HELSINKI METROPOLIA UNIVERSITY OF APPLIED SCIENCES
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Is the European Union Emissions Trading Scheme (EU ETS) the best tool to combat climate change?

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ABSTRACT

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The objective and purpose of this research is to discuss and answer whether European Union Emissions Trading Scheme (EU ETS) is the best tool to combat climate change and reduce industrial greenhouse gas emissions. The research is also intended to identify why was the EU ETS chosen amongst other tools/options to combat climate change. Different components that make up the EU ETS were examined to understand and get a clear idea of how the system works and if it is functioning as intended. Currently, global warming being an issue requiring immediate action, governments are in urgent need to find the best tool to reduce greenhouse gas emissions. Does the urgency to find the best tool bias judgment over the choice of the right tool, or is any tool the best tool as long as it favors free market capitalism? Did other options to combat climate change like carbon tax, shifting to low-carbon technologies, use of renewable energy sources or total abandonment of the use of fossil-fuel energy have been considered before the ETS was fabricated?

Methodology: Critical review of diverse relevant data has been carried out both from the proponents of the EU ETS and that of authors and non-governmental organization who are against the EU ETS. Ideas and literatures from both sides have been critically and objectively analyzed to be able to answer the research question satisfactorily.

Findings: The research concluded that the EU ETS is not the best tool to combat climate change considering other better and working alternative tools are available to implement. The EU ETS has many flaws and weaknesses that cannot be corrected using reformation.

Research limitations: The fact that there were not efficient ways to measure (satisfactory data to be able to confidently say that emissions have been reduced) emissions and their reduction results in marginal errors.

Key words: climate change, EU ETS, Emissions trading, cap and trade, Offset, greenhouse gases, emission reduction, low-carbon technologies

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1 INTRODUCTION

An Emissions Trading Scheme (System) is a system where emission allowance permits are given out to certain polluting industries and they can pollute under this permit without exceeding the allowance permit. Emission Trading Schemes work by means of two ways: 'cap and trade' and 'offsets'. Cap is the permitted allowance and trading is the part where industries under the cap, if they have not used the full allowance they can sell and those who have used the allowance fully can purchase from those who have not used the full allowance (saved). The second means is offset. Offset is for pollutants to be involved in some project that contributes to emissions savings (reduction) and the pollutant get the equivalent of the emissions savings as a credit for the right to pollute.

The European Union Emissions Trading Scheme (System) is by far the biggest emissions trading scheme globally, and is implemented widely across member states of the European Union. It is a cornerstone of the European Union's policy to combat climate change and reduce industrial greenhouse gas emissions cost effectively. (European Commission Climate Action 2015a)

1.1 Aim and structure of the research

The purpose of this dissertation is to find out whether the EU ETS is the best tool to combat climate change or not. Emissions trading in general is introduced before going over the details of what EU ETS is in practice. The goal of this research is to closely examine the emissions reductions that are reported to have existed and what factors contribute to these emissions reductions. In addition, it is intended to indicate what possible flaws and possible strengths does the EU ETS have that will help in the process of combating global warming.

The research follows this structure:

- Literature review – generally discusses about global warming, what might have caused it and what are the possible courses of action if we want to prevent the consequences of global warming. This part also discusses in detail about the EU ETS as it is the main topic of the research question.

Finally it discusses some theory that is closely relevant to the research question intended to answer.

- Research methods – explains the research methods chosen and used, what the limitations of the research is and what are the ethical consideration taken in to account.
- Analysis and discussion – The analysis and discussion part as it name implies analyzes and discusses the truthfulness of the literatures under discussion objectively. It also evaluates the concepts with respect to their applicability in practice.
- Conclusions – The conclusion part summarizes the findings of the research and provides necessary courses of action.

2 LITERATURE REVIEW

2.1 Climate change and who caused it?

A large number of facts supported with studies point out that the Earth's climate is changing rapidly and these studies reveal the causes of the change are the increases in greenhouse gases (GHG). Human activities are the major cause for increased GHGs and in turn changing the climate. Since pre-industrial times, concentration of carbon dioxide (CO_2) have risen from 280 parts per million (ppm) to 380 ppm now with the increased concentrations of other GHG like methane and nitrous oxide. These rises in concentration are a result of burning fossil fuels, deforestation and other land use changes. (Stern 2006: 4)

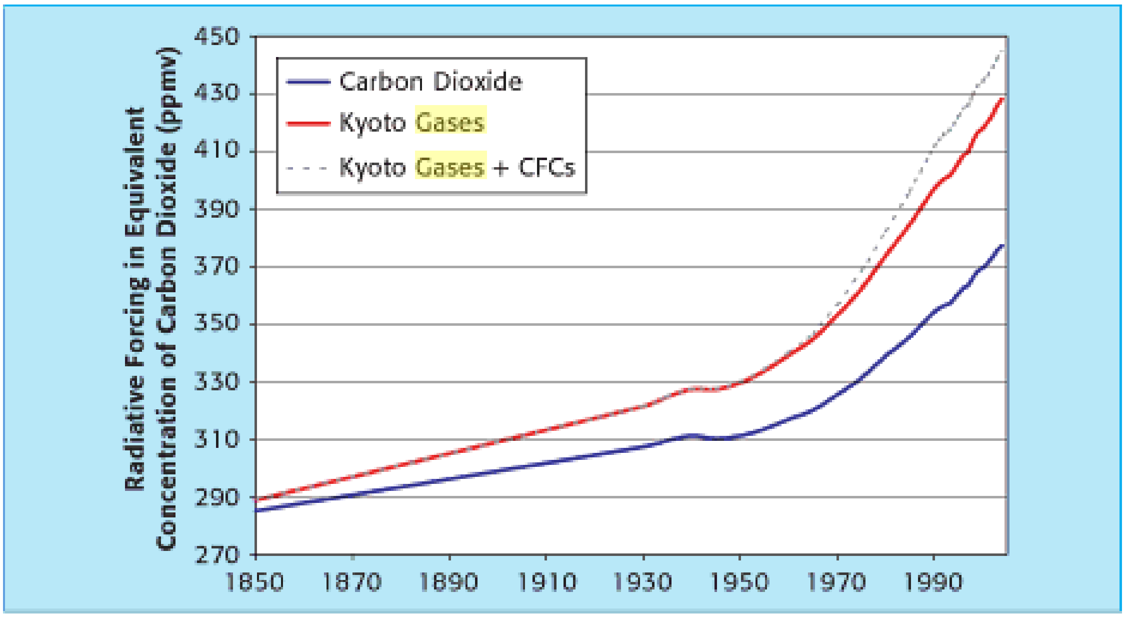

Figure 1 Rising levels of greenhouse gases

Source: Stern (2006)

The figure above shows the warming effects of GHG in the form of equivalent concentration of carbon dioxide (CO_2 equivalent). The blue line is carbon dioxide, the red line is the six Kyoto GHGs (carbon dioxide, methane, nitrous oxide, PFCs, HFCs and SF_6) and the grey line is the Kyoto GHGs including CFCs (Chlorofluorocarbon), which is regulated under the Montreal Protocol.

There is evidence that the increase in the GHGs have a direct effect on the warming of the climate in that the GHGs help the heat energy (infrared radiation) from the sun to stay in the atmosphere and not completely reflected by earth. This phenomenon is called the 'greenhouse effect'. The warming effect of all the Kyoto GHGs emitted by human activities is now equivalent to 430 ppm of CO_2 equivalent (CO_2e) and rising every year by around 2.3 ppm that can be seen from Figure 1 above. At the moment, the levels of greenhouse gases are the highest in history when we look back the past 650,000 years. (Stern 2006: 5)

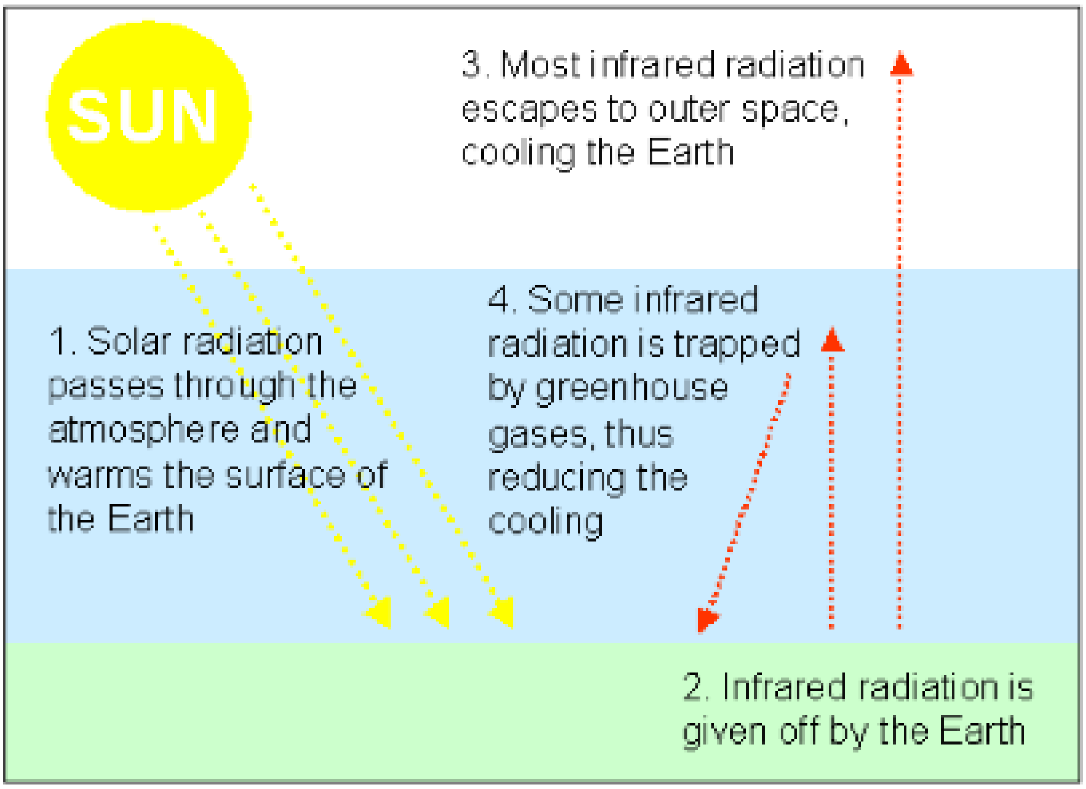

Figure 2 The greenhouse effect
Source: Stern (2006)

In the past 100 years the global mean surface temperatures have risen by 0.7°C and in the last 30 years, even more at a greater rate approximately 0.2°C per decade. The International Panel for Climate Change (IPCC) came to a conclusion based on evidence and investigation that most of the global warming caused in the past 50 years is as a result of human activities. While natural factors like the change in solar intensity and volcanic eruptions can explain the global temperatures of the early nineteenth century, the only explanation for the rise in global temperatures in the last 50 years is the increasing levels of the GHGs. (Stern 2006: 7)

Figure 3 below shows the change in world average temperature from 1850 -2005. The red bars show the individual yearly average temperatures.

