Bachelor Thesis:

The European Trade Scheme explored: using the ETS to overcome the clean dark/clean spark margin.

A case study on Germany.

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Abstract.

Within this paper we aim to conduct research on how the European Union can influence the European Trade Scheme and thereby challenge the clean dark and clean spark margins. Once it is capable of determining the main variables, the EU can promote gas-fired plants, which compared to coal-fired plants, have 50% less GHG output.

Germany will be our case study. This study aims to show that under the model of Delarue E., Lamberts H., & D'haeseleer W. (2007) we are capable of calculating the break-even allowance price in which gas-fired plants will become more efficient than coal-fired power plants.

Data will include the efficiency levels of both gas and coal-fired power plants. We also have to take into account the GHG-output levels of both the former and the latter. Both coal and gas prices are also in the model.

There has been a lot of research on switching from fossil fuels to green energy. While the EU should keep promoting green energy, a switch from coal- to gas fired plants already reduces output with 50%. We want to show that while the ETS might have failed in promoting green energy options, a switch to gas may remain an option for the EU to use.

From the research done in this paper I can conclude that choosing to implement and promote legislation towards natural gas efficiency levels would be the most effective way in trying to influence the bandwidth.

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Chapter 1.

Chapter1.1 Introduction.

The research I conduct is on how the European Trade Scheme might influence the reduction of greenhouse gas emissions (from now on GHG) in the context of the current production methods. I will focus on the clean dark/clean spark bandwidth. The clean dark/clean spark bandwidth is the profit made when selling energy on the market which has been produced through either coal (clean dark) or gas (clean spark). My research will try to explain how energy producing industries can be motivated to switch from coal to gas production when creating electricity.

The European Trade Scheme is a system that creates a cap on the total amount of GHG output that can be emitted by all the involved parties. Allowances are then partially sold and partially allocated for free. Installations must report their GHG-output to the EU. If companies have more output than allowances, they will receive a fine.

This system tries to influence companies to reduce their GHG-output. The EU has started this project to reach to Kyoto protocol which forces the Member States to reduce their GHG-output with 20%.

Research within this subject often has been on how the ETS scheme promotes companies to invest in to green types of energy. The transition to solar, wind or nuclear energy has often been explained. It showed that since the ETS scheme started, industries with high GHG output tend to spend more money on innovation for alternative energy sources (Gagelmann F., Frondel M. (2005)).

While investing into green types of energy surely is an honorable cause, realism ensures us to see that while companies invest more in R/D, the actual switch to green energy methods has not yet been made (Gagelmann F., Frondel M. (2005).

Researchers have also tried to analyze the micro- and macro economic effect of the ETS on both firm and country level. Literature given by Alexeeva-Talebi V. (2011) and Lund P. (2007) have for instance checked the influence on companies and on country-specific economies.

Literature studies also revealed that researchers tried to discover the price-drivers that influence the allowance price. This is important for my research, since I use the model given by Delarue E., Lamberts H., & D'haeseleer W. (2007). The reason why I choose this model is because my literature study revealed that it uses the most important variables to calculate the break even point. How this model works, which variables are in it and why I leave certain variables out will be explained later in our research design.

Regression analysis done by Alberola E., Chevallier J., & Cheze B. (2007) gave me significant information on what variables are significant and which variables are not. The study gave a formula which could calculate and predict the European Union Allowance Price. Compared to the model of Delarue E., Lamberts H., & D'haeseleer W. (2007) I notice some accesory variables like for instance the temperature. While the model is not important for calculative reasons, the reason why I will give some information about this model is because it gives me an indication about the variables that could influence the clean dark/clean spark margin. When working out and explaining the research methodology I will tell why I will choose for the former model instead of the latter model.

I therefore assume that Germany also holds for other EU countries. This is because about 40% of all the electricity created in Europe is still being produced by using coal as the main ingredient.

There is quite a lot of case-law. Most of this case law contains questions about the National Allocations Plans (from now on NAPs). Member States are realizing that their sovereignity is questioned and therefore try to influence the NAPs. The text of Van Zeben, J.A.W. (2012) which covers the most important case-law, shows us that since the EU is 'grandfathering' (accepting NAP's with the power to revisite them) Member States try to search grey area's within the directive.

While coal is the cheapest way of firing up an energy plant and creating energy, it has also two times as much GHG emission output compared to gas. If I could ensure that gas is used to create electricity, a 50% output decrease can be realized.

Within this study I aim to show that with the current coal and gas prices, using the ETS can help us to overcome this margin. Germany, still using a lot of coal power plants, will be the main focus in my case study, which investigates the efficiency levels of both gas and coal-fired power plants, combining GHG output and current gas and coal prices.

While there has been a lot of writing on this subject, I have not found a country specific research investigating the effect of the European Trade Scheme when looking at the clean dark and clean spark margin. Since there has recently been a lot of negativity surrounding the ETS, it might be good to show both citizens and industries of the EU that the Trade Scheme might not have influence on investing in green energy (or switching to green energy) but that it can at least prevent power plants being fired on coal. Recent changes in America have also led to the fact that both the clean spark and dark margins are interesting when comparing it with the allowance prices the EU is using.

There has been a lot of interest in importing coal out of the U.S. due to the fact that the U.S. is not binding the coal price with its oil price, leading to lower coal prices. Since both China and the EU have been importing a lot of coal from the U.S., prices have started rising once again, reducing the clean dark margin when compared with the clean spark bandwidth. Therefore the opportunity has risen to make sure that power plants will be fired with gas.

By committing myself to this subject, I expect to have a broader sense on how the European Union can influence these bandwidths with the ETS. Explaining how the ETS can and should influence the margins will be the main focus of my thesis. The influence of legislation should not be forgotten when trying to control the clean dark/clean spark margin. Recommendations will be made based on the legislative power that the European Union has in this area.

Chapter 1.2 Research Question.

The research conducted will therefore be an explorative study. Combining the theory of Delarue E., Lamberts H., & D'haeseleer W. (2007) with possible legislative recommendations has not been done before. The main research question that I want to propose therefore is:

How can the European Union influence the clean dark / clean spark margins taking into account their given power within Directive 2003/87/EC and its adjacent legislation to ensure that the fuel switch from coal-fired power plants to gas-fired power plants is made?

This research question is divided into two sub-questions which contain both the explorative case study within Germany and the recommendations made for the legislative part.

The first (sub) research question will be:
Which variables influences the clean dark/clean spark margin the most when looking at the German situation?
And the final (sub)research question will be:
What can the European Union do under the power given within Directive 2003/87/EC and its adjacent legislation to influence these variables and thereby make sure that they promote the fuel switch from coal-fired power plants to gas-fired power plants?

Chapter 1.3 Hypothesis.

Now that we have explained both the variables that might influence the European Trade Scheme allowance break-even price and because we have stated our research question, a hypothesis can be given:

I expect that the European Union through *both Directive 2003/87/EC, Article 95(3), Directive 2008/1* and *Articles 174 till 176 (ex articles 130r till 130t)* can at least influence the following variable given in the model of Delarue E., Lamberts H., & D'haeseleer W. (2007):

- Efficiency output levels of gas
- GHG output levels of Coal-fired power plants.

By trying to influence the efficiency of gas, this model will be influenced in such a way that the AC*switch* allowance price will drop, making it more interesting to make the fuel switch at a lower price.

We have to take into account that third parties such as the European Commission or the Council of Ministers might not even want to change the current situation. However, within my hypothesis I will only assume which variables might be interesting to change when there is a willingness to conquer the clean dark/clean spark margin.

