is not under long-term contracts.

3.2.3 Partial grandfathering

If the rights are partly grandfathered, the potential cost rise for industry consists of three components:

a The electricity part of CHP which will be auctioned to industry (minus the deliveries to the net).
b The costs of buying 20% rights for covering their emissions from other installations and the heat production from CHP.
c The higher electricity price for their purchases of electricity.

[20] In addition, one may observe that since 2003 gas prices have increases much more than coal prices which may alter the analysis conducted by Reinaud.

Figure 6 presents the results for this allocation mechanism.

Figure 6 Potential cost price increase as percentage to sector's total costs, partial grandfathering, € 20/ton

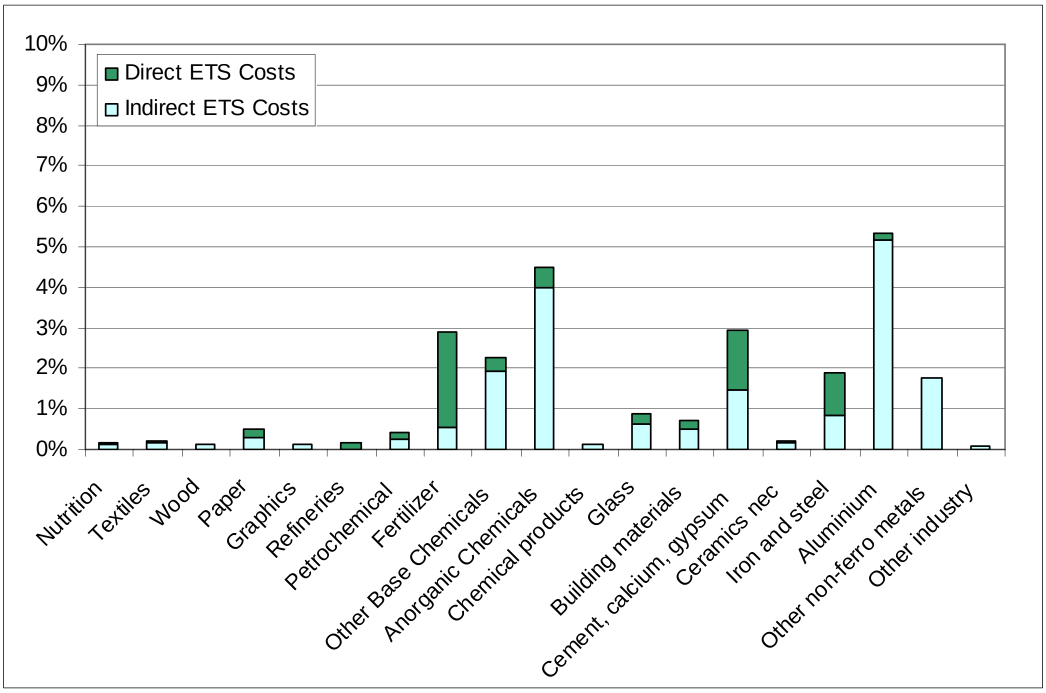


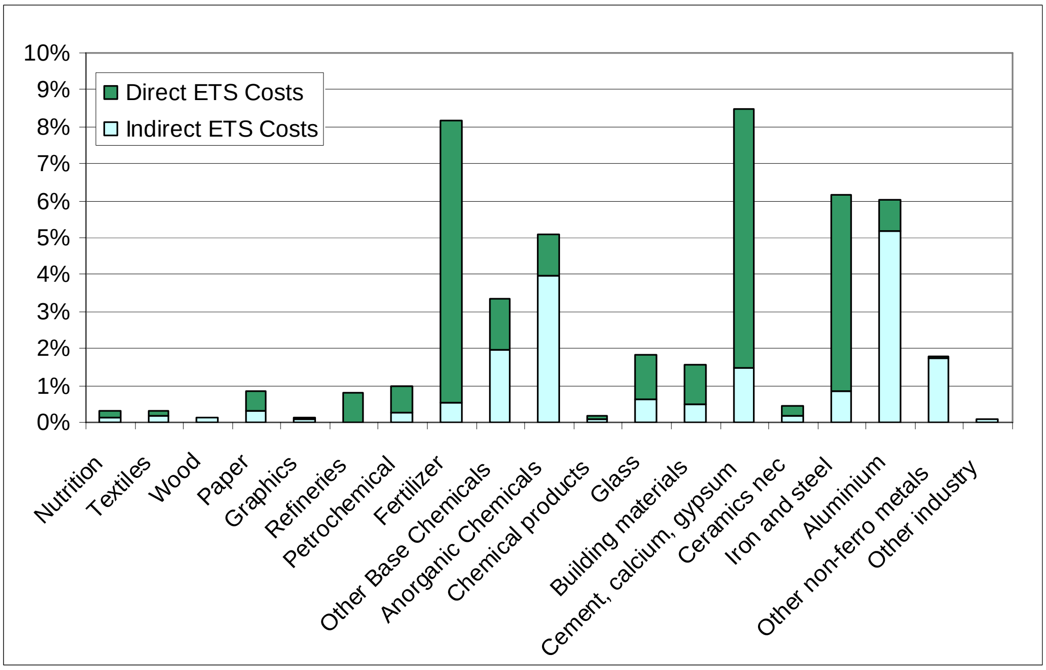
Figure 6 shows that if allowances are grandfathered, the largest part of the cost price increases stems from the electricity price increases (indirect ETS costs). Most sectors face potential cost price increases below the 1%. However, fertilizer, inorganic chemicals, other base chemicals, cement and aluminium face cost increases above the 2%. For aluminium (+5,3%) and inorganic chemicals (+4,5%) this is mainly due to the increase of indirect ETS costs, for fertilizers due to the increase of direct ETS costs. The total cost increase of industry is slightly below the 0,3%, almost € 700 million annually.

3.2.4 Full auctioning

If the rights are auctioned, the potential cost rise for industry consists of two components:
a The higher electricity price for their bought electricity.
b The costs of buying 100% rights for covering their present emissions.

If all the allowances would be auctioned and the revenues are not recycled to industry, the total average cost increase of industry will double to 0,6%. This is equivalent to 1,4 billion of Euros annually. Figure 7 gives the results for the various subsectors from a procentual perspective.

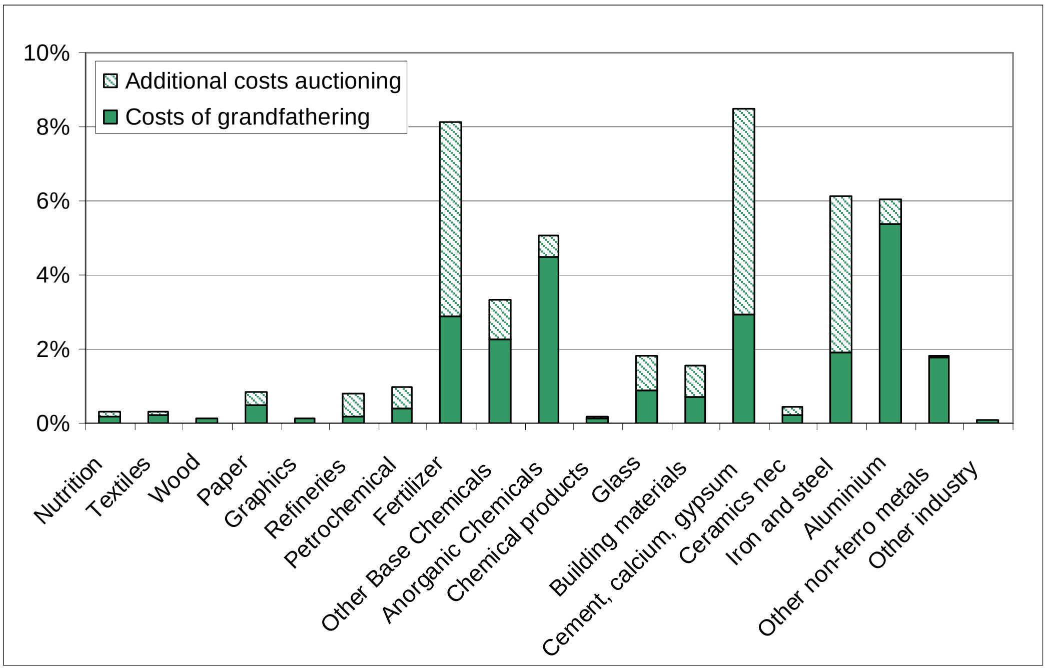
Figure 7 Potential cost price increases as percentage to sector's total costs, full auctioning, € 20/ton



Various sectors show now cost price increases above the 2%. The four sectors with the total costs rising the most are cement (+8,4%), fertilizers (+8,1%), iron and steel (+6,2%) and aluminium (+6%). For the first three sectors the direct ETS costs are the driving factor for aluminium it is the indirect ETS costs.

Figure 8 gives the comparison of the impact of auctioning compared to grandfathering for the sectors. The lower fixed bar gives the results from grandfathering and the bars with dashed lines give the additional costs if rights would be auctioned.

Figure 8 Additional costs of full auctioning compared to partial grandfathering, € 20/ton



As shown in Figure 8, the fertilizer, cement and iron and steel would have much higher potential cost increases under auctioning than under grandfathering. For inorganic chemicals and aluminium there is hardly any difference between auctioning and grandfathering. The differences in absolute terms (i.e. million of Euros, not given here) are the largest for the refineries, petrochemicals and iron and steel.

3.3 Sensitivity analysis

How do these results change if we would have taken different assumptions or a different approach in calculating the additional costs due to EU ETS. In this paragraph we will investigate the following adaptations:

a The potential cost price increases if firms can apply abatement technologies (par. 3.3.1).
b The potential cost price increases if firms would apply marginal cost pricing strategies (par. 3.3.2).
c The potential cost price increases if emission prices would rise to € 50/ton CO_2 (par. 3.3.3).
d The outcome of the analysis if we could use the indicator 'value at stake' (par. 3.3.4).
e The outcome of the analysis if we could achieve a higher level of sector disaggregation (par. 3.3.5).

3.3.1 Potential cost price increases with abatement technologies

The previous paragraph showed the potential cost price increases from the perspective that sectors can only buy EUAs. However, these may be perceived as the *maximum potential cost price increases* as firms have a choice between buying EUAs and investing in abatement technologies. Rational firms will invest in technologies until the marginal price of reduction equals the price of EU ETS. Hence, as a logical result, the potential cost price increases identified above are an overestimation of the true costs sectors occur. In order to estimate the *actual potential cost price increase*, one has to investigate the possibilities and costs of reduction measures that can be taken in industry.

Costs and reduction potentials of the reduction measures in this study have been taken from the 'Optiedocument energie en emissies' 2010/2020 (ECN and MNP, 2006). More information on the costs and calculations performed using the results from that study can be found in Annex B[21].

Under auctioning with an emission price of € 20, the actual cost price increase will be determined by three factors:

a The higher electricity price for the electricity bought;
b The abatement expenditures for measures lower than € 20/ton CO_2;
c The costs of buying allowances to cover the remaining emissions if abatement expenditures are taken.

If allowances are auctioned off, the actual potential cost price increase for the industry as a whole amounts to 0,5%, i.e. 0.1% lower than the maximum *potential* cost price increase outlined in paragraph 3.2.4.. Figure 9 gives the differences between the actual and maximum potential cost price increase under auctioning.

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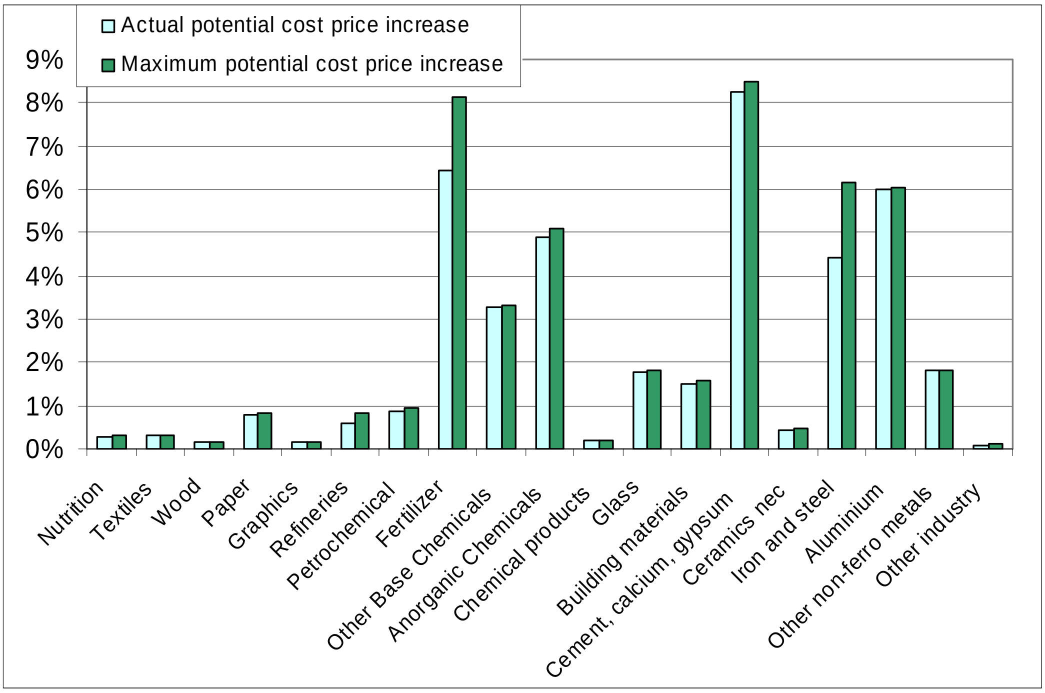
[21] One important feature is that this study identifies several options with negative costs (i.e. net benefits) for the year 2020. We assumed here that these options would have been taken in any case, even if no EU ETS was present. Hence, the additional costs of EU ETS for these options are zero.

Figure 9 Maximum and actual potential cost price increase, full auctioning, € 20/ton CO_2



We see here that mainly the fertilizer sector and the iron and steel sector have cheaper options to reduce emissions according to the *Optiedocument*[22]. Refineries are another sector where several options to reduce emissions below the € 20 have been identified. For other sectors the differences are small or absent.

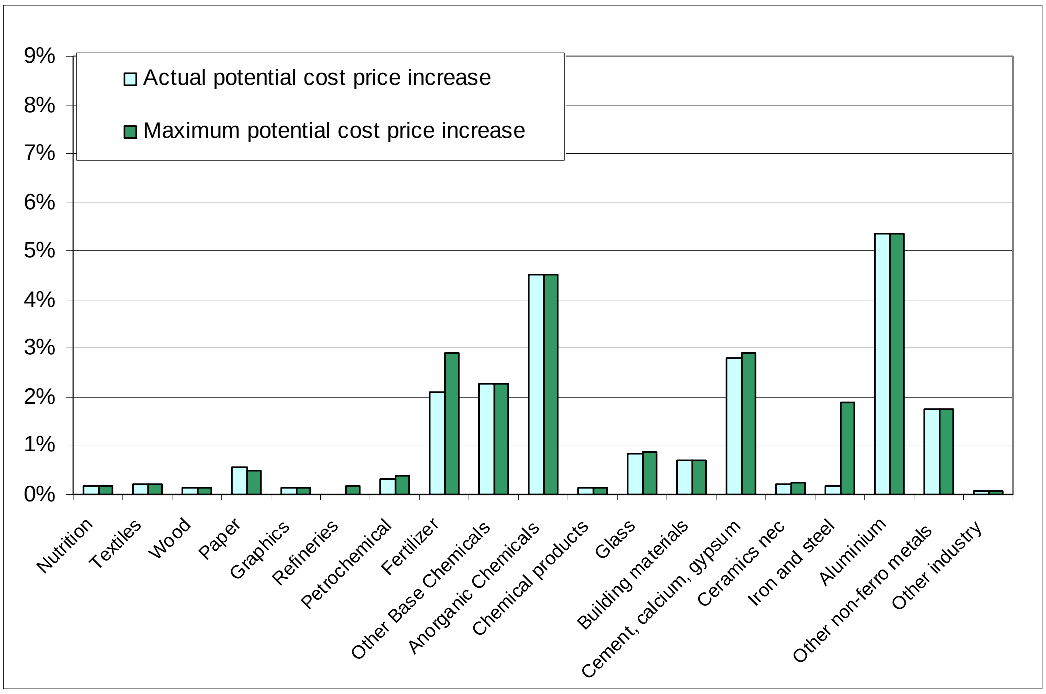
If emissions would be grandfathered, the actual cost price increase will be determined by four factors:

a The higher electricity price for the electricity bought.
b The abatement expenditures for measures lower than € 20/ton CO_2.
c The costs of buying allowances to cover the remaining 20% emission reduction and the electricity part of CHP if all abatement expenditures under € 20 have been taken.
d The benefits of selling allowances if abatement larger than 20% reduction has been taken.

Figure 10 gives the results from this exercise.

22 It should be noted here that the sectors themselves view these options differently and less attractive than ECN. For Iron and Steel, for example, this option is based on a different process and not yet operational in the world. We have not investigated this issue any further in this study as the results from the actual cost price increases do not play an important role in the conclusions of this study.

Figure 10 Maximum and actual potential cost price increase, partial grandfathering, € 20/ton CO_2



Again the iron and steel and fertilizer sector show the largest differences. Refineries and the iron and steel sectors would become net sellers of emission allowances. The total actual cost price increase for the industry is now 0,2% (compared to 0,3% under the maximum potential cost price increase). This figure can be interpreted as the total direct additional costs of Dutch industry of complying with EU ETS (and the accompanying climate change policy for sectors that currently do not fall under EU ETS)[23].

For the remaining analysis in this study we will always refer to the *maximum* potential cost price increases and hence give results in a more pessimistic way as if all of the measures from the 'Optiedocument' will not be taken by industry until 2020.

3.3.2 Marginal cost pricing

As explained in Chapter 2, the costs of auctioning can be considered as being largely similar to the marginal cost price increases. The only exception is the costs of CHP production within the industry sectors which, at the margin, will be valued similar to the costs of bought electricity. Figure 11 gives the results from full marginal cost pricing where also the electricity generated within industry is valued against €14/MWh.

[23] If emission prices would rise to € 50/ton, the figure for the whole industry would be doubled to 0,4%. If emission prices rise, more reduction measures are taken.

Figure 11 Potential cost price increases at the margin, € 20/ton

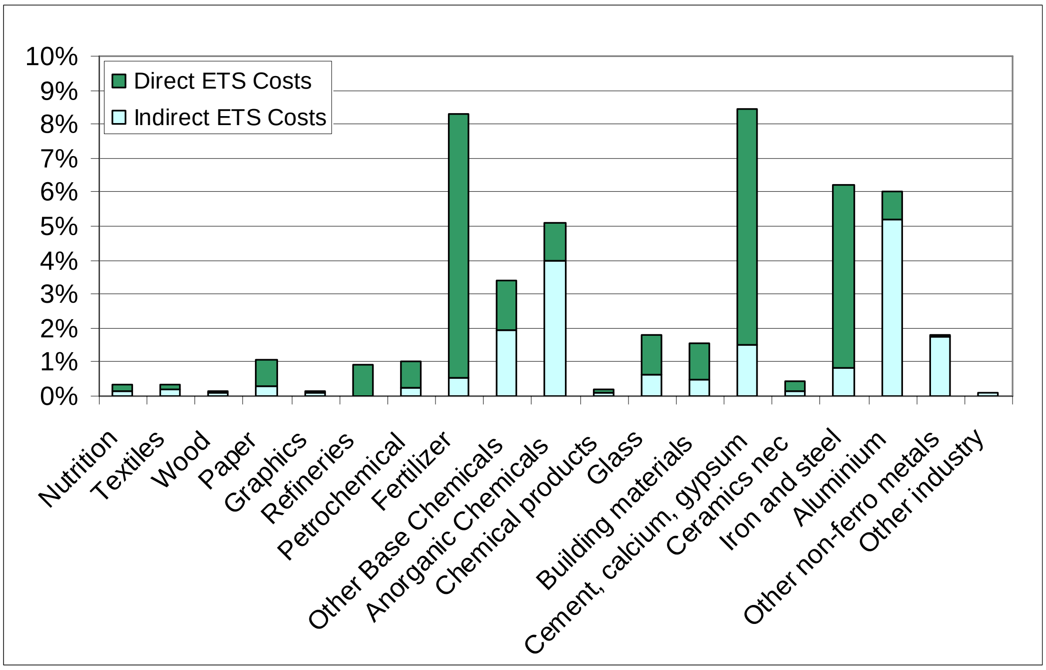


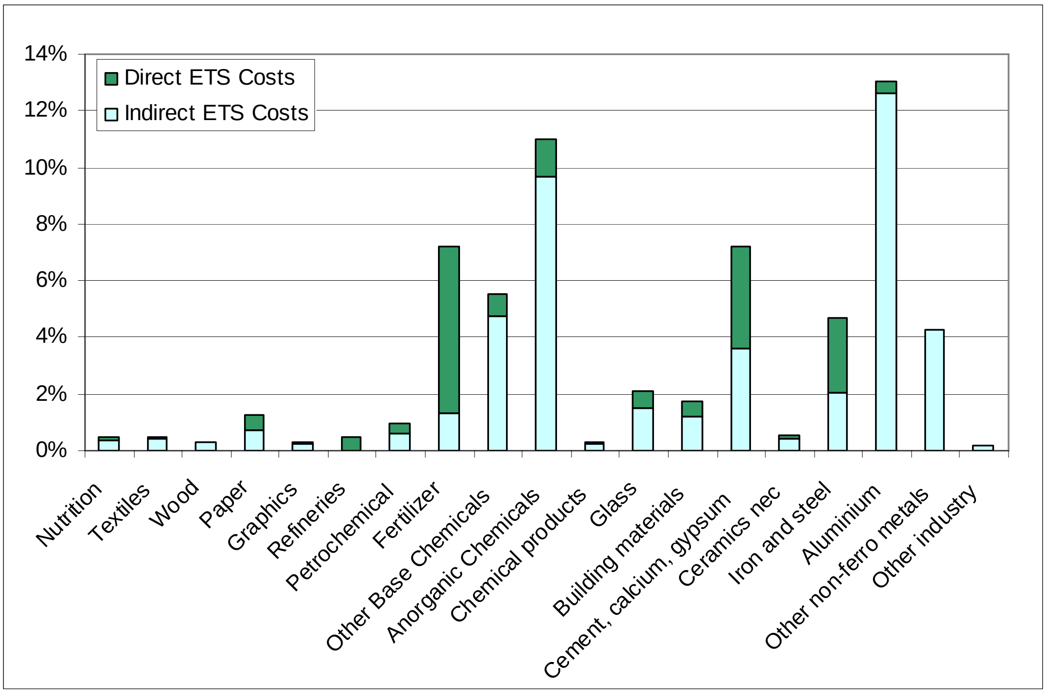
Figure 11 reveals almost no differences with the potential cost price increases under auctioning (par. 3.2.4), assuring that the results from auctioning can indeed be interpreted as an indication of the marginal costs for sectors. However, if rights would be grandfathered marginal cost pricing within sectors may result in windfall profits. This of course largely depends on the possibilities of firms to pass on the costs, as well as the design of the allocation mechanism (see Chapter 2). Chapter 4 will go in more detail into the opportunities of firms to pass on the costs.

3.3.3 Higher emission prices

All results above have been given for emission prices of € 20/ton. These prices are in line with price levels taken in other studies. However, one could be interested in what would happen if the emission prices would rise to much higher levels. For this purpose we conducted a sensitivity analysis into the price effects of € 50/ton. This higher price would both raise the indirect costs (through a higher electricity price) and the direct costs.

Figure 12 gives the result for partial grandfathering of these higher price levels. This figure shows that prices will increase substantially for all sectors. Aluminium and inorganic chemicals should expect potential price increases of above the 10%. Total average cost increase for Dutch industry would be 1,6 billion of Euros.

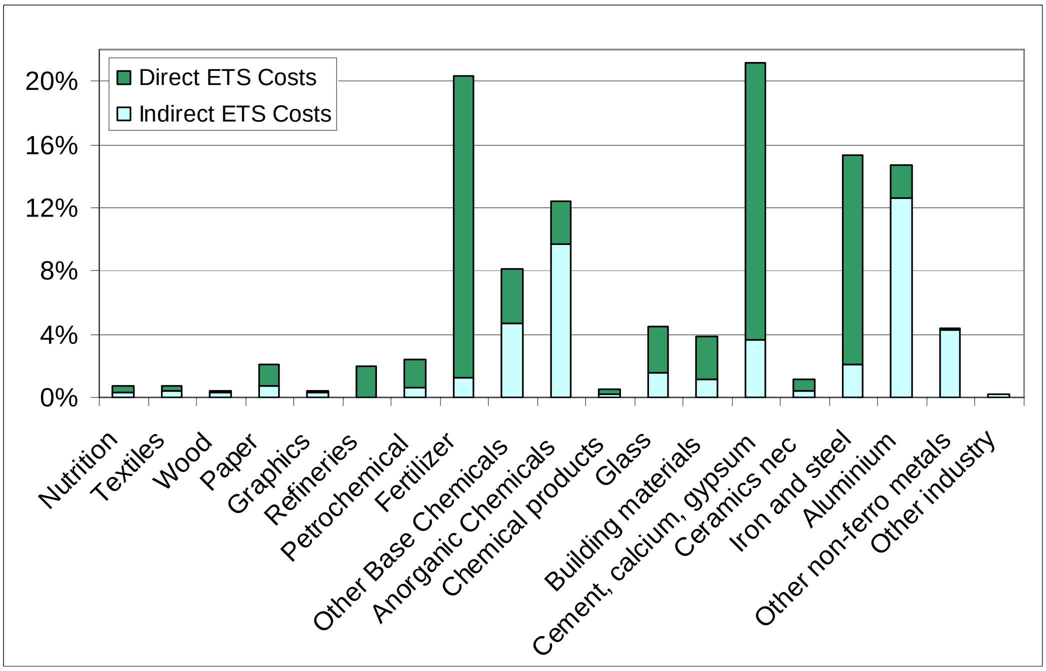
Figure 12 Potential cost price increase, partial grandfathering, € 50/ton CO_2



For auctioning the cost increases will be even much higher. Cement and fertilizer now face a cost price increase of more than 20%. With such prices also paper, refineries, petrochemicals, glass and building materials face impacts above the 2%.