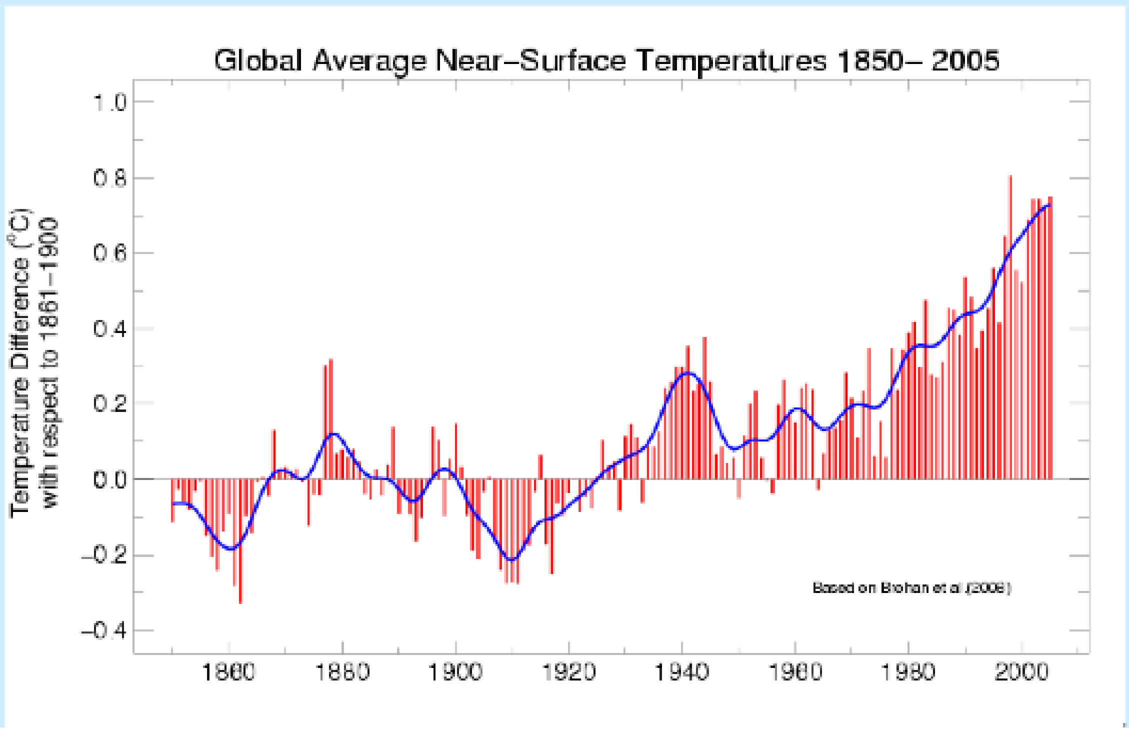

Figure 3 The earth has warmed 0.7°C since around 1900.
Source: Stern (2006)

2.2 What can be done?

Our planet will be very hostile to live in during the next hundred years if GHGs continue to rise the way they do and not get reduced so that the global temperatures reach the expected levels. Climate change threatens the very existence of humans by limiting access to water, food production, health, the environment and the use of land. If present trends continue, where average global temperatures on the rise by 2-3 degree Celsius, devastating impacts will be seen as a result of the rise in temperature in the next fifty years. These include frequent droughts and floods in addition to melting glaciers, declining crop yields, ocean acidification, rising sea levels not to mention the deaths from malnutrition and heat stress. (Stern 2006: 65)

Even though the above-discussed point reveals a severe, harsh and devastating impact of the climate change as a result of the increase in the average global temperatures, there are some measures that can be taken to delay or even avoid the worst impacts of the climate change but if only acted up on urgently and globally. Measures that can be taken should be shared in all parts of the world. It is not only the responsibility of developed countries but also that of the developing countries. This does not mean that the developing countries should take on all the costs of the action on climate change but with the help of the developed countries. Developed countries have started to finance low-carbon development through Clean Development Mechanism (CDM). It is possible to reduce emissions to keep the required average global temperatures with carefully studied policies if both developing and developed countries work together with shared value and long-term goals. For this global action and policy there needs to be three essential characteristics.

- Pricing of carbon- put in to effect through tax, trading or regulation
- Developing and innovating low-carbon technologies
- Removing barriers to energy efficiency

These essential characteristics should include structures like technology cooperation, action to reduce deforestation, adaptation and emissions trading. (Stern 2006)

Technology cooperation

Coordination and cooperation between governments allow effectiveness for research and development of new low-carbon technologies. In addition to that, cooperation allows for the production of energy efficient product with better standard.

Action to reduce deforestation

The presence of forest has the ability to cool the atmosphere. In comparison to the transport sector, deforestation annually causes more global warming. Action to reduce deforestation and keeping more and more areas forested is one of the most cost-effective ways of reducing emissions. This type of program can be carried out for instance in CDM.

Adaptation

The most exposed countries to climate change are the poorest countries with reference to their location and the fact that they cannot do much to change the situation because of poverty. So it is very important that developing countries seriously consider climate change in their development programs and developing countries support their incentives concerning climate change.

Carbon tax

It is essential to support and actively encourage carbon tax on carbon contents of fossil fuel namely coal, oil and natural gas. Promoting carbon tax to national and global level is necessary because it has a driving effect to drastically reduce emissions and incentivize pollutants to move to cleaner and low-carbon energy sources.

2.3 The fossil-fuel generation

There are plenty of reasons to say we are a fossil-fuel generation. China and India are expected to generate 60 percent of the increase predicted in global economic growth, which is 115 percent by year 2035. As the economic growth of the emerging markets reaches that of the developed countries, the global production is predicted to increase 75 per cent in global production per person. The growth in population and its demand is the reason for the projected production increase. But as a result of energy efficiency only a 37 per cent increase in energy consumption is expected. (Wolf 2015)

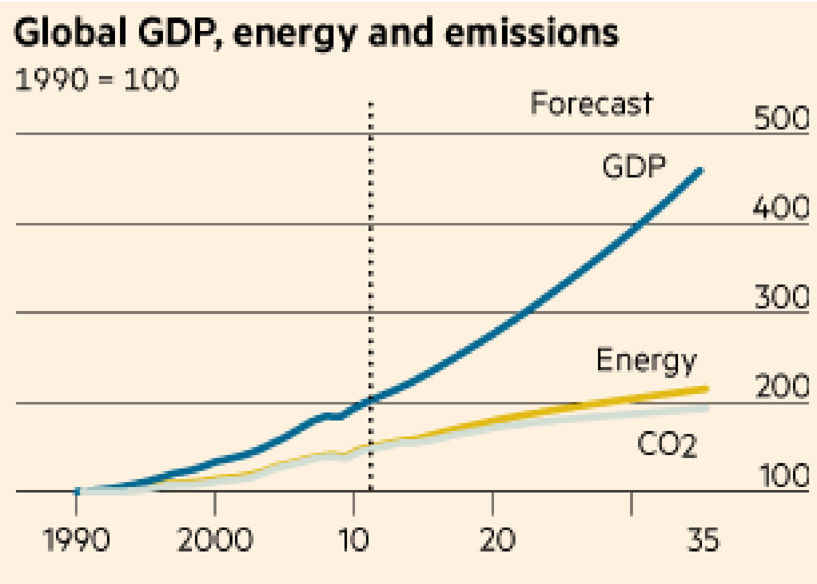

Figure 4 Global GDP, energy and CO_2 emissions
Source: Financial Times

Carbon dioxide emissions are predicted to increase by 25 per cent but compared to the output projected the emission looks far less. Looking at it in terms of keeping the global average temperature under 2°C, it is not acceptable. In 2035, CO_2 emissions are expected to be 18 billion tones more than the amount suggested to keep the global rise in average temperatures under 2°C.