Chapter II.

Chapter 2.1 Theory/Literature review.

Chapter 2.1.1
Understanding the model: Variables influencing the clear dark/clear spark margin.

A lot has been written about the European Trade Scheme. While there is not a lot of literature combining the allowance-price drivers and legislation, there is enough information about both subjects seperately. As I said before, the first (sub)research questions contain information about how the clean dark/clean spark margin can be conquered by the ETS and which variables influence this margin. These variables are so called price-drivers.

The formula that I will defend is the one of Delarue, E., Lamberts, H., & D'haeseleer, W. (2007). Within this paper the authors defend the formula they created to calculate the break even point (switching point) from coal fired electricty to gas fired electricty generation, which can be part of the Kyoto-protocol GHG emission reductions that have to be reached by 2020. This formula will be the fundamental component of my investigation of the coal and gas fired electricty power plants in Germany.

The authors created a formula which takes into account several variables. It takes into account the level of GHG emission output of both the coal and gas fired power plants, it takes into account the coal and gas price, and last but certainly not least, it uses the efficiency levels of both a coal and gas fired power plant (while absolute numbers will be given in the real thesis, for now it is safe to assume that coal fired power plants have less efficiency). This leads to the following formula:

$$\mathrm{AC}_{\mathrm{switch}} = \frac{\eta_{\mathrm{coal}} \cdot \mathrm{FC}_{\mathrm{gas}} - \eta_{\mathrm{gas}} \cdot \mathrm{FC}_{\mathrm{coal}}}{\eta_{\mathrm{gas}} \cdot \mathrm{EF}_{\mathrm{coal}} - \eta_{\mathrm{coal}} \cdot \mathrm{EF}_{\mathrm{gas}}},$$

In which AC_{switch} is the switching point in [€/$KG_{\text{-co-2}}$];
n_{coal} the coal plant's efficiency in [G_{je}/G_j];
n_{gas} the gas plant's effiency in [G_{je}/G_j];
FC_{coal} the fuel cost of coal [€/G_j];
FC_{gas} the fuel cost of gas [€/G_j];
EF_{coal} the GHG emission factor of coal [$KG_{\text{-co-2}}$/Gj];
EF_{gas} the GHG emission factor of gas [$KG_{\text{-co-2}}$/Gj]

When determining the gas and coal price the authors looked at the National Balancing Point which is the only liquid market place for gas and the coal price that was provided by the IEA. Using different scenarios with different levels of efficiency points, different average cost prices were calculated. Efficiency levels were set at respectively 38% (coal) and 50% (gas). I will determine these efficiency levels myself by gathering information about power plants in Germany.

Other writers have tried to determine whether other variables might determine the switching price of the allowances. Alberola, E., Chevallier, J., & Cheze, B. (2007) show us that there are other factors determining the AC-switch price.

Within this paper the authors once again try to give a model that sustains the daily price fundamentals that might influence the European Trading Scheme. In comparison to the the first text of Delarue E., Lamberts H., & D'haeseleer W. (2007) the authors of this text try to use more variables and from thereon create a regression-model.

They take into account the energy prices (the price on which energy is sold), they take into account carbon prices and temperature variables. They also take into account both clean dark and spark margins yet forget the efficiency output levels of both coal and gas fired power plants. This leads to the following formula:

$$
\begin{aligned}
p_t = {} & \alpha_i + \beta_i(L)p_t + \chi_i break_1 + \delta_i break_2 \\
& + \phi_i(L)brent_t + \varphi_i(L)ngas_t \\
& + \gamma_i(L)coal_t + \eta_i(L)switch_t \\
& + \iota_i(L)elec_t + \kappa_i(L)clean\ dark_t \\
& + \lambda_i(L)clean\ spark_t + \Theta_i Temp \\
& + \mu_i Tempext5 + \nu_i Tempex95 + \varepsilon_{i,t},
\end{aligned}
$$

Not explained variables are dummy variables which take into account extreme weather measurements, extreme gas/coal prices to compensate ensuring that it does not affect the model.

What I want the reader to notice is that this is not the calculative part of this formula, but simply that this formula of Alberola, E., Chevallier, J., & Cheze, B. (2007) gives an additional variable that should be taken into account when performing our research. The additional variable given is the temperature described as *Tempext5*, *Tempex95* and *Temp*.

Most of the other variables described can be found in the text of Chevallier J. (2010) who in his updated literature review gives the most important variables. Other variables explained are the weather, macroeconomic and financial market shocks like the current financial crisis we face.

Later on in the methodology part of this paper I will explain that I will take these variables into account. We will not use them as variables, but instead as indicators. The text of Alberola et al. (2008b, 2009) who created an econometric analysis shows us that the relationship of these variables can be covered by the carbon price itself. Temperature, macoeconomic and financial market shocks *ceterus paribus* influence the carbon price which is covered in the formula of Delarue, E., Lamberts, H., & D'haeseleer, W. (2007).

Weak points of all the other literature given in the text of Chevallier J. (2010) is that they focus purely on a certain subject while not combining them. As far as I could find there was no other formula than that of Delarue, E., Lamberts, H., & D'haeseleer, W. (2007) which combined not only gas and oil prices (therefore taking into account all variables following the macro-economic idea of Alberola et al. (2008b, 2009)), but also both effiency levels (which are different when fired on gas or coal) and GHG-output of both coal and gas.

Chapter 2.1.2
Influencing the model: Power of the EU within directive *Directive 2003/87/EC* and its adjacent legislation.

The second research question we would like to answer is about how possible legislative power of the European Union could influence the clean dark/clean spark margin making sure that gas-fired power plants prevail.

As is said before, there has been case law on the European Trade Scheme. Most case law introduced in the time of the beginning of the system was about the principle of equal treatment. Since the scheme covers around 50% of all the GHG-output industries, not all sectors (especially certain chemical installations and the plastic and aluminum sector) were included. A so called 'Keck" case. (Chalmers, Davies & Monti 2010) A case is called a 'Keck' case when creating certain boundaries within a subject of EU law. This forced the court to give the ETS some space, acknowledging that not all industries were in the ETS, but that time should solve this problem (C-127/07). Other case law focuses on EU-state aid problems regarding the NAP's with the ETS directive and clashes between the ETS directive and fundamental rights (public interest vs. human rights and its limitations). A deeper investigation will be done later in this chapter.

To understand how the European Union could use the European Trade Scheme to influence the clean dark/clean spark margin we first have to look to *Directive 2003/87/EC* itself which was agreed upon by the Member States and signed on 25-10-2003. While the ETS directive itself is of course important, one must, when trying to analyze legislation and its case law first describe its legal basis.

The European Trade Scheme directive is based upon the articles 174 till 176 (ex. articles 130r till 130t). Until the Single European Act was created, no real basis was founded for a community environmental policy plan. When the SEA came into force it made a title specificially, which made it a turning point.

The enviroment policy of the European Union lies on the legal principles of precuation, prevention and tries to rectify the pollution, bringing it back to the polluter described as the principle of the 'polluter pays'. Something that is done today within the ETS scheme and which might be interesting when trying to influence the clean dark/clean spark bandwith. The 'polluter pays' principle links articles 174 till 176 *with Directive 2004/35/EC* on environmental liability with regard to the prevention and remedying of environmental damage.

The Treaty of Amsterdam influenced the European Union environment policy even more by allowing Article 6 (ex. Article 3c) of the EC treaty to become one of its main objectives. The article explicity mentions that within all the policies of the EU, protection of the EU should be taken into account.