If emission prices would rise to € 50, Dutch industry could cover a considerable amount of their emissions with applying abatement technologies that are cheaper. This has two implications: (i) Dutch industry would be faced with lower actual cost increases; (ii) some sectors will be able to reduce more thereby becoming net sellers of emission rights.

Figure 13 Potential cost price increases, full auctioning, € 50/ton CO_2

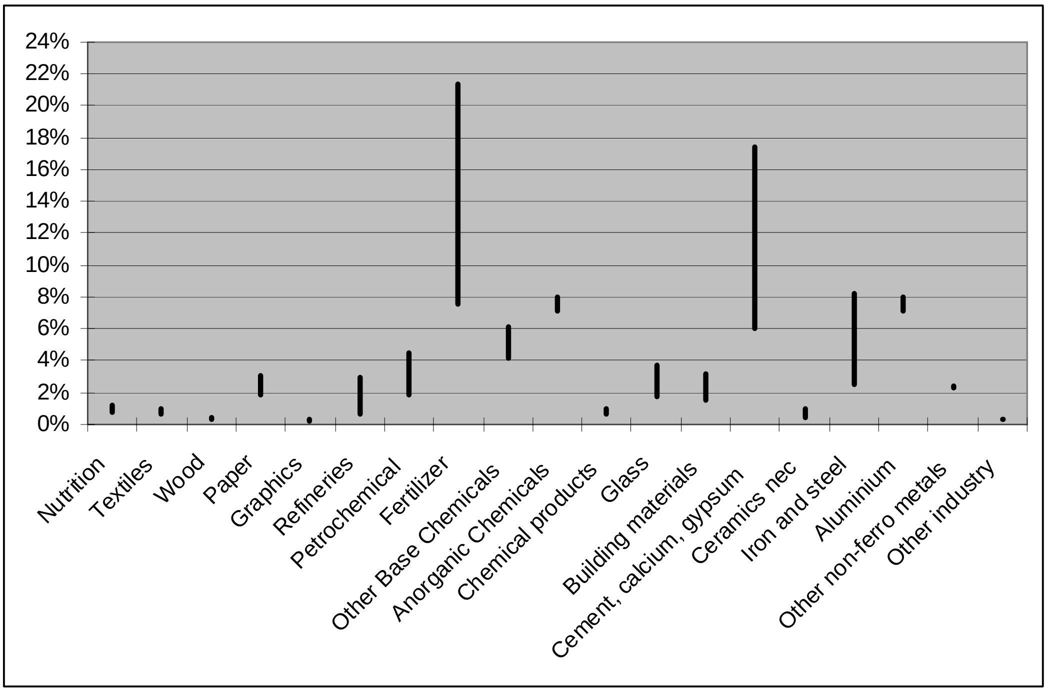


3.3.4 Potential cost price increase presented as value at stake

In the literature (i.e. Climate Strategies, 2007) a preference has been expressed for using the value at stake concept as an indication of the effects of EU ETS. In the Netherlands this is not possible with statistical data as sectoral value added is only available at the 2-digit level from CBS. In addition to this practical concern, we also believe that the potential cost price increase gives a better approximation of the effects on profit margins, as outlined in paragraph 2.3.3, which are indicative for the effects on competitiveness.

Although we have no data on value added available for the subdivision within the chemical, building materials and base metal industries, one may calculate provisionary data using the assumption that the ratio of value added to sales is similar within the subsectors. Using this assumption, we can calculate provisionary the value at stake and use a similar indicator as in Climate Strategies (2007). The important question here is whether this would alter the conclusion about the sectors that face high potential costs due to EU ETS.

Figure 14 Value at stake using provisionary data on value added, € 20/ton CO_2



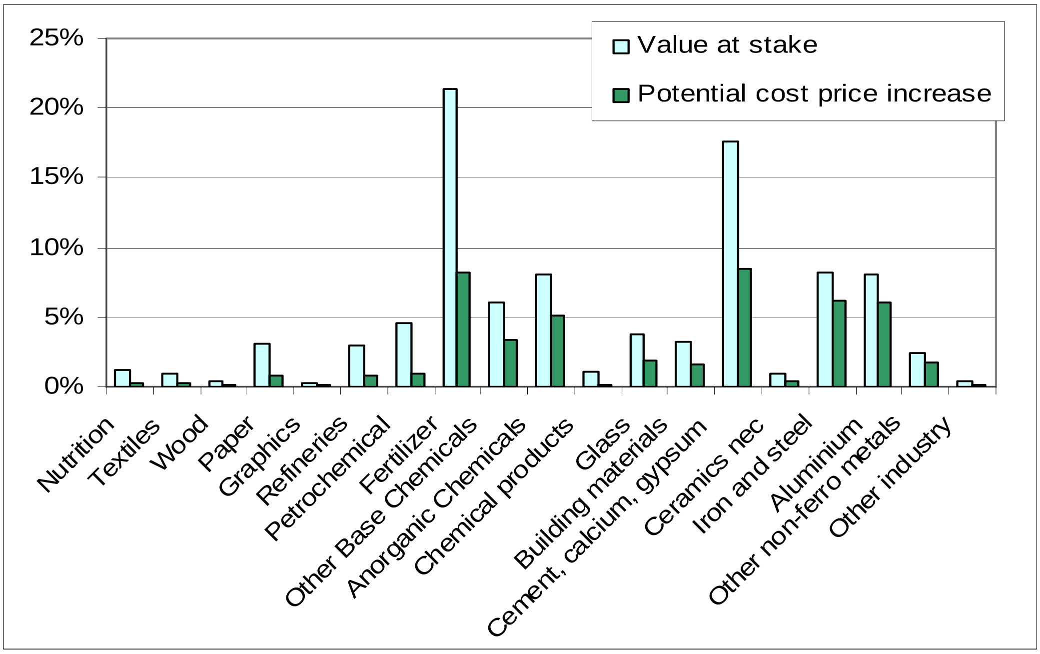
Note: The upper parts present the effects from auctioning, the lower parts from free allocation of rights.

The value at stake is presented here as a range where the upper part indicates the value at stake if the rights are auctioned and the lower part the value at stake if the rights for industry are under the scenario of "partial grandfathering". The difference between both figures shows the additional impact auctioning can have on the value at stake. The value at stake under auctioning is in Climate Strategies (2007) labelled as the "maximum value at stake".

We see here that the maximum value at stake for the fertilizer sector is the largest (over 20%), followed by the cement industry (almost 18%). In addition, various sectors have a value at stake of more than 2%: paper, refineries, petrochemicals, inorganic chemicals, other base- chemicals, glass, building materials, iron and steel, aluminium and other non-ferro metals. Just as under the potential cost price increases, fertilizer, cement and iron and steel face the largest impacts if rights will be fully auctioned instead of being grandfathered.

Figure 15 compares the results of the value at stake indicator with the potential cost price indicator for auctioning.

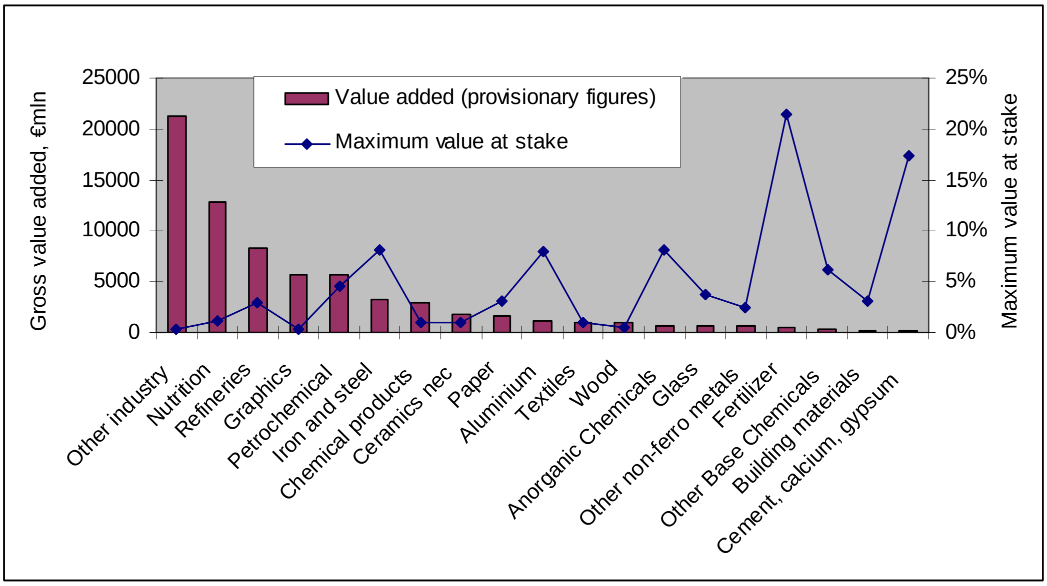
Figure 15 Value at stake and potential cost price increase as percentages, full auctioning, € 20/ton CO_2



The value at stake concept gives higher values than the potential cost price increase in all cases, but the differences are especially large for paper, refineries, petrochemicals, fertilizer and cement. Hence an analysis into the 'value at stake' tends to give preferential treatment to these sectors. These sectors typically add relatively little value to their costs - partly because they are labour extensive. For the base metal sector the differences are among the smallest.

Although the value at stake is difficult to relate to an estimated impact on profit margins (which matter for competitiveness), there is one advantage which is related to the possibility of relating this to some extent to the concept of total value added of which GDP is an indicator. Figure 16 gives this information for the value at stake due to auctioning.

Figure 16 Maximum value at stake compared with provisionary data on absolute value added of sectors, € 20/ton, 2005



We see here that the sectors which have a high value added tend to have low values at stakes and that the value at stakes becomes more substantial for economic activities which have a low value added. If one would assume that all of the potential cost price increases due to auctioning would be 'lost', the figure would be smaller than 0,3% for the Dutch economy in terms of value added. In reality this is not 'lost' of course. First, the total amount would be smaller because revenues can be recycled and firms can reduce costs by applying abatement technologies. Second, the total amount may be larger if firms close and lose market shares to other companies.

3.3.5 Further sectoral disaggregation

The analysis conducted so far showed large potential cost price increases in some sectors and moderate to small cost price increases in other sectors. However, this does not imply that there are no effects in the sectors for which we did not find a substantial increase in cost prices. The essence of any analysis into competitiveness is that the outcomes very much depend on the chosen level of sector analysis. In general, the less aggregated level of analysis is chosen, the more impacts on the asset value of economic agents can be identified.

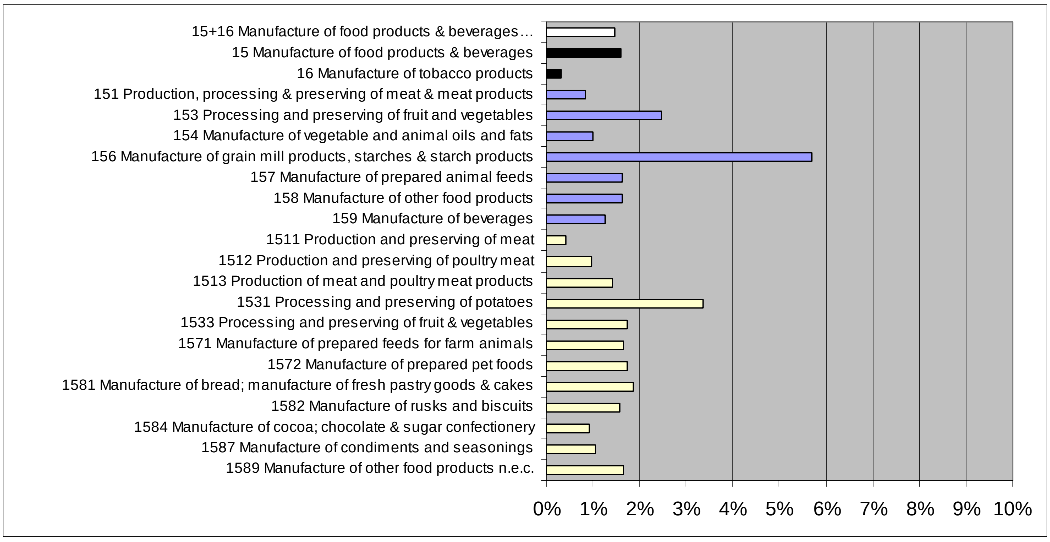
As a matter of fact, our analysis in paragraph 3.2 can underline this. If one analyzes only industry as a whole, the effects seem to be moderate, cumulating to a total impact of 0.3% in the case of grandfathering to 0.6% in the case of auctioning (see the results from paragraph 3.4). However, if we make the sectoral split as we did in this study, several sectors show much higher increases in their potential cost price increase. Of course, this process does not end here. If we could make a further refinement in the sectoral classification, more economic activities could be discovered with a potential impact on competitiveness through a higher potential cost price increase.

However, data availability makes a further refinement in sectoral classifications impossible. Data are often only available at the level of 2 digits, especially for the emissions of CO_2. The question is now: how robust would our results be if we were able to obtain a more detailed level of sectoral classification. For this purpose, one may investigate the proportion of energy costs into the total costs of companies. A high share of energy costs implies that companies are prone to direct and indirect cost price rises due to EU ETS. From CBS, statistics exist that give, for large companies (with over 100 employees) information on energy costs and total costs. This information can be used to indicate whether the present level of analysis has omitted processes with potentially significant impacts from EU ETS.

The question is now whether within these sectors, and especially the food- and paper sectors activities can be singled out that show a high energy costs related to total costs.

Figure 17 shows the results for the food sector. This figure shows that for the sector as a whole (SBI 15+16) the energy costs constitute about 1,5% of the total costs of this sector for large companies. However, if we expand the sectoral subsectors we find that the production of wheat (i.e. sector 156) might show impacts of EU ETS as its share of energy costs is almost four times higher than that of the sector's average.

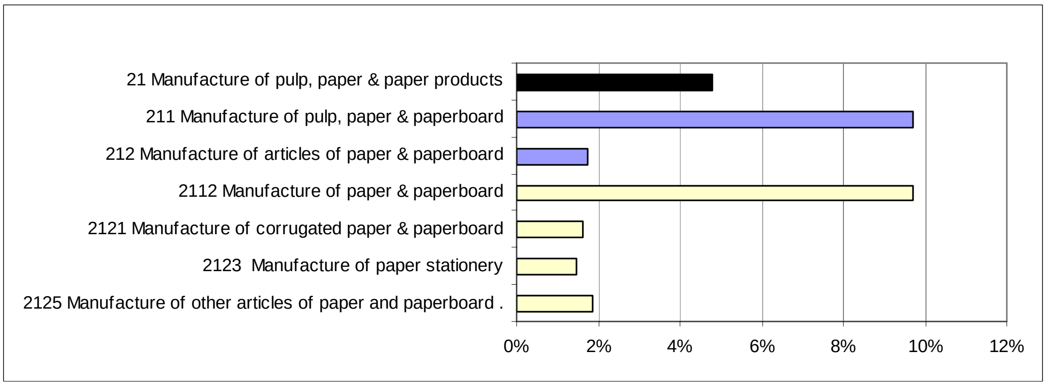
Figure 17 Share of energy costs for subdivisions of the nutrition sector. Only companies >100 employees



It should also be noted here that several subcategories within the nutrition sector (i.e. sugar cane production) could not be included because of data confidentiality. Climate Strategies (2007) showed that in the UK manufacturing of malt, and to a lesser extent sugar, may also be impacted from EU ETS and we would expect that similar results would hold in the Netherlands as well.

Also within the paper sector, some processes are much more energy intensive than the sector's average (see Figure 18).

Figure 18 Energy costs relative to total costs for subdivisions within the paper sector. Large companies only.

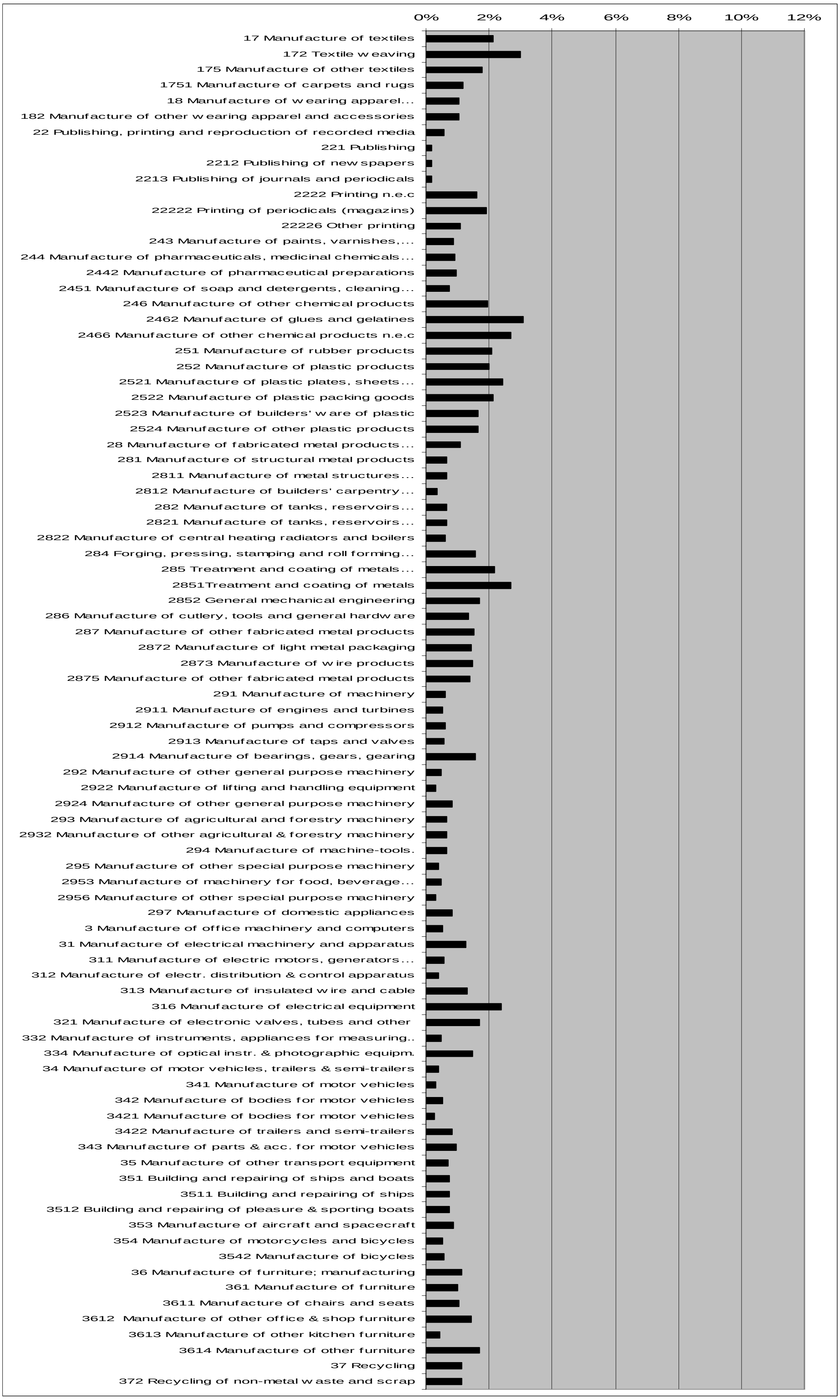


This shows that the percentage of energy costs for the sector 2112 (making of paper and cardboard) are more than double than that for the sector as a whole. Hence, the potential cost price increases for the paper sector (SBI 21) will surely underestimate the potential cost price increases for the subsector 2112[24].

Figure 19 gives the results for the other, not yet elaborated, sectors of the Dutch economy. This figure shows that for the remaining sectors, given the availability of data from CBS, no other production processes could be discovered that have high energy costs relative to their total costs (i.e. over 3%). Therefore, one could expect that within the rest of the economy, no effects from inclusion into EU ETS (or the additional costs of climate change policies) can be expected.

24 A very preliminary analysis showed that the potential cost price increases might be a factor 3 larger than indicated in paragraph 3.4, both for auctioning and grandfathering.

Figure 19 Energy costs relative to total sector's costs. Large companies (>100 employees) only



3.3.6 An analysis of products instead of sectors

The present analysis is valid at the level of sectors. We have chosen "sectors" as an entity in this study mainly for reasons of data availability.[25] However, for some sectors one could make a different type of analysis on the level of products. This is only the case if the product is very homogenous and is made in a single installation that does not produce other products. Such criteria would apply to aluminium, steel, zinc, cement and some products from the chemical industries (e.g. chlor, phosphor).

For one product, aluminium, we conducted an additional analysis on the level of the product "primary aluminium" in order to outline the consequences of taking the product level as entity in the analysis. Primary aluminium production in the Netherlands equaled 333,800 tonnes in 2005, according to BGS (2008). Primary aluminium production is very electricity intensive (15 MWh per ton of aluminium)[26]. Hence, total energy requirement in the Netherlands would be about 5,000 GWh in 2005. Calculating with an energy price increase of €14,3/MWh, one arrives at a total price increase for the production of primary aluminium equivalent to almost € 72 million. In addition aluminium production causes about 0,6 Mton direct CO_2 emissions. With an emission trading price of €20/ton CO_2 this would imply additional costs of € 12 million if these installations would face additional climate change policies. Hence, total costs would be equivalent to € 84 million. For each ton of aluminium this implies a cost price increase of € 250.

This figure could be related to the cost price in order to derive at an indicator for the cost price increases but unfortunately we do not know the total costs of primary aluminium production alone. Only two primary aluminium smelters exist in the Netherlands but the Dutch Statistical Office counts 60 companies in the category 2,742 in the Netherlands which include production of aluminium powder and foils and recycling activities. A more logical alternative if working with products is to relate the additional costs to the product prices. This would give an indication of the product price increases if all costs were to be passed on to the customers.

From BGS (2008) we see that aluminium prices at the LME have risen sharply during 2005. The average sales price of primary aluminium (cash buyer) would be near $1,800 per ton. Taking an average exchange rate of € 0.82 for one dollar in 2005, this implies that the average sales price was € 1,475 in 2005. We can now relate the additional cost price increase to the product price to figure out that the total price increase of the *product* primary aluminium is 17%.

This figure of 17% of course sharply contrasts with the figure presented earlier in this chapter of an additional cost price increase of aluminium in the case of auctioning of 6%. The only difference here is that the sector 'aluminium production' (2742) includes secondary aluminium production and a number of enterprises that deal with the production of aluminium powder, aluminium foils, etc. While these companies have minor CO_2 emissions, they do have costs of production that are

[25] In addition one may point at the fact that many companies are vertically integrated and that they often produce more than one product but are also involved in later stages of the product cycle.

[26] Notice that secondary aluminium would require only five percent of this amount (McKinsey, 2006).

included in the total costs of the sector. As the cost price increase is the additional costs due to EU-ETS over the total costs of a sector, the figures are in absolute terms much lower if sectors are taken as an entity in the analysis than products.

3.4 Conclusions

This chapter has elaborated the cost price increase for sectors of the Dutch industry. It was shown that under partial grandfathering two sectors face relatively large potential cost price increases: aluminium (+5,3%) and inorganic chemicals (+4,5%) due to high electricity consumption of these two sectors. Also the iron and steel industry, cement, fertilizer, other non-ferro and other base chemicals face potential cost price increases near and above the 2%. For the other sectors no substantial effect could be detected at this level of sector aggregation.

If the rights would be auctioned, and revenues would not be recycled to the sectors themselves, cost increases are much larger. Especially fertilizer, cement and iron and steel would be confronted with higher potential cost price increases than under free allocation. For the aluminium sector and inorganic chemicals, the impact of auctioning compared to free allocation would be small. The higher potential cost price increases due to auctioning can be lower if revenues from this auction would be recycled to industry. Chapter 5 will elaborate the possibilities for recycling the revenues and other mitigation options.

The potential cost price increases tend to be somewhat lower if corrected for the technical measures that sectors can take to reduce emissions. However, this does not fundamentally alter the analysis conducted here as the majority of technical measures are primarily found in the fertilizer and iron and steel industries and they relate to technical measures that are not operational yet but should, according to ECN/MNP become available by 2020.