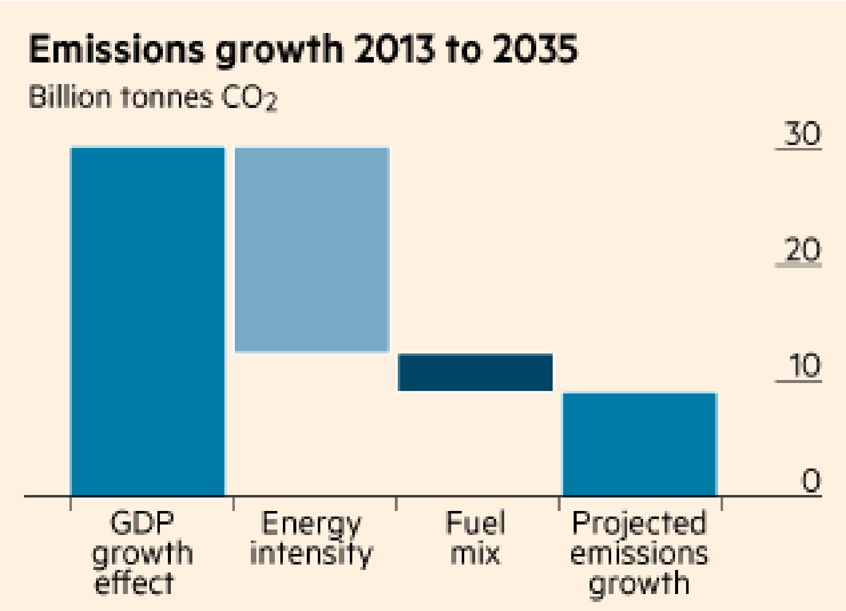

Figure 5 Emissions growth 2013-2035

Source: Financial Times

Achieving a better energy efficiency is hugely important to reduce emissions. Between 2013-2035, renewable energy output is predicted to increase by 320 per cent. But its share in primary energy production is only to increase from 2.6 per cent to 6.7 per cent.

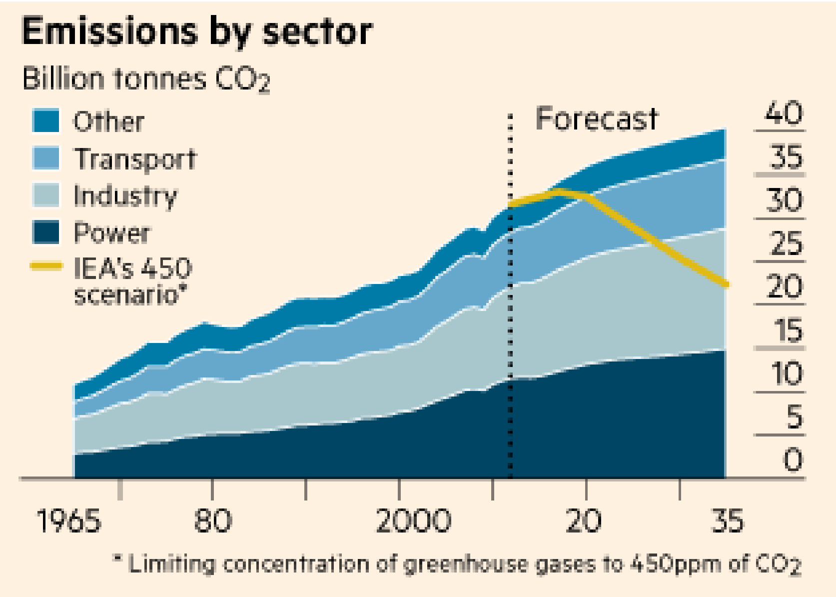

Figure 6 CO_2 emissions by sector

Source: Financial Times

Renewable energy, hydroelectricity and nuclear power together increase only from 9 per cent to 19 per cent. These predictions are not simple. They show a faster increase in energy efficiency for instance between 2000-2013. But our planet is still depending on fossil-fuel and it will emit large quantities of GHGs and these predictions make this age the fossil-fuel age.

2.4 What is the EU ETS?

Before going to discuss what the EU ETS is let us first digest some important concepts.

2.4.1 Emissions trading (Carbon trading)

An economist called Ronald Coase start to promote the idea of 'pollution trading' in the 1960s. He thought pollution should be part of a cost of production ('the right to perform a certain action'). He explained this in his theory 'the problem of social cost' referring to the actions of business firms that have harmful effects on others. He believed if some price were assigned for pollution as a cost of production, it would discourage firms from polluting the environment because it would be more and more expensive for them as production increases. (Coase 1990: 155) wrote

> "If factors of production are thought of as rights, it becomes easier to understand that the right to do something which has a harmful effect (such as the creation of smoke, noise, smells, etc.) is also a factor of production. Just as we may use a piece of land in such a way as to prevent someone else from crossing it, or parking his car, or building his house upon it, so we may use it in such a way as to deny him a view or quiet or unpolluted air. The cost of exercising a right (of using a factor of production) is always the loss which is suffered elsewhere in consequence of the exercise of that right- the inability to cross land, to park a car, to build a house, to enjoy a view, to have peace and quiet or to breath clean air".

Coase started his pollution-as-a-cost-of-production idea early before governments started to worry about climate change as much. When governments started to increasingly worry about climate change and finding a solution to emissions reduction they started to pick up Coase's idea. The Kyoto Protocol is one place where pollution trading (carbon trading) was presented as an option for tackling global climate change.

The Kyoto Protocol is the international treaty for climate change that pledges countries to reduce greenhouse gas emissions under a notion that global warming exists and human action has caused it. In the Kyoto Protocol countries are categorized in two groups: those who should act according to the target set in the protocol also known as Annex 1 countries and those who do not have to. Annex 1 countries are those very industrialized countries that contribute to the majority of the greenhouse gas emissions. The Annex 1 countries are required to reduce their emissions under the target with the exception of Australia, Iceland and Spain that can increase their emissions but they can still increase their emissions under the target. Since the greenhouse gas emissions of the developing countries are negligible, there is no target set for them. (Kill et al. 2010: 33)

In the Kyoto protocol in 1997, the USA not only refused to sign the treaty but also played a major role in promoting Emissions trading in the major provisions of the Kyoto protocol. (Saundry 2013) As a condition for accepting the Kyoto Protocol, the United States introduced carbon trading for the Annex 1 countries. This means that if the Annex 1 countries do not want to reduce their emissions locally they can produce emissions as much as they want as long as they could buy promise of emissions reduction in other Annex 1 countries. This actually means there is no reduction in emissions but rather to fully use what is under the target set. In addition to cap and trade the surplus allocations for countries under the Kyoto Protocol, it is also possible to increase emissions out of the cap by a means of offsets in the project called Clean Development Mechanism (CDM) and report that they are still under the cap. That is how the conception of emissions trading came about. Emissions (carbon) trading is a system with an objective to meet emissions reduction target with a minimal cost for companies and governments. In reality though, the targets can be met without emission reduction.

Carbon trading is a complex system that works mainly in the form of 'Cap and trade' and 'Offsets' and sometimes a combination of the two. Some pollution trading systems use only emissions trading ('cap and trade') an example of this is the US sulphur dioxide market. The Kyoto Protocol and EU Emissions Trading Scheme use a combination of the emissions trading ('cap and trade' allowances) and 'offset' trading.

2.4.2 Cap and Trade

Cap and trade is a system where governments or government bodies give out pollution permits called 'carbon permits' for different industries. If one industry then pollutes less than the given allowed carbon permits, it can trade the unused allowance to another industry that has fully used its permits. This is the system under which the EU ETS is functioning since adopting it in 2005. The EU ETS is the largest carbon trading market, estimated at USD 63 billion in 2008 and increasing. The theory of 'cap and trade' is that the carbon allowances will be abated through time so the market keeps its value. The cap part sets the regulation on the limit of pollution and on the other hand the trading part does not reduce emissions but rather gives room for companies that fail to meet the required legal pollution limit to pollute more by buying permits cheaper. This allows companies to pollute as much as they want with no restrictions or consequences inexpensively. (Gilbertson and Reyes 2009:10)

The cap and trade works this way. Let's assume two companies A and B both with a pollution capability of 100,000 tonnes of CO_2 per year. If the government wants them to reduce their emissions by 5%, then their granted emission allowance now is 95,000 tonnes of CO_2 per year. This means that if company A or B choose to emit more than 95,000 tonnes of CO_2 a year, they need to buy it from the market or from each other. If the market price for allowances is €10 per tonne and company A find a way to be able to reduce its emissions for €5 per tonne, it is simply reasonable for company A to reduce its emissions by 5,000 tones and pays €25,000 instead of paying the market price €50,000. More preferable and more profitable scenario for company A would be to save its emissions by 10,000 tonnes and sell the extra 5,000 tonnes for a market price of €50,000. Company A can achieve this without paying anything extra but saves €25,000 if it was to buy 5,000 tonnes. The more emissions cut company A makes the more money it will make.

On the other hand for company B, is it somehow expensive to make emissions reductions, it will cost €15 for a tonne. Obviously, company B would prefer to buy 5,000 tonnes of extra allowances from A cheaper and pays €50,000. It would have cost company B €75,000 to reduce emissions but now company B saves €25,000.

The idea here is that the two companies have cut emissions according to the regulation but by sharing the emissions reduction target. In addition to meeting the emissions reduction target, they now (with the presence of the trading) can also save money or even make more money that they would not have without the presence of trading. (Gilbertson and Reyes 2009:47)

2.4.3 Carbon offsets (Carbon credits)

Carbon offsets are basically emissions saving projects, the largest being the UN Clean Development Mechanism (CDM) with over 7600 projects (UNFCCC 2015). Carbon offsets are considered to be emissions reduction but they do not reduce emissions. It is not reducing emissions in one location but rather assuming that emissions saving will happen somewhere else so pollution stays the same level at the first location. The idea is based on calculating how much greenhouse gas has entered the atmosphere compared to the scenario where the emissions saving project did not happen at all. The mathematical conclusion of carbon offsetting is that, as a result of the emissions saving project less greenhouse gas will be entering the atmosphere and as a result emission is reduced.