Article 95(3) (ex. Article 100A) of the EC treaty once again repeats this by stating:

"health, safety [and] environmental protection' must take as a base 'a high level of protection, taking account in particular of any new development based on scientific facts. Within their respective powers the European Parliament and the Council will also seek to achieve this objective."

Responsibility can be given either to the EU itself or to national or regional levels depending on the situation. If the situation can be better dealt with on a national or regional basis, both the European Parliament and Council will use the principle of subsidiarity.

Due to the fact that environmental policy has become one of the main pillars of the EU, a lot has been achieved. While we should not forget the European Trade Scheme itself a lot of achievements have already been made. Several Community Environment Action Programmes have been released trying to influence climate change and biodiversity; environment and health; and a sustainable use of natural resources.

All these projects have to be financed. While most of the money that is invested into environmental policy can be claimed by using the 'polluter pays' principle, the Commission has also set up the LIFE+ instrument which is created to create financial support for the environment. This financial instrument has replaced the existing financial programme LIFE and brings around 2 billion euros for the period 2007-2013.

Other achievements would be creating the European Environment Agency, The community Eco-labels and promoting international environmental cooperation.

Now that we have described the legal basis we can start looking more into the directive itself and its case law. When we start reading the ETS directive we notice that the European Union focusses on promoting green energy instead of investing in current methods which have less GHG-ouput. It states in the directive that:

"(20)This directive will encourage the use of more energy efficient technologies, including combined heat and power technology, producing less emissions per unit of output, while the future directive of the European Parliament and of the Council on the promotion of cogeneration based on useful heat demand in the internal energy market will specifically promote combined heat and power technology".

We also notice that although the European Trade Scheme tries to promote less GHG-output and investing into green sources of energy, it cannot force Member States to do so. This would ofcourse be rather harsh and might have substantial economical consequences. In point 21 it states that:

"(21)Council Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control (3) establishes a general framework for pollution prevention and control, through which greenhouse gas emissions permits may be issued. Directive 96/61/EC should be amended to ensure that emission limit values are not set for direct emissions of greenhouse gases from an installation subject to this Directive and that Member States may choose not to impose requirements relating to energy efficiency in respect of combustion units or other units emitting carbon dioxide on the site, without prejudice to any other requirements pursuant to Directive 96/61/EC".

Directive 96/61/EC is the directive concerning integrated pollution prevention and control. This directive lays down specific rules about how Member States should deal with new installations that have GHG-output and what should be done about the existing installations. Within this directive significant power is laid down to the EU. Article 5 states that:
"(5)Member States shall take the necessary measures to ensure that the competent authorities see to it, by means of permits in accordance with Articles 6 and 8 or, as appropriate, by reconsidering and, where necessary, by updating the conditions, that existing installations operate in accordance with the requirements of Articles 3, 7, 9, 10, 13, the first and second indents of 14, and 15 (2) not later than eight years after the date on which this Directive is brought into effect, without prejudice to specific Community legislation"

This is interesting because it seems that the EU can influence existing installation's GHG-output after 8 years. Because this directive has already been ratified in 1996, the EU could use its competence within this area to ensure that either efficiency levels of power plants go up, or that its GHG-output will decrease.
When analyzing *Directive 2003/87/EC* one can see that the EU was rather careful. Most of the articles laid down the sovereignity at a Member State level. The only thing that it can use is the method of allocation. Article 10 states:
"(10)For the three-year period beginning 1 January 2005 Member States shall allocate at least 95 % of the allowances free of charge. For the five-year period beginning 1 January 2008, Member States shall allocate at least 90 % of the allowances free of charge"

Member states themselves are also limited in their power. While they are allowed to determine the total allowance need, nothing more is required due to article the focus of article 87 and 88 on state aid. More information about this will be given when analyzing the case law.

There is however one point the European Union could use within Annex III which lays down the criteria for the allocation of the allowances. Article 1 states:

"(1)The total quantity of allowances to be allocated for the relevant period shall be consistent with the Member State's obligation to limit its emissions pursuant to Decision 2002/358/EC and the Kyoto Protocol, taking into account, on the one hand, the proportion of overall emissions that these allowances represent in comparison with emissions from sources not covered by this Directive and, on the other hand, national energy policies, and should be consistent with the national climate change programme. The total quantity of allowances to be allocated shall not be more than is likely to be needed for the strict application of the criteria of this Annex. Prior to 2008, the quantity shall be consistent with a path towards achieving or over-achieving each Member State's target under Decision 2002/358/EC and the Kyoto Protocol".

The Commission and Parliament can influence the allocation of allowances when it is not consistent with the path towards achieving or over-achieving each Member State's target under the Kyoto Protocol which forces the EU to reduce 20% of it's GHG-output Compared with the levels of 1990 by 2020. All of the Member states have ratified this and are therefore bound to follow this path. If the EU can influence the National Allocation Plans so that the allowances will become scarce, prices will go up. This could then influence the clean dark/clean spark bandwith making sure that gas-fired power plants are promoted.

Other directives such as *Council Directive 85/337/EEC* and *Directive 2001/42/EC* are created to assess projects, programmes and plans of Member States. While they do not offer legislative power, they might give some peer pressure.

Chapter 2.1.3
Case-Law: Who wants what?

In trying to understand the agents active in the European Trade Scheme and how they react to the legislation, case law could give us an understanding on how we might influence the clean dark/clean spark margin.

When analyzing case law there seem to be 5 aspects of particular importance (Epiny 2012). These five subjects contain:

- The scope of *Directive 2003/87*
- Questions concerning fundamental rights
- Judicial review
- Relationship between Direcive *2003/87* and *Directive 2008/1*.
- The sanctions in case of non-compliance.

The scope of the directive.

There are numerous activities and sectors that are not covered while still having a relatively high GHG-output. In several occasions the question arose whether *Directive 2003/87* would not comply to the principle of equal treatment. This principle ensures that there is a prohibtion of direct or indirect discirimation. *Case-127/07 Society Arcelor Atlantique et Lorraine and Others v Premier minister, Ministre de Lecologie et du Development durable, Ministre de l'Economie, des Dinances et de l'Industrie* describes the situation in which several companies (Arcelor Atlantique, Lorraine and others) active in the steel sector complained about the fact that other sectors with a high GHG-output were not involved in the ETS, therefore not being forced to buy allowances. There are several important factors within this judgement. The court stated that:

"(69)In the light of the foregoing and having regard to the step-by-step approach on which Directive 2003/87 is based, in the first stage of implementation of the allowance trading scheme, the difference in treatment between the chemical sector and the steel sector may be regarded as justified".

The Court recognizes that while the ETS was still in its first phase (2005-2007) the EU was allowed to differentiate between sectors because of the step-by-step approach of the EU.

- Another important factor described in the judgment was that of the GHG output calculated within both sectors.

- *"(70)As regards, second, the non-ferrous metal sector, it appears from the scientific report mentioned in paragraph 52 above, which, according to the observations of the Parliament, the Council and the Commission, the Community legislature made use of in drafting and adopting Directive 2003/87, that direct emissions from that sector amounted to 16.2 million tonnes of* CO_2 *in 1990, while the steel sector emitted 174.8 million tonnes of* CO_2*."*

"(72)The difference in the levels of direct emissions between the two sectors concerned is so substantial that the different treatment of those sectors may, in the first stage of implementation of the allowance trading scheme and in view of the step-by-step approach on which Directive 2003/87 is based, be regarded as justified without there having been any need for the Community legislature to take into consideration the indirect emissions attributable to the various sectors."