At the level of the national economy, the total direct costs of EU ETS would be 0,2% of GDP for an emission price of € 20 per ton CO_2. If emission prices would double to € 50, the direct costs would be 0,4% of GDP. Under these prices several sectors would face relatively high potential cost price increases. In general one could say that the sectors facing the highest potential cost price increases are the sectors with the lowest value added to the Dutch economy - except for the iron and steel industries. This would imply that auctioning, from a macroeconomic perspective, probably has a small impact compared to grandfathering but such effects should finally be revealed with economic modelling.

The results from this analysis typically depend on the level of sector aggregation. Some production processes in the food industries and the paper industries will face higher costs than was revealed in the present analysis and could be elaborated in future research.

4 Cost pass through and net cost price increase

4.1 Outline

Some portion of the potential cost price increase resulting from EU ETS will be passed on in the product prices. Although in truly competitive markets increases in cost prices should automatically translate into higher product prices, there can be many reasons why a strict application of this principle is undesirable from the perspective of companies.

One of the main criteria here is the amount of competition with suppliers for which carbon has no price, i.e. suppliers from outside the EU. Indeed, Climate Strategies (2007, p12) has stated that 'The biggest single constraint to pass CO_2 related costs on to customers is foreign competition from regions outside the EU ETS region, and the simplest measure of this is the existing degree of trade intensity'. Although we also want to restate the importance of trade intensities in this respect, one should remind that the current trade intensities are by no means an indication for the trade patterns that will evolve when EU ETS is in place and firms apply cost price increases or reduce their profits. For this, an additional analysis of the market structure is required.

This chapter will analyze both trade intensities and market structures for the most exposed sectors. It has the following outline. First in paragraph 4.2 we will outline the methodological approach chosen in this study. Then, in paragraph 4.3 empirical results from our investigation on trade intensities will be presented. In paragraph 4.4 and Annex C the market structure of some sectors facing high potential cost increases will be investigated and the estimated net cost price increases will be given. Paragraph 4.5 contains a qualitative analysis into the possibility for carbon leakage. Conclusions will be presented in paragraph 4.6.

4.2 Framework of analysis

4.2.1 Theoretical framework

The possibility to pass through the additional costs of EU ETS largely depends on the market power firms have. We consider here the relevance of cost pass through for both auctioning and grandfathering.

In the case of auctioning, profit margins will be negatively influenced unless sectors could raise prices sufficiently, thereby passing through the additional CO_2 costs to customers. Such a price increase could, however, lead to a fall in demand and market share. Firms face a potential loss of exports and possibly displacement of domestic production by imports due to price differences.

In other words: the possibility to pass through the costs will largely determine the potential of carbon leakage. If companies are able to pass through their costs without a loss in market share, there is no chance of carbon leakage. If, on the other hand, firms cannot pass through the costs without losing a substantial part of the market, the danger of carbon leakage is present.
In the case of free allocation, firms that can pass through the costs will do so as the costs of allowances are considered as ‘opportunity costs’: the amount of money the company could otherwise earn if it made no use of its CO_2 emission allowances. Although the company did not pay for its allowances, it still makes use of them in production, even though it could have used them differently - by selling them. Under normal competitive markets, firms pass these costs on to their customers and earn ‘windfall profits’: an increase in the profitability of the firm because of their pricing strategy. However, firms that are not able to pass through the costs of allowances will, most likely, not be engaged in marginal cost pricing which is possible because their total profits are not affected by free allocation. Such ‘strategic pricing’ can even be rational from the perspective of the firm. Strategic pricing is defined here as temporarily pricing below equilibrium prices in order to achieve a strategic goal. In most of the literature on strategic pricing the goal is driving a competitor out of business, or reducing a new entrant’s expectation of future profits (Milgrom, 1988; OECD, 1989). In this case, the goal would be to stay in business at least until foreign competitors also face climate policy related increases in marginal prices. Strategic prices are lower than marginal costs under perfect competition.

Summarizing, firms that face severe competition from countries where carbon has no price will try to allocate their ETS costs to markets other than the product market. It is hard to imagine that installations would be possible to allocate costs to the labour market, so the most obvious market to allocate costs to would be the capital market. This would mean that companies would forego profits. This can only be sustained if profits are increased in another way. Grandfathering would be one way to sustain profits. Recycling of revenues to, e.g., lower corporate taxes could be an alternative (see Chapter 5).

4.2.2 Empirical framework

The two best indicators for the ability of firms to pass through their costs are:
1 Exposure to international trade.
2 Market power.

These two concepts are related in the sense that limited exposure to international trade can indicate strong market power. The exposure to international trade can be approached by investigating the degree op openness of the Dutch economy. Price differentials from countries where carbon has no price might fuel imports from and restrain exports to other countries. However, it is not only the pure trade intensity that matters in this respect, but rather the trade intensity with countries that do not face higher costs for production of CO_2. Trade within the EU will in general not be affected as all countries have to make arrangements to reduce carbon emissions. Also other countries that have agreed to CO_2 reductions under the Kyoto protocol (e.g. Japan) will have to implement environmental policies which increase the costs of CO_2 intensive production.

The trade intensities in this study have been based on the Eurostat COMEXT data (see Annex B). We have identified three groups of countries:

1 The EU-27.
2 Annex I-countries that have signed and ratified the treaty, or are likely to do so in the future. These are: Belarus, Switzerland, Croatia, Japan, Liechtenstein, Norway, New Zealand, Russia, Turkey and the Ukraine.
3 Annex-I countries that have not signed or ratified the Kyoto Protocol (i.e. United States and Australia) and the rest of the world.

In terms of the Kyoto protocol this implies that only the countries which have not signed the Kyoto protocol can be expected to face a situation where CO_2 still has no cost.

Two indicators can be constructed to represent the degree of exposure to competition, which will be used in paragraph 4.3.:

1 **Export ratio** (= Exports/Production).
   This gives the portion of sales that is being exported.
2 **Import ratio** (= Imports/Apparent consumption).
   To estimate the risk of substitution by imports, we need to know the share of imports from non-EU countries in meeting total domestic demand. To this end, imports are expressed as a percentage of 'apparent consumption'. Apparent consumption is defined as follows:

   apparent consumption = production + imports - exports.

   It is labeled 'apparent' as we do not measure consumption directly but rather indirectly as a balance equation from other statistics[27].

In addition to the trade intensities, market power is also an important aspect. Whether firms are price takers or price makers on the EU market depends on their degree of market power and thus on the market structure. In a fully competitive international market, it would not be possible to adjust prices. However, if markets are specialty markets where only a few suppliers exist, or markets are limited by long-term contracts, possibilities for price making may exist. An analysis into the market structure is in essence an analysis into trade barriers that might exist that justify a price differential between EU and non-EU products. High trade barriers imply that firms can pass through the costs - low trade barriers imply that they will be faced with import substitution. Import substitution in turn causes carbon leakage.

[27] Problems may arise with this concept as additions to stock are mistakenly regarded as consumption. However, as a loose indicator, it may give some information on the structure of the market in the Netherlands.

One important question is how long the situation will last where companies in the EU face costs for meeting climate change targets and companies in other countries are not being faced with additional costs. The analysis conducted here is for the year 2020 which implies that at least until 2020 there will be no advancements in international climate policy. Moreover, as firms take a longer time perspective for investments, the analysis conducted here assumes in essence that until 2030 no other countries except the present Annex-I countries that have signed and ratified the Kyoto protocol will agree upon binding targets for reducing their CO_2 emissions. Hence, the analysis presented here in essence assumes that international climate policy will fail. This is of course a 'worst case scenario' – the likelihood of this scenario falls however outside the scope of this research.

4.3 Trade intensities

4.3.1 Data issues

Annex B describes the trade and production data that have been used in this study in order to calculate the import and export intensities. We have been using detailed statistics on production, import and export of more than 4.500 products. The import and export intensities in this chapter have been based on approximately 70% of total production value. Due to data confidentially we could not establish more accurate figures. Hence the assumption is here that the import and export intensities for the remaining 30% of the production value are similar to the covered 70%. One other issue in this analysis deals with the re-exports through the port of Rotterdam. The Eurostat COMEXT database does not properly correct for re-exports. There are virtually no data available on the amount of re-exports in the COMEXT database. We have constructed here a routine, described in Annex B, which corrects for these re-exports. Hence we speak, below, about 'corrected imports' and 'corrected exports'. The figures used here tend to slightly overestimate the imports and exports when compared to the more aggregated information available at CBS on re-exports[28]. However, as the margin of error is below the 10% we feel some confidence in proceeding with the 'corrected' figures of exports and imports.

[28] For the final analysis this implies that the total costs due to EU ETS tend to be slightly overestimated.

4.3.2 Import and export ratios

Total exports from Dutch industry equalled in 2005 € 280 billion of which an estimated € 120 billion was due to re-exports. Imports of industrial products equalled € 250 billion of which, again € 120 billion was re-exported. The largest share, in terms of monetary values, of both imports and exports is seen in the 'other industry' sectors which accounts for nearly 40% of all corrected imports and exports. Other important sectors are the nutrition sector, the petrochemical industry, the refineries and the chemical products. The other sectors account for less than 15% of the total exports. Figure 20 gives the total share of Dutch industry in exports.

Figure 20 Sectoral shares in corrected exports

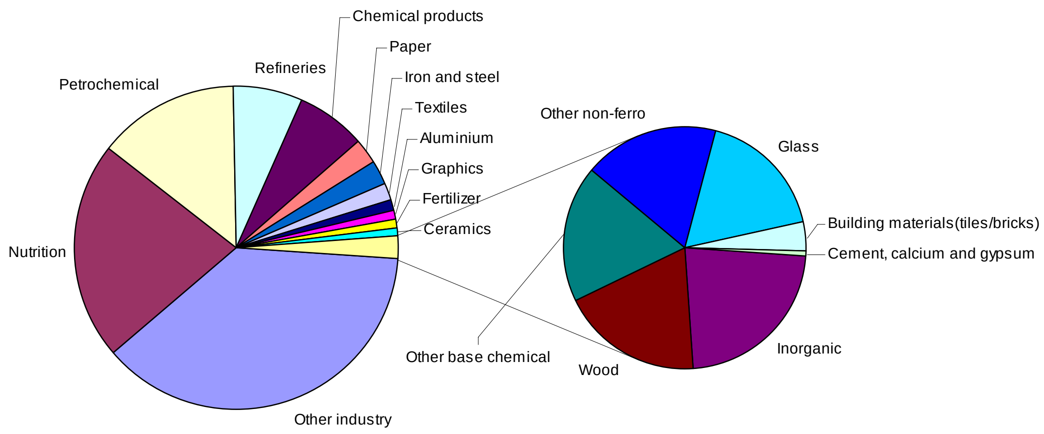
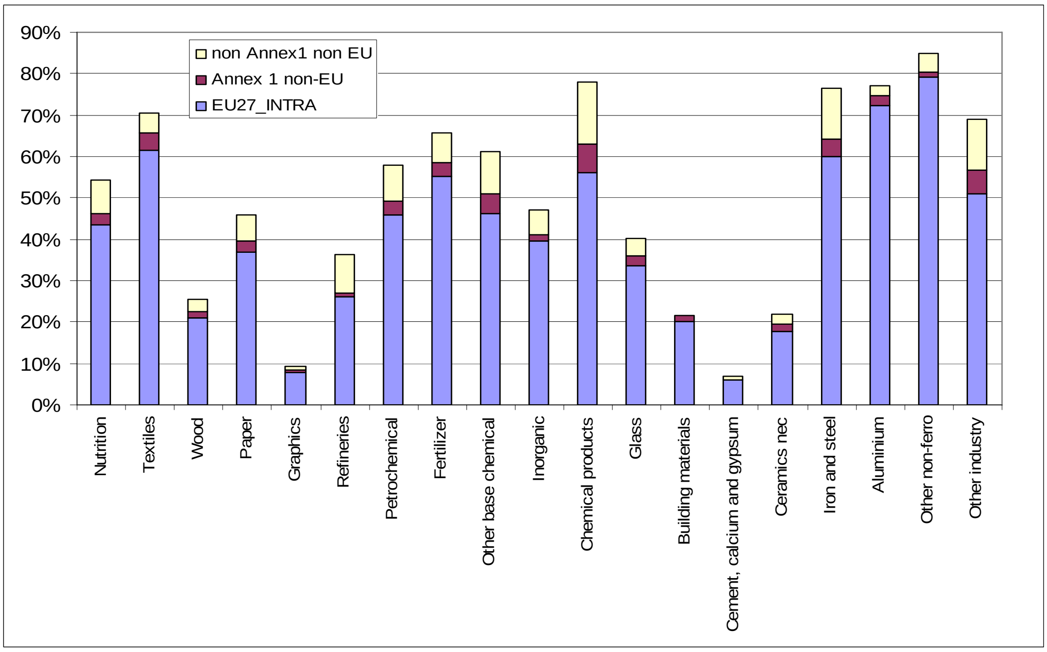


Figure 21 give the export intensity of the Dutch industrial sectors (the export intensity is specified as the ratio of the total corrected value of exports related to the total value of production).

Figure 21 Corrected export intensity of Dutch industrial sectors

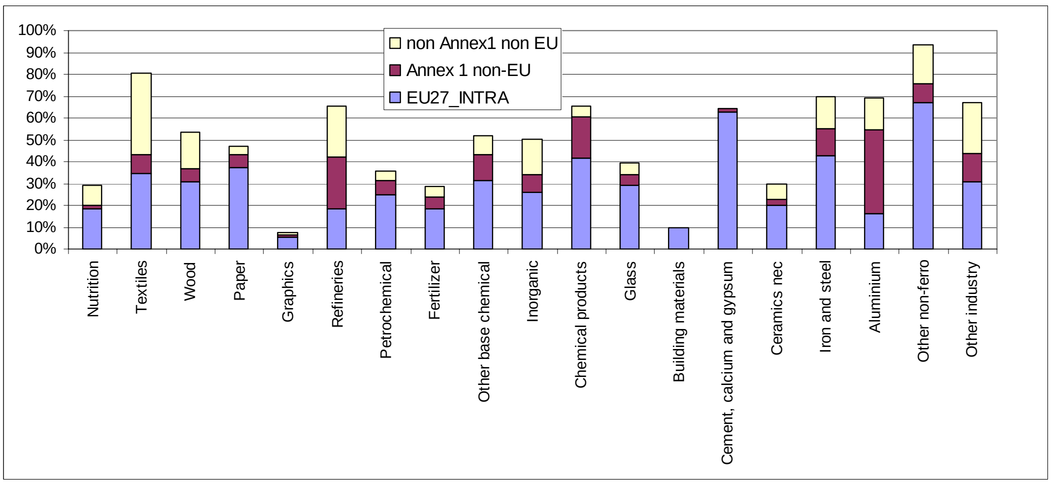


It appears that the base metal sectors (iron and steel, aluminium and other non-ferro) together with the chemical products have the highest share of corrected exports of all Dutch sectors, reaching over 75%. Graphics and cement, calcium and gypsum have the lowest export share, below the 10%. All sectors export mainly to other EU countries.

Chemical products, Iron and steel and the 'other industry' sector also have considerable market shares of exports to non-Annex-I countries.

Figure 22 presents the outcome for the corrected import intensity, defined as the amount of apparent domestic consumption that is served by corrected imports.

Figure 22 Corrected import intensity, 2005



It appears that again the other non-ferro metals group has the highest import share. Textiles, refineries, chemical products, iron and steel and aluminium have high import shares of domestic demand. Only in the case of graphics and building materials the market is predominantly served by domestic producers.

If we investigate the share of corrected imports from non-exposed countries, we see that especially textiles and products from refineries are subject to competition from countries which currently do not face costs for their CO_2 emissions. On the other hand, sectors like cement, building materials and graphics face hardly any competition from countries outside the EU. For cement and building materials this is due to the high transport costs compared to the value of these products.

4.3.3 Interpretation of the results

The trade intensities identified above have some implications for the possibility to pass through the costs. In general, one may assume that the opportunities to pass on the costs are limited in markets dominated by companies from countries that face no costs of reducing CO_2 emissions. Especially China is a good example where it will be very hard to pass on any costs as long as China has not signed binding reduction targets for their industry. The possibilities to pass on the costs in exports to other Annex-I countries may be also quite limited. Of course, this will depend amongst others on (a) the costs that companies in Annex-I countries face of meeting the CO_2 targets of their governments[29], and (b) the market structure. If the market is dominated by imports from non-Annex-I countries, for example, the possibilities to pass on the costs may be quite limited.

The possibility to pass on the costs in the EU market is dependent on a number of factors that characterize the market situation (see Annex D). However, one may assume that for markets in which imports from non-Annex-I countries are currently dominant may show less possibilities for cost-pass through than markets in which imports from these countries are at present insignificant. This also applies for the domestic market. In terms of the analysis presented in the previous paragraph (Figure 22) this implies that one would expect a priori that the cement, building materials and graphics sectors have some possibilities to pass on the costs of climate change measures.

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[29] It should also be noted here that not only the direct costs may matter for companies. The competitiveness of a country that exempts heavy industry from climate change measures but taxes heavily its citizens for reducing CO_2 emissions may in the end be even worse off. Workers will, most likely, try to pass on the costs of meeting their CO_2 targets to the companies by demanding higher wages keeping up with the inflation. If the costs of meeting the CO_2 targets are higher for measures in e.g. the build environment, the total costs for companies may be even higher than for a country in which climate change measures were primarily taken by the business sector.

Table 6 gives an overview of the opportunities to the identified markets:

Table 6 Suggested opportunities to pass through the costs in export markets

Markets in	
Export to Non-Annex-I countries	Very limited possibilities to pass through costs.
Export to Annex-I countries	Possibilities depend on the market structure, the amount of imports from non-Annex-I countries and the costs that companies in Annex-I countries face of meeting the CCP targets of their governments.
Export to other EU countries and domestic markets	Possibilities depend on market structure (amount of imports from non-Annex-I countries).

As the largest share of production of Dutch industry goes to other EU countries and to the domestic market, one may especially be interested in the question whether cost pass through onto these markets would be possible. This will be elaborated below.

4.4 Market structure and cost pass through rates

Based on the analysis of the potential cost price increase of EU ETS (Chapter 3) and the trade intensities, six sectors have been identified in this study for further analysis into the possibilities to pass through the costs on the EU market. These sectors are: aluminium, iron and steel, fertilizers, inorganic chemicals and cement. Refineries were added to this selection because in absolute terms their impacts are large due to the sheer size of the refineries sector in the Netherlands. Finally, the paper sector was selected for a short investigation based on the fact that the current sectoral classification may not be representative for eventual problems in the paper industry (see paragraph 3.3.5). In general, these sectors correspond to the sectors that also have been investigated in other studies in more detail (McKinsey, 2006 and Climate Strategies, 2007).

4.4.1 Cost pass through rates on the EU market

Whether firms are able to pass through CO_2 costs to their customers by raising product prices depends on the level of competition in the markets in which they operate. The pressure from international competition not only depends on production cost differentials between countries, but also on the additional costs that foreign (non-EU) producers face when they bring their products on the European market. Examples are transport costs and import duties. Such costs act as trade barriers and will thus protect domestic markets. Other non-price aspects that might limit international competition are product differentiation, service differentiation and environmental product requirements.

Based on a quick scan of market characteristics, presented in Annex C, we estimated the risk of import substitution in a qualitative manner. It allows us to give some indication of cost pass through opportunities and, subsequently, of the net costs that sectors face due to EU ETS if all rights are being auctioned. The net costs are here identified as the potential cost minus the amount of costs that can be passed through to the customers. One important caveat must be mentioned here: our literature search was based on EU-wide studies into the ability to pass on the costs. Although we corrected for the specific geographical location of the Netherlands with respect to transport costs, we did not correct for a different cost structure of Dutch industry. Dutch industry could have lower or higher marginal costs than EU average. If the costs are higher, the impacts of EU ETS on Dutch industry will be more severe. On the other hand, if the marginal costs are lower, they might be possible to pass on a larger share of costs onto the customers.

Table 7 shows the main conclusions of our analysis. Two scenarios can be distinguished. First, the 'most likely' scenario of cost pass through reveals which situation is most likely to occur. Its definition is based on insights from the existing literature on products markets and trade. In addition, we determined results for the case in which pass through turns out to be lower; the 'worst case' scenario. This pass through rate is rather arbitrarily set at half the most likely scenario, unless results of other studies induced us to take other rates.

Table 7 An estimation of the net cost increases for selected Dutch industrial sectors due to EU ETS on the EU markets under auctioning (CO_2 price = € 20/ton)

Sector	**Net cost price increase (%)**
Fertilizer	
Most likely scenario: 0% cost pass through	8,1
Iron and steel	
Most likely scenario: 50% cost pass through	3,1
Worst case: 6% cost pass through	5,8
Other inorganic chemicals	
Most likely scenario: 50% cost pass through	2,5
Worst case: 25% cost pass through	3,8
Refineries	
Most likely scenario: 75% cost pass through	0,2
Worst case: 25% cost pass through	0,6
Cement	
Most likely scenario: 100% cost pass through	0
Worst case: 50% cost pass through	4,3
Paper	
Most likely scenario: 30% cost pass through	0,6
Worst case: 0% cost pass through	0,8

Table 7 reveals that two of seven evaluated sectors have no or hardly any pass through opportunities:

- *Aluminium:*
  There is overall consensus on the view that European aluminium producers can probably not pass through any of the EU ETS costs. They are highly exposed to foreign competition and seem to have a competitive disadvantage due to higher production costs. This holds particularly for primary aluminium production. The Dutch aluminium sector will be even more affected as its share of primary production in total aluminium production is higher than for the EU as a whole.
- *Fertilizers:*
  Cost pass through opportunities seem to be absent in the fertilizer subsector of the chemical industry. These substances are traded in global markets. They can be relatively easily transported. However, we did not find much empirical evidence and more study into the trade barriers from the fertilizer sector may be required in order to better estimate the cost pass through opportunities.

The other five sectors in Figure 8 seem to be in the position to pass a median to high share of the additional CO_2 costs on to their customers:

- *Iron and steel:*
  The steel industry is expected to be able to pass on a significant share of the CO_2 costs, at a price of € 20/ton CO_2. Trade barriers, among which transport costs in particular, protect the European and Dutch industries from foreign competition (IEA, 2003). At higher carbon prices, pass through might be more limited, especially for the BOF (Basic Oxygen Furnace) subsector. In the Netherlands, nearly all steel production is of the BOF type. However, we notice that the literature greatly diverges when it comes to the possibilities of the steel sector to pass on the prices and therefore we took the 'worst case' scenario from McKinsey (2006) that estimated the pass through-rates, without making clear how they derived these, at about 6% for BOF.
- *Other inorganic chemicals:*
  Although comprehensive and independent research on this sector is unavailable, we found some indication that it can pass through part of their costs. Our rough estimate is 25 to 50%. Imports from non-EU countries appear to be limited since transport of these chemicals is risky and/or expensive. Chlorine is one of the chemicals in this product group and it is used as an example.
- *Refineries:*
  Our analysis revealed that refineries in Europe and the Netherlands are expected to pass through a substantial share, 75%, of the additional CO_2 costs. As long as worldwide production capacity remains tight, they are partly price makers in the EU market. In addition, strict European regulation on sulphur levels in oil help to protect domestic markets. If worldwide production capacity will be enlarged, pass through rates may fall substantially, however, indicating the lower end of 25% for the more pessimistic scenario.

– *Cement:*
  The cement sector might adjust prices to include all of the EU ETS costs. International pressure seems to be limited or even absent at the moment, which is particularly due to high transport costs. The cement industry would face an additional CO_2 cost of maximal 8 Euro per ton, while transport costs for imports from European neighbours are estimated at 12 Euro per ton. This result would not hold for the European cement sector as a whole, since other EU countries face more competition due to their geographical location. A more pessimistic scenario takes account of the possibilities of import substitution and reduced prices on the Dutch cement market. However, such results only hold if the cost structure of the Dutch cement manufacturing is similar to the EU. If marginal costs of production are higher, possibilities to adjust prices will be limited.
– *Paper:*
  Cost pass through opportunities in the Dutch paper industry seem to be present, 30% on average. The production is mainly based on recycled fibre and this production technology has lower costs of meeting carbon targets and probably better opportunities to pass on these costs than the production from virgin materials.

Further information on our sectoral analysis on competitiveness issues is provided in Annex C.

4.4.2 An estimate of the magnitude of the net cost increase

Given the potential cost price increase (Chapter 3), the trade intensities (paragraph 4.3) and the cost pass through rates on the EU market (paragraph 4.4.1) we can now roughly estimate the effect of EU ETS on profits by investigating the *net cost increase* due to EU ETS. This net cost increase shows directly the impact of EU ETS on the profitability of firms and is therefore the best indication of competitiveness this study has to offer.

The cost pass through rates identified above apply to the EU market. In order to arrive at an estimation of the net cost increase we furthermore assume that in exports to non-Annex-I countries none of the costs can be passed through. For the Annex-I countries we, rather arbitrarily, assume in the most likely scenario the cost-pass through rates are similar to that of the EU while in the worst case scenario none of the costs can be passed through. This assumption is of course arbitrary but as the exports to Annex-I countries are very small it does not influence the results substantially.