Let us consider again the companies A and B used previously for the carbon offset. Both with a pollution of CO_2 100,000 tonnes per year and the state want from company A and B an emission reduction of 5%. This time also the allowances of emissions granted for companies A and B are the same as before which is 95,000 tonnes of CO_2 per year. What is different this time is that the state added a condition where if companies A and B do not want to make emissions reductions, they can invest in emissions reduction projects mainly in developing countries that cut emissions by 5,000 tonnes. This project (credit) costs €4 per tonne because of different factors, for instance low labor cost, subsidies from states and World Bank. Now it is much cheaper for both companies A and B to buy the credits from this kind of projects from developing countries than to make emissions reduction. As seen previously using 'cap and trade' system it would cost €25,000 for company A and €75,000 for company B to make emissions reduction by 5,000 tonnes if they do not trade. Using carbon offset credits, it would now cost company A and B

€20,000 each to make emissions reduction by the same amount which is €5,000 and €55,000 cheaper for company A and company B respectively. (Gilbertson and Reyes 2009:48)

Emissions trading schemes become overly complex when trading systems use a combination of more than one system, for instance when companies under the scheme are given the option of reducing their own emissions and/or trade allowances with each other and buy offset credits from developing countries in any combination.

2.4.4 EU ETS

Now that emissions trading, cap and trade and carbon offsets are explained, the EU ETS can then be elaborated. As European Commission Climate Action (2015a) says

> "The EU Emissions Trading System (EU ETS) is a cornerstone of the European Union's policy to combat climate change and its key tool for reducing industrial greenhouse gas emissions cost-effectively. The first and still by far the biggest internal systems for trading greenhouse gas emission allowances, the EU ETS covers more than 11,000 power stations and industrial plants in 31 countries, as well as air lines."

The EU ETS is in effect in 28 of the member states in addition to Iceland, Liechtenstein and Norway and covers close to half of the EU's greenhouse gas emissions. It is a major source of investment in an environmentally sustainable development as it is the biggest market for emissions saving projects where by carbon credits are generated. The EU ETS also an inspiration for other emissions trading systems in different parts of the world. (European Commission Climate Action 2013)

How the EU ETS works

The EU ETS works with a 'cap and trade' principle where high emitting industries with in the EU under the cap are given emission allowances, and they can buy and sell under this cap. Starting from 2013, every year the cap for emissions of industries is abated by 1.74% until 2020 leading to a reduction of 21% greenhouse gas emissions compared to the level that was in 2005. On the other hand for the aviation industry the target is to reduce it by 5% for the whole 2013-2020 from where the average annual emissions were in 2004-2006. (European Commission Climate Action 2013) Emitting industries are also able to buy credits from some approved emission saving projects from other parts of the world.

The fact that companies under the cap have to buy allowances, use credits or sell allowances gives them a motivation and encouragement to reduce their emissions. These flexibilities lead companies to use the most cost effective methods for their emissions, for instance whether to invest in more efficient technology/low carbon technology or to buy extra allowances or choose both.

The EU ETS allowances

So far there are two types of allowances, freely allocated allowances and starting from 2013, the auctioning method to allocate allowances. Before 2013 allowances were mainly given for free which the EU now sets a goal to phase out by 2027. As of 2013 all power generators must buy allowances by auctioning. This is because it has been seen that power generators have put prices to customers that is equivalent to the cost of allowances even though they get the allowances for free.

Beginning in 2013, more than 40% of the allowances are auctioned and this percentage will be increasing year by year. Eighty eight per cent of the allowances will be auctioned out to governments based on the emissions percentage they had in 2005, ten per cent will be distributed to the poorest member states to help them acquire extra revenue and the last two percent will be given for 9 member states as a reward for Kyoto goals reducing greenhouse gas emissions by 20% in 2005. The member states getting the reward are Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania and Slovakia. In areas other than the power generation where free allowances still exist, the change to auctioning will be implemented gradually. For instance, manufacturing industry will be given 80% of its allowances for free in 2013, which will decrease gradually to 30% by 2020. For the aviation sector, 85% of its allowances will be for free from 2013-2020. (European Commission Climate Action 2013)

Phase I (2005-2007)

For member states of the EU to reach the target set by the Kyoto Protocol, there needs to be a place where the EU ETS needs to function effectively and efficiently, where the

EU ETS can learn from experience and by doing, that is Phase I. In Phase I the EU ETS dealt with CO_2 from power generators and energy intensive industries and allowances were given to different industries free of charge. Phase I marked the establishment of the biggest carbon market possibly in the world but the lack of securing reliable emissions data made it in such a way that caps were set on the basis of guessing. This was shown in 2007 when the price of carbon fell to zero as a result of excessive distribution of allowances. (European Commission Climate Action 2015b) The Phase I allowance cannot be used in Phase II. Even though surplus allowances were granted to different industries, Phase I played a major role in collecting real annual emissions data from the participants, putting a solid foundation for setting caps for Phase II.

Phase II (2008-2012)

At the beginning of Phase II, Iceland, Liechtenstein and Norway joined from the EEA-EFTA area and nitrous oxide emissions from nitric acid production was introduced. The free allowances were decreased by some 10%. The penalty for non-compliance was increased from €40 in Phase I to €100 in Phase II per tonne. In phase II industries were allowed to buy carbon credits from CDM and Joint Implementation (JI) that adds up to 1.4 billion tonnes of CO_2e. As a result of the possibility of buying carbon credits, EU ETS became the biggest source of demand for carbon offsets, which in turn makes the EU ETS the major tool for clean energy investment both in developing countries and economies in transition.

Depending on the collected annual emissions data in Phase I, the cap was fixed, decreasing allowances by 6.5% from 2005 level. There was a lot less demand for allowances in Phase II as a result of the economic crisis in 2008 that allowed a surplus of unused allowances on the carbon market. The aviation sector was introduced to the EU ETS at the beginning of 2012 setting the cap at 97% of what aviation emissions were 2004-2006 and 85% of the allowances were given for free. (European Commission Climate Action 2015b)

Phase III (2013-2020)

Phase III is different from previous phases and had went through a serious revision that is approved in 2009 to make EU ETS strong. In Phase III instead of the previous national caps, a single EU-wide cap is adopted. The default method has changed from the earlier free allowances to auctioning where at the beginning of Phase III, 40% of allowances are auctioned and a gradual shift towards auctioning of allowances will be developed instead of the free distribution of allowances every year. (European Commission Climate Action 2015a) The rest of the free allowance still being granted will be based on greenhouse gas emissions performance. Those with low emissions production will be rewarded with more free allowances and those with high emissions will get less free allowances forcing industries to reduce their emissions, buy additional allowances or credits to cover their emissions. In Phase III also 300 million allowances were put aside to fund renewable energy technologies and carbon capture and storage.

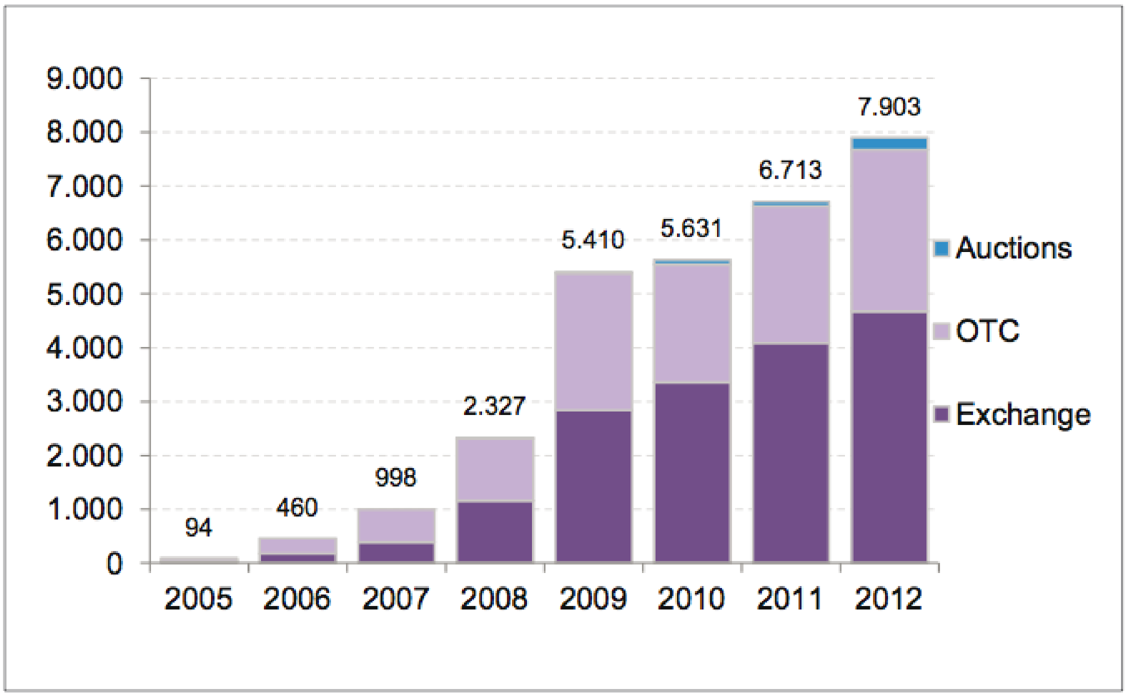

Figure 7 Trading volumes in EU emission allowances (in millions of tones)

Source: European Commission EU ETS factsheet

2.5 The problem of the social cost

'The problem of the social cost' is an article by Ronald Coase that explains the problem of externality that action of business firms, which have harmful effects on others. He used examples to illustrate his idea. One of the examples he used is the cattle-herder versus the farmer and the other one is the confectioner versus the doctor, which are going to be discussed below.