"(73) Accordingly, the Community legislature did not infringe the principle of equal treatment by treating comparable situations differently when it excluded the chemical and non-ferrous metal sectors from the scope of Directive 2003/87".

This ruling confirms that the EU is willing to grant exceptions on fundamental rights guaranteed such as the equal treatment principle when legislation about the ETS and the environment is being discussed.

Question concerning Fundamental Rights.

In the first phase of the European Trade Scheme the Member States had the responsibility to give the allowances determined by previous output to the industries involved in the project. Since 2008 the EU has started 'grandfathering' which entails that the EU based on NAPs of the Member States determines how many allowance are freely given. In the second phase (2008-2013) the EU gave away 95% of its allowances for free. Within the third phase starting in 2014 this should be 90%. It should be noted there currently is a lot of discussion around this subject within the European Parliament.

By allowing the EU to 'grandfather' these allowances fundamental rights such as the freedom to conduct a business (Art. 16 Charter of Fundamental Rights of the European Union) and the protection of property can be touched. These fundamental freedoms are particularly important for those provisions that are about buying allowances in order to emit GHG. Most of the case law has been on this subject. A good example is *T-489/04 US Steel Košice v Commission* in which a steel company complained about the fact that there were a lot of negotiations- which were non-transparent - between the Commission and the Slovak Republic influencing the NAP which was later on ruled to be inadmissible.

Judicial Review

There have also been a lot of cases about the individual right to complain about National Allocation Plans. While the Court could have grabbed this competence, it instead chose to bring this back to the national court. Complains were filed that this would influence the legel certainty of individuals within the European Union. In Case C-503/07 P the court shows its reason:

"(2)The possibility of determining more or less precisely the number or even the identity of the persons to whom a measure applies, by no means implies that it must be regarded as being of individual concern to them within the meaning of the fourth paragraph of Article 230 EC, as long as it is established that that application takes effect by virtue of an objective legal or factual situation defined by the measure in question.

With regard to the application of Directive 2003/87 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Directive 96/61, a Commission decision addressed to a Member State and rejecting in part a National Allocation Plan (NAP) for such allowances for the second allocation period is of general application, since it applies to objectively determined situations and entails legal effects for categories of persons regarded generally and in the abstract. Also, the fact that that decision resulted in the prohibition of the maintenance in force of the allocation guarantee which could have been claimed by certain operators under a national law concerning allocation of allowances for the first allocation period is not capable of conferring on that decision the character of a conglomeration of individual decisions. In that regard, the fact that the NAP notified by the Member State to the Commission must contain a list of the installations covered by the emission trading scheme and a statement of the allowances which that State intends to grant to those installations, does not make it possible to conclude that, by that decision, the Commission ruled on the individual applications.

In any case, whilst they cannot apply for the annulment of the contested decision, the operators concerned retain the possibility of challenging the national measures taken in application of the contested decision and, in that context, of relying on its illegality before the national courts, adjudicating in accordance with Article 234 EC"

Cases concerning the Relationship of Directive 2003/87 and Directive 2008/1.

Directive 2008/1 is the directive that concerns the permits given to new installations. However, because these installations contain GHG-output they automatically fall under the competence of the European Trade Scheme. There has however been some case law about a specific part of Directive 2008/1 which contains the following:

"(9) The objective of an integrated approach to pollution control is to prevent emissions into air, water or soil wherever this is practicable, taking into account waste management, and, where it is not, to minimise them in order to achieve a high level of protection for the environment as a whole."

Questions were raised about the meaning of the word 'high' in this context. A lot of cases containing the principle of proportionality were made. In C-343-09 *Afton Chemical Limited v Secretary of State for Transport* asked the Court whether the provisions relating to metallic additives which would reduce GHG-output from the use of transport fuels were disproportionate.

Once again the Court was willing to give up a fundamental principle to make sure that the enviroment would not suffer.

The sanctions in case of non-compliance.

An important factor that influences how efficient the European Trade Scheme is, is how the Court deals with sanctions when there is a form of non-compliance. The problem we face is that the only way the EU can deal with non-compliance is via the infringement procedure which is well-known to be rather time consuming (an infringement procedure can take up to five years).

There have only been two cases in which the Commission brought both Italy and Finland to the Court of Justice. Both cases concerned the faillure to implement the directive.

In both cases the Court ruled that:

'(1)Declares that, by failing to adopt, within the prescribed period, all the laws, regulations and administrative provisions necessary to comply with Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Communityand amending Council Directive 96/61/EC, the Italian Republic has failed to fulfil its obligations under that directive.".

The Court of Justice seems to be standing rather postive towards the European Trade Scheme. In the cases we have seen it even obtains a certain level of freedom when being faced with important legal principles.

Chapter 2.2 Research Design

To explain our research design I once again have to divide our research question into the two subcategories. The first question which I want to answer is how the clean dark/clean spark margin by using the European Trade Scheme can be conquered and which variables influence this margin. As explained before I will use the model made by Delarue, E., Lamberts, H., & D'haeseleer, W. (2007). The ACswitch price of Germany will be calculated, and a counterfactual hypothetical study will be performed, which will show which variable is most interesting to influence through legislative change.

When one uses a model it always faces certain restrictions. However, to determine which variables influence the margins certain sacrifices have to be made. The data which entails the ETS is simply too rich to analyze it without restricting it with certain assumptions. I simply do need a model to determine the relationship between variables and the price of an allowance.

The variables that determine the allowance price in the model that I will use ofcourse face limitations. That's what one gets when using a model. The variables used are the price of both oil and gas, the GHG output when using a gas- and coal-fired powerplant and the efficiency rates (coal/gas input vs electricity output) when using either gas or coal.

As I said in the literature review other variables have been given. I could also take into account variables such as temperature and financial and economic fluctuations. These are ofcourse serious confounders and it could make sure that the allowance price being determined by the model is not accurate. However, Alberola et al. (2008, 2009) describe that the carbon price has a significant relationship with these former called variables. So instead of using them as a variable, I will use them as an indicator to determine my coal and gas price. This makes sure that all the variables that the literature review gave me are taken into account. I can never be sure that the relationship between these variables and the allowance cost price is correct. It is simply impossible to create a model from I can be absolutely sure that it creates the perfect break-even price. The European Trade Scheme can be influenced by variables that lie outside our model.

However, while the use of a model is not perfect, it does allow me to partially create an idea about how the European Union could influence the clean dark/clean spark margin and promote the switch from coal to gas fired power plants.

The situation described above is ofcourse the fundamental problem described as the omitted variables problem. In this case I do not have to fear multicollineartiy. While I might have biased outcomes of the variable that is influenced by the confounder, this change will only lead to the correct price of the allowance, because the price of units of coal or gas is given in the model.

Another issue is the choice to conduct a case study. Within this study it would be a crucial case study: a case study that investigates a phenomenon against the background of a received theory. There are certain clear limitations when using a case study. I do not have a pre-test, no treatment and no control group making sure that I can be ensured that I will not discover a certain correlation. Single-time-series design tend to have a lower internal validity in comparison with a time-series design.

I also have no spatial or temportal variation. The only thing that I can conduct is a hypothetical counterfactual situation in which I would describe a situation different than what it would be when calculating the ACswitch price in our model. This is exactly what I will do. After wI calculated the ACswitch price of Germany I will start calculating elasticity levels of all the variables within the model to measure which variable influences the model the most (both positive and negative). Once this has been calculated I will give recommendations which legislation should be changed (and which legislative change would be most effective and be discovered by calculating these elasticity measures).