So far we have conducted the analysis for the whole industrial sector. For reasons of comparability we would like to continue this approach, but the cost pass through rates for sectors not identified above are not known to us. However, one may assume that they will to some extent depend on the current degree of non-EU imports. For these sectors we have set up an arbitrary division of the cost pass through rates according to the two scenarios, as indicated in Table 8.

Table 8 Assumptions for cost pass through rates for other sectors in the EU market

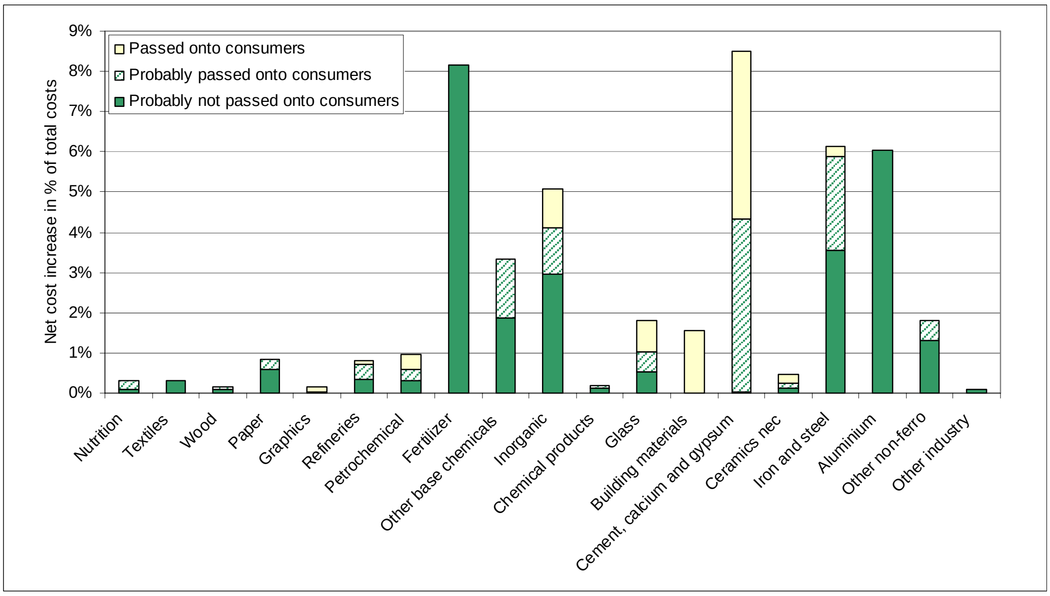
	'Most likely scenario'	'Worst-case scenario'
No cost pass through	If more than 40% of the current market is served by non-EU imports	If more than 20% of the current market is served by non-EU imports
Full cost pass through	If 0% of the current market is served by non-EU imports	If 0% of the current market is served by non-EU imports

By interpolating these assumptions for each sector's trade intensities, one arrives at sector specific rates of passing through the costs. Such would imply that for textiles no cost pass through is possible, even in the most likely scenario, while the building materials sector could pass on most of their costs. This seems rather logical at first glance. Although we admit that this approach is very crude, the potential cost price increases for these other sectors are very small (<2%) under auctioning - with the exception of the other base chemicals (SBI 2411 and 2412). Hence the effects would be small anyway -no matter what assumptions we take here[30].

Figure 23 gives the result of the estimation of the net cost price increases. The height of the bars show the total potential cost price increases if all rights would be auctioned. These figures are similar to Figure 23 in paragraph 3.4.3. The fixed dark (green) bars show the costs that cannot be passed onto consumers for the sectors. The dashed bars show the costs that can be passed onto consumers if the 'most likely' scenario applies. However, if the 'worst-case' scenario would apply these costs cannot be passed onto the consumers. The difference between both scenarios is especially appealing for the cement sector that can only pass through a very limited part of their costs under the worst case scenario - a fact that has more to do with uncertainty in the literature than with a thorough analysis of the cement sector. Finally, the upper part of each bar represents the costs that can be passed onto consumers, even if the 'worst case scenario' would prevail. Cement and inorganic chemicals can pass on part of the costs onto the consumers but a large part of this pass through is uncertain as being dependent on the scenario chosen. We also want to restate here that if emission prices would be larger than € 20/ton CO_2, these sectors will soon be faced with diminishing possibilities to pass on the costs to their consumers. Possibilities to pass on the costs to consumers furthermore exist in the building materials industry, glass production, and to a lesser extent, petrochemicals.

30 We should also bear in mind that the absolute size of the profit margins does not matter here, as only the pass through capabilities are being discussed. If profit margins are currently very small, this does not indicate that there will be no possibilities to pass on the costs as long as all competitors within the EU are being faced with similar cost price increases.

Figure 23 An estimation of the potential cost price increase that can be passed on to consumers under auctioning



This analysis implies that of the total costs increase for Dutch industry due to auctioning, half of it could be passed onto consumers due to higher prices. However, if the worst case scenario would become reality, only about one seventh of the potential cost price increase could be passed onto the consumers.

4.5 A qualitative analysis of the chances for carbon leakage

4.5.1 Introduction

One of the key consequences of a robust, non-uniform climate policy, whether at the national or European level, are so-called ‘spill-over effects’. These effects can manifest themselves cross-sectorally, inter-temporally and interregionally. Interregional spill-over is generally taken to mean the relocation of energy-intensive industrial activities to regions or countries with laxer environmental and climate policies in place. In the literature this particular negative spill-over effect, is usually referred to as ‘carbon leakage’[31]. It means that there is an increase in CO_2 emissions in non-abating countries due to the implementation of climate policy in EU member states through increased import substitution in the EU. Carbon leakage is presumed to undermine the effectiveness of climate policy as well as economic policy.

[31] Positive spillovers, on the other hand, refer especially to the inducement of carbon-saving technological innovations and the diffusion of these innovations, both at home and abroad (MNP, 2004).

4.5.2 Nature and scale of carbon leakage

To understand the scale of carbon leakage it is important to first review, in a general sense, the factors that can potentially influence investment decisions (including choice of location) and the competitiveness of businesses, industries and/or entire sectors. The existence of robust environmental and climate policy in a particular region will not usually be the only reason for companies and their financers to relocate their (energy extensive or energy intensive) operations elsewhere. Other factors of influence include the speed with which a given sector or industry is physically capable of transferring its activities (i.e. their inertia[32]) and the extent to which 'lock-in', 'sunk costs', exceptional synergy (e.g. *economic clusters*) and early write-off of investments are relevant for individual players. Trade barriers, both financial and organisational, might form another reason why firms are unwilling or unable to relocate their activities. In some sectors more than others, ever intensifying global competition is also an issue and, above all, the degree to which this induces companies in a given sector to adapt, relocate or discontinue their activities in a given market.

When it comes to adapting their operations, capital intensive sectors - which are also generally the most energy intensive - are typically characterised by relatively high inertia. This is because they are often constrained by investment cycles spanning several decades, as in the case of power generation, steel and aluminium production and oil and gas recovery, for example. The degree of 'lock-in' in these sectors is therefore comparatively high, certainly in internationally competitive markets for homogeneous products. The 'sunk cost' element of this kind of long-term, capital-intensive investment and the consequently relatively high burden of fixed costs may mean that operating losses (following a price slump due to overheated global production, for example) have to be sustained over prolonged periods.

With regard to the inertia of existing capital stock in individual sectors, Lempert et al. (2002) stress that 'capital has no fixed cycle'. By this they mean that the service life of capacity that is environmentally 'antiquated', say, can generally be extended through reinvestment. Concerning current capital stock Lempert et al. (2002) state that the anticipated lifetime of a production plant is not often a significant driver of plant closure, in the absence of robust (environmental/ climate) policy and market incentives, at any rate. In the European situation the inertia of the existing stock of capital goods in the energy sector is an important issue for policymakers, as this may represent an obstacle to new investments. For effective policymaking it is crucial that we come to understand the specific microeconomic 'tipping points' at which investors become likely to close old plant and/or make new investments. However, research into these tipping points is often quite suggestive and almost never empirical.

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32 The tendency of companies to remain where they are despite any advantages a new location may offer, often because of the huge amounts of capital and real estate invested in the buildings. The drawbacks of staying at the old location are thus seen as 'taking the rough with the smooth'.

On a more general level, there has been little empirical evidence so far supporting the view that environmental regulations have caused carbon leakage. For example, in an ex-post study, MNP (2004) found a weak statistical relationship between environmental policy and the relocation behaviour of firms. IEA (2008) found no statistical evidence that CO_2 prices have induced carbon leakage in the aluminium sector through changes in trade patterns (import penetration). However, this conclusion is based on existing regulations that have, so far, imposed only minor environmental costs to firms. The question is therefore whether this conclusion holds for future policies as well with much larger cost increases. In some CO_2 intensive sectors, the climate agenda may generate much higher environmental constraints than existing ones (OECD, 2005b). There is a chance that future environmental policies imply a break in time series. Therefore we can almost only look at studies that have modelled such policies ex-ante.

A number of multiregional models have been used to estimate carbon leakage rates. Outcomes in the 1990s ranged from close to 0% to 70%, but in subsequent years some reduction in this variance has occurred in the range 5%-20% (Hourcade and Shukla, 2001). Although these figures may be perceived as relatively large in terms of economy and employment, one should be cautious to conclude that 20% of the jobs in industry are at stake. Impacts on the national economy tend to be much smaller or even negligible as long as all production factors are fully utilized. Carbon leakage would, in economic terms, imply a transfer of jobs in energy intensive sectors to jobs in energy extensive sectors. Temporarily unemployment may exist but this will have the effect of dampening the wage demands by workers which, in the end, will be partly beneficial for employment of the economy as a whole. Such analyses are underscored by modelling exercises into the costs of EU wide carbon taxes (CPB, 2002), which has shown that, on average, the total welfare effects are small.

4.5.3 Sectoral analysis

The net cost price increases identified in paragraph 4.4 are already highly uncertain. However, the effect from a reduction in profitability is even more uncertain. It is clear that there is a risk of carbon leakage for the sectors that lose profitability, but this depends on numerous factors as identified above. Although the sectoral analysis in Annex C does contain some observations on the chances for carbon leakage within each sector, we find these results too meagre to include them in the main report.

It is clear, however, that the chance of carbon leakage highly depends on the autonomous development of industry until the year 2020 in the absence of climate change policies. In the aluminium sector, for example, the risk of carbon leakage seems high at first glance. With no ability to pass on CO_2 costs, firms might migrate to countries with no carbon costs. It is, however, crucial to note that EU ETS only seems to accelerate an ongoing process, not causing it. New capacity is already located elsewhere and such is likely to continue in the future.

4.6 Conclusions and discussion

Some of the potential cost price increases may be passed onto consumers. The possibility to pass on the costs to consumers typically depends on the exposure to international trade from suppliers that are not being faced with climate change policies and market power. These in turn depend on various trade barriers. Most of the exports of Dutch industry go to the EU where carbon will have a uniform price. Only the 'chemical products' sector has a relatively large share of corrected exports to non-EU countries. On the domestic market, corrected imports from non-EU countries are relatively large for textiles, products from refineries and aluminium. A sectoral analysis revealed that the sectors that are faced with high potential cost price increases have, in general, not so much possibilities to pass on these costs. This especially applies to aluminium and fertilizer. For iron and steel, inorganic chemicals, refineries and paper, the situation is more mixed. The cement industry should be able to pass on its costs if carbon prices are about € 20/ton. However, if prices rise to € 30/ton, import substitution can be expected if the sector would pass on all of its costs.

If the rights were auctioned, half of the total costs of industry would likely be passed on to the customers. However, if a less optimistic scenario with respect to pass through rates applied, only one seventh of the additional costs of auctioning could be passed on to the customers.

The results of this analysis should be interpreted with great care. First trade statistics are rather unreliable and the analysis here has been based on incomplete and corrected trade figures. Second, the cost-pass through rates have been taken from the literature for other countries. There exists almost no empirical evidence on the possibilities to pass on the costs due to high costs of environmental regulation. Hence, much of the literature takes an ex-ante perspective or uses models that are based on the current cost structure. But in the end, this cost structure itself may change due to environmental regulation. For example, Porter and van der Linde (1995) have hypothesized that environmental regulation would actually stimulate innovation thereby altering the cost structure of firms to more competitive levels. They claim that companies have imperfect information about their possibilities to save costs and lack attention to realize such cost-savings. Environmental regulation may capitalize these savings and thereby improving the competitiveness of the firm. This fact is underlined by the cost data on energy saving measures that generally assume that firms leave cost-effective options to reduce energy aside. In that case, environmental regulation may indeed stimulate competitiveness and lower cost increases can be expected than shown in the present study. Summarizing, the net cost increases established here could be overly pessimistic. However, there is virtually no way to reveal the truth in this respect.

5 Compensations mechanisms

5.1 Introduction

The European Commission proposes to auction allowances as the principle mechanism for initial allocation instead of allocating them for free. The main advantage of auctioning is that emission reduction can be achieved against lower costs than in the case of (certain types of) free allocation. A related advantage is that eventual windfall profits, which imply a transfer of money from citizens to industry, are skimmed off. However, as many non-EU countries do not have emission reduction targets (yet), these advantages come at a price. Installations in the EU might lose competitiveness relative to their competitors in non-EU countries, as the former see their costs rise whereas the others do not.

The loss of competitiveness can be remedied by several means. This section explores the advantages and disadvantages of three options:

1. Free allocation based on a benchmark - the remedy proposed by the Commission (par. 5.2).
2. Border tax adjustment - a solution advocated amongst others by the French government (par. 5.3). and
3. Recycling of the revenues back to the industry (par 5.4).

Each of these options is described in a separate section below. The effect of recycling of revenues back to the industry through various schemes will also be empirically estimated in paragraph 5.4.

5.2 Free allocation

The Commission proposes free allocation of emission rights as a mean to alleviate the impacts on competitiveness of firms. They propose a system of free allocation of rights based on fixed benchmarks for the sectors that are being faced with severe impacts on their competitiveness. In paragraph 5.2.1 we will shortly elaborate the theoretical and practical consequences of this allocation mechanism and compare it with some alternatives that - in our view - should not be chosen as they hamper efficiency in the EU ETS even more.

5.2.1 Free allocation based on fixed benchmarks

With free allocation based on fixed benchmarks, companies receive emission allowances free of charge on the basis of some performance standards or *benchmarks*. These benchmarks may be output benchmarks, such as units of products (e.g. the amount of CO_2 per ton of steel) and are fixed at the beginning of the trading period (i.e. 2012). As long as the commission forces companies to hand in their emission rights in case of closure, they do not represent an opportunity cost to companies in the long-run. However, in the short-run the freely allocated rights will present an opportunity costs for the companies: they can decide to reduce output and still receive the emission rights for free on the basis of historical data on production and the benchmark.

The closure rule introduces inefficiency in the system as companies can only consider taking technical measures for reducing emissions. If the companies could sell their rights, they might easier chose to quite operations and sell the emission rights on the market. For a closed economy, it is more efficient if the opportunity costs of the rights are passed on in the product prices and consumers take the full costs of carbon into account in their purchasing decisions. However, in an open economy this greater deal of efficiency comes at the price of impacts on competitiveness and carbon leakage. Therefore, free allocation based on fixed benchmarks with the closure rule seems a fair way of reducing impacts on competitiveness while at the same time minimizing the loss of efficiency.

There are two major practical hurdles to take when opting for free allocation on the basis of a benchmark. First, sectors that are exposed to international competition have to be identified. There will most likely not be a clear distinction between sectors that are exposed to and sectors that are sheltered from international competition. Rather, there will be an almost continuous spectrum of sectors. This implies that the identification of sectors will always be arbitrary.

Second, for these sectors, benchmarks have to be developed. This is by no means a trivial issue. Hardly any sector, if at all, has uniform products and processes. Where products and processes differ, installations vary in emissions per unit of output. This means that any benchmark will have distributional impacts in which some installations receive more allowances relative to their need, and others receive relatively less. This issue has been demonstrated in the case of aviation, the first sector where the European Commission has proposed a specific benchmark. Aviation is a sector with a uniform product (transporting passengers and freight) but with a variety in business models (short haul flights only or also long haul, quality aspects such as business and first class, specialized in freight, passengers or both, et cetera). In this case, it has been demonstrated that it is impossible to design a benchmark that is neutral with respect to business models (MMU/CE, 2007). And the distributional impact can be rather large with some benchmarks. This means that designing a benchmark is not a purely technical exercise but has important implication on the competitiveness of individual firms as well.

In addition to the practical hurdles, policy makers face the trade-off between equity and efficiency in developing benchmarks. This is most clearly illustrated in the case of the electricity sector, even though this sector would not be considered for free allocation in the Commissions proposal. One could either develop one benchmark for the entire electricity sector, e.g. CO_2 emissions per kWh produced. This would incentivise fuel switching as a way to lower emissions, but it could be considered unfair to operators that have invested in coal fired power plants before the ETS had been introduced, as they face a decrease of the value of their assets. This inequity could only be solved by developing several benchmarks for coal fired plants, gas fired plans and oil fired plants, but this would have the disadvantage of

ruling out the option of fuel switch to lower emissions, which would reduce efficiency.
In sum, free allocation on the basis of benchmarks has the advantage that the negative impact of the EU ETS on the competitiveness of installations under the system is lowered relative to full auctioning. The competitiveness will still be negatively affected, however, but to a lesser extent (due to the costs of reducing emissions and the indirect price increases from electricity generation). The identification of sectors that will be eligible for free allocation on the basis of a benchmark will be arbitrary to a degree. Any benchmark will have distributional impacts in the sector, allocating relatively more allowances to some installations than to others because of small differences in products and processes.
The Commission therefore rightly proposes that allocation will not be based on updated historical emissions.

5.2.2 Free allocation based on updated benchmarks

Although the Commission proposes free allocation on the basis of fixed benchmarks for the post-2012 EU ETS we briefly consider here what would happen if in the end an alternative allocation mechanism would be chosen. A clear alternative is to allocate the emission rights on the basis of an updated benchmark. Companies may find it fairer to periodically update the benchmarks, especially if technological improvements make the older benchmarks outdated. If the Commission would periodically update the benchmarks, opportunity benefits from production growth will be introduced into the system. The result is that although the marginal production costs are *increased* by the emission allowances one requires for production (opportunity costs), the marginal production costs are simultaneously *decreased* by the emission allowances one earns by production according to the benchmark (opportunity benefits). Hence total production will be larger than in the case of allocation through fixed benchmarks and the costs of an emission allowance will rise. This allocation mechanism in essence implies a transfer of welfare from the non-exposed sectors (which fall under auctioning and are being faced with higher emission prices) to the exposed sectors. As the non-exposed sectors will pass on the costs of EU ETS, it boils down to a transfer from consumers to the exposed energy intensive industry.

5.2.3 Free allocation based on updated historical emissions

Most countries have used in the first and second trading period of EU ETS a scheme in which the rights are distributed on the basis of (updated) historical emissions. Like in the case of updated benchmarks, inefficiency is introduced to the system as production is implicitly subsidized due to the updated reference period. However, firms have now also fewer incentives to apply technical and operational measures to reduce emissions, as doing so will be penalized by given them less allowances in the next period. Hence the total costs of EU ETS will be larger and emission prices will be higher compared to the other allocation mechanisms. Again, this would imply a transfer from the non-exposed sectors to the exposed sectors.

5.3 Border tax adjustments

Border tax adjustments (BTA) can most efficiently be applied if all rights would be auctioned as a mean to alleviate the impacts on competitiveness. An efficient system of border tax adjustments consist of a combination of export subsidies and import tariffs. Companies from EU countries which export to other countries get a refund for the costs of CO_2 allowances they incurred during production according to a benchmark, e.g. the CO_2 emitted to produce the product according to the best available technology. A charge is imposed on imported products from non-EU countries according to the same benchmark.

In the case of border tax adjustments according to a benchmark, the working is the same as free allocation of allowances on the basis of a benchmark, except for the important fact that the working is refined to production for the exports and imports only. Production by the exposed sectors for the internal market is *not* subsidized but companies can now pass on the costs of allowances into their prices. Therefore, border tax adjustments are more efficient than benchmarking: it confines the potential inefficiency to the smallest share of total production.

5.3.1 Jurisdictional issues

Border tax adjustments raise juridical questions. It has sometimes been argued that border tax adjustments are not permissible under GATT and WTO rules, because it is not possible to discriminate on the basis of production processes.

Ismer and Neuhoff (2007) agree with this point in principle, but conclude that a border tax adjustment need not violate GATT and WTO rules provided that the export subsidy and import levies are not related to the actual CO_2 emissions in the production process, but to the CO_2 emissions in a best available technology. In this case, best available technology should be defined as minimal emissions per unit of output. A levy based on best available technology would not discriminate on the basis of production processes, but treat like products equally. Furthermore, Ismer and Neuhoff (2007) conclude that a BTA could be made compliant with the 'most favoured nation' principle and would certainly not discriminate against foreign produces.

A brief analysis by CE Delft (2007) shows even if a BTA would discriminate on the basis of production processes, this is not necessarily forbidden under WTO rules. Jurisprudence shows that GATT and WTO allow discrimination on the basis of production processes as long as two conditions are met:

- First, the trade barriers imposed must be based on international consensus on environmental problems and policies, preferably laid down in agreements. Arguably, the UNFCCC is such an agreement on climate policy. Its aim is to stabilise 'greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system'. Currently, it has been ratified by 192 countries[33]. So there is an international consensus to reduce greenhouse gas emissions.
- Second, developed nations support developing nations technically and financially to meet the criteria.

From this brief analysis and other papers, we preliminarily conclude that the legal barriers for a BTA are not insurmountable (see e.g. De Cendra, 2006; Ismer and Neuhoff, 2007; Demailly and Quirion, 2007). Especially if the BTA is based on best available technology, rather than on actual emissions, it stands a fair chance of being held up against WTO rules. Clearly, a full analysis can only be made once a BTA has been properly designed.

5.3.2 Practical issues

Border tax adjustments raise practical issues as well. A BTA may be relatively easy to implement if tax adjustments are only levied on products of ETS sectors. In some cases, these products are relatively homogenous (e.g. power, cement, chlorine, gasoline, etc.). However, such a design would only shift the impact on competitiveness to downstream sectors. An example can illustrate this point. Suppose that a BTA is in place for steel. In that case, EU steel producers would not be impacted by their inclusion in the EU ETS. After all, their exports are compensated for the costs associated with CO_2 emissions during production. And their sales in the EU market face competition from outside the EU which has been levied according to the CO_2 emitted during its production. Hence steel prices in the EU would rise. However, a steel using industry, such as car manufacturing, would be negatively impacted. The car manufacturing industry in the EU would need to buy steel for a higher price than a company located outside the EU. Consequently, it would see its competitive position deteriorate. This example shows that a proper border tax adjustment may be required for all imports and exports, even to composite products like cars[34].

Apart from legal and practical considerations, the political consequences of a BTA should be considered. This has two components. First, a system of BTA may increase -in return- the chances of taking protective measures in non-EU countries. The risk of *trade wars* may be increased. Therefore, a global commitment in the

[33] http://Unfccc.int, accessed 7 April 2008.

[34] Since a BTA would be levied on all imports and exports, the materials of which each import and export is made up of should be known. This would put an administrative burden on importers and exporters to declare what their products are made of. The administrative burden would be higher if the level of detail was increased. This would go hand-in-hand with accuracy of emission estimates.

WTO arena on a system of BTA for climate policies seems to be desirable. This may therefore be a lengthy process.
Second, at a time when the EU needs allies in its strive for a global climate policy agreement, could it risk losing some allies from developing countries that could get the impression that the EU limits their exports to the EU? Answering this question is well beyond the scope of this report, but it needs to be considered before implementing a BTA.

In sum, in theory border tax adjustments have significant benefits over free allocation based on benchmarks as an instrument to prevent carbon leakage. It creates less inefficiencies and does not need an arbitrary identification of sectors as being exposed to international competition. Furthermore, BTAs need not have the same distributional impacts as benchmarks. BTAs, if properly designed, probably would not encounter legal difficulties. However, BTAs may impose an administrative burden on both importers and exporters and may give undesired political signals increasing the risk on trade wars.

5.4 Recycling of the revenues from auctioning

Another way to mitigate the impacts on competitiveness would be to recycle the revenues from auctioning to industry. We consider here lowering the labour taxes paid by the company (paragraph 5.4.1), lowering the corporate tax (paragraph 5.4.2) and earmarking the revenues for subsidies of energy saving technology (paragraph 5.4.3). In paragraph 5.4.4 the effects from recycling the revenues will be empirically estimated.

5.4.1 Lowering labour taxes paid by the companies

In this case, the revenues of auctioned allowances are recycled, e.g. through lowering labour taxes - for example to lower the contribution employers pay for social security (e.g. the ‘*werkgeversdeel sociale zekerheid*’). There are two basic ways to implement this option. The first option is to recycle the revenues through an economy wide lowering of income (labour) taxes. This will probably hardly help the exposed sectors, however, since the exposed sectors are generally capital intensive and labour extensive. Therefore, the exposed sectors will receive much less from the rebate than they contributed with their auctioning. Hence, this option in essence implies redistribution from welfare of the energy intensive sectors to the other sectors of the economy.