In the cattle herder versus the farmer Coase (1990) wrote

> "I propose to start my analysis by examining a case in which most economists would presumably agree that the problem would be solved in a completely satisfactory manner: when the damaging business has to pay for all the damage caused and the pricing system works smoothly (strictly this means that the operation of a pricing system is without cost)
>
> A good example of the problem under discussion is afforded by the case of straying cattle, which destroy crops growing on neighboring land. Let us suppose that a farmer and a cattle-raiser are operating on neighboring properties. Let us further suppose that, without any fencing between the properties, an increase in the size of the cattle-raiser's herd increases the total damage to the farmer's crops. What happens to the marginal damage as the size of the herd increases is another matter. This depends on whether the cattle tend to follow one another or to roam side by side, on whether they tend to be more or less restless as the size of the herd increases, and on other similar factors. For my immediate purpose, it is immaterial what assumption is made about marginal damage as the size of the herd increases.
>
> To simplify the argument, I propose to use an arithmetical example. I shall assume that the annual cost of fencing the farmer's property is $9 and that the price of the crop is $1 per ton. Also, I assume that the relation between the number of cattle in the herd and the annual crop loss is as follows

Number of herd (Steers)	Annual Crop Loss (Tons)	Crop Losss per Additional Steer (Tons)
1	1	1
2	3	2
3	6	3
4	10	4

> Given that the cattle-raiser is liable for the damage caused, the additional annual cost imposed on the cattle-raiser is he increased his herd from say 2 to 3 steers is $3, and in deciding on the size of the herd, he will take this into account along

with his other costs. That is, he will not increase the size of the herd unless the value of the additional meat produced (assuming that the cattle-raiser slaughters the cattle) is greater than the additional costs that this will entail, including the value of the additional crops destroyed. Of course, if , by the employment of dogs, herdsmen, aeroplanes, mobile radio, and other means, the amount of damage can be reduced, these means will be adopted when their cost is less than the value of the crop which they prevent being lost. Given that the annual cost of fencing is $9, the cattle-raiser who wished to have a herd with 4 steers or more would pay for fencing to be erected and maintained, assuming that other means of attaining the same end would not do so more cheaply. When the fence is erected, the marginal cost due to the liability for damage becomes zero, except to the extent that an increase in the size of the herd necessitates a stronger and therefore more expensive fence because more steers are liable to lean against it at the same time. But, of course, it may be cheaper for the cattle-raiser not to fence and to pay for the damaged crops, as in my arithmetical example, with 3 or fewer steers.

It might be thought that the fact that the cattle-raiser would pay for all crops damaged would lead the farmer to increase his planting if a cattle-raiser came to occupy the neighboring property. But this is not so. If the crop was previously sold in conditions of perfect competition, marginal cost was equal to the price for the amount of planting undertaken, and any expansion would have reduced the profits of the farmer. In the new situation, the existence of crop damage would mean that the farmer would sell less on the open market, but his receipts for a given production would remain the same since the cattle-raiser would pay the market price for any crop damaged. Of course, if cattle-raising commonly involved the destruction of crops, the coming into existence of a cattle-raiser industry might raise the price of the crops involved and farmers would then extend their planting. But I wish to confine my attention to the individual farmer.

I have said that the occupation of a neighboring property by a cattle-raiser would not cause the amount of production, or perhaps more exactly the amount of planting, by the farmer to increase. In fact, if the cattle-raising has any effect, it will be to decrease the amount of planting. The reason for this is that, for any given tract of land, if the value of the crop damaged is so great that the receipts from the sale of the undamaged crop are less than the total costs of cultivating

> that tract of land, it will be profitable for the farmer and the cattle-raiser to make a bargain whereby that tract of land is left uncultivated. This can be made clear by means of an arithmetical example. Assume initially that the value of the crop obtained from cultivating a given tract of land is $12 and that the cost incurred in cultivating a given tract of land is $10, the net gain from cultivating the land being $2. I assume for the purposes of simplicity that the farmer owns the land. Now assume that the cattle-raiser starts operations on the neighboring property and that the value of the crops damaged is $1. In this case $11 is obtained by the farmer from sale on the market and $1 is obtained from the cattle-raiser for damage suffered and the net gain remains $2. Now suppose that the cattle-raiser finds it profitable to increase the size of his herd, even though the amount of damage rises to $3; which means that the value of the additional meat production is greater than the additional costs, including the additional $2 payment for the damage. But the total payment for the damage is now $3. The net gain to the farmer from cultivating the land is still $2. The cattle-raiser would be better off if the farmer would agree not to cultivate his land for any payment less than $3. The farmer would be agreeable to not cultivating the land for any payment greater than $2. There is clearly a room for a mutually satisfactory bargain which would lead to the abandonment of cultivation." Pp. 96-99

In the above example, the scenario is that the cattle-raiser is liable for the damage of the crops. It can also be observed below that if the cattle-raiser is not liable for the damaged crops, the allocation of resources would not change.

> "The farmer would suffer increased damage to his crop as the size of the herd Increased. Suppose that the size of the cattle-raiser's herd is three steers (and that this is the size of the herd that would be maintained if crop damage was not taken into account). Then the farmer would be willing to pay up to $3 if the cattle-raiser would reduce his herd to two steers, up to $5 if the herd were reduced to one steer, and up to $6 if cattle-raising was abandoned. The cattle-raiser would therefore receive $3 from the farmer if he kept two steers instead of three. This $3 foregone is therefore part of the cost incurred in keeping the third steer. Whether the $3 is a payment which the cattle-raiser has to make if he adds the third steer to his herd (which it would be if the cattle-raiser was

liable to the farmer for damage caused to the crop) or whether it is a sum of money which he would have received if he did not keep a third steer (which it would be if the cattle-raiser was not liable to the farmer for damage caused to the crop) does not affect the final result. In both cases $3 is part of the cost of adding a third steer, to be included along with the other costs. If the increase in the value of production in cattle-raising through increasing the size of the herd from two to three is greater than the additional costs that have to be incurred (including the $3 damage to crops), the size of the herd will be increased. Otherwise, it will not. The size of the herd will be the same whether the cattle-raiser is liable for damage caused to the crop or not.

It may be argued that the assumed starting point – a herd of three steers- was arbitrary. And this is true. But the farmer would not wish to pay to avoid crop damage, which the cattle-raiser would not be able to cause. For example, the maximum annual payment, which the farmer could be induced to pay, could not exceed $9, the annual cost of fencing. And the farmer would only be willing to pay this sum if it did not reduce his earnings to a level that would cause him to abandon cultivation of this particular tract of land. Furthermore, the farmer would only be willing to pay this amount if he believed that, in the absence of any payment by him, the size of the herd maintained by the cattle-raiser would be four or more steers. Let us assume that this is the case. Then the farmer would be willing to pay up to $3 if the cattle-raiser would reduce his herd to three steers, up to $6 if the herd were reduced to two steers, up to $8 if one steer only were kept, and up to $9 if cattle-raising were abandoned. It will be noticed that the change in the starting point has not altered the amount, which would accrue to the cattle-raiser if he reduced the size of his herd by any given amount. It is still true that the cattle-raiser could receive an additional $3 from the farmer if he agreed to reduce his herd from three steers to two and that the $3 represents the value of the crop that would be destroyed by adding the third steer to the herd. Although a different belief on the part of the farmer (whether justified or not) about the size of the herd that the cattle-raiser would maintain in the absence of payments from him may affect the total payment he can be induced to pay, it is not true that this different belief would have any effect on the size of the herd that the cattle-raiser will actually keep. This would be the same as it would be if the cattle-raiser had to pay for damage caused by his cattle, since a

> receipt foregone of a given amount is the equivalent of a payment of the same amount.
>
> It might be thought that it would pay the cattle-raiser to increase his herd above the size that he would wish to maintain once a bargain had been makde, in order to induce the farmer to make a larger total payment. And this may be true. It is similar in nature to the action of the farmer (when the cattle-raiser was liable for damage) in cultivating land on which, as a result of an agreement with the cattle-raiser, planting would subsequently be abandoned (including land which would not be cultivated at all in the absence of cattle-raising). But such maneuvers are preliminaries to an agreement and do not affect the long-run equilibrium position, which is the same whether or not the cattle-raiser is held responsible for the crop damage brought about by his cattle.
>
> It is necessary to know whether the damaging business is liable or not for damage caused, since without the establishment of this initial delimitation of rights there can be no market transactions to transfer and recombine them. But the ultimate result (which maximizes the value of production) is independent of the legal position if the pricing system is assumed to work without cost." Pp. 102-104

From the above famous cattle versus crops example, it can be seen that there is a conflict of interest that the farmer wants to grow crops and the cattle-raiser wants his cattle to roam in the farmer's crop. The question is whether the cattle-raiser is responsible for the damage the cattle made to the crop or it is the cattle-raiser's right to leave the cattle to damage the crops. (Bryan 2013) Coase as shown above says that regardless of the allocation of resources, both the cattle raiser and the farmer are responsible for the externalities. He says it is possible for both the cattle-raiser and the farmer to bargain to reach to the most efficient system where some amount of cattle raising and crop planting is possible costlessly or without transaction cost. This means the farmer and the cattle-raiser can agree in some bargain that is far better than the crops destroyed or the cattle fenced.

In addition to this, he tried to show above that if the bargain is reached, it does not make a difference whether the cattle-raiser is given the right to leave his cattle to roam in the crop and make the farmer pay for fencing and growing his crop or give the right for the farmer to grow crops and make the cattle-raiser pay for the damage of crops.

Taking Coase's theory of 'the problem of social cost' and trying to translate it to the ETS, it is clear that governments want to reduce emissions and industries want to pollute; that is the conflict of interest. Once again, should industries be responsible for their emissions or should governments stop imposing emission taxes when industries pollute? Or is there a middle ground where industries can pollute to some extent and governments can reduce emissions without any transaction cost?

According to Coase both the industries and governments are responsible for the externality and if governments and industries agree, the efficient way is that the government can put a cap on pollution and the industries can pollute with in the cap set but without any trading. This way the industries can still pollute and the governments reduce emissions, both are better of with this bargain than the increase in emissions or the pollution stopped. In theory this seems working but in reality it is not possible. Consider the case where a cap is placed and industries obey the cap set. If they exceed the permitted allowance, a pollution tax is implemented and industries are strictly regulated. In this scenario, the economic growth of nations will be weakened and backward, and the governments that wanted emissions reduction will not be satisfied with the outcome. That is the reason why governments cannot agree on a carbon tax.