Using a case study leads to certain internal validity and external validity threats. Internal threats can be the following:

- Ambiguous temporal precedence
- Selection bias
- History
- Maturation
- Testing effects
- Instrumentation
- Statistical regression
- Attrition
- Non-compliance
- Contamination
- Reputation effects
- Experimenter effects

Ambiguous temporal precedence means that there is a lack of clarity about which variable occurred first. It can therefore not be clear which variable can be seen as the cause, and which variable can be seen as the effect. Because I do not have a temporal and spatial varation I can not draw any conclusions.

Selection bias refers to an unequal number of test subjects that have similar variables that might influence the subject being investigated. A problem that I face might be that Germany is completely not representative for the rest of Europe, thereby limiting the research-generalizability.

History explains the situation in which acts of nature influence how experimental participants respond allowing for biased outcomes. Because I do not have a temporal and spatial varation, I do not have to fear for this problem.

Maturation takes into account that subjects being investigated are changing during the course of an experiment or between measurements. I have no temporal variation which make sure that I face no maturation problems.

Testing effects occur when measuring the participants several times may lead to biased outcomes. I have no temporal variation which make sure that I also face no testing effects.

Statistical regression occurs when subjects are only chosen because of their extreme outcomes. Postive or negative outcomes later on in the experiment might occur because of a subject that returns towards the mean instead of having an effective experiment. I have no temporal variation and therefore do not have to fear this internal validity threat.

Attrition takes into account dropouts. Experiments that only take into account people who followed the whole experiment might forget the reason why certain people dropped out. There might be an unexplained variable that allows for people to stay or drop out. I have no temporal variation and therefore do not have to fear this internal validity threat.

Non-compliance explains the situation in which people do not want to comply to the experiment. The data of our case study cannot be influenced by Germany. I therefore do not have to fear this threat.

Contamination allows for subjecs to influence eachother. This leads to biased outcomes. Due to the fact that I only use Germany I do not have to fear this internal validity threat.

Reputation effects can be explained as a subject given answers to certain questions due to the social pressure on certain subjects. This might therefore lead to biased outcomes. I do not face this problem because I am not planning on using a survey.

Experimenter effect is a situation in which a researcher unconsciously influences the participant. This leads to biased outcomes. I do not face this problem because I have no interaction with my subject.

The selection of Germany as a case study can be a threat to internal validity. Germany might contain certain specific variables that influence the measurement of our ACswitch. Our instrumentation is rather strong. I have a formula in which there will be no level of decay or whatsoever.

Our external validity faces issues due to the fact that I am only measuring at one point in time.

When trying to create recommendations I will simply have to look what power the EU has towards the legislation created. Case law and directives will be our main focus. There is no point in trying to check for internal/external validity.

Our reliability is rather strong. Due to the fact that I am using a model, I can be assured that the use of this model will give us the same results every time I use the same data.

Germany however, is a typical case study. It represents a country that is representative for the whole European Union. I ofcourse know that when I want to check other countries it would be wise to find their efficiency levels. Every power plant is unique. By using this model, the generelizability of my research is rather high. Other countries can (when taking into account their own efficiency levels) calculate their own allowance cost price and from there on decide whether it would be interesting for them to switch from coal to gas. I therefore assume that Germany also holds for other EU countries. This is because about 40% of all the electricity created in Europe is still being produced by using coal as the main ingredient. While Germany is extreme in its coal usage, it still has a high generalizability. Conclusions about which legislative proposal would be the best could therefore also be used when advising other EU countries. Germany, although chosen because of its coal-dependence, should be seen as an calculative example to see how the EU as a whole could benefit from this clean dark/clean spark switch.

In trying to answer my second part of the research question I do not need to take into account methdological problems. The influence of the EU can be found in both literature and case law research. By trying to understand the former and latter I will show what manouvering space the European Union has within the legislation of the ETS. Recommendations will follow.

Chapter 2.3
Case selection and sampling.

Germany will be the focus of my case study. I chose Germany because of its dependence on coal fired power plants. It would be interesting to see how the AC*switch* price would lead to certain policy recommendations. I will need average efficiency data and GHG-output of the power plants within this country when burning coal or gas. This data will be gathered by using literature review and retrieving data from the National Balancing Point (gas and coal prices) and from the website of USEPA (GHG-output levels).

This sample data will be derived from several sources. Most of it will be retrieved from sites like the ISI web of knowlegde, google scholar and Jstor.

Case law and directives can be gathered from the EURLEX site where all data regarding legislation and case-law is saved.

Chapter 2.4
Data Collection.

The data neccessary to perform research will mostly be data necessary to complete our model. I will need the current coal and gas prices, I will need the average efficiency levels of the gas and coal power plants and I will need to gather information about the GHG-output of the fossil fuels used in these power plants.

Information about the current coal and gas prices can be gathered from the National Balancing Point which is the only liquid market place for both coal and gas.

Efficiency levels can be gathered from data used in literature and other research. Both the GHG-output of fossil fuels used in the power plants of Germany can be found on the website of the USEPA (United States Environmental Protection Agency).

Both the directive and case law interpretation will have to be done by literature review. From here on recommendations can be made about the future steps had have to be made when trying to influence the clean dark/clean spark margin.

My sources for articles are sites like the ISI web of knowlegde, google scholar and Jstor. Case law and directives can be gathered from the EURLEX site where all data regarding legislation and case-law is saved.

Chapter 2.5
Data Analysis.

Once the data has been obtained and interpreted, the model of Delarue, E., Lamberts, H., & D'haeseleer, W. (2007) will be used. By using this model, I mean that it will lead to the break even price. I will calculate this price for Germany, which will allow me to calculate counterfactual hypothetical situations which could be interesting for all the Member States. By gathering efficiency levels, coal and gas prices and GHG-output levels, I will be capable of determining this ACswitch price. From here on I can start making recommendations, taking into account the legislative power the EU has within this directive.

Chapter III

Chapter 3.1
Calculations: a typical hypothetical counterfactual case study involving Germany's power plants.

The model I will use contains several variables which I will explain. Calculations will be explained within this topic to make sure that replicability and transparency is guarenteed. The model we want to use contains the following variables:

In which AC_{switch} is the switching point in [€/KG-co-2];
N_{coal} the coal plant's efficiency in [Gje/Gj];
N_{gas} the gas plant's effiency in [Gje/Gj];
FC_{coal} the fuel cost of coal [€/Gj];
FC_{gas} the fuel cost of gas [€/Gj];
EF_{coal} the GHG emission factor of coal [KG-co-2/Gj];
EF_{gas} the GHG emission factor of gas [KG-co-2/Gj]

Together this forms the following formula as composed by Delarue, E., Lamberts, H., & D'haeseleer, W. (2007).

$$AC_{\text{switch}} = \frac{\eta_{\text{coal}} \cdot FC_{\text{gas}} - \eta_{\text{gas}} \cdot FC_{\text{coal}}}{\eta_{\text{gas}} \cdot EF_{\text{coal}} - \eta_{\text{coal}} \cdot EF_{\text{gas}}},$$

We have to take into account that all the variables given have to be calculated from their original price or weight category to a price or category per Gigajoule. Germany is our case study because currently it has 36 coal-fired power stations from which 34 are coal or oil fired power stations and only 2 are natural-gas fired power stations. A switch made from coal to gas would therefore have a large impact on the total GHG-output.

Once calculations have been done, hypothetical counterfactual situations will be given to determine which variables influence the ACswitch price the most. Once these elasticity calculations have been done, conclusions can be drawn about which variable would influence the ACswitch price the most, and would therefore be our most preferred variable to be influenced when trying to implement a change into current legislation.