The second option is to recycle the revenues to the exposed sectors in particular. Such a lowering of labour taxes for specific companies will probably be considered by the WTO as a forbidden form of state aid and is therefore not further considered here.

5.4.2 Lowering the corporate tax

Next to labour taxes, auction revenues can also be recycled by lowering corporate taxes. This option will lower average production costs. Whether or not recycling auction revenues through a decrease of corporate taxes alleviates the risk of carbon leakage in the exposed sectors depends on the amount of corporate taxes these sectors pay. If currently the tax is high compared to revenue, a rebate lowers the average cost associated with ETS considerably; if taxes are low, the impact of lower taxes is small. Likewise, when a large share of corporate taxes is paid by exposed sectors or by sectors currently in the EU ETS, the lower taxes will improve the competitiveness of the sectors that are most affected by it. If, however, ETS sectors pay only a small amount of corporate taxes, the benefits of the lower tax rate will accrue to non-ETS sectors.

5.4.3 Subsidies to energy saving measures

Another option to recycle auction revenues is to subsidise energy saving measures. Such a subsidy would result in transfer to sectors implementing these measures, a larger uptake of these measures, and consequently a lower energy use. If these energy saving measures are in the ETS sector, they would result in lower allowance prices, since the difference between the business as usual development (including energy saving measures) and the cap would decrease.

Subsidizing energy saving measures in the ETS sectors would obviously reduce the efficiency of the market as it can be considered as an implicit subsidy on energy use. But the advantage is that the subsidies are better targeted to the sectors that are most exposed to the risk of carbon leakage. As a result, the risk of carbon leakage could be reduced in two ways. First, the price of allowances would be decreased, resulting in a lower increase in marginal costs for all sectors. Second, the average costs in energy intensive sectors would be lowered. The latter would allow companies to engage in strategic pricing, i.e. price their products below marginal costs, without affecting their profit margin.

Currently, Dutch subsidies to energy saving investments (EIA and VAMIL) are designed as rebates in corporate tax. However, since energy intensive sectors pay relatively small amount of corporate taxes, there may be a limit to how much of the revenues can be recycled in this way. Alternatively, one could restructure energy saving investments to normal subsidies or set up a fund which could tender subsidies and award the subsidies to parties that have the most cost-effective measures. However, in such a system the aims of compensating specific sectors and maximizing cost effectiveness are logically be opposed and administrative costs are surely larger than in the case of a reduction in corporate taxes or labour taxes.

5.4.4 A quantitative estimation of the effects of recycling revenues

Each of the three options to mitigate the risk of carbon leakage through recycling of revenues have been analysed quantitatively.

1. Recycling the auction revenue through lower labour taxes.
2. Recycling the auction revenue through lower corporate taxes.
3. Recycling the auction revenue through higher energy subsidies.

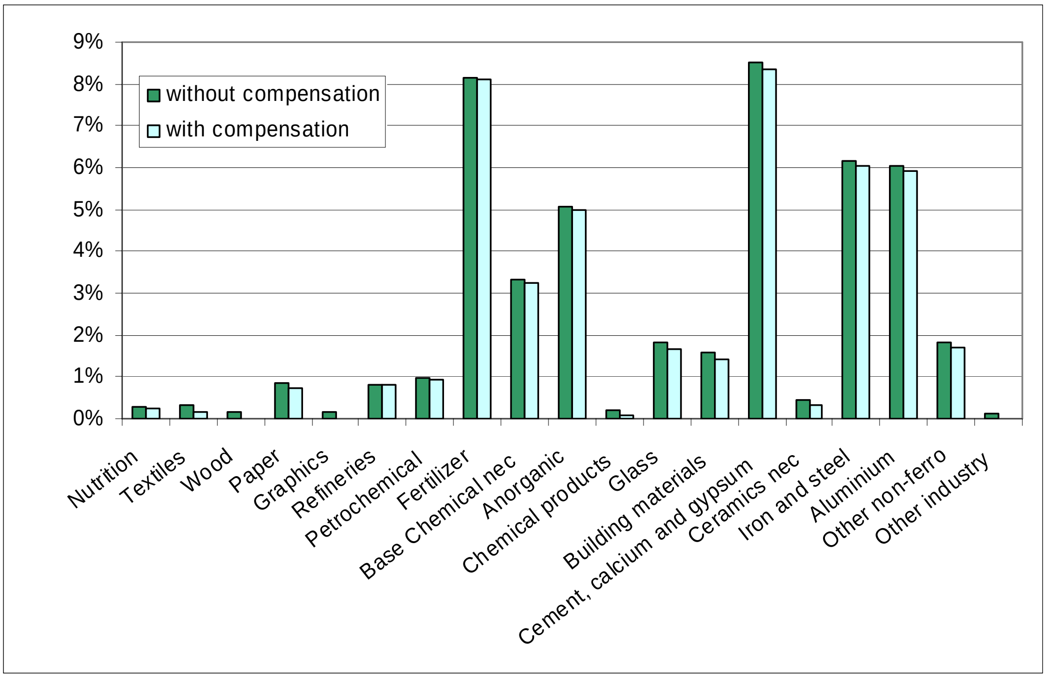
These estimates are necessarily crude as they include only direct effects. The impact that recycling of ETS revenues might have on firms' behaviour or on prices is not taken into account. The labour taxes, corporate taxes and energy subsidies have also not been modelled for their specific tariffs. Instead, the recycling is modelled as a reduction on the amount of employees' contribution to social security funds and a reduction in the amount corporate taxes companies pay currently. In the case of subsidies on energy investments we have assumed that sectors will receive a complete reduction on the additional net costs for their investments on energy reduction up to € 50/ton CO_2.

The total revenues from auctioning the rights were estimated at about 1,5 billion of Euros annually. The auction revenues used for recycling is assumed to be 80% of the total revenue as the current proposal suggest that 20% of the revenues could be earmarked for a number of other issues. Furthermore we have assumed that also the revenues from auctioning in the electricity production sector are used to compensate industry. As households also consume electricity and are being confronted with higher prices, the analysis assumes here that some transfer of income from households to business takes place. We explicitly state here that we did not do this because we think that such a transfer is necessary but to investigate the maximum possible compensation for companies.

Another assumption underlying the calculations here is that it will not be possible to recycle revenues to industry alone in the case of reductions in labour taxes and corporate taxes. Hence all agents paying labour and corporate taxes will profit from the reduction.

Figure 24 gives the results from a reduction of the tariff of the labour tax. Of the whole reduction of labour taxes, industry would receive about € 220 million. Comparing these with the additional costs of auctioning (€ 1,4 billion) one can conclude that this recycling option only partially compensates industry. Moreover, from Figure 24 it comes clear that the sectors facing the highest cost increases are almost not compensated by lowering the labour taxes. The sectors wood, graphics and other industry would be more than compensated for their increase in costs due to climate policies.

Figure 24 Effects from a reduction in labour taxes paid by the companies, auctioning, € 20/ton



The effects on the corporate tax are given in Figure 25. For industry as a total, € 310 million is now recycled. If you assume that on average firms have to pay 23% corporate tax, revenue recycling then would lead to a decline of the tariff by approximately 1.8 percentage points. Although the effects are somewhat larger they are still very minimal for sectors facing the highest cost increases.

Figure 25 Effects from a reduction in corporate taxes paid by the companies, auctioning, € 20/ton

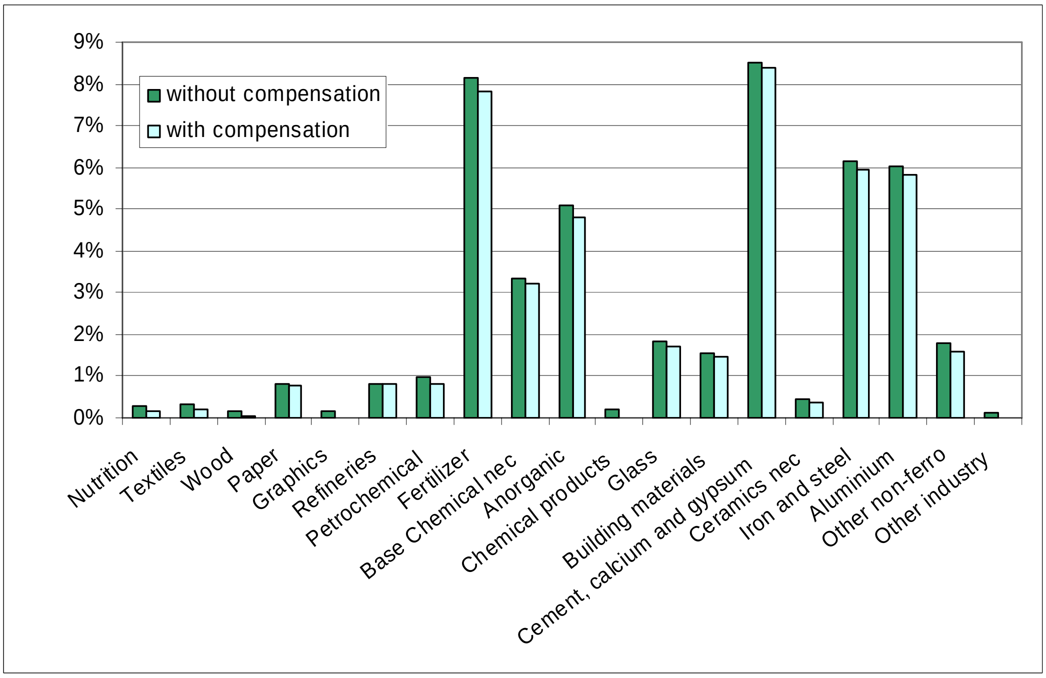
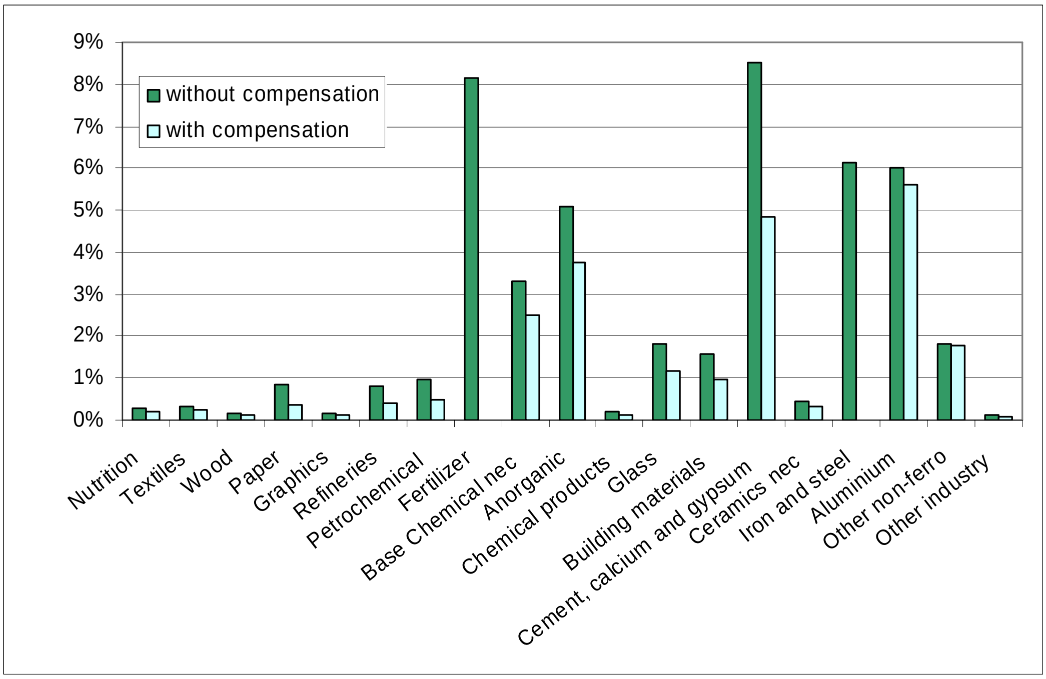


Figure 26 gives finally an indication of the effects from earmarking the revenues through subsidies for energy saving investments. Subsidies for energy saving investments can be applied for industry or for reduction measures outside the industrial sector. We have assumed here that the subsidy scheme fully subsidizes the unprofitable top of every climate measure up to € 50/ton CO_2. Hence the marginal costs of applying such measures to the firm are zero. The consequence is that emissions in industry will be reduced by about 30 Mton. The industrial sectors would receive more than half of the revenues, i.e. € 800 million.

Figure 26 Effects from earmarking revenues from auctioning for energy saving investments reducing the unprofitable top of these investments up to € 50/ton CO_2, auctioning, € 20/ton



At first sight this option reduces the costs of various energy intensive sectors significantly. Cost increases for the fertilizer and iron and steel sector would vanish and cost increases for most other sectors would be between 20-50% lower. Only for the aluminium sector and the other non-ferro sector there would be almost no impact on the cost structure.

We need to emphasize here that such effects have been calculated with a fixed emission price of € 20/ton CO_2. If industry would be able to reduce it's emissions with 30 Mton (for example because carbon capture and storage becomes attractive) the price of a CO_2 allowance would become much lower. This would in turn further lower the costs of emission reduction in industry and power generation. Indirect costs will fall - which in turn would be beneficial for sectors that show little improvements in the Figure above. However, also the revenues from the auction will fall which means that less projects can be subsidized. Finally this will result in a new equilibrium where demand and supply on the emission market are in balance. Such an analysis falls outside the scope of the present study but we would suggest that the analysis here has shown that this might be a route worthwhile investigating in further research.

5.5 Conclusions and discussion

Inclusion of sectors exposed to international competition in the EU ETS dents their competitiveness. There are several remedies to this, but none is perfect. Many practical obstacles have to be overcome before one can decide which strategy is best adopted to satisfy both a high degree efficiency in reducing emissions and to minimize effects on competitiveness of energy intensive sectors. The option considered by the Commission is to allocate the rights for free to industry. Free allocation on the basis of a fixed benchmark still indicates costs for companies, as they will have to reduce emissions in order to meet the targets and are being faced with higher costs of electricity inputs. Such an allocation scheme may solve competitiveness issues for the iron and steel industry, fertilizer and cement industries - as shown in Chapter 3. Also under free allocation these sectors will be suffering from cost price increases but these tend to be a factor 4 smaller than in the case of auctioning. However, for aluminium production and inorganic chemicals free allocation hardly reduces costs as they depend heavily on electricity consumption.

The disadvantage of this system is that there will not be a uniform criterion against which it can be decided if a sector is harmed by auctioning or not. There is indeed a continuous spectrum of smaller to larger effects and this will in the end result in a plea of all sectors to be excluded from auctioning. Free allocation with the closure rule has the disadvantage that production of energy intensive activities will be larger and therefore less efficient than under auctioning. As the targets are fixed, the emission prices are higher with free allocation than under auctioning.

Other options to compensate for the higher costs for industry due to auctioning exist. Revenues of the auction could be recycled to industry. Our analysis showed that recycling is possible through lowering corporate tax or reducing the labour taxes paid by the employer. The exposed sectors, however, hardly profit from this recycling scheme as they employ relatively few people and pay a minority of the corporate taxes. However, recycling of revenues in this way may provide a stimulus for other sectors in the economy that have a higher labour intensity, pay a large share of corporate taxes and are - in general - less polluting.

Recycling of revenues to subsidy schemes for investments in energy savings is, at first sight, more promising in mitigating the effects for energy intensive industries. Our analysis showed that several sectors would be faced with a considerable reduction in costs due to EU ETS. When applied at the EU level this may lower emission prices and have mitigating effects for all sectors that fall under EU ETS. However, efficiency of the whole system would be lower than in the case of auctioning as technical measures to reduce emissions are favoured over reductions in output. In addition the basis of these subsidies has to be altered from a rebate in corporate taxes to a direct subsidy for the unprofitable top of the energy investments.

From a theoretical perspective, the best option would be to set up a system of border tax adjustments and export subsidies to compensate for the higher costs of EU ETS. The effectiveness of such a system would, however, highly depend on the accuracy with which these taxes can be determined and the effects that other countries might undertake when being faced with import restrictions and export subsidies of EU member states. If other countries would take compensating mechanisms in their trade tariffs, the effects could, in the end, be even worse.

Table 9 summarizes the pros and cons of various compensation options to mitigate the adverse effects of EU ETS.

Table 9 Pros and cons of various compensation mechanisms

Compensation mechanism	Pros	Cons
Free allocation of rights (on the basis fixed benchmarks) to exposed sectors.	Easy to implement, low administrative costs, directly targeted at energy intensive industries	Higher prices of EUA due to the fact that production is implicitly subsidized, which implies a net transfer of money from non-exposed sectors to exposed sectors. Free allocation of rights gives no solution for competitiveness impacts in the aluminium and inorganic chemicals sectors that have high electricity consumption.
Border tax adjustments and export subsidies.	No impacts on competitiveness and minimization of net costs of EU ETS.	Risk of compensating measures in other countries when being faced with EU export subsidies and import tariffs, which, in the end, will limit trade and harm competitiveness.
Recycling revenues through labour taxes or corporate tax.	Easy to implement, low administrative costs. Minimizes potential costs of EU ETS and can form an impetus for a less polluting industrial structure.	Almost no effect on the competitiveness of the energy intensive exposed sectors.
Recycling revenues through large scale subsidies on energy saving measures.	Targeted at energy intensive industries and lowering the price of CO_2 rights.	Risk of high administrative costs and risk of being classified as state-aid.

6 Conclusions

6.1 Background of the study

The EU emissions trading scheme was launched in 2005 to cap CO_2 emissions from large industrial facilities. Covering almost half of all EU CO_2 emissions, it forms the centrepiece of European policy on climate change. The Commission is currently designing the post 2012 EU ETS. Novel to this system is that part of the allowances will be auctioned. Auctioning in general assures a greater deal of efficiency compared to (certain types of) free allocation, lowers the administrative costs and prevents eventual windfall profits.

However, auctioning also implies a potential loss of competitiveness for industry as the costs for industry are higher under auctioning than under free allocation of the rights. Especially if no international agreement on future climate policies is reached, firms in the EU are being faced with higher costs which may harm their export position and foster import substitution from non-EU countries where carbon has no price. A change in trade patterns without a change in consumption simply implies no (or a very small) effect on global CO_2 emissions. This phenomenon has been labeled as 'carbon leakage'. For this reason, the Commission has proposed to exempt exposed sectors from auctioning and allocating them rights on the basis of a benchmark. A severe loss of competitiveness is here the main criterion against which it is decided whether sectors will be subject to auctioning or free allocation.

Unfortunately, competitiveness is an ill-defined concept in economics and there is no common methodology for analyzing the effects of higher costs due to environmental regulation. The trade-off between a higher degree of efficiency due to auctioning versus the risk on carbon leakage is most thoughtful addressed with economic modelling. However, most models lack enough detail of the economic activities that might be at stake and have a number of other drawbacks as well. Therefore, partial microeconomic analysis into the effects of higher CO_2 prices has become dominant in the debate on the future design of EU ETS.

The present study has extended this research tradition by offering a partial microeconomic analysis of the costs of future EU ETS. The advantage is a more targeted level of detail than could be arrived with economic modelling. The disadvantage is that the approach focuses on the direct costs of EU ETS only and neglects some benefits or indirect costs to society.

Within this study, competitiveness is interpreted as the additional costs firms face under EU ETS that cannot be covered by higher product prices. These costs, labeled in this study as the ***net cost price increases***, present a loss to the company, which might itself be translated into either a loss of profitability or a loss in market share if the firm tries to keep its profit margins constant. No matter which strategy the firm chooses, in the end the effect will be a less attractive climate for investments, i.e. a loss of competitiveness. The net cost price increase is made up from the ***potential cost price increases*** and deducts from these the costs that may be passed on to the customers. In the end, however, net cost price increases have large margins of error. This is due to the fact that it is very difficult to ex-ante estimate the possibility of firms to pass on the higher costs of EU ETS.

6.2 Main empirical results of this study

The results of this study indicate that the net cost price increases due to EU ETS for several sectors might be substantial. Sectors with the highest cost tend to have the least possibilities to pass through these costs to their customers - at least according to the literature we have investigated in this study. If the rights would be auctioned, aluminium and fertilizers industries would face considerable impacts on their profitability. Other sectors with high (i.e. >2%) potential cost price increases are the inorganic chemicals, other base chemicals iron and steel and cement industries. These sectors might recover part of the potential cost price increase through higher product prices. For cement and iron and steel this may fully depend on the carbon price as transport costs act as the main barrier of entry.

Other impacts may occur for the small subsector ‘other non-ferro metals’ as they face a cost price increase of nearly 2% which probably cannot be passed onto the consumers. The paper industry, refineries and petrochemical industries face lower cost price increases that -to some extent- can be passed onto consumers although the number of studies that have investigated these sectors in more detail are relatively small.

The current literature has indicated that for the most affected industries, risks on carbon leakage are high. Carbon leakage implies no (or a small positive or negative) effect on global CO_2 emissions, only a shift in trade patterns which in turn may influence income and jobs. However, one should bear in mind that the most affected sectors, with the exception of the iron and steel industry, contribute very little to GDP and employment in the Netherlands. Indeed, there seems to be an inverted relationship between the potential cost price increases and the contribution to Dutch GDP of the various sectors.

6.3 Compensation measures

In order to compensate for the adverse effects on competitiveness, the government may choose various compensation options. First option is to allocate the rights for free to industry on the basis of a fixed benchmark, as indicated in the proposals of the Commission. This still results in additional costs for companies, as they will have to reduce emissions in order to meet the targets. Moreover, electricity generation will still be under auctioning and result in higher prices for industry. Free allocation on the basis of a fixed benchmark may solve some competitiveness issues for the iron and steel industry, fertilizer and cement industries. However, for aluminium production and inorganic chemicals grandfathering does hardly reduce costs as these depend heavily on electricity consumption. They could in theory be compensated by giving them free allowances on the basis of their electricity consumption, but this has not been analyzed in the present study.

The precise effects on efficiency of a system of free allocation greatly depend on the details with respect to the basis of allocation and entry/exit conditions. The Commission has proposed to allocate rights on the basis of a fixed benchmark (to be determined in 2012) and apply a closure rule in which companies that quit operations must hand over their freely allocated rights. Such an allocation scheme fares better with respect to allocative efficiency than a system where e.g. benchmarks are periodically updated. A disadvantage is that it may be very difficult to agree upon a common benchmark in every sector and that almost in every benchmark there will be trade-offs between efficiency and equity (e.g. rewarding companies that have improved their production standards prior to EU ETS). Moreover, it will be very difficult to decide which sectors would be granted with free allocation and which sectors would fall under auctioning. Poor decisions may have large consequences here: windfall profits if the sector would wrongly receive the rights for free and a loss in competitiveness if the sector would wrongly be under auctioning.

Other options to compensate for the higher costs for industry due to auctioning exist. Revenues of the auction could be recycled to industry. Our analysis showed that recycling is possible through lowering corporate tax or reducing social security contributions paid by the employer. The energy intensive sectors, however, hardly profit from this recycling scheme as they employ relatively few people and pay a minority of the corporate taxes. However, recycling of revenues in this way may provide a stimulus for other sectors in the economy that have a higher labour intensity, pay a large share of corporate taxes and are - in general - less polluting.

Recycling of revenues to subsidy schemes for investments in energy savings is, at first sight, more promising in mitigating the effects for energy intensive industries. Our analysis showed that several sectors would be faced with a considerable reduction in costs due to EU ETS. When applied at the EU level this may lower emission prices and have mitigating effects for all sectors that fall under EU ETS. However, efficiency of the whole system would be lower than in the case of auctioning as technical measures to reduce emissions are favoured over reductions in output. In addition the basis of these subsidies has to be altered from a rebate in corporate taxes to a direct subsidy for the unprofitable top of the energy investments.

In theory, the best option, from the perspective of mitigating the effects for energy-intensive industries - would be to set up a system of border tax adjustments and export subsidies to compensate for the higher costs of EU ETS. The effectiveness and costs of such a system would, however, highly depend on the accuracy with which these taxes can be determined and the effects that other countries might undertake when being faced with import restrictions and export subsidies of EU member states. If other countries would take compensating mechanisms in their trade tariffs (retaliation), the effects could, in the end, be even worse.

Table 10 summarizes the pros and cons of various compensation options to mitigate the adverse effects of EU ETS.

Table 10 Pros and cons of various compensation mechanisms

Compensation mechanism	Pros	Cons
Free allocation of rights (on the basis of fixed benchmarks) to exposed sectors. Companies that reduce output must hand in their rights.	Easy to implement, directly targeted at energy intensive industries.	Higher prices of EUA due to the fact that production is implicitly subsidized, which implies a net transfer of money from non-exposed sectors to exposed sectors. Difficulties in determining which sectors would be gifted with free allowances and in arriving at a benchmark that is efficient and fair.
Border tax adjustments and export subsidies.	In theory no impacts on competitiveness and minimization of net costs of EU ETS.	Risk of compensating measures in other countries when being faced with EU export subsidies and import tariffs, which, in the end, will limit trade and harm competitiveness. Difficulties in setting up the correct tariffs.
Recycling revenues through labour taxes or corporate tax.	Easy to implement, low administrative costs. Minimizes potential costs of EU ETS and can form an impetus for a less energy intensive industrial structure	Almost no effect on the competitiveness of the energy intensive exposed sectors.
Recycling revenues through large scale subsidies on energy saving measures.	Targeted at energy intensive industries and lowering the price of CO_2 rights.	Lowering the efficiency of the system (higher output) compared to auctioning.