Further, this bargain is theoretically identical whether you give polluting rights to the industries and force the government for the right to pay pollution taxes itself (find other costly ways to reduce emissions by planting trees, using CDM, developing low-carbon technologies or pay for reducing emissions) to fulfill its target, or whether you give the taxation rights for the government and force the industries to pay for polluting the environment.

In the EU ETS the Coase's theory of the problem of social cost has been paralleled but the one difference is the market based part of the EU ETS. I personally believe that the market element being implemented in the EU ETS is the one of the many aspects that makes the EU ETS fail to work properly as it was intended to.

3 RESEARCH METHODS

3.1 Choice of method

The method of research used for this research is qualitative data collection because the research is explanatory that provides information that is useful to understand the research question. Quantitative research is not used as this research is not carrying out experiments or testing an idea or hypothesis. The qualitative data collection method is used to evaluate the existing methodology and concepts can be applied to the research in question or new methodologies should be forged (Collins and Hussey 2009: p. 5)

A diverse variety of literatures have been used to carry out this research. Different academic and current secondary data such as books, journal articles, newspaper articles, reports, websites, inter-governmental and non-governmental institution's publications have broadened the spectrum of the research. There was slightly more leniency towards online resources for the ease of access to current data and institutional publications.

3.2 Use of the chosen method

A critical review of literatures on climate change, EU ETS and in general ETS has created the need for more research on how the ETS concept was developed. That led to research on Ronald Coase's theory of 'the problem of the social cost' that directly relates to the EU ETS. His theory and its understanding gave a clear idea on how the whole research project question should be considered and evaluated.

3.3 Limitations

There are limitations to this research.

Primary data could have been used but the nature of the research question would not allow that and as a result secondary data was implemented. The lack of technology and accurate measuring tools might result on misleading or distorted results when reporting the emission results. For the time being the data was measured with the current tools. Not only measuring tools but measuring methods might have also give a distorted figure. It is also very hard to predict the intentions of the authors in the literatures that are against the EU ETS.

In future when the technology is advanced and better measuring tools are designed, those tools may make it possible to have more accurate figures. Instead of measuring all greenhouse gases as carbon dioxide equivalent we would start to measure every greenhouse gas separately and have better, more precise figures and a truer measure of their impact on global warming.

3.4 Ethical consideration

The research is conducted ethically by taking an objective in depth review of the literatures in research. The research is conducted by reviewing literatures from proponents of the EU ETS namely European Union and that of the authors and institutions that are against the EU ETS. The data were analyzed and presented keeping objectivity and truthfulness.

4 ANALYSIS AND DISCUSSION

4.1 cap and trade

From this research it can be seen that the cap and trade system could not make a difference in reducing emissions mainly because the market-based part of the cap and trade system allowed companies to manipulate the system according to their needs that resulted in no tangible emissions reduction. The European Union might believe that it came up with a solution to reduce GHG emissions that is cost effective where polluting companies can keep polluting for cheaper but what is cheap now might cost greatly in the long term.

A result of industries lobbying and inadequate measurement abilities has led to over allocation of permits to industries. In addition permits were allocated based on previous trends of pollution. The biggest polluters are allowed to have the maximum amount of pollution permits (Gilbertson and Reyes 2009:10) and they are getting the benefit of polluting the most for much cheaper prices. The extra allowances one industry does not use can be sold to other industries so they too can avoid reducing their GHG emissions. If there are no strict regulations on emissions caps, there will not be reduction in emissions as a result of a useless system that failed to achieve its intended purpose.

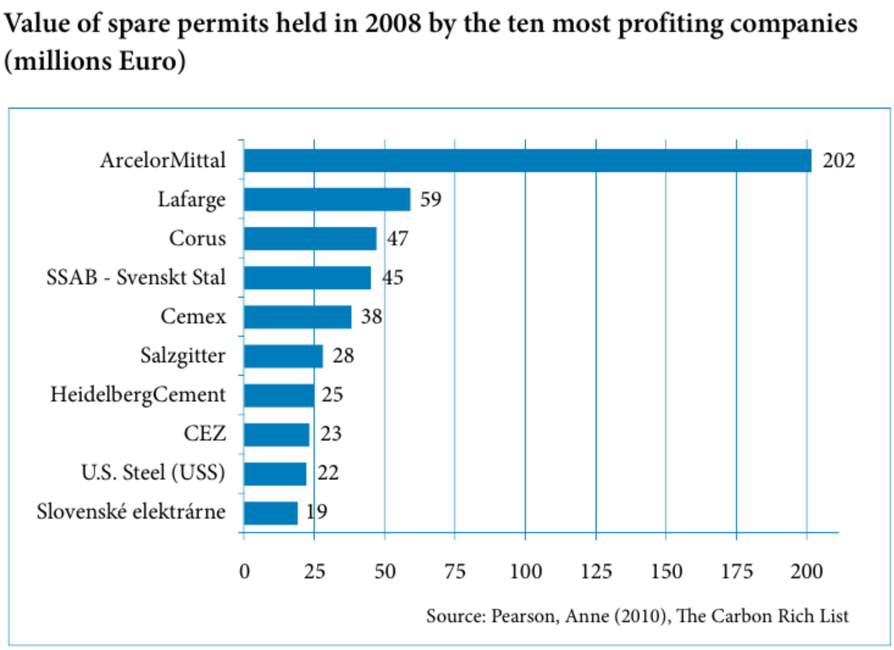

Figure 8 Value of spare allowances held in 2008

In Phase I of the EU ETS there were surplus permits given out that expired by the end of 2007. Once it was discovered that surplus permits had been granted in excess of the actual industries' needs, the price of permits crashed. The permits that were not used in Phase II can be transferred to Phase III. Because of the over allocation once again and the economic slowdown in 2008, companies have excess permits that they have not used in Phase II but can transfer to Phase III. The amount of transfer permits from Phase II to Phase III is equal to 14 times the emissions reduction reported in 2008 by the EU. (Kill et al. 2010:30) This clearly shows that there is a continued over allocation of permits being granted.

The other issue is that developing countries (countries that are not Annex 1) are not under any obligation to pay for allowances. This means industries in Annex 1 countries can set up their production facilities in developing countries that are not under obligation and still can pollute as much as they want.

4.2 Measuring greenhouse gases

There has been a study that different greenhouse gases affect the climate differently to different extents for different periods. Just for the sake of calculation, in the EU ETS all greenhouse gases are treated and generalized as one greenhouse gas 'carbon dioxide equivalent'. (Kill et al. 2010:24) Global Warming Potential (GWP) is an index that tries to show the different impacts of GHGs by calculating their global warming impact over 100 years by comparing it with CO_2. (UNFCCC 2014) To determine the six major GHGs as equivalent brings errors in calculations, which further bring inaccurate measurements in emissions.

IPCC guidelines for measuring GHGs show that there are uncertainties in calculating GHGs. The uncertainties for CO_2 are up to 10 per cent in electricity generation, cement and fertilizer production. Up to 60 per cent for land use change and forestry. For methane the uncertainty is higher and for nitrous dioxide it is 50 per cent for industrial processes. (Kill et al. 2010:25) One could simply imagine the uncertainty (error) of calculating GHGs added with the uncertainty of measuring the emissions from industries compared to the emissions reduction or even emissions reduction targets could cancel each other, if not the uncertainty in measurement could exceed.

The following table shows how different GHGs contribute to global warming differently.

Greenhouse gas	Pre-industrial concentrations*	2008 concentrations	Human source	GWP 100 years
Carbon dioxide (CO_2)	278 ppm	365 ppm	Fossil fuel combustion, land use changes, cement production	1
Methane (CH_4)	700 ppb	1745 ppb	Fossil fuels; rice paddies; waste dumps; livestock	25
Nitrous oxide (N_2O)	270 ppb	314 ppb	Fertiliser; industrial processes; fossil fuel combustion	298
Hydrofluorocarbons (e.g. HFC-23)	0	14 ppt	Liquid coolants	14,800**
Perfluorocarbons (e.g. CF_4)	0	80 ppt	Refrigerant; electronics industry and aluminium industry	6,500
Sulphur hexafluoride (SF_6)	0	4.2 ppt	Insulator in electronics and magnesium industry	22,800

* ppm, parts per million by volume; ppb, parts per billion by volume; ppt, parts per trillion by volume.

** This figure was changed in 2007 from 11,700 to 14,800.[25]

Figure 9 Varying effects of different GHGs

Source: Global Warming Potential UNFCCC

4.3 Carbon offsets

Offset projects like Clean Development Mechanism (CDM) or Joint Implementation (JI) are supposedly emissions reduction projects in theory but when they are seen in reality they actually have a potential to increase emissions. This can be seen in two ways, in a short-term perspective and in a long-term perspective.

In a short-term offsetting is not reducing emissions, it actually gives industries the right to pollute outside the cap. The idea of offsetting by itself is wrong in that it is imagining to have reduced emissions by placing an offset project and comparing it if the offsetting project would not have existed there would have been more increase in emissions. It does not necessarily mean that there is emissions reduction. In reality whether the projects are there or not the industries have increased their emissions.