Calculations.

These calculations have been done on may the 6th. Price changes have to be taken into account in both coal and natural gas prices. The coal price was 59,17 United States Dollar per Short Ton. The gas price was 4 United States Dollar per Million British Thermal Unit.

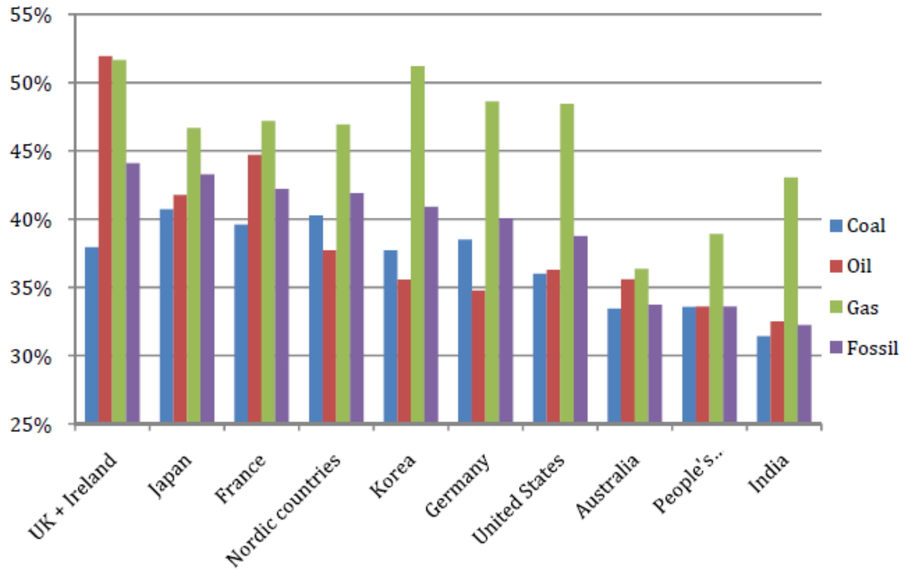
Both of these prices have to be redefined to Euro per Gigajoule.
To calculate the Euro per Gigajoule price of coal we first have to redefine the variables. Information gives us that one metric tonne of coal gives around 27-30 Gigajoule. To change short ton into metric tonne we will have to divide 59,17 through 1.102331. This leads to a coal price of 53.678122 per metric tonne. We know that per metric ton we receive around 27-30 GJ.

We therefore divide 53.678122 through 28.5 (in between 27-30) and get a price of 1,88 dollar per GJ. One euro equals 1.31 dollar (on may 6, 2013). Therefore 1,88 equals 1,43 euro. We therefore have a coal price of 1,43 Euro per Gigajoule.

To calculate the gas price we have to calculate from the 4 United States Dollars per Million British Thermal unit to Euro's per Gigajoule. To change from mmBtu to GJ means that we have to multiply 4 with 1.054615. This leads to a United States Dollar to Gigajoule price of 4.21846. To re-alculate this to the Euro we once again have to take into account that one Euro equals 1.31 dollar. Therefore 4.21846 dollars equals 3.22 Euro. Therefore we have a natural gas price of 3.22 Euro per Gigajoule.

The average efficiency levels can be determined by the Ecofys international comparison of fossil power efficiency (2011). Ecofys uses data of power-generation efficiences for the last three years available, which is the period from 2006-2008. The information is summarized within the following table:

Table 1: Power generation efficiency levels of energy sources, per country, 2006-2008.



Source: Ecofys (2011)

As can be seen Germany is rather innovative when looking at its natural gas-fired power plants which have an effiency level of 52%. Coal-fired power plants have an efficiency level of 37.5%.

The last variables needed for our calculations are the GHG-output levels of both natural gas and coal. Data from the USEPA tell us that different kinds of coals have differnet levels of Co2 output. The table gives a summary in which we have to take into account dat the data given contains mmBtu as a measurement level. This has to be redefined into Gigajoules. We will use data of the mixed electric power sector.

Table 2. Emissions per mmBtu of energy production methods.

Fuel Type	Heating Value	CO_2 Factor	CH_4 Factor	N_2O Factor	CO_2 Factor
	mmBtu per short ton	kg CO_2 per mmBtu	g CH_4 per mmBtu	g N_2O per mmBtu	kg CO_2 per short ton
Coal and Coke					
Anthracite Coal	25.09	103.54	11	1.6	2,598
Bituminous Coal	24.93	93.40	11	1.6	2,328
Sub-bituminous Coal	17.25	97.02	11	1.6	1,674
Lignite Coal	14.21	96.36	11	1.6	1,369
Mixed (Commercial Sector)	21.39	95.26	11	1.6	2,038
Mixed (Electric Power Sector)	19.73	94.38	11	1.6	1,862
Mixed (Industrial Coking)	26.28	93.65	11	1.6	2,461
Mixed (Industrial Sector)	22.35	93.91	11	1.6	2,099
Coke	24.80	102.04	11	1.6	2,531
Fossil Fuel-derived Fuels (Solid)					
Municipal Solid Waste	9.95	90.70	32	4.2	902
Petroleum Coke (Solid)	30.00	102.41	32	4.2	3,072
Plastics	38.00	75.00	32	4.2	2,850
Tires	26.87	85.97	32	4.2	2,310
Biomass Fuels (Solid)					
Agricultural Byproducts	8.25	118.17	32	4.2	975
Peat	8.00	111.84	32	4.2	895
Solid Byproducts	25.83	105.51	32	4.2	2,725
Wood and Wood Residuals	15.38	93.80	32	4.2	1,443
	mmBtu per scf	kg CO_2 per mmBtu	g CH_4 per mmBtu	g N_2O per mmBtu	kg CO_2 per scf
Natural Gas					
Natural Gas (per scf)	0.001028	53.02	1.0	0.10	0.05450

Source: USEPA (2011)

Now that all the data is collected we can start using the formula. The reader has to take note that once filling in all of the data in the model the ACswitch is calculated as in €/KG-co-2] while the allowance price itself is per tonne of C0-2 output. The answer has to be multiplied with a thousand.

Calculations for Germany lead to a ACswitch price of :

(0.375 *3.22) – (0.52*1.43)/(0.52*99.534564) – (0.375*55.915687) = 0.0150667

This leads to an allowance fuel switch price of 15.066781 Euro. An interesting price, meaning that if the EU could manage to decrease the number of allowances in the upcoming years, prices of allowances will rise, making sure that the fuel switch is made. The current price according to the European Energy Exchange (which is the main auction platform) is 0.01 Euro per allowance. If the EU could make sure that the number of allowances will decrease in the upcoming years until at least 2020, it will make sure that prices will go up, allowing at least Germany to perform its fuel switch.

Hypothetical counterfactual situations.

To investigate which variable should be influenced by implementing new legislation the EU should first take a look at which variable would influence the model of Delarue, E., Lamberts, H., & D'haeseleer, W. (2007) the most. Within this part of the paper we will take into account effiency levels change with 10%, price change of 10% and C0-2 output change of 10%. From there on, we will consider what impact this has on the fuels switch price. The variable that lowers the ACswitch price the most will be the one most interesting to influence by legislation due to the fact that the EU still faces problems in keeping up a decent allowance price. The reader should be advised that all the sitations described below are ceteris paribus. We of course acknowlegde that changes in two or more variables might lead to a bigger increase or decrease. While we just want to know which variables seperately lead to the largest decrease in the ACswitch price, we will only look to situations in which one variable changes.