6.4 Final thoughts

Allocation of the emission rights is in essence a distributional question. While overall efficiency may be enhanced if emission rights are being auctioned, there exists a risk on carbon leakage. It appears that especially in the aluminium, fertilizer, iron and steel , inorganic and other base chemicals sectors relatively high cost price increases can be expected which may not be fully passed on to their customers. Profitability in these sectors may be reduced and the risk of carbon leakage increased.

In terms of impacts on the national economy (i.e. GDP) the effects are, however, probably small. First, the sectors that face the highest cost increases are in general the smaller sectors of the Dutch economy with the exception of the iron and steel industry. Second, some of the costs may be passed on over to the customers although the extent is rather uncertain at present. Third, sectors may apply abatement technologies which lower their costs of compliance. Finally, if international climate policy until the year 2020 will result in more countries agreeing on binding reduction targets, impacts on competitiveness will be smaller than analyzed here.

Nevertheless there is a risk that auctioning results in impacts on the industrial structure in the Netherlands. If the government wants to alleviate the impacts for energy intensive sectors thought may be given to a system of border tax adjustments and the recycling of revenues to energy saving investments next to the free allocation of rights.

6.5 Caveats

We want to emphasize that the results of this study only hold for the type of analysis that has been conducted: a partial microeconomic analysis on the additional costs of sectors. The partial micro economic analysis conducted here implies that only the direct costs of EU ETS are estimated. Eventual benefits through lower energy consumption, improvements in air quality and improvements in innovation (i.e. the Porter hypothesis) have not been included in this analysis. Additional indirect costs, such as a loss in jobs and - indeed - carbon leakage also cannot be estimated using this approach. The results hence only give an indication of the impact EU ETS could have on carbon leakage but we have not conducted any quantitative estimation in that direction.

Furthermore, a number of other caveats apply to these results. Firstly, we have chosen here sectors as entities of analysis. Even if we conclude that a sector, on average, shows no effects, still various firms within a sector may show rather significant effects as the ratio between CO_2 emissions and costs may not be evenly spread within a sector. This assumption may need to be scrutinized in more detail in future research. Especially within the food and paper sectors there is some evidence that the level of detail obtained in this study is too rough. Secondly, only indirect cost price increases due to electricity are analyzed in this study. However, if half of the costs can be passed through to the customers, some other indirect effects might exist for industrial sectors consuming products from the energy intensive sectors. These have not been included here. Third, we have assumed here that EU ETS will be matched with climate change policies of the installations smaller than 20 MW. If these latter policies will not become operational, or not result in cost increases because financed through subsidies, results from this analysis might be different. Finally, the results from this analysis assume that international climate policy will fail. All cost calculations have been based on the situation where only the EU and some of the Annex-I countries that have signed and ratified Kyoto advance their climate change policies. The rest of the world, including China, India and all the states in the United States, will face a situation where carbon will have no price at least until 2020 and also for the years after. Only under these circumstances price differentials between countries that adhere to climate change policy goals and countries that do not have any type of climate change policies are sustained. This is of course a very pessimistic scenario and therefore the results from this study are typically to be interpreted as the ‘worst case scenario’.

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Impacts on Competitiveness from EU ETS

An analysis of the Dutch industry

Annexes

Delft, June 2008

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A Impacts on electricity prices for industry

One important element to the quantitative analysis is how the power sector will pass on the costs of auctioning into the price of electricity. Power plants fall under EU ETS and have to buy EUAs for all their CO_2 emissions in an auction. As the power plants will be able to pass on these costs to their costumers, auctioning of the rights will have only very limited consequences for the power sector[35]. However, because of the rise in electricity prices, industry will face additional costs[36]. The question is how these **indirect costs** for industry should be estimated.

A.1 Calculation based on average costs

One simple way of establishing the electricity price increase would be to multiply the CO_2 emissions of the power sector with the emission price. This way it can be easily calculated that the electricity price rise is equivalent to € 14,3/MWh for a CO_2 price of € 20/ton and € 35,8/MWh for a CO_2 price of € 50/ton (a 30% emission reduction)[37]. These price increases are in general higher than the European average as the Dutch electricity sector is relatively CO_2 intensive.

A.2 Marginal cost pricing according to the literature

Pricing in the power sector rarely follows the logic of average cost pricing. Instead, the pricing follows the costs of additional CO_2 rights to the marginal production unit. Given the fact that the marginal production unit in the Netherlands most likely is a gas-fired CHP plant, the CO_2 price passed through may well be lower than the above calculated prices based on average production costs.

Reinaud (IEA, 2003, 2007) gives an extensive and thoughtful analysis of the pricing strategies of electricity producers. From a theoretical perspective, the degree of cost-pass through depends on several factors: level of generating capacity on the market, the fuel mix in the power markets, the elasticity of demand, the possibilities to governmental interventions in the power market and the allocation method. Reinaud argues that in case of tight available capacity, prices are expected to rise by the additional carbon cost to the marginal producer. If capacity is not tight and the short-run marginal costs of two marginal players in the electricity market are significantly different, then the firm with the lower costs has the incentive not to urge the marginal firm out of the market, thereby profiting from the higher electricity market price. In this case the marginal firm is likely to pass on its EU ETS costs. If capacity is tight but the cost difference between the marginal players not significant, the degree to what EU ETS costs will be passed on

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[35] Notice that the electricity prices will rise irrespective of whether the rights are auctioned or grandfathered. One feature of the power plant sector is that they not only pass the direct costs on to their consumers but also the opportunity costs in the case of grandfathering.

[36] In practice other price increases (e.g. refineries that pass through the costs to their consumers) might exist but these are beyond the scope of this study (and they are not included in the Climate Strategies or McKinsey studies either).

[37] Based on 54 Mton emissions in 2005 minus the emissions from coke oven gas that have been covered by EUA allocated to the iron and steel sector (4,4 Mton).

depends on whether or not these costs are perceived as soft costs that can be absorbed by the firm without any ‘real’ financial losses. Are they considered as real costs or as soft costs and competition between marginal players is relatively low, then the pass through rate is higher than if costs are considered as soft costs and firms are less competitive.

An empirical investigation into the cost price increase by Reinaud has resulted in an estimated 21 percent increase in Europe’s wholesale power prices from a carbon emission price of € 20/ton. Since the average European industrial electricity price in 2000 was € 47,12 per MWh (IEA data) this translates into weighted average carbon cost on the market of 10€ per MWh for € 20/ton CO_2. These figures have been used in the Climate Strategies study (2007) and McKinsey (2006).

A.3 Calculations from the CAFÉ model

The question is how these results can be translated to the Dutch situation. 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. Related to other countries in the EU, nuclear energy and renewable energy provide very little of the total primary energy supply in the Netherlands.

Instead of analyzing the cost-pass through using existing power plants, as has been done in Reinaud, we will here analyze the effects on new power plants using the CAFÉ-model, developed by CE Delft and CIEP for a Dutch think-tank on energy issues (*Bezinningsgroep Energie*)[38]. To a certain extent, new electricity plants can be regarded as the marginal unit of production in the long-run. We also emphasize here that such a long-run perspective may give a better picture for industry as electricity is often purchased through long-term contracts. Figure 27 gives the average costs of production for these techniques under different CO_2 prices[39].

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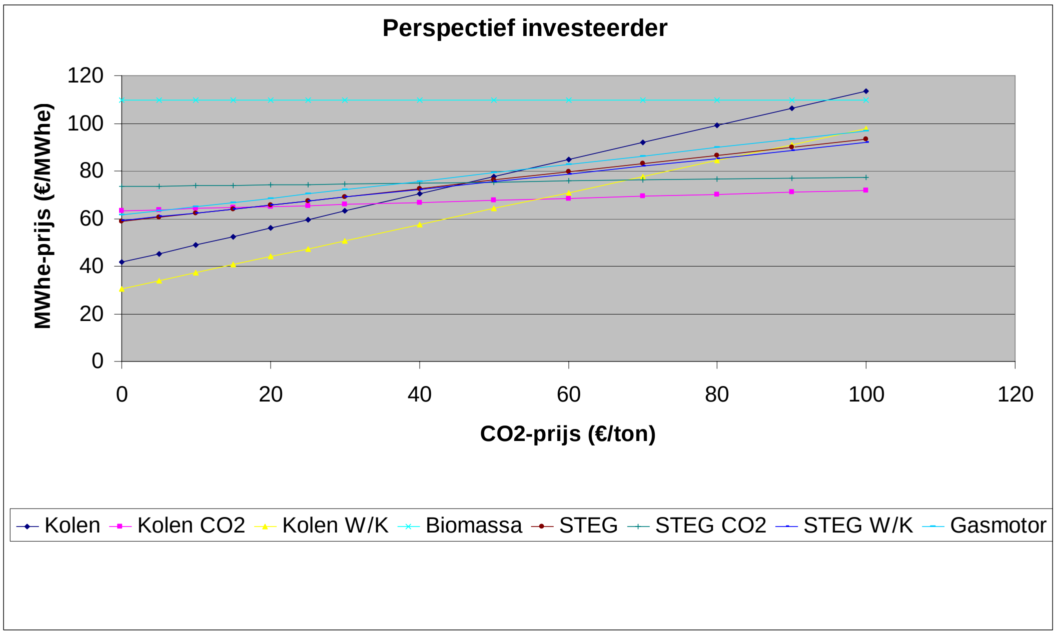
[38] This is a cash-flow model that simulates the investment decision for an investor implementing new energy plants under various scenarios.

[39] For the calculations we took price levels of 2005: coal prices of € 2,7/GJ, gas prices of € 5,6/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.

Figure 27 Outcomes of a model run using the CAFÉ model



From this model one may conclude that with an ETS price under € 30, coal fired power plants connected to the heat grid are the most economical option from the perspective of an electricity company. Above the € 55, gas fired STEG with CCS would become the most economic option.

If no EU ETS would be in place, the price per MWh would be € 33 for a new coal fired power plant. If the EU ETS price would rise to € 20, the average costs per MWh would be € 47 for this technique. This results in a price increase of € 14, assuming a full cost-pass through. For an emission price of € 50, the average costs per MWh would rise to € 67[40]. The marginal price increase for a new power plant would hence be € 34 if all costs will be passed through.

Notice that these figures are larger than used in McKinsey (2006) and Climate Strategies (2007). This comes because we assumed here that for long-term contracts probably the coal fired plant presents the marginal production unit. For industry we feel that this might be a more realistic scenario although more research into the pricing strategies for long-term contracts may be required to settle this issue finally.

A second observation is that the chosen values are very similar to the average costs, presented above. Hence, profitability of the power sector will most likely be unaltered under auctioning of the rights. Finally we must notice that we have assumed that eventual price increases due to obligations relating to renewable energy are not incorporated in the cost price increase. Electricity prices may go up

[40] Under an ETS price of € 50 nuclear power energy would be a more cost-effective option. We have not calculated with these prices though, because planning a new nuclear power plant may be a lengthy procedure easily spanning over a decade. Hence, it is unclear whether by 2020 a new nuclear power plant can be in operation in the Netherlands.

to a larger extent than the values of € 20-50 due to obligations from renewable energy policies. However, one may argue that such price increases should be attached to the societal costs of renewable energy policies instead of the costs of EU ETS. An alternative view would be that prices remain largely unaltered if the revenues from auctioning will be recycled to renewable energy projects, as the Commission has proposed.

B Description of Data and Calculations

B.1 Data for chapter 3 and Following

This Annex describes all the data that have been used in this study

B.2 Direct CO_2 emissions

Direct CO_2 emissions refer to the emissions from burning fossil fuels or CO_2 related process emissions that occur in Dutch industry.
The data have been extracted from various sources: CBS, ER and NEA and the National Inventory Report, (NIR, 2007). We used throughout the report the IPCC definition for emissions.

Data issues
CBS data have been applied for refineries, chemicals, basic metal, food and building materials. A further split for the chemicals into base chemicals, fertilizer and chemical products was obtained using information from the Emissieregistratie. For the rest of the chemical industry a further division has been achieved by using information on energy use. We took here the final energetic energy use and extracted the electricity component from it. This was subsequently used as a basis for dividing the emissions between the petrochemical industry (SBI 2414. 2416 and 2417), the Base Chemical NEC (2411 and 2412) and the inorganic base chemicals (SBI 2413). Hence, this split is relatively rough and should be interpreted with some care.

The split for the non-ferrous metals sector was obtained from information from the Nederlandse Emissie Authoriteit (NEA). The CO_2 emissions from the NEA do not include process emissions from aluminium production. Using production data from aluminium from BGS and the emission factor of 0.00145 tons CO_2 per ton aluminium (NIR, 2007), one may arrive at the insight that the CO_2 emissions of the aluminium sector were to be raised with 0,48 Mton if these process emissions were to be included. Combined with the 0,13 Mton emissions from the combustion processes from NEA, the total emissions equal 0,61 Mton for the aluminium sector.

The CO_2 emissions from the iron and steel sector include in this analysis part of the emission of coke oven gas which is used in the electricity production from NUON. However, only that part of emissions for which emission rights have been granted to Corus have been included for the iron and steel sector. The remaining emissions (about 1,6 Mton) have been attributed to the power sector as these emissions would appear if an equivalent of power was produced in a coal fired installation.

Emissions for zinc have been based on natural gas consumption as given in the *Milieujaarverslag* of Zinifex Budel B.V. and based on the emission factors as given in Annex B3. The resulting emissions were checked using data from EcoInvent. Although EcoInvent came to higher emissions, we notice that the total direct CO_2 emissions remained small in any case not influencing the results. Hence, we stuck to the figures calculated from Zinifex Budel.

The division for the building materials sector has been based on NIR (2007, p168). As the NIR emissions sum up to a lower total emissions compared to CBS, the emissions of each sector have been up scaled by 15% in order to match with the total from CBS. This also gives a rather rough division between

B.3 Electricity use

The data on electricity use have been taken from CBS: Energiebalansen. For every sector an energy balance has been constructed in which the electricity use is characterized by two indicators:

1. Net electricity deliveries: this is the sum of the electricity bought minus the electricity sold to other sectors or the grid.
2. The net auto produced electricity. This is the total amount of auto produced electricity minus the losses (i.e. grid transportation) of electricity during the production.

The two combined give the net final energetic electricity use of every sector.

Data issues
All data for 2005 have been used. In a few cases, a further division was achieved using information from the production statistics: (*Energieverbruik en -kosten industrie*). One should notice that the Energiebalansen and Production Statistics from CBS have been established through different routes (respectively energy sales and surveys) and that results are not entirely comparable. Hence we choose to use the information from the *Energiebalansen* as our route of departure and that only the subdivision between some subsectors (e.g. sector 20, 21 and 22) has been arrived from the production statistics.

To determine the electricity consumption from the petrochemical industry, a split had to be made between subsectors 2411/2412 on the one hand and 2416/2417 on the other hand. This proved not to be possible with these figures. Here we had to refer to much older statistics (i.e. 1999) relating to the energy costs of these sectors in order to be able to split the data between these two sectors. This split is therefore relatively unreliable, however, the totals still make sense. The small fraction of sector 247 (yarn industry) was not split from the main category 241 for electricity use as no possibilities existed. Older data from 1999 showed that the energy costs of sector 247 were only 1,7% of that of the total 241 sector so we feel confident in assuming that these costs are a very small fraction of the total costs of this sector.

Sector 265 (cement and limestone production) could not be singled out from the sector 263 (ceramic tiles). Hence electricity consumption within the cement industry includes that from 263. As the electricity consumption in this subsector is probably very small, this should not affect the total results.

The division in electricity consumption between aluminium and other non-ferro metals has been made on the basis of LCA EcoInvent, Annex D (see PRé Consult), combined with production statistics on primary and secondary aluminium and zinc in the Netherlands. The totals calculated on the basis of LCA came very close to the totals from the statistics, hence we have some trust in these figures. The electricity consumption of the other non-ferro metal sector is also very much in line with what could be expected from the *Milieujaarverslag* of Zinifex Budel B.V.

Auto produced electricity has been taken from CBS and the same routine has been applied for splitting up the amount of electricity and heat produced for some sectors as described above. The CO_2 emissions stemming from auto producers have been calculated using the gas input and multiplying by the emission factors:

CO_2 emission factor	1,78	$kgCO_2/m^3$
Caloric value natural gas	31,68	GJ/m^3

The CO_2 emissions have subsequently been divided between heat and electricity by using the caloric value of the two output streams. We assume that only the electricity part of WKK will be due to auctioning under EU ETS.

B.4 Costs and turnover

All data have been extracted from CBS from the statistic: *Arbeids- en financiële gegevens bedrijven*. This statistic gives a division on 2-digit level for all companies within industry and on 4-digit level for companies with more than 100 employees.

The subdivision in the chemical industry has been based on the >100 employees statistics. We assume that all big companies reside in the subsector 241 (base chemicals) while the smaller companies can be found in the categories 242-247 (chemical products). For subsectors 2411, 2415 and 2417 there is no information in this statistics. Information from the turnover has been based on Prodcom for the subsectors 2411, 2415 and 2417. Turnover arrived via Prodcom gave < 0,5% errors compared to the turnover data for the base chemical industry as a whole and should hence be considerably reliable. The share in costs for these subsectors was assumed to be similar according to their share in sales.

For the subdivision of the building material industry, the division was based entirely on the sales from Prodcom. The reported sales in Prodcom constitute for about 80% of total turnover in this sector. The subsectoral division from Prodcom is applied to the total in order to create a sectoral subdivision. Again we had to assume that the ratio of costs to sales is similar within the building materials industry in order to establish figures relating to costs.

The subdivision of the base metal industry was also obtained from Prodcom. Again we had to assume that the ratio of sales to costs is similar in the base metal sector.

B.5 Trade data

Import and export data have been retrieved from Eurostat's COMEXT database, sales data from Prodcom, published by the CBS. Both sources report more than 8,000 products, at the level of 8 digits. However, they differ in their sector classification: one issue here has been the translation from the SITC product groups into the Prodcom product groups. For this a transformation table has been established in the project where each of the SITC products a corresponding Prodcom category has been defined.

Due to confidentiality many product categories reported no data. If we compare the total sales of industry achieved through the Prodcom data with the total turnover of industry in the Netherlands, we find out that approximately 65% of total sales of Dutch industry has been covered by the Prodcom data. As some of the turnover in Dutch industry is generated by selling services, this seems to be a reasonable coverage at first hand. The consistency of the import and export data was subsequently checked using the OECD STAN database. It appears that especially for refineries and chemical products the Prodcom database underrates the trade flows. For these categories we took information from the Stan Database. Production data for cement, refineries and iron and steel were unreliable from the Prodcom database and have been established from the statistics on total turnover. This may give an underestimation of the export flows for the iron and steel and cement sectors but there was no way to check this and correct the figures.

If we subsequently compare the derived export flows with the production flows we observe a second problem relating to the re-exports. Almost half of all the imports and exports that are recorded in the Comext data have to do with re-exports, mainly through the port of Rotterdam. This issue, which is particular for the Netherlands, must be corrected as re-exports do not fall under EU ETS. Such correction cannot be executed by statistical information as only on a very aggregate level some statistical information is present on re-exports. Therefore we undertook a common routine where we calculated the *share* of production of imports to satisfy domestic demand. The import that is not used for domestic demand can then be classified as re-exports and subsequently subtracted from both the export and import statistics to derive *corrected* trade statistics.

Share analysis Suppose that a sector sells 10 billion of products. This figure is representative for the production of the sector. The imports are 15 billion and the exports 20 billion. As the exports are larger than production one may assume that the largest share of the exports relates to re-exports: goods that are imported and without any conversion being exported. If we apply the formula (apparent consumption = production + import - export) we can calculate that the apparent domestic consumption equals 5 billion. This consumption is 'served' by 10 billion of production and 15 billion of imports. If we cannot identify the origin of this domestic consumption, one may assume that 2/5 of the total available products on the domestic market (i.e. the sum of production and imports) comes from the domestic production while 3/5 come from imports. Hence one can say that of this 5 billion consumption, 2 billion were generated through domestic production and 3 billion through imports. This implies that 12 billion of the imports are simply re-exports. The adjusted figures are now as follows: production 10, imports 3, exports 8. The 12 billion of re-exports are not counted in the statistical analysis.

B.6 Cost Curves of Industry for Reducing CO_2 Emissions

Data on the cost effectiveness of technical measures were obtained from the combined statistical and model study of Daniëls and Farla (ECN, 2006). Appendix E of this publication (*Optiedocument 2010/202)* and some of the tables in its main text provided rounded data. The complete database is available as a set of fact sheets, one for each technical measure[41].

The set described in annex E from Daniëls and Farla (ECN, 2006) contains 359 (mainly technical) emission reduction measures as 'variants' of 170 'options', each measure by:

- A description of the option.
- A variant number.
- The main or 'goal' substance to be mitigated.
- The economic sector in which the measure is to be applied.
- The degree, ranging from 0% to 100%, to which the measure should be applied according to the model used by Daniëls and Farla when the efficiency loss due to interference between the measures is to be excluded; the resulting package of options (measures) fits to the use of emissions from the 'actualised Global Economy scenario' as reference emissions, as is the case in this study.
- The national or macroeconomic costs of the measure.
- The end user's or microeconomic costs of the measure.

[41] Some unexpected discrepancies between the tables and the fact sheets were observed during our investigation. The column in the table from appendix E presenting the reductions of the emission of other greenhouse gases than carbon dioxide was systematically shifted upward one position. The error was corrected and, to be sure of the correction, the affected data were replaced by the data from the corresponding 'fact sheets', assuming that the latter were more precise. See http://www.energy-use.info/optiedoc2005/optiedoc/factsheets/emissie.html. The remaining differences between the data from the appendix and the fact sheets showed differences which were larger than rounding errors, but mostly did not exceed the range of ±5% for large emission reductions and ±10% for smaller ones. These differences were accepted in order to avoid the excessive production costs of extracting the - assumedly - correct data from the individual fact sheets.

- The mitigation potentials of the measure for emissions of CO_2, other greenhouse gases (OGHG) as CO_2, total greenhouse gases (GHG) as CO_2, NO_x as NO_2, SO_x as SO_2, NH_x as NH_3, total acidifying gases as H^+, non-methane volatile organic substances (NMVOS) and fine particles or 'fine dust' into air, and for the use of primary energy and the use of fossil fuels expressed as energy.

As the fact sheets show, it is possible to split the equivalent emissions of other greenhouse gases in the equivalent emissions of methane (CH_4), nitrous oxide (N_2O) and 'F-gases' (HFC's et cetera). This was not the case in the used data from appendix E and it was not done in order to control the research budget either.

Each measure or 'option' has up to four 'variants', each of which may be treated as a separate measure, which is done here in order to increase the accuracy of the shadow prices and the auxiliary mission reductions at the standards. For each variant, redefined as a measure, only one combination of levels of (intended and ancillary) reductions of the involved emissions is given, in other words one size of the measure's emission reduction vector $\underline{r_m}$. Because each the higher numbered variant of an option is specified as an extension to the next lower numbered (i.e., preceding) variant, thus cumulating the cost and the emission reductions, the increments of the latter variables with respect to the preceding variant are calculated for further processing of each variant as an independent measure.

An important and realistic element in the output data of Daniëls and Farla (ECN, 2006) is the number specified for each measure, representing the degree (0 to 100%) to which the measure is included in (the package of measures applied in) the 'Actualised Global Economy' scenario. We used here these degrees as the extents to which the measures can be combined within a realistic scenario without rendering interfering with other too much, in other words, without deteriorating the efficiency of the package too much. The alternative is to ignore this mechanism and to apply each measure up to its specified maximum emission reduction, which is not very realistic either.

In Daniels and Farla, measures for specific sectors as well as general applicable measures are given. The former are with respect to the sectors Petrochemicals, Inorganic chemicals, Fertilizers, Aluminium, and Iron and Steel. We allocated the reduction potentials of the latter (the general applicable measures) to all sectors. Some of the measures are not available yet, but will come available until 2020. If these incur negative abatement costs we assumed that these would be taken independently of the EU ETS system. Thus we decided not to assign the negative costs to the effects of ETS. However, since these measures *will* be taken, the corresponding emission reduction has been taken into account. The emission potentials given in ECN and MNP (2006) are with respect to the year 2020. Since we carry out an ad hoc analysis for the year 2005, assuming that the whole reduction has to be realized at once, we did apply a correction factor to the emission potentials. Finally, we removed from the database all measures dealing with a reduction in output (*inkrimpscenario's*).

In the actual calculation, we chose to include all technical measures available in the *Option document* dataset, in other words not to assume that the measures counteract each other.

C Sectoral analysis

C.1 Outline analysis competitiveness in some industrial sectors

In this Annex, we will analyze the impact of EU ETS on some industrial sectors. Since most of the existing literature is based on CO_2 prices around € 20/ton CO_2, we will base our analysis solely on cost estimates under this scenario. Emission rights are assumed to be allocated through auctioning for all evaluated industries. Sectors analyzed here are: aluminium, iron and steel, fertilizers, other inorganic chemicals, refineries and, to a lesser extent, cement and paper.