> "… an idea which flows not from environmentalists and climate scientists trying to design a way to reverse global warming but from politicians and business executives trying to meet the demands for action while preserving the commercial status quo." (Davis 2007)

In a long-term perspective, assuming that the offset projects bring about emissions reduction, what needs to be seen is the effect of the project over a long period of time. If the offset project reduces emissions by 1 tonne just to produce 2 tonnes as a consequence of the offset project in 30 to 50 years is worthless. The rightful increase in emissions as a result of buying offset credits and the consequences of the bought (invested) offset projects over long period of time would not probably sum up to zero. Offsetting, whether in short-term or long-term weakens the notion for change towards clean environment and diminishes innovations leading to a low-carbon future. (Anderson 2012) An offset project will be truly low-carbon, only if its consequence does not lead to more emissions in the long-term.

4.4 The 'market based' solution and Neoliberalism

Carbon trading is set up in such a way that the biggest and largest polluters are rewarded with the most profit and their property rights unthreatened when it should be the other way around. (Gilbertson and Reyes 2009:17) Instead of reducing emissions, what it is set out to accomplish, carbon trading allows polluters to pollute as much as they want for a low-cost. Under the cap set or with other substitute mechanisms to get around the cap to pollute as much as before or even more than before carbon trading started is possible now and all this is possible because of 'market based' solution to emissions reduction.

In carbon trading the idea of a cap is to lower the allowances gradually so emission reduction can be achieved, but there is no deadline set for the complete discontinuation of the use of fossil-fuel. Despite the constant criticism and failures the EU ETS is to continue in its third phase with new reforms. This 'market based' solution would not have been so popular and stand against the criticisms and failures if it is not part of neoliberalism. Neoliberalism takes different forms to establish centralized global control, this time it takes the form of global warming trying to take emissions trading schemes global.

4.5 Transport sector

Transport accounts for almost one quarter of the GHG emissions in the EU making it the largest emission sector after energy. Even though other sectors have showed a decrease in emissions, the transport sector showed a constant increase until 2008. The efficiency of cars and the slow rate of growth in movement might have contributed to the decrease since 2008. Around two third of the emissions from the transport sector comes from land transport but the aviation and maritime sectors are also increasing rapidly. (European Commission Climate Action 2015c) Some studies show that the emissions from aviation from high altitude and its all radiation effects may exceed the radiation effect of CO_2 by a factor of 2.5. (Antes et al 2011: 87)

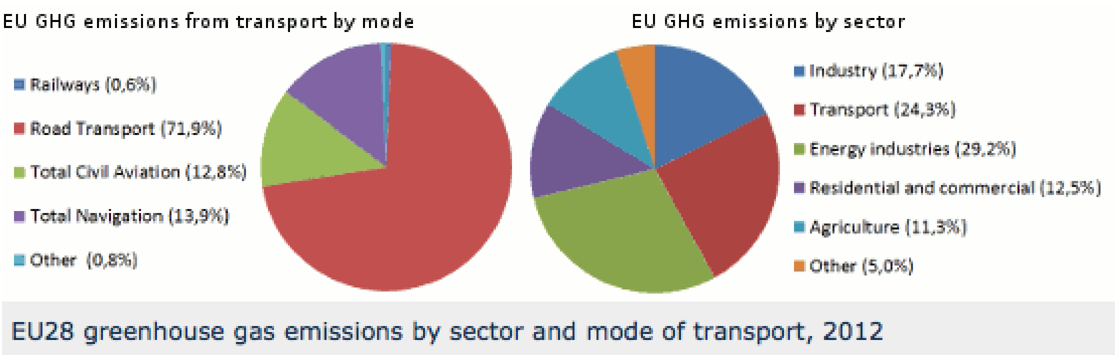

Figure 10 The EU GHG emissions by sector and mode of transport in 2012
Source: European union climate action: Transport

While the emissions from the transport sector are significant, why has nothing been done to reduce these except simple measures like CO_2 labeling of cars so that customers choose what car to buy and increasing the quality of fuels? Why did it take until 2012 to integrate the aviation sector in the EU ETS? Not that it is necessarily the right move to include aviation into the EU ETS because it is another way of expanding the system that has showed failure at least for a decade.

Even when the aviation sector joined the EU ETS its frame of reference was based on the emissions from 2004-2006 not the 1990 as for the other part of the EU ETS. (Gilbertson and Reyes 2009:48) This makes it easier for the aviation industry to keep emissions targets feasible than if calculations were based on 1990 aviation's emissions data. Another scenario would be to make the allowances given out in greater proportion once again so the aviation industry can sell the surplus emissions they might have and capitalize on that.

4.6 Overall emissions reduction

One of the main objectives of the EU ETS is to reduce emissions from polluting industries within the EU. There has been evidence that the emissions reduction reported by industries is somehow to make it look like emissions reduction was achieved. For instance calculating the amount of coal burnt instead of actually measuring the CO_2 emissions from the burned coal. (Fern 2013:6) Another point is that it is very difficult to say whether the emissions were actually reduced or moved to some place else. Since industries in the EU can outsource their production outside of the EU, they can claim that they have reduced their emissions in the EU but in reality they have increased their emissions and as a result global emissions have increased.

There was emissions reduction between 2008 and 2010 but this because of the economic crisis. The European Commission also admits in its report *The state of the European carbon market in 2012* that the results achieved in emissions reduction by 10% in 2008 are not only the direct result of the EU ETS but a major consequence of the economic crisis. (European Commission 2012:3)

Different studies show that there is not much evidence to show the relationship between the EU ETS and emissions reduction. (Fern 2013:6) Once again the rise in emissions in 2010 when the economy recovered favors the idea that emissions reductions were not achieved. The over allocation of allowances in Phase I led to 26 million tonnes more emissions than in 2005 in the EU.

Thinking analytically, and knowing how the emissions trading works, it is very clear that no emissions reduction would be achieved. The way the emissions trading is designed does not make it possible for emissions to be reduced. Consider a company is given some fixed allowance to pollute, then the company is introduced an option to pollute more by purchasing it cheaper from others, if that is not enough the company still has the possibility to invest in an imaginary project that is even more cheaper to pollute. What option the company has, to maximize its profit with the low-cost or to find a more expensive solution to reduce its emissions, of course it will buy cheap allowances and pollute even more. It is very much less likely for a company to invest in expensive, clean and low-carbon technology when there is a cheap and easy possibility to pollute more. That is the more logical and easy way that the EU ETS is shaping (promoting) for the pollutants. As a result of these options to pollute more and more it is unimaginable how to reach emissions targets.

4.7 Crime

The EU ETS has also been a target for fraud. This probably has emerged because not only the parties involved in the ETS can trade but also third parties that have no connection with ETS. There have been fraudulent activities in the emissions trading platform. It is reported that 90 per cent of the market is filled with fraudulent activities and as a result of this approximately 5 billion euros were lost from different national tax revenues. (Europol 2009) Criminals could easily trade and exchange carbon credits between member states where they can manipulate the difference in the levels of the value added tax and disappear with the money.

Fern (2013) wrote,

‟ The problems faced by the EU ETS in relation to fraudulent activity are yet another inherent weakness within any emissions trading systems that will forever leave it wide open to financial crimes. One key reason is the nature of the ‘commodity’ being traded. Carbon, unlike corn or oil- is not a tangible product. It is commoditized as a ‘permission to pollute in the future’ (permit); or ‘Promise that pollution will not happen’ (credit). In some ways these transactions resemble the medieval sale of indulgences more than a modern commodity trade. For both permits and credits, the measurement of whether the pollution has or has not occurred is estimated by proxy measures and other unsatisfactory methodologies."

4.8 EU ETS drives investment in low-carbon technologies

The EU ETS, other than being the key tool to reduce industrial GHG emissions cost effectively, also promotes investments in clean and low-carbon technologies. (European Commission Climate Action 2015a) Carbon prices have not been sufficiently high to promote investments in low-carbon technologies but rather designed in a way the high polluters could choose the low-cost alternative, being carbon trading, over the long-term investment in low-carbon technologies. (Kill et al 2010: 52) Carbon trading is also designed in such a way that emissions allowances or offset credits can be purchased cheaply meaning that it makes the action taken to go to low-carbon technologies slow.

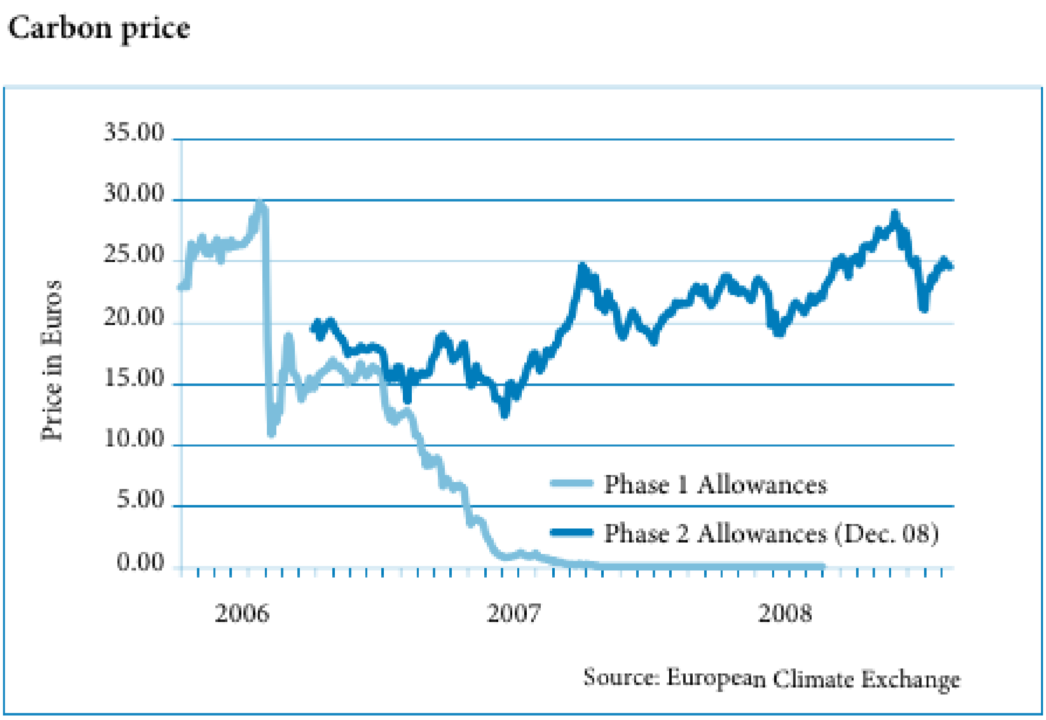

Figure 11 Carbon price between 2006-2008
Source: Trading carbon (Kill et al 2011:52)