Table 3. Hypothetical counterfactual situations when price changes.

Coal price 10% +	ACswitch = 12.651679 Euro
Natural gas price 10% +	ACswitch = 16.573459 Euro
Coal Price 10% -	ACswitch= 17.481883 Euro
Natural gas price 10% -	ACswitch= 11.145001 Euro

As could be expected, a decrease of natural gas price and a rise in the coal price would lead to a lower ACswitch price. Compared with the original price of 15.066781 the largest price change is when natural gas prices would decrease with 10%. This would lead to ACswitch price decrease of 26.02%. The price elasticity would then be -2.6% (for every procent the natural gas price drops, the ACswitch price will drop with 2.6%). Of course we realize that for instance an increase in the coal price and a drop in the natural gas price would ensure an even lower ACswitch price.

The next situation we would have to describe would be when there is a change in efficiency outcomes from the different kind of power plants.

Table 4. Hypothetical counterfactual situations when efficiency changes.

Coal efficiency 10% +	ACswitch= 31.188956 Euro
Natural gas efficiency 10% +	ACswitch= 7.8761905 Euro
Coal efficiency 10% -	ACswitch= 3.9003705 Euro
Natural gas efficiency 10% -	ACswitch= 29.127284 Euro

When looking at the ACswitch changes, the largest change would be when we would decrease the coal efficiency output with 10%. This would lead to a switch price of 3.9003705. Compared with the original price of 15.066781 this is a decrease of the ACswitch of 69.41%. This would mean that there is a price elasticity of -6.941%. Because this is not a realistic measure to implement we will take into account the fact that a 10% + change in natural gas efficiency also leads to a drop in the ACswitch price. This leads to a decrease of the ACswitch price of 47.72% in comparison with our price discovered when taking Germany as our case study. This leads to a price elasticity of - 4.77%.

The last variable that we would have to describe would be the C0-2 output levels of both the coal and gas-fired power plants. We will once again calculate the situations in which both types of power plants have an increase or decreaes of 10% in their GHG output level in comparison with the Germany case study. It has to be noted that in this hypothetical situation we will both calculate the ACswitch point in situations where the C0-2 output is rising. This is exactly the opposite of what we want to achieve.

Table 5. Hypothetical counterfactual situations when C0-2 Output changes.

Coal C0-2 Output 10% +	ACswitch= 13.148753 Euro
Natural gas C0-2 Output 10% +	ACswitch= 16.481514 Euro
Coal C0-2 Output 10% -	ACswitch= 18.462709 Euro
Natural gas C0-2 Output 10% -	ACswitch= 14.379792 Euro

Changes in C0-2 output lead to smaller changes when compared with the other variables. While the largest decrease in ACswitch price would be the one when rising the C0-2 output of coal with 10%, this is once again not what we would want to achieve. The best option therefore would lie in decreasing the C0-2 output of natural gas with 10%. This leads to a decrease in

ACswitch of 4.55% in comparison with the original price of 15.066781 Euro. Our price elasticity would be -0.45 %.

Concluding remarks.

By using the model of Delarue, E., Lamberts, H., & D'haeseleer, W. (2007) we have now calculated the current situation in which Germany could and should perform a fuel switch. Taking Germany as our case study, we then started calculating counterfactual situations in which one of the variables would change. We now have a clear view on which variables are the most efficient in terms of decreasing the AC switch price. A lower switch price will make sure that countries are sooner willing to perform a fuel switch, due to the economic benefits that will be obtained.

From this point on, we can see on which issues the EU should improve its legislation concerning the fuel switch to reduce the GHG-output within Europe.

Conclusions from the case study above are that improving natural gas-fired power plants to ensure a higher level of efficiency would be the most important factor to improve. Once this has been done the EU could start working on trying to influence the natural gas price. The least effective way of influencing the clean dark/clean spark margin would be by trying to reduce the C0-2 output while producing.

EU legislative actors would therefore be advised to implement legal acts that could force natural gas-fired power plants to innovate, ensuring a higher level of efficiency. It should be noted, that new technology available already makes sure that efficiency levels of around 60% are obtained. We have to take into account that all these implementations can only be done if legislative proposers such as the Commission are willing to implement these changes.

Chapter 3.2
The EU: legislative advice

From the research conducted in the previous chapter we can conclude which part of legislation would be the most beneficial to legislative promotion of fuel switching. Trying to influence the efficiency level of natural gas fired-power plants would be by far the most interesting option.

Within this chapter I will conduct research on which legislative basis the EU will stand most firm when implementing legislation on the variables described in our research done in the previous chapter. We will compare the powers given within this legislation. From there, I will draw conclusion which variable should be based on which directive when trying to influence the clean dark/ clean spark margin. Within this chapter I will analyze all of the implemented legislation above and see how this can be used when trying to influence the clean dark/clean spark margin. I do not wish to explain on how other agents might influence decision making. I only want to make clear which legal basis suits best for which variable. It is then for the EU to decide how to act on it.

Within our research we will use the Directive 2003/87/EC and its most adjacent legislation: Directive 96/61/EC replaced by Directive 2008/1 and *2001/80/EC.* Soft law regulations like *Council Directive 85/337/EEC* and *Directive 2001/42/EC* are also taken into account.

Directive 2003/87/EC.

Within the European Trade Scheme directive itself the EU has some powers it could use to influence the European Trade Scheme. While this is not really the direction our research, it is important to know that the EU can influence the number of allowances in the upcoming years, therefore indirectly influencing the allowance prices. The value of the current allowances lie around 0.01 Euro. This is far to low when the EU wants to influence the bandwith. Our case study of Germany has learned us that we need an allowance price of around 15,00 Euro. Until the end of this year, the EU can only reduce the number of allowances back to 90%. However, after 2014 it can start influencing the ETS system so that it will make sure that the obligations in the Kyoto protocal to be met in 2020 are acomplished. The Directive states that:

The total quantity of allowances to be allocated for the relevant period shall be consistent with the Member State's obligation to limit its emissions pursuant to Decision 2002/358/EC and the Kyoto Protocol, taking into account, on the one hand, the proportion of overall emissions that these allowances represent in comparison with emissions from sources not covered by this Directive and, on the other hand, national energy policies, and should be consistent with the national climate change programme. The total quantity of allowances to be allocated shall not be more than is likely to be needed for the strict application of the criteria of this Annex. Prior to 2008, the quantity shall be consistent with a path towards achieving or over-achieving each Member State's target under Decision 2002/358/EC and the Kyoto Protocol".

So while the Directive does not give legislative powers influencing the model we used to conduct our research, it can influence the allowance price making sure that the allowance price reaches its much needed level.

Directive 96/61/EC (replaced by Directive 2008/1).

It is within this directive that the EU has the most legal competences to influence the natural gas-fired power plants. *Directive 96/61/EC* has the power to create permits for new and already existing power plants. Within these permits the EU can force countries to use the so called 'best available technique'. It states in article 3 of the directive that:

"Member States shall take the necessary measures to provide that the competent authorities ensure that installations are operated in such a way that: (a) all the appropriate preventive measures are taken against pollution, in particular through application of the best available techniques".

The Energy Technology Systems Analysis Programme (2010) stated that around 2020, most countries will have gas-based turbines which would have efficiency levels around 64%. This is an increase of around 20% compared to current techniques. If the EU could ensure that countries are forced to follow the 'best available technique', future innovations could make sure that the clean dark/clean spark margin will be conquered.