Each section has the following structure. After a short introduction to the sector, the first question to be answered is whether firms are able to pass through CO_2 costs to their customers. Based on market characteristics we indentify the risk of import penetration when prices are raised. This immediately reveals the risk of carbon leakage through import substitution. When cost pass through seems to be an option, the expected fall in domestic consumption is estimated whenever possible. The severity of this fall depends on de price elasticity of demand for the particular product, whose value is frequently uncertain/ unknown. Such an effect would be an intended effect of EU ETS. When pass through seems to be impossible, and firms are expected to face a drop in profitability, the risk of carbon leakage through relocation is considered. This would be an unintended effect of EU ETS.

Section C.2 handles with the aluminium sector, section C.3 considers the impact on the iron and steel industry, where after section C.4 takes the refineries into account. Section C.5 covers an analysis of the chemical subsectors, whereas section C.6 offers some short remarks on other sectors such as cement and the paper and pulp industry.

C.2 The aluminium sector

C.2.1 Introduction

The aluminium sector is currently not covered by the EU ETS Directive, but it might face serious indirect consequences of carbon pricing through increased electricity prices. Two types of aluminium production can be identified:

1. Primary production. It means that aluminium is made out of raw materials. Bauxite is mined and refined to alumina. Aluminium is then formed by melting alumina.
2. Secondary production. This comprises remitting of aluminium scrap. An example is the recycling of aluminium used in beverage cans.

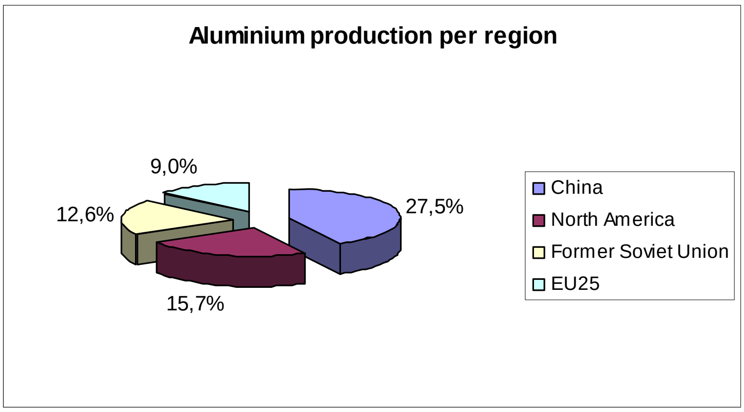
About 50% of European aluminium is produced by primary smelting, an equal part is produced by secondary smelting (McKinsey, 2006). In the Netherlands, total aluminium production in 2005 was nearly 454 ton, of which 74% was produced by primary production and 26% consists of recycled aluminium (BGS, 2008; CE, 2006).

Only the producers of primary aluminium are expected to face serious problems since the production is very electricity intensive (15 MWh per ton of aluminium). Secondary aluminium requires only five percent of this amount (McKinsey, 2006). Our main focus will therefore lie on the primary aluminium industry.

C.2.2 Market outline

During the last ten years, global demand in aluminium has grown with a compounded annual growth rate of 1.7% (McKinsey, 2006). Yet, the EU-25 region has hardly been able to benefit from this development. It only accounts for 9% of total aluminium production, see Figure 28.

Figure 28 Aluminium production per region (% of total production in 2006)



Note: Underlying data is obtained from EVD (2008).

There are three underlying and interrelated reasons for the relatively low importance of the EU region:

- Aluminium is a relatively homogeneous product. The industry is characterized by highly international trade flows and competition. (McKinsey, 2006; Climate Strategies, 2007). Subsequently, companies can be considered as price takers (IEA, 2008) and production costs are highly relevant for production- and investment decisions.
- Aluminium is a relatively expensive metal to produce, due to its high electricity consumption. Electricity makes up 35% of the total production costs of aluminium (EU, 2007). Consequently, energy prices determine the location for smelters. They are concentrated in areas with access to cheap energy (IEA, 2005a; McKinsey, 2006). The climate for investment in the EU region is not attractive in this regard. Production costs are also high because the raw materials, bauxite and alumina, are found several thousand miles away from European smelters (IEA, 2005a).
- Transport costs are relatively low. Aluminium has a very high value to weight ratio making it relatively cheap to transport (NERI et al., 2007a).

A new smelter in Iceland or China could deliver aluminium to Europe or the US at a cost 10% lower than for European production, including the transport costs, even before an EU ETS driven increase in electricity prices (McKinsey, 2006). Smelting capacity is being expanded in several areas of the world, from Russia to the Middle East and Africa (IEA, 2005a).

C.2.3 Cost pass through

The ability of the EU aluminium sector to pass additional CO_2 costs on to consumers is minimal. It is even argued that none of the cost increase can be passed through due to the industry's competitive intensity (McKinsey, 2006; IEA, 2008). European producers are highly exposed to foreign competition and already seem to have a competitive disadvantage (as mentioned above). Freight costs offer limited protection against foreign competition since the increased electricity cost as a result of EU ETS is likely to supersede transport costs (IEA, 2005a). Consequently, foreign imports can successfully compete in European aluminium markets. It is therefore reasonable to assume that further price increases will fuel import penetration and that imports will replace domestic production. Sectors need to reduce profit margins in order to maintain their market share[42]. According to IEA (2005a), operational margins would decrease with 29% due to a CO_2 price of € 10 per ton.

Note that the above described impacts particularly hold for primary aluminium sectors because their production processes are electricity intensive. The effect on secondary aluminium production from scrap is expected to be rather marginal due to its low electricity consumption. Hence, it is hardly affected by an increase in power price. As a consequence, the Dutch sector will be relatively more affected

[42] It should be noted however, that a recent ex-post evaluation of 1999-2006 data (IEA, 2008) found no significant statistical evidence of the fact that CO_2 prices have had any adverse effect on the primary aluminium sector so far. This may be due to the existence of long term electricity contracts, which have protected European smelters from any increase in electricity prices as a result of EU ETS in that period.

than the EU sector as its share of primary production is higher (76% compared to 50%).

If no cost pass through is possible, Dutch aluminium firms face the full cost increase due to EU ETS. The increase in cost price is 6%.

C.2.4 Carbon leakage

The risk of carbon leakage through the relocation of production capacity is significant in the aluminium sector. The profitability of European aluminium firms, and Dutch ones in particular, is under pressure due to the large indirect cost increase resulting from the EU ETS. This might accelerate a migration of primary aluminium to countries with lower electricity cost and/or higher CO_2 efficiency, typically producing electricity from hydro or stranded gas, e.g., Iceland or the Middle East (McKinsey, 2006). Although direct relocation is not occurring at the moment, it is apparent that new capacity is located elsewhere (NERI et al., 2007b). EU secondary production from scrap, on the contrary, has some potential that could be exploited in the future (NERI et al., 2007a).

It is worth highlighting, however, that CO_2 regulation doesn't seem to be the determining factor of relocation, rather an accelerating one. That is, the shutdown of primary smelting in Europe would most likely happen irrespective of CO_2 costs because of the general development in energy prices. Most of the primary smelting capacity in Europe and the United States is likely to be shut down over the next 20 years due to increased power prices and the search for cheaper, stranded energy (McKinsey, 2006).

C.2.5 Conclusion

Most of the impact on aluminium production originates from increased electricity prices due to EU ETS. The additional production costs are expected to cause a loss in the competitiveness of European and Dutch aluminium sectors. Due to international competition, they are not in the position to pass costs on to customers. Maintaining profitability would lower their market share since price increases will fuel import penetration. As a consequence, the aluminium sectors will incur a significant reduction in profitability and the risk of carbon leakage through relocation is high. Nevertheless, EU ETS is identified as a factor that will foster migration to areas with lower energy prices, not causing this trend.

C.3 Iron and Steel

C.3.1 Introduction

The production of steel (and iron) is one of the most energy intensive manufacturing sectors and accounts for an estimated 5.2% of total global greenhouse gas emissions (OECD, 2005a). It can therefore be expected that carbon pricing under EU ETS has a significant initial impact on this sector.

Impacts might differ within the steel sector since steel is not a homogenous product. There are variations in steel grades and quality to satisfy a wide range of applications, including construction, automotive, packaging and manufacturing industries. Broadly two types of steel production can be identified:

1. Primary steelmaking.
   This comprises the smelting of primary materials as iron ore and coal coke. It is performed in large scale integrated facilities (3-15 Mt), mainly involving basic oxygen furnace (BOF) (Hatch Beddows, 2007). The majority of the final products that emerge from this production process are so called flat products[43]. These are often specialties with a relative high value, especially used in the automotive industry (McKinsey, 2006; Climate Strategies, 2007).
2. Secondary steelmaking.
   Steel is created by remelting secondary scrap that arises from downstream manufacturing processes and consumer goods. It is performed in relatively smaller mills, generally involving electric arc furnaces (EAF) (Hatch Beddows, 2007). The largest part of the production is focused on long products[44]. These are mostly commodities, used in for example the housing sector (McKinsey, 2006; Climate Strategies, 2007).

The BOF production process used much more energy than the EAF process; it would be, on average, be 4.5 times more emission intensive (OECD, 2005a). BOF plants would therefore bear most of the cost increase from carbon pricing.

Total steel production in the EU-25 region was about 184 million tons in 2003, whereby the greatest part, about 62%, originates from BOF processes (McKinsey, 2006). In the Netherlands, nearly all steel production is covered by BOF plants (around 6,8 million tons) (BGS, 2008; Climate Strategies, 2007)[45]. Our main focus will therefore will lie on this type of production.

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[43] In the EU, 75% of the steel products from BOF plants are flat end-products, 25% are long end-products (McKinsey, 2006).

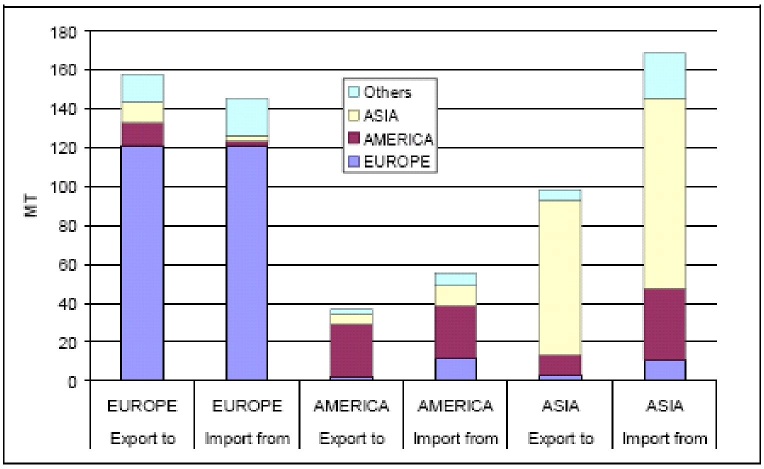
[44] About 85% of the products from EAF plants are long end-products, 15% are flat end-products (McKinsey, 2006).

[45] Worldwide, the main production process is also BOF, accounting for almost two thirds of global production. The main driver for this high share is China, where production via this process has increased significantly (NERI et al., 2007a).

C.3.2 Market analysis

Steel is a heavily traded good; about 40% of worldwide production is being traded. This trade mainly takes place within regions (Climate Strategies, 2007; NERI et al., 2007b). Figure 29 shows trade volumes between and within Europe, America and Asia. These regions account for 80% of world exports and 90% of total imports. The EU is a net exporter of steel, mainly to America and Asia. Imports from these regions are minimal.

Figure 29 Steel trade across regions by volume



Source: Climate Strategies, 2007.

The EU market can be considered as an oligopoly, meaning that producers are price makers to a certain extent[46]. This has to do with the fact that steel industries in Europe have undergone considerable consolidation over the past decades. The top five producers hold 53% of the EU market, with the transregional steel company ArcelorMittal as market leader (McKinsey, 2006). In addition, new producers face high entry barriers, since the industry is capital intensive and market entrance requires specific investments (IEA, 2005a; McKinsey, 2006).

The European steel market also seems to be somewhat protected from foreign imports through trade barriers. Current non-EU steel import ratios, both in the EU as in the Netherlands, are surprisingly low given the difference in operating costs observed throughout the world. The average BOF western EU plant has 40% higher operating costs than Brazil and Russia. This gap falls to around 20% for

46 The publicly announced price increase in 2008 by ArcelorMittal underscores the view that certain price setting is possible. Steel suppliers seem able to pass higher energy and ground prices on to customers, especially in the US (6-9% price increase) where supply is limited (Financiële Telegraaf, 2007). They apparently have a strong position in the market. It has also been mentioned that European steel prices could be intentionally influenced by, for example, temporary shut-down of units in Europe (Hindustan Times 2006 in NERI et al., 2007b).

India and China (Climate Strategies, 2007)[47]. For the Netherlands, non-EU imports are probably higher, given the existence of main port Rotterdam.

C.3.3 Cost pass through

There exists trade barriers in the market which would protect European producers from foreign competition, thereby indicating that certain cost pass through is possible. The following relevant non-prices aspects have been identified (Climate Strategies, 2007):

- Service differentiation. Many steel consumers have preferences for high quality services, with might be best met by local producers (Climate Strategies, 2007).
- Product differentiation. In some countries, high quality standards and certification issues may disqualify imports, particularly for long products and especially from developing countries. When standards do not apply, product differentiation relative to their quality may be a barrier to trade. Consumers seem willing to accept higher prices for these quality products (Climate Strategies, 2007). This especially holds for flat products demanded by the automotive industry. In the EU, products and production methods are generally advanced compared to other regions (Hatch Beddows, 2007). Obviously, such an advantage may vanish in the medium-term as technology spreads quickly (Hatch Beddows, 2007). The emergence of transnational firms may particularly reduce technological differences across regions, or at least fuel harmonization.
- Cost of instability. The trade risk for steel seems to justify a small differential, especially in long-term contracts.
- Import restriction. EU import duties might play a role, but they are limited to a few specific products. Hence they are unlikely to be a core explanation of low import rates (Climate Strategies, 2007). Export tariffs can also be relevant. For instance, the Chinese government increased the export tariffs by 5% on many finished and semi finished steel products in 2007 while scrapping or lowering a range of export rebates (IEA, 2007 in Climate Strategies, 2007).
- Transport cost. Freight costs are important in the steel sector, not only for long products, which are large, heavy and have limited value, but also for high quality flat products which require convenient packaging. High transport costs help to protect EU domestic markets since they reduce the net price difference with imports from non-EU regions. In the case of Hot Rolled Coil steel, for example, CO_2 price must be higher than € 28/ton CO_2 in order to make Chinese steel more attractive than EU steel (IEA, 2005a). NERI et al. (2007b) even indicate that competitiveness issues hinge more on the issue of transport costs than on industry concentration due to high profile mergers.

Nevertheless, there is no agreement in the literature on the degree of cost pass through. Climate Strategies (2007) mention intermediate pass through, whereas IEA (2005a) calculated that the transport costs for HRC steel are high enough to avoid import penetration as long as CO_2 prices are under € 28 per ton CO_2,

[47] Concerning the EAF plants, operating costs vary much less among regions (Climate Strategies, 2007), so low trade intensities are not striking as far as cost differences are concerned.

thereby indicating that full pass through is possible[48]. Hatch Beddows (2007) is more negative on cost pass through. When costs are fully translated into prices, import penetration is expected to rise by up to 5%. Their analysis is, however, based on higher CO_2 prices[49]. According to McKinsey (2006), the EAF sector would be able to pass 66% of the additional costs through to customers, whereas the BOF sector could only pass on 6%. This difference arises because long products compete in local markets whereas flat products from BOF are traded in global markets (McKinsey, 2006). The industry itself claims that there is very limited, next to zero scope of CO_2 cost pass through (CEPS, 2008).

In the light of all the existing trade barriers, or even if we solely consider transport costs, it is reasonable to assume that there are opportunities for cost pass through in the steel industry. This holds for both European and Dutch sectors, although the situation for the Netherlands might be somewhat worse than for the rest of the EU since the Dutch steel sector produces solely BOF and non-EU imports are possibly higher. We also want to emphasize that to our knowledge, IEA (2005a) is the only study that has investigated the various trade barriers for the steel sector quantitatively and that we put some more confidence in this result than the results from modelling exercises that cannot be verified. Therefore we assume that in the most likely scenario the Dutch steel sector is able to pass 50% of all CO_2 costs on to consumers in order to defend their profit margins on the EU market. The net cost price would then grow with 3% for the shares in the EU market.

For the worst case scenario, when pass through turns out to be disappointing, we use the result of McKinsey (2006). Total cost price grows in that case with almost 6%.

C.3.4 Demand response

Since BOF steel producers are expected to pass on 50% of their CO_2 costs on to consumers, the demand for steel products might lower. In Western European countries, the price elasticity of demand (e_d) for steel is estimated at -1,56 (IEA, 2005a), which means that steel consumption is highly depended on price.

Table 11 Steel price increase in response to EU ETS and subsequent demand reduction on the EU market (e_d =-1,56)

Pass-through scenario	Product price increase (%)	Demand reduction (%)
Most likely scenario: 50% cost pass through	3,1	4,8
Worst case scenario: 6% cost pass through	0,4	0,6

[48] These freight costs estimates cover the period 1996-2004. Since then, transport costs are even higher due to continuing rising oil prices.

[49] They use an additional variable cost of € 50 per ton steel (auctioning of credits).

Table 11 reveals the expected price increase and demand response. Under the most likely scenario, steel prices increase with 3,1% on average in the EU market, causing a fall in domestic demand of about 5%. When cost pass through would be only 6%, expected price increases are rather low and, despite the relative high elasticity of demand, only a marginal reduction in domestic consumption can be expected.

C.3.5 Carbon leakage

Since cost pass through is probably possible to a certain extent, EU ETS is not expected to have an immediate negative impact on the profitability of European and Dutch steel producers. However, while product differentiation and other trade barriers may allow the EU flat steel producers to maintain profitability in the short term, it might not suffice in the long-run to facilitate new investment or to re-investment in existing plants. Therefore, the risk of carbon leakage through relocation might still be present.

Whether leakage will actually take place depends on the actual and expected CO_2 prices, or in general climate policy abroad and at home. Uncertainty regarding climate policy might form a barrier to relocation. The fact that steel is a capital intensive sector might also limit relocation. Additional barriers are (Climate Strategies, 2007):

- The reluctance of firms to fire large numbers of workers. Labour unions are quite powerful in the EU steel sector.
- High sunk costs that tend to slow down the relocation process.
- Boom in the steel market which ensures sufficient profitability, even for high cost plants.
- Semis tend to be high quality and hence differentiated products. Not all parts of the world have the ability to produce high quality products.
- Instability of some non-EU countries, with regulatory risks and corruption.
- Countries, especially China, seem reluctant to host plants dedicated to export, which would increase their dependency on energy or raw material imports. This may lead increasingly to the implementation of export tariff for energy intensive products.

Several modelling exercises have estimated leakage rates. According to three models of the steel sector, even moderate climate policies - resulting in abatement cost levels of 10-25 US $/tCO_2$ - lead to high rates of carbon leakage, varying between 25-45 percent of the sectoral emissions reduction in the abating countries (MNP, 2004). This is significantly higher than the general leakage estimates (5 to 20%) presented in the third assessment IPCC report (i.e. Hourcade and Shukla, 2001).

In addition, various other empirical studies investigated the risk of carbon leakage in the steel sector under the assumption that the competitiveness impact of an emissions trading scheme would be identical to that of a homogenous carbon tax. These studies reveal leakage rates of 35% to 60%, depending on the tax rate (Gielen and Moriguchi, 2002; OECD, 2002 in Climate Strategies, 2007). Latter

study claims an output reduction of 12% and a leakage rate of 60% for a tax of $ 25/ton CO_2. These results are relevant for our analysis in which emission rights are put up for auction. Obviously, when the rights are allocated for free, the risk of carbon leakage is reduced[50].
At the moment most steel plants are built to supply the local markets, whereas only a few exporting capacities are built abroad. If we suppose that relocation in BOF plants will occur in the future, the intensity of such an evolution is uncertain. Some argue that high cost plants might be relocated whilst other plants might not. The latter is coherent with the ArcelorMittal investment plans that forecast the closure of EU inland plants by 2020 and relocation to Brazil. Especially transnational firms are in the position to take advantage of cost differences across countries and shift parts of production activities outside the EU. Others point out that ArcelorMittal's plans to bring back iron making to Liege despite Belgian inland costs suggests that steel making in the EU is still sufficiently profitable (Climate Strategies, 2007).

C.3.6 Conclusion

The EU ETS impact on the competitiveness' of the EU steel sector is twofold. First, BOF plants produce in an energy intensive manner but they have some ability to pass additional CO_2 costs on to customers. However, uncertainties are high. According to some studies CO_2 regulation is expected to harm the BOF steel sector in its competitiveness. The risk of carbon leakage is present but there are some relocation barriers. Second, for EAF plants, the negative impact of the EU ETS is likely to be smaller; a large percentage of the additional carbon costs can be passed on to consumers and the production process has a lower CO_2 intensity so producers face a lower cost increase from the EU ETS implementation.

The Dutch steel sector seems to be more affected by EU ETS than the steel sectors in other European countries. This is due to the fact that production is only BOF.

C.4 Chemical Industry

C.4.1 Introduction

Chemicals is a complex sector that comprises of 20 subsectors with various types of production processes and outputs. Subsequently, CO_2 emissions and the successive impact of EU ETS may vary widely.

The EU basic chemical production is dominated by a few countries. Germany is on top, followed by, France, UK, the Netherlands, Belgium and Ireland (NERI et al., 2007a). In terms of turnover, the subsectors other organic chemicals and plastics in primary form are most important. The two sectors under consideration

50 When allocation would be based on grandfathering, these results might overestimate the EU ETS impact (IEA, 2005a). Grandfathered allowances give industry the flexibility not to pass on the full opportunity cost of CO_2 allowances on to product prices (Climate Strategies, 2007).

Figure 30 Total Turnover by Sub-Industry and by Country in 2003, EUR millions

Table 3.1 – Total Turnover by Sub-Industry and by Country in 2003, EUR millions

Country	Industrial Gases	Dyes and Pigments	Other Inorganic	Other Organic	Fertilizers	Primary Plastics	Synthetic Rubber	TOTAL 24.1
Germany	*834*	4591	3469	23994	2382	29864	*834*	65968
France	2088	1210	2765	15413	2391	5187	951	30006
UK	*2040*	*2040*	2370	11622	1410	5724	1104	26310
Netherlands	*272*	758	1356	12820	1192	7725	*272*	24395
Ireland	*56*	*56*	46	21242	302	221	0	21923
Italy	1228	905	1841	2725	944	12124	204	19971
Belgium	622	650	2042	8549	401	3676	665	16604
Spain	976	798	1444	2801	905	7425	262	14609
Finland	192	281	939	626	366	1073	297	3774
Poland	251	*26*	294	793	1098	838	*26*	3326
Austria	216	*41*	266	489	360	1270	*41*	2683
Hungary	156	34	94	142	113	1105	1	1644
Portugal	182	53	118	332	222	669	0	1576
Slovenia	51	107	76	57	0	44	0	334
TOTAL	9165	11550	17120	101604	12085	76944	4655	233121

Source: Eurostat SBS and own calculations
Note: Figures in smaller italic script are interpolated estimates

Source: NERI et al., 2007a.

Nevertheless, former chapters revealed that two other subsectors are particularly noticeable regarding CO_2 emissions and additional costs due to EU ETS:

1 Production of fertilizers and nitrogen compounds. Various types of fertilizers are produced. They can be in single nutrient form and contain straight nitrogen (N), straight phosphorus (P) or straight potassium (K). Fertilizers can also be in a complex form, meaning that they may contain any combination of N, P and K. This may be achieved by chemical means (compound fertilizers) or in a mechanical way (blended fertilizers) (Yara, 2007).

2 Manufacturing of (other) inorganic chemicals, such as gases, inorganic acids, chlorates, sulphates, nitrates and salts. Chlorine is a relevant chemical here since its production is highly electricity intensive. Energy consumption is about 3,440 KWh per ton of chlorine. In addition, 55 percent of Europe's overall chemical production is directly or indirectly dependent on chlorine (Euro Chlor, 2008). The chief application of chlorine is in the manufacturing of PVC[51].

Fertilizers

With respect to the fertilizer and nitrogen compounds industry, N is the most important mineral fertilizer nutrient. In 2005/2006, 153 million tons of nutrients in mineral fertilizers were consumed globally of which 91 million tons were N (59%). Each type of N-fertilizer has a different content of nitrogen. The most important ones are urea (46%), ammonium nitrate (AN, 33-35%) and calcium ammonium nitrate (CAN, 25-28%). Nonetheless, although there are different types of N-fertilizers, all N-fertilizers form one single product market since the products are partly interchangeable from a customer perspective (Yara, 2007).

[51] With the production of chlorine, caustic soda is also produced. This co-product also has a wide range of applications, among which the production of pulp and paper.

Chlorine
Chlorine is produced by electrolysis using three main technologies; mercury, membrane and diaphragm. Mercury has been the principal process in the EU, representing 43% of production capacity in 2006. In the future, the industry is expected to move towards mercury free technologies (in response to safety and environmental concerns), particularly to the more energy efficient membrane process (Euro Chlor, 2007).