Currently the EU uses more coal than it used in 2005. This might be as a result of USA is exporting more coal and that the price of coal has dropped. The fact that the price of the coal has dropped in the last five years gave an inclination to use coal in greater amount in EU. (Fern 2013:8) According to the authors Calel and Dechezlepretre (2012:4),

> " … Only 2 per cent of the post-2005 surge in low-carbon patenting can be attributed to the EU ETS… our findings suggest that, while EU ETS regulated firms have responded strongly, the scheme so far has had at best a very limited impact on the overall pace and direction of technological change. The EU ETS is expected to remain an integral part of the EU's strategy for building a low- carbon Europe but in its current form the EU ETS may not be providing incentives for low-carbon technological change on a large scale "

Figure 12 Dropping price of coal

Source: Financial times: coal prices

5 CONCLUSIONS

The purpose of this dissertation is to find out whether the EU ETS is the best tool to combat climate change. The research conducted in many levels shows that the EU ETS has many flaws and weaknesses even to the very design of the system in itself. The EU ETS is far from the best tool specially when climate change has been and still is a demanding issue that needs urgent and thoughtful attention. It is clear that human activities and their life styles have caused the risks and impacts we are about to face in the near future. There might still be a chance to save the planet from devastating consequences as a result of climate change but not by using a system full of flaws and not by simply giving it a major reform after trying it for a decade.

An analysis of the different aspects of the EU ETS has been carried out and discussed. For the EU ETS to work effectively (there is no guarantee that it would work efficiently even under the following suggestions) the pollution permits have to be cut/decreased significantly; the trading/ 'market based' part of the EU ETS has to be eliminated or it has to work only between sectors of the same kind and only institutions under the scheme can trade; greenhouse gases have to be treated/measured as how and to what extent they are affecting the atmosphere not as carbon dioxide equivalent; the idea of offset should be eliminated but governments of developed nations can still keep the offsetting projects as a precautionary measure for climate change; the transport sector should be included fully and regulated strictly; and there should be more developed and accurate systems and technologies to monitor and/or measure the emissions in all sectors. All these measures should be done in pressuring industries under the scheme to incentivize and use clean energy and low-carbon technologies but more importantly to put an end to the use of fossil fuel. Because setting up a goal/target is irrelevant unless there is a proper means or technology or system to control if the target is actually achieved and if there is no technology to control the targets set, then the system should not be set up in the first place.

The right move for European Union or the world, as Emissions Trading Schemes are in the process of implementation in different parts of the world, is to find an alternative way to combat global warming than to cling on emission trading schemes. The EU ETS should be regarded as an example of a system that is poorly designed at its core and that any reformation would not change its function.

Alternative necessary courses of action to combat global warming include:

Deep emission cuts

The only possible, reasonable and first thing to do for emissions to reduce is to cut emissions. The accumulated GHGs in the earth's surface can at least be maintained as they are only if we cut emissions now drastically other wise there will be more and more accumulated. This should be the first step and should be implemented using a system that does not allow any leniency.

Carton tax

If governments agree to implement carbon tax like they have on Emission Trading Schemes, it would give a spur and incentive to be more energy efficient and less polluting. (Wolf 2015)

Developing clean energy sources and low-carbon technologies

Strong investment in science and technologies to innovating and developing clean energy sources and low-carbon technologies are expected from governments. Not only developing them but also making use of them in an international level by spreading the availability of the technologies globally is important.

The use of land to cool the earth

The use of land to cool the planet is something that should not be ignored easily. Techniques like enriching soil carbon, creating high-carbon cropping systems, promoting climate-friendly livestock production systems, protecting existing carbon stores in natural forests and grasslands and restoring vegetation in degraded areas are some of the measures that can be taken to cool the planet. (Worldwatch Institute 2009)

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APPENDIX 3: Key terms and concepts

UNFCCC	United Nations Framework Convention on Climate Change
ETS	Emissions Trading Scheme (System)
EU ETS	European Union Emissions Trading Scheme (System)
GHG	greenhouse gas
NGO	Non-governmental Organizations
IPCC	Intergovernmental Panel on Climate Change
GWP	Global Warming Potential
CDM	Clean Development Mechanism
CO2e	Carbon Dioxide Equivalent
JI	Joint Implementation

Annex 1 countries – in Kyoto Protocol countries under obligation to reduce their emissions when they sign the agreement.

Carbon permits – carbon dioxide emission permits allowed in cap and trade.

Offsets – projects that save emissions in developing countries sponsored by developed countries.

Carbon credits – refers to carbon offsetting, the value of an emissions permit granted for participating in an offset project.

Externality – actions of a firm or a business transaction that has harmful effect on others that are not involved in the transaction.

Cap and trade – emission permits or allowances that can be traded between industries or nations.

Carbon tax – per unit tax on goods and services based on the quantity of carbon dioxide emitted during production or consumption process.

Transaction cost – a cost incurred in making an economic exchange. (the cost of participating in the market) the payments banks and brokers receive for their role in the transaction.

Clean development mechanism – A part of the Kyoto Protocol that allows developed countries to get credit for helping developing countries in projects that reduce emissions.

APPENDIX 1: GHGs Global Warming Potentials

Species	Chemical formula	Lifetime (years)	Global Warming Potential (Time Horizon)		
			20 years	100 years	500 years
CO_2	CO_2	variable §	1	1	1
Methane *	CH_4	12±3	56	21	6.5
Nitrous oxide	N_2O	120	280	310	170
HFC-23	CHF3	264	9100	11700	9800
HFC-32	CH2F2	5.6	2100	650	200
HFC-41	CH3F	3.7	490	150	45
HFC-43-10mee	C5H2F10	17.1	3000	1300	400
HFC-125	C2HF5	32.6	4600	2800	920
HFC-134	C2H2F4	10.6	2900	1000	310
HFC-134a	CH2FCF3	14.6	3400	1300	420
HFC-152a	C2H4F2	1.5	460	140	42
HFC-143	C2H3F3	3.8	1000	300	94
HFC-143a	C2H3F3	48.3	5000	3800	1400
HFC-227ea	C3HF7	36.5	4300	2900	950
HFC-236fa	C3H2F6	209	5100	6300	4700
HFC-245ca	C3H3F5	6.6	1800	560	170
Sulphur hexafluoride	SF6	3200	16300	23900	34900
Perfluoromethane	CF4	50000	4400	6500	10000
Perfluoroethane	C2F6	10000	6200	9200	14000
Perfluoropropane	C3F8	2600	4800	7000	10100
Perfluorobutane	C4F10	2600	4800	7000	10100
Perfluorocyclobutane	c-C4F8	3200	6000	8700	12700
Perfluoropentane	C5F12	4100	5100	7500	11000
Perfluorohexane	C6F14	3200	5000	7400	10700

§ Derived from the Bern carbon cycle model.

* The GWP for methane includes indirect effects of tropospheric ozone production and stratospheric water vapour production.

Source: UNFCCC GHG data

APPENDIX 2: GHG Emissions from Land Use

Box 3–1. Greenhouse Gas Emissions from Land Use

Carbon dioxide (77 percent), nitrous oxide (8 percent), and methane (14 percent) are the three main greenhouse gases that trap infrared radiation and contribute to climate change. Land use changes contribute to the release of all three of these greenhouse gases. (See Table.) Of the total annual human-induced GHG emissions in 2004 of 49 billion tons of carbon-dioxide equivalent, roughly 31 percent—15 billion tons—was from land use. By comparison, fossil fuel burning accounts for 27.7 billion tons of CO_2-equivalent emissions annually.

Deforestation and devegetation release carbon in two ways. First the decay of the plant matter itself releases carbon dioxide. Second, soil exposed to the elements is more prone to erosion. Subsequent land uses like agriculture and grazing exacerbate soil erosion and exposure. The atmosphere oxidizes the soil carbon, releasing more carbon dioxide into the atmosphere. Application of nitrogenous fertilizers leads to soils releasing nitrous oxide. Methane is released from the rumens of livestock like cattle, goats, and sheep when they eat and from manure and water-logged rice plantations.

Naturally occurring forest and grass fires also contribute significantly to GHG emissions. In the El Niño year of 1997–98, fires accounted for 2.1 billion tons of carbon emissions . Due to the unpredictability of these events, annual emissions from this source vary from year to year.

Land Use	Annual Emissions (million tons CO_2 equivalent)	Greenhouse Gas Emitted
Agriculture	6,500	
Soil fertilization (inorganic fertilizers and applied manure)	2,100	Nitrous oxide*
Gases from food digestion in cattle (enteric fermentation in rumens)	1,800	Methane*
Biomass burning	700	Methane, nitrous oxide*
Paddy (flooded) rice production (anaerobic decomposition)	600	Methane*
Livestock manure	400	Methane, nitrous oxide*
Other (e.g., delivery of irrigation water)	900	Carbon dioxide, nitrous oxide*
Deforestation (including peat)	8,500	
For agriculture or livestock	5,900	Carbon dioxide
Total	15,000	

* *The greenhouse gas impact of 1 unit of nitrous oxide is equivalent to 298 units of carbon dioxide; 1 unit of methane is equivalent to 25 units of carbon dioxide.*
Source: See endnote 4.

Source: State of the world 2009