The directive already made sure that the already built power plants had to change to the 'best available technique'. It states in article 5 that:

"Member States shall take the necessary measures to ensure that the competent authorities see to it, by means of permits in accordance with Articles 6 and 8 or, as appropriate, by reconsidering and, where necessary, by updating the conditions, that existing installations operate in accordance with the requirements of Articles 3, 7, 9, 10 and 13, Article 14(a) and (b) and Article 15(2) not later than 30 October 2007, without prejudice to specific Community legislation".

While the directive wants new and existing power plants to use the 'best available technique' it also forces plants to reduce, if possible, their C0-2 output. Article 3 states that:

"Member States shall take the necessary measures to provide that the competent authorities ensure that installations are operated in such a way that: (b) no significant pollution is caused".

So while it can enforce power plants to use the highest efficiency levels it can also force plants to reduce their GHG-output. This does have effect on our model and it directly influences the level of CO-2 output.

This directive gives a lot of power to the European Union, and forcing the Member States to follow could become an important factor in trying to overcome the clean dark/ clean spark margin.

Unfortunately we do not see how this directive could influence the gas and oil prices which are rather market-determined.

Directive 2001/80/EC.

The large cumbustion plant directive enforces Member States to legislatively decrease the emissions from combustion plants which have a therma capacity of 50 MW or greater. This directive does not only apply to fossil-fuel based power plants but also to the steel industries and petroleum refineries.

Within this directive certain limitations have to be noted. First of all the directive is not capable of influencing every type of power plant. In the directive it is stated that:

“Plants powered by diesel, petrol and gas engines shall not be covered by this Directive”.

This directive could therefore only try to influence the C0-2 output of coal fired-power plants. While this does reduce the C0-2 output and therefore this is advisable, the reader must take note that it does influence the ACswitch price in an unadvisable way making it rise. However, we try to reach the ACswitch price because we want to reduce GHG-output within Europe. Therefore not accepting a GHG-output decline in coal fired-power plants is a paradox. I would like to propose to give this paradox an official name from now on: the Akse-paradox of GHG output.

The directive does however give substantial power to the European Union to ensure that there is indeed a decrease in emissions. In Article 4 of the directive it states that:

“(2)Member States shall take appropriate measures to ensure that all licences for the construction or, in the absence of such a procedure, for the operation of new plants, other than those covered by paragraph 1, contain conditions relating to compliance with the emission limit values laid down in part B of Annexes III to VII in respect of sulphur dioxide, nitrogen oxides and dust”.

“(3)Without prejudice to Directive 96/61/EC and Council Directive 96/62/EC of 27 September 1996 on ambient air quality assessment and management (1), Member States shall, by 1 January 2008 at the latest, achieve significant emission reductions by: (a) taking appropriate measures to ensure that all licences for the operation of existing plants contain conditions relating to compliance with the emission limit values established for new plants referred to in paragraph 1; (b) ensuring that existing plants are subject to the national emission reduction plan referred to in paragraph 6”.

While this directive can not influence the efficiency levels of natural gas-fired power plants, it can reduce the C0-2 output of coal fired-power plants and should therefore be taken into consideration.

Council Directive 85/337/EEC.

While the first three directives were more binding in their nature, the European Union has also implemented soft law to promote reduction of GHG. Council Directive 85/337/EEC serves as a good example in which the EU tries to influence both public and private projects when assessing their effects on the environment. Article 2 of the directive states that:

“(1) Member States shall adopt all measures necessary to ensure that, before consent is given, projects likely to have significant effects on the environment by virtue inter alia, of their nature, size or location are made subject to an assessment with regard to their effects.
These projects are defined in Article 4.
(2) The environmental impact assessment may be integrated into the existing procedures for consent to projects in the Member States, or, failing this, into other procedures or into procedures to be established to comply with the aims of this Directive.
(3) Member States may, in exceptional cases, exempt a specific project in whole or in part from the provisions laid down in this Directive. In this event, the Member States shall:
(a) consider whether another form of assessment would be appropriate and whether the information thus collected should be made available to the public;
(b) make available to the public concerned the information relating to the exemption and the reasons for granting it; (c) inform the Commission, prior to granting consent, of the reasons justifying the exemption granted, and provide it with the information made available, where appropriate, to their own nationals. The Commission shall immediately forward the documents

received to the other Member States. The Commission shall report annually to the Council on the application of this paragraph".

Its considerative nature is given in article 8 that states:

"Information gathered pursuant to Articles 5, 6 and 7 must be taken into consideration in the development consent procedure".

Therefore it cannot force Member States and companies to commence any action when trying to influence the variables used in our model. However, while it does not ensure that projects with a high GHG-output are canceled, it might influence the operators due to the peer-pressure involved.

Directive 2001/42/EC.

This directive, compared with *Council Directive 85/337/EEC* had just one difference. Instead of assessing projects and buildings, this directive has been given life to asses plans and programmes from the Member States themselves, including those co-financed by the European Community.

Article 2 explains the difference:

"For the purpose of this Directive: (a) "plans and programmes" shall mean plans and programmes, including those co-financed by the European Community, as well as any modifications to them: which are subject to preparation and/or adoption by an authority at national, regional or local level or which are prepared by an authority for adoption through a legislative procedure by the Parliament or Govermand and which are required by legislative, regulatory or administrative provisions".

As stated before: it simply cannot force Member States and companies to commence any action when trying to influence the variables used in our model. However, while it does not ensure that projects with a high GHG-output are canceled, it might influence the operators due to the peer-pressure involved.

Chapter 3.3
Conclusions: Combining the model of of Delarue, E., Lamberts, H., & D'haeseleer, W. with legislative options.

With the research done in the previous chapters we can now answer our hypothesis. The hypothesis we stated assumed the following:

I expect that the European Union through *both Directive 2003/87/EC* and its adjacent legislation should influence the following variables given in the model of Delarue E., Lamberts H., & D'haeseleer W. (2007):

- Efficiency output levels of gas;
- GHG output levels of Coal-fired power plants.

So, can the European Union with its current legislation influence these given variables?

As given above in our hypothesis we expected that the elasticity of both the efficiency levels of gas and the GHG output levels of coal-fired power plants would be the highest.

Our model proved that changing the elasticity of efficiency levels of gas fired power plants proved to be very effective. With an elasticity level of -4.77% legislation should continue to promote the 'best available technique'.

Changing the GHG output levels of coal-fired power plants would not be effective. Instead, the ACswitch price would rise if legislation would be implemented to promote this kind of change. The second point in my hypothesis is therefore not valid and should be forgotten.

Other variables that could be used to influence the bandwidth are:

- Reduction of natural gas prices;
- Improving efficiency levels of coal-fired power plants;
- Reduction of GHG output of natural gas-fired power plants.

The first point seems rather hard to accomplish due to the fact that natural gas prices are influenced by variables entailing the whole world. The EU could only have a marginal influence. One also has to consider that influencing this price hardly seems to have effect on the ACswitch price, while giving subsidies might give both financial and legislative problems. This is due to the fact that giving the whole EU subsidies on natural gas might be rather expensive, and according to EU law, subsidies can be seen as state aid.

The second point would be improving the efficiency levels of coal-fired power plants. While we actually would not want to promote this (due to the fact that we want to achieve a switch to gas fired-power plants) it does lower the ACswitch price marginally. Because of this marginal effect, it therefore seems not interesting to make this switch.

The last point would be reducing the C0-2 output of natural gas-fired power plants. While we would of course encourage companies to do so, the effect it does have on the ACswitch price seems rather marginal. We would therefore advise to use this as a complementary project to promote the decrease of the ACswitch price.

Chapter IV
Literature List.

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