C.4.2 Market outline

Fertilizers
Over the last 20 years there has been a strong decline in N-fertilizer capacity in Europe. New Production capacity has been built in regions with inexpensive energy such as Russia, China, Middle East and North Africa. EU has gone from a position of self sufficiency of nitrogen to become a net importer of 20% to 30% of nitrogen consumed (Yara, 2007). At the moment, Asia is by far the largest producer of ammonia and urea, accounting for nearly 50% respectively 60% of total world production.

In terms of net trade in ammonia, Eastern Europe and Central Asia are the largest net exporters of basic chemicals. North America is the largest net importer, followed by Asia and Western Europe. The position of Asia in urea is close to being balanced in proportional terms. Latin America, North America and Western Europe are relatively large net importers relative to their domestic production levels (NERI et al., 2007b).

Imports presently account for approximately 20% of European consumption. Moreover, the EU imports substantial quantities of ammonia for upgrading into finished N-fertilizer products so that a further proportion of EU produced N-fertilizers are based on ammonia imported from outside the European Union. The most important sources of finished products and ammonia are the low-cost gas feedstock locations: Russia, Ukraine, North Africa and the Middle East (Yara, 2007).
The Dutch chemical industry is in general more open than that of the EU. It reveals a high export-import ratio compared to other EU countries (SEO, 2006; NERI et al., 2007b). It should be pointed out, however, that the situation with high trade flow solely holds for sectors whose products can be easily transported, among which the fertilizer industry. The supply of large quantities of anhydrous ammonia to the fertilizer industry, for example, is global as the product can be shipped worldwide in large vessels (Yara, 2007).

Chlorine
With respect to other inorganic chemicals, trade between the EU and non-EU regions appears to be limited. High risks associated with transports of substances like chlorine translate into low non-EU trade intensities for those chemical sectors (Climate Strategies, 2007). In addition, transport costs might be substantial for products with chemical inputs that require temperature to be controlled (NERI et

al., 2007b). Chlorine is mainly used at the site where it is produced in a variety of downstream units such as those for PVC (Euro Chlor, 2008).

Europe produces about 10,4 million tons of chlorine a year thereby accounting for about 20% of world output. Germany is the largest chlorine producer, making 43,8% of the European production, followed by Belgium/The Netherlands with 13,5% (2006 figures) (Euro Chlor, 2007).

C.4.3 Cost pass through

Fertilizers

For ammonia and urea containing fertilizers, we suspect that cost pass through is very limited. Those chemicals are globally supplied and highly traded, so that EU price differentials with the rest of the world will increase the risk of import penetration. The sector itself considers pass through opportunity to be nil (see Yara, 2007).

The position of the Netherlands might be worse than the situation of Europe in general since the Dutch fertilizer industry is more export oriented. The high Dutch export intensity indicates a good competitive position, but also a higher vulnerability. On the other hand, it might be indicative that the fertilizer industry is capable of competing on the EU market better than other countries.

However, given the limited evidence, we suggest to assume that Dutch fertilizer producers can pass none of the additional CO_2 costs on to customers. Their total cost rises with 8,1%.

Chlorine

For some other inorganic chemicals, those with dangerous substances or substances that require special handling, it has been mentioned that non-EU trade is not substantial due to transport risks and/or substantial transport costs. Chlorine is a typical example. In these cases, European and Dutch producers face some protection against competitors from outside regions. During our research we did not find references estimating the potential of cost pass through for the whole inorganic sector. However, there is reason to assume that part of the additional CO_2 costs can be passed through but more study is required to determine this.

When the Dutch sector could pass on 50% of its additional CO_2 costs, its total cost price would grow with 2,5%. In the worst case scenarios firms are not able to adjust product prices, they then face a cost price increase of 3,8%. Again we need to emphasize that such assumptions are highly speculative given the limited evidence.

C.4.4 Carbon leakage

Given the variety of products it is not feasible to consider carbon leakage based on the main production process for chemicals. Nevertheless, it is clear that companies require heat, electricity (and steam) for the production of nearly every chemical. Consequently, if there were potentially similar plants in two countries, advantages with respect to energy costs and country regulations/taxes and enforcement would tip the balance. Uncertainty with respect to variation in the latter certainly makes it difficult to plan and take investment decisions (NERI et al., 2007b).

With respect to fertilizers, it can be expected that increased production costs will lead to closures in the EU. This capacity will be substituted by new capacity in regions with low energy prices. Hence, most likely the reduction in European production capacity will lead to higher global GHG emissions (Yara, 2007).

With respect to other inorganic chemicals, it is uncertain to what extend EU ETS will cause relocation. Part of the additional costs might be passed through to consumers. What should be noted is that expansion of chlorine production capacity in Europe is unlikely. Not so much because of EU ETS, but because the market seems to have reached maturity in Europe. Global demand for chlorine is expected to grow by 2,2% a year (MC, 2007), but this demand is expected to come from countries with fast growing economies.

C.4.5 Conclusion

There is a lack of thorough independent studies that have analyzed the possibility that the chemical sector can pass through the EU ETS costs. For fertilizers there can be expected to be no pass through and there exists a risk of carbon leakage. In the other inorganic basic chemicals segment some pass through might be possible.

C.5 Refineries

C.5.1 Introduction

Refineries are very large complex industrial plants converting crude oil to a large range of products, from asphalt to fuel gas based on various crude oil grades (IEA, 2005b). The refinery sector consists of all refinery sites that take in the oil and produce finished products, such as gasoline.

The refining process varies in complexity (IEA, 2005b) but all techniques do follow a similar production pattern. The process can be split into three parts (McKinsey, 2006):

1. Separation. The crude oil is broken up into its components, for example, via distillation.
2. Conversion. Depending on the end products required, several intermediate streams can be converted, typically by further breaking up molecules.
3. Finishing. It means that different intermediate streams are blended to achieve the desired qualities, and impurities are removed.

The refining sector has been responsible for nearly 3.5% of EU-25 CO_2 emissions (Climate Strategies, 2007). These are by and large direct emissions, thus created during the refinery route (McKinsey, 2006). The industry faces a challenge since there is an increasing global demand for refined products and at the same time a worldwide tendency to shift to cleaner fuels (IEA, 2005b).

C.5.2 Market outline

The world refinery industry can be characterized by its regional character. Refinery capacity is dominated by the Middle East, Eastern Europe and South America, which together account for almost two thirds of global refineries (IEA, 2005b).

The European refineries have, on an individual basis, limited possibilities to influence market prices at the EU market, both upstream and downstream of the value chain. First, the price of crude oil is fixed across Europe, whereas refinery products are treated as commodities. Prices are set by market operators quoted in specialized energy reviews including the Platt's and Argus. Contracts for supply of refined products are generally based on these quotations (IEA, 2005b). Second, crude production, refining and distribution/retail are still separate businesses.

There are a number of large oil companies active in all segments but their operations are not vertically integrated because there are open markets in between. All crude oils enter the international market and very few, if any, EU refiners use their ‘own’ crude. This gives producers the opportunity to maximize the value of their crude while refiners the opportunity to optimize their crude slate. A large proportion of EU retail is in the hands of independents who are not refiners. Refiners compete with importers to supply them. Such trade exposure would be most pronounced for motor spirits, where the overwhelming portion is imported or even residential fuel oils with an import share of almost half (CEPS, 2008).

Yet, there is also strong indication that the EU refinery sector as a whole might have enough market power to be price makers at the moment. There is a strong demand for refinery products in high growth regions with insufficient refining capacity such as China, Asia, and North America. In addition, the amount of EU imports is limited by the capacity of foreign refineries to meet European demand and its specific quality and environmental specifications (for example on sulphur levels) (McKinsey, 2006; IEA, 2005b). These requirements form high entry barriers for new (foreign) producers on the EU market. In certain product market segments, European refineries almost exclusively supply several European countries (IEA, 2005b). This holds for the provision of aviation gasoline, motor gasoline and fuel oil.

There are some trade flows in and out of the European Union, but these would involve selected products. This trade can be considered as structural (McKinsey, 2006). Apart from this structural trade, however, refineries are trade at local/regional markets.

Within the EU, Northern European countries tend to produce more automotive fuels. Southern Europe still generates a large proportion of fuel and gas oils, although this is slowly changing as Southern European industrialists and power generators are switching to natural gas as a heat or power source (IEA, 2005b). Whereas countries like Italy and Spain have simpler refineries where more low value products are made, the Netherlands has relatively complex refineries which produce relative high valued products. The Netherlands seems to produce relatively more LPG, ethane and naphtha than other EU countries (IEA, 2005b). A possible explanation is that ethane and naphtha are mainly used as input for the chemical industry. The Netherlands has a relatively large chemical industry compared to its GDP.

C.5.3 Cost pass through

The previous analysis shows that refineries are partly price makers. However, a rise in European product prices might encourage foreign imports. Refineries are relatively homogenous products and trade exposure is high. The oil industry itself argues that EU refineries may find it difficult to raise prices enough to fully cover additional CO_2 costs. For costs above € 20/ton of CO_2e, many non-EU importers could increase market share. As to refining, the industry claimed that a price of € 30/ton of CO_2e would largely wipe out margins (CEPS, 2008).

At the moment, however, it is reasonable to assume that the EU refinery sector will have some potential to pass costs through without fuelling import penetration. This is partly due to the tightness of the market. There is excess demand in China and North America. As long as worldwide capacity remains tight, EU firms might be able to raise prices. In addition, there exist some trade barriers:

- Relatively high costs for transport and logistics. Usually, transport costs are higher for refined products than for crude oil (CS, 2007). This is because refined products required dedicated tankers/pipelines for each product to ensure product quality, and because the volume of products refined from crude oil is slightly higher thus requiring more transport.
- Tightening environmental regulation. As a result of higher EU environmental specifications, investments are needed in desulphurization of oil (amounting to USD 2-4 per barrel) in order to grant foreign finished products access to the EU market (IEA, 2005b). Refiners must reach sulphur levels below European standards if they wish to export into the EU: transporting refined products through bunkers or pipelines often adds sulphur to the transported product, as neither vessels nor pipes can be cleaned after each use. Their sulphur specification must therefore surpass European standards. The additional costs that foreign refiners may incur to enter the European market probably influences their choice of market they wish to supply more than an increase in cost for European refineries (IEA, 2005b).

In certain product markets, those in which European refineries supply the EU countries almost exclusively, it is even 'conceivable that EU refineries are main players … and would thus have the possibility to pass on most if not all of their CO_2 costs to consumers' (IEA, 2005a; 11).

According to McKinsey (2006), EU refineries can pass 25 to 75% of the additional cost through to customers, so that the drop in their margins will not be significantly. Dutch refineries might even be in a better position to raise prices, given the relatively high value of their products. The Netherlands has more export to non-EU countries, but as long as these regions show excess demand, this feature forms no limitation for the pass through of CO_2 costs.

If the sector can pass through 75% of the additional carbon costs, which is in fact a conservative most likely scenario, the total net costs increase would be 0,2%. The worst case scenario covers the case that pass through turns out to be more disappointing, 25%. The total rise would be 0.6%. This is the lowest prediction of McKinsey (2006).

C.5.4 Demand response

Refineries are expected to pass on 75% of the total ETS costs through higher product prices. They will grow with 0,6% on average (see Table 12). The demand for refinery products is expected to be rather inelastic. For motor gasoline elasticities vary from -0.1 to -0.6 in the literature. Goodwin et.al. (2004) find that price elasticities may be significantly larger than close to zero in the long term. A value of -0.6 is seen as a better approximation of the long-run effects than smaller values. However, given the small product price increases due to EU ETS, demand reduction is small.

Table 12 Refinery price increases in response to EU ETS and subsequent demand reduction (e_d =-0,6)

Pass-through scenario	Product price increase (%)	Demand reduction (%)
Most likely scenario: 75% cost pass through	0,6	0,36
Worst case scenario: 25% cost pass through	0,2	0,12

In the worst case scenario, refineries would still be able to pass 25% of their costs on to consumers. Product prices are then expected to increase with 0,2%, causing a negligible change in domestic consumption.

C.5.5 Carbon Leakage

Even when the profitability of refineries would be negatively affected, migration seems to be low. Several factors are responsible for the fact that refinery capacity is close to consumption (Climate Strategies, 2007):
- Transport costs.
- Investors are reluctant to invest in capital-intensive facilities in many of the countries that are exporting oil due to fears of expropriation or political instability.
- Refineries that are located near markets have the flexibility to optimize their production by mixing various types of crude oil in response to seasonal changes in product demand and market changes. This is difficult for refineries that are located close to oil production and dedicated to a particular crude oil steam. In addition, those plants have to deal with long shipping times to markets.
- Refineries in producing countries face higher risk in the event of supply disruption from their dedicated crude oil sources.

New refining capacity or capacity expansion is, however, not expected to take place in the EU region, irrespective of EU ETS (Climate Strategies, 2007). According to the World Energy Outlook, the bulk of future refinery investment will occur in the Middle East and Africa. Part of the investments will also take place in Asia in response to the region's strong growth in demand for refined products, particularly in China and in India. These investments will mainly involve simple or semi complex facilities, far from the European or North-American facilities in terms of environmental requirements. They will serve essentially the local markets, and pose hardly any risk for EU refineries (IEA, 2005b).

Yet, some carbon leakage might take place because European refiners can import more semi-processed products (such as Russian fuels) to lower their CO_2 emissions and thus their CO_2 costs. Freight costs would not constitute a barrier in this case (IEA, 2005b).

C.5.6 Conclusion

At the moment, it is reasonable to assume that European and Dutch refineries can pass a substantial part of the additional CO_2 costs on to consumers. This situation is likely to hold at least as long as worldwide capacity remains tight. In addition, trade barriers that protect the domestic markets have also been identified. These are high transport costs, product differentiation and environmental regulation regarding sulphur levels in oil.

The effect on domestic demand for refineries is presumably low, since consumers of these products are not very responsive to price. Carbon leakage is unlikely to occur through relocation of EU or Dutch firms, since they are likely to stay profitable at their current location. However, carbon leakage might occur through the import of semi-processed 'dirty' products for non-EU countries.

C.6 Some short remarks on other sectors

C.6.1 Cement

There is a global market of cement with a total production of 1.94 billon ton cement (2003 figures) (IEA, 2005a). China is the main player on the market, accounting for 67% of world production, followed on distance by the EU with 10%. Nevertheless, the top five EU producers hold a large share in the global cement market. Their share is estimated at around 30% (McKinsey, 2006). These large companies own facilities in several countries, so that the market becomes geographically highly fragmented. The reasons that cement is produced in virtually all countries are (1) that cement is an important construction material and (2) that the raw material (limestone) needed for cement production is geographically abundant (IEA, 2005a). Three production methods can be distinguished: dry, semi-dry and wet processes (McKinsey, 2006). In the EU-25, dry production process represents 95% of the total production, only 5% is accounted for by wet processes (McKinsey, 2006). Cement manufacturing contributes to about three percent of the total anthropogenic emissions of energy related CO_2 in the EU (IEA, 2005a). A large part of these emissions are a direct consequence of the cement production (EU, 2007). It is a highly energy intensive activity.

At the EU level, the industry appears to face low international pressure. Producers would have enough market power to adjust prices. They passed the latest rise in their electricity costs on to consumers (ETUC, 2007 in Climate Strategies, 2007). Pass-through in the European cement sector is assumed to be high (Climate Strategies, 2007). This result is, however, not per definition valid for cement sectors in individual EU member states. Production is highest in large EU countries and in the Mediterranean area (Spain, Italy and Germany) (NERI et al., 2007a). Prices and the profitability of the sector in these countries depend mainly on national factors like the number of players or the balance between consumption and production capacity (Gerald and Scott, 2007 in Climate Strategies, 2007). In addition, there is great variation in non-EU trade intensity across EU countries due to their geographical position. In areas close to seaports and near (southern) EU borders, such as Greece, Italy, southern France and Spain, there will hardly be any pass through opportunities since the risk of import substitution is highest (Climate Strategies, 2007). Several export capacities are available in the countries' neighbourhood (NERI et al., 2007b). In these countries, EU ETS is likely to lead to cost increases.

For other countries, such as the Netherlands and Germany, international pressure seems to be limited or even absent at the moment. Producers are protected by high transport costs and some other trade barriers (Climate Strategies, 2007). Freight costs are high compared to the production costs of Europe and might not be overcome by the cost of carbon at the prevailing price of CO_2 (IEA, 2005a). Freight costs from northern Africa or the eastern European countries outside the EU to Antwerp are, for instant, roughly equal to 12 Euro per ton of final cement (McKinsey, 2006). Our analysis reveals that these costs are indeed higher than additional CO_2 costs at a CO_2 price of € 20/ton CO_2. When emission rights are auctioned, we estimate that carbon costs are maximal around € 8 per ton cement[52]. The Dutch cement sector is therefore expected to face less serious consequences due to carbon pricing than EU studies indicate[53]. They might be able to pass all costs on to their customers. When the CO_2 price becomes € 50/ton CO_2 , however, additional marginal CO_2 costs are expected to be around € 20 per ton cement minimum, which is higher than transport costs. In that case, import penetration becomes a risk for the Dutch cement industry.

It is reasonable to assume that 100% of the additional CO_2 costs can be passed through higher product prices when the CO_2 price is € 20/ton[54]. The associated cost increase faced by the Dutch cement industry is therefore nil (see Table 13).

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52 This estimate is based on the assumption that the cement sector faces all CO_2 costs of the broader 'cement, calcium and gypsum' segment.

53 Some argue that international pressure on the EU is growing since cement would be transported over longer distances. They point at increasing non-EU import rates. However, growth of EU consumption and the lack of new domestic capacities are the most likely underlying rationales, rather than increased pressure from importers due to reduced trade barriers (Climate Strategies, 2007).

54 There will be no pass through opportunity at a CO_2 price of 50 €/ton. Please recall that we do not include the scenario of a CO_2 price of €50/ton in this analysis on competitiveness issues.

Table 13 Net cost increases for the Dutch cement sector due to EU ETS (CO_2 price = €20/ton)

Pass-through scenario	Net cost price increase (%)
Most likely scenario: 100% cost pass through	0
Worst case: 50% cost pass through	4,3

In a worst case scenario, there would be some risk of import penetration and the cost pass through rate would be only 50%. McKinsey (2006) has calculated lower values for the EU in general but Netherlands seem to be protected a bit better than countries like Greece and Spain due to the transport barriers. We assume here that in that case only half of the costs can be passed through.

The corresponding price increases would be 8,4% respectively 4,2% (see Table 14). The subsequent decrease in the domestic demand for cement is, however, expected to be relatively low. The price elasticity of demand is estimated at -0.27 (IEA, 2005a), so that consumption by full cost pass through would fall with 2,5% and in the worst case pass through scenario with nearly 0,4% The low price elasticity is, according to the literature on tax incidence, another reason why one would expect a priori that cement can pass on the largest part of the costs to the consumer.

Table 14 Cement price increase in response to EU ETS and subsequent demand reduction (e_d =-0,27)

Pass-through scenario	Product price increase (%)	Demand reduction (%)
Most likely scenario: 100% cost pass through	8,4	2,5
Worst case scenario: 50% cost pass through	1,3	0,4

Given the limited impact on profitability, at least when the CO_2 price is € 20/ton, the risk that the European and Dutch cement industry relocates the entire cement production process is considered to be rather low. Several relocation barriers have been identified in, among which the capital intensive nature of the industry (high investment costs) and the potentially unstable political situation in low cost counties (Climate Strategies, 2007). When relocation would take place, this process would be driven by transnational firms that are already active in multiple countries (Climate Strategies).

It is more likely, however, that partial migration takes place, particularly when CO_2 prices increase. The most carbon- and energy intensive part of cement production, i.e., clinker, would then be relocated to non-carbon constrained counties bordering Europe (IEA, 2005a; Climate Strategies, 2007). In this case, only emissions associated with power consumption would continue to fall under EU ETS, so indirect cost remain.

C.6.2 Paper

There is a competitive, global market in which paper faces competition from alternative markets (IEA, 2005a)[55]. Europe represents a quarter of world paper production and consumption. Its paper industry produces over 90 million tons of paper and board and about 84 million tons of pulp per year (McKinsey, 2006). This pulp production is almost equally split between production from recovered fibre, i.e. secondary pulp, and production from wood, the so-called primary pulp (McKinsey, 2006). The production of primary pulp is dominated by chemical pulping (30%), which is the least energy consuming process compared to mechanical (6%) and thermo mechanical (12% of production) pulping. In 2002, the pulp and paper sector represented 5 percent of European CO_2 emissions (IEA, 2005a).

According to McKinsey (2006), the European paper industry would be able to pass on 0 to 20% of the additional costs under a CO_2 price of € 20/ton. With respect to primary pulp production, cost pass through would be best in the chemical pulping sector. CO_2 cost increases are relatively low and it is expected that about 50% of the additional costs can be passed through to customers. Mechanical and thermo mechanical pulp production are more problematic. They face a higher CO_2 costs and can pass through maximal 15%. With respect to pulp and paper production based on recovered fibre, up to 33% of the cost increase can be passed through to customers. IEA (2005a) seems to be more optimistic on cost pass through in general for the paper sector.

Within the EU, Germany, Finland and Sweden are the major players, which individual production over 12 million tons (EIPPCB, 2001; VNP, 2007). The Dutch sector is relatively small in this regard, its production of paper and carton is about 3,4 million tons (VNP, 2008). A priori, competitiveness effects for the sector are expected to be smaller than is indicated at EU level. First, exports to non-EU countries are smaller for the Netherlands. Whereas it exports over 70% of total production, this is mainly to other EU countries (80% of the exports) that also face CO_2 regulation by EU ETS (VNP, 2008; NERI et al., 2007b). Second, the majority of the paper and carton (75%) is based on recycled fibre (NeR, 2004; Climate Strategies, 2007), for which cost increases are less than mechanical and thermo-mechanical pulping and pass through rates are somewhat higher.

[55] Plastics in the packaging sector and alternative media in communication (IEA, 2005a).

D LCA results

Table 15 gives the results from the analysis of energy requirements and CO_2 emissions for the base metal sector based on data from EcoInvent established through the LCA software program Simapro:

Table 15 LCA results for a few selected processes

		Energy *Final energy use at plant* (MJ)	Gross electricity use (MJ)	CO_2 emissions *(whole chain)* (kg CO_2 –eq.)	CO_2-emissions *Only production at plant (excl. electricity)* (kg CO_2-eq.)	CO_2-emissions from electricity use* (kg CO_2 –eq.)
Steel process: Basic Oxygen Furnace	Steel, converter, low-alloyed	**14,4** (1,02+1,88+1,3+10,2)	**2,45**	**1,7**	**0,459** (0,194+0,0879+0,175)	**0,148** (1,02 * 0,145)
	Steel, converter, unalloyed	**10,92** (0,716+10,2)	**1,13**	**1,24**	**0,175**	**0,104** (0,716 * 0,145)
	Steel converter, chromium steel	**36,85** (11,7+15,5+9,65)	**11,9**	**4,74**	**2,253** (1,6+0,653)	**1,697** (11,7 * 0,145)
Steel process: Electric Arc Furnace	Steel, electric, un- and low-alloyed at plant	**1,82** (1,82)	**2,04**	**0,571**	**0**	**0,264** (1,82 * 0,145)
	Steel. electric, chromium steel	**38,17** (13+15,5+9,67)	**13,2**	**4,53**	**2,254** (1,6+0,654)	**1,885** (13 * 0,145)
Primary aluminium	Aluminium, primary, at plant	**71,6** (15,3+56,3)	**57,4**	**11,9**	**1,42**	**8,164** (56,3 * 0,145)
Secondary aluminium	Aluminium secondary, old scrap	**11,97** (1,87+10,1)	**2,04**	**1,3**	**1,075** (0,257+0,16+0,658)	**0,271** (1,87 * 0,145)
	Aluminium secondary, new scrap	**3,75** (0,707+3,04)	**0,78**	**0,408**	**0,215**	**0,102** (0,707 * 0,145)

* Based on current labelling (*stroometikettering*) (CE Delft, 2007).

E Formulae for the potential cost increases

E.1.1 Mathematical formulation

For both auctioning and grandfathering, the formulation of both the (maximum) potential cost price increases and the actual potential cost price increases can be given as follows:

Table 16 Maximum potential cost price increase

	Direct Sectoral ETS Costs	
Grandfathering	EUA buyer	EUA seller
	$(E^N - A) * p$	*Not relevant*
Auctioning	$E^N * p$	

Table 17 Actual cost price increase

	Direct Sectoral ETS Costs	
Grandfathering	EUA buyer	EUA seller
	$\left(\int_{E^A}^{E^N} AC'\right) + \left(E^A - A\right) \cdot p$	$\left(\int_{E^A}^{E^N} AC'\right) - \left(A - E^A\right) \cdot p$
Auctioning	$\left(\int_{E^A}^{E^N} AC'\right) + E^A p$	

Where:

E^N: Emission level if no abatement takes place, i.e. emission level of 2005.
E^A: Actual emission level if ETS is in place.
A: Number of allowances grandfathered, i.e. either 80 or 70% of E^N.
p: Respective EUA price.
AC': Marginal abatement costs.